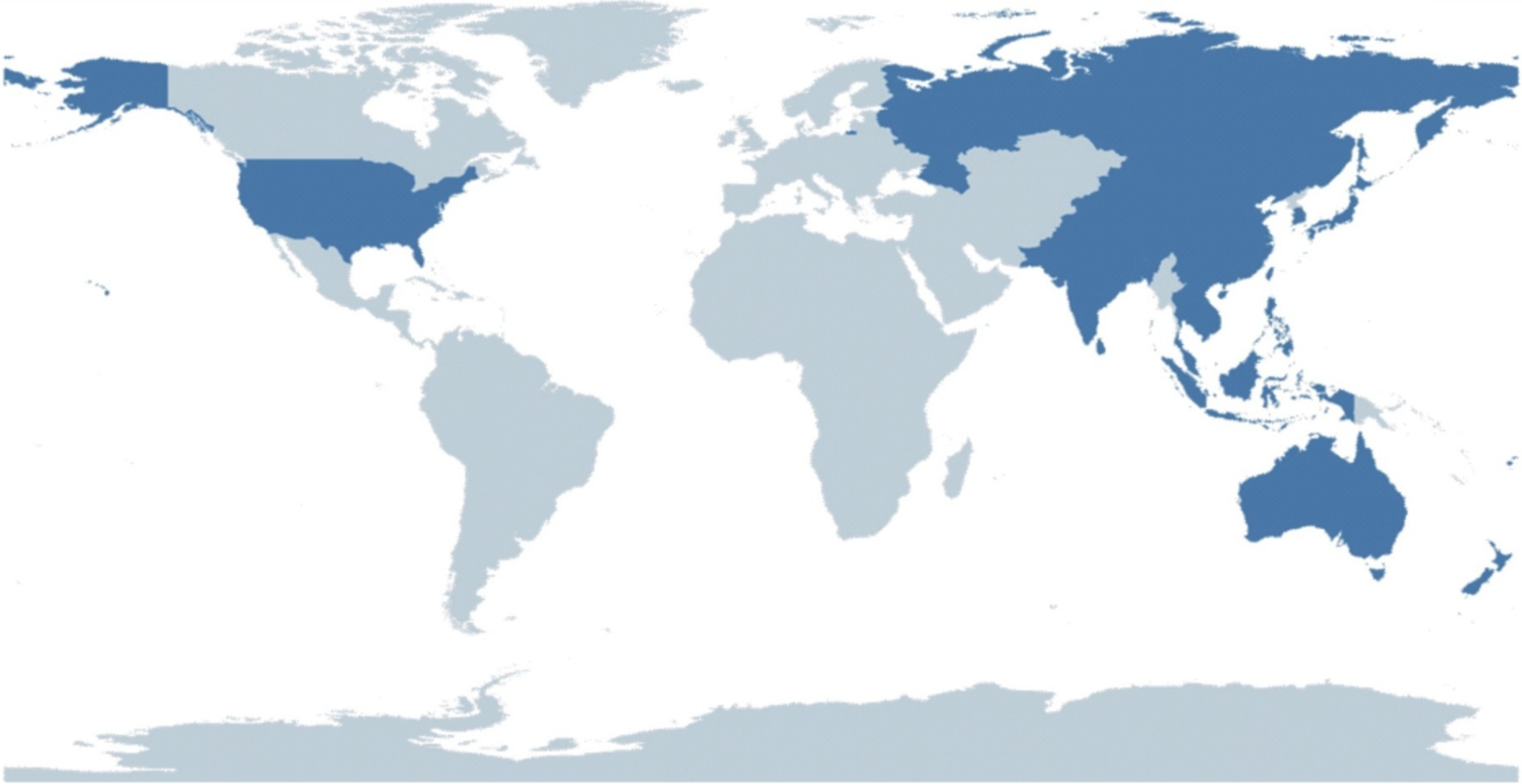
FINAL REPORT for APN PROJECT
Project Reference: CBA2010-11NSY-DeGuzman



Capacity Building for Research and Monitoring of Marine Protected Areas: An Adaptive Mechanism for Climate Change in the Asia-Pacific Region

The following collaborators worked on this project

Asuncion B. de Guzman, Mindanao State University at Naawan & MSUN Foundation for Science & Technology Development, Inc., Philippines, *sony_deguzman@yahoo.com*

Ruddy Suwandi, Center for Coastal and Marine Resource Studies, Bogor Agricultural University Bogor, Indonesia, *rdsuwandi@yahoo.com*

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Final Report submitted to APN

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OVERVIEW OF PROJECT WORK AND OUTCOMES

Minimum 2pages (maximum 4 pages)

Non-technical summary

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Marine protected areas are considered potential measures for climate change adaptation, particularly in increasing the resilience of coral reefs to bleaching and loss of biodiversity due to changing environmental conditions. Effective MPA management, however, is constrained by weak monitoring programs due to inadequately trained manpower. The project *"Capacity Building for Research and Monitoring of Marine Protected Areas: An Adaptive Mechanism for Climate Change in the Asia-Pacific Region"* under the APN CaPaBle Programme contributes to building local and regional capacity for MPA monitoring. Developing a pool of capable MPA monitors in selected coral reef-rich countries in the Asia-Pacific region is a means of improving MPA governance and increase their ability to adapt to climate change, human-induced stresses and other environmental effects. The project was implemented by the Mindanao State University at Naawan Foundation for Science and Technology Development, Inc (MSUNFSTDI) in collaboration with the Center for Coastal and Marine Resource Studies of the Bogor Agricultural University in Bogor, Indonesia. The project implemented two training courses: a Local Training course attended by 20 participants from the Philippines, and a Regional Training course that benefitted 20 participants from Indonesia, Thailand, Vietnam, Timor Leste, and the Philippines.

Objectives

The main objectives of the project were:

1. enhance the capacity of MPA researchers through technical training in coral reef, seagrass, and mangrove assessment and monitoring;
2. train participants in data management, report preparation and communication of results; and
3. assist participants in formulating an MPA monitoring and evaluation plan.

Amount received and number years supported

The Grant awarded to this project was US$ 35,600 for Year 1.

Activities undertaken

The project conducted two training courses that benefitted a total of 40 certified scuba divers from academic institutions, local government units, non-government organizations, and government line agencies involved in MPA monitoring. The Local Training component of this capacity building project was a 5-day training program conducted on August 23-27, 2010 at the Mantangale Alibuag Dive Resort in Balingoan, Misamis Oriental in Mindanao Island, southern Philippines. The Regional Training was held on 26-30 November 2010 at the Salagdoong Resort in the municipality of Maria in Siquijor Island, central Visayas, Philippines. The project also produced an MPA Training Manual which was used during the two training courses. A Post-Training Evaluation was conducted between April and May 2010 as a means of determining the impact of the training courses on manpower development for improved MPA governance in the Asia-Pacific region. This included a meeting held at the Center for Coastal and Marine Resource Studies (CCMRS) of the Bogor Agricultural University (Bogor IPB) in Bogor, Indonesia and a field visit to Pari Island MPA near Jakarta being monitored by IPB faculty who attended the Regional Training course.

Results

The training courses were conducted by a team of experienced scuba divers and specialists in MPA monitoring from the Mindanao State University at Naawan and the University of the Philippines in Mindanao. The Local Training was attended by 20 participants from four academic and research institutions, four local NGOs, and five Local Government Units in Mindanao, including a mayor from a remote town in Mindanao that implements several MPA projects. The Regional Training was attended by 20 participants from five countries in the Asia-Pacific Region, namely, Indonesia (8 participants), Thailand (3), Vietnam (2), Timor Leste (1), and Philippines (6). Majority of the participants (55%) hold various positions in academic institutions, others in government agencies, NGOs, and LGUs and are all certified scuba divers. Both training courses had a lecture, field assessment, data management and reporting components. The training modules used in both courses cover standard techniques in monitoring of coral reefs, seagrass beds, and mangrove forests. A technical report was prepared by the participants using data gathered during the field monitoring activities in both training courses. Participants also drafted monitoring plans for their respective MPAs. A post-training evaluation evaluation conducted toward the end of the project showed that around 42% of the participants were actively involved in MPA monitoring activities following their graduation from the two training courses under the project.

Relevance to the APN Goals and Science Agenda, Scientific Capacity Development and Sustainable Development

This capacity building project was implemented in response to the need to build local and regional capacity for environmental monitoring that integrates scientific approach in data gathering and proper data handling in order to evaluate the status of important intervention projects such as MPAs. While participatory coastal resource assessment (PCRA) approaches are fast and easy, they often do not obtain enough scientific information to document the beneficial effects of MPAs in terms of enhancing biodiversity and biomass and habitat improvement in coastal ecosystems placed under protection. Overall, the project has enhanced the monitoring skills of the participants for improved scientific evaluation of MPA projects in their respective countries. More importantly the training program has advocated the critical importance of regular monitoring, standardization of methods, and increasing accuracy and consistency in biophysical assessment of different habitats within the MPA. Sustaining local and regional efforts in technical monitoring and evaluation would improve MPA governance and contribute to sustainable reef management in the Asia-Pacific region.

Self evaluation

The project was originally conceived to provide an advanced level of training in MPA monitoring and evaluation, thus, only certified scuba divers who have been assisting MPA projects in their respective countries were admitted into the training. Contrary to expectations and care in screening and qualifying of participants for the two training courses, some participants had very little preparation to undertake a training in scientific assessment of coastal habitats and marine protected areas. Performance of participants in diving-related work was very variable – some with excellent diving skills while others with very little experience and had to deal with scuba diving issues such as buoyancy and pressure problems. A few came to the training with sufficient experience in coral reef, seagrass, and mangrove monitoring and the training enhanced their skills in data management and reporting. Majority had very little skill to begin with, especially in accurately identifying coral lifeforms and fish species underwater. Toward the end of the training courses field performance was much improved, yet many of them need to improve on their reef fish identification in order to accurately report biodiversity and biomass inside the MPA. The post-training evaluation conducted in May 2011 showed that only about 42% of the graduates of the training courses can be considered to have the confidence and skill needed in doing regular MPA monitoring work. Future capacity building projects along this line should consider increasing the period and scope of training to improve monitoring skills of participants. Despite these limitations, however, through the two training courses the project has contributed to developing a pool of experts in biophysical monitoring of MPAs in five countries. Graduates of these courses would hopefully use their skills in implementing a regular monitoring and evaluation program for the MPAs they assist.

Potential for further work

An important realization of this project is that building capacity for scientific monitoring of MPAs that requires a good combination of diving skills and technical ability for detailed biodiversity and ecological monitoring cannot be achieved within a short time. This capacity building project, therefore, has need for a series of skills development, each one more advanced than the other so that the goal of developing a pool of expert MPA monitors and multiplying this to create more will be realized. In light of climate change, more issues emerge that require monitoring ability, such as increased frequency of bleaching events and prevalence of coral diseases. Monitoring coral reef health will require more funding but its expected outcome is improved MPA governance through providing science-based adaptive management.

Publications (please write the complete citation)

De Guzman, A.B., Abrea, R.A., Nañola, C.L. and W.H. Uy. 2010. Monitoring Marine Protected Areas in the Asia-Pacific Region: A Training Manual. Asia-Pacific Network for Global Change Research and MSU Naawan Foundation for Science and Technology Development, Inc. 65p.

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Uychiaoco, A.J., S.J. Green, M.T. dela Cruz, P.A. Gaite, H.O. Arceo, P.M. Aliño and A.T. White. 2010. Coral Reef Monitoring for Management (2nd ed). University of the Philippines Marine Science Institute, UNEP, GEF-Small Grants Program, Guiuan Development Foundation Inc., Voluntary Service Overseas, UP-CIDS,USAID-CRMP, FISH and EcoGov Projects. 124 p.

Acknowledgments

This project is a fruitful collaboration between the Asia-Pacific Network for Global Change Research (APN) and two academic institutions, namely, the Mindanao State University at Naawan Foundation for Science and Technology, Inc. (MSUNFSTDI) and the Center for Coastal and Marine Resource Studies (CCMRS) of the Bogor Agricultural University in Bogor, Indonesia. We gratefully acknowledge the generous funding from APN under the CaPaBle Programme, the administrative support and fund management provided by the MSUNFSTDI and MSU at Naawan, and the assistance and facilitation of Dr. Tridoyo Kusumastanto, Dr. Ruddy Suwandi and Ms. Isdahartatie of CCMRS-Bogor IPB in organizing the Regional Training; the assistance of Renoir Abrea, Dr. Wilfredo Uy, Cleto Nañola, Eugene Moleño, Jerry Garcia and Avril De Guzman-Madrid in the conduct of the training courses, and of Ramon Francisco Padilla in providing most of the legwork for the project. We are eternally grateful for the generous support of the Provincial Government of Siquijor in providing facilities and equipment and in assistance in field coordination by Daryll Pasco and his colleagues.

TECHNICAL REPORT

Minimum 15-20 pages (excluding appendix)

Preface

Aside from maintenance of fish stocks and critical spawning biomass, marine protected areas are considered potential measures for climate change adaptation, particularly in maintaining high biodiversity, buffering the effect of increasing ocean temperatures on coral bleaching, and hastening recovery from climate-induced stresses and overfishing. Effective MPA management, however, is constrained by weak monitoring programs often due to inadequate manpower. Building the capacity of MPA managers in the Asia-Pacific region for scientific research and monitoring and effective feedbacking is critical in convincing policy makers to increase support for MPAs as a cost-effective adaptation measure.

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1.0 Introduction

Global climate change is expected to have profound effects upon habitat health and biodiversity of marine ecosystems and its associated fisheries which will undoubtedly affect local communities dependent on these resources. Several incidents of coral bleaching observed in many Philippine coral reefs in the last 20 years have been associated with increasing ocean temperatures (WorldFish Center, 2005). More recently, increasing sea surface temperature (SST) has also been associated with disease outbreaks in corals of many tropical reefs (Raymundo and Calvell, 2008). Capture fisheries of shallow coastal ecosystems such as coral reefs are most vulnerable to effects of changing climates, thus, threatening the livelihood and economic well-being of coastal communities, particularly of poorer countries. Establishment of MPAs and MPA networks have been linked to possible adaptation of coral reef systems to natural disturbances such as global climate change (Aliño et al., 2004). MPAs are perhaps the most effective mechanism for conserving marine biodiversity, which is why a large number of MPAs have sprouted in archipelagic states such as the Philippines and Indonesia (Cheung et al., 2002). A monitoring report on coral bleaching (Arceo et al., 2002) stresses on the importance of effective management of MPA networks as adaptive mechanisms to hasten recovery of coral reefs from coral bleaching events.

Marine protected areas are considered potential measures for climate change adaptation, particularly in buffering the effect of coral bleaching and in sustaining coastal fisheries. Under strict protection MPAs enhance marine biodiversity which, in turn, increases ecosystem resilience and hastens recovery from both climate-induced stresses and overfishing. Effective MPA management, however, is often constrained by lack of funds, weak law enforcement, and lack of monitoring. Many coastal LGUs in the Philippines have invested heavily on the establishment of MPAs but do not have adequately trained manpower to undertake a regular monitoring program and feedbacking on the status of these management interventions. Capacity building of MPA managers, LGU and NGO staff, and academic personnel in biophysical monitoring of MPAs can improve MPA governance by providing scientific information for policy makers.

The main objectives of the project were:

1. enhance the capacity of MPA researchers through technical training in coral reef, seagrass, and mangrove assessment and monitoring;
2. train participants in data management, report preparation and communication of results; and
3. assist participants in formulating an MPA monitoring and evaluation plan.

2.0 Methodology

The Local and Regional Training courses covered a wide variety of research and monitoring techniques in evaluating the bio-physical condition of MPAs as an adaptive mechanism for climate and global changes. These are included in the following training modules:

- Introduction to MPA Monitoring for Global Change
- Monitoring Techniques in Coral Communities/Benthic Lifeforms
- Monitoring Fish Communities
- Monitoring Seagrass Communities
- Monitoring Mangrove Communities

Each module contained lectures on ecological importance of the particular habitat and associated resources, monitoring techniques to detect changes in community structure, actual field assessment to gather data on the resource, and data management and analysis. A training manual was produced by the project containing standard and emerging techniques in assessment and monitoring of coastal habitats, as follows:

1. Coral communities - *Line Intercept Technique* and *Digital Photo-transect Technique and an introduction to monitoring coral diseases*
2. Reef fish communities - *Daytime Fish Visual Census technique*
3. Seagrass communities – *Transect-Quadrat* and *Belt method*
4. Mangrove communities – *Transect-Plot method*

In both training courses, a preliminary dive was conducted outside the MPA to allow the training participants to adjust buoyancy and practice underwater identification of coral lifeforms and fish species. Participants were grouped into coral/LIT and FVC teams in alternating dive schedules in order to optimize the use of scuba equipment .

In the Local Training, actual assessment of coral and fish communities was conducted in reefs inside the MPA and in a non-MPA site in Sipaka Point (Table 1). The inside-outside comparison is now the standard protocol in evaluating the efficacy of MPAs in improving coastal habitats and resources after years of protection. During field work participants were also asked to record incidences of coral bleaching and diseases which are telltale signs of climate-associated stress on coral reefs.

Table 1. Location of field activities of the Local Training in MPA monitoring.

Ecosystem	Name of MPA/Site	Location
Coral Reef	Cantaan Marine Sanctuary Duka Marine Sanctuary Sipaka Point Reef	Municipality of Guinsiliban, Camiguin Province; Municipality of Medina, Misamis Oriental; Municipality of Talisayan, Mis. Oriental
Seagrass	Mantangale Reef Flat	Municipality of Medina, Misamis Oriental
Mangrove	Mantangale Mangrove Forest	Municipality of Medina, Mis. Oriental

The Regional Training course held in Siquijor Island, Central Visayas, Philippines had a special component which is a presentation by country representatives of their experiences in MPA monitoring. The field component of the Regional Training was conducted for three days in various MPA sites in Siquijor Island. Diving activities were facilitated by the Coco Groove Resort in San Juan, Siquijor and the Provincial Government of Siquijor which provided some of the scuba equipment for the training. Assessment of coral and fish communities was conducted in two MPA sites in the municipality of San Juan while the mangrove and seagrass assessment were conducted in other areas (Table 2).

Table 2. Location of field activities under the Regional Training in MPA monitoring in Siquijor province.

Ecosystem	Name of MPA/site	Location
Coral Reef	Tubod Marine Sanctuary Maite Marine Sanctuary	Municipality of San Juan, Siquijor
Seagrass	Minolulan Reef Flat	Municipality of Maria, Siquijor
Mangrove	Tulapos Mangrove Sanctuary	Municipality of Enrique Villanueva, Siquijor

After each field day the participants were taught how to manage and analyze data, and to prepare a simple monitoring report which they presented on the last day of the training. A brief workshop was conducted on the last day, dividing the participants into geographic groups which then drafted an MPA Monitoring and Evaluation Plan for their respective bay, province, or country. A Post-Training Evaluation was conducted to obtain update on the participants' progress in MPA monitoring of their respective sites.

3.0 Results & Discussion

Participants' Profile

Local Training. The Local Training was attended by 20 participants representing various institutions and organizations in Mindanao (Fig. 1). Participants from government line agencies were staff assigned to coastal resource management (CRM) of the BFAR in two administrative regions. Four academic and research institutions, four local NGOs, and five LGUs were represented in the training, including a municipal mayor of the remote town of Tabina, Zamboanga del Sur which implements several MPA projects.

The participants ranged in age from 20-50 years old (Fig. 2), the male slightly exceeding (55%) female participants. All participants were certified SCUBA divers, a prerequisite of applicants for the training in coral reef monitoring. Majority (70%) of the participants had been involved in bio-physical monitoring of MPAs, but only a few adopted the standard scientific monitoring methods. Among LGUs and NGOs the most popular approach to MPA monitoring is the use of PCRA tools (e.g. snorkeling methods) that the community can easily adopt but fail to produce detailed information on reef community attributes such as coral and fish diversity, population density and biomass estimates. Participants were mainly motivated by the need to enhance their knowledge and skills in evaluating the effectiveness of MPAs in coastal habitat improvement and resource enhancement.

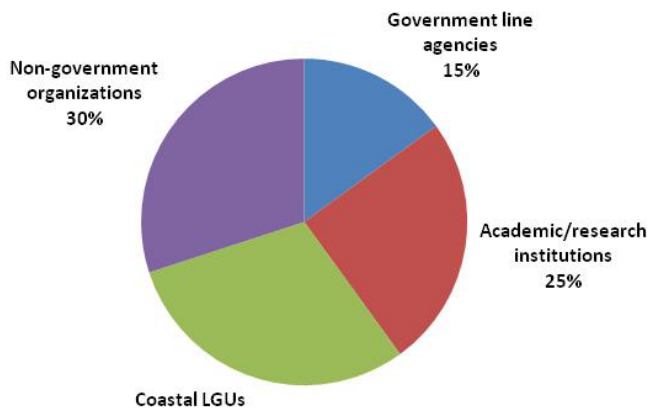


Fig. 1. Institutional profile of participants of the Local Training in MPA research and monitoring.

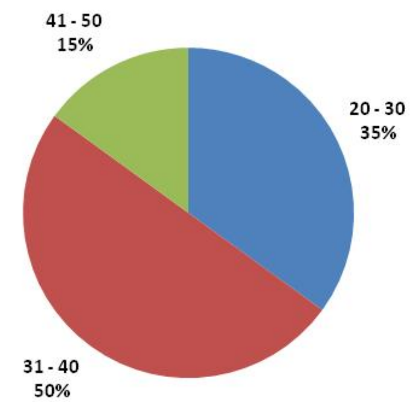
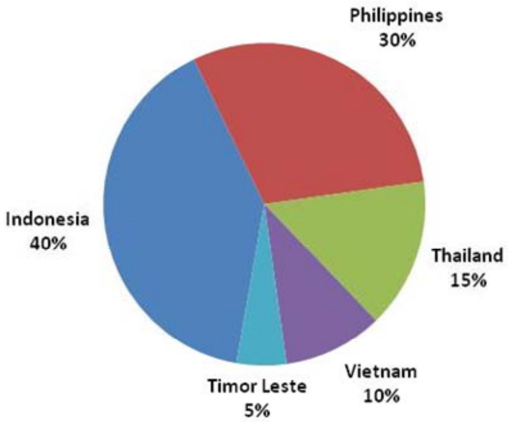


Fig. 2. Age profile of participants of the Local Training in MPA research and monitoring.

Regional Training. The training was attended by 20 participants from different countries in the Asia-Pacific Region, namely, Indonesia (8 participants), Thailand (3), Vietnam (2), Timor Leste (1), and Philippines (6). Majority of the participants (55%) hold various positions in academic institutions, others in government agencies, NGOs, and LGUs and are all certified scuba divers (Fig. 3). Many of them work closely with MPAs as managers or involved in technical monitoring of coral, fish, and other resources inside the MPAs. Others are involved in academic research, provide technical support to LGUs, or promote tourism in connection with their MPA projects.



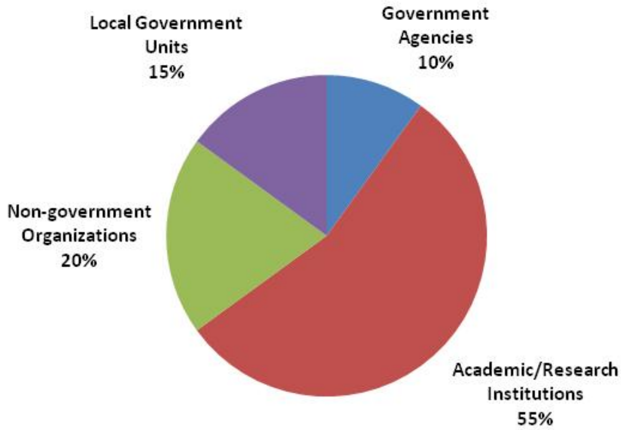
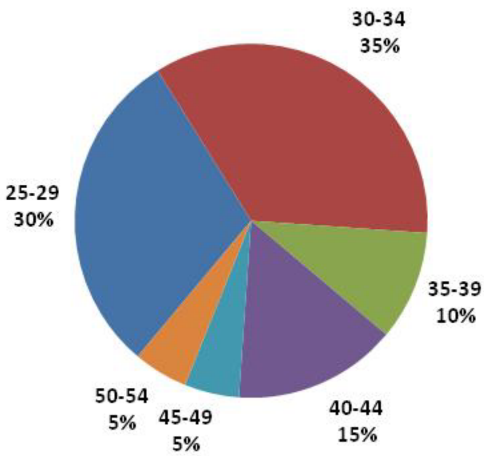


Figure 3. Country of origin (left) and institutional representation (right) of participants in the regional training.



Most of the participants (75%) of the regional training were young (25-39 years old) researchers and staff from academic institutions, government agencies, and NGOs (Fig. 4). This time, the male participants exceeded the females by 15:5, an upset readily explained by the higher proportion of male researchers who are trained scuba divers working in coral reefs in most countries.

Figure 4. Age profile of participants in regional training in MPA monitoring.

Outputs of Local and Regional Training Courses

The Local Training and Regional Training courses in MPA monitoring have two important outputs, namely, a technical monitoring report based on data on selected MPAs collected by training participants and draft MPA monitoring plans drawn from the group outputs during the final day workshop.

Local Training Output

Biophysical Monitoring Report on Selected MPAs

The following report presents a profile on the status of coral and fish communities in two reef sites in Misamis Oriental: Duka Bay MPA in the municipality of Medina and Sipaka Point reef in the municipality of Talisayan, a non-MPA site. Assessment of benthic lifeform cover was made using the Line Intercept Technique (LIT) while survey of fish communities was accomplished through the Daytime Fish Visual Census (FVC) technique described by English et al. (1997) and widely used in reef assessment (Fig. 5).

Figure 5. Field activities of the local training course. Clockwise from left to right: Trainers brief training participants on field work; check-out dive to test buoyancy and adjust pressure;demonstration on conduct of LIT and FVC; and trainees conduct mangrove assessment.

Live or hard coral cover in the unprotected Sipaka reef was generally poor (mean cover of 21%) based on the categories of reef status established by Gomez et al. (1981). Most of the living coral was of the non-*Acropora* type (18.09%) while *Acropora* corals made up only 2.68 % of the reef (Fig. 6). The Duka MPA, on the other hand, had a higher hard coral cover (36%), although dead coral (28%) was also higher than in Sipaka Reef (21%). In both sites massive coral was the most abundant growth form while branching coral was quite rare. The high proportion of abiotics, made up mostly of coral rubble, in Sipaka (43%) suggests that the reef had sustained much damage in the past, either from storm surges or blastfishing prevalent in Mindanao reefs.

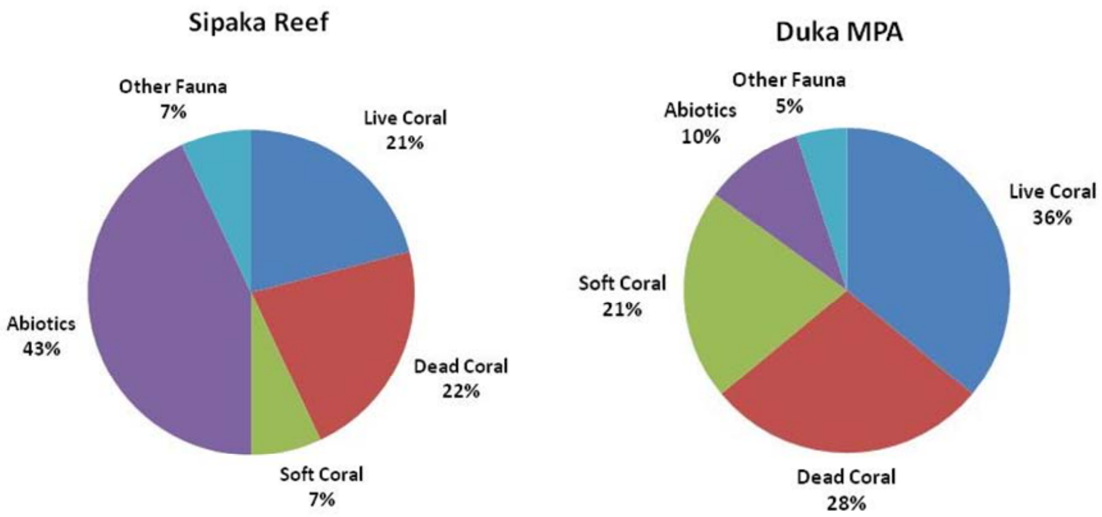


Figure 6. Comparison of benthic lifeform attributes between an unprotected reef (Sipaka Reef) and an established MPA (Duka).

Reef Fish Communities

The fish community in Sipaka reef consisted of 52 species belonging to 11 families of reef fishes, dominated by colorful but tiny damselfishes belonging to Family *Pomacentridae* (55%) and fairy basslets belonging to Family Serranidae:SubFamily Anthiinae (35%). A more diverse fish community was found inside the Duca MPA with 107 species belonging to 20 families (Table 3). Damselfishes also dominated (72%) the reef inside the Duca MPA but at higher density than in Sipaka reef. Other families of reef fish occurred at very low densities (Fig. 7).

Table 3. Comparison of fish community attributes between an unprotected (Sipaka Reef) and protected (Duca MPA) reef.

Reef Site	Species Richness (No. Species/1000m2)	Abundance (No. Indiv./1000m^2)	Biomass (kg/1000m^2)
Sipaka Reef	52	953	16.98
Duca MPA	107	1635	50.39

Results show that the MPA in Duca is superior to the unprotected Sipaka Reef based on various fish community attributes of species richness, abundance and biomass. Species richness in Sipaka Reef is considered moderate while that in Duca MPA is high according to categories in Aliño and Dantis (1999). Both sites had moderate abundance but biomass in Duca MPA is considered high while that in Sipaka Reef is just moderate based on categories set by Hilomen et al. (2000).

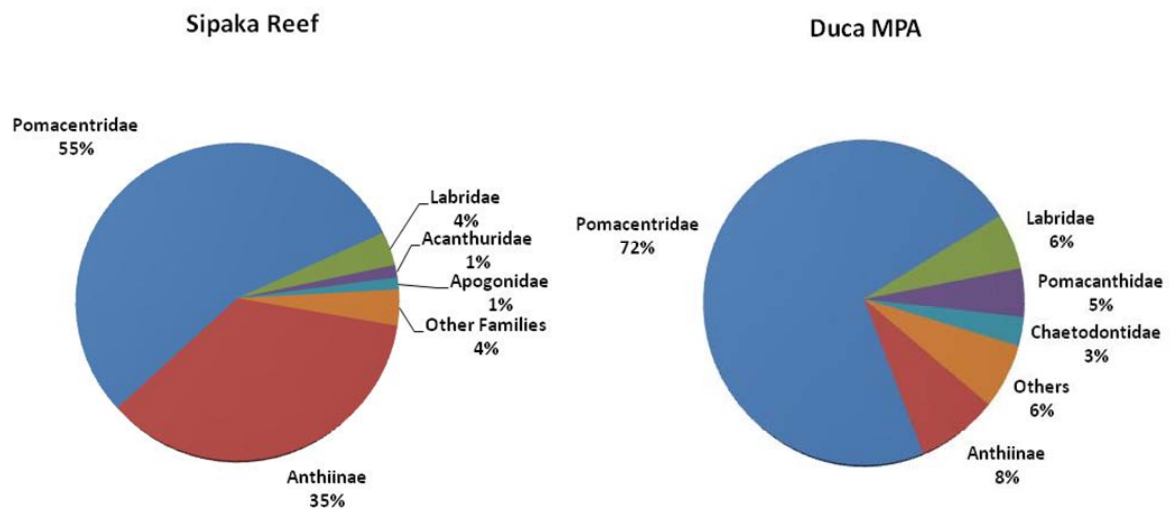


Figure 7. Top five most abundant families of reef fish in the unprotected Sipaka Reef and Duca MPA.

The amount of available fish biomass on the reef is an important indicator of the success of marine protected areas, also known as 'no take areas', in enhancing fish community structure as it combines the parameters of population density and body size. Fish biomass is a function of body size and density of fish in a given area. Reef fish are generally grouped into three categories: target food fishes which are often predators, indicators of healthy reefs, and the commonly abundant demersal fishes. From Figure 8 it is apparent that in each of the three categories the reef fish community inside Duca MPA had much higher biomass than Sipaka, particularly of target food fishes – an expected outcome when no fishing is allowed. In 'to take areas' fish can grow to their maximum size and attain the largest biomass.

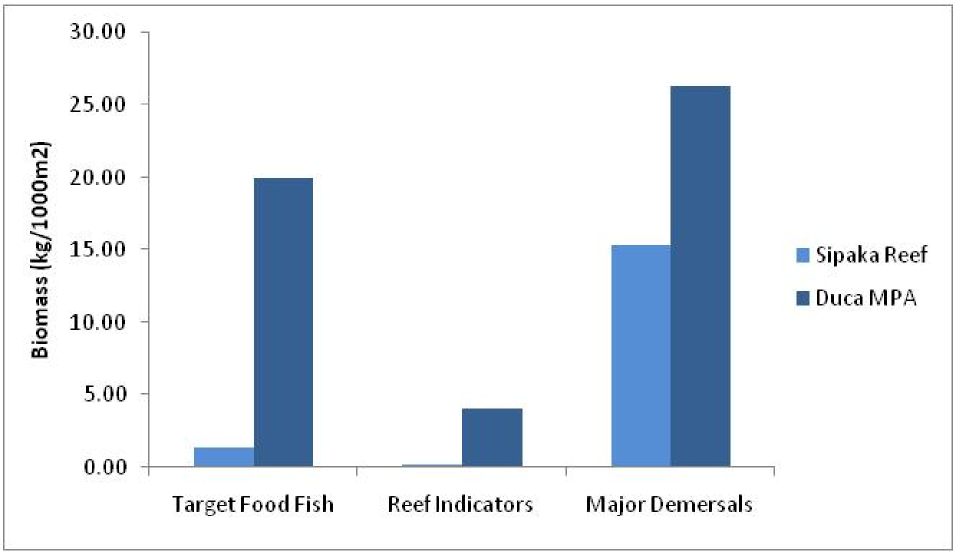


Figure 8. Comparison of fish biomass between an unprotected and protected reef in Misamis Oriental, Philippines.

MPA Monitoring and Evaluation Plan

The planning workshop conducted on the last day of training generated eight MPA monitoring and evaluation (M&E) plans for their respective geographical origin (Appendix A). The plans vary in scope and budgetary requirements according to the technical capability and access to funding of each group.

Regional Training Output

Biophysical Monitoring Report

The following technical report provides a profile on the status of corals, reef fishes, seagrass and mangrove resources of Siquijor Island, Philippines based on data obtained by the Regional Training participants from their field monitoring activities. Reef diving activities were accomplished by dividing the participants into two dive groups, designated as Coral and Fish teams based on their preferences to specialize in either coral or fish monitoring. For purposes of reducing disturbance or stress on the MPA each team was again split into two sub-teams to undertake the LIT and FVC activities in batches. The participants were also grouped into four teams for the conduct of seagrass and mangrove assessments, however, actual data gathering was accomplished simultaneously.

<u>Coral Community and Other Benthos</u>

Assessment of corals and reef fishes in the Tubod MPA and Maite MPA both in San Juan Siquijor was conducted on November 27-28, 2010 by two dive groups (Table 4) along two transects laid out at a depth of 5-8 meters (Fig. 9). Mean hard coral cover (HCC) from both sites is 53.78%, considered a "good" reef condition according to Gomez et al. (1994). The two sites have similarly high cover of live coral; their lifeform compo sition, however, vary. The Tubod MPA has a higher *Acropora*-type coral cover (16.50%) mostly of branching form than Maite MPA (8.55%) where branching and massive non- *Acropora* coral (other genera) dominated (37.98%). Dead corals in Maite exceeded those of Tubod MPA (Fig. 10).

Table 4. Participants assigned to coral and benthos assessment using LIT.

Coral Team 1	Coral Team 2
Anselmo Amaral (East Timor)	Nilnaj Chaitanavisuti (Thailand)
Syaruni Ilyas (Indonesia)	Sirusa Kritsanapuntu (Thailand)
Khoi Le Nguyen (Vietnam)	Nurliah Buhari (Indonesia)
Dondy Arafat (Indonesia)	Iman Teguh (Indonesia)
Zulhamsyah Imran (Indonesia)	Dean Apistar (Philippines)

Figure 9. Regional training participants determine coral cover on the reef using the LIT method. (Photo by Jerry Garcia)

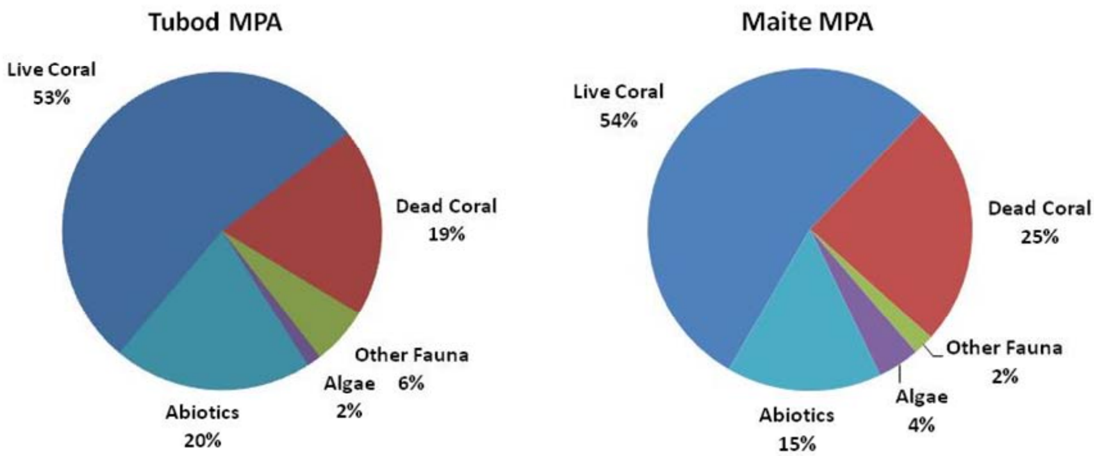


Figure 10. Comparison of benthic lifeform attributes of two MPAs in Siquijor (November 27-28, 2010).

Participants had highly variable readings of coral cover and that of other benthic attributes of the reef along the same transects, indicated by the standard error bars on Fig. 11. indicating the need to standardize their identification of live and dead coral, algal assemblages and even abiotic forms (rubble, rock or sand).

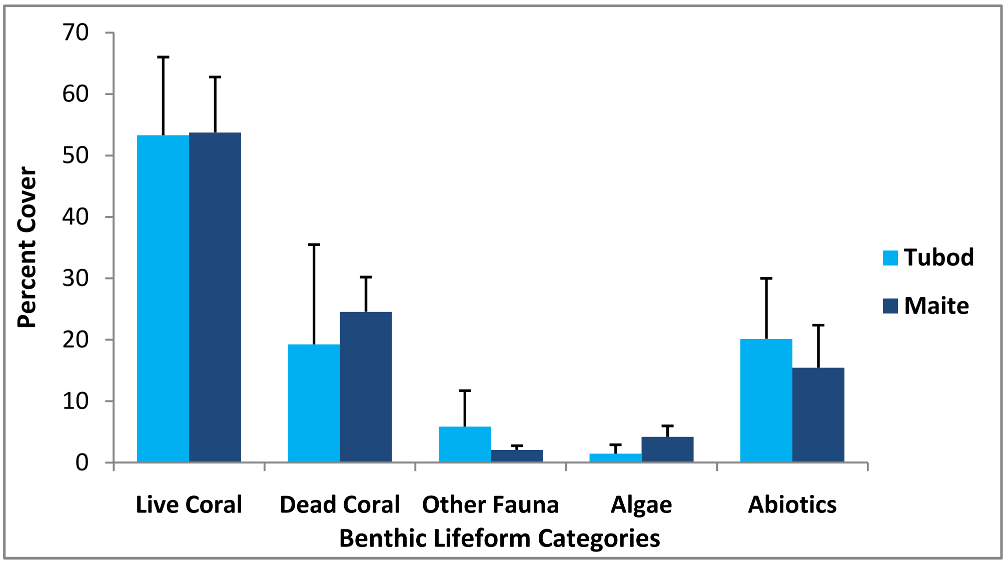


Figure 11. Comparison of benthic lifeform attributes between Tubod and Maite MPAs in Siquijor (November 27-28, 2010).

Reef Fish Communities

Two groups of training participants undertook the assessment of fish communities on the reefs of the marine protected areas in Tubod and Maite, San Juan, Siquijor (Table 5) using the fish visual census (FVC) technique (Fig. 12). Results obtained from these assessments show that the fish assemblages in the two MPAs differ in the various attributes of diversity, abundance, and biomass (Table 6).

Table 5. Participants assigned to conduct reef fish assessment by FVC.

Fish Team 1	Fish Team 2
Beginer Subhan (Indonesia)	Alvin Laping (Philippines)
Allyn Duvin Pantallano (Philippines)	Sakol Poepetch (Thailand)
Ahmad Haerudin (Indonesia)	Darryll Pasco (Philippines)
Christopher Jade Largo (Philippines)	Arselene Bitara (Philippines)
Ramli Malik (Indonesia)	Thuan Le Vinh (Vietnam)

Figure 12. Regional trainees conduct fish visual census on selected MPAs in Siquijor, Philippines (November 27-28, 2010).

Table 6. Comparison of fish community attributes between two protected reefs, Tubod and Maite MPAs in San Juan, Siquijor, Philippines.

Reef Site	Species Richness (No. Species/1000m2)	Abundance (No. Indiv./1000m2)	Biomass (kg/1000m2)
Tubod MPA	38	2,225	17.70
Maite MPA	67	1,206	26.79

Maite MPA had higher species richness with 67 species belonging to 20 families than those in Tubod MPA with only 38 species from 9 families. Species richness in Maite is considered moderate while that in Tubod is considered low based on established categories of fish assemblages on the reef (Aliño and Dantis, 1996). The most diverse family in both MPAs was Pomacentridae, a group of small, colorful damselfishes that have as many as 20 species in Tubod and 29 species in Maite. Damselfishes were also the most abundant group (Fig. 13) comprising 66% and 69% of the fish communities in both MPA sites. The dominance of this group of reef fish is characteristic of most coral reefs in the Philippines and Asia, lending color and variety to these underwater ecosystems.

An important feature of the MPAs in Siquijor is the high density of butterfly fishes (Family Chaetodontidae) comprising 17% and 7% of Tubod and Maite MPAs, respectively. Butterflyfishes, Moorish idols (family Zanclidae, and a few wrasses (family Labridae) are known as obligate corallivores, *i.e*. they feed only on live coral, and therefore are considered good indicators of healthy coral reefs. Their occurrence in Siquijor in such abundance indicates that coral reefs inside the MPAs are quite healthy. High hard coral cover (>53%) indicates that these reefs are in good condition providing sufficient food for butterflyfish and other reef indicators.

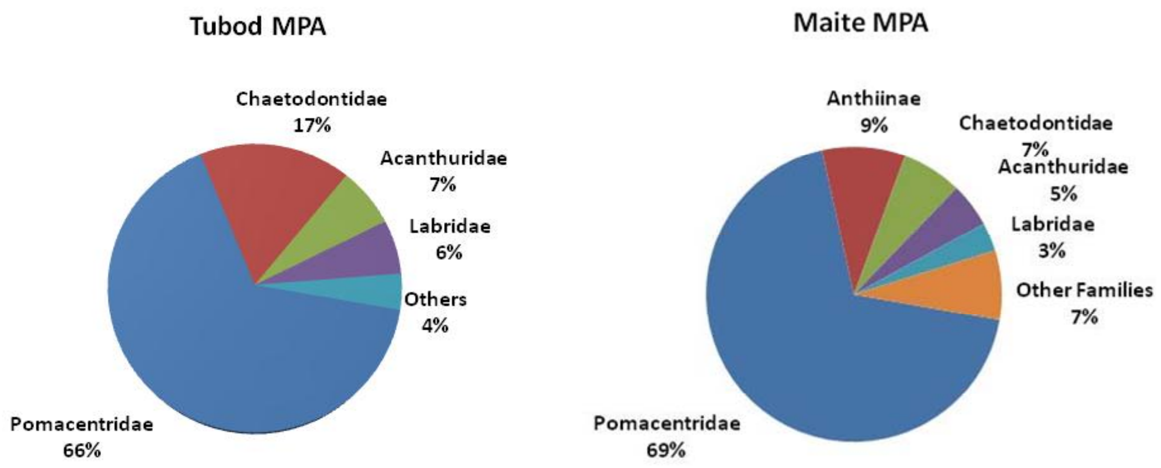


Figure 13. Comparison of relative abundance of reef fish families in two MPAs in San Juan, Siquijor (November 27-28, 2010).

Overall abundance of fish in Tubod (2,225 individuals/1000m^2) is considered high while that in Maite MPA (1,206 individuals/1000m^2) is considered moderate abundance based on categories described by Hilomen et al. (2000). Conversely, estimated fish biomass in Maite MPA was higher (26.79 kg/1000m^2) due to larger body size of fish than in Tubod MPA (17.70 kg/1000m^2)

where fish were smaller although more numerous. A comparison across different reef fish groups (Fig. 14) shows that biomass of target food fish (7.52 kg/1000m^2) in Maite far exceeded that in Tubod (0.80 kg/1000m^2), largely due to higher abundance of common food fish such as surgeonfishes (family Acanthuridae), emperors (Nemipteridae) and parrotfishes (Scaridae) in Maite. Reef indicators also exhibited a large biomass in both MPA sites in Siquijor, a consequence of higher density and larger body size than those recorded in MPA sites in Misamis Oriental (*see Fig. 7)*.

Seagrass Resources

The assessment of seagrass was conducted at Minolulan, Maria, Siquijor on November 29, 2010 to generate data and information on the species composition, relative cover, and relative shoot density, and associated fauna on seagrass beds. Seagrass assessment was conducted by four groups of training participants each working on one transect (Table 7). The participants' task was to identify the various species of seagrass *in situ*, characterize the SG community, and to identify invertebrate fauna found on the seagrass beds using the uniform transect quadrat method (Fig. 15).

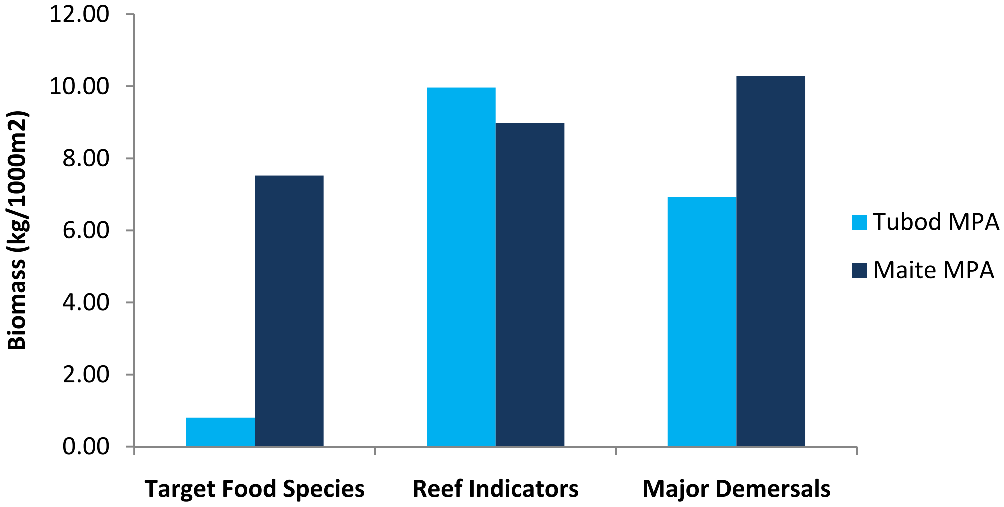


Figure 14. Comparison of estimated biomass of fish groups on the reefs of two MPA sites in San Juan, Siquijor.

Table 7. Distribution of participants per transect for seagrass activity.

Group 1 Transect 1	Group 2 Transect 2	Group 3 Transect 3	Group 4 Transect 4
Allyn Duvin Pantallano Iman Teguh Zulhamsyah Imran Christopher Jade Largo Khoi Lee Nguyen	Arselene Bitara Sirusa Kritsanapuntu Beginer Subhan Ahmad Haerudin Daryll Pasco	Nilnaj Chaitanavisuti Thuan Le Vinh Syaruni Ilyas Dean Apistar Ramli Malik	Sakol Poepetch Anselmo Amaral Dondy Arafat Alvin Laping Nurliah Buhari

Six species of seagrass were found in Minolulan reef flat with an overall seagrass cover (all species) of 59.1%. The most abundant seagrass was the dugong grass *Thalassia hemprichii* with an average benthic cover of 29.8% (Table 8), representing 50% of the entire seagrass community on the reef flat (Fig. 16). Highest shoot density, however, was observed in the tiny fiberstrand seagrass *Halodule pinifolia* (Table 7; Fig. 17).

Figure 15. Participants brave the sun as they conduct seagrass assessment in the Minolulan reef flat in Maria, Siquijor (November 29, 2010).

Table 8. Comparison of mean cover and shoot density of six seagrass species found in Minolulan, Maria, Siquijor (Nov. 29, 2010).

Seagrass Species	English Name	Mean SG Cover (% of benthos)	Mean Shoot Density (no./m^2)
Cymodocea rotundata	Roundtip seagrass	7.1	57
Enhalus acoroides	Tropical eelgrass	2.1	17
Halodule pinifolia	Fiberstrand grass	18.9	332
Halophila ovalis	Spoon grass	0.4	14
Syringodium isoetifolium	Syringe grass	0.8	12
Thalassia hemprichi	Dugong grass	29.8	104

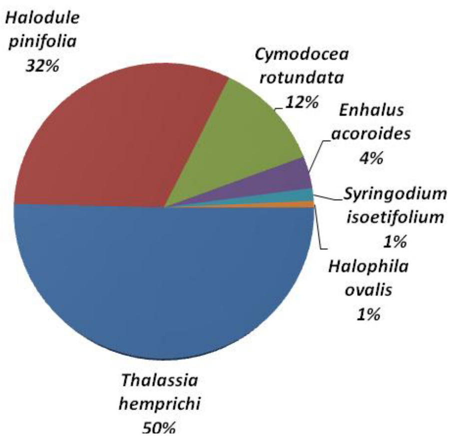


Figure 16 . Relative abundance (%) of different seagrass species in Minolulan, Maria, Siquijor Province (Nov. 2010).

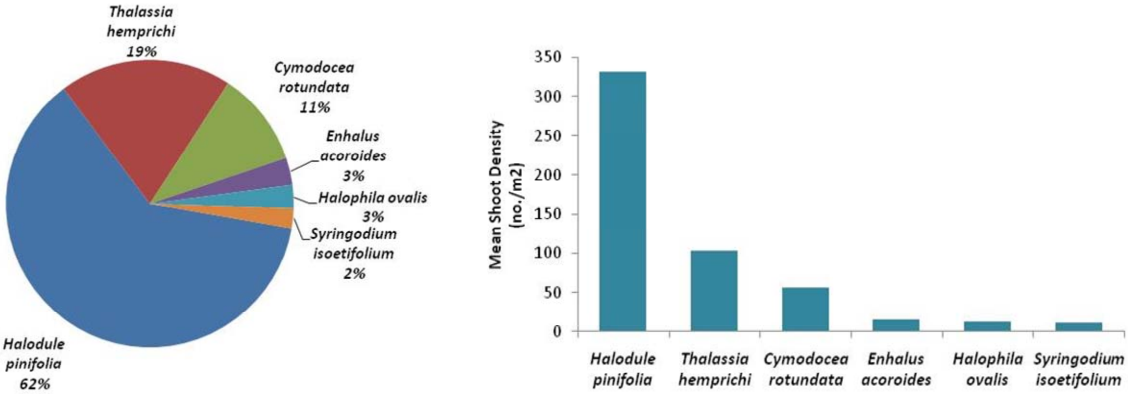


Figure 17 . Relative abundance of seagrasses in Minolulan reef flats based on shoot density (left) and a comparison of average shoot density by species (right panel).

Mangrove Resources

Field work for the mangrove assessment component of the training was carried out in the Tulapos mangrove sanctuary in the municipality of Enrique Villanueva, Siquijor on November 29, 2010. The participants were again divided into four groups to conduct the assessment along four transects. Along each transect, a number of 10x10m plots were established then in each plot the participants identified the species of mangroves, determined the number of trees, saplings and seedlings of each mangrove, and obtained measurements of girth-at-breast height. These data were later analyzed to describe the mangrove community structure inside the protected forest.

The Tulapos mangrove sanctuary is a mixed natural and rehabilitated forest. Six species of mangroves were identified during the survey, the most abundant of which is *Rhizophora mucronata* comprising >63% of the entire mangrove community (Fig. 18). Majority of the mangroves in the area were young juvenile plants or seedlings (51%) and saplings (13%) and the rest are trees with stem diameter of >40mm. Figure 18 shows the size composition of the six mangrove species.

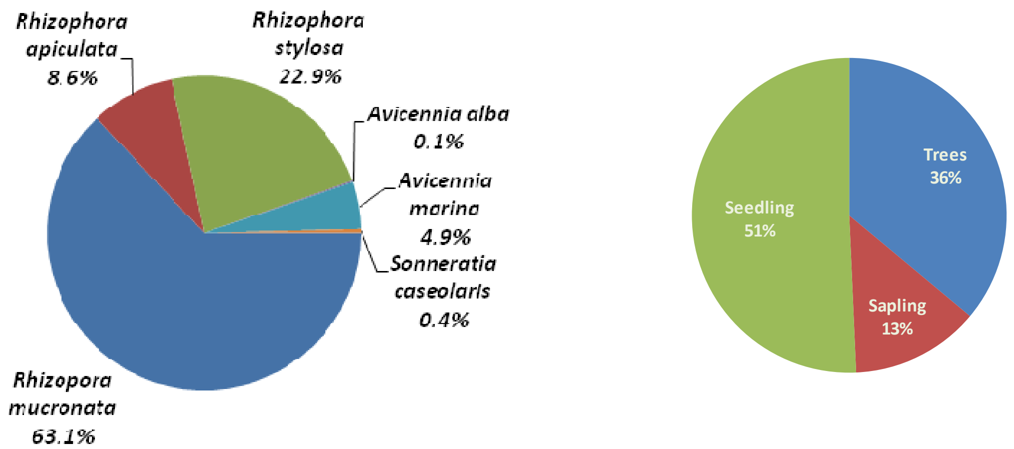


Figure 18. Relative abundance of six mangrove species found in Tulapos mangrove sanctuary (left) and proportion of mature and juvenile plants (right).

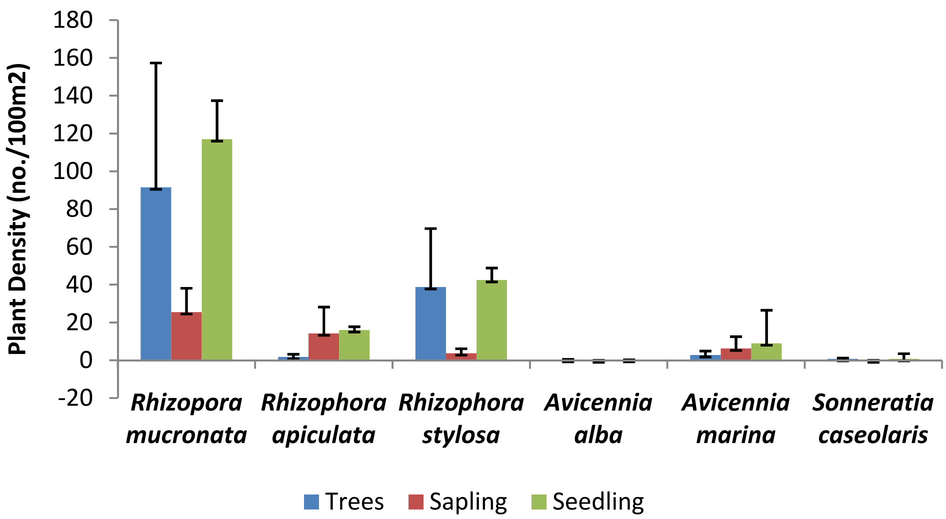


Figure 19. Size composition of different species of mangroves in Tulapos mangrove sanctuary.

Formulation of Country Monitoring Plans

On the last day of the training the participants prepared draft MPA monitoring plans by country (Appendix B) their respective MPAs. These plans will serve to guide them in drafting a comprehensive plan for the long-term monitoring of MPAs in the presence of their colleagues and endorse the plan to competent authority for adoption and implementation.

Generalizations about Monitoring Results

Results of technical assessment conducted by the training participants demonstrated that strict protection (i.e. MPA) can significantly improve coastal habitats and resources therein. Coral cover has been demonstrated in many assessments to increase under strict protection from unsustainable or destructive use. Similarly, fish communities improve in diversity, abundance, and available biomass once fishing stops as demonstrated by marine sanctuaries or MPAs.

As many of the participants were not experienced in scientific monitoring of MPAs, their estimates of community attributes were widely variable. Participants tend to differ in their identification of coral lifeforms, such as between submassive and digitate categories. The widest variations in participants' observations were on species identification of reef fish and estimates of body size and abundances. Species richness reported by various participants became a function of the individual's ability to identify and delineate among species of fish that appear similar. In the regional training, there were wide differences between the assessment by an expert (trainer) and by the training participants who tended to see and identify fewer species. For example, the reef fish expert recorded 82 species in Tubod MPA while participants listed only 38 species. Participants listed 67 species in Maite while the expert identified only 63 species; the higher number of species from participants is a consequence of pooling species lists of around 8 fish readers with variable species composition. Many of the species ID were uncertain and often a fish species was named differently among readers. Participants' estimates of abundance and biomass also tended to be lower than those of the expert/trainer.

Most participants, on the other hand, were already good at identifying and estimating abundances of seagrass and mangroves. A good number of training participants have excellent computer skills urgently needed in data management and analysis. The apparent inconsistency in fish identification can be remedied by constant practice through regularly conducting fish census on the reef. Fish monitors should regularly upgrade their fish taxonomy skills by constant study of reef fish identification guides. More accurate estimations of fish length and number can improve estimates of biomass using the length-weight relationship model on fish. Likewise, more practice is needed to improve estimation of benthic lifeform cover using LIT.

Post-Training Evaluation

A post-training evaluation was conducted between April and May 2011 in order to track the progress of training participants in MPA monitoring. A trip was made to the Bogor Agricultural University (IPB), Bogor, Indonesia for a meeting with Indonesian graduates of the regional training on May 20, 2011 at the Center for Coastal and Marine Resource Studies (CCMRS). Unfortunately only 4 out of 8 trainees attended the meeting. Also in attendance were members of the Faculty and staff or CCMRS, in particular Dr. Ruddy Suwandi, the main collaborator in this project. A powerpoint presentation was made by the Project Leader on the results of monitoring different MPA sites in Siquijor as training activities (Fig. 20). Following that was a presentation on the results of a post-training monitoring (sometime in December 2010) of the Pulau Pari (or Pari Is.) marine protected area in Seribu National Park off Jakarta was presented by Beginer Subhan from Bogor IPB, who declared that the MPA monitoring training has improved his coral and fish assessment skills and particularly in handling monitoring data more accurately. A two-page questionnaire was administered to those in attendance, while a copy was emailed to all the other training graduates for their feedback and updates.

Figure 20. Dr. De Guzman, Project Leader, presents the Regional Training results to IPB-CCMRS staff and training graduates (left). On the right panel, Mr. Subhan makes a presentation on the post-training monitoring of Pari Island MPA in Jakarta.

A trip to Pari Island was made with the training graduates the following day (May 21) for a site assessment and to validate Mr. Subhan's report. A quick dive on the reef revealed the great diversity of coral and fish life in the small island marine sanctuary. Pari Island is inhabited by a small community of fishers and seaweed farmers who also enforce MPA regulations (Fig. 21). A fortunate encounter and interview with the local MPA manager revealed that the Pari Island sanctuary lacks funding support for surveillance and law enforcement. Biophysical monitoring of the MPA site, on the other hand, is annually conducted by a team of divers under contract with the city government of Jakarta.

Figure 21. Trip to Pari. Clockwise from top left: approaching Pari Island from Jakarta; APN training graduates preparing to dive; conversing with the local MPA manager (in green shirt); and signage in the island declare MPA rules.

A summary of the returns on the post-training evaluation questionnaire sent via email to most participants is presented in Fig. 22. Out of 40 graduates of both the Local and Regional Training, only 17 (42.5%) did biophysical monitoring activities while 22.5% did not have any such tasks following their graduation from the training resource. A large portion (35%), however, did not respond to the survey although it is possible that some of them may have done some form of MPA monitoring. A few of the active training graduates have monitored several MPAs, and at least four of them have conducted training workshops for their monitoring team, students or local partners. Majority of the respondents appreciated how the training contributed to improvement of their underwater monitoring skills in either coral or fish communities. Results indicate that participants from the academe and research institutions have higher multiplier effect than those coming from the NGO or local government.

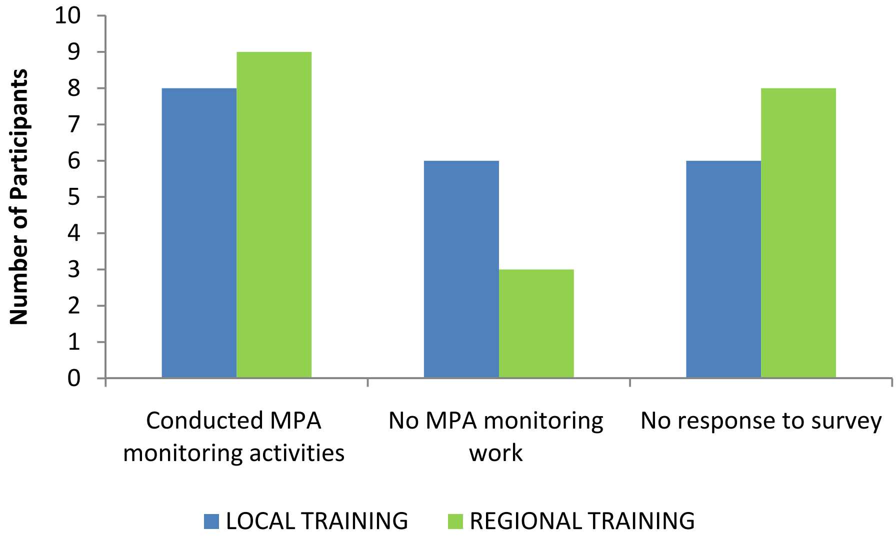


Fig. 22. Comparative summary of updates on MPA monitoring activities of APN training graduates.

4.0 Conclusions

This capacity building project was implemented with the following main objectives:

1. enhance the capacity of MPA researchers through technical training in coral reef, seagrass, and mangrove assessment and monitoring;
2. train participants in data management, report preparation and communication of results; and
3. assist participants in formulating an MPA monitoring and evaluation plan.

The technical reports on MPA monitoring activities conducted during the training show that the participants were able to collect substantial data from these field activities, process them and prepare simple reports which they can share with the local community and policy makers in their respective areas or countries. Participants, however, greatly varied in the quality of their field assessments – a natural consequence of varied backgrounds and ability. The apparent inconsistency in benthic lifeform and fish identification can be remedied by constant practice through regularly conducting coral assessment and fish census. Fish monitors should regularly upgrade their fish taxonomy skills by constant study of reef fish identification guides and in order to obtain more accurate estimations of biomass from abundance and fish length data.

A common observation among skills training or capacity building programs is that only a small proportion of those trained are able to put to practice whatever skills they have learned or become trainers themselves. The post-training evaluation conducted toward the end of the project showed that only 17 out of 40 participants (~42%) became actively involved in MPA monitoring activities within a year of graduation from the two training courses under the project. Four of these 17 successful graduates have begun to multiply their skills by training either students, colleagues or members of local monitoring teams.

5.0 Future Directions

Results of this project provided insight into how to improve future capacity building activities along similar goals. MPA establishment as a multiple-objective management intervention is sprouting everywhere in the Asia-Pacific, yet this project has created merely a dent in satisfying the great manpower needed to sustain and expand MPA efforts. The Post-Training Evaluation indicated that only about 42% of the graduates of the two training courses were later involved in MPA monitoring activities and have the potential to multiply the skills by training others as reef monitors. In light of this result more effort will be exerted to access additional funding in order to train more scuba divers in scientific monitoring of the habitats and resources inside designated protected areas. An indicative next step is to conduct a "Training of Trainers", the pool of participants or beneficiaries to be taken from the best performing participants of earlier training courses. A more stringent selection process for this training should be employed to ensure higher probability of success and utility of trained manpower in scientific monitoring of MPAs within the region.

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Appendix

A. Trainings Conducted

1. Local Training in MPA Monitoring

Title: LOCAL TRAINING in MONITORING MARINE PROTECTED AREAS
23-27 August 2010
Mantangale Alibuag Dive Resort, Balingoan, Misamis Oriental

PROGRAM OF ACTIVITIES

Date/Time	Activity	Responsible Person/Trainer
22 August 6:00 PM 7:00 PM	 Arrival at Mantangale Alibuag Resort Dinner	
23 August 8:00 AM 8:30 AM 9:00 AM 9:00-9:20 9:25-10:40 11:00-12:00	 Registration Opening Program • Welcome Remarks • Training Rationale & APN Project Brief • Introduction of Participants & Training Staff • Briefing on House Rules TRAINING MODULES in MPA MONITORING: Lecture Series • Introduction to MPA Monitoring for Global Change • Techniques in Coral Monitoring • Monitoring Fish Communities	 Mr. Ramon Francisco Padilla *APN-CaPaBle Project Asst.* Dr. Wilfredo H. Uy *Vice President, MSUNFSTDI* Dr. Asuncion B. de Guzman *Project Leader & Training Coordinator* Prof. Renoir Abrea *Training Staff* Mantangale Resort Management Sony de Guzman Renoir Abrea Sony de Guzman
12:00-1:30 PM	LUNCH BREAK	
1:30-2:15 2:25-3:15 3:30-5:00	• Monitoring Seagrass Communities • Monitoring Changes in Mangrove Community Structure Briefing on Field Activities	Wili Uy Wili Uy Training Staff
6:00-10:00	DINNER & SOCIALS	
24 August 6:00-6:30 AM 7:00-9:00 10:00 11:00-12:00 Lunch Break 1:00-3:00 PM	 Breakfast Field Activity: Seagrass Assessment Departure for Cantaan, Camiguin Is. Dive Group 1: Coral Assessment – *Line Intercept Technique & Fish Visual Census* (Inside MPA) Dive Group 2: LIT and FVC (Outside MPA)	 Wili Uy Renoir, Gary, Yob, Eugene & Sony

4:00	Trip back to Resort	
6:00	DINNER	
7:00-9:00	Data Management	Renoir, Sony & Wili
25 August 6:00-7:00 AM 7:30 8:30-10:00 10:30-12:00 Lunch Break 1:30-2:30 3:00-4:00 4:30	 Breakfast Departure for Sipaka Pt. Dive Group 1: LIT and FVC (Inside MPA) Dive Group 2: LIT and FVC (Outside MPA) Dive Group 1: Coral Phototransect Dive Group 2: Coral Phototransect Trip back to Resort	
6:00	DINNER	
7:00-9:00	Data Management	Training Staff
26 August 6:00-6:30 AM 7:00 9:00-10:00 11:00-12:00 Lunch Break 1:00-2:00 PM 3:00-4:00 4:00	 Breakfast Departure for Gosoon, Carmen, AdN Dive Group 1: LIT and FVC (Inside MPA) Dive Group 2: LIT and FVC (Outside MPA) Dive Group 1: Coral Diseases/Bleaching Dive Group 2: Coral Diseases/Bleaching Trip back to Resort	
6:00	DINNER	
7:00-9:00	Data Management	Training Staff
27 August 6:00-7:00 AM 8:00-10:00 10:00-12:00	 Breakfast Data Management & Analysis Presentation of Monitoring Reports	
12:00-1:00	LUNCH BREAK	
1:00-2:30	Formulation of MPA Monitoring Plan (by bay or region)	Sony de Guzman & Renoir Abrea
2:30-3:00	Training Evaluation	
3:00-3:30	Closing Program	
4:00	Homeward Bound	

PARTICIPANT'S DIRECTORY (PHILIPPINES)

NAME	AGE	AFFILIATION/ AGENCY	DESIGNATION/ POSITION	E-MAIL
Loida B. Arreglado	31	BFAR XIII	CRM Staff	lois_2100 @yahoo.com
Mario Octavio C. Arsenal	40	LGU, Tabina, Zamboanga Del Sur	OIC-CRM Office	
France Guillian P. Bandigan	29	Davao Oriental State College of Science and Technology	Instructor/ Research	fra_bandigan@ yahoo.com
Lemuel T. Cardona	35	Davao del Norte State College	Research Coordinator	cardona_lemuel@ yahoo.com
Eduardo F.Cardoniga	41	LGU-Nasipit	AT-Fisheries	eduardocardoniga@ yahoo.com
Riolito G. Cordero	40	CCMPC	CCMPC B.O.D	ccmpc@yahoo.com
Nelson T. Cuaresma	50	COASTLINE Inc.	Project Leader	coastline.ngo@ gmail.com
Julie Fe O. Dalogdog,	30	BFAR 10	CRM Staff	crmdiver_07@ yahoo.com
Joseph L. Delos Santos	37	LGU-Carmen, Agusan del Norte	AT-Fisheries	josephdelosantos72@ yahoo.com
Greg A. Dayondon	33	LGU, Tabina, Zamboanga Del Sur	Municipal Mayor	greg-day@yahoo.com
Rustan C. Eballe	39	MSU-Naawan	Aquaculture Technologist	rakans2@yahoo.com
Kristine A. Galarrita	28	XU-McKeough Marine Center	Research Asst.	krisgals07@yahoo.com
Umalsali D. Hawani	41	LGU-Pagadian IBRA-9	Chief Fishery Law Enforcement Section, M&E member	mike_gunz01@yahoo. com rowena.soria11@yahoo com
Mae Carla Sharon B. Jasma,	30	CERD	SFD Coordinator	mcs_sha2@yahoo. com
Divina H. Lade	25	XU-McKeough Marine Center	Research Assistant, IEC	divina_hojas@yahoo. com
Elmer Lauron	31	LGU-Cortes	Fishery Tech.	elmerlauron@rocketmail. com
Abegail G. Papong	25	PARTS Inc.	Conservation Biologist	ghailpops@gmail.com
Laarni C. Paraboles	20	Center for Empowerment and Resource Development Inc.	Technical Staff	laarniparaboles@yahoo. com
Quimpo, Rowena R.	34	CCMPC/ Camiguin Composite Team Volunteer	CRM Staff Volunteer/CCMPC Member	rowenaquimpo@yahoo. com
Valdez, Jeffry M.	41	BFAR 10	CRM Staff	frx2008@gmail.com

2. Regional Training in MPA Monitoring

Title: REGIONAL TRAINING in MONITORING of MARINE PROTECTED AREAS
26-30 November 2010
Salagdoong Resort, Maria, Siquijor, Philippines

PROGRAM OF ACTIVITIES

Date/Time	Activity	Responsible Person/Trainer
25 November 10:00 AM-6PM 7:00 PM	Arrival of Trainers & Participants & Registration at Salagdoong Resort Dinner	Darrell Pasco & Christopher Jade Largo Ramon Francisco Padilla *Secretariat*
26 November 7:00 AM 8:00 AM 9:00 AM 9:00-9:15 9:15-10:15 10:15-10:30 10:30-12:00	Breakfast **Opening Program** • Opening Prayer • Philippine National Anthem • Welcome Remarks & Message • Training Rationale & APN Project Brief • Introduction of Participants & Training Staff • Briefing on House Rules • Posterity Pose **TRAINING in MPA MONITORING: Lecture Series** • Introduction to MPA Monitoring for Global Change • Sharing of Experiences in MPA monitoring in the Asia-Pacific (Indonesia,Thailand,Vietnam, Philippines, Timor Leste) BREAK • Monitoring changes in Coral Community structure	Training Staff Training Participant Hon. Rebecca D. Padayhag *Municipal Mayor of Maria, Siquijor* Dr. Asuncion B. de Guzman *Project Leader & Training Coordinator* Avril Adrianne B. de Guzman *Visayas State University* Salagdoong Resort Management All Participants, Staff & Guests AB de Guzman Participants (by country) Renoir A. Abrea *Mindanao State University at Naawan*
12:00-1:30 PM	LUNCH BREAK	
1:30-2:00 2:25-3:15 3:15-3:30 3:30-5:00	• Monitoring Fish Communities • Monitoring Seagrass & Mangrove Communities BREAK Briefing on Field Activities	Cleto L. Nañola *University of the Philippines-Mindanao* AB de Guzman *Mindanao State University at Naawan* Training Staff
6:00-10:00	DINNER & SOCIALS	
27 November 6:00-6:30 AM 7:00	Breakfast Departure for Diving Activity	

8:30-12:00 12:00-1:30 1:30-2:30 3:00-4:00 4:30	Check Dive: Group I Check Dive: Group 2 Snorkeling in shallow parts of the reef LUNCH BREAK Dive Group 1: Coral Assessment – *Line Intercept Technique & Fish Visual Census* (Inside MPA) Dive Group 2: LIT and FVC (Inside MPA) Trip back to Resort	Renoir Abrea, Ting Nañola, Sony De Guzman, Gary Garcia & Ed Vince A. Ruiz
6:00	DINNER	
7:00-10:00	Data Management	Training Staff
28 November 6:00-6:30 AM 7:00 9:00-10:00 11:00-12:00 12:00-1:00 1:00-2:00 PM 3:00-4:00 4:00	 Breakfast Departure for Diving Activity (Maite MPA) Dive Group 1: LIT and FVC (Inside MPA) Dive Group 2: LIT and FVC (Outside MPA) Lunch Break Dive Group 1: Coral Phototransect, w/ notes on Coral bleaching & diseases Dive Group 2: Coral Phototransect; Coral bleaching & diseases Trip back to Resort	Renoir Abrea, Ting Nañola, Gary Garcia & Ed Vince Ruiz
7:00-9:00	Data Management: Seagrass & Mangrove Assessment	Training Staff
29 November 6:00-6:30 AM 7:00 9:00-12:00 12:00-1:00 1:00 2:00-4:00 PM 4:00	 Breakfast Departure for Field Activity (Minolulan, Maria) Seagrass Assessment LUNCH BREAK Departure for Mangrove Site (Tulapos MS) Mangrove Assessment Trip back to Resort	AB de Guzman & Training Staff AB de Guzman & Training Staff
6:00	DINNER	
7:00-9:00	Data Management & Grouping for Presentation of Training Report	Training Staff
30 November 6:00-7:00 AM 8:00-12:00 1:00-3:00 3:15-4:15 4:15-5:15	 Breakfast Data Management & Report Preparation Presentation of Monitoring Reports Formulation of MPA Monitoring Plan (by country) Presentation of MPA Monitoring Plan Training Evaluation	Participants by Group Participants by country Secretariat
6:30 7:30	Closing Program Farewell Dinner & Fellowship	
1 December 4:00 AM	Homeward Bound Departure	Daryll Pasco & Christopher Jade Largo

REGIONAL TRAINING PARTICIPANT'S DIRECTORY

NAME	AFFILIATION/ AGENCY	ADDRESS/ COUNTRY	DESIGNATION/ POSITION	EMAIL
Dondy Arafat	Bogor Agricultural University	Bogor Raya Permai FL1 N0 1A, Bogor, Jawo Borat	Assistant Lecturer	dondy_arafat@ yahoo.com
Nurliah Buhari	Mataran University	BTN. Bumi Bung Permai Blok A11/20 Makassar, Indonesia	Lecturer	Li_buhari @yahoo.com
Ahmad Haerudin	Bogor Agricultural University	Panngawo Island, Jakarta	Researcher	
Syahruny Ilyas	Fisheries Dept. of Gowa Regency	Malengkeri Raya No. 77	Extension Officer	ny_ilyas@yahoo.co m
Zulhamsyah Imran	Aquatic Resources Management, IPB	JL. Linglear Aleademile, Kampus IPB Permagi-Bogor	Research	zulhamsyah.imran @yahoo.com
Ramli Malik	Indonesia coastal and Marine Foundation (PESUT)	JC.DI.Panjaitan No. 80, GSV. Balikpapan-Indonesia 76122	CRM Advisor	ramli_m2000 @yahoo.com
Beginer Subhan	Bogor Agricultural University	Dept. of Marine Science and Technology, Campus IPB-Darmaga Bogor	Junior Lecturer/ Researcher	begi_ners @yahoo.com
Iman Teguh	Bogor Agricultural University	JL. Atang Sundjaya 02/04 Bogor, Jawa Barat	Researcher	imanteguh_IPB @gmail.com
Dr. Nilnaj Chaitanavisuti	Aquatic Resources Research Institute, Chulalongkorn University	Chulalongkorn University, Bangkok, Thailand 10330	Lecturer	nilnaj_cl @hotmail.com
Dr. Sirusa Kritsanapuntu	Faculty of Science and Industrial Technology, Prince of Songkia University	Prince of Songkla University Suratthani Campus, Suratthani Thailand 84000	Lecturer	kanutr@ hotmail.com
Sakol Poepetch	Prince of Songkla University	Prince of Songkla University Suratthani Campus, Suratthani Thailand 84000	Scientist	sakol16_SLC @hotmail.com
Anselmo Lopes Amaral	National Director of Fisheries and Aquaculture (NDFA)	Comoro-Dili, Timor Leste	Head of Conservation and Marine Protected Areas Section	alopamaral@ yahoo.com
Thuan Le Vinh	Culao Cham MPA	Hoi An, Quang Nam, Vietnam	Deputy Head division Patrolling and Tourism	thuanva2002 @Yahoo.ocm
Khoi Nguyen Le	Center for Marine Life Conservation and Community Development (MCD)	14 Hoang Hoa Tham St. Nha Trang City, Khanh Hoa Province	Project Officer	khoiln2000@ yahoo.com
Dean R. Apistar	Coastal Conservation and Education Found.	PDI Condominium, Banilad Cebu City	Research and Monitoring Team	deanniro@ yahoo.com

Arselene U. Bitara	Palawan State University	Tiniguiban Heights, Puerto Prinsesa City	Instructor	rcu_bitara76 @yahoo.com
Alvin Q. Laping	LGU-Maria Siquijor	Poblacion Sur, Maria Siquijor	Agricultural Technologist	Alvinlaping @yahoo.com
Cristopher Jade M. Largo	Provincial Agriculture Office	Larena, Siquijor, Philippines	Regulatory Staff	Crustyompao @yahoo.com
Allyn Duvin S. Pantallano	CECAM Project MSU Naawan	Naawan, Misamis Oriental, Philippines	Research Assistant	allyn_dsp @yahoo.com
Darryl T. Pasco	Provincial Agriculture Office	Larena, Siquijor, Philippines	Senior Aquaculturist/Chie f CRM, Regulatory	pasco_d @yahoo.com

Funding sources outside the APN

Additional funding for this project was provided by the following agencies:

Agency	Description of Support	Estimated Amount (USD)
Mindanao State University at Naawan	Portion of Project Leader's salary (40%)	5,600
MSUN Foundation for Science and Tech., Inc.(MSUNFSTDI)	Portion of salaries of accounting clerk and bookkeeper	1,080
CCMRS, Bogor IPB	Meeting expenses, communication and travel support for three participants	580
Provincial government of Siquijor, Philippines	Nine sets of Scuba equipment & two vehicles	750
	Total additional funds	USD 8,010

List of Young Scientists

(No young scientists were involved, as this project is a capacity building/training activity. Apart from the participants everyone involved in this project are trainers and training assistants, as follows:)

Renoir A. Abrea, Mindanao State University at Naawan, Trainer in Coral Monitoring
Cleto Nañola, University of the Philippines-Mindanao, Trainer in Reef Fish Monitoring
Wilfredo H. Uy, Mindanao State University at Naawan, Trainer in Seagrass Monitoring (Local)
Jerry P. Garcia, MSU Naawan/ICE CREAM Project, Training Assistant in Coral Monitoring
Eugene P. Moleño, MSU Naawan, Training Assistant in Fish Monitoring (Local Training)
Ed Vince A. Ruiz, Private Individual, Training Assistant in Fish Monitoring (Regional Training)

Glossary of Terms

Include list of acronyms and abbreviations

CCMRS	-	Center for Coastal and Marine Resource Studies, Bogor Agricultural University, Bogor, Indonesia
BFAR	-	Bureau of Fisheries and Aquatic Resources (Philippines)
CERD	-	Center for Environment and Resource Devbelopment (Local Phil. NGO)
DENR	-	Department of Environment and Natural Resources (Philippines)
DPT	-	Digital Phototransect method

DOSCST	-	Davao Oriental State College of Science and Technology
FVC	-	Fish Visual Census (daytime method in reef fish monitoring)
ICRMP	-	Integrated Coastal Resource Management Project (of the DENR)
LGU	-	Local Government Unit
LIT	-	Line Intercept Transect (technique in coral/benthos monitoring)
MAO/CAO	-	Municipal/City Agriculture Office
MPA	-	Marine protected area
MSU Naawan	-	Mindanao State University at Naawan
MSUNFSTDI	-	Mindanao State University at Naawan Foundation for Science and Technology Development, Inc.
NGO	-	Non-government organization

B. MPA Monitoring Plans (Local Training Output)

Appendix A. Plans for monitoring and evaluation of MPAs in Mindanao generated by local training participants.

Bay: Macajalar Bay Province: Misamis Oriental Prepared by: Divina Lade, Kritine Galarrita¸Rowena Quimpo & Riolito Cordero		MPA Names: Duca MPA, Agutayan Is. MPA	
M&E Activities	Frequency	Annual Budget and Funding Source	Responsible Group or Persons
Biophysical Monitoring			
1. Seagrass Component	Annual	P 10,000.00 (MLGU; PLGU; NGOs; NGAS; POs)	XUMMC; MLGU; PLGU: POs: Fisher folk; DENR: BFAR
2. Seaweed Monitoring	Annual	P 10,000.00	
3. Fish and Coral Monitoring	Annual	P 60,000.00	
4. Mangrove Component	Annual	P 10,000.00	
5. Invertebrates Component	When needed	None- to be integrated with SG/SW monitoring	
Socio Economic Monitoring			Same
1. Fish catch monitoring	Monthly	P 120,000.00	
2. Gear Mapping	Annual	P 30,000.00	
Management Performance			Same
1. Reorganize DFW's	Every 3 years	P 20,000.000	
2. Organize LGU Coastal Law Enforcement Team	Every 3 years	P 30,000.000	
3. Training Update on Fisheries Laws	Every 3 years	P 20,000.00	
Bay: Illana Bay Province: Zamboanga Del Sur Prepared by: Mario Octavio Arcenal, Greg Dayondon & Umalsali Hawani		MPA Names: Talisay, Tambunan, & Dao-dao Marine Sanctuaries	
Biophysical Monitoring			
1. LIT	Twice a year	P 25,000.00	M & E Team
2. FVC	Twice a year	P 25,000.00	
3. Mangrove	Once a year	P 15,000.00	

4. Seagrass	Once a year	P 15,000.00	
Socio-Econ. Monitoring 1. Fish catch monitoring	Twice a month	P50,000.00	M & E Team
Management Performance 1. Bantay Dagat Training	Once a year	P 150,000.00 (Pagadian City)	LGU, BFAR, IBRA-9
2. Review of CRM/MPA Plan	Once in 5 years	P20,000.00	Sangguniang Bayan, Sangguniang Panlungsod
Bay: Iligan Bay Province: Misamis Oriental Prepared by: Jeffrey Valdez, Juliefe Dalogdog, and Rustan Eballe	MPA Names: Biga & San Pedro Fish Sanctuary		
Biophysical Monitoring			
1. Fish Community	Twice a year	P 36,000.000 (LGU)	LGUs, BFAR, MSUN, Fisherfolk
2. Coral Community	Once a year	None – intregated with Fish monitoring	
3. Seagrass Community	Twice a year	P 12,000.00 (LGU, MSUN,)	
4. Mangrove community	Once a year	P 12,000.00 (LGU, MSUN)	
5. Macroinvertebrates Community	Twice a year	None – integrated with SG & SW	
Socio Economic Monitoring 1. Fish Catch Monitoring	Twice a year	P 25,000 per site (MSU, BLGU, MLGU)	LGU, MSUN, Fisherfolk
Management Performance 1. Management plan implementation	Once a month	P 800.00 per site per month MSUN	MSUN; BFAR
Bay: Murcielagos Bay; Panguil Bay Province: Misamis Occidental Prepared by: Nelson Cuaresma and Abegail Papong	MPA Names: Sibutad, Rizal, Sapang Dalaga, Baliangao & Hulaw-hulaw MPAs		
Biophysical Monitoring			
1. Coral cover	Annual	P 60,000.00 (LGU, Community)	NGO, LGU, POs, Academe
2. Fish density, biomass, diversity	Annual	None- integrated with coral monitoring	
3. Seagrass Cover	Annual	P 10,000.00 (LGU, Community)	
4. Shellfish density	Annual	None- integrated with SG/SW mon.	
5. Mangrove assessment	Annual	P 10,000.00 (LGU, Community)	
Socio economic monitoring 1. Fish catch (CPUE)	Bi-annual	P 5,000 (LGU)	NGO, LGU, PO LGU
2. Fishing effort (gear, fishers, boats)	Annual	P 15,000 (LGU)	
Management Performance 1. Effectivity of law enforcement	Annual	P15,000 (LGU)	NGO, LGU, PO
2. Stakeholders support and involvement	Annual	P10,000 (LGU)	

Bay: Butuan Bay Province: Agusan Del Norte Prepared by: Joseph de los Santos, Eduard Cardoniga & Loida Regalado		MPA Names: Cahayagan & Gosoon MPA, Carmen and Nasipit MPAs	
Biophysical Monitoring			
1. Fish Visual Census	Every 6 months	P 25,000.00 (LGU, BFAR, Private Sector)	LGU Nasipit; MRDP; LGU Carmen; BFAR
2. Coral Reef Assessment	Every 6 months	P 25,000.00 (LGU, BFAR, Private Sector)	
3. Seagrass Assessment	Once a year	P 25,000.00	
4. Mangrove Assessment	Once a year	P 25,000.00	
Socio-economic monitoring **1.** PCRA (Carmen and Nasipit**)** **2.** Fish catch & effort monitoring	Once (January) Once a year	P 20,000.00 (LGU ; MRDP; BFAR; private sector) P10,000 (LGU, MRDP)	LGU ; MRDP; BFAR
Bay: Hinatuan and Lanuza Bay Province: Surigao Del Sur Prepared by: Mae Carla Sharon Jasma Laarni Paraboles & Elmer Lauron		MPA Names: <u>Port Lamon; Loyola; Talisay, Cambatong; San Juan MPA & municipal MPA (Mun. of Hinatuan); Bupa, Burgos, Mabahin, Taganongan, Tigaw, Poblacion and Capandan MPA (Mun. of Cortes)</u>	
Biophysical Monitoring			
1. Mangrove Monitoring (establishment of permanent quadrats)	Once a year	P 12,000.00 Hinatuan (CERD, PAO); Cortes (MAO)	Hinatuan: Mangrove committee, CERD Staff, MAO Staff Cortes: MAO staff; Local Community
2. Seagrass Monitoring (percent cover & abundance of fish & invertebrate fauna)	Once a year	P 12,000.00 Hinatuan (CERD, PAO); Cortes (MAO)	Hinatuan: Fish sanctuary committee CERD Staff, MAO Staff Cortes; MAO Staff; Local Community
3. Corals and Fish Monitoring (coral cover, fish abundance and biomass	Yearly	Hinatuan; P28,000.00 (CERD, PO, BLGU) Cortes; P33,000.00 (MAO Budget)	Same
Socio-economic monitoring 1. Fish Catch (CPUE)	Every 3 years	P50,000.00 (Hinatuan: PO Counterpart and MAO Budget; Cortes: NGO Counterpart)	Hinatuan: Core group of LRMT, CERD Staff, and MAO Staff Cortes: MAO Staff, Local Community
2. Gear Mapping	Once	P10,000.00	Same
Management Performance 1. Law Enforcement	Monthly	10,000.00 (MAO Budget)	Same
2. Coordination of fish wardens, municipal enforcement action team and other stakeholders	Twice a year (midyear and year end assessment)	None - integrated with monitoring law enforcement	Fish wardens; members of the municipal enforcement team

Bay: Pujada Bay Province: Davao Oriental Prepared by: France Bandigan & Lemuel Cardona		MPA name: all MPAs in Pujada Bay	
Biophysical Monitoring			
1. Establish baseline information on habitat and resources	Start of project	P1.0 million ADB and GEF through ICRMP of Davao Oriental	DOSCST research group; DENR-11 and BFAR-11; community partners
2. Monitoring of habitats & resources • Coral reefs (corals & fish communities) • Seagrass & seaweeds • Mangroves • Invertebrates	Semi-Annual	P200,000 (Same sources)	Same
Socio-economic monitoring			
1. Establish baseline data through socio-economic profiling.	Once	P50,000 (Provincial & municipal LGUs; BFAR, DENR)	DOSCST research group; DENR-11 and BFAR-11; NGO & community partners
2. Monitor threats and disturbances by the	Monthly	P60,000 (same sources)	Prov'l & municipal coastal law enforcement team
3. Fisheries monitoring – fishing effort & fish catch	Quarterly	P60,000 (same sources)	
Management performance			
1. Planning evaluation and management review	Mid-year and year end review	P30,000 (ICRMP)	Executive committee, DENR, BFAR, project stakeholders, DOSCST
2. Review of performance of coastal law enforcement	Year end performance review	P10,000 (DENR and BFAR)	Community, DENR and BFAR

Appendix B. MPA Monitoring and Evaluation Plan for five countries.

1. Indonesia

Site: Seribu Island Province: Jakarta	Name of MPA: APL Pulau Panggang, APL Pulau Kelapa		
M&E Activities	**Frequency/Months**	**Budgetary Requirements and Funding Source**	**Responsible Group or Persons**
Biophysical Monitoring		US$4000 LGU,CCMRS, NGO, Seribu National Park	CCMRS-IPB, Dept. Marine Science and Technology, IPB
1. Coral and Reef Fish	12		Dondy Arafat/Beginer Subhan, Local University
2. Sea grass	12		Ahmad Haerudin and Local University
3. Mangrove	12		Iman Teguh and Local University
4. Water Quality	12		Beginer Subhan/IPB
Socio Economic Monitoring Community Participation; Income Level & Sources	12	US$1000 RGU,CCMRS, NGO, Seribu National Park	Nurliah Buhari, Syahruni Ilyas
Management Performance 1. Effectiveness	6	US$1000 RGU,CCMRS, NGO, Seribu National Park	Zulhamsyah Imran, Ramli Malik (CRM Advisor, Indonesia Coastal and Marine Foundation)
2. Surveillance	1		Zulhamsyah Imran
3. Financial evaluation	12		Zulhamsyah Imran

2. Thailand

MPA Names: Had Chao Mai Marine National Park		Location: Ko Muk Province: Trang, THAILAND	
M&E Activities	**Frequency/Months**	**Budgetary Requirements and Funding Source**	**Responsible Group or Persons**
Biophysical Monitoring			
1) Seagrass Monitoring	Twice/year	US$ 150 -The Biodiversity Research of Thailand (BRT) - Thailand Research Fund (TRF)	- Academic Cooperation (Chulalonglkorn University and Prince of Songkla University) - Had Chao Mai MNP - Ko Muk Local government
2)Coral Reef Monitoring	Once/year	US$ 150 - The Biodiversity Research of Thailand (BRT) - Thailand Research Fund (TRF)	- Academic Cooperation (Chulalonglkorn University and Prince of Songkla University) - Had Chao Mai MNP - Ko Muk Local government
Socio Economic Monitoring			
1) Fisheries activities and yield	4times/year (SE monsoon vs. NE monsoon)	US$ 100 -The Biodiversity Research of Thailand (BRT) - Thailand Research Fund (TRF)	-Academic Cooperation (Chulalonglkorn University and Prince of Songkla University) - Had Chao Mai MNP - Ko Muk Local government
2) Tourism status	Twice/year	US$100	-Academic Cooperation

	(low season vs. peak season	-The Biodiversity Research of Thailand (BRT) - Thailand Research Fund (TRF)	(Chulalonglkorn University and Prince of Songkla University) - Had Chao Mai MNP - Ko Muk Local government
Management Performance			
1) Guideline for Utilization of marine resources at Ko Muk, Had Chao Mai MNP	Once/year	US$200 -The Biodiversity Research of Thailand (BRT) - Thailand Research Fund (TRF)	-Academic Cooperation (Chulalonglkorn University and Prince of Songkla University) - Had Chao Mai MNP - Ko Muk Local government
2) Decision Making for Management of marine resources at Ko Muk, Had Chao Mai MNP	Once/year	US$200 -The Biodiversity Research of Thailand (BRT) & -Thailand Research Fund (TRF)	-Academic Cooperation (Chulalonglkorn University and Prince of Songkla U) - Had Chao Mai MNP - Ko Muk Local government

3. Vietnam

Location: Van Phong Bay **Province: Khanh Hoa – Viet Nam**		**MPA names: Trao reef**	
M&E Activitives	**Frequency**	**Budgetary requirements and funding source**	**Responsible group or persons**
Biophysical Monitoring			
1. Reef fish	2 times/year	5,000 USD Local government + NGO	Local government, local community + MCD
2. Coral reef	2 times/year	5,000 USD Local government + NGO	Local government, local community + MCD
Socio Economic Monitoring			
1. Economic structure of households in Van Hung Commune	3 times/year	2,500 USD Local government + NGO	Local government, local community + MCD
2. Participation in Trao Reef activities and capacity building in the Commune	3 times/year	2,500 USD Local government + NGO	Local government, local community + MCD
Management performance			
1. Effectiveness	2 times/year	1,000 USD Local government + NGO	Local government + MCD
2. Finance	2 times/year	1,000 USD Local government + NGO	Local government + MCD

4. Philippines

MPA Names: 17 MPAs		**Province: SIQUIJOR**	
M&E Activities	**Frequency/Months**	**Budgetary Requirements and Funding Source**	**Responsible Group or Persons**
Biophysical Monitoring & Related Activities			
6. Capacity Building Training	1st quarter	Php 30,000.00	REMOTE & PROMOTE (Resource Monitoring Team; Provincial Monitoring Team)

7. Line-Intercept Transect (LIT)	Semi-annual	Php 80,000.00	REMOTE & PROMOTE
8. Daytime Fish Visual Census (FVC)	Semi-annual	Php 80,000.00	REMOTE & PROMOTE
9. Data Analysis	Quarterly	Php 10,000.00	REMOTE & PROMOTE
10. Presentation of results to LGUs			REMOTE & PROMOTE
Socio Economic Monitoring Income level & sources Socio-economic status of fisherfolk	Once a year	Php 17,000.00	REMOTE & PROMOTE
Management Performance 1. MPA performance Rating	4th quarter	Php 17,000.00	REMOTE & PROMOTE
2. Community Perception Survey			

C. Field Data on MPA sites

Appendix Table 1. Percent cover of corals and other benthos in Sipaka Point Talisayan, Misamis Oriental (August 24, 2010).

Lifeform Category	Transect 1	Transect 2	Mean
Live Coral			
Acropora	1.56	3.8	2.68
Non-*Acropora*	15.9	20.28	18.09
Soft Coral			
Soft Coral	4.22	9.76	6.99
Others			
Macro Algae	0	2.76	1.38
Coralline Algae	0.46	1.16	0.81
Algal Assemblage	0.74	0.3	0.52
Other Flora And Fauna	4.62	4.28	4.45
Dead Coral			
Dead Coral	0.96	0	0.48
Dead Coral with Algae	15.12	27.68	21.4
Abiotic			
Sand	3.38	3.14	3.26
Ruble	51.56	26.06	38.81
Water	1.48	0.78	1.13
Total	**100**	**100**	**100**

Appendix Table 2. Percent cover of corals and other benthos in Duka MPA in Medina, Misamis Oriental (August 26, 2010).

Lifeform Category	Transect 1	Transect 2	Mean
Live Coral			
Acropora	1	11.92	6.46
Non-Acropora	34.8	25.5	30.15
Soft Coral			
Soft Coral	23	19.04	21.02
Others			
Macro Algae	0	0	0
Coralline Algae	0.46	0.7	0.58
Algal Assemblage	4.48	0	2.24
Other Flora And Fauna	2.74	0.98	1.86
Dead Coral			
Dead Coral	1.52	0.64	1.08
Dead Coral with Algae	23.42	30.56	26.99
Abiotic			
Sand	0.8	0	0.4
Ruble	7.58	5.2	6.39
Water	0.2	5.46	2.83
Total	**100**	**100**	**100**

Appendix Table 3. Categories by which to evaluate ecological health of coral reef fish communities according to Alino et al. (1991) and Hilomen et al.(2000).

Parameter	Measure	Category
Species Richness	Number of species per 1000m2	
	<26	Very poor
	27-47	Poor
	48-74	Moderate
	75-100	High
	>100	Very High
Abundance	Number of fish per 1000m2	
	< 201 fish	Very Poor
	202-676	Low
	677-2267	Moderate
	2268-7592	High
	> 7592	Very High
Biomass	kg/1000m2	
	1.0-3.0	Very Low
	3.1-10	Low
	10.1-20	Moderate
	20.1-50	High
	>50	Very High

Appendix Table 4. Relative abundance and biomass of reef fishes in Sipaka Point, Talisayan, Misamis Oriental (August 24, 2010).

Family	**Density (ni/1000m2)**	**Relative Abundance(%)**	**Mean Biomass (kg/1000m2)**
Pomacentridae	548	57.48	11.98
Serranidae/Anthiinae	303	31.76	2.79
Labridae	43	4.46	0.43
Acanthuridae	14	1.44	0.93
Scaridae	11	1.18	0.18
Apogonidae	10	1.05	0.03
Mullidae	9	0.92	0.30
Chaetodontidae	5	0.52	0.24
Pomacanthidae	5	0.52	0.05
Blennidae	5	0.52	0.03
Tetraodontidae	1	0.13	0.05
TOTAL	**953**	100.00	16.98

Appendix Table 5. Relative abundance and biomass of reef fishes in Duca MPA, Talisayan, Misamis Oriental (August 25, 2010).

Family	**Mean Density (ni/1000m2)**	**Relative Abundance (%)**	**Mean Biomass (kg/1000m2)**
Pomacentridae	1165	71.25	20.43
Serranidae/Anthiinae	138	8.41	0.30
Labridae	90	5.50	4.18
Pomacanthidae	84	5.12	0.52
Chaetodontidae	48	2.91	2.95
Scaridae	23	1.38	10.00
Apogonidae	20	1.22	0.24
Mullidae	16	0.99	3.52
Acanthuridae	13	0.76	2.01
Zanclidae	11	0.69	1.10
Nemipteridae	9	0.54	1.85
Tetraodontidae	5	0.31	0.51
Balistidae	4	0.23	2.06
Lutjanidae	3	0.15	0.29
Haemulidae	3	0.15	0.11
Holocentridae	1	0.08	0.18
Blennidae	1	0.08	0.00
Pinguepididae	1	0.08	0.01
Scorpaenidae	1	0.08	0.08
Ostraciidae	1	0.08	0.07
TOTAL	**1635**	**100.00**	**50.39**

Appendix Table 6. Percent cover of corals and other benthos in Tubod and Maite MPA, San Juan, Siquijor (November 27-28, 2010).

Lifeform Category	Maite MPA	Tubod MPA	Mean % Cover
Hard Corals			
Acropora			
Branching	4.24	14.50	9.37
Tabulate	0.01	2.00	1.01
Encrusting	0.30	0.00	0.15
Submassive	3.64	0.00	1.82
Digitate	0.36	0.00	0.18
Total	**8.55**	**16.50**	**12.53**
Non-*Acropora*			
Branching	17.58	7.55	12.57
Massive	20.40	10.35	15.38
Encrusting	2.50	10.00	6.25
Submassive	3.80	0.00	1.90
Foliose	0.60	6.85	3.73
Heliopora	0.43	0.00	0.22
Mushroom	0.39	1.35	0.87
Millepora	0.00	0.00	0.00
Tubipora	0.00	0.70	0.35
Total	**45.70**	**36.80**	**41.25**
Total Hard Coral	**54.25**	**53.30**	**53.78**
Dead Coral			
Dead Coral (recently dead)	13.40	7.95	10.68
Dead Coral with algal cover	12.20	11.30	11.75
Total	**25.60**	**19.25**	**22.43**
Other Fauna			
Sponge	0.14	3.35	1.75
Soft Coral	1.45	2.05	1.75
Zoanthid/s	0.11	0.00	0.06
Others	0.46	0.45	0.46
Total	**2.16**	**5.85**	**4.01**
Algae			
Macro algae	0.51	0.00	0.26
Turf algae	0.60	0.00	0.30
Halimeda	0.00	0.00	0.00
Coralline algae	0.95	0.00	0.48
Algal assemblages	0.88	1.45	1.17
Total	**2.94**	**1.45**	**2.20**
Abiotic			
Rubles	1.20	7.50	4.32
Sand	0.84	7.15	4.00
Sandy Silt	0.36	0.00	0.19
Rock	3.20	5.50	4.53
Water	9.45	0.00	4.52
Total	**15.05**	**20.15**	**17.56**
Grand Total	**100.00**	**100.00**	**100.00**

Appendix Table 7. Comparison of abundance and biomass of fish families inside the Tubod MPA in San Juan, Siquijor, Philippines (November 27, 2010).

Family	Mean Density (ni/1000m2)	Relative Abundance (%)	Mean Biomass (kg/1000m2)
Acanthuridae	150	6.74	0.69
Chaetodontidae	380	17.08	9.77
Labridae	135	6.07	0.50
Pomacentridae	1470	66.07	5.34
Serranidae/Anthiinae	45	2.02	0.22
Serranidae/Epinephelinae	10	0.45	0.11
Syngnathidae	10	0.45	0.87
Tetraodontidae	10	0.45	0.01
Zanclidae	15	0.67	0.20
TOTAL	**2225**	**100.00**	**17.70**

Appendix Table 8. Comparison of abundance and biomass of fish families inside the Maite MPA in San Juan, Siquijor, Philippines (November 28, 2010).

Family	Mean Density (ni/1000m2)	Relative Abundance (%)	Mean Biomass (kg/1000m2)
Acanthuridae	58	4.84	1.80
Aulostomidae	5	0.37	0.59
Balistidae	4	0.29	0.32
Chaetodontidae	80	6.59	7.82
Labridae	38	3.14	0.49
Lutjanidae	1	0.08	0.08
Monacanthidae	5	0.41	0.13
Mullidae	1	0.08	0.68
Nemipteridae	10	0.83	0.58
Ostraciidae	2	0.17	0.10
Pomacanthidae	7	0.58	0.11
Pomacentridae	829	68.73	7.66
Scaridae	18	1.45	3.39
Scorpaenidae	2	0.17	0.04
Serranidae/Anthiinae	1	0.08	0.33
Serranidae/Epinephelinae	110	9.12	0.65
Siganidae	1	0.08	0.66
Syngnathidae	1	0.08	0.02
Tetraodontidae	20	1.64	0.17
Zanclidae	15	1.24	1.15
TOTAL	**1206**	**100.00**	**26.79**

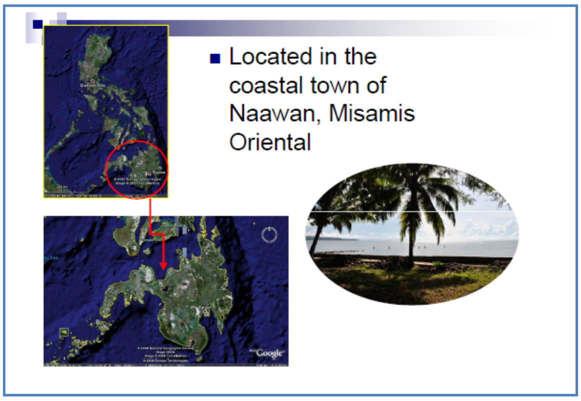
Appendix Table 9. Post-training MPA monitoring activities of APN training participants.

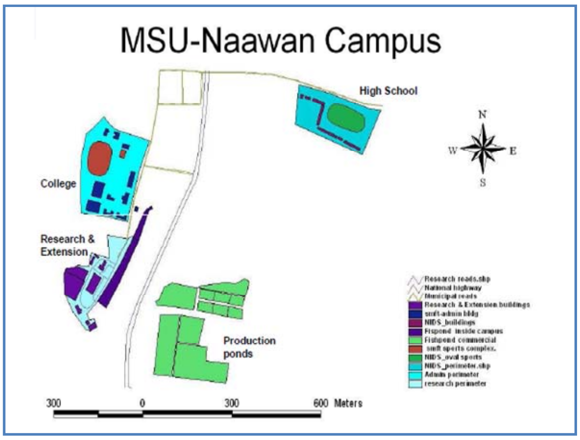
MPA Monitoring Activities of Local Training Participants	**MPA or Reef Site/Location**	**Resources/Parameters Monitored**
Lemuel Cardona (*Note: also conducted training of local communities)*	3 MPAs in Island Garden City of Samal, Davao (Aundanao MPA, Tagbaobo MPA and Catagman MPA	Corals, reef fishes, seagrasses and mangroves
Jeffrey Valdez & Juliefe Dalogdog	Duka MPA, Medina, Misamis Oriental; Tubay (non-MPA) for SRMI Tubay, Agusan del Norte; ZAM100 Power Plant , Zamboanga City (non-MPA)	Coral cover; fish diversity & abundance
France Bandigan	Guang-guang and Pujada Island, Mati, Davao Orientsal	Preliminary assessment of coral cover
Rustan Eballe	Cahayagan MPA, Carmen, Agusan del Norte	Fish diversity, abundance & biomass
Octavio Arcenal & Greg Dayondon	3 MPAs in Tabina, Illana Bay	Coral cover and fish abundances (per family; no species level data)
Mae Sharon Jasma	MPAs in Hinatuan Bay, Surigao del Sur	Coral and fish species richness, densities and biomass

Appendix Table 10. MPA monitoring activities of Regional Training participants.

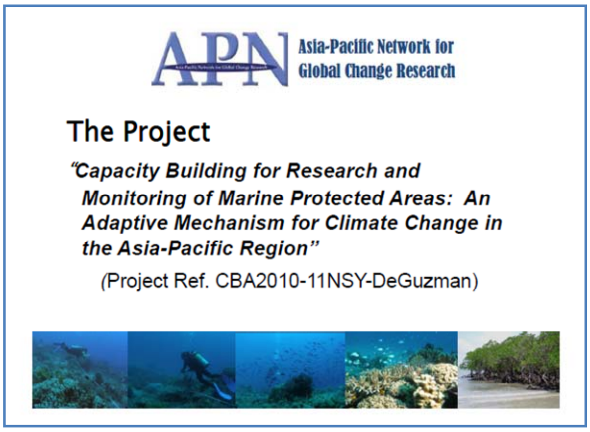
	MPA Site/Location	**Resources/Parameters Monitored**
Beginer Subhan & Dondy Arafat (*Note: used MPA training manual to train students in coral reef monitoring)*	3 MPA sites in Pari Island (part of Seribu Island National Park), Indonesia	Coral and fish communities
Allyn Pantallano	Capayas Island Marine Sanctuary, Lopes Jaena, Misamis Occidental; Tubajon MPA, Laguindingan¸Mis. Or., (Philippines)	Fish community structure: species richness, densities and biomass
Dean Apistar	4 MPAs in Tuburan, Cebu; 2 MPAs in Tabuelan, Cebu; 9 Sites in Mabini and Tingloy, Batangas; 1 MPA in San Juan, Siqujior and the whole outer barrier reef of Danajon bank double barrier reef (Philippines)	Coral cover; fish diversity, abundance & biomass
Daryll Pasco, Christopher Largo & Alvin Lapinig	17 MPAs in Siquijor (Philippines)	Coral cover; fish diversity, abundance & biomass
Nilnaj Chaitanavisuti & Sirusa *(Note: conducted training-workshop for students in Muk Island*	Muk Island, Trang province in Andaman Sea, Thailans	Coral and seagrass communities

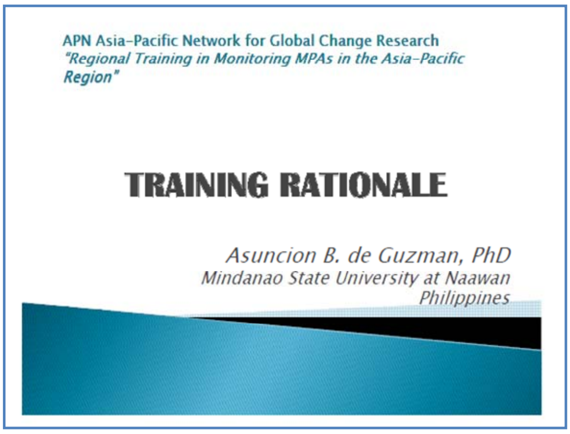
1. Introducing MSU at Naawan

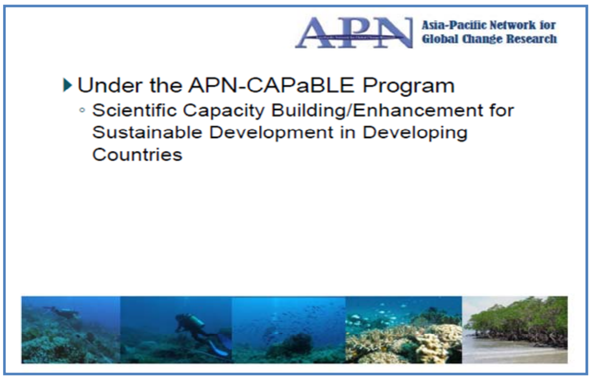


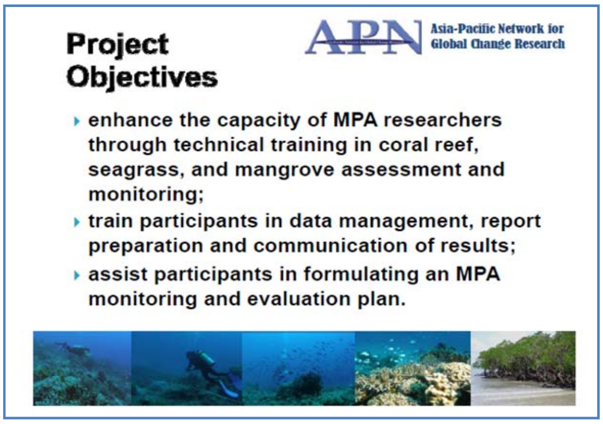


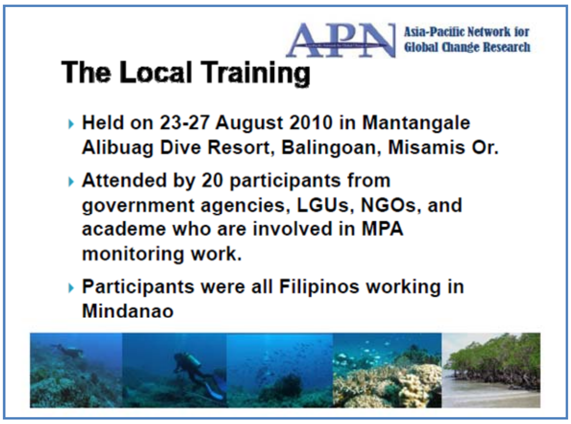
1. Training Rationale



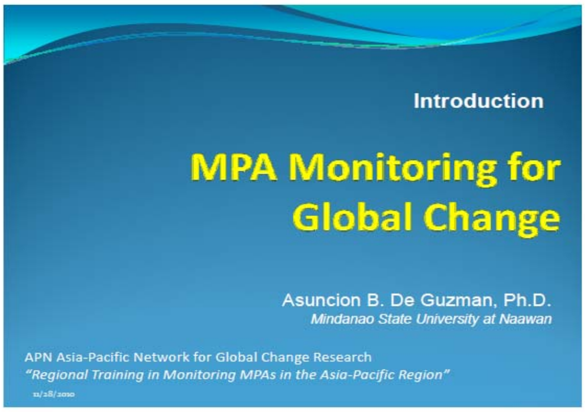








3. MPA Monitoring for Global Change



Marine Protected Areas

- Most popular tool in CRM
- Ecosystem-based Fisheries Management
- Builds up public participation/ involvement
- Community ownership

Marine protected areas:

A strategy for managing habitats and fisheries

Adaptive mechanism for Climate Change and other Global environmental disturbances

Fisheries management aims to reduce fishing effort to sustainable levels and to improve the overall ecological integrity of the fishery and its habitats.

Fisheries Code R.A. 8550 definition

- **Fishery refuge and sanctuaries**
  "A designated area where fishing or other forms of activities which may damage the ecosystem of the area and human access may be restricted."
- **Fishery reserve**
  "A designated area where activities are regulated and set aside for educational and research purposes."

Strategic Goals of an MPA

- Biodiversity conservation
- Protection of contiguous marine habitats (mangroves, seagrass beds & coral reefs)
- Refuge of fish fromareas that are fished
- Recruitment of fish & invertebrates
- Prevent fishery collapse ("insurance policy")
- "Spillover effect" helps improve fisher catch and income

Monitoring Coral Reefs

Importance of Baseline Data:

- Establish the *original condition* of the project (e.g. MPA)
- Basis for planning and designing
  - How big should the MPA be?
  - Design that maximizes protection of target resources
- Basis for comparing changes and evaluating project performance

Why monitor MPAs?

- **Determine *changes* in habitat quality & amount of resources**
  - Live vs dead coral
  - Abundance, diversity and biomass of fish & other resources (invertebrates, seagrass, seaweeds and mangroves)

Components of MPA M&E

- **Technical Evaluation - effectivity of MPA or sanctuary in terms of:**
  - Improving ecological conditions
  - Increase in fish diversity, abundance and potential harvest (fisheries)
- **Program Management Evaluation - basis for improving management strategy**

Inter-LGU MPA Networks could enhance and scale up benefits of natural processes and LGU-level management interventions

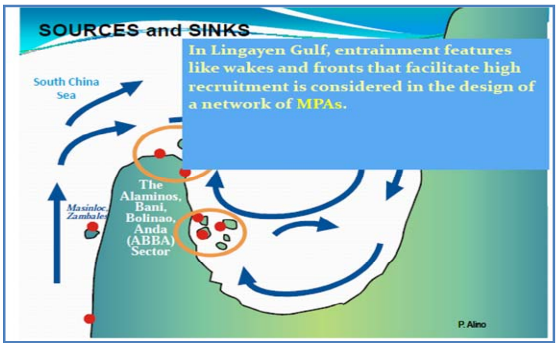
- Biodiversity conservation
- Fisheries productivity and livelihood of fisherfolk
- Recreational and aesthetic value of the environment
- Effectiveness of local environmental governance

MPA Networks and Inter-LGU Coordination

An MPA network is a group of marine sanctuaries or MPAs placed under unified mgt by a group of LGUs or mgt bodies

- Considered by many conservation groups as most effective way of protecting ocean biodiversity and its economic values
- A strategy to reduce costs for MPA mgt due to "economies of scale"

- An efficient way to avail of funding due to:
  - lower transaction costs
  - expected higher economic benefits
  - Increase in effective area of protection
- Could be a means to resolve boundary conflicts or issues between LGUs

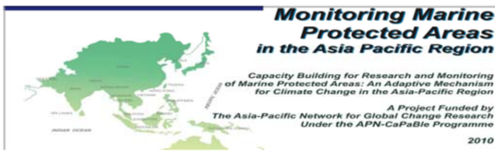


Adaptive Mechanism for Global Change

- Climate Change impacts(storminess, increasing SST, bleaching/diseases, coastal erosion, etc)
- Overfishing
- Improve Environmental governance

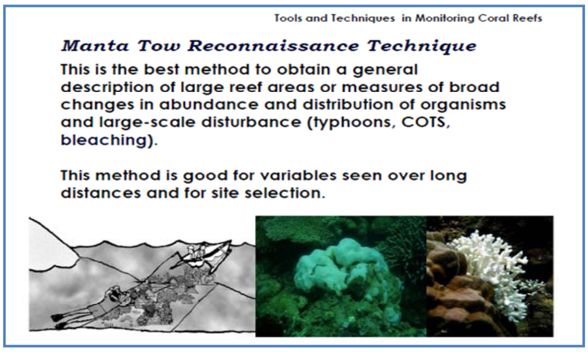
4. Monitoring Corals and Other Macrobenthos

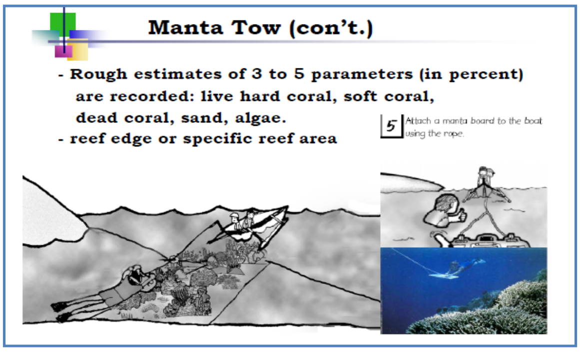
MONITORING OF CORALS AND OTHER MACROBENTHOS IN MPAs

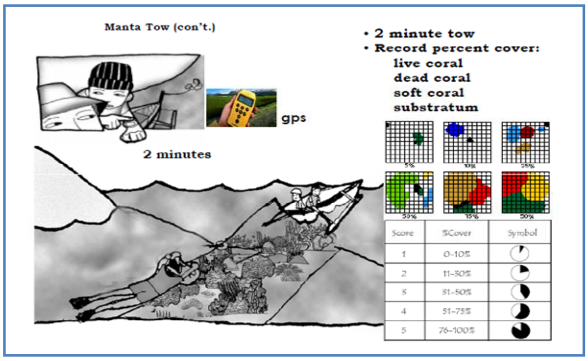


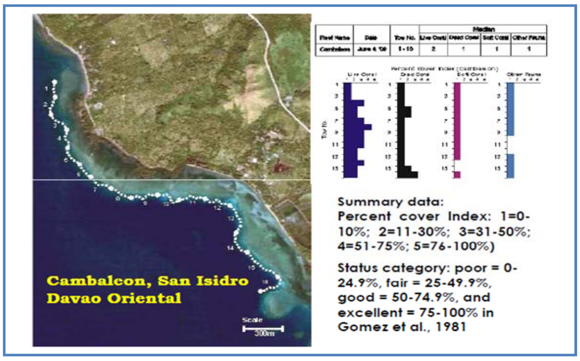
Tools and Techniques in Monitoring Coral Reefs

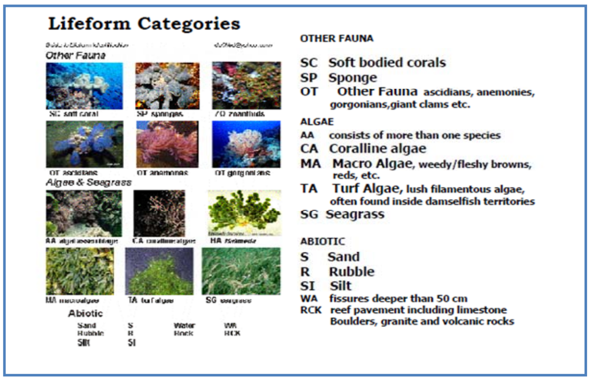
- *Manta Tow Reconnaissance Technique*
- *Line-Intercept Transect*
- *Photo-Transect Method*
- *Monitoring impacts of climate change and other environmental events*

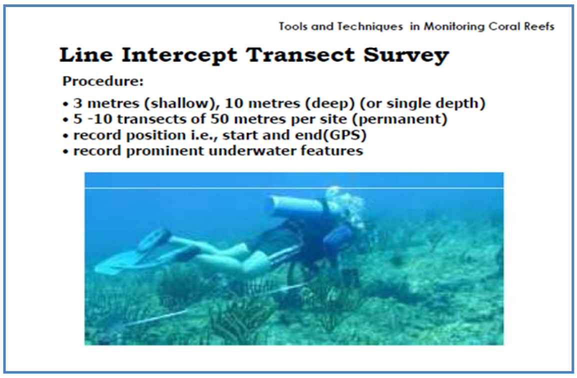

Tools and Techniques in Monitoring Coral Reefs
Manta Tow Reconnaissance Technique
This is the best method to obtain a general description of large reef areas or measures of broad changes in abundance and distribution of organisms and large-scale disturbance (typhoons, COTS, bleaching).
This method is good for variables seen over long distances and for site selection.

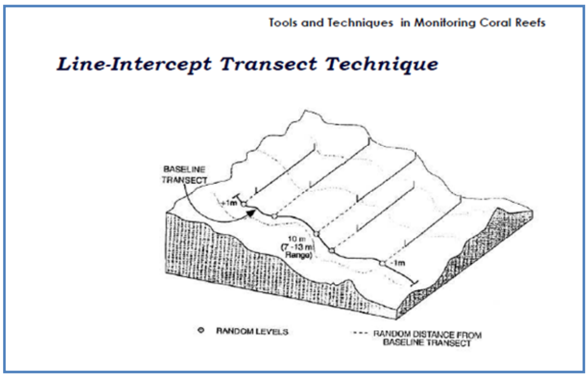

Manta Tow (con't.)
- Rough estimates of 3 to 5 parameters (in percent) are recorded: live hard coral, soft coral, dead coral, sand, algae.
- reef edge or specific reef area
5
Attach a manta board to the boat using the rope

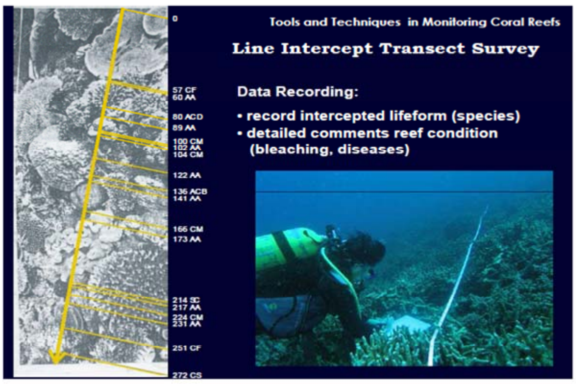

Manta Tow (con't.)
gps
2 minutes
• 2 minute tow
• Record percent cover:
live coral
dead coral
soft coral
substratum
Score
%Cover
Symbol
1
0-10%
2
11-30%
3
31-50%
4
51-75%
5
76-100%


Cambalcon, San Isidro
Davao Oriental
Summary data:
Percent cover Index: 1=0-10%; 2=11-30%; 3=31-50%; 4=51-75%; 5=76-100%)
Status category: poor = 0-24.9%, fair = 25-49.9%, good = 50-74.9%, and excellent = 75-100% in Gomez et al., 1981


Lifeform Categories
Other Fauna
Algae & Seagrass
Abiotic
OTHER FAUNA
SC Soft bodied corals
SP Sponge
OT Other Fauna ascidians, anemonies, gorgonians,giant clams etc.
ALGAE
AA consists of more than one species
CA Coralline algae
MA Macro Algae, weedy/fleshy browns, reds, etc.
TA Turf Algae, lush filamentous algae, often found inside damselfish territories
SG Seagrass
ABIOTIC
S Sand
R Rubble
SI Silt
WA fissures deeper than 50 cm
RCK reef pavement including limestone Boulders, granite and volcanic rocks


Tools and Techniques in Monitoring Coral Reefs
Line Intercept Transect Survey
Procedure:
• 3 metres (shallow), 10 metres (deep) (or single depth)
• 5 -10 transects of 50 metres per site (permanent)
• record position i.e., start and end(GPS)
• record prominent underwater features


Tools and Techniques in Monitoring Coral Reefs
Line-Intercept Transect Technique
BASELINE TRANSECT
10 m (7 - 13 m Range)
RANDOM LEVELS
RANDOM DISTANCE FROM BASELINE TRANSECT


Tools and Techniques in Monitoring Coral Reefs
Line Intercept Transect Survey
Data Recording:
• record intercepted lifeform (species)
• detailed comments reef condition (bleaching, diseases)

Tools and Techniques in Monitoring Coral Reefs

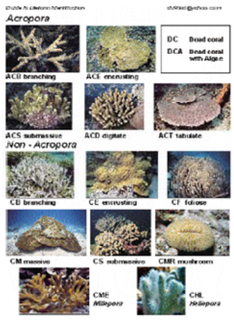
Line-Intercept Transect Technique

Method description:
Line intercept transect (LIT) is used to determine the percentage cover of benthic communities.

Information obtained:
Percentage cover of benthic communities e.g. hard coral, soft coral, sponges, algae, rock, dead coral.

The LIT method requires *in situ* identification of the lifeforms directly under the transect tape. The community is characterized using lifeform categories which provide a morphological description of the reef community.

Lifeform Categories



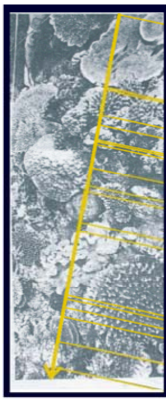
LIVE CORAL
Acropora
ACB at least 2° branching e.g. *Acropora palmate, A. formosa*
ACE usually the base-plate of immature Acropora forms, *A. palifera*
ACS robust with knob or wedge-like form e.g. *A. palifera*
ACD no 2° branching, typically includes *A. humulus, A. digitifera*
ACT horinzontal flattened plates e.g. *A. hyacinthus*

Non-Acropora
CB at least 2° branching, e.g. *Seriatopora sp.*
CE major portion attached to substratum as a laminar plate e.g. *Porites vaughan*
CF coral attached at one or more points, leaf-like appearance e.g. *Merulina ampliata Montipora aequituberculata*
CM solid boulder or mound e.g. *P. daedata*
CS tends to form small columns, knobs, or wedges e.g. *Porites lichen*
CMR solitary, free-living corals of the Fungia
CME fire coral
CHL blue coral

Dead Coral
Dead Coral with Algae

Tools and Techniques in Monitoring Coral Reefs

Line Intercept Transect Survey



0
57 CF 57 - 0 = 57 CF
60 AA 60 - 57 = 3 AA
80 ACD 80 - 60 = 20 ACD
89 AA 89 - 80 = 9 AA
100 CM 100 - 89 = 11 CM
102 AA 102 - 100 = 2 AA
104 CM 104 - 102 = 2 CM
122 AA 122 - 104 = 18 AA
136 ACB 136 - 132 = 4 ACB
141 AA 141 - 136 = 5 AA
166 CM 166 - 141 = 25 CM
173 AA 173 - 166 = 7 AA
214 SC 214 - 173 = 41 SC
217 AA 217 - 214 = 3 AA
224 CM 224 - 217 = 7 CM
231 AA 231 - 224 = 7 AA
251 CF 251 - 231 = 20 CF
272 CS 272 - 251 = 21 CS

Data Processing & Analysis

- summary data showing percent cover of different lifeforms

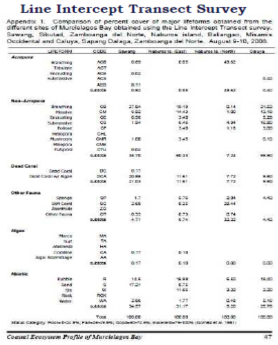
$$\text{Percent cover} = \frac{\text{Total length of category}}{\text{Length of transect}} \times 100$$

CF: Total length = 57 + 20 = 77
% cover = 77 / 272 x 100 = 28.3%
CM: Total length = 11 + 2 + 25 + 7 = 45
% cover = 45 / 272 x 100 = 16.5%

Transition	Lifeform	Taxa		Transition	Lifeform	Taxa		LIFEFORM	% Cover
								PERCENT COVER	
6	CE	Galaxea	6	42	ACB	Acropora		*Acropora*	
29	DCA		23	19	ACB	Acropora		ACB	1.22
41	CM	Porites	12	41	ACE	Acropora		ACT	0.60
52	DCA		11	30	ACT	Acropora		ACE	0.82
61	HA	Halimeda	9	7	CA			ACS	
93	DCA		32	7	CB	Montipora		ACD	
122	CE	Cyphastre	29	15	CB	Montipora		subtotal	2.64
182	CF	Pectinia	60	6	CE	Galaxea			
209	DCA		27	29	CE	Cyphastrea	Non-*Acropora*		
216	SP		7	6	CE	Porites		CB	0.44
222	DCA		6	13	CE	Porites		CM	6.40
228	HA	Halimeda	6	8	CE	Porites		CE	22.18

Line Intercept Transect Survey

Tools and Techniques in Monitoring Coral Reefs



Gomez et al. 1981:
0-24.9% = poor
25-49.9% = fair
50-74.9% = good
75-100% = excellent

Tools and Techniques in Monitoring Coral Reefs

Digital Photo Transect

The video transect technique (Osborne and Oxley 1997, Page et. Al. 2001) reduces the bottom time of the observer to as short as 8 minutes per transect as compared to 45 minutes with LIT

The Photo-Transect method is a modification of the video transect technique described by Osborne and Oxley (1997). It involves the use of digital still cameras attached to a distance bar. A digital camera inside a waterproof case is attached to an aluminum distance bar, the length of which is predetermined so that the substrate covered by the image is 0.5m wide. Photographs of the substratum are taken at 1m intervals to come up with 51 frames per 50m transect.

Tools and Techniques in Monitoring Coral Reefs

Digital Photo Transect Method

The photo transect method is proposed over other survey methods because of several advantages, such as:

1) equipment outlay is much cheaper and laboratory processing time is reduced in comparison to the video transect technique;

2) the survey can be conducted by non-technical persons (with little knowledge of advanced technology and even non-biologists);

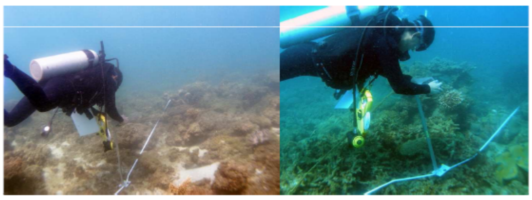
3) diver bottom time is reduced in comparison to the LIT, and

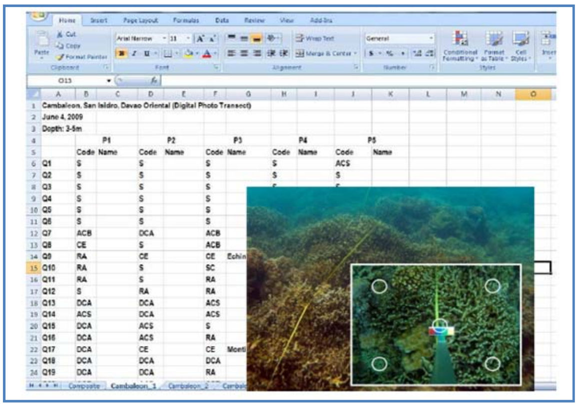
4) taxonomic identification of biota is improved since image resolution is much better than video camera resolution (0.3 megapixel vs. 10 megapixel or higher).

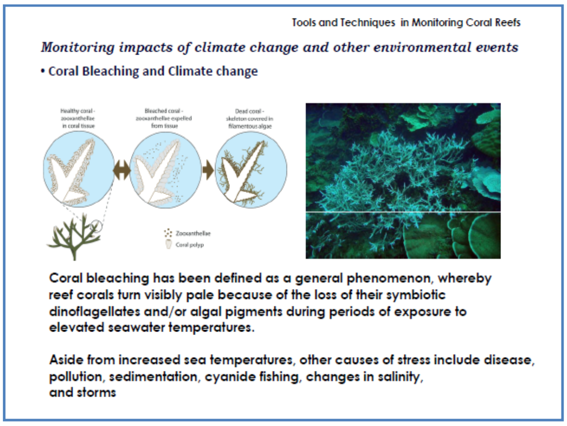
Tools and Techniques in Monitoring Coral Reefs

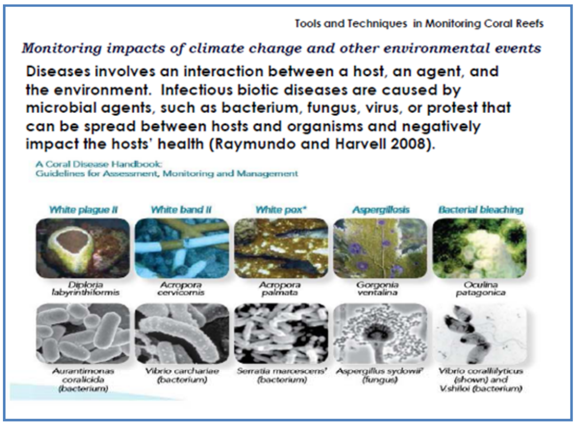
Digital Photo Transect Method

Digital camera
Transect tape 50m (5-10 transects) = 51 frames

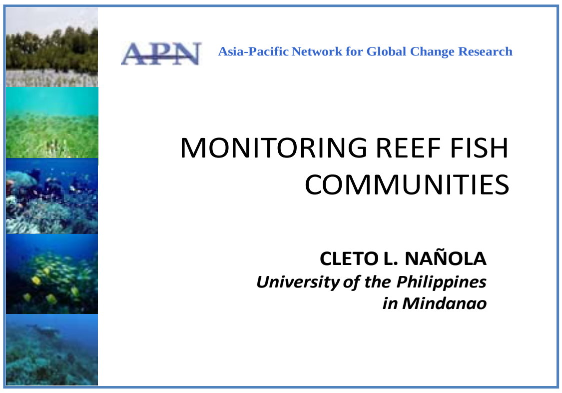


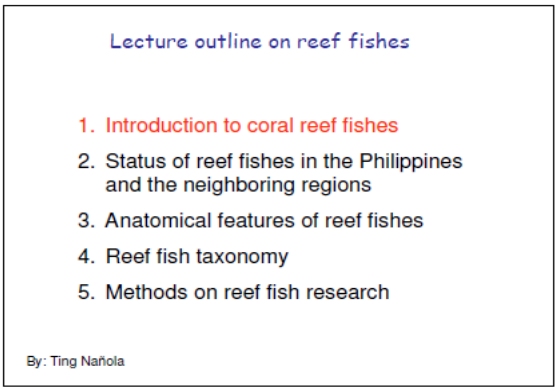






5. Monitoring Reef Fish Communities





Characteristics

A) Group features

highly diverse

- 4,000 species in the Indo-Pacific (18% of all living fishes)
- ~ 2,500 species in the Philippines
- center of the center (Carpenter and Springer 2005)

Global comparison of reef fish diversity (size represent diversity)

Characteristics...

A) Group features...

occur in many forms

- highly specialize feeding structures (functional groupings)
  - grazers = scarids (molmol), acanthurids (labahita)
  - invertebrate feeders = labrids (labayan)
  - piscivores = groupers (lapulapu), cardinal fishes, lizardfishes
  - planktivores = fusiliers (dalagang bukid), many damsels (palata)
- variability in size [e.g. Family Labridae (wrasses)]
  - *Minilabrus striatus*, 3 cm SL
  - *Cheilinus undulatus* (mameng), 290 cm SL

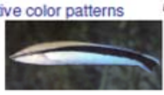
Characteristics...

B) Ecological traits

- life cycle
  - pelagic larvae
  - adults settled in reefs
- high fecundity
- fertilization is external
- broadcast spawners some exhibit egg care (seahorses), brooders
- rely heavily on vision (clear waters)
- developed complex behavior patterns associated with the development of distinctive color patterns
- mimicry

Canthigaster valentini (Tetraodontidae)

Paraluteres prionurus (Monacanthidae)



Aspidontus taeniatus (Blenniidae)

Labroides dimidiatus (Labridae)

Characteristics...

C) Habitat association

- many groups remain in the reef throughout their life cycle
  - Scaridae (parrotfishes) = maya-maya
  - Acanthuridae (surgeonfishes) = labahita, indangan
  - Siganidae (rabbitfishes) = samaral, danggit
  - Chaetodontidae (butterflyfishes) = alibangbang
  - Pomacanthidae (angelfishes) = alibangbang
  - Labridae (wrasses) = labayan
  - Pomacentridae (damselfishes) = pata, palata
- others visit the reefs to feed
  - Haemulidae (sweetlips) = bakoko
  - Lutjanidae (snappers) = maya-maya

Ecological importance

nutrient recycling and source

trophic structure

- condition of the standing stock
- reef habitat modification

Economic importance

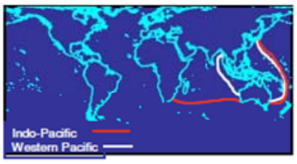
food source

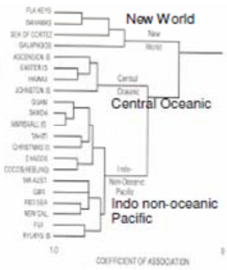
aesthetic value (tourism)

Characteristics...

D) Distribution patterns

- most have broad geographic distribution
- some taxa are restricted
  - Western Pacific Ocean
  - Atlantic Ocean
  - Indian Ocean





Cluster analysis at family level From Thresher 1991

Characteristics...

E) Taxonomic characteristics

dominated by perciform teleost (maya-maya body shape)

- 445 families (Nelson 1984)
  - 150 perciforms
- 150 families (Myers 1989)
  - 51 perciforms

others:

elasmobranch (sharks), anguillids (eels), scorpaenids (scorpionfishes), holocentrids (soldierfishes), syngnathids (seahorses)

Allen, G. 2009. Conservation hotspots of biodiversity and endemism for Indo-Pacific coral reef fishes. Aquatic Conserv: Mar. Freshw. Ecosyst. 18: 541–556

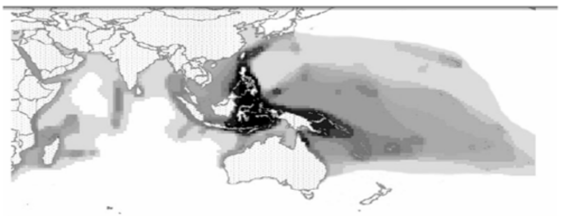


Figure 3. Map of the Indo-Pacific region showing diversity isopleths for tropical reef fishes. The lightest shade represents between 200 and 400 species and the darkest shade between 1300 and 1700 species.

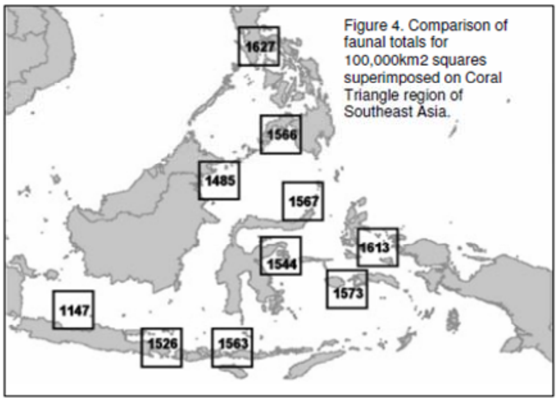


Figure 4. Comparison of faunal totals for 100,000km2 squares superimposed on Coral Triangle region of Southeast Asia.

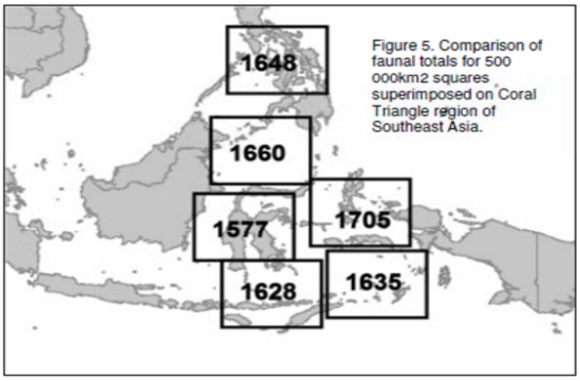
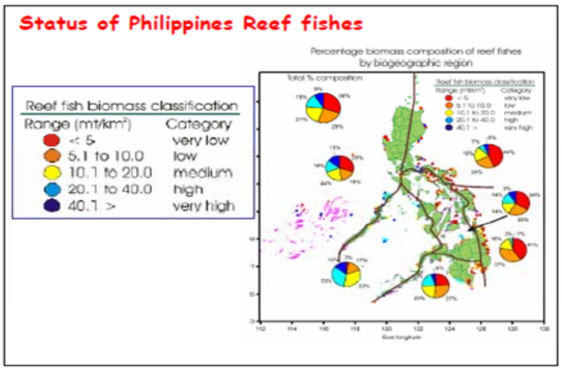
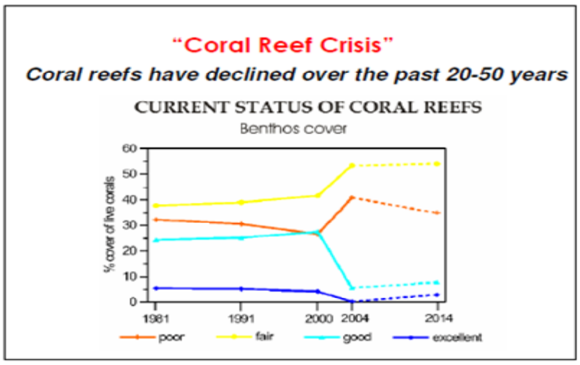
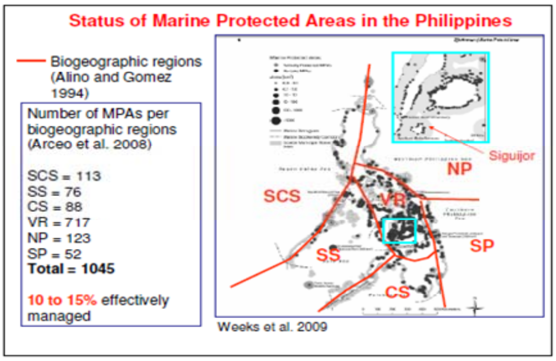
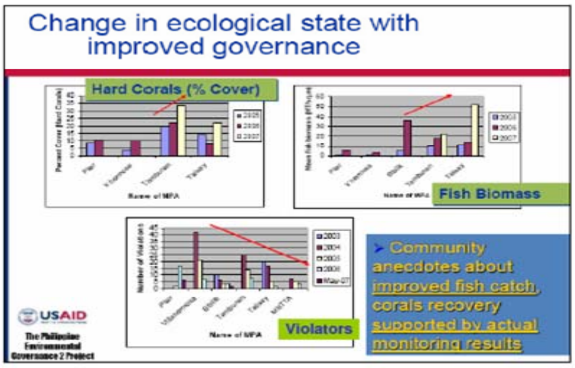


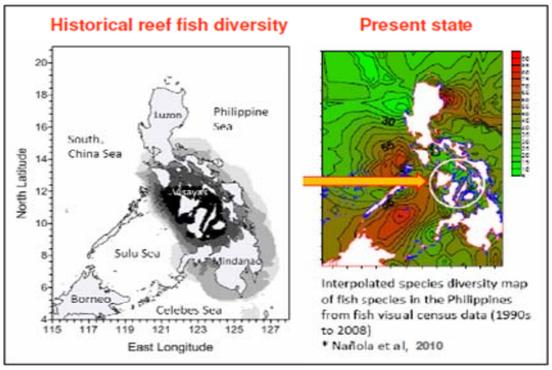
Figure 5. Comparison of faunal totals for 500 000km2 squares superimposed on Coral Triangle region of Southeast Asia.











Assessment of reef fishes

What is the purpose of the assessment?
- species richness or diversity
  = unique or endemic species
- determine the status of the stocks
  = increasing or declining thru time
- reef integrity or reef health
  = high or low top carnivores
  = density of herbivores

Methods on reef fish stock assessment

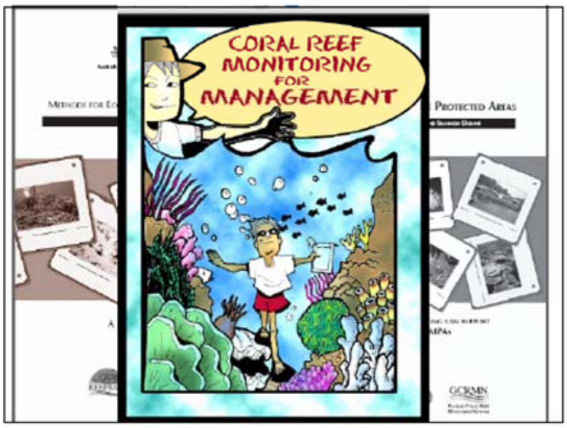
Fishery based
- Municipal fishery monitoring (i.e. different fishing gears)
  = catch composition
  = extraction rate (CPUE)
  = population analyses (i.e length data)

  limitation
  = difficulty in getting the total (all or major species) stock
  = bias brought about by the selectivity of the fishing gears

Independent survey
- Blast fishing
- Use of poison
- Use of fishing gears thru experimental fishing
- Underwater fish visual census

Why underwater fish visual census?

- Rapid
- Non-destructive
- Inexpensive
- Can be done repeatedly
- Gives a snap shot of the fish composition per unit time and area



Limitation of the method

- Can be done only in clear waters
- Knowledge of the observer in fish taxonomy
- Length estimates might be far from actual size
- Cryptic species (moray eels, gobies, etc) are under represented

Type of information

Species diversity
= listing at a species level but limited within the desired width of the transect

Fish density
= area surveyed is known

Size class distribution
= sizes are being estimated in collecting the data

Fish biomass estimate
= based from the size estimate and using the relationship of $W=aL^b$, weight can be computed. Where *a* and *b* are growth parameters per species (available at www.fishbase.org).

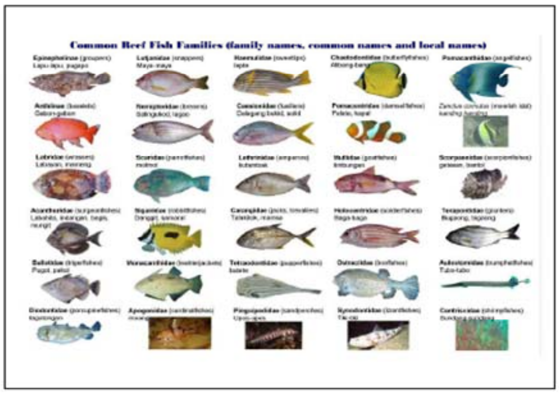
Equipment and manpower needed

At least two divers (minimum)
Plus Boat man

Boat or banca
Snorkling equipment
Scuba diving gears
Writing slate or slate board
Transect line (50 or 100 m in length)
GPS
Underwater camera (optional)

Exercises on data standardization

- Knowledge on the biology and ecology of reef fishes
- Training on fish taxonomy
  laboratory and field exercises
- Size estimate standardization using dummy fishes field exercises
- Census time
  20-30 min for a 50m transect
  45-60 min for a 100m transect

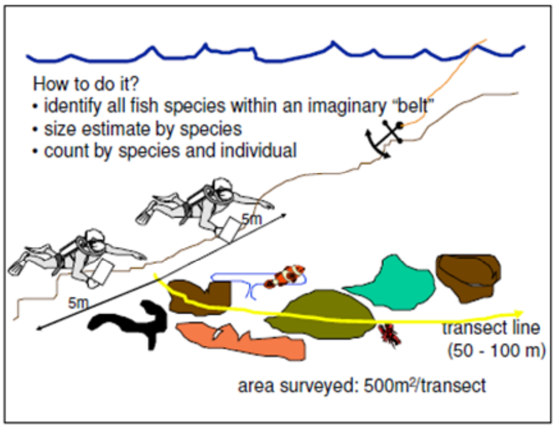


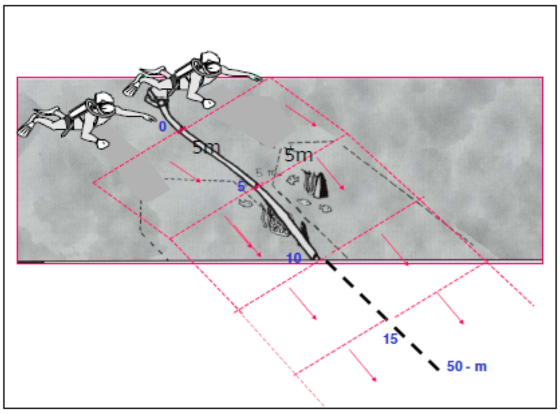
Methods:

a. Prior to conduct of study, observers must standardized among themselves fish names and size estimates.
b. Lay the transect line at a constant depth.
c. Wait 5-10 minutes for the disturbed fishes to return.

d. Two observers (one on each side of the transect line) identify and record the size and number of fish encountered 5-meters to his side while swimming along the transect. Size estimate can be actual total length (up to the nearest cm) or size classes.

e. Identify and count first fast-moving fishes then the site-attached fishes





Sample data sheet for technical survey

size estimate in cm

March 8, 2003
Site: T4, depth 20ft, steep slope, clear water
0-5 Poma brachialis 7-10 — total count
Chae trifasciatus 10-1
Labr dimidiatus 5-2
Chro viridis 8-20, 5-8
5-10 Amb curacao 12-3
Labr dimidiatus 7-1
Bali undulatus 15-1
Lut decussatus 20-1

Fish density computation = total count/area
Size class distribution = bar graph of frequency distribution by species or family

Computation of fish biomass

From the relationship: $W=aL^b$

e.g. Acanthurus nigricans a=0.067; b=2.669
[*a* and *b* values from existing length-weight (gm) relationship data]

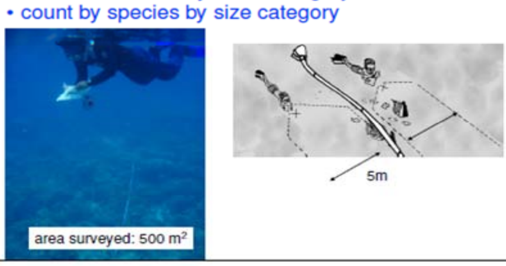
from data recorded: L=15cm, total count 5

$W=0.067(15^{2.669})*5$
$= 461.352$ grams

What to do since data are not exact size. Normally use the average of the size class (e.g. 0-4 use 2, 4-8 use 6) or the max size to get the minimum and maximum.

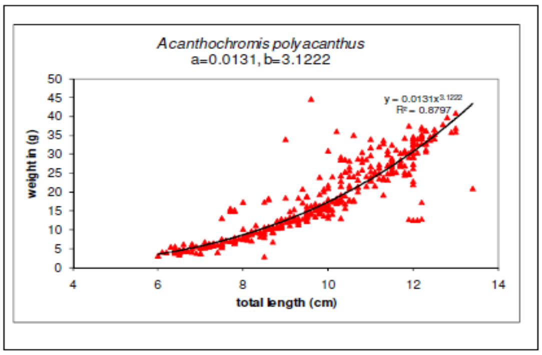
Snorkling survey

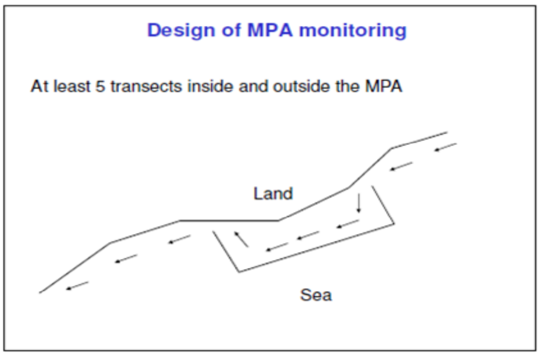
• identify all species group (i.e. target species) within an imaginary belt
• estimate the size by class category
• count by species by size category

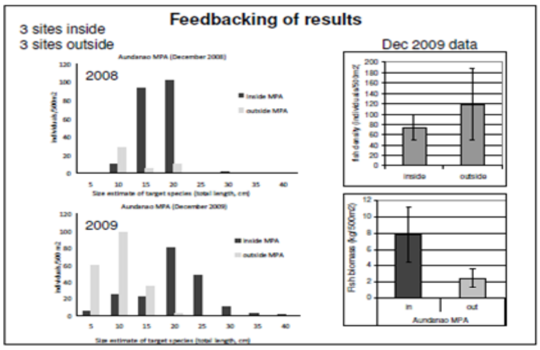


Data sheet for participatory assessment

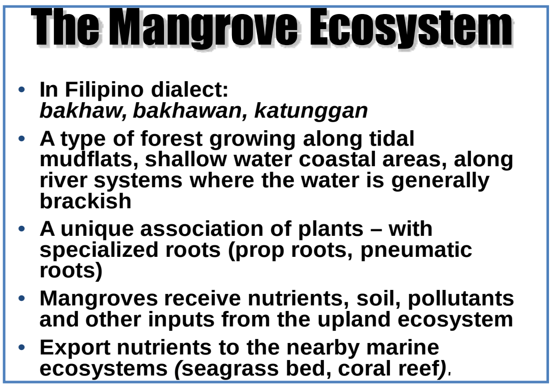
Name of Fish	0-4in (0-10cm)	4-8in (11-20cm)	8-12in (21-30cm)	>12in >30cm
Grouper	1	3	2	2
Goatfishes			1	
Parrotfishes			1	
Butterflyfishes		4		
etc				



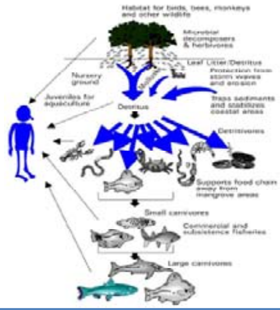




6.0 Monitoring of Mangrove Resources



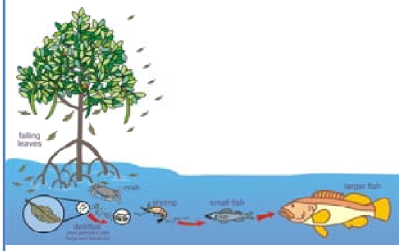
Economic and Ecological Benefits



Benefits to humans:

- Clean water
- Fish, shellfish, mollusks, etc.
- Medicines
- Tannins
- Wood (fuel and construction)
- Honey
- Alcohol
- Shore protection
- Research data
- Education
- Recreation/tourism
- Biodiversity

Contribution of mangrove litterfall to marine food chains.



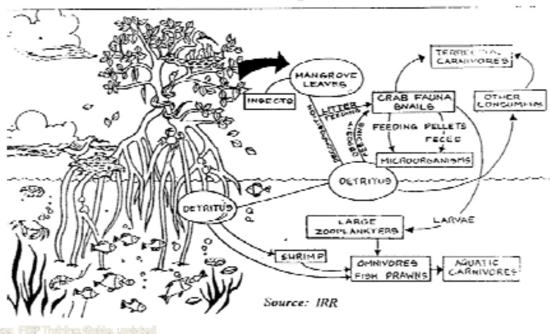
- one hectare of mangrove trees produces up to **3.6 tons of litterfall** annually.
- One hectare of healthy mangrove ecosystem produces about 1.08 tons of fish per year.

Functions of Mangrove Ecosystem

Ecological/Environmental Functions

- **Environmental Protection – mangrove 'greenbelts' (***flooding, typhoon, tsunami***)**
- **Nutrient Enrichment (***leaf litter decomposition)*
- **Fish Stock Replenishment** *(nursery of fish & invertebrates)*
- **Pollution Sink (**receives wastes from land & sea**)**
- **Wildlife Sanctuaries (**birds, mammals, fish)

Interactions in Mangrove Ecosystems



When restoration efforts turn wrong

By David Malakoff
*Science*NOW Daily News
15 July 2008

Conservation disaster. At this 10-hectare mangrove-restoration site in the Philippines, more than 90% of the seedlings died within a year of planting.

People are planting the trees in the wrong places.

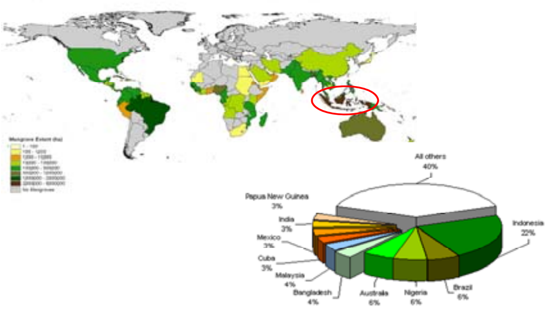
Ignorance or greed?

Threats to Mangrove Ecosystems

- Cutting for lumber, firewood, etc.
- Charcoal production (1960s-70s)
- Massive conversion to:
  - fishponds
  - industries
  - infrastructure
  - real estate

Worldwide Status

Mangrove extent per country (hectares).



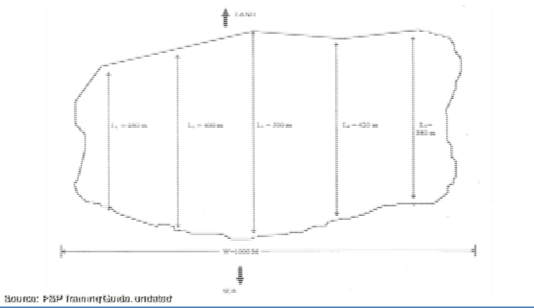
Field Methods

- **Location of sampling sites, establishment of transect lines and plots**
  - **At least 3 transects**
  - **10x10 meter plots (no/transect depends on length**
- **Identification and counting of tree species, saplings & seedlings**
- **Measurement of girth of tree stem at 1.3 m above ground**
- **Record observations on human or natural impact on mangroves**
- **Measurement of mangrove area (GPS)**

Materials Needed

- Transect line/surveying tape or rope
- Plastic slates w/ pencil
- Net bag (for leaf or flower specimens)
- Booties, shoes
- Tape measure
- Identification guide

Position of Lines in Mangrove Forest



Source: PSP TrainingGuide, undated

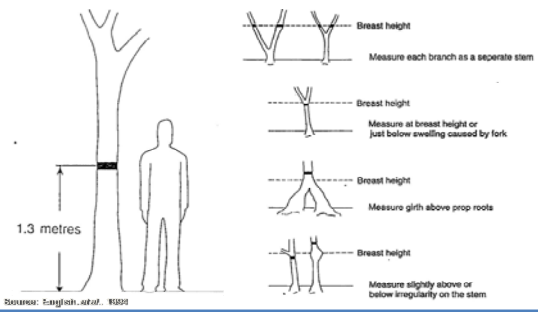
Classification of Mangrove Plants

Table 1.Classification of mangrove species (English *et al*.1997).

Classification	Circumference (cm)	Diameter (cm)	Height (m)
Trees	more than 12.5	more than 4	-
Sapling	less than 12.5	less than 4	greater than 1
Seedling		-	less than 1

a.) Trees b.) Saplings c.) Seedlings

GBH (girth-at-breast height) Measurement



Source: English et al. 1997

Analysis of Field Data

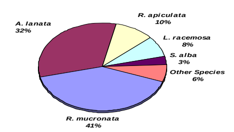
- **Tabulation of data according to diversity, density and basal area**
- **Graphical representation of data on species composition and life stages** (trees, saplings, seedlings)
- **Enumeration of evidence of impacts & threats**
- **Suggestions on management options**

Basal Area Measurements

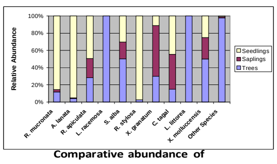
- **Convert girth (circumference) measurements to diameter: dbh = c/π**
  - **Example: c = 25 cm d = 25/3.1416 = 7.96 cm**
- **Calculate for basal area (per species):**

  $A = \pi r^2$
  - **Example: d = 7.96 cm; r = 3.98**
  - **$A = 3.1416\ (3.98)^2$**
  - **Basal area = 49.74 cm**
- **Sum up BA for all species**
- **Convert to m2/hectare**

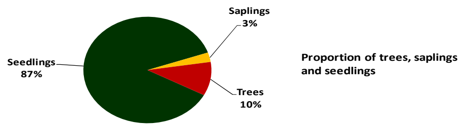
Sample Charts for Feedbacking Results



Relative abundance of different mangroves

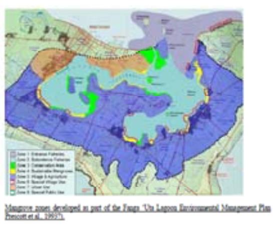


Comparative abundance of trees, saplings & seedlings



Proportion of trees, saplings and seedlings

Planning for Mangrove Management



Mangrove Resource Use Map

Strict protection forest
Rehabilitation areas
Sustainable use zone

7. Seagrass Monitoring

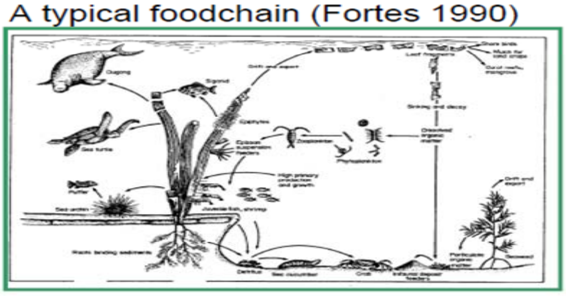
Monitoring Seagrass Communities

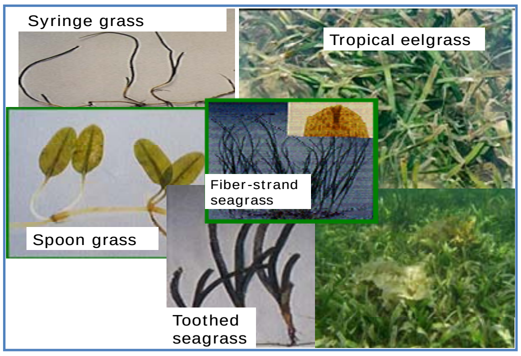
Asuncion B. de Guzman "SONY"
Mindanao State University at Naawan
9023 Naawan, Misamis Oriental

Seagrass Ecosystems

- ***A healthy seagrass meadow is one of most productive ecosystems in tropical coasts.***
- **Diversity**
  - **Worldwide: 60 species**
  - **Philippines: 16 species**

A typical foodchain (Fortes 1990)





Seagrasses Are a Food Resource

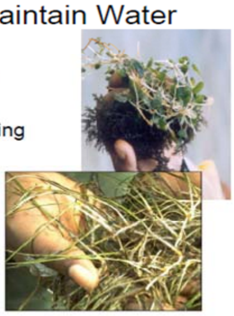
- Eelgrass - primary food source of dugongs
- Sea turtles consume seagrass
- Fruits of eelgrass (*E. acoroides*) are a delicacy as salad
- Abundant with edible sea urchins

Seagrasses Provide Habitat and Shelter

- Leaves provide habitat for tiny plants
- Tiny plants are the food resource of many fish, shellfish, and crustaceans
- Leaves provide hiding spots for juvenile fish and other animals

Seagrasses Help Maintain Water Quality

- Roots trap sediments and promote water clarity
- They reduce sediment stirring caused by currents
- Stems and roots hold dead materials in place for decomposition

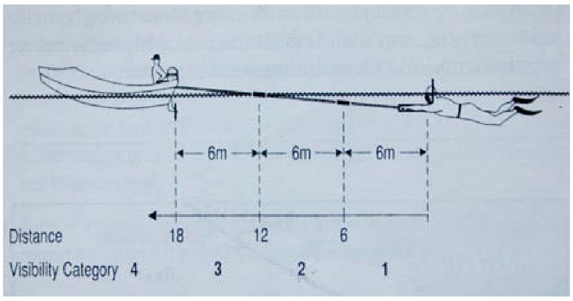


Diversity of seagrass meadows

- most meadows are monospecific (temperate)
- mixed meadows in tropics ~ 5-12 species
- major biological diversity contributed by associated flora and fauna

METHODS

1. Manta Tow Reconnaissance Survey - pagsusi sa lokasyon sa kalusayan



1. Transect Quadrat Method

Parameters Measured:

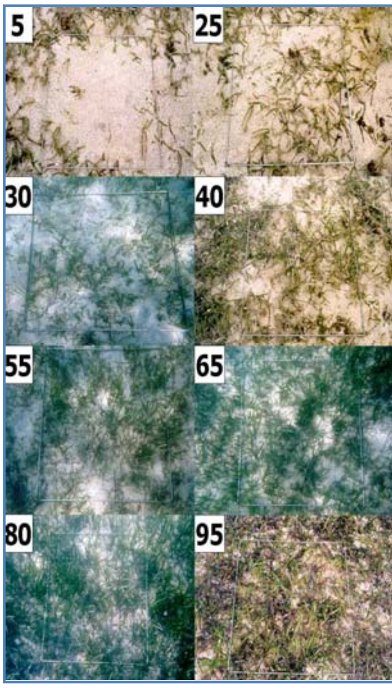
- species of seagrass and macro invertebrates
- % cover of seagrass
- Substrate type
- Fish abundance

Expected Output:

- Species composition
- Average % seagrass cover
- Density of macroinvertebrates
- Density of fish

Materials Needed

- 50m pvc transect tape or calibrated polyethylene rope (calibrated every 5 m interval)
- Mask & snorkel or goggles
- Underwater slates with attached pencil
- Boat and fuel
- Laminated seagrass, invertebrates, and fish identification guides (optional)
- GPS
- Herbaria presser and paraphernalia



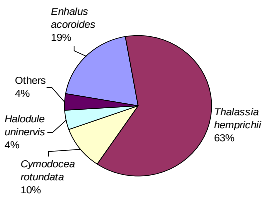
Important Note:

NEED TO STANDARDIZE READINGS

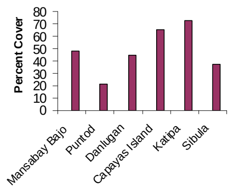
MACROINVERTEBRATES (Shellfish, sea urchins, etc.)

- Conduct with the SG survey
- Snorkeler swims/floats above the transect line while observing 2-5–m on both sides and forward until the next 5-m mark
- The observer swims and stop every 5-m along the line to record the type and counts of macroinvertebrates until the transect is completed

Sample Charts for Feedbacking



Relative Abundance of Different Seagrasses



Comparison of Seagrasses Cover in Different Sites

SEAGRASS HABITAT ASSESSMENT

TRANSECT DATA

Date: **Location:**

Transect No.	Quadrat No.	Species	% Cover	Substrate Type	Other Observations (seaweeds, macroinverts)