CSI info

ENVIRONMENT AND DEVELOPMENT IN COASTAL REGIONS AND IN SMALL ISLANDS

N° 12

An ecological assessment of

Ulugan Bay

Palawan, Philippines

UNESCO

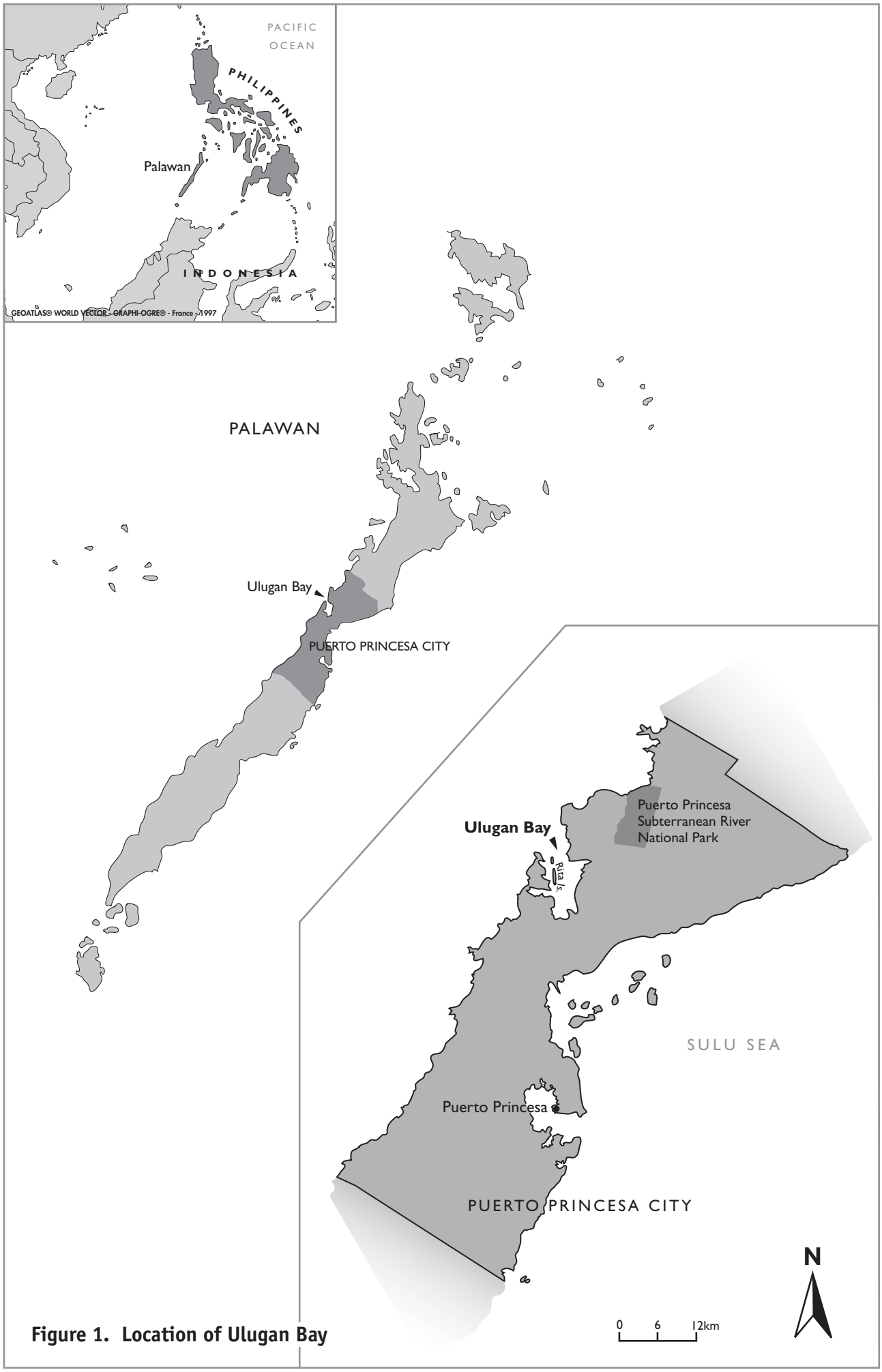

Figure 1. Location of Ulugan Bay

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An ecological assessment of

Ulugan Bay

Palawan, Philippines

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Preface

Balancing conflicting priorities, such as those deemed essential for improving individual and collective livelihoods by local communities and those perceived as being in the national interest by governments, is always difficult, and never more so than in a beautiful and relatively pristine island, such as Palawan in the Philippines archipelago, often deemed the 'last frontier of the Philippines'.

It is these very conflicts, together with a host of others, which are addressed in an ongoing field project: 'Coastal resources management and ecotourism: an intersectoral approach to localizing sustainable development, Ulugan Bay, Palawan, the Philippines'. This project, which commenced in 1996, is one of the 23 intersectoral and interdisciplinary field projects initiated by UNESCO's platform for 'Environment and Development in Coastal Regions and in Small Islands' (CSI).

Approach and methodology

With the added support of the UNESCO Chair in Integrated Coastal Management for Sustainable Development in Coastal Regions and in Small Islands at the University of the Philippines, and the Internet-based discussion forum on 'Wise Coastal Practices for Sustainable Human Development', this project involves the communities and other stakeholders in the development of sustainable livelihoods for the 6,000 inhabitants of Ulugan Bay. One of the major activities focuses on the development of ecotourism, as a sustainable and locally controlled activity.

This report documents one of the preliminary project activities, an ecological assessment of the bay, conducted in 1997–1998. While the results are important, perhaps one of the most interesting aspects of the assessment is that it was conducted by persons representing the communities, government and non-governmental organizations active in this part of Palawan. Not only were these persons trained in the collection of scientific data, but also in applying the information to the management of Ulugan Bay. By adopting approaches such as this one, through all the project activities, it is anticipated that the resources of Ulugan Bay can be utilized by existing generations and those still to come.

Dirk G. Troost.
Chief, CSI.

Acknowledgements

This ecological assessment would not have been possible without the important contributions of a considerable number of agencies, institutions and individuals. Firstly, we would like to thank the Marine Science Institute of the University of the Philippines, the National Committee of Marine Science under the UNESCO National Commission of the Philippines, and the Puerto Princesa City Government, in particular Mrs Melissa Macasaet, Mrs Tutu Almonte and Mr Roy Magbanua from the Agriculture Office. Among the national institutions we would especially like to thank the Palawan Council for Sustainable Development (PCSD), the Naval Forces Western Command and the Coast Guard, the National Economic and Development Agency (NEDA), the Department of Tourism (DOT), the Department of Environment and Natural Resources (DENR) and the Department of National Defense (DND). All of these institutions have made important contributions to this assessment.

Furthermore, we are much indebted to the local communities of Ulugan Bay (Barangays Bahile, Macarascas, Buenavista, Tagabenit, Cabayugan) and the two indigenous communities (Certificate of Ancestral Domain Claim – CADC) Cabayugan and Kayasan who, through their commitment and co-operation, have made this project a success.

Finally, we would like to thank the United Nations Development Programme (UNDP), who provided financial and technical support for the activities following on from this ecological assessment.

For the preparation of this report, we acknowledge the equal contributions of Stefano Fazi, Miguel D. Fortes and Hans D. Thulstrup, and for the editing, Gillian Cambers and Claire Blackburn.

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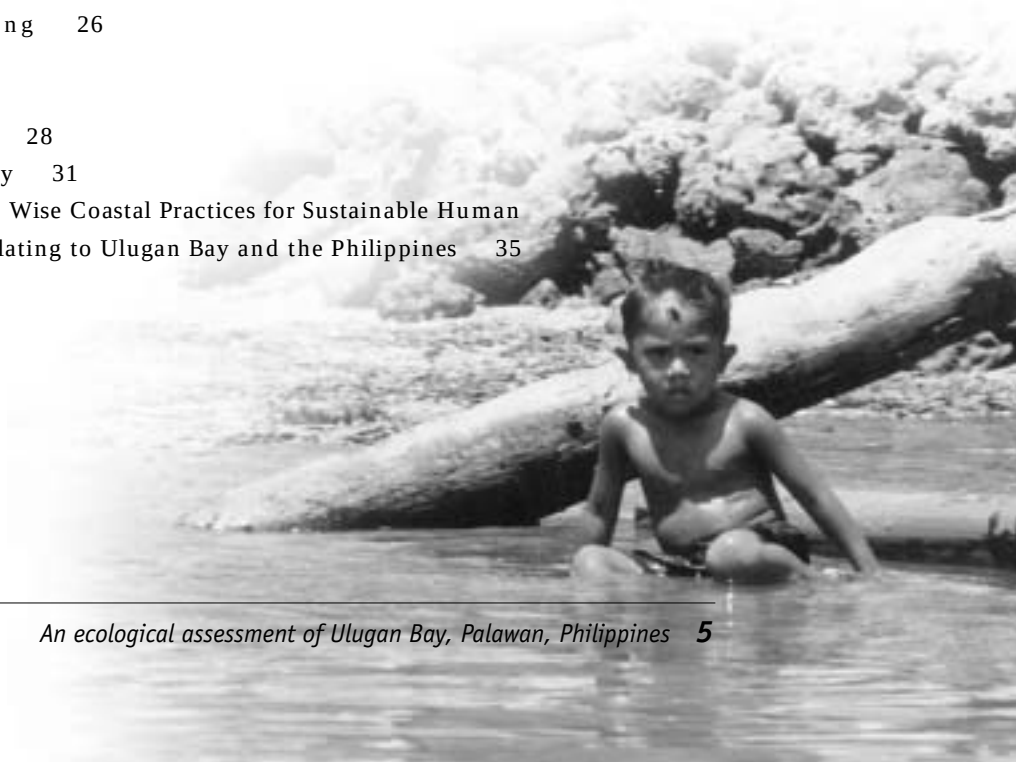


List of acronyms

CADC	Certificate of Ancestral Domain Claim
CSI	Environment and Development in Coastal Regions and in Small Islands
CS-ESP	College of Science – Environmental Science Program
dbh	(mangrove) diameter at breast height
DENR	Department of Environment and Natural Resources
DND	Department of National Defense
DOT	Department of Tourism
ELAC	Environmental Legal Assistance Center
ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
EU	European Union
GPS	Geographical Positioning System
ICM	Integrated coastal management
LCC	Live coral cover
LIT	Line intercept transect method
MAB	Man and the Biosphere Programme
NEDA	National Economic and Development Agency
NGO	Non-governmental organization
PCG	Philippine Coast Guard
PCSD	Palawan Council for Sustainable Development
SD	Standard deviation
SSI	Sorensen's Similarity Index
TL	Transect lengths
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
URL	Uniform Resource Locator
WiCoP	Wise Coastal Practices for Sustainable Human Development (forum)

Executive summary

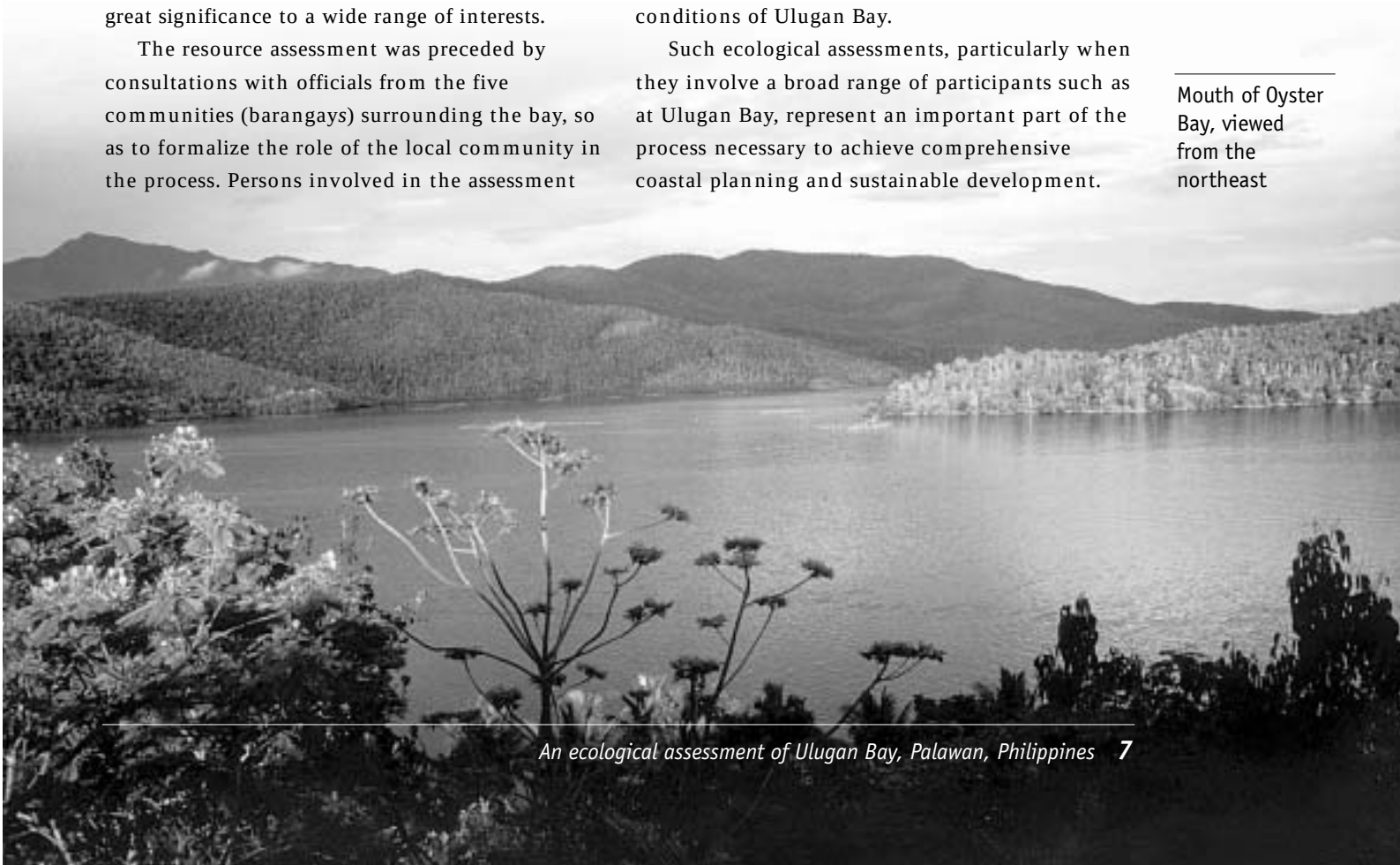
This document describes the approach, methodology, results and application of an ecological resource assessment at Ulugan Bay, Palawan, the Philippines. This assessment was conducted as one of the activities of a field project which is part of a global initiative of UNESCO's 'Environment and Development in Coastal Regions and in Small Islands' platform.

Ulugan Bay was selected because of its unique combination of environmental, social and locational aspects as well as its future potential role as a major site for ecotourism. Home to 15% of the mangrove forests of the Philippines, and an important site for coral reefs and seagrass beds, the area has extensive natural, biological and economic value. Furthermore, its location adjacent to the famous Puerto Princesa Subterranean River National Park and World Heritage Site, and its additional function as an important natural harbour for the Armed Forces, make it a place of great significance to a wide range of interests.

The resource assessment was preceded by consultations with officials from the five communities (barangays) surrounding the bay, so as to formalize the role of the local community in the process. Persons involved in the assessment came from a broad range of institutions and organizations including the local government, provincial institutions, the national park, the Navy, and other non-governmental organizations. The assessment had two main objectives, to provide input to a fisheries and biodiversity database and to train participants in data collection and the application of the scientific information to resource management and planning. A training course was held for the participants prior to the data collection. After the data collection, analysis and application, there was a post-assessment briefing and evaluation of the entire exercise.

During 1997–1998, data were collected on coral reefs, seagrass beds, mangroves, fish, seaweeds and water quality. These data are presented and discussed in this report. Key criteria were used to establish the current status of the ecological resources and environmental conditions of Ulugan Bay.

Such ecological assessments, particularly when they involve a broad range of participants such as at Ulugan Bay, represent an important part of the process necessary to achieve comprehensive coastal planning and sustainable development.



Mouth of Oyster Bay, viewed from the northeast

Introduction

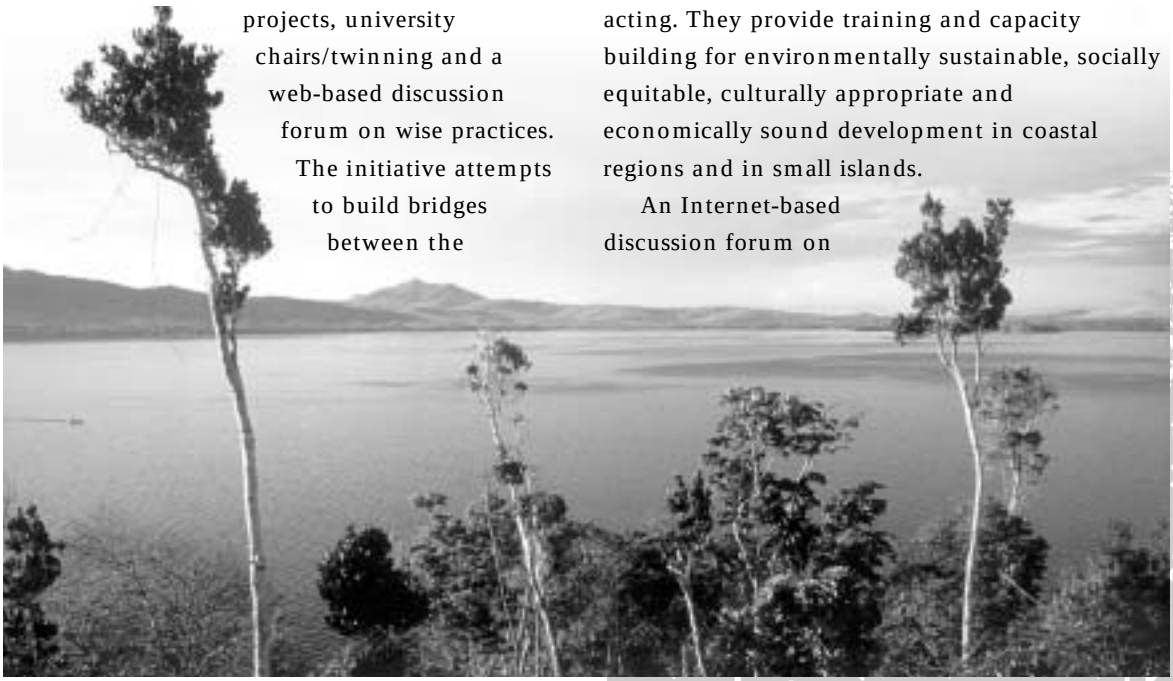
The coastal ecotone – a transitional belt linking the terrestrial and marine environments – is extremely complex and requires interdisciplinary teamwork for understanding and management. For truly integrated coastal management to take effect, co-operation across academic disciplines from the natural, social and human sciences is needed, coupled with political, public and private sector participation.

UNESCO's platform for Environment and Development in Coastal Regions and in Small Islands (CSI) was initiated to help foster such synergy. UNESCO's broad and essentially intellectual mandate as the United Nations specialized agency for education, science, culture and communication places the Organization in an ideal position to take the lead in bringing together the various agencies and institutions with potential bearing on sustainable coastal development. Launched in 1996, CSI's approach is intersectoral and interdisciplinary and employs three main modalities: field projects, university chairs/twinning and a web-based discussion forum on wise practices. The initiative attempts to build bridges between the scientific disciplines themselves, and between science and the challenges of the real world that face coastal managers and the people who make their homes in coastal cities and on small islands.

A series of field projects initiated around the globe seek to establish examples showcasing the positive impacts of *wise practices* in sustainable coastal management. To date, over 20 intersectoral field projects have been established in 60 countries, involving all sectors of society. From initial, integrated entry-points, these projects expand to encompass other related issues and further broaden their scope. This strategy allows project partners to learn how intersectoral co-operation is best put into practice, thereby enhancing the strength and quality of response to coastal and small island issues.

University chairs in sustainable coastal development and university twinning networks are being established at educational institutions worldwide to support the pilot projects and to foster new interdisciplinary ways of thinking and acting. They provide training and capacity building for environmentally sustainable, socially equitable, culturally appropriate and economically sound development in coastal regions and in small islands.

An Internet-based discussion forum on



'Wise Coastal Practices for Sustainable Human Development' (WiCoP forum) seeks to widen the framework of participation and expose the findings on wise coastal practices, obtained from the field projects and university chairs, to a much wider audience.

Linking the various knowledge systems to management is a major component of the CSI platform. It is planned to achieve this through the elaboration of wise practices, guidelines and principles, and ethical codes of practice for specific domains, thereby promoting the equitable sharing of coastal resources – which will provide a basis on which societies in small islands and coastal regions can further develop their own agendas for sustainable living in a world undergoing globalization.

Background to the project

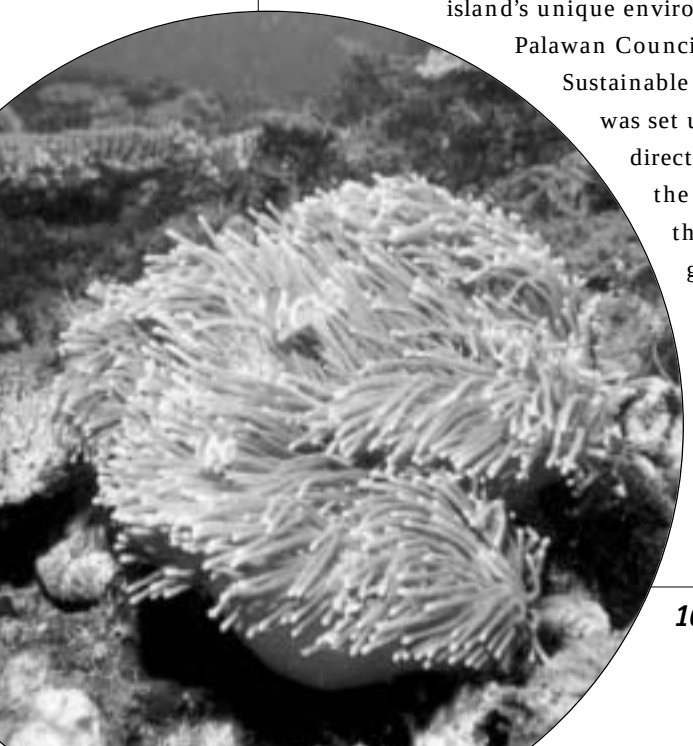
This document presents and examines in detail an ecological assessment carried out in 1997–1998 at Ulugan Bay in Palawan, the Philippines. Ulugan Bay is one of three CSI field project sites in southeast Asia, the others being Jakarta Bay in Indonesia and the Surin Islands in Thailand.

Often deemed the Philippines' 'last frontier', Palawan is home to a natural splendour rarely found elsewhere in the Philippines. The entire province has, since 1992, been classified as a UNESCO Biosphere Reserve, a reflection of the Philippine Government's recognition of the island's unique environment. The Palawan Council for Sustainable Development was set up under the direct authority of the President of the Republic to guide the development of the province in accordance with the highest environmental standards. The capital city of Puerto Princesa has for a number of years been known as the 'cleanest and greenest city in the Philippines'. Palawan is home to two UNESCO World Heritage Natural Sites: Tubbataha Reef Marine National Park, one of the most species-diverse coral reefs in existence; and the Puerto Princesa Subterranean River National Park, which lies directly northeast of Ulugan Bay, and centres on the Saint Paul Mountain Range, a spectacular limestone region, through which flows the longest underground river in the world, the Saint Paul. This river passes through eight kilometres of diverse cave formations before entering the sea.

Considering this background, it is perhaps not surprising that Palawan as a whole, and in particular the provincial capital Puerto Princesa, has chosen to focus on tourism as a cornerstone of the provincial economy. Tourism centres to an overwhelming extent on the coastal zone. Some areas in northern Palawan such as El Nido and Coron are already well-established names in the tourism industry. Exploring the development of environmentally sound and sustainable tourism has become a key issue for Palawan, in the hope that the less fortunate development experiences elsewhere in the country and the southeast Asian region may be avoided. Among the key concerns is the development of a tourism industry that benefits, and takes place on the terms of, the local population.

In recognition of this, the CSI platform at the UNESCO Jakarta Office began to elaborate, in 1996, a framework for activities targeting the management of coastal resources and the development of sustainable tourism at Ulugan Bay. A field project entitled 'Coastal resources management and ecotourism: an intersectoral approach to localizing sustainable development, Ulugan Bay, Palawan, the Philippines' was started in 1996 (see Appendix I for the project summary). Then in 1998, a UNESCO Chair in 'Integrated Coastal Management for Sustainable Development in Coastal Regions and in Small Islands' was initiated at the University of the Philippines and formally established in 2000. The chair provides interdisciplinary research support

Underwater scenario in Ulugan Bay



View of Ulugan Bay from the observation tower on Rita Island

to the field project as well as other projects, and serves as a focus for innovative training for the students and future coastal managers (see Appendix II for a summary of the chair activities).

Ways in which the field project and university chair activities have interlinked are discussed in the WiCoP forum, where ideas are exposed to a wider international audience. Appendix III contains extracts of three contributions to the forum, one dealing with the linkage between research and training at Ulugan Bay, another with illegal logging and tourism operations in Palawan, and a third with the problems caused by migrant fishers in Ulugan Bay.

Ulugan Bay was selected as the project site because of its unique environmental, social and locational features as well as for its potential as a major ecotourism destination in the coming years. Several events have taken place under the CSI umbrella of activities in and around Ulugan Bay since 1996. Key among these are:

- A Strategic Planning Workshop for the Stakeholders of the Ulugan Bay Area, Palawan, the Philippines, 27–29 November 1996. The workshop was held at the Palawan State University, sponsored by the Palawan Council for Sustainable Development and the UNESCO Jakarta Office, and attended by 36 stakeholders from the Ulugan Bay area.
- A series of local consultations among the communities of Ulugan Bay, focusing on identification of alternative income-generating activities. These were conducted over the course of several field visits by UNESCO staff during 1997 and 1998.
- UNESCO and the United Nations Development Programme (UNDP) organized a national symposium on Sustainable Tourism and Coastal Management for the 21st Century, 2–3 December 1997. This scientifically-based discussion focused on the role of ecotourism in sustainable coastal development and in biodiversity and cultural diversity conservation in the Philippines. A special section of the meeting focused on the island of Palawan.
- The St. Paul World Heritage Nomination Forum and Workshop, held 4–5 December 1997 at Puerto Princesa City, with the objective of assisting the Government of the Philippines in ensuring the successful re-nomination of the St. Paul River and its surroundings as a World Natural Heritage site. The workshop was supported financially by the World Heritage Centre.
- Coastal Resources Assessment (discussed in this document) meeting, held in June 1998 at Puerto Princesa City and Ulugan Bay. Associated with the assessment, several other events were organized, principal among these the Advanced Training Course for Coastal Zones Assessment and Zonation, held 8–12 December 1997.
- A Participatory Rural Appraisal Training Course organized in December 1998 by UNESCO in co-operation with the City Government of Puerto Princesa and the Tambuyog Development Centre.

Following these activities, fieldwork started in January 1999 on the UNESCO-UNDP project Coastal Resources Management and Sustainable Tourism. This project seeks to assist the City of Puerto Princesa and its sister authorities in ensuring the ecologically sound, economically sustainable development of Ulugan Bay.

The flow of consecutive activities building upon one another illustrates the key field project objective of developing tangible frameworks for collaborative action among sectors, agencies and stakeholder groups.

Biophysical and social settings

Aerial view of Ulugan Bay and Rita Island

Ulugan Bay covers an area of approximately 71 km^2, and is located slightly north of the geographical centre of the 450 km-long island of Palawan, the main land mass of the westernmost province of the Philippines. Palawan lies between the South China Sea and the Sulu Sea, and is orientated in a northeast-southwesterly direction, surrounded by more than a thousand smaller islands and islets (see Figure 1 on inside front cover).

Ulugan Bay itself can be visualized as a deep indentation in Palawan's fairly straight South China Sea coastline. The southern tip of Ulugan Bay marks the narrowest point of the island.

The area around the bay is flat, consisting of alluvial material, sandstone and shale. The coastal plain does not extend more than a few kilometres inland before rising steeply to form a rugged hinterland. In the lowland areas, the forest cover has been largely cleared for agriculture and settlement; however, the mid to upper slopes still retain extensive areas of secondary and primary forest. Eleven relatively small rivers drain Ulugan Bay's catchment area.

Palawan experiences a tropical/monsoon climate. It is subject to the influence of tropical depressions but only occasionally experiences typhoons, the northern area being the most prone. However, in December 1998, after the resource assessment exercise was conducted, the most severe typhoon in memory struck the Ulugan Bay area, causing extensive damage to the forests and coral reefs, including those off the coast at Sabang.

In terms of floral and faunal regimes, the island of Palawan resembles its giant neighbour to the south, Borneo, more than it does the other main islands of the Philippines. Ulugan Bay claims international recognition for its natural environment. Home to an estimated 50% of the province's mangrove forests and to 15% of the total mangrove cover of the Philippines, the bay's mangrove resources alone merit global attention. However, Ulugan Bay also harbours extensive seagrass beds and coral reefs, as well as abundant fish and other marine fauna.

Five rural communities – 'barangays' in Philippine administrative terminology – surround Ulugan Bay. Proceeding clockwise from the northeastern tip of the bay, the communities are Cabayugan, Tagabenit, Buenavista, Macarascas, and Bahile. Fishing is the main livelihood of the approximately 6,000 inhabitants of the villages in

the bay's barangays; agriculture comes a close second. In the mangrove areas, fisher folk harvest the abundant shrimps, crabs, oysters and other shellfish, while the coral reefs and deeper waters are home to a wide range of commercially valuable fish species.

A survey conducted in 1998 by the Coastal Environment Program of the Department of Environment and Natural Resources (DENR) shows that agricultural land in Ulugan Bay produces rice, coconuts, cashews, peanuts, corn and a variety of fruit and vegetables. Particularly for the inhabitants of Cabayugan, tourism is growing in importance as an alternative source of income. This barangay is close to the best-known tourist attraction of Palawan, the Puerto Princesa Subterranean River National Park, and includes the township of Sabang, also experiencing its tourism development.

Population growth in Ulugan Bay is significant to the extent that, over the next twelve years, the population is expected to increase by as much as 60%. While fishing and agriculture provide a steady income for most inhabitants, social problems and hardships do exist. In a recent survey, 388 children in Ulugan Bay were found to be suffering from malnourishment (Rivera-Guieb, 1999).

Due to its strategic location, its wealth of resources and its natural beauty, Ulugan Bay is a place of great significance to a very wide range of interests. To each interest group, indeed to each individual, the bay signifies something distinct and personal.

For the Armed Forces of the Philippines, the bay is a point of extreme strategic importance in terms of national security. In military terms, Ulugan Bay is the only significant indentation on Palawan's South China Sea coastline, and is within easy reach of the often-disputed Spratly Islands group. Oyster Bay, a bay within Ulugan Bay, offers a near-perfect natural harbour for military purposes. At the moment, to the consternation of the coastal inhabitants, there is a proposal that the bay become home to a naval base. However, with a more comprehensive definition of 'national security' now prevailing in military circles, and with the emphasis on the role of ecological balance being in the best interest of Filipinos, there might be hope for a functional co-existence among all the stakeholders in the bay, including the military.

Traditional means of transportation of the local and indigenous communities

To the fisher folk of Palawan, Ulugan Bay and its surrounding waters represent a fishing ground and nursery of unequalled significance and, to some, a place to secure a quick profit.

To the tourist, Ulugan Bay is neighbour to the Puerto Princesa Subterranean River National Park, the primary tourist attraction of Palawan and a World Heritage Site. It is an unexplored wilderness of pristine mangroves and corals, hidden and secluded beaches, and coves. It is a place the passing traveller can view in wonder, at a distance, on their way to other established tourist destinations. To conservationists and eco-tourists, Ulugan Bay is a site of spectacular scenery and home to the best-preserved mangrove forests of the Philippines, as well as to a magnificent variety of coral reefs, seagrasses, fish and water birds.

But most important of all, to its some 6,000 inhabitants, Ulugan Bay is home. Let us reiterate here a key point – the sustainable livelihood of the local population remains the focus of the project's activities in Ulugan Bay.

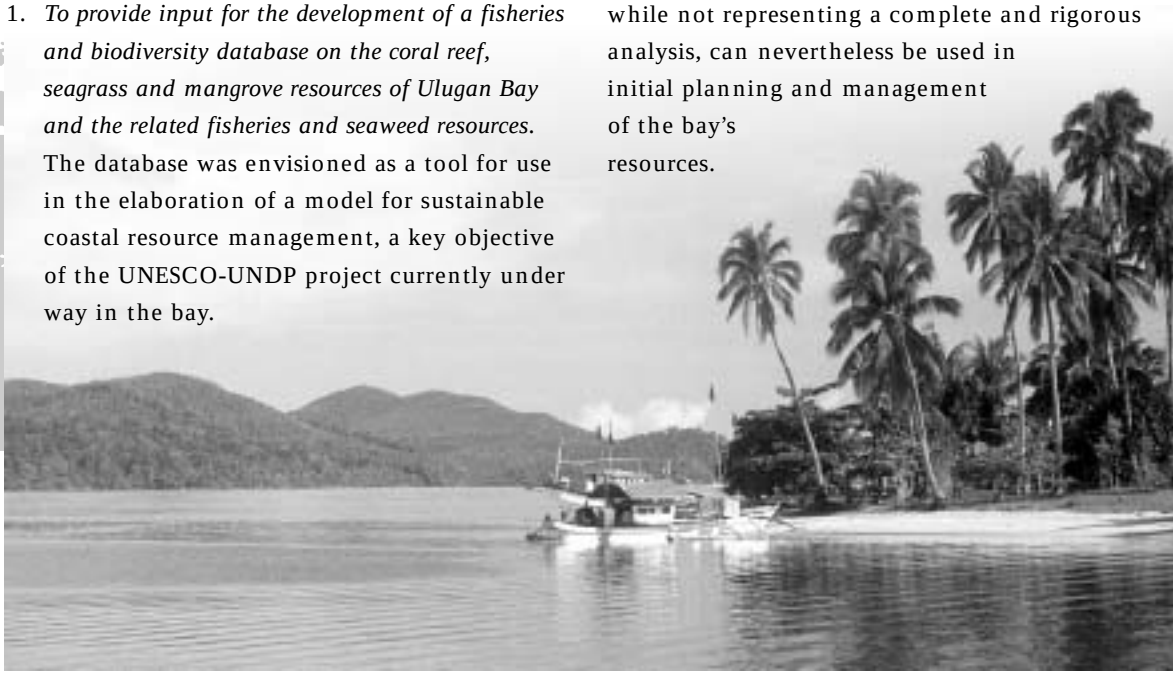
Coastal resources assessment

Objectives

In June 1998, a series of coastal resources assessment exercises were carried out in Ulugan Bay and Puerto Princesa City. The assessments were conducted by the National Committee on Marine Sciences of the UNESCO National Commission of the Philippines, with support from the UNESCO Jakarta Office. Participants came from a broad range of institutions and organizations active in Ulugan Bay and Puerto Princesa, and included staff from the Puerto Princesa City Government, the Puerto Princesa Subterranean River National Park, the Philippine Navy Western Command, and the Palawan Council for Sustainable Development, as well as local, national and international non-governmental organizations (NGOs). The assessment had two primary objectives:

1. *To provide input for the development of a fisheries and biodiversity database on the coral reef, seagrass and mangrove resources of Ulugan Bay and the related fisheries and seaweed resources.* The database was envisioned as a tool for use in the elaboration of a model for sustainable coastal resource management, a key objective of the UNESCO-UNDP project currently under way in the bay.
2. *To train participants in the identification, quantification and documentation of the ecological resources of Ulugan Bay and in the application of this information to resource management.* Through the application of ecological data to socio-economic and management issues, participants were able to develop their understanding of integrated coastal planning for sustainable tourism and the enhancement of living standards.

The following analysis and discussion demonstrates the value of a scientific and ecological assessment of coastal resources, not only with a view to obtaining ecological data in itself, but also for the transfer of technology and skills when such an exercise is conducted in a participatory manner. The exercise provides a 'rapid ecological assessment' of the bay and, while not representing a complete and rigorous analysis, can nevertheless be used in initial planning and management of the bay's resources.



Ulugan Bay: View of Rita Island

Integrated coastal management principles are only useful if they are founded on solid scientific and socio-cultural grounds. This foundation, in turn, is attainable only through scientific acquisition of relevant data, their effective dissemination, and eventual validation and use in the management decision-making process. In the Philippines, the failure of a number of management systems has been traced in large part to the inability of implementers to realize and apply these basic principles of research and development. Hence, assessment and documentation of the coastal and marine resources of Ulugan Bay are essential for future development activities.

Approach and methodology

The coastal assessment activities were preceded by consultations with officials from the five barangays surrounding the bay. This process was necessary to ensure that the local government and communities were informed of the nature and objectives of the exercise. Furthermore, it helped to formalize the role of the local community in the process. Participants at these introductory sessions were invited to air any reservations and concerns they felt about the activity, and agreements were reached on a number of critical issues.

Following the local community consultations, a pre-assessment briefing was held to ensure that all materials and theoretical requirements for the exercise were prepared and in place.

The Advanced Training Course for Coastal Zones Assessment and Zonation was held in December 1997, with the objective of training participants in the fundamentals of ecological assessment. The training course included both theoretical and practical elements.

During 1998 the assessment was conducted. A post-assessment briefing was held, during which a preliminary review and evaluation of the entire activity was carried out and prepared for inclusion in the activity reports. This organization of activities ensured the full co-operation and commitment of all parties.

Site selection

The assessment study started with the selection of the study sites from satellite images provided by a recent United Nations Economic and Social Commission for Asia and the Pacific (ESCAP)/ United Nations Environment Programme (UNEP) project. Sites were selected based on their representation of the prevailing coastal and underwater conditions of the bay and its vicinity, and the likelihood of reliable results.

In addition to the focus on habitat types, the selection of specific sites considered a number of criteria conventionally applied for the determination of protected areas, as follows:

- *ecological importance:* the strategic location of the site, its function as a source of larvae or propagules for downstream areas, its function as a nursery or spawning ground, the variety of its habitats, and the presence of rare or endangered species;
- *state of naturalness:* considering the degree of protection of the site from the influence of man's activities;
- *economic importance:* the site's existing and potential contribution to the economic well-being of the local communities;
- *social importance:* the site's existing and potential significance for the local, national and international community due to its heritage, historical, cultural, traditional, aesthetic, educational, or recreational qualities;
- *scientific importance:* the value of the site for research, education and monitoring;
- *practicality and feasibility:* the site's social and political acceptability as a research location, the extent of community support, accessibility for tourism and recreation, compatibility with existing uses and management practices, ease of management.

The study sites and associated communities are shown in Figure 2 and Table 1 on the next page.

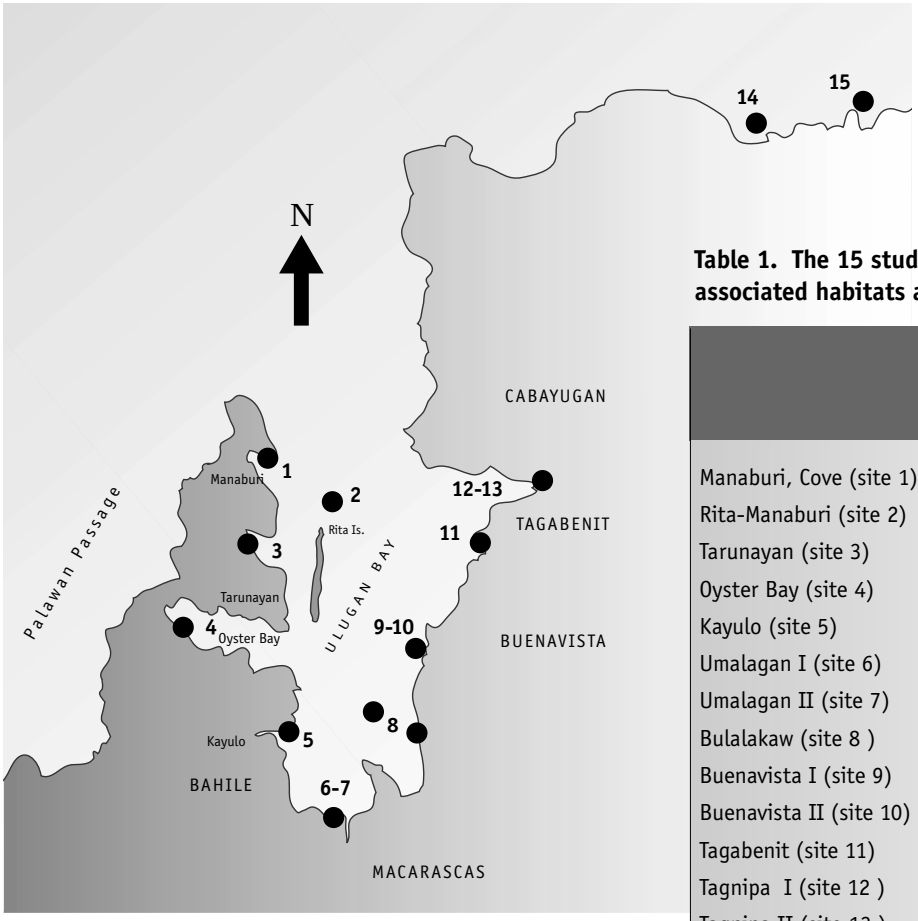


Figure 2. Location of the study sites in Ulugan Bay

Table 1. The 15 study sites in Ulugan Bay and their associated habitats and communities *(✔ = surveyed)*

	Mangrove	Seagrass	Seaweed	Coral reef	Coral fish
Manaburi, Cove (site 1)	✔		✔		
Rita-Manaburi (site 2)		✔	✔	✔	✔
Tarunayan (site 3)	✔	✔	✔		
Oyster Bay (site 4)	✔	✔	✔	✔	
Kayulo (site 5)	✔				
Umalagan I (site 6)		✔	✔	✔	✔
Umalagan II (site 7)	✔				
Bulalakaw (site 8)	✔			✔	✔
Buenavista I (site 9)	✔	✔	✔	✔	✔
Buenavista II (site 10)	✔				
Tagabenit (site 11)	✔				
Tagnipa I (site 12)	✔				
Tagnipa II (site 13)	✔				
Sabang (site 14)	✔		✔	✔	✔
Saint Paul Bay (site 15)			✔	✔	✔

Parameters investigated

Based on the criteria above, a series of ecological field assessments were performed with reference to the following focus areas: coral reefs, coral fish, seagrass beds, seaweeds, mangrove forests, seaweeds and water transparency. Habitats were assessed for their species composition, abundance, and intensity of environmental and human impacts. The status of coral reefs was measured based on the cover of six life form categories at seven sites, or stations. In the case of seagrasses, the abundance of the eight species present in the bay was determined at five stations in terms of density and frequency. The mangrove communities were assessed at ten sampling stations through measurement of frequency, diameter at breast height (dbh), number of cut and dead trees, and number of seedlings and saplings. A water transparency profile of Ulugan Bay was made using a Secchi disc and a Geographical Positioning System (GPS). The results of these assessments are discussed in the following sections.

Research findings

Coral reefs

In the assessment of coral reefs, the line intercept transect (LIT) method was used (English *et al*., 1994) to assess the sessile benthic community of the coral reefs. Along 150 m transect lines laid at the 5 m isobath, the community was characterized using six life-form categories (*Acropora*, hard coral, soft coral, dead coral, macroalgae, other) to provide a morphological description of the reef. Divers swam along lines placed roughly parallel to the reef crest at the desired depths along three 33.33 m transect

lengths (TL). In a 150 m line, the three TLs were the first-, middle- and end-segment of the line. For future monitoring, the location of each site was recorded and marked on the reef with a permanent metal mark. A team of at least three personnel was required – two divers and a person in the boat. All observers were familiar with the definitions of each life-form and they spent 30–45 minutes in the water at the beginning of each field trip, comparing and standardizing their interpretations of the various life-forms.
Table 2 shows the percentage cover of the six life-forms and two other categories (silt and sand) at the seven sites.

Live *Acropora* and non-*Acropora* represent on average 42%, dead corals cover 21% of the reef, while soft corals were the least dominant group. Sand, silt and rocks cover on average 19%.

Comparing the various sites, healthy coral communities were relatively more abundant at the stations of Buenavista, Bulalakaw and St. Paul. At St. Paul, non-*Acropora* was particularly prevalent. In contrast, dead coral dominated at Oyster Bay. A general trend was noticeable in that the branching or digitate forms of coral were relatively more abundant than the massive or submassive forms at the cleaner or more exposed sites such as Buenavista, Bulalakaw, Sabang, St. Paul and Rita-Manaburi.

Assessment of coral reefs using the line intercept transect method

Table 2. Percentage benthic cover at the study sites

	SITE 2 Rita-Manaburi	SITE 4 Oyster Bay	SITE 6 Umalagan I	SITE 8 Bulalakaw	SITE 9 Buenavista I	SITE 14 Sabang	SITE 15 St. Paul Bay
Live *Acropora*	**13.4**	**8.8**	**4.4**	**40.3**	**34.4**	**14.0**	**39.6**
Branching	5.3	8.2	4.3	8.9	4.4	1.4	20.4
Digitate	1.1	-	0.1	2.5	16.3	0.4	2.2
Encrusting	0.6	0.5	-	-	-	-	0.1
Submassive	0.3	0.1	-	2.2		-	-
Tabulate	6.1		-	26.7	13.7	12.2	16.9
Dead *Acropora*	**-**	**8.1**	**0.8**	**3.8**	**1.1**	**0.6**	**-**
Branching	-	8.0	0.8	2.6		-	-
Tabulate	-	0.1	-	1.2	1.1	0.6	-
Live Non-*Acropora*	**16.9**	**10.2**	**21.9**	**14.1**	**11.4**	**15.9**	**46.0**
Branching	0.6	-	1.2	0.1	1.2	1.9	3.8
Digitate	-	-	0.3	0.1	-	-	0.1
Encrusting	10.8	-	0.0	5.3	4.1	5.3	3.3
Foliose	0.7	-	0.2	0.5	0.8	0.2	22.6
Massive	2.8	8.4	6.3	5.2	2.9	5.3	7.1
Submassive	2.0	1.8	12.9	0.7	1.2	1.5	8.9
Mushroom	-	-	0.1	2.2	1.2	1.7	0.2
Heliopora	-	-	0.5	-	-	-	-
Millepora	-	-	0.4	-	-	-	-
Dead Non-*Acropora*	**18.4**	**28.9**	**18.0**	**23.6**	**17.4**	**19.5**	**6.0**
Soft coral	**1.1**	**-**	**0.5**	**1.7**	**12.5**	**10.7**	**3.4**
Others: sponges, zoanthids	**0.1**	**5.7**	**4.2**	**1.3**	**1.1**	**0.8**	
Algal assemblage	**4.0**	**8.1**	**6.2**	**3.9**	**2.8**	**15.7**	**2.9**
Seagrass, Halophila	**-**	**2.5**	**3.1**	**-**	**-**	**-**	**-**
Abiotic	**45.5**	**27.7**	**22.1**	**3.1**	**15.9**	**18.2**	**2.0**
Sand	45.5	10.2	22.1	3.1	15.9	18.2	2.0
Silt	-	17.5	-	-	-	-	-
Live coral cover (LCC) (%)	**30.3**	**19.0**	**26.3**	**54.4**	**45.8**	**29.9**	**85.6**
LCC index	**fair**	**poor**	**fair**	**good**	**fair**	**fair**	**excellent**

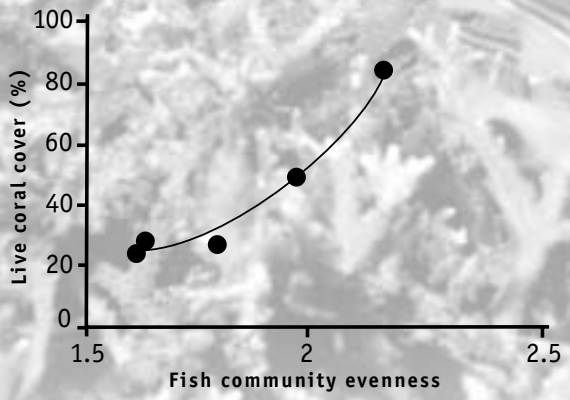


Figure 3. Direct relationship between live coral cover and biodiversity of the fish community

This contrasted sharply with the more protected stations, such as Oyster Bay and Umalagan, where the more massive/submassive forms dominated.

This observation is consistent with the general statement that the larger surface area in branching corals is an adaptive mechanism designed to help the coral cope with the lower level of nutrients and the stress imposed by crowding and shading from neighbouring coral species at the more exposed sites. Correspondingly, massive corals are better adapted to more protected, silted environments. In extending these arguments, it is often stated that the relative proportion of these two main coral forms – branching and massive – at a given site can be seen as an indicator of the site's degree of disturbance or siltation.

On the whole, the corals of Ulugan Bay are at a relatively late stage in the succession process, rather than a transitional phase. This was indicated by observations such as the preponderance of hard corals in contrast to the relatively low abundance of soft forms, and was particularly marked at the more protected stations of Oyster Bay and Umalagan, where soft coral forms were all but absent.

Coral fish

Coral reef fish populations were assessed by visual census along 150 m transects during daylight hours using SCUBA in conjunction with the Line Intercept Transect (LIT) for corals. Fish counts were made every 5 m along the line with a width of 10 m. All fish present within the belt transect were identified, counted and their standard lengths estimated (in cm). Juvenile fish were also monitored using the same method but with a narrower width of 2 m to facilitate observation.

Where applicable, the diversity index (Shannon-Wiener Index – Hs) was determined and the community similarity was estimated (Sorensen's Similarity Index – SSI) (Zar, 1984).

A total of 3,000 individual fish were recorded at six transect sites. They represented 63 species, 35 of which are of commercial value (see Table A, Appendix IV, for further details on fish data). Of the 25 families recorded, *Labridae*, *Pomacentridae* and *Chaetodontidae* were represented by the highest number of species with 10, 9 and 8 respectively. This result is consistent with similar studies undertaken elsewhere in the Philippines (Alino, 1994; Nanola *et al.*, 1994).

In Sabang and Rita-Manaburi, the fish community shows the highest similarity (see Table B, Appendix IV) and presents the highest number of species (29) and low diversity (Hs = 1.6–1.7). Evenness values were significantly reduced by the dominance of a few species (Sabang: *Abudefduf* sp., Rita-Manaburi: *Pterocaesio diagramma* and *Pomacentrus* sp.).

Offered the highest degree of protection from waves and wind of all sampling sites, and located adjacent to thick mangrove vegetation, Umalagan had the lowest number of fish individuals and the weakest association with the other sites. However, some similarities were noted with neighbouring Bulalakaw – similarity index of 56% (see Table B, Appendix IV). Rita-Manaburi had the overall highest species diversity with 34 recorded species, and also the highest number of individuals: 1,028.

Of interest is the direct relationship between fish community evenness and live coral cover (see Figure 3). These results emphasize the strong dependence of the fish community on the benthic sessile community.

Seagrass beds

Data on seagrasses were collected inside 50 x 50 cm quadrats placed at regular intervals along selected transects, perpendicular to the shore. The transects represented prevailing gradients in water depth, substrate, and exposure to wind and waves. The structure of the plant communities was assessed in terms of their composition, abundance, and status in relation to prevailing habitat conditions. In addition to % frequency and cover, density – the number of shoots per unit area, a more reliable index of abundance in discrete communities – was also used. Because of the inherent heterogeneity in the morphology of the species, frequency and/or density rating were used in the case of species with discrete habits (e.g. can be counted individually).

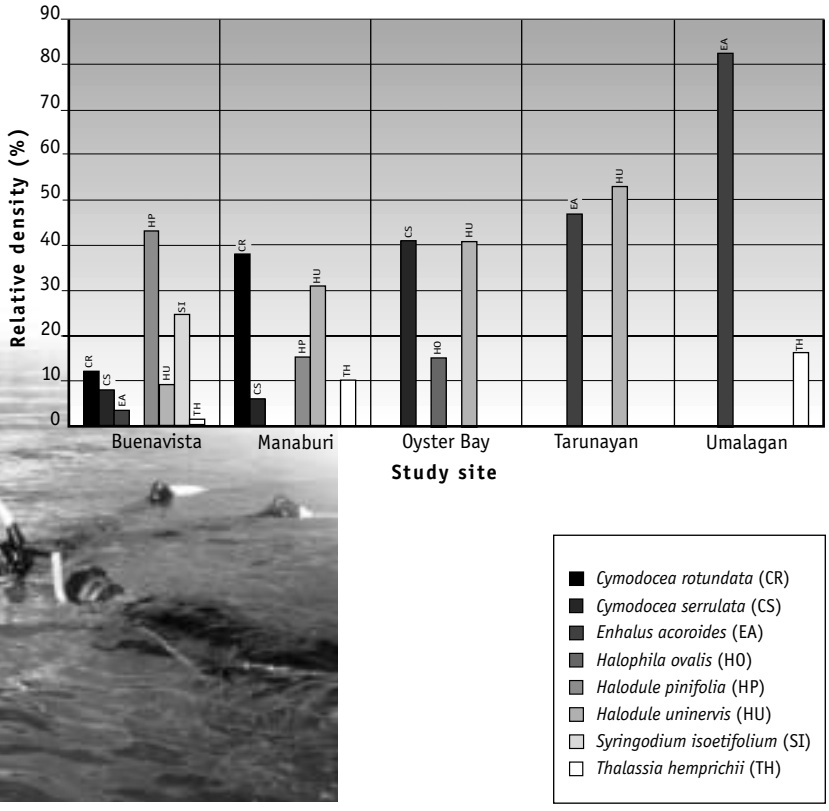
A series of photographs were taken periodically of representative quadrats using a Nikonos V underwater camera. The photographs not only allow speedy collection of data in the field, but also provide a permanent record of the quadrat, which is useful for long term monitoring of growth, mortality and recruitment (Gittings *et al.*, 1990). Monitoring of seagrass over time using observation and photography can also be a useful technique for detecting sediment smothering (Rogers, 1990).

The results of the surveys at the five seagrass stations demonstrated that seagrass species dominance in the bay is highly site-specific. The highest overall density was recorded for *Halodule pinifolia* at Buenavista, with 876 individuals per m^2. Details of species preponderance and density are provided in Figure 4 below and in Table C, Appendix V.

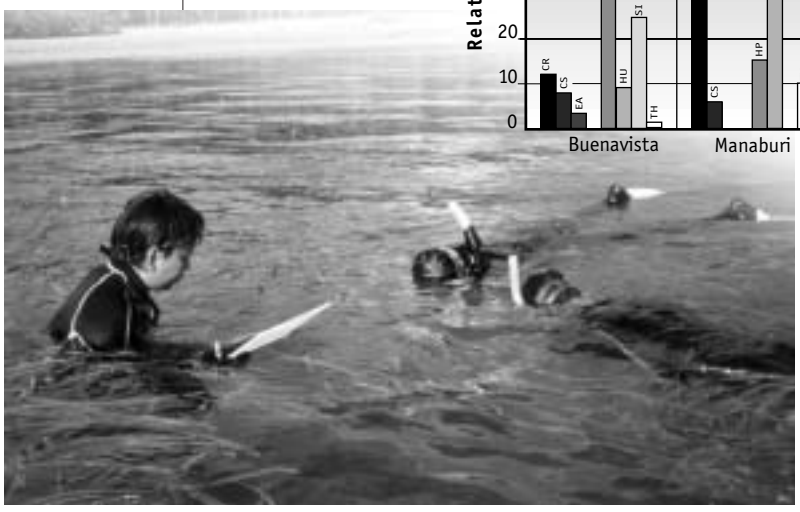
Among the five most dominant species in Ulugan Bay, the following sequence of decreasing ecological abundance (with values expressed in relative density) was established:

1. *Enhalus acoroides* (up to 82.8 %)
2. *Halodule uninervis* (up to 53.2 %)
3. *Cymodocea serrulata* (up to 46.5 %)
4. *Halodule pinifolia* (up to 43.3 %)
5. *Cymodocea rotundata* (up to 37.2 %)

Figure 4. Relative seagrass density per m^2 at the study sites



Seagrass survey in shallow coastal waters



It appears that the bay, as represented by the seagrasses at the five stations, is characterized by varying stages of ecological development. In turn, these stages represent the varying degrees of perturbation the stations are exposed to, whether natural or man-made. Seagrass vegetation proceeds from apparently more stable, highly diverse, mixed seagrass communities at Buenavista and Manaburi to the stable but less diverse, climax vascular vegetation found at Umalagan (*Enhalus acoroides* and *Thalassia hemprichii*) and Oyster Bay (*Cymodocea serrulata*, *Halodule uninervis* and *Halophila ovalis*), to less stable, similarly low diversity pioneering vegetation at Tarunayan (*Halodule uninervis*).

As referred to in the section on coral reefs, Umalagan and Oyster Bay represent deep indentations in the bay and as such are protected from wave action and are characteristically muddy. In contrast, Tarunayan, Buenavista and Manaburi are more frequently exposed to wave action, hence have coarser sediments. The pioneering and ecologically sensitive *Halophila ovalis* was observed in high density but only at one location, Oyster Bay.

In terms of diversity, the highest number of species observed at any one location was seen at Buenavista, where seven species were recorded (of the bay's eight species, only *Halophila ovalis* was absent). For details of individual species at the sampling stations see Figure 4. It is interesting to note that the distribution of seagrasses among the sites follows a pattern such that more protected sites have fewer species. However, as can be seen in Table C, Appendix V, the relative frequencies of these are correspondingly higher. Similarly, more exposed sites featured more species with overall lower frequencies. This observation demonstrates the classic inverse relationship between diversity and dominance, the latter expressed in relative density.

The total area within the bay covered by coral reefs and seagrasses is 12.4 km^2, based on an analysis of the satellite imagery employed in the assessment exercise. This figure is 24% higher than has been previously reported (Walters, 1996), and represents a coverage of 18% of the total bay area. Whether this figure represents an improvement in the cover after two years, or is simply a function of different data collection methods, is an important subject for further study. It should be noted, however, that the figure used in the present study was obtained from the latest satellite imagery, while the 1996 figure was the result of an approximation.

Seaweeds

Seaweed communities at the study sites were closely associated with seagrasses and coral reefs, i.e. were recorded along transects where these habitats were surveyed. Thirteen different species of seaweed were found at the seagrass sites and eight species were recorded at the coral reef sites (see Table D, Appendix VI). It should be noted that the seaweed data may be incomplete, as seaweeds have different requirements when compared to seagrasses, coral reefs and mangroves. Of the seaweeds recorded in the bay, a number have significant economic potential and are used as food and for medicinal purposes (see Table E, Appendix VI).

Mangroves

The mangroves were assessed at twelve sampling sites located in the most representative mangrove areas of the bay. Five 500 m^2 quadrats were established randomly at each site. Within each quadrat, data on the following parameters were collected: number of trees per species, diameter at breast height (dbh), number of cut and dead trees and number of seedlings and saplings.

The ten dominant tree species are listed below, ranked in order of decreasing density (average number of trees per 500 m^2):

1. *Rhizophora apiculata* (47.2)
2. *Rhizophora mucronata* (17.5)
3. *Bruguiera gymnorrhiza* (11.9)
4. *Aegiceras floridum* (3.2)
5. *Xylocarpus granatum* (2.1)
6. *Sonneratia alba* (1.8)
7. Unidentified (0.3)
8. *Bruguiera cylindrical* (0.2)
9. *Ceriops tagal* (0.2)
10. *Xylocarpus moluccencis* (0.1)

A surprisingly high percentage of the trees were young, with dbh values between 5 and 20 cm. Only one tree, a *Xylocarpus granatum* recorded at Sabang, had a dbh value of over 70 cm. In fact, it was only at Sabang that the mangrove trees were relatively evenly distributed in terms of dbh values. At the other locations, the distribution of trees was skewed towards the narrower, younger categories (see Table F, Appendix VII).

These findings show a predominantly young mangrove vegetation, which could indicate that the community is not at a stable stage and/or is recovering from a perturbation (i.e. harvesting). Over-harvesting results in the trees not attaining long lives and substantial growth. The distribution of trees belonging to various dbh classes varied between the sampling stations, and even between localities within each station. At stations in close proximity to human habitation, such as Bulalakaw, Buenavista, Tagnipa and Tagabenit, the mangrove tree populations were notably younger than average. In combination with physical evidence of cut trees (see below), this indicates that trees are cut for local household use.

Measuring the diameter at breast height of a mangrove

Line transect through mangroves

In contrast, at stations further removed from human settlements (such as Kayulo and Umalagan) or at stations under protection regimes (such as Oyster Bay and Sabang), trees had in general attained bigger trunk diameters and greater heights. At all sites, trees were generally younger at the frontal mangrove zones closer to the water body.

That the Ulugan Bay mangrove populations are dominated by recruitment over-harvesting was supported by the assessment of cut and dead trees. Overall, cut and dead trees occur more frequently and abundantly among the younger trees, although cut trees were observed among all dbh categories (see Table G, Appendix VII).

The abundance values of the seedlings reflect the degree of potential for recruitment of the trees and hence, their rate of colonization or re-colonization of a given area. In Ulugan Bay, seedling populations were assessed at all locations, revealing *Bruguiera gymnorrhiza* to have the most abundant seedlings with an average density of 78.2 individuals/500 m^2. The other species have the following density: *Rhizophora apiculata* (53.6), *Rhizophora mucronata* (45.1), *Aegiceras floridum* (12.6) and *Sonneratia alba* (10.0).

Saplings are somewhat older than seedlings, indicating their ability to survive the prevailing conditions for a period of 1–3 years after the seedling stage. Again, *Bruguiera gymnorrhiza* exhibited the highest total abundance at 60.8 individuals/500 m^2. A ranking similar to that

recorded for seedlings was established for the remaining species. The results show that the ratio of seedlings to saplings is generally slightly lower than 1. This shows that during the period of study, recruitment is greater than mortality in the overall development of the mangrove system.

Water transparency

Water transparency analysis was carried out at the sampling sites using a Secchi disk. In general, Ulugan Bay waters are clear throughout the year, with mean readings of 11.4 m (±6.58 SD). From the isolines (sampling points with similar depths), waters ranged from transparent, clear to very clear (disk readings greater than 10 m). These were noted predominantly at the more open, northern half and middle portions of the deeper part of the bay. On the other hand, relatively turbid waters (depth readings less than 10 m) were noted at the eastern, exposed sides of Rita Island and the southern and eastern bay margins. Consistently, the more turbid areas with depth readings less than 5 m were found at the mouths of the rivers inside Tarunayan and Oyster Bay, in small coves along the southwestern half of the bay and in shallow areas along the southeastern sections.

Preliminary application of assessment to planning

While gathering and analysing scientific data on Ulugan Bay's environment and natural resources constituted a significant part of the assessment exercise, equally important was the demonstration of the practical applications of scientific analyses for integrated coastal management.

Using the data collected during the assessment, participants discussed criteria to establish the current status of the coastal resources and environmental conditions in Ulugan Bay. The criteria adopted were based on specific management objectives and the natural characteristics of the sites (see Table 3 on next page). These criteria provide a good example of the type of categories that need to be considered in the preparation of an integrated management plan. However, establishing a set of criteria is very site- and circumstance-specific. For this reason, the criteria established in Ulugan Bay might not be directly applicable in a different setting.

As an example, the Ulugan Bay assessment indicated the prime importance and urgent need for protection of Sabang (due primarily to its pristine mangroves) and to Bulalakaw and Tagnipa (due to the undisturbed condition of Bulalakaw's highly diverse coral communities in the south-eastern corner of the bay, and the pristine old-growth condition of Tagnipa's mangroves). This assessment was achieved through weighting of ecological and economic criteria, since the local population had identified ecological and economic concerns as the most immediate issues in Ulugan Bay at the pre-assessment hearings. However, in contrast, when pragmatic criteria, rather than the ecological/economic criteria, were considered paramount, Tagnipa and Oyster Bay were of prime importance and in most urgent need of protection.

Assessment briefings of staff

Table 3. Criteria for the determination of management options

Ecological Criteria

Diversity
The variety or richness of ecosystems, habitats, communities and species. Areas having the greatest variety are rated the highest. Note that this criterion does not apply to pioneer or climax communities or to areas subject to disruptive forces, such as shores exposed to high-energy wave action.

Naturalness
The absence of disturbance or degradation. Degraded systems have little value to fisheries and tourism and make only marginal biological contributions. In contrast, if restoration of degraded habitats is a priority, degraded systems score high marks.

Dependency
The degree to which a given species depends upon an area, or the degree to which an ecosystem depends on given ecological processes occurring in the area. If an area is critical to more than one species or process, a high rating should be granted.

Representation
The degree to which an area represents a habitat type, an ecological process, a biological community, a physiographic feature or other natural characteristics.

Uniqueness
Whether an area is 'one of a kind'. Habitats of endangered species occurring in only one area are an example. To keep negative tourism impacts to a minimum, tourism may be prohibited while allowing for limited research and educational activities. Unique sites should always have high ratings.

Integrity
The degree to which the area is a functional unit, that is, an effective self-sustaining ecological unit. The more ecologically self-contained an area is, the more likely its values can be effectively protected. Consequently, a higher rating should be given to such areas.

Productivity
The degree to which productive processes within the area contribute benefits to particular species, including humans (eutrophic areas excluded).

Vulnerability
An area's susceptibility to degradation by natural events or by the activities of people.

Economic Criteria

Importance to species
The degree to which certain economically important species depend on the area.

Importance to fisheries
The number of fishers dependent upon the area and the size of the fisheries yield.

Nature of threats
The extent to which changes in land use patterns threaten the overall value to people.

Economic benefits
The degree to which protection will affect the local economy in the long term.

Tourism
The existing or potential value of the area to tourism development that is compatible with the aims of conservation efforts.

Pragmatic Criteria

Urgency
Whether immediate action should be taken, lest values of the area may be transformed or lost.

Size
Which and how much of various habitats should be included in a given protected area. Note that the protected area must be large enough to function as an ecological unit to receive a high rating.

Degree of threat
Present and potential threats from direct exploitation and development efforts.

Impact
Of the potential protection status on the environment and its inhabitants.

Concluding remarks

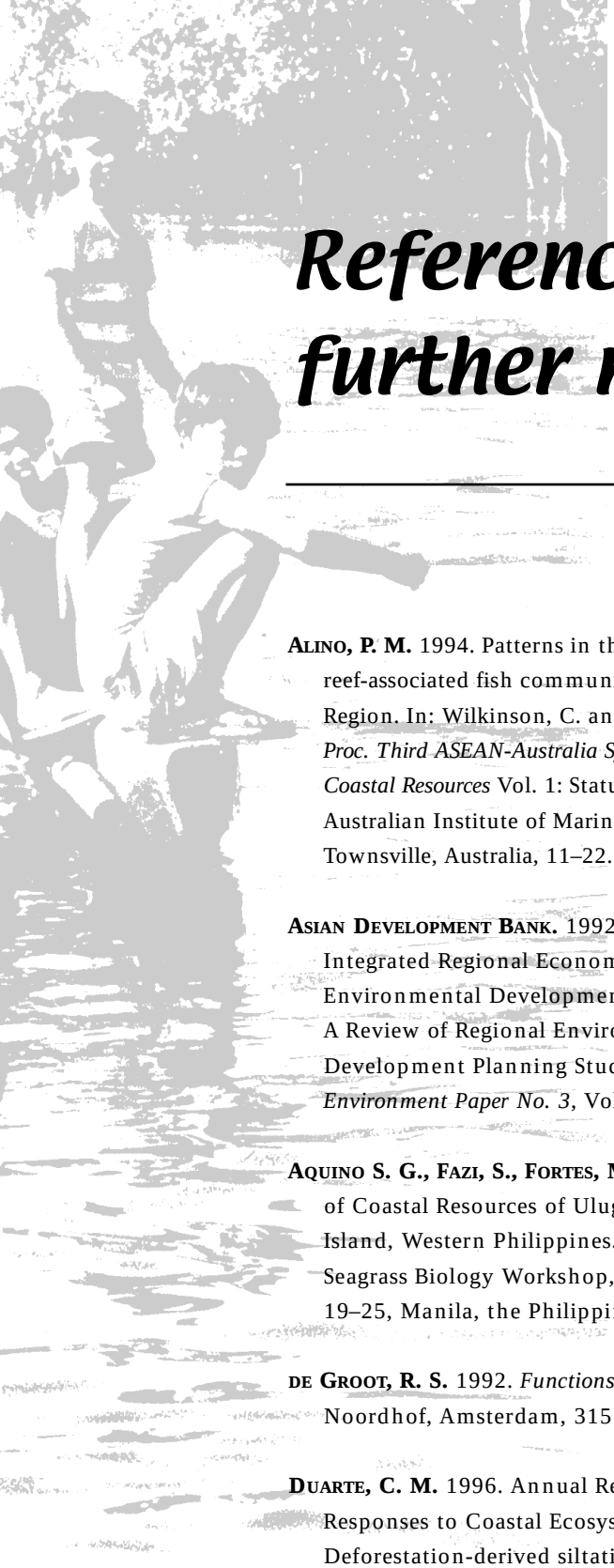
In the Philippines, the last ten years have witnessed an increasing interest in coastal environmental planning. This interest seeks to achieve a development modality that integrates environmental needs with economic development planning. Most land use planning decisions have hitherto been made without proper regard for coastal areas, and have been formulated principally on the basis of economic criteria, emphasizing development supported by infrastructure. Key in this planning has been the minimization of economic costs and the maximization of economic advancement. When the natural environment has been considered, it has often been as an economic constraint for development.

Flooding, slope stability, soil structure and seismic activity have been viewed as environmental factors reducing development potential, factors which could be made benign through engineering solutions. This improper regard for environmental factors in development planning '[...] has led to significant environmental degradation, irreversible loss of precious ecological and natural resources and, in many instances, hazard to life and property, unanticipated social costs, loss of amenity and quality of life' (Asian Development Bank, 1992). In addition, too much concentration on overall economic growth has engendered socio-economic disparities, which in turn have led to the creation of urban slums and their attendant effect on water supply and sanitation. Hence, there is an urgent need to modify development planning to incorporate protection of nature and her resources, as well as the provision of acceptable habitation for even the poorest of the poor (School of Urban and Regional Planning, 1997).

Thus, acceptable and comprehensive coastal planning has yet to be developed in the Philippines. Such planning should aim to create sustainable competitive advantages in coastal and marine industries – including the application of science and technology – and so contribute to industrial diversification and new opportunities for employment. It should also act as a catalyst to improve co-ordination between and within the public and private sectors.

This document demonstrates the significance and primary importance of ecological assessment as a tool in the coastal planning process. Our case in point, Ulugan Bay, is one of the relatively few remaining significant coastal areas in southeast Asia that has yet to see significant infrastructural development despite its location near a major urban settlement. It is still possible to see in Ulugan Bay natural scenery as it may have been prior to human settlement in the region. While this document by no means wishes to deter the economic development of the coastal zone, the hope is that such development will take place with due consideration that man-made laws simply serve to support the laws of nature. As recent examples from around the region have shown, unchecked development may end up costing society much more than the potential profit. The floods along China's rivers and their heavily logged catchment areas bore witness to this in the summer of 1999, as did the coastal areas of central Vietnam where previously mangrove-covered tidal areas had been left exposed to the ravages of tropical cyclones striking with disastrous effects. The application of scientifically supported interdisciplinary coastal planning is a key tool towards realizing this objective.

At Ulugan Bay, the chance exists to set an example for coastal development that balances the economic and social needs of the people with the long-term needs of the environment – both human and natural.



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Appendix I

FIELD PROJECT SUMMARY

Coastal resources management and ecotourism: an intersectoral approach to localizing sustainable development, Ulugan Bay, Palawan, the Philippines

Revision date	1 November, 2000
Title	Coastal resources management and ecotourism: an intersectoral approach to localizing sustainable development, Ulugan Bay, Palawan, the Philippines
Goal	To generate a model for community-based coastal resources management using an intersectoral approach strongly linked to the development of sustainable livelihoods
Location	Ulugan Bay, Puerto Princesa, Palawan, the Philippines
Starting date	1996
Partners	City Government of Puerto Princesa, Palawan; National Commission of the Philippines for UNESCO; United Nations Development Programme (UNDP); UNESCO: World Heritage Centre, Man and the Biosphere Programme, Coastal Regions and Small Islands platform.
Pilot project leader	Dr Miguel Fortes Environmental Science Program, College of Science, University of the Philippines Diliman 1101, Quezon City, the Philippines *tel:* 632 922 3959, *fax:* 632 924 7678 *e-mail:* mdfortes@pacific.net.ph, mdfortes138@yahoo.com
Description	Ulugan Bay is an important area within the Palawan Biosphere Reserve and the northeastern part of the bay is adjacent to the Puerto Princesa World Heritage Site. The natural resources of the bay (reefs, seagrass beds, mangroves) provide livelihoods to more than 5,000 residents and represent a significant source of fish for markets in Puerto Princesa. Major issues include unsustainable fishing and agricultural practices, conflicting private land ownership, pressures from tourism, the planned naval base and marginalized indigenous people.

The main activities in this project are as follows:

1. A strategic planning workshop was organized by UNESCO in 1996; this resulted in the establishment of a working group and was followed by a series of consultations with stakeholders around the bay. A needs survey was also conducted.

2. In 1997, efforts were concentrated on the development of a project document for planning inter-sectoral activities in the bay and capacity building for local institutions particularly in the field of data collection.

3. With the support of UNDP, and the close collaboration of the Government of the Philippines and the City Government of Puerto Princesa City, UNESCO started a 2-year project in 1998: Coastal resources management and sustainable tourism in Ulugan Bay. Following a data collection phase (ecological, traditional use, socio-economic profile, potential for sustainable tourism), the project focused on four main activity lines:

- Community-based experimental areas for sustainable fish farming in Ulugan Bay
- Assessment of biodiversity trends and establishment of a fisheries database
- Master plan for community-based sustainable tourism
- Non-formal environmental education for youth, and training

At the end of this two year project, in July 2000, a policy and management workshop was organized to foster open communication about the model between policy-makers and the communities in order to emphasize the lessons learnt.

Achievements & assessment

1. A platform has been created for the development of policy and management practices at the community level in Ulugan Bay. A linkage has been established between data and policy such that data can provide a significant input for managerial decisions. There now exist practical guidelines for managers and policy-makers.

2. An empirical model has been generated for sustainable development in coastal areas which can now be tested in other areas of the Philippines.

3. Local institutions have been strengthened to continue the biophysical monitoring activities and use these in addressing local issues.

4. Strong links have been established with other major UNESCO projects (Man and the Biosphere Programme, World Heritage Sites) as well as with the UNESCO Chair in Integrated Coastal Management and Sustainable Development. Activities funded by other agencies also complement this project, e.g. a European Union (EU) funded project on 'Prediction of recovery and resilience in disturbed coastal communities in the Tropics' and a project on mangroves implemented by the United Nations Economic and Social Commission for Asia and the Pacific.

Future directions

The activities initiated by the project are envisioned to be further enhanced and sustained via the gains and commitment by partners – local, national, regional and international. This will start the formal institutionalization process. Gaps in knowledge and management will be continuously addressed so that, at the end, the entire project will be transformed into a model in integrated coastal area management, not just in the Philippines but in the region as well.

Following the policy and management workshop in July 2000, a project proposal has been prepared and submitted to donors for the implementation of various sustainable tourism activities.

Appendix II

UNIVERSITY CHAIR SUMMARY

Revision date	1 March, 2001
Title	UNESCO Chair in Integrated Coastal Management for Sustainable Development in Coastal Regions and in Small Islands at the University of the Philippines, Diliman
Goals	In the short-term, to institutionalize a Chair in Integrated Coastal Management for Sustainable Development in Coastal Regions and in Small Islands at the University of the Philippines, Diliman. Emphasis is on disciplines, which the country and the region need: coastal ecosystem dynamics, integrated coastal management, socio-economics, cultural anthropology and institutional/legal dynamics. In the long-term, to use highly trained manpower to implement 'wise' management options for the sustainable development of coastal areas in the Philippines and the southeast Asian region.
Location	University of the Philippines, Diliman, Quezon City, the Philippines
Starting date	November 1998. The chair was formally established on 21 July 2000, with an agreement signed by the UNESCO Director General and the President of the University of the Philippines.
Partners	College of Science, Environmental Science Program (CS-ESP), University of the Philippines; UNESCO: Man and the Biosphere Programme (MAB), Coastal Regions and Small Islands platform.
Contact person	Dr Miguel D. Fortes Coordinator, CS-ESP Villadolid Hall, University of the Philippines Diliman 1101, Quezon City, the Philippines *tel:* 632 922 3959, 632 920 5301 loc. 7919 *fax:* 632 924 7678 *e-mail:* mdfortes@pacific.net.ph, mdfortes138@yahoo.com
Chairholders	Dr Miguel D. Fortes, Marine and Coastal Science, Second Semester, 1998–1999 Dr Luzviminda L. Valencia, Environmental Sociology, Second Semester 1998–1999 to First Semester, 1999–2000; *e-mail:* c/o Dr Miguel Fortes

Prof. Rebecca Rivera-Guieb, Social Sciences, First Semester, 1999–2000;
e-mail: rrivera@netgazer.com.ph, beckyguieb@usa.net
Dr Esteban Magannon, Social Anthropology, First Semester, 2000–2001;
e-mail: magannon@cybercable.fr

Description

The University of the Philippines and UNESCO jointly launched the chair to advance opportunities for promoting an integrated system of research and training, and to link the chairholders with pilot project activities in Ulugan Bay and MAB activities in Puerto Galera.

The following activities have been undertaken:

Research activities

1. The chair provides support for promoting an integrated system of learning that is accommodated as special topics in the CS-ESP. In the lectures and seminars for CS-ESP, the chairholders use their research data and involvement in the field projects as case studies and 'seeds' for class projects.

2. Dr Valencia, as a technical consultant in charge of the social aspects of development activities, has evaluated Environmental Impact Assessment reports on the provinces of Palawan and Mindoro.

3. Dr Fortes' class project in Environmental Science 282 (Environmental Impact Assessment) for the Second Semester 1999–2000 focused on the tourism development plan of Puerto Galera. Likewise, his other classes have produced studies that informed both the Ulugan Bay and Puerto Galera projects. He worked on the ecological profile of Ulugan Bay and uses this case study in his lectures.

4. Prof Rivera-Guieb's thrust is to utilize case studies, such as the Philippines experience on sustainable integrated coastal management (ICM) and the livelihood projects within the Fisheries Sector Program, to demonstrate ICM approaches. She worked on the socio-economic profile of Ulugan Bay and uses this case study in her lectures.

Support to pilot projects

1. The chairholders are actively involved in the UNESCO activities in Ulugan Bay and Puerto Galera. Dr Fortes, for example, was responsible for a study on seagrass-fish interaction in Ulugan Bay. Prof Rivera-Guieb used the socio-economic profile of Ulugan Bay as a basis for a community-based sustainable tourism initiative in the area.

2. The chairholders have interacted with the City Government of Puerto Princesa City in Palawan and the Environmental Legal Assistance Center (ELAC), the NGO in charge of the education campaign for the Ulugan Bay project.

3. Dr Fortes presently coordinates the UNESCO programme in Puerto Galera in the Province of Oriental Mindoro and has transformed the site into a laboratory for his classes so that the students can have a practical hands-on experience and a better appreciation of local and on-the-ground strategies. Dr Fortes and Prof Rivera-Guieb also participated in the Ecotone IX held in Puerto Galera in May 2000, as workshop coordinator and convenor of the socio-economics module, respectively.

Training activities

1. For the second semester 1998–1999 and with 15 students and 3 young researchers, the class in Environmental Science 297 (Special Topics: Coastal Ecosystem Dynamics) went to Ulugan Bay to conduct studies on coral reefs, seagrass beds and water quality. This initiative was the first attempt to monitor the damage wrought by the December 1998 typhoon. The results of these studies have contributed to an understanding of the natural components and processes in the bay.

2. For the first semester 1999–2000, the class in Environmental Science 297 tackled the same subject matter as in the previous semester, this time, emphasizing an ecosystem approach as well as an ICM approach. These combined methodologies are new additions to the academic content of the course.

3. In support of the activities in Ulugan Bay, Prof Rivera-Guieb facilitated training on participatory research and coastal resource management planning in 1998 and 1999. Community organizers from various NGOs in Palawan and community extension workers of the City Government participated in the training.

Achievements & assessment

1. The chair is laying down a foundation for an integrated system of research, training, information and documentation in the field of ICM and sustainable development in coastal regions and in small islands. This integrated system of learning is designed for the students, many of whom are trainers, researchers, NGO workers and government staff. Exchanges among the faculty, students and researchers use concrete examples that relate to practical strategies and local actions, which directly impact people's livelihoods.

2. One of the most significant achievements of the chair is to link teaching and research with project activities in Ulugan Bay and Puerto Galera. The scientific input guides the project activities and learning is enhanced by expanding the base of knowledge to include the views and perspectives of stakeholders from the project sites.

3. Efforts are being made to establish and expand institutional linkages. For example, the Philippine Coast Guard (PCG) of the Department of Transportation and Communication is expected to forge a co-operative venture with CS-ESP. The latter will train PCG personnel on the fundamentals of ecological science and pollution prevention, control and monitoring. The PCG has modern laboratory facilities which the CS-ESP lacks. The objective is to train personnel from all over

	the country and to institutionalize the effort so that capacity is built and maintained. In addition, CS-ESP coordinates activities with the National Defense College (where Dr Fortes is a Fellow) and plans to link up with the Department of Human Geography of Stockholm University, Sweden, and Connecticut College in the USA.
Future directions	To continue with the activities already initiated by the chair and to sustain efforts of the CS-ESP in institutionalizing the integrated system of research, training, information and documentation in the field of ICM and sustainable development in coastal regions and in small islands.

Appendix III

Contributions from the Wise Coastal Practices for Sustainable Human Development Forum relating to Ulugan Bay and the Philippines

The Wise Coastal Practices for Sustainable Human Development Forum may be accessed at: http://www.csiwisepractices.org, user name = csi, password = wise.
Each contribution has a number such that the uniform resource locator (URL) for a contribution is: http://www.csiwisepractices.org/?read=x where x is the number of the contribution.
The URLs are included for the three following contributions, as well as for the list of additional contributions relating to the Philippines, listed at the end of this Appendix.

Combining research and education in protected area management / Ulugan Bay, the Philippines.

(http://www.csiwisepractices.org/?read=78)
Posted by: Miguel Fortes
Date: Thursday, 12 August 1999

(Extract)
As part of the bigger project, a workshop undertaken by Green Globe, an international NGO, mandated to take charge of the tourism component, was held in Puerto Princesa, 16–18 June 1999. It looked at the potential of Ulugan Bay as a tourism destination. But the way their recommendations were formulated was not culturally sensitive enough, so we reacted strongly (but discreetly) against it. Simply prescribing cottage industries just because there are people who make baskets is courting disaster. Somewhere within the prescription, there has to be an effective cultural dimension to link with the action.

A most significant and surely a wise practice is our integration or linking of the research and teaching obligations of the UNESCO chairholders with the tourism and management activities in Ulugan Bay. For my part, my team does the assessment of the coastal resources (seagrasses, coral reefs, mangroves, fishes, seaweed) and investigates the demographic dynamics of mangrove saplings at both reforested and natural sites (with a scholar for the M.Sc. degree). This management-oriented research now forms the basis for the tourism plan, likewise augmenting and updating the body of knowledge useful in the formulation of policies for area protection and sustainable use.

On the other hand, the chairholder in the social sciences very recently finished a socio-economic profile of the communities in the bay. In contrast to similar or related works in the past, this profile is much more receptive to the actual needs and perceptions of the people. With the scientific and educational inputs, it now forms a major basis for the tourism and management thrusts of the project. Come August, all these inputs (scientific, socio-cultural, anthropological, legal and educational) will be collated and integrated in a workshop in Palawan and immediately shared with the people.

Dr Miguel D. Fortes
Environmental Science Program
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University of the Philippines
Diliman, the Philippines

Exposing the hypocrisy of some 'environmental' resorts

http://www.csiwisepractices.org/?read=174
Posted by: Miguel Fortes
Date: Saturday, 19 February 2000

In response to:
'The role of non-governmental organizations in programme implementation'
by Jean Wiener

It is not only self-serving governments and NGOs that we have to deal with, but also the owners and managers of self-serving 'environmental' tourism operations.

The Province of Palawan is the 'last frontier' of the Philippines as it is relatively the most environmentally pristine. This month (February 2000), environmental compliance monitoring was conducted of a resort in Puerto Princesa, Palawan. This resort is known internationally as a destination for nature lovers.

The results of the compliance monitoring showed several violations of our environmental laws:

1. The possession of several large pieces of fresh-cut squared timber, all of which have no existing permits (nato, a hardwood species);
2. Use of fresh-cut premium hardwood of the manggis species and of nato and saket species, for the construction of a staff house, all without any permits to possess or utilize the above mentioned premium hardwood or for its transport – manggis is classified as a banned premium hardwood as it is now a threatened species;
3. Building of a structure without any building permits nor an Environmental Compliance Certificate, with the use of fresh-cut round timber without any permit; the said structure was built in contravention of the mangrove stewardship agreement, knowing all too well that no permanent structures may be erected under such agreement; and,
4. The existence of an unauthorized corral for black tip sharks.

For several years now our communities have been reporting illegal logging activities in their respective barangays. The illegal loggers have been saying that the wood that they have been cutting from the mountains of Palawan was destined for this resort. For several years now, we have been trying to catch them in the act, and now we have finally succeeded.

This resort is operating without an Environmental Compliance Certificate. Their application is pending with the Regional Executive Director for Region 4. The owners and managers of this resort claim to be advocating the cause of the environment. They are nothing but hypocrites. They are one of the reasons why the hardwoods of Palawan are being cut, further compounding the critical state of our environment.

Dr Miguel D. Fortes
Environmental Science Program
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University of the Philippines
Diliman, the Philippines

The impact of migrant fishers on sustainable development / Ulugan Bay, Palawan, the Philippines

(http://www.csiwisepractices.org/?read=330)
Posted by: Rebecca Rivera-Guieb
Date: Friday, 2 February 2001

In response to:
'Enforcing environmental laws: a societal approach / the Philippines'
by Bob Johannes

The prevalence of illegal fishing is indeed a very complex social phenomenon that needs careful and thoughtful analysis. It is unfortunate that poverty is sometimes used as an excuse for the continued use of destructive fishing methods. Poverty largely influences such methods but there are a variety of other factors that account for its prevalence. The existence of institutions with

their corrupt practices has been mentioned. A lack of environmental consciousness and ecological values may be another. I want to share with you, an interesting insight in the socio-economic research done in Ulugan Bay for the UNESCO-CSI/UNDP (United Nations Educational, Scientific and Cultural Organization – platform for Environment and Development in Coastal Regions and Small Islands/United Nations Development Programme) project on community-based sustainable tourism.

The residents of Ulugan Bay in Palawan Island, the Philippines, have observed the effects of temporary migrant fishers' activities on their livelihoods. Although an accurate number of these migrants has yet to be established, residents have reported that, in Buenavista, 3–5 boats of migrants from the Visayas (another island in the Philippines) regularly fish in the bay every year. Each boat carries 30 fishers. These migrants fish for about 5 days and then leave, only to return again after 3 months. This pattern of operation means that these groups fish for approximately 20 days in a year. They are reportedly using compressors and cyanide. In the adjoining community of Cabayugan, about 100 fishers from the Visayas also regularly fish in the bay using cyanide. They fish for a full straight month, at least six times in a year.

It is the residents' opinion that these temporary migrants do not care about Ulugan Bay because they can always go to another area if they can no longer catch anything in the bay. These migrant fishers are also organized into groups managed by medium to large-scale fishing businesses, thus, their concern is possibly only to earn as much as they can and then move from one area to another. Their pattern of exploitation is observable but little is known of their organization, their skills and conditions. What has been observed is their apparent lack of responsibility and sense of ownership of the waters they exploit.

There are very few studies that have looked at the conditions of temporary migrant fishers. Their number is increasing as fish catches become more scarce, thus an investigation of their impacts on local fishing, their relationships with the communities they temporarily stay with, and their values and perspectives on the environment is badly needed.

Prof Rebecca Rivera-Guieb
Environmental Science Program
College of Science
University of the Philippines
Diliman, the Philippines

Other contributions to the Wise Coastal Practices for Sustainable Human Development forum relating to the Philippines include:

Environmental impact assessment as a management tool / the Philippines
Miguel Fortes
http://www.csiwisepractices.org/?read=37

Public-private partnerships for marine pollution management / Batangas Bay, the Philippines
Chua Thia-Eng
http://www.csiwisepractices.org/?read=57

Local stakeholders' concerns versus business priorities
Philippe MacClenahan
http://www.csiwisepractices.org/?read=61

Usefulness of the consultative processes
Chua Thia-Eng
http://www.csiwisepractices.org/?read=65

Further questioning the role of some NGOs / the Philippines
Miguel Fortes
http://www.csiwisepractices.org/?read=146

Further developments at Ulugan Bay, the Philippines
Miguel Fortes
http://www.csiwisepractices.org/?read=150

Sustainable tourism in a biosphere reserve, Puerto Galera, the Philippines
Miguel Fortes
http://www.csiwisepractices.org/?read=197

UNEP's Global 500 awards: wise practices in action
Moderator
http://www.csiwisepractices.org/?read=248

Local (Palawan, the Philippines) and global aspects of renewable energy
Hugh Trudeau and Stefan Gössling
http://www.csiwisepractices.org/?read=254

The future of the Wise Practices Forum – an Asia-Pacific regional perspective
Maarten Kuijper
http://www.csiwisepractices.org/?read=285

Education rather than purchasing is a better option for conservation / the Philippines
Guillermo H. A. Santos
http://www.csiwisepractices.org/?read=292

Sustainable tourism through the preparation of a tourism master plan / the Philippines
Melissa Macasaet and Martin Felstead
http://www.csiwisepractices.org/?read=298

Enforcing environmental laws: a societal approach / the Philippines
Bob Johannes
http://www.csiwisepractices.org/?read=300

Land purchase/lease for conservation does work – some examples
Ray Leonard, Jean-Luc Solandt, Clive Gilbert, Sibylle Riedmiller, Collette Wabnitz
http://www.csiwisepractices.org/?read=329

Appendix IV

Fish Data

Table A. Fish visual counts in Ulugan Bay along 50 m transects at various study sites
The total number of individual fish, the number of species, the Shannon-Weiner Diversity Index (H') and Evenness (E(H')) for each site are listed. Commercially important taxa (*) and the feeding habits of each taxon are indicated.

FAMILY	FEEDING HABIT **	SPECIES	SITE					
			2	7	8	9	14	15
Acanthuridae	a	*Acanthurus gahhm* *	9			6	10	1
Acanthuridae	a	*Prionurus* sp. *	1					
Apogonidae	bc	*Apogon* sp. *		10	30	500		
Apogonidae	bc	*Cheilodipterus quinquelineatus*			10		1	
Aulostomidae	de	*Aulostomus chinensis*	2					
Balistidae	cef	*Sufflamen fraenatus* *	6			1	2	2
Blenniidae	t	*Aspidontus taeniatus*					3	
Caesionidae	acf	*Caesio cuning* *	10		5		25	
Caesionidae	acf	*Pterocaesio diagramma* *	550					
Carangidae	predator	*Carangoides dinema* *					1	
Chaetodontidae	bcdfg	*Chaetodon lineolatus*				3		
Chaetodontidae	bcdfg	*Chaetodon* sp.		2	2	4		1
Chaetodontidae	Gi	*Chaetodon trifascialis*	3					6
Chaetodontidae	hgjf	*Chaetodon vagabundus*	2		3	5	1	
Chaetodontidae	c	*Forcipiger longirostris*			1			
Chaetodontidae	gu	*Heniochus* sp.				2		2
Chaetodontidae	gu	*Heniochus varius*				1		
Ephippidae	fue	*Platax orbicularis*		3				
Haemulidae	k	*Plectorhinchus chaetodonoides* *		1				1
Holocentridae	B	*Myripristis* sp. *			6		5	3
Labridae	cnlm	*Cheilinus chlorourus* *	12	4	3	2	1	
Labridae	cnlm	*Cheilinus undulatus* *	1					
Labridae	cnlm	*Cheilio inermis*	1				2	
Labridae	cnlm	*Choerodon anchorago* *		2	1	2		
Labridae	cnlm	*Coris pictoides*			2			
Labridae	cnlm	*Halichoeres* sp.	28				6	
Labridae	cnlm	*Labroides dimidiatus*	4			6	5	7
Labridae	cnlm	*Thalassoma lunare* *	20		3	3	21	15
Labridae	cnlm	*Thalassoma lutescens* *		1				1
Labridae	cnlm	*Thalassoma* sp. *			13	6	1	
Lethrinidae	dn	*Lethrinus lentjan* *					1	
Lutjanidae	dea	*Lutjanus decussatus* *				1		5
Lutjanidae	dea	*Lutjanus fulviflamma* *					1	5
Lutjanidae	dea	*Lutjanus vitta* *					1	
Mullidae	c	*Parupeneus barberinoides* *	1					

Mullidae	c	*Parupeneus* sp. *	4				1	
Mullidae	c	*Upeneus moluccensis* *	3					
Mullidae	c	*Upeneus tragula* *	1			5	2	3
Nemipteridae	ca	*Scolopsis affinis* *	11		1	5		
Nemipteridae	ca	*Scolopsis bilineatus* *		2	6		8	
Nemipteridae	ca	*Scolopsis ciliatus* *	1					
Pempheridae	Bb	*Pempheris* sp. *					8	
Pomacentridae	Bbf	*Abudefduf notatus*					35	
Pomacentridae	Bbf	*Abudefduf sexfasciatus*						54
Pomacentridae	Bbf	*Abudefduf* sp.	121	80	70	240	310	67
Pomacentridae	BbF	*Amphiprion frenatus*	1					1
Pomacentridae	acf	*Chromis caudalis*						5
Pomacentridae	fd	*Chrysiptera parasema*			150			
Pomacentridae	acf	*Dascyllus trimaculatus*		8	5		3	
Pomacentridae	fad	*Neoglyphidodon* sp.	10	20	33	25	36	49
Pomacentridae	fv	*Pomacentrus* sp.	164	12	15	5	3	10
Scaridae	o	*Scarus dimidiatus* *				1		
Scaridae	o	*Scarus* sp. *	48	1			9	1
Serranidae	Bbd	*Epinephelus fasciatus* *			1	2		
Serranidae	Bbd	*Plectropomus maculatus* *	1		2			6
Siganidae	Fpq	*Siganus fuscescens* *					30	
Siganidae	f	*Siganus virgatus* *	1	2	2	2	4	
Synodontidae	r	*Synodus variegatus* *	1			1		
Zanclidae	s	*Zanclus cornutus*	3			3		5
Number of individuals			1020	148	364	831	536	250
Number of species			29	14	22	24	29	22
Shannon-Weiner Diversity Index, H'			1.650	1.657	2.006	1.199	1.805	2.209
Evenness, E(H')			1.637	1.613	1.977	1.185	1.779	2.167

** Feeding habit: a - planktivore; B - large zooplankton; b - small zooplankton; c - small benthic invertebrates; d - small crustaceans; E - fish; e - small fish; F - filamentous algae; f - algae; G - *Acropora polyps*; g - coral polyps; h - small anemones; i - coral mucus; j - polychaetes; k - sand-dwelling invertebrates; l - wide variety of invertebrates; m - toxic, prey e.g. crown-of-thorns, boxfish, sea hares; n - mollusks; o - algal film growing on coral rocks; p - leafy algae; q - seagrass; r - voracious predator of small fish; s - primarily on sponges; t - tubeworms, demersal fish eggs; u - other invertebrates; predator, eats fish, mollusks, crustaceans, etc. in various sizes.

Table B. Pairwise comparison of the coral reef, fish study sites in Ulugan Bay using Sorensen's Similarity Index (SSI)

SSI = 2c/(a+b). Where a is the number of fish species present at one site; b is the number of fish species present at the other site; c is the number of fish species present at both sites.

		SITE						
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
Buenavista I (9)	(1)	x						
Bulalakaw (8)	(2)	56.5	x					
Rita-Manaburi (2)	(3)	50.8	42.6	x				
Sabang (14)	(4)	45.3	51.0	58.8	x			
Saint Paul (15)	(5)	52.2	31.8	45.9	43.1	x		
Umalagan II (7)	(6)	42.1	55.6	34.0	37.2	38.9	x	
Entire data set	(7)	55.2	51.8	76.5	63.0	51.8	36.4	x

Appendix V

SEAGRASS DATA

Table C. Seagrass density (D = individuals/m^2) and frequency (F) per m^2 at the study sites
Values in parenthesis are relative density (RD, %) and relative frequency (RF, %).

	SITE 2 Rita-Manaburi		SITE 3 Tarunayan		SITE 4 Oyster Bay		SITE 6 Umalagan I		SITE 9 Buenavista I	
	D (RD)	F (RF)	D (RD)	F (RF)	D (RD)	F (RF)	D (RD)	F (RF)	D (RD)	F (RF)
Cymodocea rotundata	337.3 (37.2)	17.8 (28.9)							249.0 (12.3)	15.4 (17.3)
Cymodocea serrulata	46.0 (5.1)	7.5 (12.2)			208.0 (41.7)	20.0 (46.5)			148.6 (7.3)	13.7 (15.4)
Enhalus acoroides			31.7 (46.8)	6.3 (61.3)			19.2 (82.8)	3.8 (79.2)	50.8 (2.5)	11.2 (12.6)
Halophila ovalis					82.7 (16.6)	6.0 (14.0)				
Halodule pinifolia	146.5 (16.1)	9.8 (15.8)							875.8 (43.3)	17.2 (19.4)
Halodule uninervis	286.7 (31.6)	15.4 (25.0)	36.0 (53.2)	4.0 (38.7)	208.0 (41.7)	17.0 (39.5)			196.0 (9.7)	12.3 (13.8)
Syringodium isoetifolium									491.3 (24.3)	16.2 (18.2)
Thalassia hemprichii	91.1 (10.0)	11.2 (18.2)					4.0 (17.2)	1.0 (20.8)	12.0 (0.6)	3.0 (3.4)

Appendix VI

SEAWEED DATA

Table D. Seaweed species found at the study site

STUDY SITE	ALONG SEAGRASS TRANSECTS	ALONG CORAL TRANSECTS
Buenavista	*Amphiroa fragilissima* *Codium arabicum* *Laurencia* sp. *Liagora farinosa* *Neomeris van-bosseae* *Padina australis* *Padina minor*	*Lobophora variegata* *Padina* sp. *Turbinaria* sp.
Bulalakaw		*Lobophora variegata* *Padina* sp. *Sargassum* sp. *Turbinaria* sp.
Manaburi Cove	*Caulerpa* sp. *Caulerpa sertularioides* *Halimeda* sp. *Padina australis* *Udotea* sp.	
Oyster Bay	*Halimeda* sp. *Padina* sp.	*Dictyota dichotoma* *Sargassum* sp. *Turbinaria* sp.
Rita-Manaburi		*Padina* sp. *Sargassum* sp.
Sabang		*Halimeda* sp. *Padina* sp. *Sargassum* sp.
Tarunayan	*Caulerpa sertularioides* *Dictyosphaeria cavemosa* *Neomeris van-brosseae*	
Umalagan	*Halimeda* sp.	*Caulerpa* sp. *Lobophora variegata* *Padina* sp. *Sargassum* sp. *Turbinaria* sp. *Udotea* sp.

Table E. The uses and economic importance of seaweeds in Ulugan Bay

SPECIES	ECONOMIC USE / IMPORTANCE
Caulerpa	Human food, medicine (anti-fungal, lowers blood pressure)
Caulerpa racemosa	Human food
Caulerpa sertularioides	Human food
Codium arabicum	Human food
Codium edule	Medicine
Dictyosphaeria cavernosa	Medicine (anti-microbial with growth regulators, auxin, gibberelin, cytokinin)
Dictyota dichotoma	Human food (source of phenols, vitamins, folic and folinic acids)
Padina australis	Human food (source of alginic acid)
Sargassum spp.	Human food (source of algin, auxin-like substance, controls heavy metals)
Turbinaria sp.	Human food (source of algin, minerals)
Laurencia spp.	Human food, Medicine (anti-fungal, antibacterial)

Appendix VII

MANGROVE DATA

Table F. Mangrove species found at the study sites categorized as to diameter at breast height (dbh)
The density is expressed as average number of trees per 500 m^2. Relative frequency (RF %) is given. In addition *Xylocarpus moluccensis* (1 in site 14); *Bruguiera cylindrica* (2 in site 9); *Ceriops tagal* (2 in site 1); unknown (3 in site 1) were found.

Rhizophora apiculata													
dbh (cm)	Study site											Total	RF
	1	3	4	5	7	8	9	10	11	12	13		
< 5	2		4	1		22	2	20	20	89	50	210	36.8
5–10	13		13	4	4	8	16	15	41	72	33	219	38.4
10–20	8	8	11	5	2	1	6	7	31	9	7	95	16.7
20–30	5	2	1	7	4			1	2	6	3	31	5.4
30–40		2		2	4			1		2		11	1.9
40–50					1						1	2	0.4
50–60										1	1	2	0.4
60–70													
> 70													
Total												570	

Rhizophora mucronata														
dbh (cm)	Study site												Total	RF
	1	3	4	5	7	8	9	10	11	12	13	14		
< 5	2		5		6	3	1	1	19	3	4	2	46	22.4
5–10		1	11		13		3	1	33	2	1	19	84	41.0
10–20			10	2	10		1		6			8	37	18.0
20–30			3	3	8							10	24	11.7
30–40				2	2			1			1	4	10	4.9
40–50											1	3	4	2.0
50–60														
60–70														
> 70														
Total													205	

Bruguiera gymnorrhiza

dbh (cm)	Study site											Total	RF
	1	3	4	5	7	8	9	10	12	13	14		
< 5				4		4	1	1		1	8	19	13.3
5–10	4	3	5	4	1	2	1	3	2		13	38	26.6
10–20			6	5			3	6			9	29	20.3
20–30	3	4	7	6	2		2			2	2	28	19.6
30–40		1	3	2	2		1			2	1	12	8.4
40–50			5	2	1		1			2	1	12	8.4
50–60				2							2	4	2.8
60–70				1								1	0.7
> 70													
Total												143	

Xylocarpus granatum

dbh (cm)	Study site			Total	RF
	1	4	14		
< 5	3	3	1	7	28.0
5–10		8	1	9	36.0
10–20		1	2	3	12.0
20–30					
30–40		2	1	3	12.0
40–50			1	1	4.0
50–60			1	1	4.0
60–70					
> 70			1	1	4.0
Total				25	

Sonneratia alba

dbh (cm)	Study site			Total	RF
	8	9	10		
< 5	4	1		5	23.8
5–10	2	2		4	19.0
10–20		4	1	5	23.8
20–30		4		4	19.0
30–40		3		3	14.3
40–50					
50–60					
60–70					
> 70					
Total				21	

Aegiceras floridum

dbh (cm)	Study site			Total	RF
	8	9	10		
< 5	1	8	2	11	28.9
5–10		7		7	18.4
10–20		9		9	23.7
20–30		11		11	28.9
30–40					
40–50					
50–60					
60–70					
> 70					
Total				38	

Study Sites

Site 1	Manaburi Cove
Site 2	Rita-Manaburi
Site 3	Tarunayan
Site 4	Oyster Bay
Site 5	Kayulo
Site 6	Umalagan I
Site 7	Umalagan II
Site 8	Bulalakaw
Site 9	Buenavista I
Site 10	Buenavista II
Site 11	Tagabenit
Site 12	Tagnipa I
Site 13	Tagnipa II
Site 14	Sabang
Site 15	Saint Paul Bay

Table G. Numbers and relative frequency (RF %) of dead and cut mangroves at the study sites, categorized as to diameter at breast height (dbh)

The numbers for cut mangroves are given in parenthesis. Density is expressed in numbers of trees per 500 m^2.

dbh (cm)	Study site												Total	RF
	1	3	4	5	7	8	9	10	11	12	13	14		
< 5	(1)		1			(1)	1		2			3	7 (2)	25.9 (9.5)
5–10	(6)		2			(1)		(3)				3	5 (10)	18.5 (47.6)
10–20	1	1				(1)	3	(1)			(1)	1	6 (3)	22.2 (14.3)
20–30	(3)			1	1			1				1	4 (3)	14.8 (14.3)
30–40	(1)											2	2 (1)	7.4 (4.8)
40–50	(1)												(1)	(4.8)
50–60	(1)										2	1	3 (1)	11.1 (4.8)
Total													27 (21)	

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