Rapid Assessment Program

17

RAP Bulletin of Biological Assessment

A Rapid Marine Biodiversity Assessment of the Calamianes Islands, Palawan Province, Philippines

CONSERVATION INTERNATIONAL

PALAWAN COUNCIL FOR SUSTAINABLE DEVELOPMENT

CONSERVATION PRIORITIES: THE ROLE OF RAP

Our planet faces many serious environmental problems, among them global climate change, soil erosion, and pollution. At Conservation International (CI), we believe that the one problem that surpasses all others in terms of importance is the loss of biodiversity, particularly because most severe and irreversible consequence is the extinction of species. Around the world, humans are responsible for a worsening trend of net loss in the amount of wild, natural habitats that cover the planet. Many of these areas are lost even before it was possible to document the rich array of organisms that thrived there, and determine their potential benefit to humankind, perhaps as sources for new medical treatments or economic livelihood. CI's Rapid Assessment Program (RAP) was developed as a methodology to quickly characterize the biodiversity found in previously unexplored areas in order to make a case for their conservation.

RAP was conceived by Murray Gell-Mann of the MacArthur Foundation and former staff of CI, including one of its founders, Spencer Beebe, and the late Ted Parker who led the first RAP surveys into the tropical forests of the Andes. The pace of forest destruction called for an inventory technique that could be deployed rapidly and yield quick results. RAP was formulated specifically to provide a first-cut analysis of biodiversity, one step ahead of the bulldozers.

An important conservation implication of losing forests never before inventoried was that a country or region had no way of knowing if its network of protected areas really included the best representative samples of overall biodiversity. Ideally, protected areas should be designated to capture the most representative and richest sites if they are to have maximum biodiversity conservation impact. One of RAP's most important contributions is to ensure that a country or region has sufficient knowledge of its biodiversity to make intelligent decisions about habitat conservation and development.

RAP forms part of a strategic approach used for setting conservation investment priorities. At a global level, we have targeted the "hotspots," twenty-five regional land areas that hold a third or more of all terrestrial diversity and are at a great risk. Our global priorities also focus on major tropical wilderness areas and the "Megadiversity" country concept, which highlights the importance of the national entities that harbor high biodiversity. We are now undertaking a series of priority-setting exercises for other major categories of ecosystems, among them marine systems, freshwater aquatic systems, deserts, and dry forests.

The next level of priority-setting is the bioregional workshop, a process where experts assemble their combined knowledge of an area to map regional conservation priorities using a geographic information system (GIS). We have also taken a taxon-based approach, working with the Species Survival Commission of IUCN to produce action plans for key groups of organisms. Where there are significant gaps in regional knowledge, RAP surveys provide the information necessary for these strategic priority-setting activities.

RAP, which assesses terrestrial, aquatic and marine ecosystems, assembles teams of international and host-country experts to generate first-cut assessments of the biological value of poorly known areas. An area's importance can be characterized by its total biodiversity, its degree of endemism, the uniqueness of an ecosystem, and the degree of risk of extinction or habitat degradation.

Before any field assessment, RAP teams consult available satellite or aerial images of an area targeted for a survey, and often carry out overflights, to pinpoint the areas most in need of field assessment. Ground travel often requires a combination of vehicles, boats, pack animals, swimming and walking to access remote sites where few, if any, roads exist. Surveys typically last from two to eight weeks.

In-country scientists form a central part of RAP teams, and surveys provide baseline information which stimulate long-term scientific studies. Local experts are especially critical to an understanding of areas where little exploration has been undertaken, as well as to facilitate the input of local communities and officials. In some cases, RAP has conducted training programs for in-country scientists, thereby helping to build in-country capacity for field biology. Subsequent research and protection of habitats following a RAP survey depend on the initiatives of these local conservationists.

RAP reports are available to the host governments and local people where surveys take place, as well as to all interested conservationists, scientists, institutions, and organizations. We hope that these reports will catalyze effective conservation action on behalf of our planet's biological diversity, the legacy of life that is so critical to us all.

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ORGANIZATIONAL PROFILES

CONSERVATION INTERNATIONAL

Conservation International (CI) is an international, non-profit organization based in Washington, DC. CI acts on the belief that the Earth's natural heritage must be maintained if future generations are to thrive spiritually, culturally, and economically. Its mission is to conserve biological diversity and the ecological processes that support life on earth, and to demonstrate that human societies are able to live harmoniously with nature.

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PALAWAN COUNCIL FOR SUSTAINABLE DEVELOPMENT

The Palawan Council for Sustainable Development (PCSD) is a policy making body created under the Philippines Republic Act 7611 or the Strategic Environmental Plan for Palawan. Its primary mandate is the implementation of the Environmentally Critical Areas Network (ECAN) strategy for the entire province by delineating important areas for conservation and providing a framework for sustainable development. The PCSD Staff (PCSDS) is the Council's technical arm created under the Office of the President that advises the PCSD and implements its policy decisions.

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AUSTRALIAN INSTITUTE OF MARINE SCIENCE

The mission of the Australian Institute of Marine Science (AIMS) is to generate the knowledge to support the sustainable use and protection of the marine environment through innovative, world-class scientific and technological research. It is an Australian Commonwealth Statutory Authority established by the Australian Institute of Marine Science Act of 1972 in recognition of a national need to manage Australia's marine environment and marine resources.

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WESTERN AUSTRALIAN MUSEUM

The Western Australian Museum was established in 1891 and its initial collections were geological, ethnological and biological specimens. The 1960s and 1970s saw the addition of responsibility to develop and maintain the State's anthropological, archaeological, maritime archaeological and social and cultural history collections. The collections, currently numbering over two million specimens/artifacts, are the primary focus of research by the Museum's own staff and others. The aim is to advance knowledge on them and communicate it to the public through a variety of media, but particularly a program of exhibitions and publications.

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EXECUTIVE SUMMARY

INTRODUCTION

This report presents the results of a rapid field assessment of the marine biodiversity of the Calamianes Island,. Philippines The Calamianes, forming the northernmost section of Palawan Province, lie between the South China and Sulu Seas, centered at 12°N latitude and 120°E longitude The group contains three relatively Barge islands. Busuanga, Culion and Coron, and a host of smaller satellite islands The Band and surrounding seas occupy approximately 3,600 square km. The islands form an integral part of the "coral triangle", comprising the countries of Philippines, Indonesia, Malaysia, Papua New Guinea. Japan, and Australia This region supports the world's richest coastal marine biodiversity, mostly concentrated in extensive coral reef, mangrove and seagrass habitats

The survey was implemented by the Marine Rapid Assessment Program (RAP) of Conservation International (CI) in collaboration with the Palawan Council of Sustainable Development (PCSD), the Institute of Marine Fisheries and Oceanology of the University of the Philipines-Visayas, and the Philippines Bureau of Fisheries and Aquatic Resources.

Overview of Marine RAP

The goal of Marine RAP is to rapidly generate and disseminate information on coastal and near-shore. marine biodiversity for conservation purposes, with a particular focus on recommending priorities for conservation area establishment and management Marine RAP deploys multi-disciplinary teams of marine scientists and coastal resource experts to determine the biodiversity significance and conservation opportunities of selected areas This is accomplished through underwater inventories generally lasting *three* weeks Marine RAP surveys produce species lists that serve as indicators of overall biological richness, as well as recording several measurement to assess overall ecosystem health During each survey, RAP supports parallel assessments of local numan community needs and concerns, which become incorporated into the final recommendations.

By comparing the results obtained from many surveys. Marine RAP is ultimately focused on ensuring that *E* representative sample of marine biodiversity is conserved within protected areas and through other conservation measures.

Calamianes Islands

The Calamianes Group is one of the least densely populated areas of the Philippines with *approximately* 60,000 inhabitants. Adjacent fishing grounds formerly supported large stocks of commercial species, but are now severely depleted by overfishing. Most residents still make their living from subsistence fishing and farming. but these activities have stretched natural resources to the limit. The primary challenge in the Calamianes is to conserve the small amount of terrestrial and marine habitat that still remains In good shape as a platform for future recovery, There is also a genuine need to introduce economic options that will relieve pressure on the natural environment. Expanded tourism is seen as the best possibility, but careful consideration of its consequences needs to be integrated with conservation management. This course of action is especially pertinent in view of the recommendations of the Department of Tourism-Japan International Cooperation Agency's 1996 study, which call for significant expansion of the Calamianes tourist industry.

The Calamianes Survey

The Marine RAP survey of the Calamianes *assessed* 38 sites over a 16-day period (6-21 February, 1998). General site areas were selected prior to the actual survey in order to maximize the diversity of habitats visited. thus facilitating a species list that incorporates maximum biodiversity. At each site, an underwater inventory was made of three faunal groups selected to serve as indicators of overall coral reef biodiversity: scleractinian corals, molluscs, and reef fishes, Additional

observations were made on the environmental condition of each site, including evaluation of various threat parameters Observations and data on local fisheries data were also gathered.

SUMMARY OF RESULTS

Despite heavy fishing pressure and environmental degradation, the Calamianes Group is characterized by a relatively diverse marine fauna. Notable results from the survey include:

- *Corals*: Most sites had significant live scleractinian coral cover, and overall species diversity was impressive. Approximately 300 coral species were recorded, including at least 20 undescribed taxa, raising the total number of zooxanthellate corals found in the Philippines to at least 462 species. The number of new species is phenomenal considering the brief observation period and the considerable amount of previous collecting in the Philippines.
- *Molluscs*: Diversity was comparatively high with 648 species belonging to 96 families being recorded. This total surpasses those from past RAP surveys in Indonesia and Papua New Guinea. However, stocks of commercially valuable species such as octopus, giant clams, and various ornamental seashells were seriously depleted.
- *Reef Fishes*: A total of 736 species were recorded, but extrapolation techniques utilizing six key indicator families reveal that at least 888 species can be expected to occur in the area. The number of gobies (101) was particularly impressive. Although small reef fishes were generally abundant with regards to both number of species and individuals, large fishes were conspicuously scarce.
- *Fisheries*: Results from the current survey and an historical review of catch rates reveal that fisheries stocks have declined dramatically following peak production in the 1970s. Productivity in 1997 was only half the 1991 level and further decline is anticipated. The poor state of fish stocks is directly attributable to over-fishing, destructive fishing methods, including the use of explosives and cyanide, and general habitat degradation. Groupers (family Serranidae), a good indicator of fishing pressure, were generally scarce and were mainly under 20 cm length.

CONSERVATION RECOMMENDATIONS

The results of the Marine RAP survey firmly establish the Calamianes Islands as a primary target for marine conservation, especially in view of its extraordinary diversity of corals, molluscs, and other organisms, rapidly diminishing natural habitats and over-exploitation of marine resources. There is an urgent need for immediate action to prevent further degradation of the environment and to conserve a still relatively rich biodiversity. As a result of our survey we make the following specific recommendations.

1) Evaluate and control impacts of land-based activities. A variety of threats to coastal environments originate from land-based sources. Depletion of terrestrial resources places additional stress on already limited marine resources. In addition, the common practice of slash-and-burn agriculture denudes natural vegetation, leading to erosion and consequent silt deposition on adjacent reefs. Terrestrial RAP surveys should be undertaken in order to properly evaluate the extent of human impact on the remaining natural ecosystems of Palawan Province.

2) Establish a network of marine protected areas. The Palawan Council for Sustainable Development (PCSD) is urged to work closely with municipal governments to implement the ECAN zoning scheme whereby critical core conservation areas are designated. Based on the results of the current RAP survey the following areas are recommended as core zones or existing zones that need to be extended to incorporate them: Twin Peaks area (RAP site 26), Coron Island; Halsey Harbour (sites 31-33), Culion Island; scenic bay adjacent to site 24 at southwest end of Coron Island; Lagat Island (site 3), Kalampisauan Island (site 13), northwestern Busuanga; Buluang Bay (site 14), northwestern Busanga; Gutob Peninsula (site 15), northwestern Busuanga; and Saddle Rock (site 35), off western Culion Island.

3) Facilitate studies (biological and non-biological) that are essential for planning the conservation of marine environments. Additional surveys, both marine and terrestrial, are urgently required in order to fully assess the biological importance and conservation potential of north Palawan Province. The present survey covered only the northern extremity of the huge area, extending from El Nido to northern Busuanga, which is targeted for major tourism development. Additional Marine RAP surveys are recommended for the area encompassing the Tres Reyes Rocks, Bulalacao and adjacent small islands, Linapacan Island, and northern Palawan Island. There is also a critical need for biological studies of potentially rare and endangered marine wildlife such as sharks, endemic reef fishes and corals, dugongs, and sea turtles. Financial support of university students would provide an incentive for these studies.

4) Implement or strengthen conservation programs for rare and endangered marine wildlife. The Calamianes Islands, and Palawan in general, harbor a rich assortment of rare and endemic marine species, including several that appear to be threatened. This important component of the fauna needs to be clearly identified, and appropriate conservation measures taken to insure that critical habitats are protected.

5) Develop tourism in a fashion that supports marine conservation. The Department of Tourism (DOT) in cooperation with the Japan International Cooperation Agency (JICA) has proposed an environmentally sustainable tourism development plan for northern Palawan Province. It proposes major development along the eastern and western coasts of Palawan Island, and on the northwestern coast of Busuanga. The proposal for the latter area includes 1,135 hotel rooms located in two complexes with supporting tourist infrastructure (aquarium, shops, restaurants, recreational facilities, etc.). If this plan proceeds it will have a profound impact on the local economy, and there is potential for deleterious impacts on marine ecosystems. It is vital to insure that local inhabitants receive direct economic benefits from any tourism development, thus taking pressure off marine resources that are now heavily relied on. There also need to be safeguards to prevent pollution, siltation, and any other form of environmental degradation that often results from

uncontrolled development. If properly managed the surrounding reef areas will serve as a magnet for sustaining long-term tourism.

6) Implement an environmental awareness campaign. This activity has proven successful in many parts of the Pacific. Local residents need to become aware of the uniqueness of their special wildlife and its dependence on particular natural habitats, as well as the advantages of conservation, and the consequences if no action is taken. This can be achieved in a variety of ways such as primary and secondary school curricula, guest speakers at town meetings, posters, and videos.

7) Promote community participation in conservation planning and management. Most coral reefs lie within the three nautical mile limit of municipal waters, which are under the jurisdiction of local communities. Therefore, Calamianes islanders have an opportunity to implement and manage conservation initiatives that will play a critical role in maintaining marine biodiversity in surrounding waters.

8) Enforce existing laws. Despite considerable legislation that prohibits illegal fishing methods and for the protection of rare and endangered fauna, there appears to be little effective enforcement at the local level. This problem is rampant throughout the Philippines and needs to be addressed if truly effective conservation practices can be implemented. Local and national governments need to allocate funds for patrol boats, trained personnel, and other resources. Additionally, effective enforcement needs to be backed up by adequate penalties in the form of heavy fines, confiscation of boats and fishing equipment, and/or jail sentences.

9) Enact more effective laws that actually regulate fishing activities. Like most of the Philippines the Calamianes has an open access fishing policy. National law defines the various fishing grounds; there are no local laws governing actual extraction of resources. Therefore a critical need exists for legislation that governs local fishing with the long-term goal of sustaining resources. This would include laws dealing with type and quantity of gear, and catch quotas for various species based on sound biological information.

10) Establish a long-term environmental monitoring program. Now that Palawan Province has been targeted for extensive tourism development it is important to identify and conserve remaining natural ecosystems. These precious resources must be sustained as they will provide the impetus for much of the anticipated tourism. It is also important to gather baseline biological and ecological data before the developmental surge commences, and natural ecosystems should be periodically monitored to insure they remain fully intact.

11) Promote cooperation among relevant government departments. Government departments frequently operate in isolation from one another. One of our recommendations is that the government commits to developing an integrated coastal management strategy that improves inter-agency coordination.

12) Make fishing laws consistent between municipalities. Municipal governments in the Calamianes and northern Palawan need to coordinate efforts in formulating effective conservation and fisheries management policies. The region needs to be considered as a whole rather than a series of isolated municipalities that often have conflicting laws governing the use of marine resources.

13) Review policies governing public access to pearl farms. The proliferation of pearl farms has resulted in diminished access to local fishing grounds, thus placing additional fishing pressure on remaining areas. The implications of an open access policy need to be carefully considered. The main question is whether the local populace would derive more benefit from open access or whether in the long term these farms are more important by functioning as marine reserves.

14) Address safety issues when fishing boats are converted to tourism use. Although there are national regulations governing health and safety issues aboard passenger vessels, there are no local laws covering areas such as passenger capacity, number of life vests, and required navigational equipment. Boat operators should be compelled to comply with safety regulations before their vessels are registered.

OVERVIEW

INTRODUCTION

The Calamianes Group occwpies the northernmost section of Palawan Province in she southwestern Philippines. The largest province in the Philippines, Palawan has continuously been labeled the country's "last frontier." or the last province to experience intense natural resource exploitation, which has resulted in the Philippines archipelago being named one of the most threatened areas ("hotspots") for biodiversity conservation is? the world. The Calamianes consist of three main islands: Busuanga, Culion, Coron. and *a* host *of* smaller satellite islands covering an area of approximately 2,200 square km or 30% of the province.

Palawan, and the Calamianes Islands in particular, supports some of the most extensive and relatively intact marine environments in the Philippines. The region also supports one of the country's most productive fishing grounds. Compared to other parts of the Philippines the area is sparsely populated, having about 60,000 inhabitants. In spite of its low population density, there has been intense fishing pressure in the area, particularly in Coron Bay, along with extensive use of illegal fishing methods, including explosives, muro-ami, and cyanide.

This report presents the results of a Conservation International Marine RAP (Rapid Assessment Program) survey of marine biodiversity in the Calamianes Islands, focusing on selected faunal groups, specifically reef-building (scleractinian) corals, molluscs, and fishes. An additional chapter presents the results of a fisheries survey that combined both underwater research and consultation with local communities and government officials. The purpose of this report is to document local marine biodiversity and the current state of fisheries exploitation in order to guide regional planning in economic development and marine conservation, especially in light of the recent proposal to transform the Calamianes Islands into a major destination for overseas tourists.

Marine RAP - Rationale and Methodology

There is an obvious need to identify areas of global importance for wildlife conservation. However. there is often a problem in obtaining the required data, considering that many of the more remote regions are inadequately surveyed. Scarcity of data. in the form of basic taxonomic inventories, is particularly true for tropical ecosystems. Hence. Conservation International has developed a technique for rapid biological assessment. The method essentially involves sending a team of taxonomic experts into the Geld for a brief period, often 2-4 weeks, in order to obtain an overview of the flora and fauna. Although most surveys to date have involved terrestrial systems, the method is equally applicable for marine and freshwater environments.

One of the main differences in evaluating the conservation potential of terrestrial and tropical marine loaalities involves the emphasis placed on endemism. Terrestrial conservation initiatives are frequently correlated with a high incidence of endemic species at a particular locality or region. Granted other aspects need to be addressed. but endemism is often considered as one of the most important criterion for assessing an area's conservation worth. Indeed. it has become a universal measure for evaluating and comparing conservation "hot spots". In contrast, corail reefs and other tropical marine ecosystems frequently exhibit relatively *loa* levels of endemism. This is particularly true throughout the "coral triangle" (the area including northern Australia, the Malay-Indonesian Archipelago, Philippines, and western Melanesia), considered to *be she* world's richest area for marine biodiversity. The considerable homogeneity found in tropical inshore communities is in large part due to the pelagic larval stage typical of most organisms. For example reef fish larvae are commonly pelagic for periods ranging from 9-100 days (Leis, 1991). A general lack of physical isolating barriers and numerous island "stepping stones" have facilitated the wide dispersal of larvae throughout the Indo-Pacific.

The most important feature to assess in determining the conservation potential of a marine location devoid of significant endemism is overall species richness or biodiversity. Additional data relating to relative abundance are also important. Other factors requiring assessment are more subjective and depend largely on the observer. Obviously, extensive biological survey experience over a broad geographic range yields the best results. This enables the observer to recognize any unique assemblages within the community, unusually high numbers of normally rare taxa, or the presence of any unusual environmental features. Finally, any imminent threats such as explosive fishing, use of cyanide, over-fishing, and mangrove logging need to be considered.

The most direct approach for assessing coral reef biodiversity is to inventory all species present at a given locality. However, due to the complexity of the coral reef fauna, it is virtually impossible to undertake a comprehensive survey of this nature. The best approach is to concentrate on a few "key" groups, which function as indicators of overall biodiversity. Reef-building corals and fishes are perhaps the best all-round indicators. Corals provide the major environmental framework for fishes and a host of other organisms. Without reef-building corals, there is limited biodiversity, This is dramatically demonstrated in areas consisting primarily of sand, rubble, or seaweeds. Fishes are also an excellent survey group as they are the reef's most obvious inhabitants and account for a large proportion of its overall biomass. Furthermore, fishes depend on a huge variety of plants and invertebrates for their nutrition. Therefore, areas with a rich fish fauna invariably support a wealth of plants and invertebrates.

Due to space limitations and general logistics, RAP surveys are most efficient if the working held-parry is confined to 3-4 taxonomic specialists In addition to corals and fishes, it is desirable to survey one or two additional groups Molluscs were selected for the Calamianes and other RAP surveys, but additional phyla or classes such as algae, sponges, soft corals, and echinoderms are worthy of future consideration

Physical Environment

Including surrounding reefs, the Calamianes Group covers an area of approximately 3,600 square km. The islands, although not particularly high, are generally mountainous. Coastlines are highly indented in such a fashion that no part of the interior is more than 11 km from the sea. Due to the complex coastline, the littoral zone is very extensive. There is an abundance of reefs, particularly coastal fringing reefs. These range in width from about 20-200 m and typically descend gradually to a depth of about 2-10 m before dropping steeply into depths of about 15-30m. The maic environmental variable is degree of protection and consequent siltation. The most highly protected reefs (e.g., Halsey Harbor) generally exhibit the most siltation.

Marine environments in the Calamianes are very diverse and some of the most extensive in the Philippines. These include mangrove forests, seagrass beds, and a large portion of the province's coral reefs that comprise 36% of the nation's total coral reef area (Pido *et al.*, 1996).

According to tide information printed on British Admiralty Chart No. 3819 (Mindoro Strait) the maximum difference between high and low water at Coron is 1.8 m with an average of about 1.0 m. We did not encounter significant current at most diving sites. However, the captain of *Busuanga Dream* pointed out several areas that are known for severe currents including the southernmost tip of Coron and Culion islands, Dicabaito Island, and the passage between Busuanga and Coron islands. Sea temperatures during the survey period were generally 27-28°C. We did not encounter any severe thermoclines or areas of cold up-welling.

The climate of the Calamianes (and the entire Philippines region) is monsoonal with a prevailing northwesterly rain-bearing monsoon from June to November, reaching peak intensity in August. The weather is dry and virtually rainless from late December to mid May. Cyclones arrive in the islands almost exclusively between July and December, with the highest probability between September-November. About 19% of typhoon intensity cyclones passing through the Philippines directly affect the Calamianes (Wright, 1975).

Socio-economic Environment

The population is composed of a mixture of indigenous people and immigrants from other parts of the Philippines, especially the Visayas. Fifty-two languages and dialects are spoken in Palawan, making it the most linguistically diverse province in the Philippines. These are two closely related groups of indigenous people, the Tagbanua and the Calamian. Their languages are almost entirely mutually intelligible (Wright, 1975). Tagalog (known as Filipino, the national language) and English are taught in local schools, and Tagalog is in general usage. The indigenous languages are used predominantly in the sural and isolated areas. The Cuyonon language, originally the language of the island of Cuyo (to the southeast of the Calamianes) is also widely spoken.

Barangays (local settlements) are located almost exclusively along the coast, although a large portion of the population actually live in the interior on small farms. Approximately 60% of the population live along the coast and fishing is a key activity, both for subsistence and commercial purposes. The waters of Palawan are extremely important for local and national fish consumption, producing 65% of all fish consumed in Manila (DOT, 1999).

Although fishing is the dominant economic activity, tourism is steadily increasing. On a larger scale, the Shell company's multi-billion dollar Malampaya Gas Project (on Palawan Island) is scheduled to begin operation in 2002. In the nearshore waters of the Calamianes, pearl farms are common (seven on Busuanga alone), and several experimental seaweed farming projects have been established recently.

In recognition of the outstanding biodiversity values of Palawan, the province was declared a Biosphere Reserve by UNESCO, and it is attempting to pursue an environmentally sustainable development plan under the auspices of the Palawan Council for Sustainable Development, a body created and administered by the Office of the President of the

Philippines. Presently, tourism is seen as one of the only major development schemes that is in line with the PCSD's Strategic Environmental Plan and the province's designation as a UNESCO biosphere reserve.

The road map for the PCSD is the Strategic Environment Plan (SEP, enacted as Republic Act No. 7611 in 1992; see details at http://www.chanrobles.com/republicactno7611.htm). The goal of the SEP is:

> *To improve the living conditions of the people of Palawan and to increase the economic contribution that Palawan can make to the Republic of the Philippines by developing its resources of land and water in ways that are environmentally sustainable, socially equitable and economically practicable.*

The objectives of the SEP are to:
1) Establish an Environmentally Critical Areas Network (ECAN) for ensuring protection of vulnerable areas;
2) implement positive development planning by intensified use of Environmental Impact Assessment (EIA) and provisions for coastal developmental activities harmful to the environment;
3) intensify lowland and low hills agricultural development;
4) foster proper use and care of common resources by local communities; and
5) rehabilitate degraded catchments and restore overused and badly damaged lands.

The ECAN strategy includes the designation of marine "core zones", areas in which commercial fishing and other marine exploitation schemes would be prohibited. There is great potential for such zones to not only protect the immediate biodiversity found within them, but also to produce the offspring of marine species that might increase their overall numbers in adjacent fishable waters.

In addition to the PCSD, a number of other agencies have key roles to play in local conservation and the sustainable development of marine species and waters. These include the Bureau of Fisheries and Aquatic Resources (BFAR), the Department of Tourism (DOT), and the Department of Environment and Natural Resources (DENR). Although the province has its separate strategic environmental plan, DENR still oversees nationally designated protected areas falling within the province, including Ancestral Domain claims. The principal such area in the Calamianes is Coron Island. How administration of ancestral domain areas fits within the framework of PCSD's SEP was not clear to our team, but clearly coordination between these bodies is essential.

The role of DOT has recently become critical in Palawan as the primary government agency working with the Japanese Bank for International Cooperation. These agencies are working on a major plan for improving infrastructure in northern Palawan to support tourism development. If this project is implemented, it is large enough to significantly impact local biodiversity, and needs to assimilate substantial environmental safeguards.

Ultimately, at least as far as coral reefs are concerned, municipalities and barangays need to be key conservation allies. The majority of the province's coral reefs lie within the three nautical mile limit of municipal waters, and these waters legally fall under the jurisdiction of local communities. Applying *bantay dagat* and similar local conservation techniques will play a critical role in maintaining marine biodiversity in the Calamianes Islands.

SITE SELECTION AND METHODS

Sites were selected through a pre-survey analysis that included reviews of literature, aerial survey data, nautical charts, and consultation with marine biologists familiar with the region. The survey team concentrated much of their effort along western Busuanga, the area identified by Palawan Province and the Philippines Department of Tourism for major tourism development. Exact site selection was made upon arrival at the general site area, and was further influenced by weather and sea conditions.

At each site, the Biological Team conducted underwater assessments that produced species lists for key coral reef indicator groups. General habitat information was also recorded, as was the extent of live coral cover at several depths. The main survey method consisted of direct underwater observations by diving scientists who recorded species of corals, molluscs, and fishes. Visual transects were the main method for recording fishes and corals in contrast to molluscs, which relied primarily on collecting live animals and shells (most released or discarded after identification). Relatively few specimens were preserved for later study and these were invariably species that were either too difficult to identify in the field or were undescribed. Further collecting details are provided in the chapters dealing with corals, molluscs and fishes.

Concurrently, the Fisheries Team used a 50 m line transect placed on top of the reef to record fish biomass, and made observations on key indicator species, groupers in particular, in order to assess local fishing pressure. Additional fisheries data were obtained through interviews with coastal inhabitants and review of documents from the three municipalities covered by the survey: Busuanga, Coron and Culion. Finally, both teams reported any sightings of sharks, sea turtles and dugongs.

The expedition took place aboard two separate vessels, *Nautika* and *Busuanga Dream*. The original intention was to use *Nautika* (a 100-foot long, steel-hulled, live-aboard dive boat) for the entire survey, but a mechanical breakdown on the seventh day of the expedition forced us to use a second vessel. Unfortunately, the *Busuanga Dream* (a 60-foot wooden outrigger formerly used for fishing) was not suitable for rough sea conditions and was considerably slower than *Nautika*. Therefore, it was necessary to alter the original plan and confine the remaining survey activities to the main Calamianes Group, thus eliminating the El Nido area and Linapacan from the itinerary. Both vessels were well equipped for diving, having ample scuba tanks and an efficient air compressor. We dived from auxiliary skiffs while

aboard *Nautika*, and at most sites directly from *Busuanga Dream* during the latter half of the trip.

SITE DESCRIPTIONS

A total of 38 sites were biologically assessed over 13.5 days. The survey sites were located off the northern, western and southern coasts of Busuanga Island (including off-shore islands as far away as Tara), the northern, western and southern coasts of Culion Island, and western Coron Island. Strong winds and high waves prevented the Team from visiting the windward (eastern) sides of the three main islands. Various reports on the eastern coasts of these three islands however indicate extensive damage from dynamite fishing. Several RAP Team members provided information used to produce these descriptions, including Dr. Veron who provided the basic summaries of coral diversity.

1. West side of Tara Island (12° 17.13' N, 112° 21.10' E)

Time: 0900, dive duration 86 minutes; depth range 1-28 m; temperature 28°C, visibility approximately 15 m, decreasing to 6-8 m at 27 m; current slight throughout dive. *Site description*: gently sloping bottom to 9 m, then sharp (50°) slope to sandy area at 17m; moderate coral cover on shallow reef flat; coral damaged and patchy below 15 m; good variety of small fishes in shallows; *Diadema setosum* (long-spined sea urchin) relatively common in shallows next to shore; visual estimate of hard coral cover = 25%, dead coral (most covered with algae) = 40%, rubble = 15% and soft coral = 5%. High coral species diversity on the reef flat down to depth of 7 m. Extensive damage by explosives.

2. Southwest end of Tara Island (12°15.83' N, 120 21.96' E)

Time: 1200 hours, dive duration 90 minutes; depth range 1-25 m; visibility approximately 10 m; temperature 28°C; no current. *Site description*: seaward slope of approximately 45° to about 14 m, then nearly 100% rubble; estimated hard coral cover = 25-30%, dead coral cover = 20-30%; also abundant soft corals; very little siltation noted; *Diadema* in low numbers; one small *Tridacna* seen; large amount of rubble could be consequence of anchor damage and explosive fishing. Moderate reef-building coral species diversity in shallow areas, and extensive areas of *Seriatopora hystrix*.

3. Southwest end of Lagat Island (12° 14.17' N, 120 21.90' E)

Time: 1600 hours, dive duration 75 minutes; depth range 1-30 m; visibility approximately 10-15 m; temperature 28°C; no current. *Site description*: Shallow reef flat at 4 m sloping at 15° to 10 m, then steeper slope (about 60°) to 20-30 m; good coral cover on shallow reef - visual estimate of 40-50% live coral; coral cover dominated by short sturdy forms; rubble on lower slope mainly encrusted with algae; relatively high density of small reef fishes noted; no siltation; low numbers of *Diadema* urchins; nine medium-sized *Tridacna* seen; possible anchor and explosive damage noted. Very high reef-building coral species diversity, especially of *Acropora, Porites* and fungiids.

4. Coconogan Point, Busuanga Island (12°12.92' N, 120 13.00' E)

Time: 0755 hours, dive duration 75 minutes; depth range 1-30 m; visibility 20 m on slope, 10 m in shallows; temperature 28°C; no current. *Site description:* shallow fringing reef with sharp 70° slope starting at about 3 m; slope drops to depth of 20-30 m on sandy bottom; scattered small coral heads with interesting fishes at base of slope; large patches of damaged and dead coral with surface algae throughout the site reflecting possible anchor damage; visual estimate of hard coral cover = 45%, soft coral = 20%, dead coral = 30%, and at least 5% rubble; an impressive dive site regarding aesthetic qualities - both above and below water; good shelter from prevailing winds. Dense *Porites* stands in shallow water.

5. Southwest end of Cabilauan Island (12° 08.85' N, 120° 11.68' E)

Time: 1140, dive duration 75 minutes; depth range 1-20 m; visibility about 7 m; temperature 27°C; no current. *Site description:* sheltered coastal lagoon with mangrove shore; shallow reef from shore to depth of 3-4 m, then sloping (60°) to sand bottom; estimated live coral cover in shallows = 20-25%; large amounts rubble covered with *Padina* and *Halimeda* algae on slope; some seagrass patches in shallows near mangrove shore. Very protected environment. Low species diversity but high coral cover to a depth of 10 m. Very large stands of *Montipora* forming delicate whorls. Extensive *Porites* and *Anacropora* in shallow water.

6. Northwest end of Cabilauan Island (12° 11.38' N, 120° 08.86' E)

Time: 1520 hours, dive duration 90 minutes; depth range 1-25 m; visibility 6-10 m; no current; temperature 28°C. *Site description*: sheltered reef with abrupt slope (60°) next to shore, ending on level sand bottom at depth of 25 m; visual estimate of live coral cover = 30%, soft coral = 10%; plentiful dead coral and rubble covered with algae; also small amount of *Padina* and unidentified fleshy algae; no fresh anchor or explosive damage; *Sargassum* common in narrow band of shallow water next to shore; minimal siltation; medium to small *Tridacna* and thorny oysters common. Coral cover up to 20%. Moderate species diversity. Very large stands of *Anacropora puertogalerae* and *A. spinosa*.

7. Northwest side of Dimaquiat Island (12° 14.55' N, 120° 05.67' E)

Time: 0730 hours, dive duration 80 minutes; depth range 1-25 m; visibility approximately 15 m; no current; temperature 27°C. *Site description*: shallow (2-3 m) reef flat and gentle slope (10°) from shore to depth of 14 m, then abrupt 10-12 m drop to level sand-rubble bottom in 25 m depth; hard coral cover = 25-35%, and soft coral cover = 25%; dead coral and rubble covered with algae and no signs of recent damage; minimal siltation; abundance of small reef fishes; three cuttlefish recorded. Moderate diversity of massive scleractinian corals, especially faviids and *Porites* in shallows.

8. Southwest (5 km) of Alarogao Pt., Busuanga Island (12° 14.26' N, 120° 02.70' E)

Time: 1050 hours, dive duration 75 minutes; depth range 1-20 m; slightly turbid with visibility about 6 m; no current; temperature approximately 28°C. *Site description*: sheltered reef adjacent to dense seagrass beds; shallow (1 m) reef flat next to shore gradually increasing in depth to 3-4 m, then sloping at 45° to about 12-15 m depth: visual estimate of hard coral cover = 30-35%, soft coral cover = 20%, mainly dead coral and rubble on lower slope: dead coral is old and overgrown with algae, no recent coral damage; very little siltation; a large rope net was found entangled over area covering approximately 6-9 m². Moderate coral diversity to a depth of 10 m.

9. South end of Tanobon Island (12° 20.41' N, 119° 57.52' E)

Time: 1500 hours, dive duration 90 minutes; depth range 1-27 m; visibility approximately 13 m; no current; temperature 27°C. *Site description*: white sand beach with coral extending to within 3 m of shore; shallow fringing reef to 8-10 m, then steep (75°) reef slope to 20 m depth; abundant algal growth on rubble near shore; rich coral growth between 2-12 m depth; estimated hard coral cover = 50%, soft coral = 25% and 20% dead coral with algal growth; large patches of rubble and dead coral, possibly evidence of past explosive fishing; over 100 small *Tridacna* seen. Moderate coral diversity on slopes. Upper slopes are dominated by branching *Porites* and branching *Montipora*.

10. Southeast end of Dimipac Island (12° 21.97' N, 119° 54.86' E)

Time: 0715 hours, dive duration 80 minutes; depth range 1-25 m; visibility approximately 20 m; no current; temperature 27°C. *Site description*: reef located off rocky portion of island, extending approximately 150 m offshore; reef flat gently slopes at 5° to depth of 10 m, then forms steep slope of 45° to 14 m depth; coral cover on crest is approximately 35% hard coral, 20% soft coral, 25% dead algal-covered coral, and 40% rubble: coral cover on reef flat approximately 20% hard coral, 20% soft coral, 30% algal-covered dead coral and 30% rubble: reef slope generally covered with rubble; occasional coral bleaching was noted (probably cyanide); *Diadema* sp. and *Padina* sp. were noted growing on dead corals and rubble. Dominant corals in shallows: *Montipora hispida* and *Porites* species, Moderate coral species diversity dominated by massive colonies.

11. Illutuc Bay, Busuanga (12° 16.30' N, 119° 53.31' E)

Time: 1130 hours, dive duration 10 minutes (abandoned due to sighting of dangerous box jellyfish); depth range 1-2 m; visibility about 1 m; no current; temperature approximately 30°C. *Site description*: sheltered inner harbor environment; heavy siltation and extremely turbid water; flat mud bottom with abundance of burrowing gobies; several mollusc species collected at this site. Low coral diversity inside bay entrance but a much higher diversity outside the entrance where the water was clear. A high diversity of *Acropora* species.

12. Mouth of Illutuc Bay, Busuanga (12° 15.93' N, 119° 52.31' E)

Time: 1200 hours, dive duration 90 minutes; depth range 1-14 m; visibility approximately 4-6 m; no current; temperature 27°C. *Site description*: reef on northern side of entrance to Ilutuc Bay; reef flat extends approximately 100 m from shore to depth of 2.5 m, then slopes steeply (80°) to depth of 4 m; outer more exposed (to surf) part of reef extends about 150 m offshore and gently slopes to crest of 1.5-2.0 m depth, then slopes (45°) to depth of 12 m; bottom of channel leading into Illutuc Bay mainly sand and rubble; hard coral cover relatively sparse, ranging between 2.5-10% cover, richest in less exposed positions; soft coral cover ranging between 2.5-25%, most abundant on upper edge of slope; algal-covered dead coral and rubble cover ranging between 10-90%, dominating the substratum of shallow reef flat; strong siltation evident and *Diadema* sp. abundant.

13. South side of Kalampisauan Island, Busuanga (12° 14.51' N, 119° 51.16' E)

Time: 1615 hours, dive duration 70 minutes; depth range 1-25 m; visibility 15 m: no current; temperature 28°C. *Site description*: extensive reef adjacent to rocky cliffs along shore: reef gently slopes (5°) seaward for 50 m *to* depth of 6 m, then drops (35°) to rubble bottom at 15 m depth; reef cover consists of 25-35% hard coral. 25-35% soft coral; and up 40 45% dear; *coral* and rubble; shallower section of reef forms gullies and ridges; occasional bleaching of hard corals (probably cyanide) and algae infestation on live coral heads was noted; three *Tridacna* sp. (30-40 cm) seen; also one unidentified shark (only one seen on survey). High coral species diversity over a large area.

14. Buluang Bay, Bususanga (12° 13.09' N, 119° 51.51' E)

Time: 0700 hours, dive duration 75 minutes; depth range 1-20 m; maximum visibility of 18 m, reduced in deeper water; no current; temperature 27.5°C. *Site description*: reef gradually slopes from shore to depth of about 9 m, then slopes to about 20 m depth, but bottom topography characterized by maze of hummocks and intervening depressions; abundant coral cover consisting of up to 65-70% hard and soft varieties; rubble also common at base of slope and in bottom of depressions; nudibranchs relatively abundant at this site. High coral species diversity over a large area.

15. West side of Gutob Peninsula (12° 11.74' N, 119° 51.59' E)

Time: 1055 hours, dive duration 75 minutes; depth range 1-17 m; visibility 15 m; no current; temperature approx. 28°C. *Site description*: reef begins about 40 m from shore and slopes at angle of 10° to depth of 8 m, then slopes with groove and buttress structure at 30° to 12-17 m depth; deeper area characterized by several large pinnacles or hummocks; reef flat covered with 45% hard coral, 25% soft coral, and 30% dead coral; up to 100% hard-soft coral cover on some sections of slope; some *Halimeda* growing on dead corals and *Caulerpa*

on reef slope. Very high coral species diversity, with many species forming very large colonies.

16. Detobet Point, Busuanga Island (12° 08.74' N, 119° 51.24' E)

Time: 1520 hours, dive duration 70 minutes; depth range 1-15 m; turbid conditions with visibility at 5-7 κ: no current: temperature 28°C. *Site description*: narrow band of barren beach rock next to shore, then reef gradually sloping to depth of 3 m before dropping (60° slope) to about 12-15 m on sandy bottom; percentage of live coral cover ranges between 15 (deeper section of slope) to 40 + (upper edge *of* slope); soft corals also common forming up to 50% cover (upper edge of slope); dead coral largely overgrown with algae. but some freshly dead patches noted (possibly due to cyanide fishing); siltation minimal; some evidence of anchor damage. Moderate to low coral species diversity.

17. Islet south of Talampulan Island (12° 06.14' N, 119° 50.71' E)

Time: 0825 hours, dive duration 85 minutes; depth range 1-28 m; visibility 8-10 m; no current; temperature 28°C. *Sire description*: reef flat gradually extends seaward on 10° slope to depth of about 4 m, incorporating gullies and algal-covered boulders; then slopes (about 50°) down to sand-rubble bottom in 28 m; reef top composed of about 40-60% hard corals, remaining dead coral largely encrusted with algae: evidence of both old and recent cyanide use; anchor damage also noted; *Tridacna* " relatively common. Moderate coral species diversity in shallows.

18. West end of Maltatayoc Island (12° 02 81' N, 119° 52.09' E)

Time: 1140 hours, dive duration 90 minutes: depth range 1-30 m; visibility 8-10 m; no current; temperature 28°C. *Sire description*: shallow reef extends seaward to 3-4 m depth, terminating in gullies and algal-covered boulders; edge of shallow reef drops at 50° to 25-30 m depth ending on sand-rubble bottom; best coral cover in 3-8 m depth with estimated coral cover up to 80% (including 50% hard corals); lower part of slope mainly rubble and sand; most of dead coral encrusted with algae; some evidence of cyanide use, both old and recent. Moderate coral species diversity. The rubble has a wide range of fungiids.

19. Southeast end of Lajo Island (11° 59.19' N, 119° 57.64' E)

Time: 1523 hours. dive duration 90 minutes; depth range 1-25 m; visibility 6 m; no current; temperature 28°C. *Site description*: area of freshwater runoff due to spring at shoreline; limited reef development about 50 m from *shore:* patchy mangroves along shore with some *Enhalus* seagrass in shallows; shallow flat between shore and reef mainly consisting of sand, rubble, and patches of dead coral; offshore reef gradually slopes to depth of about 25 m; slope is badly damaged with *mostly* dead coral and rubble (less than 5% live coral): in addition to *Enhalus acoroides*, four other seagrass species were seen: *Thalassia hemprichii, Halophila ovalis, Cymodocea rotundata and C. serrulata*; several fishing lines were entangled on reef; hundreds of *Diadama setosum* seen in shallow water. Low coral species diversity, but an interesting turbid water environment.

20. Isolated rock off southern tip of Galoc Island (11° 55'85' N, 119° 49.20' E)

Time: 0825 hours, dive duration *90* minutes; depth range 1-20 m; visibility 12 m; slight eastward current; temperature 27°C. *Site description*: isolated rock rises from depth of about 10 m, breaking surface: fringing reef around periphery of rock to depth of 10 m, then gradually slopes to 20 m depth; visual estimates of 20% hard coral, 25% soft coral, 40% dead coral, and 20% rock and rubble in area above 10 m depth; sea whips relatively common throughout site; distinct evidence of dynamite damage; also extensive coral bleaching and algal growth. Low coral specie?;diversity.

21. Southeast tip of Galoc Island - 2 dives on consecutive days (11° 56'62' N, 119° 50.02' E)

Time: 1130 hours. dive duration 90 minutes; depth range 1-23 m: visibility 10 m; no current; temperature 27°C. *Site description:* fringing reef in sheltered bay; reef begins near shore and gradually slopes to depth of 4 m. then steeper slope to bottom of bay; most of corals concentrated in shallow water (to 8-10 m), but on northeastern side of bay reef slopes down to 25 m depth: maximum live coral cover about 25-35% except as high as 60% in shallows (1-4 m); reef on western side of bay interrupted by large sea grass bed; seagrasses noted were *Halodule uninervis, Cymodocea serrulata* and *Halophila ovalis;* bay has high novelty value for fishes and corals - several species seen here and nowhere else during survey; three large (50 cm) *Tridacna* sp. noted and several smaller ones in shallows. Moderate diversity in coral species,

22. Southwest tip of Galoc Island - 2 dives on consecutive days (11° 56.81' N, 119° 49.47' E)

Time: 1530 hours. dive duration 90 minutes: depth range 1-25 m; visibility 8-10 m; no current; temperature 27°C. *Site description*: fringing reef surrounding protected embayment end extending seaward for 150 m; reef flat slopes gently (approximately 10°) with occasional deep depressions and gullies, then approximately 50 m from shore it plunges moderately (20°), forming reef terraces to a depth of 25 m; dead coral with algal growth dominates benthic cover: 50% on reef Cat, 45% on crest an3 60% on reef slope: live coral cover on reef flat is composed of 30% soft coral and 20% hard coral. The outer edge of the flat is approximately covered with 30% soft coral and 25% hard coral: outer slope cover was 20% hard coral and 10% soft coral: rubble dominates the lower slope: noted bleaching in some corals especially in staghorn *Acropora*; also some bleaching due to possible cyanide *usage,* Moderate coral species diversity.

23. Southern tip of Galoc Island (11° 56.44' N, 119° 49.34' E)

Time: 1630 hours, dive duration 80 minutes; depth range 1-20

m; visibility 5-7 m; slight current; temperature 27°C. *Site description*: rocky cliff next to shore continues underwater to depth of 3-4 m then reef forms zone of gullies and algal-covered boulders, with eventual transition to large rocky outcrops and low coral heads, ending in rubble at depth of 20 m; shallows largely rock with some dead coral and rubble; dead coral not recent and encrusted with algae; soft coral cover as high as 75% in some sections; hard coral cover generally very low (5-10%), largely short sturdy colonies of *Acropora*; no evidence of recent cyanide use. Moderate coral species diversity.

24. Southwestern tip of Coron Island near Calis Point (11° 48.83' N, 120° 15.33' E)

Time: 1100 hours, dive duration 75 minutes; depth range 1-25 m; visibility 20+ m; slight current; temperature 27°C. *Site description*: scenic above water with steep cliffs plunging into sea, but outside reef totally destroyed by blast fishing; a narrow, wave-washed fringing reef then slopes at 70° to sand rubble bottom in 25 m depth; more than 90% dead coral with large amounts of *Padina* and algae - a very depressing reef; in contrast, a scenic amphitheater-like bay situated adjacent to site is far more interesting than outer fringing reef; contains large patches of live coral and good variety of fishes; has shallow sill across entrance and deep (28 m) lagoon occupying much of inner part of bay. Moderate to high coral species diversity.

25. Coron Island, south of Banol Point (11° 55.76' N, 120° 11.81' E)

Time: 1530 hours, dive duration 70 minutes; depth range 1-30 m; visibility 8-10 m; no current; temperature 28°C. *Site description*: similar bottom topography to previous site; reef slopes steeply (60°) to beyond 30 m depth; entire reef destroyed (reduced to rubble) by explosive fishing; live hard coral cover less than 5% on reef crest and 100% dead elsewhere; no soft corals either. Low coral species diversity, with only massive corals.

26. Twin Peak Islands, western Coron Island (11° 57.40' N, 120° 12.57' E)

Time: 0830 hours, dive duration 90 minutes; depth range 1-35 m; visibility 15+ m; no current; temperature 28°C. *Site description*: excellent dive site with spectacular drop-off, abundant black coral, and good variety of fishes and corals; reef surrounds two small rocky islets a short distance from Coron Island; reef top occupies about a hectare and around much of the periphery slopes off on the edge at 45° to depth of 12 m, but in some sections forms a spectacular 90° drop beginning in only 1 m depth; inner, more protected reef facing Coron Island generally covered with 90% hard coral and 10% rubble on western portion and approximately 60% hard coral and 40% dead coral with algae on eastern side; outer portion facing the Coron Bay generally covered with 70% hard coral and 30% rubble; reef flat covered with 55% hard coral and 45% rubble. *Diadema setosum* observed in crevices on reef flat. One of the highest ranking sites for coral species diversity.

27. Southwestern tip of Tangat Island (11° 57.59' N, 120° 03.56' E)

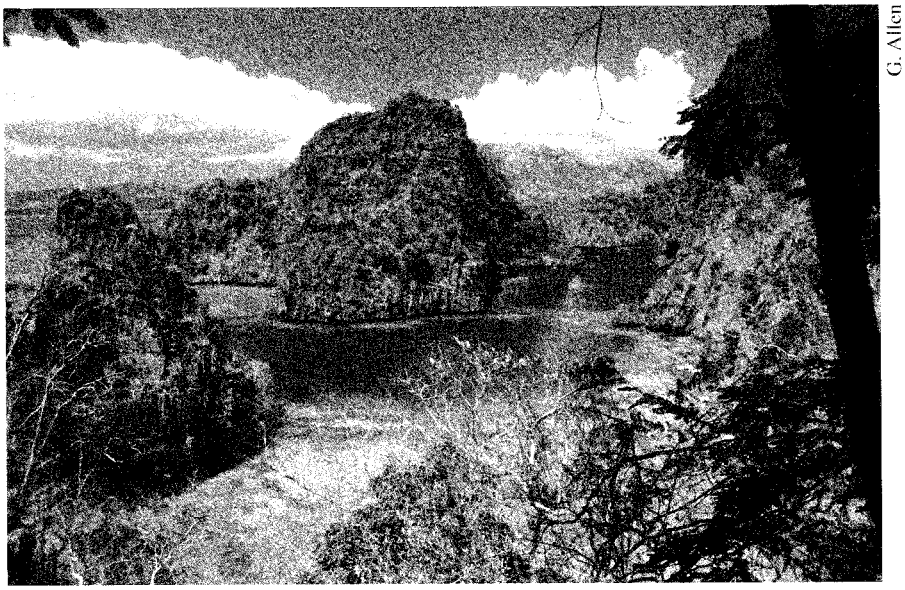
Time: 1500 hours, dive duration 90 minutes; depth range 1-25 m; visibility 6 m; no current; temperature 28°C. *Site description*: fringing reef on edge of steep, high cliffs forming southwestern Tangat Island; narrow fringing reef about 20 m in width with outer edge in about 2.5 m depth, then dropping steeply at 45-90° to depth of about 20 m, ending on sand-rubble bottom; upper edge covered with 50% hard coral, 30% dead coral with algae, and 20% rubble; upper slope covered with 40% dead coral, 25% hard coral, 25% rubble, and 10% sand; lower slope covered with 50% dead coral with algae, 35% rubble, 10% sand, and 5% hard coral; *Padina* on rubble; occasional coral bleaching noted, especially on staghorn *Acropora*. Low diversity in coral species except for pectiniids.

28. West side of Calumbuyan Island (12° 00.53' N, 119° 56.42' E)

Time: 0830 hours, dive duration 75 minutes; depth range 1-25 m; visibility 6-10 m; moderate current at beginning of dive, but none towards end; temperature 27°C. *Site description*: fringing reef extends approximately 100 m from shore; outer edge at depth of 2.5 m, then descends to 60 feet at 45 to 50° slope; upper edge covered with 70% hard coral 15% dead coral with algae, 10% rubble, and 5% soft coral; upper slope covered with 60% hard coral, 20% dead coral with algae, 10% soft coral, and 10% rubble; lower slope composed of 40% dead coral, 40% rubble, 10% hard coral, 5% soft coral, and 5% sand; interesting flat-bottom area in seaward direction from slope, consisting of abundant sponges, fans, and sea whips - obviously exposed to periodic strong currents. Moderate coral cover over most of the slope, but very high cover in some of the shallows.

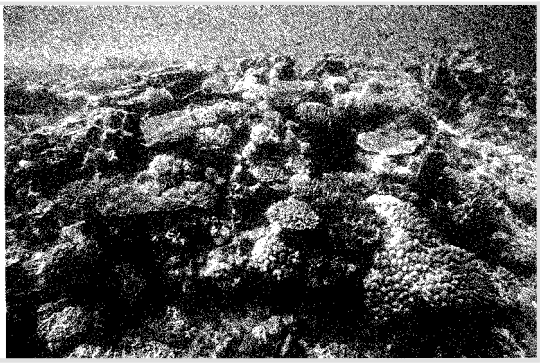
29. North side of Popototan Island (12° 00.04' N, 119° 51.34' E)

Time: 1120 hours, dive duration 90 minutes; depth range 1-22 m; visibility 6 m; no current; temperature 28°C. *Site description*: fringing reef extends approximately 250 m from shore; shoreline is rocky and reef flat shows gradual transition from bare shallow beach rock to live reef towards outer margin; some *Sargassum* noted on sand bottom near shore; water depth on reef top gradually increases to 8 m, then abruptly drops to 20 m depth on 45° slope; benthic cover on crest composed of 60% hard coral, 20% dead coral with algae, 10% soft coral, 5% rubble, and 5% sand; mid- to upper-slopes composed of 35% hard coral cover, 30% dead coral with algae, 20% rubble, and 15% soft coral; lower slope composed of 55% dead coral with algae, 30% rubble and sand, and 15% hard coral; lots of suspended particles in water; *Padina* noted on dead corals; two crown of thorns starfish seen; one bottle of ammonium nitrate used for dynamite recovered. Moderate coral species diversity.



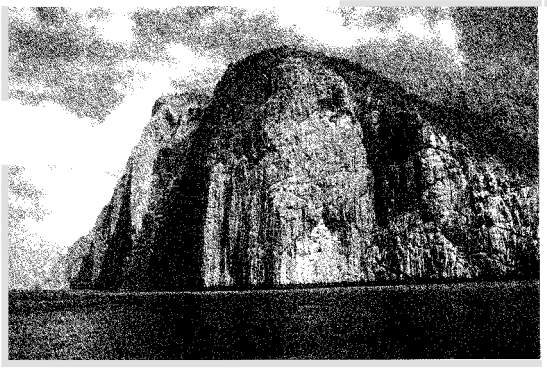
G. Allen

Northwest Coron Island, looking towards Busuanga Island.



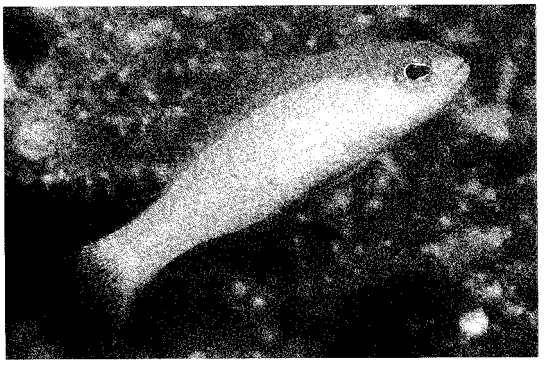
R. Steene

Coral reef, west coast of Culion Island



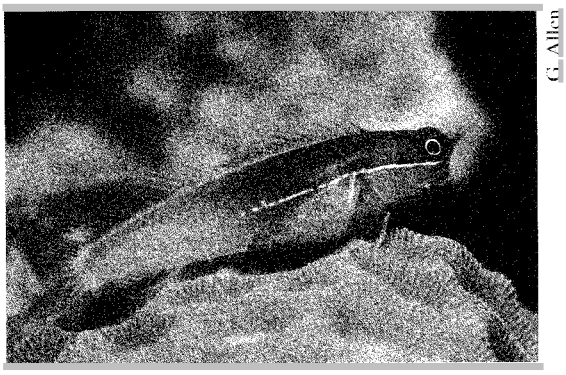
G. Allen

Spectacular coastline of southwestern Coron Island



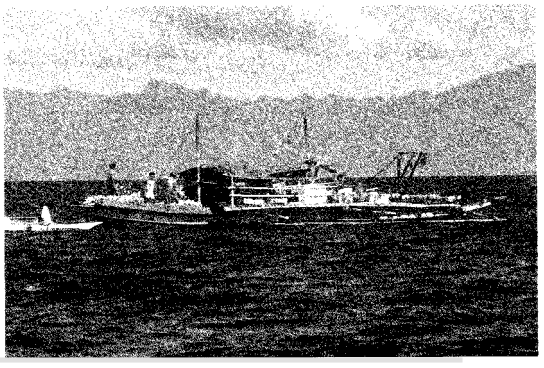
G. Allen

Golden dottyback, *Pseudochromis diadema*.



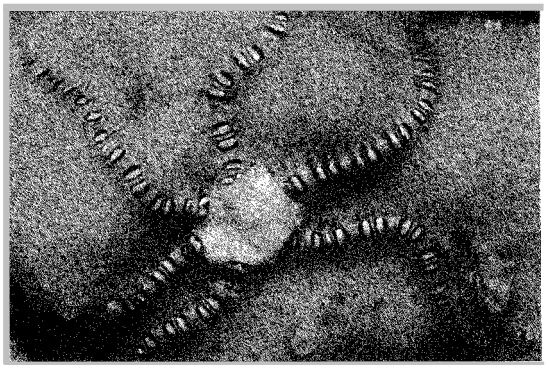
G. Allen

New species of *Ecsenius* blenny



G. Allen

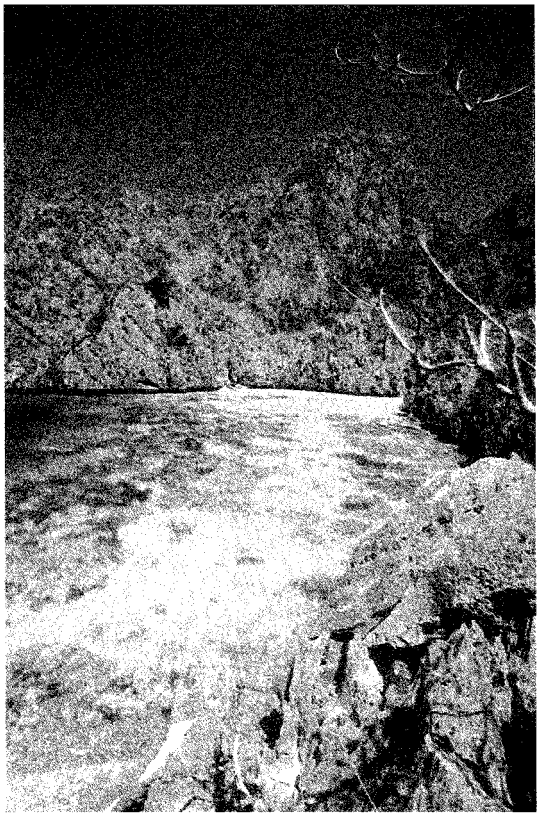
Illegal net-fishing, Coron Bay



R. Steene

Brittlestar on sponge.

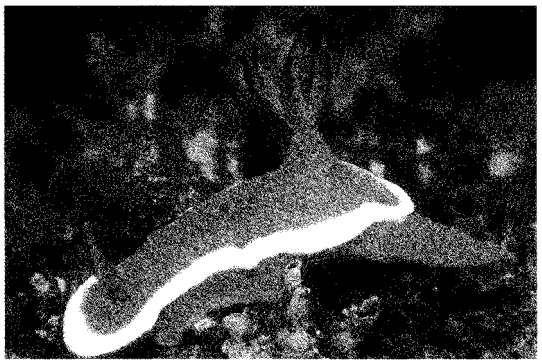
G. Allen



Secluded bay on Coron Island

R. Steene

RAP scientist G. Allen recording fish species, Busuanga Island.



R. Steene

Violet nudibranch. *Chromodoris bullochi.*

1998 Calamianes Marine RAP Science Team. Coron Island.
Back row (L to R): T. Werner. R. Ledesma. G. Allen. R. Steene. D. Fenner
Middle row (L to R): R. Martinez. V. Bungabong. J. Veron, F. Wells
Front row (L *to* R): J. Pontillas. J. Ingles, S. Curran, M. Comer

30. Culion Island, 10 km north of Halsey Harbor (11° 57.27' N, 119° 53.52' E)

Time: 1600 hours, dive duration 90 minutes; depth range 1-22 m; visibility 10 m; no current; temperature 28°C. *Site description*: protected cove with fringing reef, reef flat extends approximately 150 meters from shore, gradually increasing to depth of 6 m at upper edge of slope, then plunging to 15-18 m depth on slope ranging between 15-90°, well-developed gullies present on some sections near outer edge of reef, upper edge of reef generally composed of 75% dead coral with algae, 20% hard coral, and 5% soft coral; upper slope composed of *70%* dead coral with algae, and 10% each of hard coral, soft coral and rubble; lower slope composed of 75% dead coral with algae, 15% hard coral, and 10% rubble. limited anchor damage and coral bleaching noted. Moderate coral species diversity of mostly faviids.

31. Research Channel, Culion Island (11° 45.54' N, 119° 55.90' E)

Time: 1000 hours, dive duration 90 minutes; depth range 1-32 m; visibility 10-12 m; no current; temperature 27°C. *Site description*: fringing reef on north side of Research Channel near entrance; reef extends approximately 150 m from shore and forms drop-off at depth of 6-7 m feet then plunges at angle of 45-70° to depth of 12 m, gradually increasing depth on channel bottom to at least 35 m; outer edge of fringing reef composed of 78% dead coral with algae and 8% rubble, and 12% is hard coral; slope generally composed of 58% dead coral with algae, 23% rubble, and 20% hard coral; some bleaching was noted on several corals; reef was definitely damaged by explosives; much of the rubble and dead coral covered with *Padina* and *Halimeda*. Low diversity in coral species with communities dominated by rapidly growing *Acropora, Montipora* and *Porites*.

32. Rhodes Island in Halsey Harbour, Culion Island (11° 45.52' N, 119° 58.08' E)

Time: 1300 hours, dive duration 85 minutes; depth range 1-28 m; visibility about 6 m; no current; temperature 28°C. *Site description*: fringing reef in middle part of Halsey Harbor; fringing reef approximately 150 m in width, with water depth increasing gradually to depth of 6 m, then plunging steeply (45-60°) to 20-25 m depth; upper edge of slope dominated by dead coral with algae (65% cover) and only 30% live hard coral; slope composed of 40% rubble, 35% hard coral, and 25% dead coral with algae; excellent site for corals - at least five potential new species found; area has good potential as protected area for giant clams (*Tridacna*) due to their abundance; *Padina* plentiful in some sections; siltation relatively high and lots of suspended particles in water. High coral species diversity of mostly non-*Acropora* species make it very unusual and taxonomically very interesting.

33. South branch of Halsey Harbour, Culion Island (11° 44.07' N, 119° 57.03' E)

Time: 1600 hours, dive duration 90 minutes; depth range 1-23 m; visibility about 5 m; no current; temperature 28°C. *Site description*: narrow channel at entrance to southern branch of Halsey Harbour; site is very protected and bordered by mountainous terrain (under initial state of de-vegetation for agriculture); fringing reef on either side of channel is 25-50 m wide and drops steeply to the channel bottom in 23 m depth; silt-sand bottom of channel has excellent population of burrowing gobies; outer edge of reef top composed of 40% rubble, 25% dead coral with algae, and 35% hard coral; upper slope composed of 40% hard coral, 40% rubble, 20% dead coral with algae; reef has been dynamited and lots of anchor damage evident. A lot of coral bleaching; *Padina* noted on dead corals and rubble; heavy siltation at this site and suspended particles plentiful in water. High faviid diversity.

34. Southwestern tip of Culion Island (11° 40.67' N, 119 56.60' E)

Time: 0920 hours, dive duration 90 minutes; depth range 1-25 m; visibility about 25 m; no current: temperature 28°C. *Site descriptSon:* sheltered bay with fringing reef; reef extends approximately 50 to 100 m offshore gradually increasing in depth to edge of drop-off at 6 m, then plunging to 15-20 m depth at an angle of 30-45°, ending *on* sand-rubble bottom; excellent coral area close to shore in 1-3 m depth consisting of 100% live cover (dominated by *Montipora platiformes/hispida* and digitiform *Acropora*); edge of drop-off and upper slope covered with dead coral with algae (52.5%) and rubble (25%), and hard coral (22.5%); lower slope covered by 75% dead coral with algae, 10% rubble, and 15% hard coral; *Padina* on dead corals and coral bleaching encountered occasionally on staghorn *Acropora*. Eow diversity in cora! species. Appears to have incurred recent damage.

35. Saddle Rock, Culion Island (11° 46.07' N, 119° 53.51' E)

Time: 1400 hours, dive duration 70 minutes; depth range 1-15 m; visibility about 20 m; no current; temperature 28°C. *Site description*: site located on isolated rocky island off southwestern Culion Island; excellent site with abundant corals on fringing reef. Reef is basically anchored to submerged rocky portion of Saddle Rock: a broad fringing reef gently slopes offshore *at* approximately 5° to depth of 8 m on northwestern portion and has excellent 80% live coral cover and remaining reef cover consisting of 10% solid rock. 5% dead corai with algae and 5% rubble: at depth of 12 m the cover consists of *50%* hard coral. *30%* dead coral with algae, and 20% rubble; below about 15 m the bottom is largely rubble. High coral species diversity.

36. Southwest side of Lusong Island (11° 58.69' N, 120° 01.12' E)

Time: 0940 hours, dive duration 80 minutes; depth range 1-25 m; visibility 10-15 m; no current; temperature 28°C. *Site description*: narrow (25-50 m) fringing reef along rocky coast; edge of reef drops steeply (70°) from depth of 3 m to 18 m, then gradually descends to sand-rubble bottom; upper edge of reef covered with about 45% hard coral, 45% dead coral with algae, and 10% rubble; upper slope composed of 45% hard coral, 40% dead coral with algae, and 12% rubble; lower slope covered with 58% dead coral with algae, 25% hard coral, and 17% rubble; parts of upper slope show evidence of explosive

fishing; also some anchor damage noted. Moderate coral diversity dominated by *Echinopora* species.

37. Northwest end of Chindonan Island (11° 55.57' N, 120° 02.14' E)

Time 1245 hours, dive duration 90 minutes; depth range 1-22 m, visibility 80 m, no current; temperature 28°C *Site description* picturesque fringing reef in sheltered bay, partly surrounded by mangroves. reef varies in width between 25-75 m sloping to depth of about 3 m before dropping steeply (70-80°) to 15-18 m depth. top edge of reef generally covered with 50% hard coral and 50% rubble; upper slope is badly damaged by explosives with 80% rubble and only 18% hard cord, Power slope also covered with rubble (85%), and smaller amounts of live coral (11%) or dead cord with algae (4%); relatively strong siltation at this site Dense stands of *Pontes cylindrica*.

38. Siete Pecados Islands, Coron Island (11° 59.06' N, 120° 13.47' E)

Time 0800 hours, dive duration 90 minutes: depth range 1-35 m; visibility 25 m; no current; temperature 28°C *Site description* cluster of small mushroom-shaped islets surrounded by excellent fringing reef. shallow reef flat has diversrty of soft and hard corals with patches of sand and seagrass (*Enhalus*); steep drop-off around edge of reef, sloping at 50-80° to sand-rubble bottom in 30 m depth, very rich coral on upper slope and edge of drop-off with 100% cover in some sections; large black coral bushes on steeper sections of slope and crinoids also abundant, small fishes very abundant and school of 12 Bumphead parrotfishes sighted Moderate coral specnes diversity

RESULTS AND DISCUSSION

Detailed results are given in the separate chapters for corals, molluscs, fishes, and fisheries, but the key findings of *the* survey are summarized here.

Corals:

- The Philippines has the highest h o w diversity of reef corals. The present survey raised the known species total from 349 to at least 462, and at least 30 additional species can be expected
- Approximately 20 undescribed species were identified during the survey, a phenomenal number for such a restricted area.
- Judging from the results of this survey and past work. it is likely that the northern Palawan region has a higher coral diversity than other parts of the Philippines
- In view of the heavy impact of fisheries, including destructive fishing methods such as cyanide, explosives, and muro-ami, most of the sites had a significant amount of live coral and overall coral diversity for the Calamianes was impressive
- The biologically richest and most aesthetic sites were site numbers 3, 15, 26 and 38 Site 32 had many rare and previously undescribed species Southwest Coron Island revealed excessive damage from explosives

Molluscs:

- A total of 648 species belonging to 96 families were recorded during the expedition including 469 gastropods, 163 bivalves, 7 chitons, 5 cephalopods, and 2 scaphopods
- The most diverse families were gastropods: Conidae (44 species); Cypraeidae (36); Thaididae (30); and Mitridae (24). Veneridae (37) was the most diverse bivalve family.
- Mollusc diversity was higher than for any previous RAP expedition and similar surveys conducted in Australia, being marginally higher than Milne Bay, Papua New Guinea (638 species) and the Montebello Islands, Western Australia (631)
- A single specimen of octopus was found at one station, indicative of high fishing pressure Similarly, low numbers of other fished species such as spider shells, conchs and abalone were also encountered
- Aside from the small *Tridacna crocea*, and to a lesser extent *T. squamosa,* very few live giant clams were seen during the expedition While the species are recorded from a number of stations, the majority of *the* records were based on dead shells, and populations appear to have been overfished Similarly, few ornamental seashells of the type sold commercially were found during the survey
- The two richest sites for mollusc diversity were 1 and 17: site 11 had the lowest diversity

Fishes:

- A total ot 736 species belonging to 250 genera and 70 families were observed or collected during the present survey An extrapolation method using six key index families (Chaetodontidae, Pomacanthidae, Pomacentridae, Labridae. Scaridae, and Acanthuridae) indicates a total fauna consisting of at least 888 specnes
- Species numbers at visually sampled sites ranged from 106 to 208, with an average of 158 per site.
- The islands off northeaster Busuanga including Tara, Dimaquiat, Tanobon. and Dimipac were generally the richest areas for fishes in the Calamianes Group with an average of 189 species per snte The lowest diversity was in the northwest sector of Coron Bay where an average of 115 species per snte was recorded
- Although reef fish biodiversity is high in the Calamianes Group, habitat diversity was relatively low More often than not the reefs were typically well-sheltered and subject to varying degrees of siltation with minimal current activity

- The Calamianes Group is home to several rare fish species including a blenny (*Ecsenius colei*), and dottyback (*Labracinus atrofasciatus*). In addition, at least three undescribed species, a dottyback (*Pseudochromis*), damselfish (*Altrichthys*) and blenny (*Ecsenius*) were collected during the survey.

- The ten richest sites for species diversity were 1, 2, 9, 10, 17, 21, 22, 24, 30, and 31; the lowest (<120 spp.) were 5, 11, 12, 19, and 37.

Fisheries:

- The history of fisheries in the region is characterized by a steady and rapid decline of resources since a peak period between 1970-1980. There has been a trend to utilize various types of gear until stocks reach an unprofitable level forcing a switch to alternative gear and/or more distant fishing grounds.

- Underwater observations at thirty sites indicate that most reefs have suffered various degrees of habitat destruction, primarily from blast fishing, *muro-ami*, cyanide use, and anchor damage. Furthermore, the reefs are characterized by severe depletion of market-sized fishes, including a notable lack of large piscivorous species such as groupers, barracudas, jacks and sharks. (The only shark recorded was at site 13). Likewise, lobsters appear to have been fished to the brink of extinction.

- The fisheries of the Calamianes area face a bleak future mainly due to the heavy exploitation of available resources. This situation has resulted in reduced catch rates and consequent decline in total production. The 1997 fish production estimate was only 50% of the 1991 level and further decline is anticipated.

- Development of tourism offers a viable alternative to fishing as a source of livelihood. Not only would it offer employment opportunities, but would effectively reduce fishing pressure and offer a means of resource protection (at least in the immediate vicinity of tourist facilities).

Sightings of large marine animals:

Only a single shark was sighted during the survey, an obvious sign of heavy fishing pressure. Reef sharks are generally territorial, long-lived, slow to mature, and exhibit low fecundity. Consequently they are easily fished out. Wright (1975) reported that Whale Sharks (*Rhincodon typus*) were rarely seen in the Calamianes, but over a two-day period in February 1974 as many as six were observed together along with a whale and manta rays.

During the current RAP survey we did not observe any turtle nesting activity, but Wright (1975) noted that sea turtles nested at West Nalaud Island and the young turtles were often harvested and sold to aquarium fish traders.

Both biological and fisheries teams recorded dugong and marine turtle sightings during the present survey. These observations are summarized in Table 1.

Biological diversity

The biological results (Table 2) of the present survey indicate that the Palawan area, including the Calamianes Group, is among the richest in the Philippines for marine biodiversity and probably represents a discrete and important biogeographic subprovince characterized by regional endemism. The subprovince has a distinct geological basis for its separation from most other parts of the Philippines, which was first recognized more than a century ago (Huxley, 1868).

Huxley's Line forms a modification of the well-known Wallace's line, a boundary originally proposed to delineate the

Table 1. Summary of turtle and dugong sightings. All team members kept on watch for these animals while diving and while traveling on the surface. The length of dugongs and turtles was estimated.

DATE	SITE NO.	LOCATION	SIGHTINGS	NO. AND LENGTH
7/2/98	4	Coconogon Pt.	Hawksbill Turtle	1 (85 cm)
7/2/98	6	Cabilauan Is.	Hawksbill Turtle	1 (36 cm)
8/2/98	7	Dimaquiat Is.	Green Turtle	2 (75 cm)
8/2/98	9	Tanobon Is.	Turtle tracks only	
9/2/98	10	Dimipac Is.	Green Turtle	2 (30-100 cm)
9/2/98	10	Dimipac is.	Hawksbill Turtle	1 (not given)
9/2/98	12	Caluit Bay	Dugong	1 (adult)
9/2/98	13	Kalampisauan Is.	Green Turtle	1 (80 cm)
10/2/98	15	Gutob Peninsula	Green Turtle	1 (45 cm)
10/2/98	16	Detobet Pt.	Dugong	1 (adult)
11/2/98	17	Talampulan Is.	Dugong	1 (adult)
12/2/98	21	Galoc Is.	Green Turtle	1 (60 cm)
12/2/98	22	Galoc Is.	Green Turtle	1 (70 cm)
17/2/98	28	Calumbuyan Is.	Hawksbill Turtle	1 (80 cm)
17/2/98	29	Popototan Is.	Green Turtle	1 (120 cm)
19/2/98	none	Halsey Harbour	Dugong	1 (adult)

separation of western and eastern components of the terrestrial biota of the Southeast Asian region (Huxley, 1868: foldout chart; Simpson, 1977; Fig. 1). Huxley's line passes between Bali and Lombok in the south and separates the Calamianes and Palawan from Mindoro, western Mindanao, and the rest of the Philippines in the north. The Indonesian islands west of Bali (Java, Sumatra, etc.), southern Borneo, and the Philippine islands, including Palawan, Calamianes, Mindoro, and western Mindanao, originated on the Eurasian plate and existed at least as early as the early Tertiary, c. 50 mya. (Hall, 1995,1996). The Indonesian chain of islands from Bali east to Wetar (and beyond), and the other Philippine islands originated on the Philippine Sea Plate to the east over a considerable period of time, and some, such as Bali-Wetar chain, formed as recently as about 15 mya and their formation is continuing. Complex tectonic movements over 50 mya resulted in extensive shifts in position of the various islands, including approximation of islands from the different plates (e.g., Mindoro and Luzon) and formation of hybrid islands resulting from the suturing of islands from the two areas (e.g., eastern and western Mindanao).

Table 2. Summary of Calamianes marine fauna recorded during the RAP survey.

FAUNAL GROUP	NO. FAMILIES	NO. GENERA	NO. SPP.
Reef corals*	19	74	305
Molluscs	96	223	648
Fishes	70	250	736

*includes Hydrocorals and Octocorallia

Relatively rich marine biodiversity (Table 2) was reported during the present RAP despite a lack of habitat diversity. Most sites consisted of reasonably well-sheltered fringing reefs that were less than 35 m deep and lacked significant ocean currents. Atoll, barrier, and platform reefs, typical of many Indo-Pacific localities were not encountered. Nor were steep outer reef drop-offs, which usually contribute a substantial element to overall biodiversity.

Although situated within the "coral triangle," an area famous for its unsurpassed marine biodiversity, the Philippines has experienced a rapid decline in marine resources/fisheries production, particularly over the past three to four decades. Much of the blame is attributed to the widespread use of destructive fishing methods (McAllister, 1988). Moreover, considerable reef destruction resulted from the well-documented decrease of inland forest cover during the Marcos regime. This situation caused huge quantities of silt, the product of erosion, to be carried out to sea by rivers where it eventually settled on coral reefs.

Gomez *et al.* (1994) reviewed the status of Philippine reefs. Surveys initiated in the 1970's have documented their rapid degradation. Based on estimates of the percentage of live coral cover approximately 70% of the country's reefs were classified as fair to poor (0-49% cover), with only 5.5% included in the excellent (75-100% cover) category (Gomez, 1991). An analysis of 85 sites at 14 locations around the country revealed that hard coral cover was substantially less than 50% at nearly every site with the exception of Polillo, Quezon (Gomez *et al.*, 1994).

Muro-ami, cyanide, and explosives are among the most destructive of fishing practices resulting in wholesale degradation of coral environments. The muro-ami method involves setting a net over a coral reef into which a group of 10-30 swimmers drive the fishes. The swimmers are equipped with weighted (usually rocks) lines that are bounced up and down on the reef in an effort to drive out the fishes.

In the 1980s the use of cyanide emerged as a favorite method of capturing specimens for the aquarium and live food-fish trades. McAllister (1988) conservatively estimated that 75,000 kg or 1,500 drums of cyanide were being sprayed onto Philippines coral reefs each year. Thankfully, cyanide-monitoring test units are currently in operation at strategic sites and should markedly reduce the use of this chemical. Although it is illegal to use cyanide, very few apprehensions occur and in the previous decade less than 1% of those arrested were actually convicted (McAllister, 1988).

During the present Calamianes survey we saw evidence of the major destructive fishing methods, which leave their characteristic marks in the form of bleached coral skeletons and rubble patches. Two sites (24 and 25) along the southwestern coast of Coron Island were *the* worst affected, essentially reduced to rubble to a depth of at least 20 meters. We also encountered an illegal drag-netting operation in Coron Bay.

In spite of intensive use of destructive fishing practices in the Calamianes Group over the past decades, much of the observed degradation was either limited in area or was relatively old, with many reefs showing good signs of recovery, evidenced by significant amounts of live coral cover. These observations are very encouraging and clearly signal that it is not too late to implement conservation measures.

Key sites

The RAP team was particularly impressed by the conservation potential of several sites, based on their wealth of organisms and scenic beauty. The top-ranked area was at Twin Peaks Islands (site 26) on the northwest coast of Coron Island near the entrance to Cayangan Lake. The reef was mainly undamaged and contained a notable abundance of corals and fishes. Moreover, the site contains remarkable scenery, both above and below the surface.

The Siete Pecados Islands (site 38), also on the northwest coast of Coron Island, is similar to the Twin Peaks area, but

slightly less attractive, underwater. The site is *e* popular dive destination and is designated as *e* Marine Core Zone under the ECAN zonation scheme of Coron municipality.

Halsey Harbour on Culion Island has well-developed reefs that support an extraordinary diversity of non-*Acropora* corals, including several species that were previously unknown to science. This large bay is sparsely populated and has good potential as a Marine Core Zone. Likewise, the incredibly scenic bay near site 24 on she southwest coast of Coron Island could be an excellent destination for tourists. A narrow passage leads to a tranquil lagoon (nearly 30 m deep) surrounded by sheer rocky cliffs that rise precipitously from the sea for hundreds of feet.

Recent developments

In June 1998, bleaching occurred on several reefs throughout the Philippines, including reefs in Palawan. Some sites recommended for protection as a result of the 1998 RAP were briefly revisited over a two-day period in December 2000. The observations are reponed in Appendix 5.

CONSERVATION ISSUES AND RECOMMENDATIONS

Like many *other* areas of :he Philippines, the Calamianes urgently require effective conservation measures. The area stil supports a high level of marine biodiversity and some reefs are in relatively good shape. However, it is imperative to enact conservation measures immediately to halt further degradation. It may be too late already for some species of sharks. rays, and groupers that have declined dramatically from over-fishing and the illegal *use* of explosives and cyanide. Fortunately, the human population density of the Calamianes is one of the low*est* in the Philippines. There is real hope that reefs can recover if fishing activities can be effectively managed. Plans for increased tourism will certainly affect environmental management policies and need *to* be carefully considered before the implementation stage.

Taking these factors into account, we make the following recommendations to conserve critical natural environments that are necessary to sustain the area's marine biodiversity.

1) Evaluate and control impacts of land-based activities. The intimate linkage between marine and terrestrial conservation must be emphasized. In the Calamianes, and Palawan Province in general, coastal communities that once derived most of their protein from the sea are now turning to terrestrial sources as fish stocks dwindle. On Coron Island, for example, where over two-thirds of the island's coral reefs have been damaged by cyanide fishing, the Tagbanua people now harvest birds, monkeys, and wild pigs. Conversely, when terrestrial resources are depleted, people turn to the sea, placing further stress on the limited marine resources. The common practice of slash and burn agriculture has all but depleted the natural forest of the Calamianes, resulting in severe erosion in some areas and consequent heavy silt deposition on adjacent reefs. Hence watersheds and agricultural practices need to be properly managed, with provision for reforestation wherever possible. In addition, terrestrial RAP surveys need to be implemented throughout Palawan Province to help define terrestrial core zones under the ECAN scheme.

2) Establish a network of n arine protected areas. A solid infrastructure already exists i.r she establishment of protected areas. Palawan Province was declared a Biosphere Reserve by UNESCO, and is presently laying the groundwork for an environmentally sustai nable development plan under the auspices of the Palawai Council for Sustainable Development (PCSD). Acting under the authority of the Strategic Environmental Plan, the PCSD is empowered to work with local governments to establish an Environmentally Critical Areas Network (ECAN) zonation scheme, which recommend strategic core areas to function as protected zones to help sustain biodiversity. Based on results of the RAP survey the Twin Peaks area (RAP site 26) should be one of the most important marine conservation priorities because of its excellent biodiversity and overall reef condition. It is located near the entrance of Cavangan Lake. an area of considerable conservation interest. and only 1-2 km south of Siete Pecados, a popular dive destination and an area designated as a Marine Core Zone under B e ECAN scheme. It would therefore be advisable to expand the existing core zone to include the Twin Peaks area. Other sites worthy of core zone designation included Halsey Harbour and southern Coron. At sites 3 1-33. situated at the entrance and inner sections (near Rhodes Island) of Halsey Harbor at Culion Island, several new coral species were discovered and tie reef community was generally well-developed. Although the outer reef slope off the southwest end of Coron Island (site 24) was terribly damaged (by explosives), there is a wonderfully scenic amphitheatre-like bay adjacent to the site. The bay incorporates shallow sand flats and reef as well as a crater-like lagoon with depths to 28 m. A *feu* other sites wish core zone potential due primarily to their rich diversity of corals and fishes include the following: Lagat Island (site 3), Kalampisauan Island (site 13), Buluang Bay (site 14), Gutob Peninsula (site 15). and Saddle Rock (site 35).

3) Facilitate studies (biological and non-biological) that are essential for planning the conservation of marine environments. A future RAP survey is recommended to assess areas not included during 1998, including the western half of Coron Bay the east coast of Coron Island, and Busuanga Island from Bocao Point to Coconogon Point. It would also be highly desirable to survey Linapacan Island and northernmost Palawan, including the El Nido area. Additional sites of interest will certainly be documented with further survey work. Two areas in particular are worthy of investigation. These include the Tres Reyes Rocks and Malaposo Island (off southern Bulalacao). Both of these areas are reported as having well-developed coral reefs and, like the Siete Pecados Islands, have been designated as Marine Core Zones. Unfortunately, we were prevented from visiting these areas during our survey due to high seas and exceptionally strong winds. In addition, there is considerable need for more information on potentially rare and endangered marine wildlife such as sharks, several endemic reef fishes and corals, dugongs, and sea turtles. One way to fill this information gap would be to work with various universities, encouraging and financially supporting students to undertake graduate research work involving the biology, distribution, and conservation of these species. Another worthwhile venture would be to convene a workshop that collates existing geophysical, political, ecological, cultural, and socio-economic information, which all relevant experts and

stakeholders might review together to achieve consensus on a strategy and to identify information gaps.

4) Implement or strengthen conservation programs for rare and endangered marine wildlife. The Calamianes area harbors a number of rare endemic marine species. These need to be identified and conservation action should be taken to protect their remaining populations and critical habitats. For example, during the current RAP, several new corals were identified, which are possibly restricted to the Calamianes. In addition, at least five endemic fishes, including three new species, were recorded. At least one of these (*Labracinus atrofasciatus*) is extremely rare and appears to be highly restricted in terms of habitat preference. It was previously known from a single specimen collected nearly 70 years ago at Culion Island. About 10 individuals were sighted during the 1998 survey, most on the shallow fringing reef at Lajo Island (site 19).

5) Develop tourism in a fashion that supports marine conservation. The northwest coast of Busuanga, particularly Gutob Bay and the peninsula immediately to the west, has been proposed as a site for major tourism development by the Philippines Department of Tourism (DOT, 1999). While considerable analysis is still required to determine the regional significance of the Calamianes' coral reef species diversity, we do know that the region is a global priority for conservation mainly because it supports the greatest diversity of reef corals yet known. Although the RAP results indicate a more diverse coral fauna in other areas of the Calamianes, the northwestern section of Busuanga (sites 13-17) was relatively diverse for corals, molluscs, and fishes combined. Kalampisauan Island (site 13) was particularly notable for its combination of high fish and coral diversity. The west coast of Busuanga also supports a significant dugong population, perhaps the largest in the Calamianes. Therefore we recommend that at least part of this area be considered as a marine core zone. Although it encroaches on the area recommended for tourism development by DOT, there is no reason why tourism and reef conservation could not be developed in a complimentary fashion. However, there will need to be strict guidelines to avoid adverse affects on coral reefs due to developmental activities such as land clearing, sewage disposal, and habitat alteration. One aspect of tourism that has proved beneficial in other locations is the unofficial policing provided by the constant presence of tourists and tour operators, which discourages illegal and destructive fishing practices and other conservation breaches.

The social implications of major tourism development are probably more serious. According to PNNI (a local NGO), the people of western Busuanga were not even aware that their area was being proposed as a major overseas tourist destination. This is a serious oversight and needs to be addressed. It is essential that local communities benefit from any tourism development. If this fails to happen their economic livelihoods will rely on further exploitation of natural resources in an already highly stressed environment. There is also concern that the proposed development will bypass Coron, and that its local economy will also rely on over-exploitation of terrestrial and marine resources. Coron is presently the gateway to the Calamianes, but this would change with the construction of the proposed international airport. A pleasant waterfront town with views of spectacular limestone peaks, Coron has great tourist potential, but currently suffers from the consequences of poor sanitation. For example, during our stay at the main waterfront hotel we were constantly exposed to a malodorous stench resulting from a mix of human waste and garbage that is discharged directly into the adjacent sea. Tourism development therefore needs to ensure that there are benefits to the local population, and that it does not result in increased pressures on the environment.

6) Implement an environmental awareness campaign. All too often local inhabitants are ignorant of the special plants and animals that share their environment. Even if they are familiar with them, in the case of endemic species they usually have no idea that the only existing populations are restricted to their area. Therefore education, concerning the special nature of their natural heritage and the urgent need to protect it, is essential. There are a variety of options for accomplishing this task, depending on local circumstances. These include incorporating biodiversity and conservation into primary and secondary school curricula, distribution of graphic posters that convey important conservation messages, slide shows and free public lectures, and booklets. Fortunately, there are many successful examples of educational programs to draw from within the international conservation community to guide one for Palawan.

7) Promote community participation in conservation planning and management. Municipalities and barangays must play a major role in conservation planning and management. Most coral reefs lie within the three nautical mile limit of municipal waters, which are under their jurisdiction. Their proximity and legal claim over these waters identifies them as a key target group for implementing marine conservation measures.

8) Enforce existing laws. Although existing laws govern land use, wildlife conservation, and fishing, there is an obvious need for more effective enforcement to curb a variety of illegal activities. During our brief stay in the Calamianes we witnessed illegal trawling operations and the use of highly destructive muro-ami fishing methods. We also witnessed numerous reefs that were partly or wholly destroyed by blast fishing and cyanide fishing. Clearly, these illegal activities must cease if conservation measures are to be successfully implemented. Local and national governments need to allocate funds for patrol boats, trained personnel, and other required resources. Moreover, effective enforcement needs to be backed up by adequate penalties in the form of heavy fines, confiscation of boats and fishing equipment, and/or jail sentences.

9) Enact more effective laws that actually regulate fishing activities. Unfortunately, fishing policies are usually formulated to address the current fisheries situation, with little or no regard to future implications. In essence, the industry has been governed by a "self-regulating" cycle of collapse, slow recovery, and overfishing. What is really needed are sound management guidelines that tightly regulate the type and

quantity of gear allowed. as well as strict catch quotas for various types of fishes, based on sound biological information Certain non-sustainable methods such as spear-fishing or live hsh-collecting with the use of either SCUBA or hookah equipment should be totally banned, regardless of core zone status, and illegal use of explosives and cyanide should also be eliminated

10) Establish a long-term environmental monitoring program. Periodic marine biological surveys are recommended to monitor the status of reef environments and of rare. endangered, or locally endemic species As in other parts of the western Pacific, marine biologists could assist in tne design of simple and inexpensive, but effective monitoring protocols which local residents, NGOs. and government officers could conduct on their own A monitoring program is especially recommended for any areas tnat are slated for major tourism development such as the northwest coast of Busuanga It is important to gather critical baseline information including environmental aariables as well as a basic inventory of major groups of organisms such as corals, molluscs, crustaceans, echinoderms, and fishes In this way, any future deleterious alteration of reef ecosystems can be more easily recognized and necessary remedial action initiated to prevent further degradation

11) Promote cooperation among relevant government departments. Marine environments and conservation issues involve an overlap of agency responsibilities and jurisdictions All too often government departments, both local and national, seem to operate independently from one another, even though coastal management requires close collaboration between multiple agencies We therefore recommend that the government of the Calamianes commit to developing an integrated coastal management strategy, which should lead to better inter-agency coordination It is particularly important to coordinate the recommendations and actions of the Palawan Council for Sustainable Development, Bureau of Fisheries and Aquatic Resources, Department of Tourism. and the Department of Environment and Natural Resources, as well as municipal government bodies

12) Make fishing laws consistent between municipalities The municipal governments of the Calamianes and other parts of northern Palawan should coordinate efforts to establish consistent fishing regulations The existing situation, in which some forms of non-sustainable fishing practices (e g . use of *hookah)* are allowed in one municipality but are illegal in another, is confusing and detrimental to conservation of the overall Calamianes region

13) Review policies governing public access to pearl farms. The proliferation of pearl farms on Busuanga and other areas of northern Palawan has reduced the area for traditional fishing, thus placing additional pressure on remaining areas. Local fishers probably should be granted free fishing access to pearl farm waters, but a study needs *eo* be commissioned *to* determine the effect this action would have on the local subsistence economy One important aspect that needs to be considered if free access were granted would be the elimination of the existing "marine reserve" function of pearl farms.

14) Address safety issues when fishing boats are converted to tourism use Although there are national regulations governing health and safety issues aboard passenger vessels, there ace no local laws covering limits on passenger capacity, number of life tests, and required navigational equipment Boat operators should be compelled *to* comply with safety regulations before their vessels are registered

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CORALS (ZOOXANTHELLATE SCLERACTINIA) OF THE CALAMIANES ISLANDS, PALAWAN PROVINCE, PHILIPPINES

J. E. N. Veron and Douglas Fenner

Summary

- The Philippines has the highest recorded diversity of shallow-water scleractinian corals. Parts of Indonesia are comparable, but relevant studies are incomplete. The present survey raised the known species total from 349 to at least 462, and at *least* 30 additional species can be expected.
- At leas: 21 undescribed species were identified during the survey; an unexpectedly high number *for* such a restricted area.
- Judging from the results of this survey and past work it *is* likely that the northern Palawan region has a higher coral diversity than other parts of the Philippines.
- Despite the heavy impact of fisheries, including destructive fishing methods such as cyanide, explosives, and *muro-ami*, most of the sites had a significant amount of live coral and overall coral diversity for the Calamianes was impressive,

Methods

The coral survey team consisted of two persons. One of us (JENV) was mainly occupied with collecting and photographing new, rare, or unusual species. This was accomplished by randomly swimming around the site, with the aim of covering all habitat situations to a maximum depth of about 40 m. The other person (DF) primarily recorded as many species as possible. The basic method consisted of underwater observations, usually during a single, 60-90 minute dive at each site. The name of each species identified was marked on a plastic sheet on which species names were printed. A direct descent was made in most cases to the base *of* the reel, to or beyond the deepest coral visible The bulk of the dive consisted of *a* slow ascent along the reef in a *zigzag* path to the shallowest point of she reef All habitats encountered were surveyed, including sandy areas, walls, overhangs, slopes, and shallow reef. Areas typically hosting few or no corals, such as sedgrass beds and mangroves, were not surveyed

Results

A total of 305 species in 74 genera of stony corals (293 species and 49 genera of zooxanthellate Scleractinia) were recorded (Appendices 1, 2) Most of these are illustrated in Veron (2000) *The* coral fauna consists mainly of Scleractinia The genera with the largest numbers of species found were *Acropora, Montipora, Pavona, Fungia, Leptoseris, Porites, Lobophyllia, Favia, Echinopora,* and *Astreopora* These 10 genera account for about 46% of the total observed scleractinians (Table 1

Table 1. Genera with the greatest number of species

RANK	GENUS	NO. SPP.
1	*Acropora*	40
2	*Montipora*	23
3	*Pavona*	12
4	*Fungia*	11
4	*Leptoseris*	11
6	*Porites*	10
7	*Lobophyllic*	9
8	*Favia*	8
9	*Echinopora*	6
9	*Astreopora*	4

Acropora and *Montipora* are invariably the two most speciose genera on western Pacific reefs, whereas the remaining genera, show considerable variation in ranking depending on geographic location (Table 2)

Table 2. Genera with the greatest number of species for various sites in the West Pacific: eastern and western Australia (E. Aus. and W. Aus.), Philippines (Phil.), Japan (all from Veron, 1993), and the Calamianes Islands (Calam.), Philippines (present survey).

RANK	GENUS	% OF FAUNA				
		E. AUS.	W. AUS.	PHIL.	JAPAN	CALAM.
1	*Acropora*	19	18	17	19	13
2	*Montipora*	9	10	10	9	8
3	*Porites*	5	4	6	6	3
4	*Favia*	4	4	4	4	3
5	*Goniopora*	4	4	3	4	1
6	*Fungia*	4	3	4	3	3
7	*Pavona*	2	3	3	3	4
8	*Leptoseris*	2	2	2	3	4
9	*Cycloseris*	3	2	3	2	1
10	*Psammocora*	2	3	2	2	2

Discussion

A total of 349 species of zooxanthellate scleractinian corals were previously recorded from the Philippines (Appendix 1). These records were primarily from Veron and Hodgson (1989), which accommodates the extensive work of Nemenzo and his colleagues. An updated list was compiled in Veron (1993). This number has subsequently been greatly increased from a spectrum of taxonomic studies associated with the recently published book *Corals of the World* (Veron, 2000). During the present survey, an unexpected high number (at least 21) of undescribed species was discovered and several records previously considered as doubtful were confirmed. Most of the species labeled "sp." in Appendix 1 are likely to be undescribed; some of these await confirmation or further study.

The total number of records of Philippines corals now stands at 462. A further 37 species are expected to occur in the Philippines on biogeographic grounds, but *they* have not been verified. A total of 499 species is thus likely to occur in the Philippines.

Although it is difficult to compare the species diversity of the Philippines with other regions or countries due to lack of accurate information for many other areas (Indonesia in particular) it would appear that the Philippines has the world's richest coral fauna (Table 3).

Judging from the results of this survey and past work it is likely that the northern Palawan region has a higher diversity than other parts of the Philippines, although further surveys are required, particularly in Luzon Strait and the area encompassing the entire eastern coast of the archipelago. The discovery of 21 new species (Table 4) during the present survey is very significant, considering this number is more than the average described worldwide for an entire year.

Aside from the discovery of new species, one of the most interesting finds was the documentation of two very distinct

Table 3. Comparison of coral faunas of various regions

REGION	APPROXIMATE NUMBER OF SPP. RECORDED
Philippines	462
Eastern Papua New Guinea	380
Ryukyu Islands/Yaeyama Islands	370
Great Barrier Reef, Australia	350
Northwest Shelf, W. Australia	300
Marshall Islands	250
Red Sea	180
Andaman and Nicobar Islands	110
Carribean Sea	60
Hawaiian Islands	46

Table 4. New species observed/collected during the 1998 Calamianes RAP survey. These were recently described by Veron (2000).

SPECIES	SPECIES
Family Acroporidae	**Family Mussidae**
Acropora fenneri	*Acanthastrea faviaformis*
Acropora filiformis	*Acanthastrea regularis*
Acropora gomezi	*Lobophyllia serratus*
Anacropora pillai	*Micromusa diminuta*
Montipora hodgsoni	*Montastrea colemani*
Montipora palawanensis	**Family Faviidae**
Montipora porites	*Favites micropentagona*
Montipora verruculosus	*Favites paraflexuosa*
Family Oculinidae	*Platygyra acuta*
Galaxea longisepta	*Platygyra discus*
Family Pectiniidae	*Goniastrea minuta*
Echinophyllia tylorae	
Mycedium steeni	

polyp types in what appears to be a single genus of a relatively rare coral (*Nemenzophyllia*). The two types are different enough to warrant assignment to separate genera, yet based on skeletal characteristics they clearly belong to one genus. The phylogenetic implications of this unique phenomenon are as yet unknown.

Approximately two-thirds of reefs surveyed were constructed on terrigenous substrates with very little cementation by coralline algae. Thus, reef habitats in the Calamianes are primarily of the continental variety as opposed to oceanic. This finding supports the geological data for the origin of this region (see discussion section at end of introductory chapter).

The surveyed reefs presented a wide range of coral development, although most were of the fringing type. Despite the heavy impact of fisheries, including destructive fishing methods such as cyanide, explosives, and *muro-ami*, most of the sites had a significant amount of live coral, and overall coral diversity for the Calamianes was impressive. There were, however, occasional sites that were devastated, particularly those lying along the southwestern coast of Coron Island (Stations 24–25). The best sites for overall diversity and aesthetic quality were Stations 3, 15, 26, and 38. Additionally, Station 32 near Rhodes Island (Halsey Harbour), rated highly due to the number of rare and new discoveries made there.

A list of coral species observed *et* the various stations is included in Appendix 2. The list was compiled by D. Fenner and is not intended to be comprehensive for each site, but rather to serve as a guide to the mainly common species that were observed. For this reason, the table should not be used to compare overall species richness between sites.

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MOLLUSCS OF THE CALAMIANES ISLANDS, PALAWAN PROVINCE, PHILIPPINES

Fred E. Wells

Summary

- A total of 648 species of molluscs belonging to 96 families were reported during the RAP survey of the Calamianes Group. All of the species with well-known distributions are widespread in the Indo-West Pacific: none are endemic to the Philippines.
- A total of 38 stations were investigated, with a mean of 57.9 ± 2.8 (SE) species collected pes station. The richest stations were the middle of the west side of Tara Island (Station 1) and a small island south of Talampulan Island (Station 17), both with 93 species. The least diverse station was Illutuc Bay (Station 11) with 11 species.
- The diversity of molluscs collected on the Calamianes expedition is higher than on any of the author's previous expeditions to Papua Sew Guinea, Western Australia, Christmas Island, and Cocos (Keeling) Islands.
- More species of molluscs can be expected from the Calamianes with increased collecting effort. Moreover, rapid survey techniques are no? conducive to the collection of small, cryptic species.
- A scarcity of octopus and ornamental shells is Indicative of high fishing pressure. Aside from the small *Tridacnea crocea*, and to a lesser extent *T. squamosa*, very few living giant clams were seer during the expedition. While the species were recorded from a number of stations, the majority of the records were based on deac shells, and populations appear to have been overfished.
- Excessive removal of ornamental shells has cat sed substantial damage to coral reef ecosystems in other areas of the Philippines, and very few specimen shells were found during the Calamianes RAP.

Introduction

This is the second report from the Marine Rapid Assessment Program (RAP) in the Indo-Pacific region. The first was undertaken in Milne Bay, Papua New Guinea in October 1997 (Wells, 1998).

As indicated in the report from the first survey, molluscs were chosen in addition to corals and coral reef fishes to serve as an example of the diversity of other invertebrates and to provide information against which to compare the data obtained from corals and fishes. Specifically, molluscs were chosen because:

- They have by far the largest diversity of any phylum in the marine environment;
- the group is relatively well known taxonomically and there are reliable guides to the larger species; and
- they are ecologically and economically important.

Diversity of molluscs is exceedingly high in the tropical waters of the Indo-West Pacific, particularly in coral reef environments. Gosliner *et al.* (1996) estimated that approximately 60% of all marine invertebrate species in the area are molluscs. While molluscan diversity is known to be high on coral reefs, no estimates are available for the total number of species in any Indo-West Pacific coral reef system. In fact, there are few estimates available of the number of molluscs living in any particular area.

In recent years the Western Australian Museum has conducted a number of coral reef surveys in Western Australia and adjoining areas such as Christmas Island and the Cocos (Keeling) Islands, both in the Indian Ocean. Data in the reports published from this work provide a basis of comparison with the work undertaken in the Calamianes Group.

Materials and Methods

Molluscs were collected at all 38 sites visited during the survey. Scuba dives were made at most sites and as many habitats as possible were inventoried to provide as complete an indication of diversity as could be made on a short investigation. At some stations intertidal collecting by hand was undertaken at low tide, particularly during morning spring tides in the first week of the expedition. Fine restrictions and the absence of suitable strandlines on the beaches prevented beach collecting of dead shells to obtain additional records. In all cases representatives of each species were returned to the boat where they were identified using standard shell books, particularly Springsteen and Leobrera (1986). Other references consulted during the trip were Cernohorsky (1972), Wells and Bryce (1988, 1993), and Lamprell and Whitehead (1992). Additional publications on particular groups were consulted after the expedition was completed.

Results and Discussion

Biodiversity of molluscs

A total of 648 species of molluscs belonging to 96 families were collected during the expedition. There were 469 gastropods, 163 bivalves, 7 chitons, 5 cephalopods and 2 scaphopods; no aplacophorans were collected. The preponderance of gastropods is in accord with previous studies using the same methodology, except that the lack of extensive sandy mudflats surveyed in the Calamianes areas meant that the proportion of bivalves was lower than on some of the previous trips. Four of the most diverse families were gastropods: Conidae (44 species), Cypraeidae (36); Thaididae (30); and Mitridae (24). Veneridae (37) was the most diverse bivalve family and the second most diverse overall. All of the species with well-known distributions are widespread in the Indo-West Pacific; none are endemic to the Philippines.

A total of 38 stations were investigated, with a mean of 57.9 ± 2.8 (SE) species of molluscs collected per station. The richest stations were the middle of the west side of Tara Island (Station 1) and a small island south of Talampulan Island (Station 17), both with 93 species; the least diverse station was Illutuc Bay (Station 11) with 11 species.

The diversity of molluscs collected on the Calamianes expedition is higher than on any previous expedition undertaken by the author, being marginally higher than in Milne Bay, Papua New Guinea (638 species) and the Montebello Islands, Western Australia (631) (Table 1). Both Milne Bay and the Montebellos have a high degree of habitat complexity that was reflected in all of the animal groups sampled, not just molluscs. Habitat diversity at stations sampled in the Calamianes Group was lower. Most stations were fringing reefs along the coast, no open water atoll reefs were sampled during the survey. This combination of high mollusc diversity despite the low habitat diversity suggests that the Calamianes Group has a higher diversity of molluscs in each habitat than occurs in either Milne Bay or in the Montebellos.

The data discussed above can be compared to provide information on the *relative* diversity of molluscs in different areas because the same person collected them (with additional help on some expeditions), using the same methodology.

However, the 648 species of molluscs recorded from the Calamianes Group should not be considered the *total* number of species to be found on coral reefs in the area, particularly as the survey did not include offshore atoll reefs. The majority of molluscs living on Indo-West Pacific coral reefs are small and/or cryptic, and no short-term expedition will record all species. To do so would require an intensive survey over a number of years.

During a survey such as this, all species collected on the first day of the expedition are new records for the survey. On the second and subsequent days the number of new records declines as progressively more species are recorded from two or more sites. This decrease in new records provides a mechanism for estimating the total number of species of molluscs that would be recorded in the Calamianes area if additional time were available for the survey. A logarithmic regression was calculated on the data using the equation: $y = A + B \ln x$.

Calculated coefficients were:

$A = 113.93$, $B = 196.13$, $r = 0.9957$

The r-value indicates that the regression explains over 99% of the variation. Thus, an expedition lasting 30 days would be expected to collect a total of 781 species. A 100-day trip would collect 1017. This suggests that the 651 species collected over the 15 days of the expedition produced a cost-effective sampling of the molluscs present in the area. If the expedition time were doubled, the number of species of the more conspicuous molluscs collected would predictably have risen by only 20%.

While there is no overall list of the molluscs of the Philippines, two publications indicate that the group is highly diverse in the archipelago. Just after the turn of the century, Hidalgo (1904–05) recorded 3,128 species of molluscs from the Philippines. This figure included non-marine molluscs and erroneous records; but nevertheless serves as a meaningful indicator of a diverse fauna. More recently, Springsteen and Leobrera (1986) figured nearly 1,700 marine mollusc species. Some are deepwater species or are characteristic of non-coral reef shallow habitats such as mangroves. However, Springsteen and Leobrera point out that their book is not intended to be comprehensive and many more species are known to occur in the area.

There was a suite of common species found at most stations. These species are characteristic of shallow-water open coral reef systems. The most commonly encountered species was the scallop *Pedum spondyloidaeum*, which lives in scleractinian corals. This species was found at 35 of the 38 stations. Other species recorded at 24 or more stations were the bivalves *Tridacnea crocea*, *Tridacna squamosa*, and *Barbatia ventricosa*, and the gastropods *Rhinoclavis asper*, *Lambis lambis*, *Conus musicus*, and *Drupella cornus*.

Drupella cornus and other members of its genus feed actively on corals. Several outbreaks of *Drupella* have caused considerable damage on coral reefs, particularly in the Ningaloo Marine Park in Western Australia. Such damage was not observed in the Caiamianes Group, with only isolated small patches of corals showing evidence of having been eaten by *Drupella*.

Table 1. Results of previous surveys of molluscs using the same collecting technique.

LOCATION	NO. COLLECTING DAYS	NO. MOLLUSC SPP.	REFERENCE
Calamianes Group	16	648	This report
Milne Bay	19	637	Wells, 1998
Montebello Islands	19	631	Wells, Slack-Smith & Bryce, 2000
Abrolhos Islands	Accumulated data	492	Wells & Bryce, 1997
Christmas Island	12 plus accumulated data	490	Wells & Slack-Smith 1988
Ashmore Reef	12	433	Wells, 1993
Kimberleys (1988)	19	413	Wells, 1988
Cocos (Keeling) Islands	20	380 on survey; total known fauna of 610 spp.	Wells, 1994
Kimberleys (1991)	19	317	Wells, 1992
Scott/Seringapatam Reef	8	279	Wells & Slack-Smith, 1986
Rowley Shoals	7	260	Wells & Slack-Smith, 1986
Kimberleys (1994)	13	232	Wells & Bryce, 1995

Exploitation of molluscs in the Calamianes Group

A single specimen of octopus was found at one station, Low abundance of octopus is a reflection of very high fishing *pressure*, seen in the constant presence of octopus fishermen at many sites throughout the survey. Octopus fishermen operate individually from small rafts, swimming the rafts along the reefs and using lures to attract them off the bottom. Each raft is operated ail day for a total catch of 3–5 kg; down considerably from catches a few years ago (J. Ingles, pers. comm.). Several rafts are based on one mother boat that proceeds along the reef on successive days. Although there is relatively low human population density in the Calamianes, local fishing pressure is intensified by fishermen from other areas. One or more octopus fishermen were encountered on most days of the expedition. Low abundances of other fished species such as spider shells, conchs and abalone were similarly encountered.

Aside from the small *Tridacnea crocea*, and to a lesser extent *T. squamosa*, very few living giant clams were seen during the expedition. While the species are recorded from a number of stations, the majority of records were based on dead shells. and populations appear to have been overfished.

Low quality seashells are collected worldwide and used for production of trinkets and other products. The fishery for such shells is extremely high in some areas of the Philippines, and extensive damage to reefs has resulted. However, such damage has not yet occurred in the Calamianes Group.

The specimen shell fishery is relatively small when compared to the fishery for low quality shells, but some individual specimen shells can command high prices (in excess of US$ 1,000). Very few specimen shells were found during the expedition to the Calamianes Group. While no evidence was found of specific fishing for specimen shells, it is likely that octopus fishers and other fishermen working on the reefs opportunistically collect them.

Acknowledgments

The diversity of molluscs recorded in the present survey was enhanced by the assistance of the other team members in collecting live and dead shells for me during the survey. I sincerely thank them for this assistance and enjoyed being on the expedition with them. In addition, I thank Mr. Andrew Reeves and Dr. Patrick Berry for access to the collections of the Western Australian Museum while I was on a leave of absence.

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REEF AND SHORE FISHES OF THE CALAMIANES ISLANDS, PALAWAN PROVINCE, PHILIPPINES

Gerald R. Allen

Summary

- A list of fishes was compiled for 38 sites. The survey involved 58 hours of scuba diving to a maximum depth of 35 m.
- The Calamianes Group has a relatively diverse reef fish fauna. A total of 736 species were observed or collected during the present survey. An extrapolation method using six key index families (Chaetodontidae, Pomacanthidae, Pomacentridae, Labridae, Scaridae, and Acanthuridae) indicated a total fauna of at least 888 species.
- Species numbers at visually sampled sires ranged from 106-208, with an average of 158 per site.
- The islands off northeastern Busuanga including Tara, Dimaquiat, Tanobon, and Dimipac were generally the richest areas for fishes with an average of 189 species per sire. The lowest diversity was in the northwest sector of Coron Bay where an average of 115 species per site was recorded.
- The fish fauna of the Calamianes Group consists mainly of widely distributed Indo-Pacific species that are associated with coral reefs.
- Gobies (Gobiidae), damselfishes (Pomacentridae), and wrasses (Labridae) are the dominant groups in the Calamianes Islands in terms of number of species (101, 95, and 83 respectively) and number of individuals. The number of gobies is particularly remarkable considering that this group is difficult to survey with visual techniques, and many more species can be expected.
- The overwhelming majority of reef fishes in the Calamianes are either carnivores or planktivores, feeding on a wide variety of invertebrates and fishes, *The* remaining 25% of the fauna are either herbivorous or omnivorous.
- Although reef fish biodiversity is high in the Calamianes Group, habitat diversity was relatively low. More often than not, the reefs were typically well-sheltered and subject to varying degrees of siltation with minimal ocean currents.
- The Calamianes Group is home to several rare or endemic fish species including two blennies (*Ecsenius kurti* and *Istiblennius colei*), and a dottyback (*Labracinus atrofasciatus*). In addition, three undescribed species were collected: a dottyback (*Pseudochromis*), a damselfish (recently described as *Altrichthys curatus*), and a blenny (*Ecsenius*).

Introduction

This section of the report contains comprehensive documentation of the reef and shore fish fauna of the Calamianes Group based on results of Conservation International's Marine RAP survey during February 1998. The background of this project and description of the 38 survey sites are provided in the introduction to this report.

The principle aim of the fish survey was to provide a comprehensive inventory of the reef species inhabiting the Calamianes Group. This segment of the fauna includes fishes living on or near coral reefs down to the limit of safe sport diving or approximately 45 m depth. However, the maximum depth for this particular survey was 35 m, due to a lack of steep outer slopes typically found in other coastal areas of the Indo-Pacific. Survey activities therefore excluded deepwater fishes and offshore pelagic species such as flyingfishes, tunas, and billfishes.

The results of this survey facilitate a comparison of the faunal richness of the Calamianes with other parts of Southeast Asia and adjoining regions. However, the list of fishes presented below is still incomplete, due to the time restriction of the survey (13.5 days) and the secretive nature of many small

reef species. Nevertheless, a basic knowledge of the cryptic component of the fauna in other areas and an extrapolation method that uses key "index" families can allow for an estimation of the overall species total.

Methods

The fish portion of this survey involved 58 hours of scuba diving by the author to a maximum depth of 35 m. A list of fishes was compiled for 38 sites. The basic method consisted of underwater observations, in most cases made during a single, 60–90 minute dive at each site. The name of each species encountered was written on a plastic sheet attached to a clipboard. The technique typically involved a rapid descent to 20–35 m and then a slow, zigzag path was traversed on the ascent back towards the shallows. The majority of time was spent in the 2–12 m depth zone, which consistently harbors the largest number of species. The visual transect at each site included a representative sample of all bottom types and habitat situations, for example rocky intertidal, reef flat, drop-offs, caves (using a flashlight if necessary), rubble and sand patches, etc. Only the names of fishes that could be identified with absolute certainty were recorded. However, there were very few (less than about 2% of those observed) which could not be identified to species level.

The visual survey was supplemented with 10 small collections procured with the use of the ichthyocide rotenone and several specimens that were collected with a multi-prong spear propelled by a rubber sling. The purpose of the rotenone collections was *to* flush out small, crevice and subsand-dwelling fishes (for example eels and tiny gobies) that are never recorded with the visual technique. A total of 51 species were added by using this method.

Results

The total fauna recorded during this survey of the Calamianes Islands consists of 736 species belonging to 250 genera and 70 families (Appendix 4). Nearly all of the fishes appearing in the list are illustrated in Allen (1991, 1993, 1997), Myers (1989), Kuiter (1992), or Randall *et al.* (1990).

General faunal composition

The fish fauna of the Calamianes consists mainly of species associated with coral reefs. The most abundant families in terms of number of species are gobies (Gobiidae), damselfishes (Pomacentridae), wrasses (Labridae), cardinalfishes (Apogonidae), butterflyfishes (Chaetodontidae), blennies (Blenniidae), groupers (Serranidae), parrotfishes (Scaridae), surgeonfishes (Acanthuridae), and snappers (Lutjanidae). These 10 families collectively account for about 66.5% of the total observed fauna (Table 1).

Table 1. Ten Largest Families of Calamianes Group.

RANK	FAMILY	NO. SPECIES	% TOTAL SPP.
1	Gobiidae	102	13.7
2	Pomacentridae	96	13.2
3	Labridae	83	13.3
4	Apogonidae	61	8.2
5	Chaetodontidae	33	4.5
6	Blenniidae	29	3.9
7	Serranidae	26	3.7
8	Scaridae	25	3.4
9	Acanthuridae	19	2.6
10	Lutjanidae	16	2.2

Table 2. Emily rankings in terms of number of species for various localities in *the* Indo-Pacific region. Data for Milne Bay is from Allen (1998), for Flores from Allen and Kuiter (1994, unpublished), for Komodo from Allen (1995, unpublished), for the Chagos Islands from Winterbottom *et al.* (1989), and for the Marshall Islands from Randall and Randall (1987).

FAMILY	CALAMIANES IS.	MILNE BAY, PNG	FLORES, INDONESIA	KOMODO, INDONESIA	MARSHALL IS.	CHAGOS IS.
Gobiidae	1st	2nd	1st	3rd	1st	1st
Pomacentridae	2nd	1st	3rd	1st	3rd	4th
Labridae	3rd	3rd	2nd	2nd	2nd	2nd
Apogonidae	4th	4th	4th	4th	6th	8th
Chaetodontidae	5th	7th	7th	6th	11th	8th
Blenniidae	6th	6th	6th	8th	9th	6th
Serranidae	7th	4th	5th	5th	4th	3rd
Scaridae	8th	10th	10th	10th	12th	10th
Acanthuridae	9th	8th	8th	7th	8th	7th
Lutjanidae	10th	9th	9th	9th	7th	18th

The relative abundance of Calamianes fish families is similar to other reef areas in the Indo-Pacific, although the ranking of individual families is variable as shown in Table 2

Habitats and fish biodiversity

The species occurring at an individual locality are largely dependent on the availability of shelter and food Coral and rocky reefs exposed to periodic strong currents *are* by far the richest habitat in terms of fish biodiversity These reefs provide an abundance of shelter for fishes of all sizes and the currents are vital for supporting numerous planktivores, the smaller of which provide food for larger predators The highest numbers of fish species are usually found at sites that incorporate the following features (1) predominantly coral or rock reef substratum, (2) relatively clear water, (3) periodic strong currents, and (4) presence of additional habitats (sand-rubble, seagrass, mangroves, etc.) in close proximity (i.e., within easy swimming distance of the primary coral reef habitat) The number of species found at each site during the current survey is indicated in Table 3 The number of species at each site ranged from 106–208, with an average of 158 per site

Table 3. Number of species observed and Coral Fish Diversity Index (CFDI) values for each site (CFDI assessment is discussed in the text below)

SITE	NO. SPP.	CFDI	SITE	NO. SPP.	CFDI
1	196	*124*	20	151	97
2	208	132	21	196	*105*
3	178	110	22	191	105
4	176	95	23	142	85
5	107	47	24	186	108
6	136	78	25	110	39
7	164	102	26	149	88
8	167	82	27	127	68
9	184	117	28	167	94
10	204	129	29	178	413
11	5	0	30	200	100
12	111	55	31	211	119
13	127	88	32	129	56
14	177	94	33	111	46
15	174	125	34	166	97
16	164	103	35	126	87
17	179	115	36	125	*70*
18	162	108	37	106	51
19	102	*53*	38	163	84

Station 11 was disregarded in this calculation as the dive was terminated after only a few minutes due to the sightings of the dangerous box jellyfish.

Types of substrata

Coral and rocky reefs are by far the richest habitat in terms of fish biodiversity. The best sites for fishes (Table 4) were invariably locations where coral reef was the dominant substratum, although these areas usually included a mixture of other bottom types, particularly sand or rubble. Mangroves, seagrass beds, and pure sand-rubble areas were the poorest areas for fish diversity. Silty bays and harbors, although supporting a variety of hard corals, also had impoverished fish communities. The five sites where less than 120 species were recorded (5, 11, 12, 19, 37) invariably consisted of highly sheltered embayments with relatively heavy siltation.

Table 5 presents a comparison of the fish fauna of major areas surveyed within the Calamianes Group. The highest average number of species (189) was recorded for the island areas lying off the northeastern coast of Busuanga. The lowest value was for sites within Coron Bay.

Index of fish diversity (CFDI)

In response to the need for a convenient method of assessing and comparing overall coral reef fish diversity in the Indo-Pacific, region I have devised a rating system based on the number of species present belonging to the following six families: Chaetodontidae, Pomacanthidae, Pomacentridae, Labridae, Scaridae, and Acanthuridae. These families are particularly good indicators of fish diversity for the following reasons:

- They are taxonomically well documented;
- They are conspicuous diurnal fishes that are relatively easy to identify underwater;
- They include the "mainstream" species, which truly characterize the fauna of a particular reef (collectively, they usually comprise more than 50% of the observable fishes);
- The families, with the exception of Pomacanthidae, are consistently among the 10 most speciose groups of reef fishes inhabiting a particular locality in the tropical Indo-west Pacific region; and
- Labridae and Pomacentridae in particular are very speciose and use a wide range of associated habitats in addition to coral-rich areas.

The Coral Fish Diversity Index (CFDI) method consists first of counting the total number of species present in each of the six families. It is applicable at several levels:

- Single dive sites;
- Relatively restricted localities such as the Calamianes Islands; and
- Countries, major island groups, or large regions.

Table 4. Ten richest fish sites recorded during the Calamianes survey

SITE NO.	LOCATION	TOTAL FISH SPP.	CFDI
31	Research Channel, Culion Is.	211	119
2	SW end of Tara Is.	208	132
10	SE end of Dimipac Is.	204	129
30	NW coast of Culion Is.	*200*	100
1	W side of Tara Is.	196	126
21	SE end of Galoc Is.	196	105
22	SW end of Galoc Is.	191	105
24	Calis Point, SW end of Coron Is.	186	108
9	S end of Tanobon Is.	384	117
17	Islet S of Talampulan Is.	179	115

Table 5. Average number of fish species recorded for major areas in the Calamianes Islands during the 1998 survey

AREA	AVERAGE NO. SPP.
Northeastern Is. (Tara, Dimaquiat, Tanobon, Dimipac)	189
Northeastern Busuanga	147
West coast of Busuanga and Culion*	161
Western Coron Is. (Sites 24, 25, 26, 38)	152
Northwestern Coron Bay (Sites 19, 27, 36, 37)	115

* Represents 50% of total survey sites

CFDI values can be used to make a reasonably accurate estimate of the total coral reef fish fauna of a particular locality by means of a regression formula. This feature is particularly useful for large regions, such as Indonesia and the Philippines, where reliable totals are lacking. Moreover, the CFDI predictor value can be used to gauge the thoroughness of a particular short-term survey that is either currently in progress or already completed. For example, due to time restraints and heavy reliance on visual observations, 736 species were recorded during the present survey. However, according to the CFDI predictor formula, an approximate total of 888 species could be expected, indicating that 83% of the fauna was actually surveyed.

The above-mentioned regression formula was obtained from an analysis of 35 Indo-Pacific locations that have been comprehensively studied and for which reliable species lists exist. The data were first divided into two groups: those from relatively restricted localities (surrounding seas encompassing less than 2,000 km^2) and those from much larger areas (surrounding seas encompassing more than 50,000 km^2). Simple regression analysis revealed a highly significant difference ($P = 0.0001$) between these two groups. Therefore, the data were separated and subjected to an additional analysis. The Macintosh program Statview was used to perform simple linear regression analyses on each data set in order to determine a predictor formula, using CFDI as the predictor variable (x) for estimating the independent variable (y) or total coral reef fish fauna. The resultant formulae were obtained: 1. total fauna of areas with surrounding seas encompassing more than 50,000 km^2 = 4.234(CFDI) - 114.446 (d.f. = 15; $R^2 = 0.964$; $P = 0.0001$); 2. total fauna of areas with surrounding seas encompassing less than 2.000 km^2 = 3.39 (CFDI) - 20.595 (d.f. = 18; $R^2 = 0.96$; $P = 0.0001$).

CFDI values obtained for individual sites, relatively restricted areas (e.g., Calamianes Islands), or larger regions or countries can be readily interpreted by referring to Table 6, which is based on numerous surveys in the Indo-Pacific by the author and various colleagues.

Summary of CFDI Assessment

A selection of CEDE values tor individual dive sates in the "coral triangle," including several from the current survey, are compared in Table 7 Only one site (2) was ranked in the excellent category and no extraordinary sites were recorded Most sites were assessed as being moderate to good (see Table 3 above) compared to other areas in the Indo-Pacific The overall CFDI total for the Calamianes Group is 268. which compares favorably with other restricted Indo-Pacific localities, being ranked fifth overall (Table 8) Owing to the short-term nature of RAP surveys and the occurrence of many cryptic fishes that are never seen unless chemical ichthyocides are used it is not possible to obtain a complete species inventory However. with the use of the regression formulas given above it is possible to extrapolate faunal totals from CFDI values This method reveals that at least 888 species of reef and shore fishes can be expected to occur in the Calamianes. Using CFDI values to compare more extensive regions it can be seen from Table 9 that the Philippines possesses the world's third richest reef fish fauna with an estimated species total of 1.525 specks, of which approximately 58 percent occur in the Calamianes Islands. The total number of reef fishes from the Philippines remains unknown and there is a critical need for a comprehensive survey of past collecting supplemented by modern surveys.

Zoogeographical affinities of the Calamianes fish fauna

The reef and shore fishes of the Philippine islands belong to the overall Indo-west Pacific faunal community. They are very similar to those inhabiting other areas within this vast region, stretching eastward from East Africa and the Red Sea to the islands of Micronesia and Polynesia. Although most families, and many genera and species are consistently present across the region. the species composition varies greatly according to locality.

The Calamianes Group is an integral part of the Indo-Australian Archipelago, the richest faunal province on the globe in terms of biodiversity. The region forms the center of what is sometimes referred to as the coral triangle. Species richness generally declines with increased distance from the Indonesian center of this region, although a secondary region of speciation in the Red Sea-Western Indian Ocean counters this effect. The damselfish family Pomacentridae provides an excellent example of this phenomenon (Table IO). Approximately 138 species occur in the Indonesian Archipelago, 122 in the Philippines, 109 in New Guinea, and only 15 and 16 respectively at Hawaii arid Pitcairn Island. which lie on the outermost fringe of the region (Allen, 1991). The total of 97 species in an area the size of the Calamianes Group is Indicative of an overall rich reef-fish fauna.

Behavioral modes and feeding relationships

The majority of Calamianes fishes are diurnal coral reef species. which either live on or near the bottom. or forage on planktonic items a short distance above it (Figs. 1–2). Approximately 10% of the species are nocturnally active. One constraint of rapid survey techniques is that cryptic species, living either in caves and fissures or beneath the substratum. cannot be comprehensively sampled. At some localities the cryptic component accounts for as much as 20% of the total fauna, compared to the figure of 4.3% obtained during the present survey.

The association of consumers and consumed organisms, involving an incredibly diverse array of plants, invertebrates, and vertebrates, results in a complex, highly intertwined food-web. The overwhelming majority of Calamianes fishes are either carnivores and/or planktivores, feeding on a wide range of invertebrates and fishes (Fig. 3). About 25% of the Calamianes species are either herbivorous or omnivorous. This breakdown is typical for coral reef fish communities in general.

Table 6. Interpretation of CFDI values in terms of relative categories of biodiversity.

RELATIVE BIODIVERSITY	SINGLE SITE	RESTRICTED AREA	COUNTRY - REGION
Extraordinary	>150	>330	>400
Excellent	130-149	260-329	330-399
Good	100-129	200-259	220-329
Moderate	70-99	140-199	160-219
Poor	40-69	50-139	80-159
Very Poor	<40	<50	<80

Table 7. CFDI values for selected single dive transects undertaken by the author at various localities.

TRANSECT SITE	CFDI	% TOTAL SPP.	TOTAL SPP.
Boirama Is., Milne Bay Province, PNG	160	59.3	270
Wahoo Reef, Milne Bay Province, PNG	159	64.9	245
Dondola Is., E. Sulawesi, Indonesia	158	59.4	266
Kri Is., Raja Ampat Is., Irian Jaya, Indonesia	156	57.1	273
Irai Is., Milne Bay Province, PNG	156	58.2	268
Seraja Besar, W. Flores, Indonesia	136	64.4	211
Tara Island, Calamianes Is., Philippines	132	64.5	208
SE end Kenau Is., Banggai Is., Indonesia	132	61.4	215
Pulau Besar, Maumere, Flores, Indonesia	130	54.4	239
Dimipac Is., Calamianes Is., Philippines	129	63.2	204
Tandah Putih, Peleng Is., Banggai Is.	126	67.0	188
SW Tara Is., Calamianes Is., Philippines	126	64.3	196
Unauna Is., Togean Islands, Indonesia	125	54.3	230
N. Komodo Is., Indonesia	122	60.4	202
Kimbe Bay, W. New Britain, PNG	120	64.9	185
Halsey Harbour, Culion Is., Philippines	119	56.1	211
Padoz Reef, Madang, PNG	111	56.3	197
Tripod Reef, Madang, PNG	105	63.6	165
Pig Is. Lagoon, Madang, PNG	102	58.0	176
Jais Aben Reef, Madang, PNG	94	57.3	164
E. Rinca Is., Indonesia	61	50.8	120
CRI Reef, Madang, PNG	58	43.9	132
Kimbe Bay, W. New Britain, PNG	57	63.3	90
Pulau Sedona, Bintan Is., Riau Is., Indonesia	41	51.9	79

Table 8. Coral fish diversity index (CFDI) values for restricted localities, number of coral reef fish species as determined by surveys to date, and estimated numbers using the CFDI regression formula (refer to text for details).

LOCALITY	CFDI	NO. REEF FISHES	EST. REEF FISHES
Maumere Bay, Flores, Indonesia	333	1111	1107
Milne Bay, Papua New Guinea	318	1084	1057
Togean and Banggai Is., Indonesia	308	819	1023
Komodo Is., Indonesia	280	722	928
Calamianes Is., Philippines	268	736	888
Madang, Papua New Guinea	257	787	850
Kimbe Bay, Papua New Guinea	254	687	840
Manado, Sulawesi, Indonesia	249	624	823
Capricorn Group, Great Barrier Reef	232	803	765
Ashmore/Cartier Reefs, Timor Sea	225	669	742
Kashiwa-Jima Is., Japan	224	768	738
Scott/Seringapatam Reefs, W. Australia	220	593	725
Samoa Is.	211	852	694
Chesterfield Is., Coral Sea	210	699	691
Sangalakki Is., Kalimantan, Indonesia	201	461	660
Bodgaya Is., Sabah, Malaysia	197	516	647
Izu Is., Japan	190	464	623
Christmas Is., Indian Ocean	185	560	606
Sipadan Is., Sabah, Malaysia	184	492	603
Rowley Shoals, W. Australia	176	505	576
Cocos (Keeling) Atoll, Indian Ocean	167	528	545
North-West Cape, W. Australia	164	527	535
Tunku Abdul Rahman Is., Sabah, Malaysia	139	357	450
Lord Howe Is., Australia	139	395	450
Monte Bello Is., W. Australia	119	447	382
Bintan Is., Indonesia	97	304	308
Kimberley Coast, W. Australia	89	367	281
Cassini Is., W. Australia	78	249	243
Johnston Is., Central Pacific	78	227	243
Midway Atoll, U. S. A.	77	250	240
Rapa (Polynesia)	77	209	240
Norfolk Is., Australia	72	220	223

Table 9. Coral fish diversity index (CFDI) values for regions or countries with figures for total reef fish fauna (if known), and estimated fauna using CFDI regression formula.

LOCALITY	CFDI	NO. REEF FISHES	ESTIM. REEF FISHES
Indonesia	418	?	1656
Australia (tropical)	401	1734	1584
Philippines	387	?	4525
Papua New Guinea	362	1494	1419
S. Japanese Archipelago	348	1315	1359
Great Barrier Reef, Australia	343	1325	1338
Taiwan	319	1172	1237
Micronesia	315	1170	1220
New Caledonia	300	1097	1156
Sabah, Malaysia	274	840	1046
Northwest Shelf, W. Australia	273	932	1042
Mariana Is.	222	848	826
Marshall Is.	221	795	822
Ogasawara Is., Japan	212	745	784
French Polynesia	205	730	754
Maldive Is.	219	894	813
Seychelles	188	765	682
Society Is.	160	560	563
Tuamotu Is.	144	389	496
Hawaiian Is.	121	435	398
Marquesas Is.	90	331	267

Table 1. Number of damselfish (Pomacentridae) species at selected localities

LOCALITY	NO. SPP.
Indonesia	138
Philippines	122
New Guinea	109
Komodo, Indonesia	100
Calamianes Group, Philippines	97
Milne Bay, PNG	97
N. Australia	95
W. Thailand	60
Fiji Islands	60
Bintan I., Indonesia	48
Maldives	43
Red Sea	34
Society Islands	30
Hawaii	15

Figure 1. Activity Modes of Calamianes Fishes

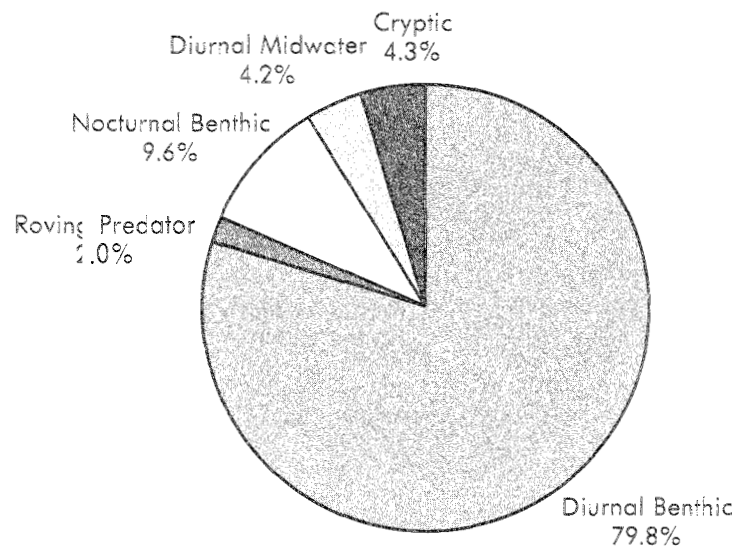


Figure 2. Habitats of Calamianes Fishes

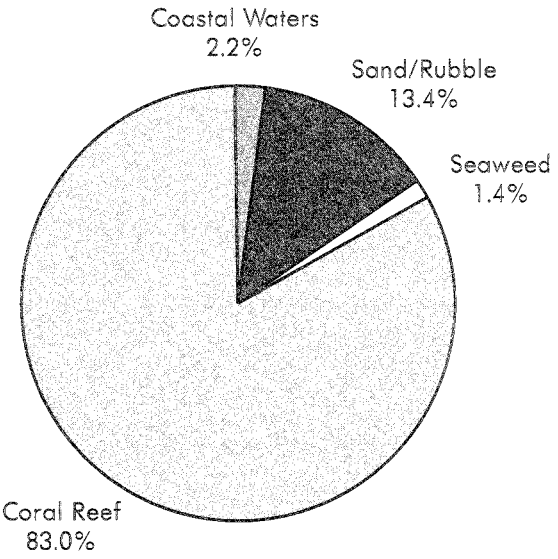
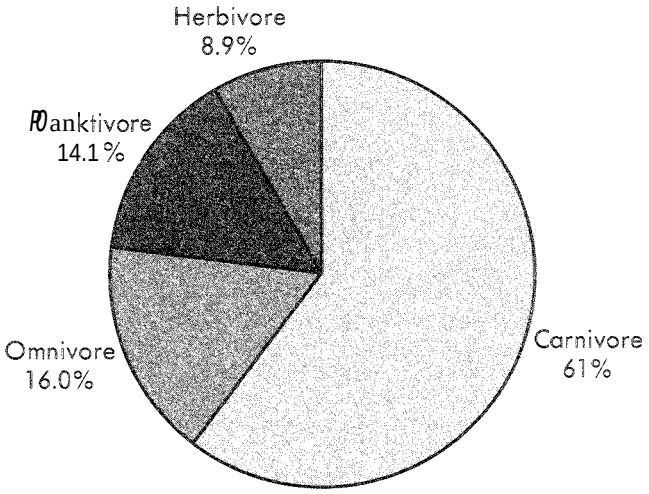


Figure 3. Feeding Modes of Calamianes Fishes

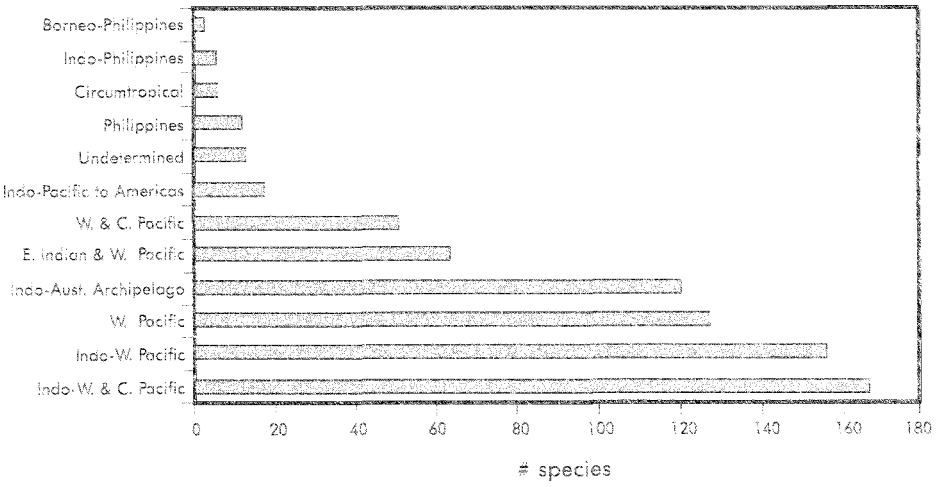


Habitats and fish biodiversity

Although habitat diversity is relatively low in the Calamianes, the area has a relatively rich marine ichthyofauna in comparison to other coral reef areas in the Indo-Pacific region It is mainly composed of widely distributed elements that are recruited as postlarvae after a variable pelagic stage The total species present at a particular locality is ultimately dependent on the availability of food and shelter and the diversity of substrata Coral reef habitats with a rich assemblage of hard and soft corals, interspersed with sections of sand, rubble, and weed generally harbor the richest fish communities The lowest diversity occurs in areas of more or less uniform sand, rubble, or weed-covered bottoms

Most Calamianes reef fishes have relatively widespread distributions within the Indo-Pacific region Nearly all coral reef fishes have a pelagic larval stage of variable duration, depending on the species Therefore, the dispersal capabilities and length of larval life of a given species is usually reflected in the geographic distribution The main zoogeographic categories for Calamianes fishes are presented in Figure 4 The largest segment of the fauna consists of species that are broadly distributed in the Indo-west and Central Pacific region from East Africa to the islands of Oceania. The remaining species have more restricted distributions within the Indo-Pacific region or occur circumtropically

Figure 4. Zoogeographic Analysis of Calamianes Fishes



General observations on Calamianes reef fish biodiversity

Although reef fish biodiversity is high in the Calamianes Group, habitat diversity was relatively low. More often than not reefs were well-sheltered and subject to varying degrees of siltation with minimal oceanic currents. For example, the diving teams did not experience any significant currents, and they saw relatively few gorgonian fans and large sponges. These animals are usually reliable indicators of periodic strong currents. Moreover, there was a scarcity of planktivorous reef fishes, with the exception of certain labrids (*Cirrhilabrus* and *Paracheilinus* spp.). Instead, the fauna was dominated by fishes that are indicative of highly sheltered conditions exposed to siltation. A list of some of the most prominent Calamianes species in this category is presented in Table 11. In most areas previously surveyed by the author these species occupy a rather limited and specialized habitat situation, but in the Calamianes they were universally common.

Several fishes that are typically common in pristine seaward reef environments were conspicuously absent. For example fairy basslets (*Pseudanthias*) and damselfishes of the genus *Chromis* were extremely scarce. Although 15 species of *Chromis* were recorded, most of these were seen in low numbers and many were observed only during the first few days of the survey off northeastern Busuanga. Surgeonfishes (Acanthuridae) were also relatively scarce, particularly the genera *Acanthurus* and *Naso*. Surgeonfishes are an excellent "indicator" of good circulation and minimal siltation. The family is invariably poorly represented in areas of high turbidity such as the Kimberley coast of northern Western Australia or the islands and reefs in the vicinity of Singapore. Hawkfishes (family Cirrhitidae) were also rare compared to other "coral triangle" localities.

Despite relatively high reef fish biodiversity, the actual number of individuals observed appeared to be low. Swarms of

Table 11. Common fishes of the Calamianes Group associated with sheltered reefs.

FAMILY	SPECIES
Serranidae	*Cephalopholis boenack*
	Diploprion bifasciatum
Apogonidae	*Apogon wassinki*
Caesionidae	*Caesio cuning*
Nemipteridae	*Scolopsis ciliatus*
	Scolopis trivittatus
Chaetodontidae	*Chaetodon octofasciatus*
Pomacanthidae	*Chaetodontoplus mesoleucus*
Pomacentridae	*Chrysiptera parasema*
	Chrysiptera rollandi
	Chrysiptera springeri
	Pomacentrus burroughi
Labridae	*Choerodon anchorago*
Scaridae	*Scarus quoyi*
Siganidae	*Siganus virgulatus*

plankton feeding *Chromis* and *Pseudanthias*, which literally fill the water column on exposed outer reefs throughout the Indo-Pacific, were seldom seen. The nucleus of the fauna was composed of approximately 50 species seen on most dives with the remainder consisting of occasional or rare sightings of a wide array of species. Approximately 33% of the fishes noted during the survey were rare in occurrence and a significant number were based on single sightings.

The goby fauna of the Calamianes is particularly impressive, considering that visual survey techniques are not suitable for comprehensive documentation of this family. It is possible that only half of the species were actually observed. The only way to properly document these small, cryptic fishes is with extensive use of ichthyocides.

Further surveys will certainly increase the Calamianes species total. The present survey was reasonably comprehensive for the northern and western sections of the island group, but the survey team was unable to sample the southeastern coast of Busuanga and eastern shores of Coron and Culion Islands due to strong winds and lack of an adequate research vessel. It would also be desirable to survey Bulalacao and Linapacan islands. It is conservatively estimated that at least 100 additional species of reef fishes can be expected to occur in the combined area.

Coron Lakes

Several slightly brackish to freshwater lakes are situated on Coron Island in the center and along the northwestern coast. Although the present survey was concerned with the coral reef and shore environments, the biological team also visited Lake Cayangan, one of the largest and most easily accessed lakes that is regularly visited by tourists. The environment was characterized by very clear and warm (approximately 30°C) water with a silty bottom and a shoreline consisting of jagged limestone cliffs. A pair of gastropod molluscs (a thiarid and a neritid), a small yellow spor
the only obvious life forms.
marized in Table 12. Althou
insignificant it is certainly w
vey of all of Coron's lakes i
rately assess its conservatio
but nevertheless fascinating

Endemism

In view of the broad dispersal capabilities via the pelagic larval stage of most reef fishes, minimal endemism can be expected in the Calamianes Group. Therefore, it is surprising that at least four species are still known only from records from the Calamianes and nearby Cuyo islands. However, future surveys of surrounding areas are needed to determine their definitive distribution status. Species that are either endemic to the Calamianes Group or are mainly known from there are discussed below.

Labracinus atrofasciatus (Herre, 1933). This species was determined from a single specimen collected nearly 70 years ago at Culion Island. About 10 individuals of this extremely rare species were seen during the survey. Most of these were at site 19 (Lajo Island). Members of the family Pseudochromidae exhibit oral egg incubation and some species have very limited geographic ranges.

Pseudochromis sp. Specimens collected during the RAP survey were initially identified as *Pseudochromis colei* (a poorly known Philippines endemic), but subsequent laboratory examination reveals it is actually an undescribed species. It is relatively common on rubble bottoms in the Calamianes, having been observed at 12 of 38 sites. The species, which was recently described by Gill and Allen (in press), is also known from the northwest tip of Panay Island, about 160 km due east of the Calamianes.

Altrichthys curatus Allen, 1999. This recently described new genus and species of damselfish was discovered during the RAP survey. A closely related species, *A. azurelineatus*, also found in the Calamianes, is the only other known member of the new genus. Both species exhibit extraordinary reproductive biology documented for the first time during the present survey. It involves the lack of a pelagic larval stage and strong parental care of offspring (Allen, 1999).

Acanthochromis polyacanthus. This is another damselfish that ranges widely in the "coral triangle," and is the only other representative of the family (out of approximately 345 species worldwide) that does not have a pelagic larval stage. Both members of the new genus are confined to the Philippines. *Altrichthys curatus* is also known from the nearby Cuyo Islands. Both *A. azurelineatus* and *A. curatus* are common in the Calamianes, residing in shallow water with abundant branching corals.

Table 12. Fish Fauna of Lake Cayangan.

SPECIES	BEHAVIOR/GENERAL HABITAT
Unidentified catfish	Solitary, swimming on bottom
Zenarchopterus sp. (Hemiramphidae)	Schooling near surface
Unidentified atherinid	Schooling near surface
Apogon uninotatus (Apogonidae)	Solitary in shoreline crevices
Cheilodipterus quinquelineatus (Apogonidae)	Solitary or in groups in crevices
Acentrogobius viganensis (Gobiidae)	Solitary, resting on bottom
Pandaka pygmaea (Gobiidae)	Solitary or in groups in crevices

Ecsenius kurti Springer 1988. This blenny was previously known only from the Cuyo Islands, which lie about 65 km southeast of the Calamianes and are also part of northern Palawan Province. The first underwater photographs of this attractive species were obtained during the survey. The genus *Ecsenius* lays demersal eggs that are guarded by the parents. Many species exhibit limited distributions.

Ecsenius sp. This brightly colored blenny is a new species that was commonly encountered throughout the Calamianes. It belongs to a well-studied genus (Springer, 1988), but has previously escaped detection. Photographs were sent to Victor Springer of the Smithsonian Institution, who confirmed that the species is new. Four specimens were collected during the surve; these formed the basis of the description recently prepared by Springer and Allen (in press). It is interesting to note that Springer did not collect this fish in the nearby Cuyo Islands during extensive collecting there in 1978.

Istiblennius colei (Herre, 1934). Originally described from Culion Island, this species has also been collected at Panay. According to Springer and Williams (1994), "this species is known only from the type series of its two nominal synonyms, collected more than 50 years ago. Considering all the collecting activity that has occurred in the Philippines in the past 20 years, it seems amazing that this clearly shallow-dwelling, once common species has not been re-collected. We fear it may be extinct." A single specimen was collected during the present survey with rotenone from the intertidal zone at Buluang Bay, western Busuanga.

In addition to the regional endemics mentioned above, an apparently rare species of labrid was photographed at Tangat Island (site 27). It is provisionally identified as *Halichoeres chlorocephalus*, a species that was recently described from five specimens collected at Papua New Guinea (Allen, 1998).

Overview of the Philippines fish fauna

The Philippine Islands possess one of the worlds richest fish faunas. Only Indonesia has more species of reef fishes. Fortunately, the area has long attracted the attention of foreign biologists. As a result there is considerable taxonomic knowledge of Philippine fishes, more so than any other country in southeastern Asia. Herre (1953) included a review of ichthyological activity on Philippine fishes between 1885 and 1948. Several important checklists were published during this period including that of Jordan and Richardson (1909) in which 830 species are listed, and one by Roxas (1937) who listed 1,918 species.

One person more than any other is largely responsible for our present knowledge of the fauna. The American ichthyologist, Dr. Albert Herre, lived to the impressive age of 94 years, dedicating a significant portion of his life to the study of Philippine fishes. Herre, a graduate of Stanford University, served as Director of Fisheries for the Philippines between 1920–1928. Although this was a relatively brief period, it provided the impetus for studies of Philippine fishes lasting for several decades. While at the Bureau of Fisheries he spent between 2–5 months in the field each year, collecting in all parts of the Philippines, including the Calamianes Group. He also made collecting trips to the Philippines and adjacent regions in 1929, 1931, 1933, 1936–37, 1940–41, and 1947–48. Consequently, he published numerous papers on Philippine fishes including important monographs on major groups such as butterflyfishes, damselfishes, and gobies. During his tenure as Director of Fisheries Herre built up the institution's collections and library resources to the extent they were considered the finest in Asia. Unfortunately, everything was destroyed during the Battle of Manila in 1945.

In 1953, at the age of 85, Herre published his *Check list of Philippine Fishes*, an invaluable annotated synthesis of the fauna containing nearly 1000 pages. Although this list forms the foundation of our present knowledge of Philippine fishes, it is cumbersome and is becoming dated. One problem is that it includes all types of fishes without division into the major ecological components. I have extracted the following totals after a time-consuming review of the 2,177 included species: 225 deep sea and deep continental shelf species; 75 open sea-pelagic species; 385 estuarine and coastal non-reef associated species; 170 freshwater species; and 1,300 coral reef species. It is interesting to note that the estimated CFDI total of 1,380 (Table 11) closely matches the number of coral reef fishes listed by Herre. The other major problem with his list is that it employs out-dated taxonomy. Numerous changes have occurred since 1953, not only with higher classification but also at the species level. In particular, Herre's list includes misidentifications and many of the listed species are now considered junior synonyms. Moreover, numerous new records for the Philippines have appeared in the literature since 1953. There is clearly a need for a comprehensive modern synthesis of the Philippines fish fauna.

In recent years there have been relatively few major works on Philippine fishes with the notable exceptions of the treatment of commercial fishes by Rau and Rau (1980) and Schroeder's (1980) well-illustrated volume on shore fishes of the western Sulu Sea.

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FISHERIES OF THE CALAMIANES ISLANDS, PALAWAN PROVINCE, PHILIPPINES

Jose Ingles

Summary

- The status of Calamianes fisheries was assessed by several methods, including a historical review, interviews with fishers, and direct underwater observations of existing reef conditions and resources.
- The fishery consists of two main sectors, an artisanal one involving local residents engaged in subsistence-level activities and a commercial sector involving vessels from other areas.
- Hook-and-line, traps, spears and jigs for octopus are the dominant types of artisanal fishing gear used in the Calamianes Group.
- The index of fisher density to available coastline ranges from 2.00 for Culion to 3.35 for El Nido. These figures are low compared to other parts of the Philippines.
- Major components of the commercial fishing fleet in the study area include live fish capture with chemicals, purse seines, *muro-ami* vessels, *largo viejo*, Danish seines and bagnets. Ring nets, trawlers, and tuna longliners were also reported, but not observed.
- The history of fisheries in the region is characterized by a rapid decline of resources since a peak period between 1970-1980. There has been a trend to utilize various types of gear until stocks reach an unprofitable level forcing a switch to alternative gear and/or more distant fishing grounds.
- Soft bottom habitats and pelagic waters formed the basis of Calamianes' fisheries during the initial phase of its development, but subsequent resource depletion has caused a shift to coral reef exploitation.
- Underwater observations at 30 sites indicated that most reefs have suffered some form of habitat degradation, primarily from blast fishing, *muro-ami*, cyanide use, and anchor damage. Furthermore, the reefs are characterized by severe depletion of market-sized fishes, including a notable lack of large piscivorous species such as groupers, barracudas, jacks and sharks. Likewise, lobsters appear to have been fished to the brink of extirpation.
- An expanding pearl culture industry is present in the Calamianes, but has yet to prove profitable. A reduction of traditional fishing grounds is a negative result of this activity.
- Fisheries of the Calamianes face a bleak future mainly due to the heavy exploitation of available resources. This situation has resulted in reduced catch rates and consequent decline in total production. The 1997 fish production estimate was only 50% of the 1991 level and further decline is anticipated.
- Development of tourism offers a viable alternative to fishing as a source of livelihood. Not only would it offer employment opportunities, but it would also effectively reduce fishing pressure and offer a means of resource protection.

Introduction

This study was commissioned by Conservation International primarily to collect and collate existing data on fisheries in the Calamianes Group as a complement to taxonomic inventories of the islands' coastal areas. It will serve as baseline data for the formulation of measures and activities geared towards the conservation of marine flora and fauna with the ultimate objective of preserving the area's biodiversity.

Tourism development (specifically, ecotourism) is being considered as one of the activities to meet the objective of conservation and at the same time harness the economic potential of existing natural resources. A study commissioned by the Department of Tourism identified western Busuanga and El Nido as the sites most suited for the development of sustainable tourism in northern Palawan (JICA-DOT 1997). The

harvesting of marine resources is the main economic activity in the area; therefore a comprehensive study of fisheries is necessary.

Scope of Work

The area of coverage includes the Calamianes group of islands composed of the municipalities of Busuanga, Coron, Culion, Linapacan and El Nido. This study incorporates historical information on fisheries of northern Palawan and field data collected during the Marine RAP between February 4-21, 1998. The latter survey includes an underwater assessment of various reef areas and collection of fisheries data from local fishing villages. Collection of basic fisheries data relied heavily on random interviews and was supported, whenever possible, with the collection of existing data from municipalities or barangays (the basic political unit).

Objectives of the Study

The general objective of this report is to characterize the fisheries in the study area including the current status and historical development of the small-scale (artisanal) and commercial fishing *sectors.*

The specific objectives of this study were to make a quantitative assessment of the fish biomass of the reef areas, and *to* determine current levels of production and exploitation. To determine the degree of fishing activity. a quantitative assessmen: was made of the groupers (family Serranidae, sub-family Epinephelinae), a high-priced group that is the target of the live-fish trade.

Limitations of the Study

This study dealt with fisheries information taken from various sources. The analysis relied heavily on statistics published yearly by the Bureau of Fisheries and Aquatic Resources from 1946-1988. Data compiled by *each* municipality, as recorded in their municij al fisheries profile or municipal development plans, were also used. Howeve', n uch of this information is outdated and its level of reliability is suspect. In one particular instance. total fisheries production of Coron is given a 36,000 metric tons! Similarly, entries of landings for Coron are incomplete and in certain years reflect *only* one or two types of fishing gear.

As pari of the visual census. counts and sizes of fishery-important groups were given greater attention than non-commercial species, Data on *the* underwater assessment were limited to the family level as *the* marine taxonomic team undertook species identification.

The fish biomass data reflects a "snapshot" of prevailing conditions at the time of sampling i;, February. This is generally considered a lean time of year as far as fishing activities are concerned. Therefore. the results presented here may underestimate the normal annual activity. The density of groupers is not affected by seasonality, as this group is highly territorial and not known to migrate like some other commercially important fishes.

Existing Literature on Fisheries

There is a general scarcity and a low level of reliability for the existing information on the fisheries of the Calamianes Group. Only two previous studies made direct assessments of the fisheries of northern Palawan. The first was the work of Baum and Maynard (1976) who conducted a baseline fisheries study around Coron and its largest fishing village, Barangay Tagumpay. Along with three other areas in the country, this study was conducted as a prerequisite for the implementation of a foreign-assisted grant called the Northern Palawan Fisheries Development Project. The study was undertaken at the peak of fishery production in the area. It also employed a holistic approach to the study of small-scale fisheries, the first such study that dealt not only with the usual characterization of the fishery, but also included socio-economic and cultural aspects of resource users.

The study area was alsc the focus of an assessment of 24 fishery statistical area, in the Philippines made by Munro (1986). However. data for northern Palawan w as treated under the statistical area of Cuyo Pass. On the basis of *data* collected in 1981, northern Palawan was identified as *an* area where further fishery development showed great economic potential. The study specifically alluded to the reef fishery as a segment of production that could be increased.

Additional research in the area was undertaken by Aprieto *et al.* (1974), who conducted test bottom trawls in northwest Palawan to determine the extent of trawlable areas. Because of its hard-bottom configuration characteristic of uneven reef terrain, only 23% of the area surveyed proved suitable for trawling. Even so, echogram surveys showed that fishes were relatively few in number and scattered within the trawlable areas. As a result, trawl fishing in these waters was considered to be uneconomical and technically unfeasible.

The prospecting of areas for pelagic fishing that occurred in the mid-1970's included northern Palawan. Aerial surveys revealed only two sightings of schooling fishes (Cintas, 1975). Nonetheless, tuna and pelagic fishing developed in the Sulu Sea area. The Linapacan passage between Linapacan and Culion and Linapacan and northern Palawan is a known migration route of yellow fin tuna (*Thunnus albacares*). Each year this species migrates from the China Sea to the Sulu Sea from June to August, and returns using the same route from August to October (Morgan and Valencia, 1983).

The most recent sources of information come from unpublished manuscripts and gray literature such as those collected by local agricultural officers (called Municipal agricultural officers or MAOs). These data are used in the preparation of municipal development plans or *In* updating municipal profiles. The fishery information contained in these sources includes *the* number of fishers, fishing craft, type of gear, and a rough estimate of total production. While the JICA-DOT (1997) study also characterized the region's fisheries. the data relied on existing information contained in the Palawan Council for Sustainable Development (PCSD) fisheries profile that used outdated (1988) data.

It was not until oil prospecting began in northern Palawan in the late 1970's that environmental assessments of the area were first undertaken. At that time the government introduced requirements for the submission of an environmental clearance certificate (ECC) for any major project development. In order to comply, an environmental impact assessment (EIA) of the project was conducted, necessitating the collection of baseline data.

Examples of major studies in the Calamianes include those conducted by MERF (Marine Environment and Resources Foundation Inc.) in 1994, the Malampaya Gas Pipeline Project (in 1997, both commissioned by Shell Philippines), and the environmental impact assessment of Club Paradise beach resort in 1991. These studies contained data on water quality and environmentally sensitive habitats such as coral reefs, mangrove swamps, and seagrass beds. More recently, the JICA-assisted project of the Department of Tourism on the development of a sustainable tourism plan for the area also undertook a marine assessment of northern Palawan (JICA-DOT 1997).

The MERF study (1994) was among the first and by far the most comprehensive. A qualitative and quantitative assessment of the coastal marine communities in Busuanga, Culion, Linapacan, in the northern tip of Palawan, El Nido (formerly Bacuit) and south as far as Malampaya Sound was undertaken. Coral and fish were surveyed at 11 locations including eight sites for seagrass and 25 sites for mangroves.

Baseline data for the Malampaya Gas project concentrated more on specific areas along the pipeline route where structures and activities during the construction might affect the environment as well as fishery activities. Nonetheless, for areas near northern Palawan, the study relied heavily on baseline data collected in 1994 by MERF.

Sampling Methods

Two separate methods were employed to meet the objectives of the study: 1) collection of relevant fisheries data to characterize the development of the fishery and evaluate its present status; and 2) an on-site field survey to directly assess the status of coral reef fisheries resources.

The field survey had two main objectives: 1) to assess coral reefs within the study area in order to document, describe, and determine the impact of fishery exploitation; and 2) to conduct interviews in fishing villages in order to obtain relevant fisheries information to supplement the field survey results. Results of the interviews also helped to validate existing fisheries information.

At each reef site, the general area was first surveyed to determine if enough reef formation existed to accommodate the 50 x 5 meter belt transect. The method followed was that of English *et al.* (1994) on visual census of fishes, with some modifications. Transect sites were randomly selected at two different depths, 3 meters and 10 meters. About 15-30 minutes after setting the transect, the number and mean lengths of target fish species were recorded. Fish abundance was tallied along a five-meter belt transect (2.5 m on each side). Where fish were abundant, a log-4 abundance scale as proposed by English *et al.* (1994) was used. An underwater video operated by another diver followed close behind to document the fishes on the transect. This procedure allowed the verification of counts, and aided the identification of species. Invertebrate counts including crown-of-thorns starfish, and estimates of coral cover were also made. The only deviation to the method described by English *et al.* (1994) was that the number of transects laid per site was limited to one instead of the recommended two or three due to lack of sufficient area of constant depth.

Three groups that support specific fisheries on the reefs were initially chosen as possible indicators of fishing intensity: lobsters, groupers and octopus. At every site, the densities of indicator species were determined by counting the number of individuals observed within 10-15 meters on either side of the 5-meter belt transect. Density is expressed as number of individuals per 1,000 square meters.

Fish biomass at each dive site was computed by converting the number and mean weights into total weights expressed as tons/km^2. Fish biomass was computed from the average sizes of fish groups. Lengths were converted to weights using available length-weight relationships for the species that represent the group. In the absence of length-weight relationships for some groups (e.g., Balistidae, Monacanthidae), the cubic law was used to estimate weights from lengths where the slope was set to b=3 and the intercept value set to zero (a=0.05).

General observations of each reef site were also recorded including physical features, degree of destruction by fishing activities (such as blasting), pollution, bleaching, diseases and

Table 1. Physical characteristics of Cuyo Pass, the area in which the Calamianes Group is included (source: Munro, 1986).

PHYSICAL FEATURES	CUYO PASS	PHILIPPINES
Length of Coastline	370	7978
Length of Baseline (km)	861	22860
Length of 200 isobath (km)	1359	17219
Area of neritic zone (km^2)	29097	224434
Area of oceanic zone (km^2)	24259	288506
Total fishing area (km^2)	53356	512940
Dendricity Index	2.33	2.87
Shelf width index	21.41	53.03

Interviews and relevant data were obtained from all possible sources in the different fishing villages and municipalities between diving activities. The main objectives of the informal interviews were to obtain information about the condition of local fisheries, to assess the status of fishing development within each area, to document the type of fishing practices used, and to record responses as to the problems and issues that confront the local fishery. Normal protocol was observed. Courtesy calls to barangay heads or officials were made at the start of village visitation and then followed by random interview of any fishermen operating a particular type of fishing gear. In general, older experienced fishers were chosen for interviews because they were considered more likely to best elucidate the historical development of local fisheries.

Study Area

The study area encompassed the municipalities of Busuanga, Coron, Culion, Linapacan and El Nido (see map). Viewed by many as the last frontier for Philippine fisheries, northern Palawan lies 150 km southwest of Manila between the coordinates 11°00.00' to 12°30.00' N and 119°00.00' to 120°35.00' E.

These areas, including the Cuyo group of islands lying east of Northern Palawan, fall under the statistical area called the Cuyo Pass. In the Philippines, there are 24 areas of roughly similar ecological characteristics that serve as categories for fisheries statistical values. Munro (1986) gives the morphological indices of this fishing ground in Table 1. The most noteworthy feature of the Cuyo Pass fishing ground is its wide shelf area (fourth largest in the country), giving rise to a very large neritic zone (29,097 km^2). Combined with its oceanic area (24,259 km^2), the total area of this fishing ground is 53,356 km^2, making Cuyo Pass the nation's third largest after west Palawan and the Sulu Sea. The types of fishing habitats within the study area vary from soft bottom substrates (e.g., Coron Bay) typically inhabited by demersal fishes, to hard substrates (reef areas), as well as vast areas encompassing the pelagic fishery. Linapacan Passage (between Linapacan and Culion Islands) is a known migration path of yellow fin tuna (Morgan and Valencia, 1983).

The most noticeable feature of the study area is the ubiquitous presence of coral reefs. Fringing reefs occur on almost every stretch of coastline of both the main and offshore islands. Likewise, there are numerous shoals and submerged reef patches, which are especially numerous along the western section of the Calamianes Group, rendering these areas potentially hazardous to navigation.

From a fisheries point of view, northern Palawan was formerly referred to as the "Alaska of the Philippines" due to its highly productive fishing grounds including Malampaya Sound, Taytay Bay, Imuruan Bay and Bacuit Bay. Anecdotes such as "boiling water" in Malampaya Sound (referring to the legions of shrimps jumping in the water when it was disturbed) only partially describe what used to be incredibly high productivity.

Development of Northern Palawan Fisheries

Artisanal fisheries sector

For the purposes of this report, artisanal fishing refers to small-scale fishing activities conducted in near-shore areas using low capital and low technology inputs. It is similar to municipal fisheries in that the size of boat used is less than three gross tons. It is different from sustenance fisheries in which the catch is used for local consumption and the excess bartered for other goods.

The traditional fishing gear used by small-scale fishers includes hook-and-line, spears and traps. Fishing craft are mainly small, paddle- or wind-driven, and no longer than

Table 2. Types and number of fishing gear observed in areas visited during the survey. Numbers were provided by interviewees. H&L - hook and line; BSGN - bottom set gillnet; BSLL - bottom set longline; DGN - drift gillnet; HKH - hookah; SP - spears; FT - fish traps; DIGN - drive-in gillnet; TMN - trammel net; BS - Beach seine; BGN - baby bagnet; FC - fish corral. Asterisk (*) indicates units used in *largo viaje* (commercial hook-and-line) operation.

AREA VISITED	H&L	JIGS	BSGN	BSLL	DGN	HKH	SP	FT	DIGN	TMN	BS	BGN	FC
Tara, Coron	250	70	20				100					18	
Bay-ang, Turda, Coron	10	10	8				10						
Buenavista, Coron	35	35						5					
Cheey, Busuanga	50				30		10	4	20		2		
Dimipak, Buluang, Busuanga	20		7					20					
Decabobo, Coron	25		15		2		15	15					
Buluang, Busuanga	120	120	1										
Okam, Okam	30	20											
Salvacion	70		20										
Panlaitan, Busuanga	150		25	15		50							
Lajo Island													5
Galoc, Busuanga	250	50	10	100	10	20		10		20			
Lajala, Coron	50		5		10	5				10			
Tagumpay, Coron	100		20		10		50					10	
Baybay, Tagumpay, Coron	60		15				30			10			
Maguinit, Tagumpay, Coron	*60						15						
Total	1280	270	181	115	62	75	230	54	20	40	2	28	5

Table 3. Length of coastline, number of fishers, number of fishing craft, and density of fishers per length of coastline for the five municipalities that were surveyed.

MUNICIPALITIES	LENGTH OF COASTLINE (km)	NUMBER OF FISHERS	NUMBER OF FISHING CRAFT	FISHERS/km OF COASTLINE
El Nido	no data	2,236[c]	804[d]	-
Coron	489.07	996	1,348	2.04
Culion	450.98	900[a]	829	2.00
Linapacan	211.29	707[b]	550[b]	3.35
Busuanga	247.94	643	799	2.59

[a]estimate given by M. Dante Garcia, Municipal Agricultural and Technician, Culion
[b]Source: Linapacan municipal profile (1997) but data refer to 1991
[c]Source: PCSD Profile (1997) but data refers to 1991
[d]Source: PCSD Profile (1997) but refers to 1994 data

eight meters in length. Because simple technology is utilized, only near-shore resources are accessible and exploited. Motorization of the fleet has proceeded at a very slow pace up to the present time. The ratio of boats without engines to those which are motorized is about 3:1 (see below for further details). The use of engines allows access to more distant fishing grounds, but even motorized operations are confined to relatively shallow waters (< 50 m).

As demand for fish increased, fishing evolved from sustenance to small-scale fisheries where fishing is a source of commercial livelihood. In the Calamianes Group, growth in the fisheries sector (as measured by the increase in number of fishers) is higher than that of the agricultural or services sector, owing to the limited agricultural possibilities in the upland areas and limited jobs in the services sector.

Thirteen different types of artisanal fishing gear are used in the areas that were visited by the survey team (summarized in Table 2). In northern Busuanga and Culion Islands hook-and-line, traps, spears and jigs for octopus appear to be the dominant types of fishing gear. While hook-and-line appears to be used universally, some types of gear are associated with the ethnic origin of the fisher. For instance, jigs for octopus are used almost exclusively by the Tagbanuas in northern Busuanga, while *hookah* is generally used by the "*bisaya*" or the Cebuano speaking group. The location of the fishing village relative to the physical character of the fishing ground may also dictate the type of gear used. For example, in northern (e.g., Cheey, Tara) and western Busuanga (e.g., Galoc, Panlaitan), drift gillnets for flying fishes are important as the villages are exposed to wide oceanic areas of the South China Sea, while spears are widely used in other reef areas. Gillnets appear to have gained wide acceptance as a method of artisanal fishing. Many different types of gillnets and netting techniques are used within the study area depending on the target species. The bottom-set gillnet exploits demersal fishes, drift gillnets catch flying fishes and sardines, and drive-in gillnets are designed for near shore species such as mullets and grunts. Trammel nets, also in use, are limited to the Coron area. This last-mentioned gear, made up of three gill net panels of two different sizes, is used to exploit seagrass fishes, mainly rabbitfishes (*Siganus*).

The type of gear used by the artisanal fishing sector has not changed much through the years. Hook-and-line and spear fishing remain the most common gear in use today. Popularity of traps, however, has declined owing to lower catches and a higher cost of raw materials. The popularity of hook-and-line and spear fishing is mainly due to its low capital input. Spear fishing is the least expensive method as it does not require a boat.

However, changes in fishing techniques using traditional gear were also observed. This was particularly visible with regards to spear fishing. Introduction of air compressors allows fishers to stay underwater for much longer periods. Called *hookah*, this accessory combined with the motorization of the fishing fleet, gives fishers access to deeper and more distant areas otherwise inaccessible to traditional spear fishermen. In effect, it is now possible to totally annihilate the few remaining fishes in an already over-fished reef area.

Table 3 lists the number of fishers from the five municipalities with El Nido having the highest and Busuanga, the least. The data presented in Table 3 are not directly comparable as they represent different time periods. The index of fisher density to available coastline ranges from 2.00 for Culion to 3.35 for Linapacan. In all instances, the number of fishers per kilometer of coastline is still very small, suggesting an availability of enough areas for each fisher. But low values such as these are highly influenced by the numerous islets and the complexity of the coastal area (e.g., Linapacan). Furthermore, some areas along the coastline are used for tourism (beach resorts) and pearl farms, and are therefore inaccessible to fishers. The index therefore would actually be slightly higher if these conditions were taken into consideration in the computation. Even so, the values are still very low compared to many traditional areas of the country where density of fishers per kilometer range between 30 in Ormoco Bay (Ingles, 1992) to as high as 246 in Manila Bay (Armada, 1994).

The number of fishing craft varies considerably between municipalities. Also, the number of craft in relation to the number of fishers reveals some discrepancies. For Coron and Busuanga, the number of craft is higher than the number of fishermen. This information is dubious and probably the

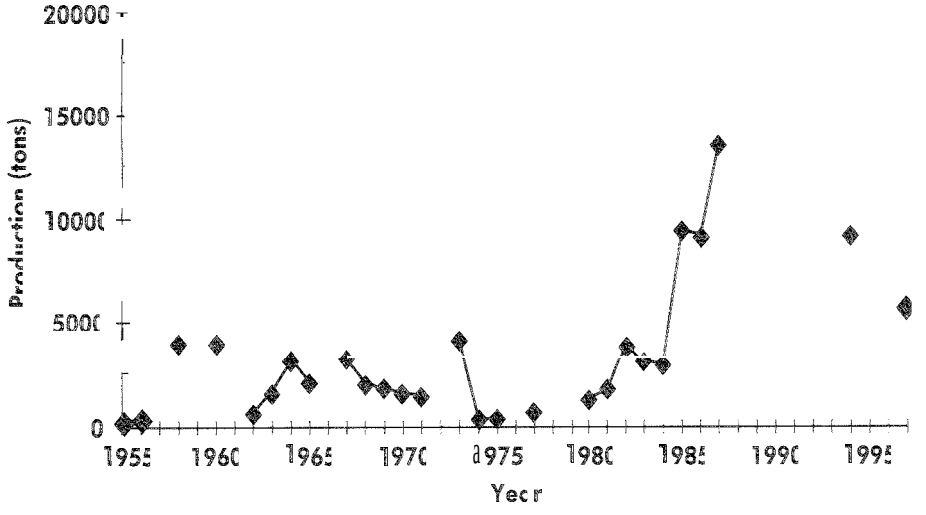

Figure 1. Fishery production of the commercial sector landed at Coron. Gaps pertain to years in which no data were collected. Sources: BFAR statistics 1947–1987; MERF (1994) and this study.

number of craft was overestimated by including those used for non-fishing activities (e.g., tourist boats, services, etc.). A closer look at the distribution of boats and fishers per barangay revealed that this discrepancy occurred only in Coron town.

Commercial fishing sector

Under the newly enacted fisheries code (Republic Act 8550), the commercial fishing sector includes boats larger than three gross tons that operate in waters beyond 80 kilometers from shore. The following represent the components of the commercial fishing fleet in the study area: purse seine, *muro-ami*, *largo viejo*, Danish seine and bagnet. Ring nets, trawlers, and tuna longliners were also reported to be operating in the area but were not observed.

Commercial fishing first started in northern Palawan at well-known traditional fishing grounds such as Malampaya Sound, Taytay Bay, Bacuit Bay and Coron Bay. The historical exploitation of fishery resources in the area closely followed the development of Manila Bay's commercial fisheries. Any new developments in the fishing industry generally start at Manila Bay and spread to the Visayas. When resources decline in these areas, the fleet then converges on Palawan. Hence, all commercial fishing vessels operating in Palawan waters have originated in places such as Malabon, Navotas in Metro Manila and from the provinces of Cavite, Batangas, and Quezon. Manacop and Laron (1953) gave the earliest account of commercial fishing (bagnets operating even before World War II). When bottom trawls were introduced in 1951, some bagnet units were converted to or were used in combination with otter trawls. This paved the way for trawling operations in Malampaya Sound, Bacuit Bay and Imuruan Bay.

Commercial fishing was suspended during the war years (1941–1945) but resumed immediately thereafter. During this time fisheries supplied only the needs of the local populace of Palawan. Although catches were phenomenal, Palawan was considered to be a remote locality and *to* fish there required large vessels *to* accommodate additional inputs of ice, fuel and supplies. It was not until the mid 1960's that fleets of bagnets (known as *tres palos* or 3-masted Soars) from Manila and neighboring provinces of Cavite and Rizal started fishing in northern Palawan (Coron and Liminangcong) because of declining catches in other areas. Fishing was highly seasonal. When the catch from the traditional grounds of Luzon and Visayas declined, the commercial fishing fleet, notably bagnets and *sapiao* (lever nets), shifted their operation to northern Palawan (Manacop and Laron 1953). The problem of distance was solved by the use of carrier boats.

The commercial fishing sector grew rapidly and probably

Table 4. Percentage of the total commercial fisheries production of Coron Bay (to 1974) and Cuyo Pass (1980–1993) by various types of fishing gear. Source: BFAR (various years).

GEAR TYPE	1960	1965	1969	1974	1980	1985	1993
Bagnet	52.80	0.10	99.60	82.00	76.90	68.70	17.10
Trawl	3.27	97.80		18.00	5.75	1.57	1.63
Seines	0.57				17.00	24.40	20.20
Muro-ami	29.50	1.97	0.15			3.09	
Hook and lane	14.10		0.20		1.24	2.16	12.50
Gillnet							0.41
Troll							4.71

reached its highest level in the decade between 1970–1980 when boats numbered about 400 units (personal observation). In 1976, bagnet units owned and solely based in Coron numbered 115 (Baum and Maynard, 1976). By 1994 there were only 42 bagnets (MERF, 1994), and in 1998 only 10 units remained (this study). From its early development in 1950 to the present, the commercial fishing sector has undergone changes in the type of fleet, featuring an historical sequence of bagnet, trawl, bagnet, Danish seine, *muro-ami* and, lastly, *largo viaje*. The general trend has been a declining catch. In the absence of any regulatory measures to curb open access, the commercial fishing fleet in northern Palawan followed a boom or bust history (Figure 1). The fish production of Coron Bay clearly shows a highly fluctuating pattern. Catches varied between 500–4,500 tons from 1955-1985. A sudden increase occured thereafter, with the highest level attained in 1987 (13,000 tons). The 1997 production estimate is about 3,090 tons.

Table 5. Fishing methods used in the Calamianes Islands.

	FISHING GEAR TYPE	DESCRIPTION	TARGET SPECIES	NOTES
Artisanal Fishing Gear	Simple Handline	A single hook attached to a line and sinker. Usually operated with a non-motorized boat. Near-shore operation along coral reef edge.	Piscivores (mostly groupers, snappers, threadfin breams, jacks and conger eels).	In Coron, some fishers join the *largo viaje*, a large boat, in order to fish distant reef patches.
	Multiple Handline	20–30 hooks using lures are attached to a main line with sinker.	Pelagic species including anchovies, crevalle, and big-eye scad.	In Coron, this gear is used to catch fusiliers using sergestid shrimps as bait.
	Troll	Used together with sailboats, it is of similar construction to the multiple handline. The only difference is that the gear is towed.	Pelagic species like bullet tuna, bonito, mackerels, jacks, and leatherjackets.	Highly seasonal in use and was not observed but reported during the Marine RAP survey.
	Bottom Set Longline	1,000–2,000 hooks attached to a main line set along the reef edge either using fish as bait or false lures made of colorful silk cloth.	Demersal fishes like threadfin breams, snappers, groupers, conger eel\. and grunts.	Only a few operations (e.g., Culion Island) were observed in the area.
	Octopus lures	Called *bitsoy*, these are large shining hooks with silvery rotating pieces attached to fish or crab figurines and dragged along the bottom by a fisher swimming on the surface using a small bamboo raft.	Octopus only, of varied sizes.	As reported during interviews, the catch-per-fisher has dramatically declined from as high as 70 kg per fisher per day to about 1.0 kg during the study period.
	Hookah	The use of air compressors in connection with spear fishing or for the collection of aquarium fishes. In the study area, this is also used to collect live groupers using cyanide poison to stun the fish.	Reef fishes, mainly groupers, haemulids, snappers, parrotfishes, and surgeonfishes.	This is a controversial fishing method that has been banned in other areas mainly for health reasons (decompression sickness).
	Gillnets	Monofilament netting material made of nylon thread varying in mesh size depending on the target species. These are set at the bottom at dawn or dusk and hauled in three hours later.	Catch is made up of crepuscular predators, mainly jacks, grunts, snappers, barracudas and others like the slipmouths, whiting, and crabs.	This is one of the most popular gears after the handline, but requires a boat as an accessory.
	Trammel Net	This is basically a gillnet made of three panels, with a smaller mesh placed in between two large meshes.	Mainly rabbitfishes of the genus *Siganus*.	Popular along the eastern coast of Busuanga, particularly in areas with substantial seagrass beds.
	Beach Seine	A seine that is set to encircle fish along the immediate shoreline using very fine mesh nets. A truly communal fishing gear that members of the community help set and retrieve.	Mainly larvae and juveniles of sardines and anchovies but also sergestid shrimps.	There are only few areas where beach seine operation is possible. In some areas of the country (e.g., Guimaras province), this gear is banned.

Table 5. Continued

	FISHING GEAR TYPE	DESCRIPTION	TARGET SPECIES	NOTES
Commercial Fishing Gear	Purse Seine	Lights are used to attract fish that are then captured in a net that surrounds them. Boat weight ranges between 90–500 GT.	Highly schooling fishes like tunas, *scads*, anchovies, sardines and squids.	In the study area, the fleet observed is based in Manila and operates in these waters during a particular season.
	Ring Net	Gear is similar but smaller than a purse seine, and uses a tom weight to close the net. Hauling of net is manual.	Same as catch of purse seine.	Ring nets operate near the shore and usually exploit fishes attracted to the fish aggregating devices (FADs).
	Bag Net	The net is like an inverted mosquito net set at the bottom of the boat. Fish are attracted using lights.	Small pelagics like anchovies, sardines, bullet tunas and round scads.	There are few units left because of resource depletion in the near-shore areas.
	Trawl	A bag net towed along the sea floor that catches everything along its path.	Demersal fishes like goatfish, slipmouths, whitings, jacks, shrimps, cram and squids.	This gear is banned in many areas and the remaining units based in northern Palawan operate in deep waters between 100–200 m.
	Danish seine	Called *hulbot-hulbot*, the net is similar to a trawl but instead of being dragged, a scareline is set in front to drive the fish within the immediate area of the net's mouth.		Very popular and very efficient as far as the amount of fish caught. In most areas of the country, this gear is banned solely on the basis of its use of fine mesh nets.
Illegal Fishing Methods	*Muro-Ami*	A surrounding net with a bag that is set to enclose large areas of fringing reefs or entire reef patches. Fishes are driven towards the net by 10–30 swimmers who pound the reef with weights attached to ropes. A modification uses a curtain of bubbles instead of swimmers.	All reef fishes.	This gear is banned but there are still 46 units operating in the reef areas west of Palawan up to the Kalayaan Islands.
	Blast Fishing	Mainly used in areas with a high density of fishes like reef areas and near FADs. The explosives are manufactured simply using ordinary fertilizers.	Reef fishes and schooling pelagics.	The massive destruction of hard corals has been attributed to blast fishing. In one particular dive near Coron, the team experienced a blast while underwater.
	Use of Poisons	Use of poisons and noxious substances like cyanide and plant extracts.	Reef fishes.	

The dominance of particular types of fishing gear at different times accounts for the fluctuating pattern. For instance, the decline of bagnet production saw the emergence of bottom-otter trawls operating in the vicinity of Coron Bay to the northern part of eastern Cuyo Pass. In the beginning, only large boats (20-50 GT) operated. After a few years, smaller vessels called *baby trawls* proliferated in the area. There were 192 units based in Coron in 1988 (MERF, 1994). The benthic fish resources (including shrimp) of shallow soft bottom areas were heavily exploited.

The constant increase in fuel prices starting in 1974 nearly terminated the trawl industry. Small boats were the first to go. By the late 1980's, in the face of declining profit (due to dwindling catch and an increase in operating costs) and a concerted effort within the artisanal fishing sector to protect its territory, trawl fishing also disappeared.

The collapse of the trawl fleet led to the introduction of Danish seines because of their low overhead costs and efficiency in catching both demersal and pelagic species. Thus, large and small Danish seines proliferated of which four units are still used in the study area.

The decline of trawlers also saw the re-emergence of *muro-ami*. This method has been operating since 1950 but bagnets and trawls always overshadowed its contribution to fish production. For instance, in 1960, *muro-ami* contributed

29.5% of Coron's overall fish production (Table 4). By 1965, its contribution was reduced to only 1.97% and disappeared entirely by 1970. But in 1985, following the decline of pelagic and demersal resources, reef fishes finally gained market acceptance. With this development, *muro-ami* fishing (with a catch composed exclusively of reef fishes) became highly profitable.

In 1997, records from the licensing division of the Bureau of Fisheries and Aquatic Resources (BFAR, unpublished data from 1997) listed 34 units of *muro-ami* operating almost exclusively within Palawan and western Mindoro waters. Most of the catch however was taken from northwestern and western Palawan waters and landed at the Navotas fish port.

With the demise of the bagnet, purse seines and ring nets became the major types os commercial gear. However there are few units (approximately 20) operating in the Calamianes Islands and all are based in Manila. Their fishing activities are highly seasonal (carried out during the northeast monsoon), exploiting principally round scads (*Decapterus* spp.) and, from February to May, squids (*Loligo* and *Dorytheutis*).

In 1990, the commercial sector suffered its most serious setback when the artisanal sector started protecting its fishing grounds. As a result of municipal laws and the creation of the *Bantay Dagat* (watchers of the sea) management mechanism, commercial fishing boats were effectively excluded from municipal waters.

This development has forced the commercial fishing sector to operate within the limits of its fishing grounds (i.e., outside the declared municipal waters). This meant that only sufficiently large fishing vessels that could reach offshore fishing grounds could operate. The *muro-ami* fleet focused its fishing activity in numerous reef patches west and northwest of Palawan and at the Kalayaan Islands and Reed Banks. The pelagic fishing fleet had to convert bagnets into ring nets. But because of the huge investments required for pelagic fishing ventures, many of the bagnets simply ceased operation or the units transferred to areas where they could operate near shore. The ring nets and purse seine fishing grounds lie north and commercial fleet, and only the Danish seines were not able to adapt because their operation is limited to near-shore waters. As a result two units, both operating illegally, remain in municipal waters.

In summary, prospects for the commercial fishing sector of northern Palawan remain bleak. The Coron-based fishing fleet has few remaining units (10 bagnets, four Danish seines, and one *muro-ami*). The rest of the commercial fleet is composed of purse seines, ring nets and *muro-ami* that are all based in Metro Manila. These units visit the area only during the fishing season.

Thus far, only the 12 large hook-and-line vessels (called *largo viaje*) appear to be earning profits. *Largo viaje* refers simply to a large boat that acts as the mother ship to a group of small hand-lining craft. Hook-and-line is the only example of an artisanal method that eventually became commercial, making its initial appearance in the mid-1980's. The method targets the larger reef carnivores and war started by operators from Metro Manila and Batangas who used large boats to bring groups of handline fishers in their small boats to distant fishing grounds. They would remain for at least a week or until a substantial catch was made. The *largo viaje* method evolved from the need for small-scale fishers to circumvent the depleted near-shore resources. The fleet based in Coron currently operates in the Kalayaan and Reed Banks during summer months and shifts to the Linapacan area during monsoon periods.

Other Non-capture Fishery Activities

Fish processing, pearl culture, and seaweed cultivation are included among fishery activities in the Calamianes Group. Fish processing is a well-developed industry in most fishing villages, especially those far from market centers. All types of fisheries products including rabbitfishes, flyingfishes, threadfin bream and squids are dried before being sold. Apparently this form of processing is the consequence of a lack of support services and fisheries infrastructure, particularly ice-making facilities. Although ice plants presently exist (2 units in Coron and 4 units in Culion), distant villages cannot utilize them. Thus, fish are simply dried (salted and unsalted) and then sold to roving fish merchants.

Pearl culture appears to be suitable in sheltered areas of the Calamianes Islands judging from the 2,859 hectares currently devoted to this practice. This subject is discussed in more detail below (see "Issues and Problems of the Calamianes Fishery"). Attempts to cultivate seaweed are underway and approximately 10 hectares are devoted to a pilot culture. *Kappaphycus alvarezii* is being tested using the Line method. however. initial results were discouraging.

Status of Fisheries of the Calamianes Islands

Palawan waters (including West Palawan waters, Cuyo Pass and West Sulu Sea in statistical listings) remain the number one supplier of fish in the country, contributing 250,402 metric tons or 14.6% of the total marine fisheries production in 1996 (BAS, 1997). Of this amount, over four-fifths (83.1%) was taken by the commercial fishing sector while only 42,411 metric tons (16.9%) were landed by small-scale fishing operations (municipal sector). In ascending order of contribution to total production, commercial fishing gear used in the study area are as follows: purse seine, ring net, hook-and-line, bagnet, *muro-ami*, trawl, Danish seine and tuna longline. The total number of units operating within the study area cannot be accurately determined because the commercial fishing fleet is highly migratory. The fishing fleets operate mostly on the northwestern and western parts of Busuanga and also on the northeastern side including the eastern and western passes of Cuyo.

The fishery production of the Calamianes Group is mainly included with that of Cuyo Pass (Busuanga, Culion, Linapacan), whereas landings of northern Palawan (El Nido) are listed under western Palawan waters. The islands included under Cuyo Pass may be considered ecologically similar to those of the Calamianes Group and support similar types of

fishery activities. Therefore any statistical trends shown for Cuyo Pass represent trends for the Calamianes Islands in general.

Production figures for Cuyo Pass from the last 10 years (Table 6) reveal a declining trend for both small- and large-scale fishery sectors. The total fish production in 1995 represented only 57.8% of the production level in 1986. The reduced production is largely the result of decreased catch of demersal and pelagic resources. Demersal fish production declined significantly with the demise of trawls and Danish seines. The number of bagnets operating likewise declined. The commercial fish production of the area is supported mainly by catches made using purse seines, ring nets and *muro-ami*.

In 1997 the fisheries production of Coron, Busuanga and Culion was estimated to be 5,735 metric tons. The contribution of the three municipalities to the total fisheries production of northern Palawan are as follows: Coron - 4,617 tons, Busuanga - 555 tons, and Culion - 563 tons. Fisheries production in the municipalities of Busuanga and Culion represent the artisanal sector's catch. However, 3,093 tons or 67.0% of Coron's production was taken by the commercial sector (particularly by *largo viaje*, Danish seine, small-scale *muro-ami*

Table 6. Latest available figures on fishery production from Cuyo Pass. Small-scale refers to municipal production (omitting inland waters). Source: Bureau of Agricultural Statistics (1990–1995).

YEAR	SMALL SCALE	LARGE SCALE	TOTAL
1995	13,315	10,288	23,603
1994	14,466	14,197	28,663
1993	12,732	10,680	23,412
1992	*	20,393	
1991	*	22,561	
1990	*	35,665	
1989	*	32,436	
1988	26,582	22,841	49,423
1987	21,584	20,449	42,033
1986	21,700	19,073	40,773

called *lintig* and bagnet) based in the municipality. Part of the catch from these vessels may have been taken outside municipal waters.

Coron's fish production has shown a decline similar to that of Cuyo Pass. In 1991, its reported catch was 9,248 metric tons with the municipal sector accounting for 5,122 tons (55.4%) and the commercial sector 4,126 tons (MERF, 1994). Thus, Coron's fish production declined by half (50.1%) in a span of six years. While both fishing sectors showed significant decline, the municipal sector registered a 70.0% reduction compared to the commercial sector's 25.4%.

The commercial sector's decline resulted from a reduction in the number of fishing boats operating in the area due to reduced catch. Moreover, many commercial boats left the area, apparently as a result of an effective campaign against poaching within municipal waters. Forced to operate in distant areas of doubtful productivity, many vessels transferred operations to other areas (e.g., Mindoro and San Vicente, Palawan) and others simply went out of business.

The main reason for declining production of the municipal sector was the dwindling catch. Table 7 shows the catch rates of artisanal fishing gear for various years. The values were based on interviews conducted during the Marine RAP survey. It appears that a significant reduction in catch rates is a general trend for most types of gear. Hook-and-line, spear fishing and use of octopus lures all registered significant declines in catch rates. Interestingly, the use of fish traps appears to be a recent development. The catch from this method, designed for exploiting threadfin bream (Nemipteridae) remains very high. First introduced in northern Busuanga (Cheey, Okam-okam), this gear is gaining popularity and has spread to Concepcion and Salvacion (western Busuanga), but has not yet spread to Culion.

The obvious consequence of decreased catch is reduced income. Over two decades ago, Baum and Maynard (1976) concluded that Coron-based fishers had very high catch rates yet remained poor because of inadequate marketing support. As a consequence, fish simply rotted along the beach. Today, fishers remain poor due to depleted resources stemming from lack of adequate fisheries management.

Table 7 Catch rates of common fishing gear used in the study area based on interview information Legend [1]lean season, [2]peak season: [3]reef based, [4]northeast monsoon, [5]southwest monsoon Catch rates for commercial gear in tons/one lunar cycle

GEAR TYPE	CATCH RATES (KILOGRAM PER DAY PER FISHER)								LOCALITY
	1980	1985	1988	1993	1995	1996	1997	1998	
Artisanal Gear									
Octopus lure			*70.0*			10.0		3 0	Tara, Coron
Bottom set gillnet		22.0						4.0	Tara, Coron
Bottom set gillnet					3.00			0.8	Dimipak, Buluang
Bottom set longline[1]				5.0				3.0	Cheey, Busuanga
Bottom set longline[2]				25.0				8.0	Cheey, Busuanga
Bottom set longline					20.00			6.0	Galoc, Culion
Hook and Line		25.0						10.0	Turda, Buenavista
Hook and Line								4.0	Tara, Coron
Hook and Line[3]	25.0					5.0	*3.00*	1.5	Dimipak, Buluang
Hook and Line			10.0					*7.5*	Buluang, Busuanga
Hook and Line			25.0					15.0	Buluang, Busuanga
Fish pots for bisugo								15.0	Buluang, Busuanga
Fish pots for bisugo[1]								*8.5*	Okam okam
Fish pots for bisugo[2]								***20.0***	Okam okam
Fish pots for bisugo								8.0	Galoc, Culion
Buhay-buhay					4.00			0.1	Tagumpay, Coron
Buhay-buhay[4]					5.00			1.0	Panlaytan, Busuanga
Buhay-buhay[5]					15.00			5.0	Panlaytan, Busuanga
Trammel Net								10.0	Lajala, Coron
Trammel Net								8.0	Maquinit, Coron
Trammel Net								25.0	Bulalacao & Malpok
Spear fishing		50.0*						10.0	Maquinit, Coron
Compressor				300				35.0	Tagumpay, Coron
Commercial Gear									
Bagnet			10-20		10.00		*0.5*	*0.2*	Coron Bay
Purse seine								15.0	West Busuanga
Muro-ami								***42.0***	West Palawan

Fisheries Resources

Soft bottom habitats and pelagic waters formed the basis of the fisheries during the initial phase of its development in the Calamianes Group Table 8 gives one more important fish resources caught within the study area for different time periods The contribution represented by each species or fish group over time varies significantly according to the dominant type of fishing gear used

Existing fisheries are mainly supported by coral *reef* species due to the collapse of demersal fish populations and the significant decrease in pelagic catches Reef fishes dominate the catch sold at the market Pelagic species are represented only by anchovies (*Stolephorus* spp), round scads (*Decapterus* spp), and Indian mackerels (*Rastrelliger* spp), whereas demersal fishes included slipmouths (Leiognathidae), mojarras (Gerreidae), breams (Nemipteridae), goatfishes (Mullidae) and snappers (Lutjanidae) These groups are caught by bottom set gillnets The quality of fishes observed *in the* market was poor. as the higher quality individuals are brought directly to merchants for export to Manila

Table 8. Percentage of total catch of various fish groups taken from Coron Bay. Data for recent years are unavailable Source. BFAR statistics (various years)

GROUP	1955	1960	1965	1970	1974
Anchovies	71.20	*8.84*	38.28	87.95	40.28
Threadfin breams		4.36			0.11
Round scads		40.60		2.36	8 14
Sardines	0.164	15.11		3.35	7.32
Shrimps		0.20			3.7
Slipmouths	0.117	2.65		1.99	*8 89*
Squids				1 1 2	1.46
Big-eyed Scad					13.7
Chub mackerels	0 001				0.198
Snappers	0 007	I.53			
Fusiliers		12.72			
Groupers		1.49			
Tunas	0 23	0.59			*2.94*
Lizardfish		0.50			
Rabbitfishes		0.45			
Surgeonfishes		8.07			
Others	28 30	10.43	172	3.23	13.24

Other Fishery Resources

Seaweed (e.g., *Caulerpa* spp. and *Kappaphycus* spp.) is naturally occurring and harvested in the area. Some 40 ha in Coron and another 10 ha in Culion are devoted to culture of algae for carageenan production using the line method. However, recent reports reveal that some of these endeavors have not been prosperous.

Holothurians (or sea cucumbers) and seahorses are also harvested from wild populations in barangay Concepcion, Busuanga. These are dried and exported to Manila. Sea cucumbers (called *trepang* locally) are used mainly as food, while the Chinese use dried seahorses for medicinal purposes.

Milkfish fry, which are collected seasonally during the northeast monsoon using fine-meshed pushnets, are another fishery resource. The fry are reared in earthen fishponds and form the basis of the aquaculture sector. Fry collection grounds include practically the entire northern and western part of Busuanga Island. The privilege of buying fry in the area is awarded to the highest bidder. In Coron, the minimum bid price of P15,000 per zone per year is set by local ordinance (Municipality of Coron, 1995).

Octopus is another resource that is heavily exploited for export to Taiwan and Japan. The indigenous Tagbanua people play a significant role in the octopus fishery.

Reef Fisheries

Seven of the 13 artisanal fishing gear types listed in Table 2 and 85.9% of the total gear counted operate in reef areas. The reef fishery is presently the *most* important component of the artisanal sector and its contribution to overall production is estimated to be over 90%.

In the commercial sector, *muro-ami* and *largo viaje* methods are also utilized on reefs. However, *muro-ami* fishing areas are mainly on reef patches and shoals on the western side of Palawan and in the Kalayaan Group. Similarly, the *largo viaje* fleet visits these areas only during the Philippine summer (March-May). At other times, the fishing ground is located around Linapacan and southern Culion.

Status of Coral Reefs

Thirty coral reef stations (see map) distributed around Busuanga, Culion and Coron Islands were assessed. Data were recorded on percentage of live coral cover, reef fish biomass, and general reef condition. The fisheries team operated independent of the biological team. Although we endeavoured to visit sites in the same general areas our transect site was often separated from the biological teams inventory site by a distance of up to several hundred meters. Therefore, values relating to benthic cover (Table 10) do not usually correspond with the values in the Sites Description portion of the previous Overview section. Of the thirty stations surveyed, based on their percentage of live coral cover, two (6.7%) were in excellent condition, six (20%) were in good condition, eight (27%) were considered fair and 14 sites or almost half (47%) were in poor condition (Table 9). The overall average cover for all stations surveyed was 35.9% (fair category). The relative degree of destruction of the corals is best described by the mortality index which is the ratio of dead corals to the total coral cover [(dead + rubble)/(live + dead + rubble)]. High mortality indices of 75% or greater were observed on almost half (14) of the 30 sites while only three sites had a low index of less than 25% (Table 10). The overall average mortality index was computed at 60.9, suggesting severe destruction.

Among the areas with severely impacted reefs were sites on the western side of Culion (Site 23), the sites inside Research Bay in Halsey Harbor (Sites 24 and 25), the tip of Coron Island (Site 17) and near Lajo Island (Site 13). Areas with minimal amount of coral destruction included the site west of Talampulan Island (Site 11), the southern end of Galoc Island (Site 14) and Saddle Rock, West Culion (Site 27).

Table 9. Classification and distribution of coral reef sites surveyed based on live coral cover.

CLASS LIMITS (%)	NUMBER OF SITES	CLASSIFICATION
1-25	14	Poor
26-50	8	Fair
51-75	6	Good
76-100	2	Excellent
Total	30	
Overall Average = 35.9%		Fair

Table 10. Mortality index [= 100 x (dead + rubble)/(live + dead + rubble)] and coral cover of 30 coral reef sites at Busuanga and Culion Islands.

SITE NO.	% HARD CORAL	% SOFT CORAL	% DEAD CORAL & ALGAE	% RUBBLE	% SAND	MORTALITY INDEX
1	20	2	52	20	6	77
3	20	0	60	10	10	78
4	25	25	30	15	5	47
6	30	30	40	0	0	40
7	13	5	35	35	15	82
8	40	15	20	20	5	42
9	15	30	15	20	5	44
10	10	0	35	25	45	80
12	10	5	30	20	20	77
14	15	15	50	20	0	70
17	40	20	20	0	10	25
18	13	10	40	10	15	71
19	5	0	50	10	40	92
20	10	70	20	0	0	20
21	23	20	50	20	0	64
22	33	30	30	10	0	40
24	5	5	60	20	0	89
25	20	5	40	25	0	72
26	50	15	30	5	0	35
27	20	0	0	40	40	67
28	60	10	20	10	0	30
29	55	6	35	3	5	42
30	5	0	95	0	0	95
32	10	6	65	15	10	89
33	10	8	30	60	0	90
34	5	0	65	15	15	84
35	80	0	5	5	5	11
36	35	0	55	10	0	65
37	35	5	60	0	0	60
38	35	15	35	5	0	50

Status of the Reef Fisheries

Fish biomass

Fish counts taken during the visual fish census were converted into weights per unit area and expressed in tons/km^2. The commercially important fishes were separated from the non-commercial species, which also included commercial species that are below- marketable length (< 6 cm).

The computed biomass (Table 11) clearly shows that there are few marketable fishes remaining in many of the reef areas of the Calamianes Group. The biomass ranges from 3.44-57.6 tons/km^2, with many sites showing biomass values under 10 tons/km^2. Clearly, the fish productivity of these reefs is low. From a fisheries point of view. these data are very discouraging as the majority of reef fish biomass consists of non-commercial species,

Table 11. Biomass (in tons/km²) of reef fishes from 30 sites surveyed at Busuanga and Culion Islands in February 1998. NC - non-commercial fishes; COM - commercial fishes.

SITE NO.	COM (= TOTAL – NC)	NC	TOTAL NO.	NO. FAMILIES
1	10.19	2.68	12.87	7
3	24.99	6.03	31.02	10
4	8.32	10.31	18.63	13
6	5.61	0.78	6.39	11
7	26.70	22.60	49.20	13
8	3.14	2.15	5.28	15
9	2.65	1.30	3.95	9
10	-		-	-
12	17.90	18.90	36.80	10
14	7.04	1.43	8.46	9
17	23.50	1.95	25.40	6
18	20.80	3.00	23.80	9
19	4.40	2.49	6.89	11
20	10.90	1.00	11.90	7
21	1.74	1.99	3.72	9
22	16.71	0.69	17.40	7
24	2.49	0.95	3.44	7
25	4.83	0.69	5.52	5
26	51.60	5.90	57.60	5
27	16.00	6.20	22.20	8
28	25.00	2.57	27.50	8
29	6.77	1.08	7.85	7
30	9.76	2.10	11.90	7
32	10.70	1.12	11.90	7
33	4.61	0.58	5.19	5
34	6.20	1.84	8.04	9
35	1.81	2.17	3.98	8
36	10.30	8.88	19.20	9
37	10.30	8.88	19.20	8
38	24.90	0.95	25.90	9

There is no apparent correlation between fish productivity and amount of coral cover or degree of destruction of the coral reefs surveyed. However, it appears that higher fish biomass occurs on reefs where some degree of protection from fishing exists. For example, reefs located near the Club Paradise beach resort (Site 5) and the protected area in Calauit Bay (Site 9) showed higher biomass of commercially important species. At seven other reefs where the biomass exceeded 20 tons/km^2 (Sites 2, 11, 12, 19, 20, 21 and 30), the small, non-commercially important species made up most of the available fish biomass. For example, at Twin Peaks (Site 19) where a fish biomass of 57.8 ton/km^2 was computed, only 10.5% of the biomass was considered commercially important.

Large piscivorous, reef-associated species such as barracudas, jacks and sharks were notably absent on Calamianes reefs. Likewise, the normally abundant schooling species such as surgeonfishes and fusiliers were observed singly or in small aggregations. Few sites yielded large schools of commercially important reef fishes. Such schools are generally observed in areas protected from fishing.

The above findings indicate that massive fish extraction has taken place on the surveyed reefs. Previous studies in the same area (MERF 1994) showed much higher estimates of fish-biomass (Table 12). The MERF study's station at Calauit, Busuanga and Site 11 of this survey are almost the exact same location. Since both surveys used the same methods, a direct comparison can be made. The 1994 survey showed a biomass estimate of 19.5 tons/km^2, compared to a slightly higher value of 25.4 tons/km^2 during the present survey. During the 1994 survey commercially important species comprised half (49.4%) of the biomass compared to only 7.68% during the present one. Moreover, surgeonfishes and wrasses accounted for 35% of the biomass in 1994 compared to the presently computed value of only 7.07%.

Based on these two studies alone, there appears to be significant differences in reef fish biomass, particularly in the commercially important fish groups. It is interesting to note that the high fish productivity of the Linapacan and El Nido areas represent by far the highest ever recorded for Philippine waters (Table 12). It is also interesting to point out that since the time of this study fishing on El Nido reefs has become highly regulated and existing laws are now rigidly enforced.

Table 12. Fish biomass estimates for nine coral reef sites in northern Palawan in 1994. Source: MERF (1994).

SITES	BIOMASS (TONS/km^2)	NO. OF SPP.	NO. OF FAMILIES
Calauit, Busuanga	19.5	113	20
Galoc Is. Culion	66.8	114	14
Culion	33.6	128	26
Cagdanao, Linapacan	105.4	125	18
Libro Point	19.2	87	14
Inambuyod, El Nido	183.4	143	22
Tres Marias, El Nido	97.8	142	22
Matinloc, El Nido	216.5	128	21
Shimzu, El Nido	111.3	148	22

Unfortunately, no recent estimates of fish biomass have been made in these areas. It is highly likely that new surveys would demonstrate the effects of unregulated fishing on fish biomass, particularly in the Linapacan area where, as is the case on Culion and Busuanga, there are no existing regulations. In fact, based on interviews, Linapacan appears to be the present favorite fishing ground for both the artisanal and commercial fishing sectors.

Density of indicator species

For this particular measurement, three fishing indicator taxa were used: groupers, lobsters and octopus. Each group forms a specific fishery. Although taken using most types of fishing gear, groupers are targeted by the live-fish trade and are primarily caught using either hook-and-line or poison. Lobsters are traditionally harvested using traps and spears, and more recently with *hookah*. Octopus, on the other hand, are caught using lures (locally called *bitsoy*) dragged from the surface by fishers aboard a small raft (or sometimes a boat). These three groups are intensively fished primarily because of their high value. Groupers, lobsters and octopus are sold locally at P800-1,200, P900-1,500, and P80-120 per kg, respectively.

Based on counts made at each dive site, the density of groupers ranged from 0–8.0 individuals per 1,000 m^2 (Table 13). The highest grouper densities were recorded at Sites 4, 6 and 11. Groupers were absent from Sites 22, 24 and 26, all located north and west of Culion Island. Higher grouper density appears to be associated more with the complexity of reef morphology rather than the existing coral cover. This is expected considering the highly territorial behavior of most species. Low grouper counts or their absence, particularly west of Culion, may be attributed to the greater accessibility of these reefs. *Hookah* and live fish catching activities are mainly based at Marily Malaki and Inoron, Culion. In summary, there are significantly more reef areas with very low grouper density (34.5%) than reefs with high grouper density (6.90% - see Figure 2). Unfortunately, there are no available production figures for groupers from the study area. However, one of the fish merchants stated that in 1996 two DC-3 cargo planes were used to ferry live groupers to Manila each week. Groupers were observed at depths between 3-16 m (10-50 feet) with the larger ones (>20 cm) generally seen in deeper water. Size of observed groupers ranged from 12-80 cm in total length with the majority of individuals below 20 cm. Note that the preferred size range for the live fish trade is 25-40 cm.

The species of groupers identified included *Cephalopholis merra, C. boenak, C. argus, C. cyanostigma, Plectropomus leopardus, Epinephelus fasciatus, E. malabaricus, Anyperodon leucogrammicus, Chromileptes altivelis* and *Variola louti.*

Lobsters appear to have been fished to extinction on most reefs. There were only four sightings made during 30 dives, all below three meters depth. The observed species included *Panulirus ornatus* and *P. versicolor.*

Table 13. Density of groupers for 30 survey sites at Busuanga, Culion, and Coron Islands in February 1998. Density is expressed as the number of individuals per 1,000 m^2.

SITE NO.	DENSITY	SITE NO.	DENSITY	SITE NO.	DENSITY
1	2.00	17	8.00	28	2.00
3	0.80	18	4.00	29	0.00
4	0.80	19	5.33	30	1.00
6	8.00	20	2.00	32	0.00
7	4.00	21	2.67	33	4.00
8	8.00	22	2.67	34	0.00
9	2.00	24	4.00	35	1.20
10	no transect	25	2.67	36	0.80
12	4.00	26	5.33	37	0.80
14	2.67	27	4.00	38	2.40

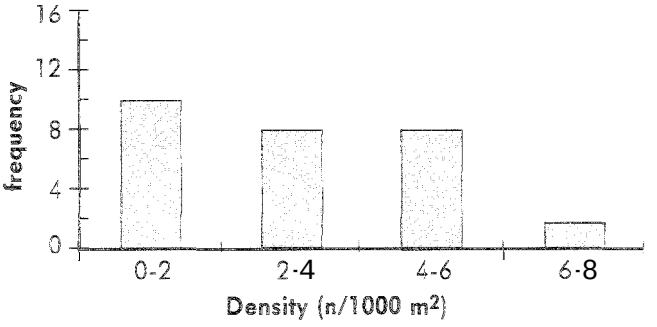

Figure 2. Frequency distribution of grouper density for the 30 reef sites surveyed in February 1998 at Busuanga, Culion, and Coron Islands.

Similarly, no octopuses were observed despite the presence of octopus fishing operations throughout the survey.

Issues and Problems of the Calamianes Fishery

Legal fishing

Fishing represents one of the most intrusive forms of human intervention in the marine environment. However, proper management and diligent monitoring can result in fisheries resources being kept within sustainable levels through regulation and curbing of unsustainable fishing practices.

As is the case with most other areas of the country, the study area is an open access fishery. The resource belongs to the people (Smith *et al.*, 1980) and anyone is free to fish with practically no regulation on resource extraction. While national laws define fishing grounds for all fishing sectors, there are no laws governing fisheries extraction. Local fishery laws deal mainly with the determination of license fees for each gear type or the zoning or assignment of specific areas for a particular usage (e.g., fry collection, protected reserves).

There are few local laws that support the establishment of protected areas. However. some initial activity has taken place. For example, Coron's plan for water use divides the waters into different fishery zones and also designates several protected areas. What is lacking, however, are laws that regulate fishing activities such as the quantity of gear allowed to be used and catch quotas. In practice, fishery policies are formulated as a reaction to the current fisheries situation instead of taking into account future trends. Therefore. fisheries management as practiced in the Calamianes Croup is "self regulating~'If the resource collapses. *the* fishery simply stops.

Fisheries development in the area has been characterized by the gradual expansion of fishing grounds at a pace that is dictated by the rate of resource depletion. Viewed as a national trend. this is a consequence of the lack of pro-active management. As the available resources In the fishing areas decrease. the fishery simply adjusts by expanding the area that is fished. When no further expansion is possible, the fishery either shifts to the exploitatioa of different resources by adjusting fishing techniques, or continues as *is.* using non-sustainable fishing methods, In both cases, the fishery becomes a species-specific fishery. In northern Palawan. these two scenarios occur simultaneously.

These two scenarios characterize the current fishery in the area. The depletion of both demersal and higher value reef fish stocks resulted in exploitation of lesser-known groups such as surgeonfishes and fusiliers. These two groups were the last to be exploited because of their low consumer acceptability and low price. Both groups cannot be harvested using *the* traditional trap, hook-and-line. or spear fishing methods. However, they car be and are exploited using gillnets.

Introduction of new technology allowed the continuation of fishing despite serious signs of over-harvesting. This situation is best exemplified by the use of air compressors for spear fishing. Commonly known as *hookah.* the use of this underwater breathing apparatus permitted access to reef fishes living below depths normally frequented by spear fishers. It also provided a more effective method of using poison (sodium cyanide and potassium cyanide) to catch live fish. Thus the use of ais compressors has markedly contributed to *the* decimation of reef fish stocks. which is reflected in the low biomass estimates on many reefs of *the* Calamianes.

Extreme poverty forces people to fish despite resource depletion. As the situation worsens, fishers will use any method to catch fish even if such practices *are* known to decimate stocks ewer further, This scenario was aptly called Malthusian overfishing by Pauly *et al.* (1998).

The impact of fishing activities on the coral reefs of Busuanga, Coron and Culion Islands is presented in Table 14. Evidence of detrimental fishing activities that were documented included blast marks on coral heads. bleaching of corals suspected as a result of exposure to cyanide, overturned coral heads and boulders due to spear-fishing activities, and anchor damage. Other negative impacts observed underwater included the presence of ropes, twines, fishing paraphernalia and other items thrown overboard (e.g., batteries, bottles). One or more forms of these desultory impacts as a result of fishing activities were observed at all surveyed sites.

Table 14. Assessment of the impact of fishing on the surveyed reef sites. (0-5 = degree of impact with 0 being none and 5 representing the highest; x = effects unknown; * effects not of recent origin).

SITE NO.	BLASTED CORALS	OVERTURNED CORAL HEADS	BLEACHING OF CORALS	DISCARDED FISHING PARAPHERNALIA	CROWN OF THORNS	SEDIMENTATION	MORTALITY INDEX
1	2	x	1	x	0	0	76.6
3	2	1	2	0	0	0	71.8
4	2	2		0	0	0	47.4
6	2	1*	1	1	0	0	40.0
7	1	0	3	1	0	0	82.4
8	2	3	2	1	0	0	42.1
9	1	2	2	1	0	0	43.8
10	x	0	x	x	0	4	80.0
12	2	2	x	x	0	2	76.9
14	3	2		1	0	0	70.0
17	2			0	0	0	25.0
18	3*	2	2	1	0	0	71.4
19	1	2		2	0	2	92.3
20	1*	x	2	1	0	0	20.0
21	3*	2"	1	2	0	2	63.6
22	2*	x	x	1	0	0	40.0
24	3*	2	2	2	1	0	88.9
25	4	3	3	3	1	0	72.2
26	2*	2*	2	2	0	0	35.0
27	2	2	3	0	0	0	66.7
28	3	I	1	1	0	0	30.0
29	0	I	I	0	2	2	42.1
30	4	1	1	0	0	0	95.0
32	1	1	1	0	0	0	88.9
33	0	0	0	0	0	4	90.0
34	0	0	1	1	0	0	84.2
35	4*	0	3	0	0	0	11.1
36	0	0	0	0	0	0	65.0
37	0	1	0	3	0	0	60.0
38	1	1	1	0	0	1	50.0

Illegal fishing

The use of non-sustainable fishing methods are rampant throughout the Philippines including northern Palawan. The best known and perhaps the worst illegal fishing method is the use of explosives, which is certainly not a recent development. Villadolid and Buñag (1953) listed the use of blast fishing and application of noxious substances as the primary causes of fish depletion in the Visayas in the early 1950's. The use of explosives is an integral part of bagnet-fishing operations. The school of fish is "stunned" with an explosive charge prior to hauling in the net in order to prevent them from escaping. Explosives were seen as a solution to the inefficiency of the bagnet technique. Their use has gradually spread to compliment other fishing techniques.

Another form of unsustainable fishing is the use of toxic substances. Poison (potassium cyanide and sodium cyanide) is used extensively for catching live groupers (locally called *buhay-buhay*) and ornamental fishes for the aquarium fish trade. Additionally, commercial vessels operate illegally in municipal waters. According to police, the numbers of apprehensions related to illegal fishing appear to have declined over the past two years. However, the data presented in Table 15 do not support this statement.

Table 15. Number of apprehensions due to illegal fishing. Data for 1993–1995 from JICA-DOT (1997). *Data for 1998 to 20 February only.

MUNICIPALITY	1993	1994	1995	1998*
Busuanga	2	-	2	0
Coron	5	2	18	2
Culion	-	1	4	0
Linapacan	1	-	-	nd
El Nido	3	1	2	nd

Records of apprehensions for illegal fishing activities, which should be kept by the Coast Guard and Philippine National Police as well as the Municipal Courts, were unavailable as they were apparently sent to the trial court in Puerto Princessa. However, according to the police, there were only two apprehensions this year in Coron Municipality that involved blast fishing.

Ecological Impact of Live Fish Trade

The very lucrative price of live groupers (P800-P1,200 per kilogram) is the compelling reason why many fishers resort to cyanide use. The use of this chemical is not only a health hazard to its users, but substantially contributes to the decimation of reef fish populations. The live fish industry mainly targets individuals of the required market size (between 0.5-1.0 kg and about 25.0-40.0 cm total length). Groupers (family Serranidae) are protandric hermaprodites–they transform from males to females upon reaching maturity (30-45 cm total length depending on species). Therefore, the live fish trade exploits mostly males, thus preventing the eventual female sex transformation. The biological consequence of this practice is obvious if the current high level of fishing pressure is considered.

The grouper sightings recorded for each dive lends support to this observation. Of the 51 sightings, only four individuals (7.84%) were above 25 cm and only two exceeded a length of 40 cm. The abundance of small-sized individuals highlights the extreme fishing pressure currently applied to the population.

Proliferation of Pearl Farms

Culture of oysters (*Pinctada maxima* and *P. margaritifera*) for the production of pearls occupies a substantial area of the near-shore fishing grounds. Highly sheltered, relatively deep (at least eight meters), unpolluted, and readily accessible areas are suitable for pearl oyster culture. The Calamianes Islands offer an abundance of such areas. Several companies have established pearl farms in the area: three in Coron (Hikari, Ecofarm, and Coron Development Corporation); three in Culion (Sakura, Somaco and Hikari); and four in Busuanga (First Nature Products Inc., Surigao Marine Products Inc., Ecofarm and Hikari).

Presently, the combined total area occupied by these pearl farms is 2,859 hectares. With the addition of a further 1,200 ha for which applications have been submitted, this will bring the total area devoted to pearl farming to 4,059 ha.

The most obvious negative effect of pearl farms is the reduction of fishing grounds available to small-scale fishers. Although the lease contract with the local government does not explicitly prevent fishing in these areas, in practice pearl farms are off-limits to fishing. On a positive note, pearl farms may have become "*protected areas*" or fish refuges and may function as sources of fish recruits to nearby fishing grounds. Economically, it is interesting to consider the value of the fishing grounds removed from local fishers for pearl farming. Assuming a catch of 100 kg/yr/ha (highly conservative), the total harvest from all areas occupied by pearl farms would be 285 tons/yr. This amounts to P10.0 million per year, using a conservative price for fish of P35,000/ton. This amount is far more than the existing annual government revenue derived from the lease of these areas, which is fixed at P200/ha and thus yield a total of P 571,800 per year. Thus from an economic standpoint, the establishment of pearl farms appears to be detrimental to the plight of small-scale fishers. However, it would be useful to assess if there are actually higher fish yields resulting in the areas outside the pearl farms as a consequence of their role in stock replenishment, and subsequently what the economic benefit might be to fishers.

Pearl farms have certainly opened jobs in the area, however, the number of those directly employed and profiting from these establishments is small compared to the number of displaced fishers forced to operate farther from the shore. Moreover, losses from increased travel time and fuel costs to and from fishing grounds were not considered in the above computations. Revenues from taxes and gross earnings also were not included in the above figures because the pearl farms are still in the initial phase of development and pearls will not be harvested until the year 2000.

A considerable number of fishers interviewed oppose the policy of banning fishing activities within the leased area. Almost all areas occupied by the pearl farms are traditional fishing grounds, and in some cases possibly belong to the ancestral domain of ethnic minority groups. For instance, the area occupied by ECOFARM in Barangay Decabobo, Coron encompasses the traditional fishing grounds of the Tagbanuas.

A continued decline in the fishery resource, coupled with increases in the overhead cost of fishing operations, will eventually create a demand for access to the pearl farm areas. From the perspective of local fishers this seems justifiable, given the fact that some pearl farms have been protected from fishing for the last five years. Thus, fish populations within these areas have probably recovered to pre-fishing levels by now.

Tourism Development Plans

An on-going program involving the construction and renovation of fishing boats into tourists boats was recorded during interviews conducted at Barangay Tagumpay, Coron. While many of the boats used in bagnet (*basnig*) and Danish seine operation remained beached and exposed to the elements, three units were undergoing various stages of construction to cater to tourists. Apparently, some fishing operators see the booming tourism industry as a viable alternative to the fast-deteriorating fishing industry of Coron.

Local regulations reveal no standard rules for the safe operation of tour boats. For example, there is no monitoring of safety and health precautions including number of passengers allowed, number of life vests, and types of radio equipment and navigational lights. However, national maritime laws address all of these issues, and boat operators should be compelled to comply with safety regulations before the vessels are registered.

Faced with a depleted catch and consequent marginalized income, local fishers view the development of tourism (as proposed in the JICA-DOT report) as a viable alternative for earning a livelihood rather than a threat. As mentioned earlier, land-based alternatives are limited owing to the poor quality of soil and unsuitable climate.

Several potential negative fisheries impacts were identified in reviewing the plan for sustainable tourism development at areas encompassing western Busuanga and El Nido. The first involved a possible conflict with the presence of pearl farms in the area. While these farms in themselves may become a tourist attraction, their presence in Gutob Bay (where major tourism development is envisioned) will certainly cause problems. Secondly, some small islands where development is planned (e.g., Kilampisauan, Buluang, and some near Busuanga) are currently used by purse seines, ring nets and carriers as sheltered anchorage during the fishing seasons. Therefore, tourism development might exclude commercial vessels from these refuges, which are especially useful during rough weather.

There are also existing plans to establish a water sports facility (with high-powered boats and jet skis) in New Busuanga. Such activities might create negative impacts for some marine life in the area. For instance, the sounds created by engines could conceivably disturb marine mammals in the area.

Fishery Laws and Policies

Fishery laws in the area are based on national laws, particularly Presidential Decree 704 of 1974 and its subsequent revisions including the Republic Act 8550 signed on February 25, 1998. Local fishery laws and policies exist only for the municipality of Coron and Busuanga. Culion has yet to formulate its own set of fishery rules and regulations.

But existing local fishery ordinances mainly reflect the revenue codes for the fishery sector (Coron Municipal Ordinance 11, series of 1995). Under this Ordinance, various zones are established for specific fishery-related activities including culture of milkfish (*Chanos chanos*) fry, pearl farms, oyster culture, and fish corrals, as well as government reserves. Unfortunately, the selection of the reserves is not based on supportive data.

In Coron, Palawan, the list of fisheries-related ordinances in the last four years includes a ban on certain kinds of fishing gear (Danish seine, beach seine, muro-ami, trawl) within municipal waters (Municipal Ordinance of Coron No. 7, 1994) as well as the use of excessive light for fishing (Resolution No. 3, series of 1994). Another law also provides monetary rewards to informers of violators (Ordinance 9, series of 1994).

Live-fish traders and fishers (Municipal Ordinance of Coron 3, series of 1995) as well as users of compressors for fishing purposes (Municipal Ordinance of Coron 4, series of 1994) are required to register with the local government. However, these laws do not regulate the number of operators but merely cover the collection of revenues

The municipality of Culion, only recently established in 1994, still lacks fishery laws. Prior fisheries management fell under the Department of Health, which owns and manages the Leper Sanitarium in the area.

Of the three municipalities, only Coron appears to have pertinent local ordinances as well as a (newly developed) plan for water use. The local government has prepared a large color-coded map, on which both fishing and protected zones are clearly delineated. From a conservation perspective, the most important areas are "no take" core zones, which extend for 500 m from shore. All fishing activity is banned within this area. Designated core zones at the time of writing included: Tres Reyes Island, Malapuso Island, Siete Pecados-Parola, and Butulan Rocks near Tara Island.

Local fishery officers in Coron, Culion and Busuanga expressed full support for the development of comprehensive and common fisheries laws for the entire northern Palawan area because the three municipalities share the same fishing grounds which are exploited by seasonally migrating fishers.

Enforcement of fishing regulations is sometimes extremely difficult and complex due to the existence of inconsistent or contradicting laws between municipalities. For instance, the use of compressors (*hookah fishing*) is banned in San Vicente, Northern Palawan. Similarly the live fish trade is banned on Linapacan. However, both activities are allowed on Coron, Culion and Busuanga, thus opening the door to fishers from nearby areas where these methods are banned.

Conclusions

The fisheries of the study area face a bleak future mainly due to the heavy exploitation of local resources. This situation has resulted in reduced catch rates and consequent decline in total production. The 1997 fish production estimate is only 50% of the 1991 level and a further decline is anticipated.

The artisanal sector barely survives, but relies heavily on reef-based resources. It seems inevitable that it will suffer the same fate as the commercial sector due to the decreasing reef-fish biomass. This decline is particularly true for commercial species, whose numbers have been significantly reduced. In simple terms, reef fish resources are nearly decimated and the prospect of recovery is bleak unless fishing pressure is reduced or fishing is completely stopped. The latter scenario is contingent on the creation of alternative income sources. Without other options, fishing activities will continue causing further destruction to fishery resources and aquatic habitats.

Tourism development would appear to offer alternative sources of livelihood and a possible solution of existing problems due to overfishing. It could effectively reduce the number of fishers, thereby easing the pressure on reefs and help to conserve existing habitats. Hopefully this would allow at least some measure of recovery for the decimated fish population.

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APPENDICES

APPENDIX 1 Coral species recorded from the Philippines or likely to occur there (compiled by J. E. N. Veron and D. Fenner).

SPECIES	SPP. RECORDED PREVIOUSLY	NEW SPP. RECORDS	SPP. NOT RECORDED BUT LIKELY TO BE PRESENT
Family Astrocoeniidea			
Stylocoeniella armata	X		
Stylocoeniella cocosensis		X	
Stylocoeniella guentheri	X		
Family Pocilloporidae			
Madracis kirbyi	X		
Palauastrea ramosa	X		
Pocillopora damicornis	X		
Pocillopora eydouxi	X		
Pocillopora meandrina	X		
Pocillopora verrucosa	X		
Pocillopora woodjonesi	X		
Seriatopora caliendrum	X		
Seriatopora hystrix	X		
Seriatopora stellata		X	
Seriatopora subseriata		X	
Seriatopora sp.		X	
Stylophora pistillata	X		
Stylophora subseriata		X	
Stylophora sp.		X	
Family Acroporidae			
Acropora abrolhosensis		X	
Acropora aculeus	X		
Acropora acuminata		X	
Acropora akajimensis		X	
Acropora anthocercis	X		
Acropora aspera	X		
Acropora austera	X		
Acropora batunai	X		
Acropora brueggemanni	X		
Acropora carduus	X		
Acropora caroliniana	X		
Acropora cerealis	X		
Acropora clathrata	X		
Acropora copiosa		X	
Acropora cuneata	X		
Acropora cytherea	X		
Acropora danai	X		
Acropora dendrum	X		
Acropora derawanensis		X	
Acropora desalwii		X	
Acropora digitifera	X		
Acropora divaricata	X		
Acropora donei		X	
Acropora echinata		X	
Acropora elegans		X	
Acropora elseyi		X	
Acropora exquisita		X	
Acropora florida	X		
Acropora formosa	X		
Acropora gemmifera	X		
Acropora grandis	X		
Acropora granulosa	X		
Acropora hoeksemai		X	
Acropora horrida	X		
Acropora humilis	X		
Acropora hyacinthus	X		
Acropora indonesia		X	

SPECIES	SPP. RECORDED PREVIOUSLY	NEW SPP. RECORDS	SPP. NOT RECORDED BUT LIKELY TO BE PRESENT
Acropora insignis		X	
Acropora kirstyae	X		
Acropora latistella	X		
Acropora lianae		X	
Acropora listeri	X		
Acropora lokani		X	
Acropora longicyathus	X		
Acropora loripes	X		
Acropora lutkeni	X		
Acropora magnifica		X	
Acropora microclados	X		
Acropora microphthalma	X		
Acropora millepora	X		
Acropora mirabilis			X
Acropora monticulosa	X		
Acropora multiacuta	X		
Acropora nana	X		
Acropora nasuta	X		
Acropora nobilis	X		
Acropora palifera	X		
Acropora palmerae		X	
Acropora paniculata	X		
Acropora parilis		X	
Acropora plana		X	
Acropora polystoma	X		
Acropora pruinosa		X	
Acropora pulchra	X		
Acropora rambleri		X	
Acropora robusta	X		
Acropora rosaria		X	
Acropora samoensis	X		
Acropora sarmenthosa	X		
Acropora secale	X		
Acropora sekiseiensis			X
Acropora selago	X		
Acropora solitaryensis	X		
Acropora spicifera			X
Acropora stoddarti			X
Acropora subglabra	X		
Acropora subulata	X		
Acropora suharsoni		X	
Acropora sukarnoi		X	
Acropora tanegashimensis		X	
Acropora tenella		X	
Acropora tenuis	X		
Acropora teres		X	
Acropora togianensis		X	
Acropora valenciennesi	X		
Acropora valida	X		
Acropora vaughani	X		
Acropora verweyi	X		
Acropora wallaceae		X	
Acropora willisae	X		
Acropora yongei	X		
Acropora sp.		X	
Anacropora forbesi	X		
Anacropora matthaii	X		
Anacropora puertogalerai	X		
Anacropora reticulata	X		
Anacropora spinosa	X		

APPENDIX 1 Coral species recorded from the Philippines or likely to occur there

SPECIES	SPP. RECORDED PREVIOUSLY	NEW SPP. RECORDS	SPP. NOT RECORDED BUT LIKELY TO BE PRESENT
Anacropora sp.		X	
Astreopora cucullata			X
Astreopora expansa	X		
Astreopora gracilis	X		
Astreopora incrustans		X	
Astreopora listeri	X		
Astreopora macrostoma		X	
Astreopora myriophthalma	X		
Astreopora ocellata	X		
Astreopora suggesta			X
Montipora aequituberculata	X		
Montipora altasepta		X	
Montipora angulata	X		
Montipora australiensis		X	
Montipora cactus	X		
Montipora caliculata			X
Montipora capitata		X	
Montipora capricornis			X
Montipora cebuensis	X		
Montipora confusa	X		
Montipora corbettensis	X		
Montipora crassituberculata	X		
Montipora danae	X		
Montipora digitata	X		
Montipora efflorescens	X		
Montipora effusa			X
Montipora florida	X		
Montipora floweri	X		
Montipora foliosa	X		
Montipora foveolata	X		
Montipora friabilis			X
Montipora gaimardi		X	
Montipora grisea	X		
Montipora hirsuta		X	
Montipora hispida	X		
Montipora hoffmeisteri	X		
Montipora incrassata	X		
Montipora informis	X		
Montipora mactanensis	X		
Montipora malampaya	X		
Montipora millepora	X		
Montipora mollis	X		
Montipora monasteriata	X		
Montipora nodosa			X
Montipora orientalis			X
Montipora peltiformis	X		
Montipora samarensis	X		
Montiopra setosa		X	
Montipora spongodes		X	
Montipora spumosa	X		
Montipora stellata	X		
Montipora tuberculosa	X		
Montipora turgescens	X		
Montipora turtlensis		X	
Montipora undata	X		
Montipora venosa	X		
Montipora verrucosa	X		
Montipora sp. 1		X	
Montipora sp. 2		X	
Montipora sp. 3		X	
Montipora sp. 4		X	

APPENDIX 1 Coral species recorded from the Philippines or likely to occur there

SPECIES	SPP. RECORDED PREVIOUSLY	NEW SPP. RECORDS	SPP. NOT RECORDED BUT LIKELY TO BE PRESENT
Platygyra lamellina	X		
Platygyra pini	X		
Platygyra ryukyuensis	X		
Platygyra sinensis	X		
Platygyra verweyi			X
Platygyra yaeyamaensis			X
Plesiastrea versipora	X		
Family Trachyphyllidae			
Trachyphyllia geoffroyi	X		
Family Caryophilliidae			
Catalaphyllia jardinei	X		
Euphyllia ancora	X		
Euphyllia cristata	X		
Euphyllia divisa	X		
Euphyllia glabrescens	X		
Euphyllia paraancora	X		
Euphyllia paradivisa			X
Euphyllia yaeyamaensis	X		
Heterocyathus aequicostatus	X		
Nemenzopphyllia turbida	X		
Physogyra exerta	X		
Physogyra lichtensteini	X		
Plerogyra eurysepta	X		
Plerogyra simplex		X	
Plerogyra sinuosa	X		
Family Dendrophylliidae			
Heteropsammia cochlea	X		
Turbinaria bifrons			X
Turbinaria frondens	X		
Turbinaria heronensis		X	
Turbinaria irregularis		X	
Turbinaria mesenterina	X		
Turbinaria patula	X		
Turbinaria peltata	X		
Turbinaria radicalis		X	
Turbinaria reniformis	X		
Turbinaria stellulata	X		
TOTALS	349	113	37

Coral species recorded at individual sites (compiled by D. Fenner).

APPENDIX 2

SPECIES	SITE NUMBERS
Family Astrocoeniidae	
Stylocoeniella armata	27, 29, 32
Stylocoeniella guentheri	5, 6, 15, 21, 24-27, 30, 32, 35, 36, 38
Stylocoeniella sp.	9, 13, 19, 21, 24, 35, 36, 38
Family Pocilloporidae	
Palauastrea ramosa	4, 6, 14, 26
Pocillopora damicornis	1, 4, 6-9, 12, 17, 18, 20-24, 26, 28, 30, 32, 34, 36, 38
Pocillopora eydouxi	2, 10, 12, 15, 17, 21, 23, 24, 29, 31, 34, 35
Pocillopora meandrina	1, 3, 10, 15, 17, 18, 20, 22, 24, 29, 34, 35
Pocillopora verrucosa	12-18, 20-22, 24-26, 28-32, 34, 35, 38
Seriatopora caliendrum	16, 19, 25, 29, 33, 36, 38
Seriatopora hystrix	1, 2, 4, 6-8, 13-15, 17-24, 26, 28, 31, 32, 35-38
Stylophora mordax	2, 12, 20-23, 30, 35
Stylophora pistillata	1-3, 5, 7, 9, 10, 13-15, 17, 18, 20, 24, 26-38
Family Acroporidae	
Acropora aculeus	2, 6, 7, 10, 21, 26, 28, 29, 31, 32, 34, 37, 38
Acropora anthocercis	13, 16, 20, 38
Acropora brueggemanni	1, 4, 5, 7, 9, 13-16, 18, 21, 24-27, 29, 31-34, 37
Acropora sp. 1	2-6, 9, 10, 15, 17, 18, 20-23, 26, 27, 29, 31, 32, 34, 36
Acropora cuneata	22, 24, 34, 38
Acropora cytherea	2, 10, 24
Acropora divaricata	1, 3, 4, 10, 12-18, 20, 21, 23, 24, 26, 28-32, 34-36
Acropora echinata	4, 6
Acropora fastigata	1, 2, 6, 17, 18, 20, 21, 28, 30, 31, 34, 36-38
Acropora florida	1, 2, 7, 8, 10, 12-17, 20, 21, 23, 26, 28-32, 34, 35
Acropora formosa	26, 28, 29, 38
Acropora gemmifera	29
Acropora granulosa	4, 6, 10, 13, 15-18, 20-22, 26-29, 34-36
Acropora humilis	1, 2, 4, 7, 8, 10, 12, 14, 15, 17-20, 23-25, 28, 30-38
Acropora hyacinthus	1-3, 7, 9, 12, 13, 16-18, 20, 21, 29-31, 35, 38
Acropora indonesia	1, 4, 12, 13, 16, 17, 20, 21, 26, 28-30, 35
Acropora insignis	3, 5, 6, 12, 15, 19, 21, 27, 29, 31
Acropora kirstyi	34
Acropora latistella	2-4, 8, 10, 12-18, 21, 23, 26, 28-31, 35, 36, 38
Acropora longicyathus	6, 9, 34, 38
Acropora loripes	1-5, 10, 12, 14-20, 22, 23, 25, 26, 28-32, 34-38
Acropora magnifica	21, 22, 26, 29, 31, 32
Acropora microclados	12
Acropora millepora	1-4, 7, 8, 12-18, 21, 23-31, 34-38
Acropora monticulosa	3, 9, 10, 12, 13, 15, 17, 18, 21, 30, 31, 34, 35
Acropora nasuta	10, 12, 18, 30, 31, 34, 35
Acropora nobilis	1, 4, 12, 17, 29, 31
Acropora palifera	1-5, 7, 9, 10, 13-34, 36-38
Acropora robusta	9, 12, 13, 21, 34
Acropora rosaria	28
Acropora samoensis	30
Acropora selago	1-3, 7, 12-18, 20, 23, 29, 34, 35
Acropora tenella	25, 26
Acropora tenuis	1, 3, 7-10, 16, 17, 29-31, 34, 35, 37
Acropora teres	26
Acropora valenciennesi	1, 2, 4, 6, 12, 16, 18, 20, 21, 23, 25, 27-31, 34, 35
Acropora valida	12, 14, 15, 17, 20-22, 25, 30, 34, 35
Acropora vaughani	3, 12, 21
Acropora verweyi	34, 35

APPENDIX 2 Coral species recorded at individual sites

SPECIES	SITE NUMBERS
Acropora yongei	7, 12, 17, 29, 30
Anacropora forbesi	21, 32, 33
Anacropora matthai	10, 13, 18, 21, 25, 31, 34
Anacropora puertogalerae	10, 25, 28, 38
Anacropora reticulata	5, 21, 28, 31, 33, 38
Anacropora spinosa	1, 4, 21, 25, 28, 31, 32, 34, 38
Astreopora expansa	5, 25, 32
Astreopora gracilis	6, 7, 9, 13, 32
Astreopora sp. 1	4, 5, 9, 20, 24, 26, 28, 29, 35
Astreopora myriophthalma	1-6, 8, 10, 14, 15, 17, 19-21, 23, 25, 26, 28-31, 35, 37
Astreopora ocellata	5, 24, 28, 31, 34, 35
Astreopora suggesta	21, 35
Montipora aequituberculata	3, 9, 12, 13, 15, 16, 35, 36
Montipora angulata	1, 3, 7, 9, 16, 31
Montipora cactus	2, 3
Montipora capitata	3
Montipora cebuensis	6, 7, 12, 13, 24, 25, 27, 28, 30
Montipora confusa	17, 20-22, 24-27, 29, 36
Montipora corbettensis	23, 29, 34, 38
Montipora crassituberculata	2
Montipora danae	5, 6, 8, 14, 16, 17, 20, 27, 28, 31, 36
Montipora digitata	3
Montipora florida	4, 6, 21, 24-28, 32, 33, 36-38
Montipora foliosa	3, 14, 16, 31
Montipora hirsuta	7, 9, 12, 13, 15, 17, 18, 21, 30-32, 35
Montipora hispida	3, 7, 14-16, 18, 35
Montipora hoffmeisteri	14-17, 21, 22, 24, 26, 27, 29, 31, 36
Montipora informis	1, 5, 9, 16, 20, 21, 23, 26, 31, 36
Montipora mactanensis	9, 24, 26, 38
Montipora mollis	15-17, 25, 28, 29
Montipora plateformis	34, 35, 38
Montipora plateformis?	3, 9, 13, 14, 17, 31, 33
Montipora stellata	3
Montipora undata	15, 20
Montipora verrucosa	4, 9, 16-18, 20, 22, 24, 28, 34
Family Poritidae	
Alveopora catalai	4, 5, 26, 27, 32, 33, 35-38
Goniopora pendulus	3, 12, 15, 20
Goniopora stokesi	24, 31, 34
Porites annae	2, 4, 13, 14, 19, 24, 27, 29, 34, 35
Porites attenuata	7
Porites cylindrica	2-4, 7-10, 12, 14, 15, 17-22, 24, 26, 28, 29, 31, 33, 34, 36-38
Porites evermanni	2, 3, 7, 10, 13, 15, 18, 20, 21, 24, 25, 27, 28, 32, 34, 36, 38
Porites sp. 1	10
Porites horizontalata	15, 30, 34
Porites latistella	2
Porites (Synaraea) moniculosa	12, 32
Porites nigrescens	1-10, 12-18, 21, 24-29, 31, 32, 34, 36, 38
Porites (Synaraea) rus	1, 3-5, 7-10, 12-14, 16, 18, 19, 21, 22, 24-32, 34-38
Family Siderastreidae	
Coscinaraea columna	1, 3, 4, 9, 12, 15-17, 21, 23-27, 29, 30, 32, 36-38
Psammocora contigua	1, 4, 6, 7, 9, 13, 17-22, 24, 26-28, 31, 32, 34, 36-38
Psammocora digitata	1, 3, 7, 10, 13, 18, 24, 26, 28-31, 35, 38
Psammocora nierstraszi	4, 10, 13, 15, 18, 21, 22, 24, 31, 35, 36, 38

SPECIES	SITE NUMBERS
Psammocora profundacella	1, 2, 21, 24-27, 36, 38
Psammocora superficialis	13, 20, 21, 26, 34, 36, 37
Family Agariciidae	
Coeloseris mayeri	1-4, 6, 7, 9, 10, 12-15, 17, 18, 20, 21, 23-25, 27-34, 36-38
Gardineroseris planulata	2-4, 9, 10, 17, 19-23, 25-33, 35-37
Leptoseris amitoriensis	32
Leptoseris cristata	19, 21, 26, 31, 36
Leptoseris explanata	14-17, 19, 21, 22, 25-29, 31-33, 36-38
Leptoseris foliosa	32, 37, 38
Leptoseris gardineri	5, 21, 25, 26, 32, 34
Leptoseris hawaiiensis	18, 19, 21, 26, 36-38
Leptoseris mycetoseroides	1, 5, 19, 21, 26, 30, 32, 33, 36, 38
Leptoseris papyracea	9, 21, 33
Leptoseris scabra	2-4, 19, 28, 30, 31
Leptoseris solida	32
Leptoseris yabei	2, 4, 9, 14-17, 20-22, 24, 26-30, 32, 35-38
Pachyseris foliosa	4, 6, 14-16, 19, 21, 25-28, 31, 32, 34, 36-38
Pachyseris gemmae	1, 3, 4, 9, 10, 12, 14-17, 19-27, 29, 32, 34, 36
Pachyseris rugosa	1-5, 7, 10, 12, 14-18, 20, 21, 23, 24, 26-32, 34, 37, 38
Pachyseris speciosa	1, 3-6, 9, 12, 14-22, 24, 26-29, 31, 33-36, 38
Pavona bipartita	28, 32, 38
Pavona cactus	4, 6, 9, 16, 18, 19, 21, 24-28, 30-34, 36, 37
Pavona sp. 1	19, 36
Pavona clavus	4, 5, 8-10, 25-27, 30, 32, 36, 38
Pavona decussata	5, 19, 26-28, 37, 38
Pavona explanulata	2, 4, 9, 15, 19-22, 24-38
Pavona frondifera	8, 12, 19, 26
Pavona minuta	16, 21, 23-25, 29
Pavona varians	1, 4, 7-10, 13, 16, 18-22, 24, 28, 30, 31, 35, 36
Pavona sp. 2	4, 21, 25, 32, 33, 37
Pavona venosa	1-4, 7-9, 12, 13, 16-19, 21, 24-26, 30-32, 35, 37
Pavona xarifae	21
Family Fungiidae	
Ctenactis albitentaculata	1, 4, 6, 9, 14, 18, 20-22, 25, 27, 28, 30, 32
Ctenactis crassa	9, 28, 29
Ctenactis echinata	1-6, 8-10, 14-16, 18, 20-27, 29-32, 34-38
Cycloseris cyclolites	15, 19, 22
Cycloseris sinensis	32, 33
Cycloseris tenuis	3, 24, 25
Cycloseris vaughani	23, 24
Diaseris distorta	15, 18, 21, 29
Diaseris fragilis	34
Fungia concinna	5, 15, 20, 21, 32, 35
Fungia fralinae	18
Fungia fungites	1-3, 5, 7, 9, 10, 13, 14, 17, 18, 20, 21, 23-26, 29-32, 34, 35, 37
Fungia granulosa	2, 3, 15, 16, 18, 20, 23, 25, 28, 29, 31, 34, 35
Fungia gravis	15-18, 21, 26-29, 31, 32, 34, 36, 37
Fungia horrida	1-4, 7, 9, 10, 15, 17, 18, 20-24, 26, 29-31, 34, 35, 37, 38
Fungia klunzingeri	2, 5, 9, 12, 15, 16, 18, 20, 21, 29
Fungia paumotensis	2-5, 9, 10, 12-16, 17, 18, 20-27, 29-31, 33, 36, 36, 38
Fungia repanda	7, 12-14, 17, 34, 38
Fungia scruposa	1, 3, 4, 9, 15, 16, 19, 22, 26, 27, 29, 30, 33-35
Fungia scutaria	2, 3, 10, 20, 23
Halomitra pileus	1-3, 9, 13-15, 17, 18, 21-23, 25, 28-31

APPENDIX 2 Coral species recorded at individual sites

SPECIES	SITE NUMBERS
Heliofungia actiniformis	1, 4, 8-10, 12, 13, 15-18, 21, 22, 24-29, 31-33, 36-38
Herpolitha limax	1, 2, 4, 5, 7, 9, 10, 12-17, 19-21, 23, 24, 26-32
Lithophyllon lobata	16, 21, 26, 27, 32, 33, 35-37
Lithophyllon mokai	26
Lithophyllon undulatum	5, 7, 19-21, 24, 26, 37, 31, 32
Podabacia crustacea	4, 6-10, 13-17, 19-21, 25-32, 34, 36-38
Podabacia motuporensis	9, 10, 14, 16, 18, 21, 22, 26, 27, 30, 34-36
Polyphyllia talpina	1-3, 7, 10, 12-18, 20, 21, 23, 24, 28-32, 34, 35, 38
Sandalolitha dentata	21, 31
Sandalolitha robusta	1, 5, 7-10, 13-32, 34, 35, 38
Zoopilus echinatus	4, 17, 18, 21, 25, 26, 31
Family Oculinidae	
Archelia horrescens	1-4, 6, 7, 13, 25, 26
Galaxea alta	3-5, 9, 21, 26, 33, 37, 38
Galaxea astreata	2, 4, 5, 13, 14, 21, 24-26, 28, 32, 34, 36-38
Galaxea fascicularis	1, 3, 4, 7, 8, 10, 12-24, 26-31, 33-38
Galaxea paucisepta	1, 4, 9, 14, 15, 24, 27, 29
Galaxea sp. 1	1, 4, 9, 21, 24, 25
Family Pectiniidae	
Echinophyllia aspera	4, 5, 7, 9, 15, 17, 20-22, 26, 29-31, 34, 37, 38
Echinophyllia echinata	26
Echinophyllia echinoporoides	6, 10, 13, 15, 18, 21-24, 27, 28, 30, 31, 35, 38
Echinophyllia nishihirai	14, 36
Echinophyllia patula	2, 15, 20-23, 27, 29, 31, 32, 34, 38
Mycedium elephatotus	3, 4, 7, 10, 13-24, 26-38
Mycedium robokaki	4, 5, 13-18, 20-23, 25, 26, 29-32, 36, 37
Mycedium sp. 1	34-36
Mycedium mancaoi	26, 30
Oxypora crassispinosa	2, 4, 6, 9, 10, 13-24, 26-30, 32, 34, 36-38
Oxypora glabra	25, 26, 32, 36, 37
Oxypora sp. 1	5, 26, 32, 34-38
Oxypora lacera	2, 4-7, 10, 13-19, 21-23, 25-30, 32
Pectinia alcicornis	4, 5, 13-19, 21-34, 36-38
Pectinia lactuca	2, 4, 13-18, 20, 22-26, 29-31, 34, 38
Pectinia maxima	19, 23, 26-28, 32, 33, 36, 38
Pectinia paeonia	3, 7, 9, 10, 14, 18, 29, 30
Family Mussidae	
Acanthastrea echinata	2, 7, 9, 13-19, 21-24, 26, 28-31, 34, 35
Acanthastrea hemprichii	9, 16, 17, 21, 22, 27-31, 34, 35
Acanthastrea ishigakiensis	7, 10, 13, 15, 22, 23, 30, 31, 34, 35
Acanthastrea lordhowensis	16, 19, 21, 23, 26, 27, 37
Acanthastrea rotundoflora	4, 14, 17, 19, 21, 25-30, 36
Australomussa rowleyensis	21, 32
Blastomussa merleti	21
Cynarina lacrymalis	4, 5, 16, 17, 19, 21, 26-29, 32, 36, 38
Lobophyllia corymbosa	2, 4, 7-10, 12, 15, 20-38
Lobophyllia hataii	3, 4, 9, 16, 21-23, 28-30, 36
Lobophyllia hemprichii	1-10, 12-29, 31, 33-38
Lobophyllia pachysepta	13, 27, 36, 37
Lobophyllia robusta	2, 3, 5, 10, 12, 15, 16, 20-22, 24-28, 31, 34, 36-38
Lobophyllia sp. 1	12, 22, 28, 31
Lobophyllia sp. 2	36
Lobophyllia sp. 3	21
Lobophyllia sp. 4	21, 28, 29, 36

SPECIES	SITE NUMBERS
Scolymia vitiensis	21, 23-28, 31-33, 36, 37
Symphyllia agaricia	8, 14-17, 20-22, 24, 25, 30, 35
Symphyllia radians	2, 4, 7, 10, 18, 20, 22, 23, 26, 28, 30-32, 35
Symphyllia recta	4, 6-8, 10, 13, 16-18, 20, 21, 23-27, 29-38
Symphyllia valenciennesii	16, 18, 21, 22, 26, 36
Family Merulinidae	
Hydnophora exesa	2, 3, 7-10, 12, 13, 15-24, 28-30, 34, 35, 37
Hydnophora grandis	13, 18, 23, 25, 28-31, 34, 35, 37
Hydnophora microconos	2, 3, 7, 10, 13, 17, 21-23, 31, 35
Hydnophora pilosa	1, 2, 4, 5, 7, 9, 10, 13-15, 17, 21, 22, 25, 29, 34, 37
Hydnophora rigida	1-5, 7, 9, 10, 12-22, 24, 26-34, 36-38
Merulina ampliata	1-10, 12-38
Merulina scabricula	1-3, 5, 7, 9, 12, 13, 15-18, 20-23, 26-35, 37, 38
Scapophyllia cylindrica	2, 4, 8, 17, 21-23, 25, 27-32, 34, 35, 38
Family Faviidae	
Barabattoia amicorum	24
Caulastrea curvata	10, 16, 18, 26
Caulastrea echinulata	27, 28, 30, 36
Caulastrea furcata	4, 5, 17, 18, 20, 24-26, 29, 31, 32, 34, 36, 38
Cyphastrea agassizi	24, 25, 35
Cyphastrea decadia	1, 6, 13, 17, 18, 21, 26, 28, 29, 37, 38
Diploastrea heliopora	1-4, 7, 9, 10, 12-24, 26-38
Echinopora ashmorensis	1-4, 7, 9, 10, 13, 17, 26, 28, 29, 31, 32, 34-36, 38
Echinopora gemmacea	13, 15, 21, 22, 31, 32
Echinopora hirsultissima	15, 20-22, 25, 29, 30, 34, 35
Echinopora lamellosa	1-4, 6, 9, 10, 12-15, 17, 18, 20-27, 29-32, 35, 37, 38
Echinopora mammiformis	2, 5, 13, 18, 19, 21, 26-28, 35-38
Echinopora pacificus	1, 2, 4, 5, 7, 9, 10, 14-17, 19, 21-20, 34-36
Favia laxa	10, 13
Favia matthaii	4, 7, 9, 10, 13, 15, 16, 18-22, 24, 28, 30-32, 37
Favia maxima	22
Favia pallida	4, 9, 12, 13, 21, 30, 31, 34, 35, 37
Favia rotundata	1-3, 9, 10, 15, 16, 18-23, 25, 29, 30, 34-36
Favia sp. 1	13
Favia speciosa	4, 7-9, 12-15, 17-19, 21, 22, 24, 26, 29-31
Favia stelligera	1-3, 7, 10, 12, 13, 15, 17, 18, 21, 23, 24, 26, 25-31, 34, 35
Favites abdita	1, 3, 10, 13, 16-19, 21, 24, 30, 31, 34-38
Favites chinensis	8, 9, 16, 18, 19, 34, 36, 38
Favites flexuosa	24-?1
Favites halicora	1, 8-10, 13, 15, 17, 18, 22, 25, 28, 30, 31, 34, 35
Favites pentagona	1, 2, 12-16, 20, 21, 23, 24
Favites russelli	20-24, 26, 28, 30, 38
Goniastrea aspera	13, 14, 29, 35
Goniastrea edwardsi	7, 10, 13, 18, 30, 35, 37
Goniastrea palauensis	15
Goniastrea pectinata	2, 4, 10, 12-17, 19, 21, 24, 26, 30, 31, 34-38
Goniastrea retiformis	12, 13, 16-18, 21, 22, 24, 30-32, 34, 35, 38
Leptastrea bottae	1, 7, 10, 13, 15, 30, 31, 35, 36
Leptastrea pruinosa	28, 30
Leptastrea purpurea	4, 5, 8-10, 12, 13, 16-19, 21, 24-28, 30-33, 35-38
Leptastrea transversa	10, 21-23, 30, 35
Leptoria phrygia	1-4, 7-10, 12-14, 16-18, 20-25, 29, 30, 32, 34, 35
Montastrea sp. 1	16, 22, 24, 30, 31, 34, 35
Montastrea curta	1, 3, 7, E, 13, 18, 24, 35

APPENDIX 2 Coral species recorded at individual sites

SPECIES	SITE NUMBERS
Montastrea sp. 2	1-3, 10, 35
Montastrea magnistellata	13, 18, 21, 22, 25, 28-32, 34, 35
Montastrea multipunctata	19, 20
Montastrea valenciennesi	12-15, 17-19, 21, 22, 24, 28, 30-32, 34, 35
Oulastrea crispata	2, 20, 21, 23-26, 30, 31, 34-36, 38
Oulophyllia bennettae	4, 6, 7, 15, 16, 18, 21, 27, 28, 30, 32, 34, 36, 37
Oulophyllia crispa	2-4, 7, 15, 17, 18, 20-24, 26, 28-31, 34-36
Platygyra contorta	2-4, 6-10, 13-18, 23, 24, 27, 29-31, 34, 45
Platygyra daedalea	1, 2, 7-10, 12-18, 20-24, 26, 28-32, 34-37
Platygyra lamellina	1-4, 8, 13-16, 18, 19, 21, 22, 24, 26, 28-32, 37, 38
Platygyra sinensis	9
Plesiastrea versipora	10, 15, 16, 20-22, 28-30, 34, 36, 38
Family Trachyphyllidae	
Trachyphyllia geoffroyi	19, 24, 26, 27, 31, 32, 34, 36, 37
Family Caryophylliidae	
Catalaphyllia jardinei	5, 28, 37
Euphyllia ancora	1, 2, 4, 7-10, 12, 14-16, 19-24, 26-38
Euphyllia cristata	7, 12
Euphyllia glabrescens	1, 2, 5, 9, 10, 12, 14, 15, 17, 19, 21-23, 26-29, 31-34, 36, 37
Euphyllia paraancora	4, 16, 19, 21, 25-29, 33, 37, 38
Euphyllia yaeyamaensis	4, 6-9, 12-15, 17-21, 24-29, 31-34, 36-38
Physogyra lichtensteini	1-3, 7, 9, 10, 12, 13, 15, 16, 18-24, 26-28, 34, 36, 38
Plerogyra eurysepta	36
Plerogyra simplex	4, 5, 9, 14, 16, 19, 21, 22, 24, 26-30, 33, 34, 36, 38
Plerogyra sinuosa	7, 10, 14, 16, 19-22, 25-29, 32, 33, 36-38
Plerogyra sp. 1	26, 32, 37
Family Dendrophylliidae	
Tubastraea coccinea	21
Tubastraea micranthus	24, 26-28, 36, 38
Turbinaria frondens	1, 6, 10
Turbinaria heronensis	14, 38
Turbinaria incrustans	1, 5, 9, 13, 31, 36
Turbinaria irregularis	12, 13, 20, 21
Turbinaria mesenterina	12, 15-23, 26-31, 36-38
Turbinaria peltata	12, 16, 19, 20, 27, 32, 36
Turbinaria reniformis	14, 20, 22
Rhizopsammia verrilli	13, 20, 21, 26-29, 32, 36
Octocorallia	
Heliopora coerulea	1, 10, 12-19, 21, 24, 27-32, 34, 36, 38
Heliopora sp. 1	2, 4, 7, 10, 12-14, 16-24, 29-32, 34, 36
Tubipora musica	1, 7, 10, 13-18, 20-22, 26, 28-30, 38
Tubipora sp. 1	15, 16, 21, 25, 29, 30, 34, 36, 37
Tubipora sp. 2	13, 17, 18, 20, 24, 28, 29, 31, 33, 36
Tubipora sp. 3	5, 9, 25
Hydrocorals	
Millepora dichotoma	1, 8, 9, 12, 16
Millepora exaesa	1, 3, 7, 12, 13, 18, 24, 30-32, 35
Millepora intricata	1, 3, 7, 9, 12-14, 18, 24, 29, 30, 34, 35
Millepora platyphylla	1-3, 9, 12, 15, 17, 21, 25, 29, 30, 32, 35
Stylaster sp.	13, 15-17, 20, 21, 29, 31
Distichopora violacea	13, 14

Molluscs recorded during the RAP survey of the Calamianes Islands (compiled by F. E. Wells).

APPENDIX 3

SPECIES	SITES
CLASS BIVALVIA	
Family Arcidae	
Anadara maculosa (Reeve, 1844)	4, 21, 37
Arca navicularis (Bruguiere, 1798)	1
Barbatia amygdalumtotsum (Roding, 1798)	6, 8, 9, 10, 12, 13, 15, 18, 24, 26, 28, 29, 31-38
Barbatia foliata (Forsskal, 1775)	4
Barbatia sp.	21, 24, 26, 29, 36
Barbatia ventricosa (Lamarck, 1819)	1, 3, 4, 7-10, 12, 14-19, 21, 24, 26, 28, 31-38
Family Cardiidae	
Acrosterigma fultoni (Sowerby, 1916)	5
Acrosterigma luteomarginata (Voskuil and Onverwagt, 1991)	28
Acrosterigma sp.	5, 32
Acrosterigma transcendens (Melvill and Standen, 1899)	5
Acrosterigma unicolor (Sowerby, 1834)	28
Corculum impressum (Lightfoot, 1786)	5, 21
Corculum laevigatum (Bartsch, 1947)	14, 24, 31
Fragum cf. *scruposum* (Deshayes, 1855)	19
Fragum fragum (Linnaeus, 1758)	1, 5, 6
Fragum unedo (Linnaeus, 1758)	27, 37
Laevicardium biradiatum (Bruguiere, 1789)	5, 12, 19, 26, 37
Trachycardium alternatum (Sowerby, 1841)	4, 24, 26, 32, 38
Trachycardium elongatum (Bruguiere, 1789)	5, 7, 9, 12, 19
Trachycardium enode (Sowerby, 1841)	5, 6, 12, 19, 24, 37, 38
Trachycardium flavum (Linnaeus, 1758)	4
Trachycardium mindanense (Reeve, 1844)	36
Vepricardium multispinosum (Sowerby, 1841)	2, 33
Family Carditidae	
Beguina semiorbiculata (Linnaeus, 1758)	5, 19, 32, 33, 34, 36, 37, 38
Cardita abyssicola (Hinds, 1843)	19
Cardita variegata (Bruguiere, 1792)	16, 17, 19, 26, 28, 30, 31, 32
Family Chamidae	
Chama limbula (Lamarck, 1819)	5, 6
Chama savigni (Lamy, 1921)	14, 18, 21
Chama sp.	2, 7, 10
Family Corbiculidae	
Polymesoda coaxans (Gmelin, 1791)	37
Family Corbulidae	
Corbula sp. 1	9, 19
Corbula sp. 2	32
Family Donacidae	
Donax sp.	1
Family Fimbriidae	
Fimbria fimbriata (Linnaeus, 1758)	5, 7, 9, 37, 38
Family Glycymeridae	
Glycymeris cf. *holsericus* (Reeve, 1843)	16, 19
Glycymeris reevei (Mayer, 1868)	4, 8, 15, 37
Tucetona amboiensis (Gmelin, 1791)	1, 24
Family Isognomonidae	
Isognomon sp.	14, 16, 17, 19, 26, 27, 28, 31, 34-38
Family Limidae	
Ctenoides ales (Finlay, 1927)	26, 36
Ctenoides annulata (Lamarck, 1819)	1, 5, 26, 33
Ctenoides philippinarum (Masahito and Habe, 1972)	36
Lima cf. *basilanica* (A. Adams and Reeve, 1850)	8

APPENDIX 3 Molluscs recorded during the RAP survey of the Calamianes Islands

SPECIES	SITES
Lima fragilis (Gmelin, 1791)	5
Lima lima (Link, 1807)	1, 2, 8, 12, 13, 16, 18, 19, 24, 26-30, 36-38
Family Lucinidae	
Anodontia edentula (Linnaeus, 1758)	19, 36
Divaricella ornata (Reeve, 1850)	21
Lucina cumingi (Adams and Angas, 1863)	37
Lucina reevei (Deshayes, 1863)	8, 9, 21, 32, 36, 37
Family Mactridae	
Lutraria impar (Reeve, 1854)	33
Lutraria sp.	19
Family Malleidae	
Malleus malleus (Linnaeus, 1758)	5, 19, 34, 35, 36, 37, 38
Vulsella vulsella (Linnaeus, 1758)	5, 7, 12, 14, 17, 19, 38
Family Mesodesmatidae	
Davila plana (Hanley, 1843)	1
Family Mytilidae	
Lithophaga sp.	1, 2, 3
Modiolus philippinarum (Hanley, 1843)	4, 5, 6, 9, 17, 18, 19, 24, 26, 36, 37
Modiolus sp.	4
Septifer bilocularis (Linnaeus, 1758)	1, 19, 21, 26, 27, 32, 33, 36, 37
Family Ostreidae	
Hyotissa hyotis (Linnaeus, 1758)	25, 31
Lopha cristagalli (Linnaeus, 1758)	6, 7, 8, 25
Saccostrea cucullata (Born, 1778)	1, 4, 10, 11, 14, 17, 23, 32, 33, 37, 38
Saccostrea sp.	1, 7, 8, 25, 28
Family Pectinidae	
Bractechlamys vexillum (Reeve,1853)	28
Chlamys corsucans (Hinds, 1845)	29
Chlamys irregularis (Sowerby, 1842)	16, 20
Chlamys lentiginosa (Reeve, 1865)	20, 36
Chlamys mollita (Reeve, 1853)	26
Chlamys squamata (Gmelin, 1791)	21, 33
Chlamys squamosa (Gmelin, 1791)	15, 27
Comptopallium radula (Linnaeus, 1758)	4, 8, 9, 12, 16, 24-29, 31, 32, 34-38
Excellichlamys histrionica (Gmelin, 1791)	29, 36
Gloripallium pallium (Linnaeus, 1758)	1, 2, 5, 7, 8, 9, 15, 17, 19, 20, 24, 26-29, 38
Mimachlamys lentiginosa (Reeve, 1853)	19
Mirapecten rastellum (Lamarck, 1819)	26
Pedum spondyloidaeum (Gmelin, 1791)	1-10, 12-19, 21-37
Semipallium tigris (Lamarck, 1819)	2, 19, 21
Family Pinnidae	
Atrina vexillum (Born, 1778)	5, 8, 12, 19
Pinna bicolor (Gmelin, 1791)	1, 31
Streptopinna saccata (Linnaeus, 1758)	1
Family Psammobiidae	
Asaphis violaceans (Forsskal, 1775)	14, 21
Gari amethystus (Wood, 1815)	19
Gari elongata (Lamarck, 1811)	19
Gari livida (Lamarck, 1818)	30, 36
Gari pulcherrimus (Deshayes, 1855)	26
Family Pteriidae	
Pinctada margaritifera (Linnaeus, 1758)	4, 5, 8, 14
Pteria penguin (Roding, 1798)	7, 8, 9, 16, 20, 25, 27, 28

SPECIES	SITES
Family Semelidae	
Semele casta (A. Adams, 1853)	19, 32
Semele cf. *exarata* (Adams and Reeve, 1848)	7
Semele jukesii (Reeve, 1853)	28
Semele lamellosa (Sowerby, 1830)	28, 33
Semele sinensis (Adams, 1853)	3
Family Spondylidae	
Spondylus butleri (Reeve, 1856)	24
Spondylus candidus (Lamarck, 1819)	1, 21, 26, 36
Spondylus multimuricatus (Reeve, 1856)	3, 7, 8, 19, 21, 26
Spondylus sanguineus (Dunker, 1852)	21, 35, 37
Spondylus sinensis (Schreibers, 1793)	1, 18, 19, 35
Spondylus squamosus (Schreibers, 1793)	5, 6
Spondylus varians (Sowerby, 1829)	19
Family Tellinidae	
Tellina astula (Hedley, 1917)	30
Tellina capsoides (Lamarck, 1818)	5, 7, 19, 32, 36, 37, 38
Tellina crucigerum (Lamarck, 1818)	29, 37
Tellina exculta (Gould, 1850)	5
Tellina gargadia (Linnaeus, 1758)	5
Tellina linguafelis (Linnaeus, 1758)	1
Tellina ovalis (Sowerby, 1825)	24
Tellina piratica (Hedley, 1918)	19
Tellina plicata (Valenciennes, 1827)	30
Tellina rastellum (Hanley, 1844)	2, 17
Tellina remies (Linnaeus, 1758)	15
Tellina rostrata (Linnaeus, 1758)	37
Tellina scobinata (Linnaeus, 1758)	3, 6
Tellina serricostata (Tokunaga, 1906)	7, 9
Tellina sp.	2
Tellina tongana (Quoy and Gaimard, 1835)	32
Tellina virgata (Linnaeus, 1758)	1, 5, 7, 15
Family Trapeziidae	
Trapezium bicarinatum (Schumacher, 1817)	16, 32, 36, 37, 38
Trapezium obesa (Reeve, 1843)	18, 21, 26
Trapezium sowerbyi (Hidalgo, 1903)	20
Family Tridacnidae	
Hippopus hippopus (Linnaeus, 1758)	1, 4, 6, 12, 14, 18, 21, 29, 36, 37, 38
Tridacna derasa (Roding, 1798)	9, 36
Tridacna gigas (Linnaeus, 1758)	1, 6, 32, 38
Tridacna maxima (Roding, 1798)	1, 2, 6, 29, 30, 32, 36
Tridacna squamosa (Lamarck, 1819)	1-4, 6-9, 12, 13, 14, 18, 21, 22, 24-34, 36, 37
Tridacnea crocea (Lamarck, 1849)	1-9, 43-19, 22, 24, 25, 27, 29, 30, 32, 34, 36-38
Family Trigoniidae	
Codakia punctata (Linnaeus, 1758)	37
Codakia tigerina (Linnaeus, 1758)	9, 14, 17, 19, 32
Family Veneridae	
Antigona cf. *corbis* (Lamarck, 1818)	35
Antigona chemnitzii (Hanley, 1844)	10, 28
Antigona clathrata (Deshayes, 1854)	1, 2
Antigona purpurea (Linnaeus, 1771)	26
Antigona restriculata (Sowerby, 1853)	1, 2, 3, 4, 5, 19, 21, 23, 25, 33
Antigona reticulata (Linnaeus, 1758)	2, 4, 5, 14, 18, 19, 23, 30, 32, 34
Callista semisulcata (Sowerby, 1851)	19

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SPECIES	SITES
Circe personata (Deshayes, 1854)	9
Circe sp.	16
Clementia papyracea (Gray, 1825)	32
Dosinia iwakawai (Oyama and Habe, 1971)	19
Dosinia juvenilis (Gmelin, 1791)	5
Dosinia sculpta (Hanley, 1845)	19
Dosinia sp.	2, 30
Gafrarium dispar (Holten, 1802)	14
Gafrarium equivocum (Holten, 1802)	30, 32
Gafrarium transversarium (Deshayes, 1854)	1
Gafrarium tumidum (Roding, 1798)	14, 17
Globivenus toreuma (Gould, 1850)	1, 2, 3, 5, 9, 15-17, 19, 22-24, 27-29, 31-37
Lioconcha annettae (Lamprell and Whitehead, 1990)	2, 5, 19, 27, 28
Lioconcha castrensis (Linnaeus, 1758)	7, 19, 31, 32, 38
Lioconcha fastigiata (Sowerby, 1851)	36
Lioconcha ornata (Dillwyn, 1817)	31, 33
Lioconcha polita (Roding, 1798)	5, 7
Lioconcha sp.	5
Marcia japonica (Gmelin, 1791)	9, 33
Meretrix meretrix (Linnaeus, 1758)	4
Pitar japonicus (Kuroda and Kawamoto, 1956)	30
Pitar lineolatus (Sowerby, 1854)	15
Pitar nancyae (Lamprell and Whitehead, 1990)	30
Pitar prora (Conrad, 1837)	5, 19
Pitar spoori (Lamprell and Whitehead, 1990)	16, 21
Tapes belcheri (Sowerby, 1852)	33
Tapes literatus (Linnaeus, 1758)	18, 19, 26, 27, 33
Tapes sericeus (Matsukuma, 1986)	8
Tapes sulcarius (Lamarck, 1818)	37, 38
Timoclea marica (Linnaeus, 1758)	24, 32
CLASS CEPHALOPODA	
Family Loliginidae	
Loligo sp.	20
Family Octopodidae	
Octopus sp.	8
Family Sepiidae	
Metasepia pfeifferi (Hoyle, 1885)	36
Sepia sp. 1	3, 8, 21
Sepia sp. 2	21
CLASS GASTROPODA	
Family Aeolidiidae	
Aeolid sp.	23, 29
Family Aglajidae	
Chelidonura amoena (Bergh, 1905)	13, 19, 22, 29, 33, 34, 35
Chelidonura hirundinina (Quoy and Gaimard, 1834)	13, 14
Chelidonura sp. 1	30
Chelidonura sp. 2	11, 17, 19, 20, 37
Chelidonura sp. 3	21, 35
Chelidonura sp. 4	33, 34
Family Aplysiidae	
Dolabella sp.	14, 24
Stylocheilus sp.	25
Family Atyidae	
Atys cylindricus (Helbling, 1779)	4, 8, 12, 16, 19, 23, 30

SPECIES	SITES
Atys naucum (Linnaeus, 1758)	4, 6, 8, 12, 32, 33, 36, 37, 38
Family Buccinidae	
Cantharus fumosus (Dillwyn, 1817)	21
Cantharus iostomus (Gray, 1834)	37
Cantharus leucotaeniatus (Kosuge, 1985)	9
Cantharus pulcher (Reeve, 1846)	9, 12, 21, 30, 32, 34, 35
Cantharus subrubiginosus (E.A. Smith, 1879)	17
Cantharus undosus (Linnaeus, 1758)	5, 10, 16, 24, 28, 29
Cantharus wagneri (Anton, 1839)	1, 2, 3, 35
Engina alveolata (Kiener, 1836)	10, 22
Engina incarnata (Deshayes, 1834)	7, 8, 9
Engina lineata (Reeve, 1846)	1, 4, 6, 7, 9, 10, 14, 15, 23, 29, 34
Engina zonalis (Lamarck, 1822)	22
Phos textum (Gmelin, 1791)	9, 12, 13, 32, 33, 36
Pisania gracilis (Reeve, 1846)	3, 15, 23, 24, 32
Pisania ignea (Gmelin, 1791)	20
Family Bursidae	
Bursa granularis (Roding, 1798)	1, 12, 15, 35
Bursa lamarckii (Deshayes, 1853)	18, 25
Bursa leo Shikama, 1964	4
Bursa rosa (Perry, 1811)	31
Bursa tuberossissima (Reeve, 1844)	35
Tutufa rubeta (Linnaeus, 1758)	25
Family Calyptraeidae	
Calyptraea sp.	9
Family Cassidae	
Casmaria erinaceus (Linnaeus, 1758)	4, 7, 28, 37
Cassis cornuta (Linnaeus, 1758)	8, 34
Family Cerithiidae	
Cerithium balteatum (Philippi, 1848)	7, 10
Cerithium batillariaeformis (Habe and Kosuge, 1966)	8, 17
Cerithium citrinum (Sowerby, 1855)	1, 4
Cerithium columna (Sowerby, 1834)	9, 12, 14, 25, 28
Cerithium echinatum (Lamarck, 1822)	3, 9, 10, 17, 25, 29, 31, 35
Cerithium lifuense (Melvill and Standen, 1895)	10, 17, 25, 26, 28, 32, 33, 34
Cerithium moniliferum (Kiener, 1841)	1, 5, 6, 8, 9, 11, 14, 17, 38
Cerithium nesioticum (Pilsbry and Vanetta, 1906)	8, 9, 15, 16, 17, 23
Cerithium nodulosus (Bruguiere, 1792)	1, 8, 9, 10, 13, 17, 27, 28, 32
Cerithium planum (Anton, 1839)	8, 12, 16, 26, 33, 36, 38
Cerithium rostratum (Sowerby, 1855)	15
Cerithium salebrosum (Sowerby, 1855)	14
Cerithium tenellum (Sowerby, 1855)	26, 28, 33
Cerithium tenuifilosum (Sowerby, 1866)	14
Cerithium trailli (Sowerby, 1855)	5, 10, 12, 14, 17
Cerithium zonatum (Wood, 1828)	2
Clypeomorus subbreviculus (Oostingh, 1925)	11
Pseudovertagus aluco (Linnaeus, 1758)	5, 37
Rhinoclavis articulata (Adams and Reeve, 1850)	10, 17, 22, 24, 29, 30
Rhinoclavis aspera (Linnaeus, 1758)	1-3, 5-9, 12, 13, 15-17, 19, 21, 22, 24, 27-29, 31-33, 36-38
Rhinoclavis sinensis (Gmelin, 1791)	1, 3, 10, 13, 24, 35
Rhinoclavis vertagus (Linnaeus, 1767)	5, 37
Family Chromodorididae	
Mexichromis sp.	23

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SPECIES	SITES
Chromodoris aff. *aureopurpurea* (Collingwood, 1881)	23
Chromodoris africana (Elliot, 1904)	28
Chromodoris bullocki (Collingwood, 1857)	10, 22, 31, 37
Chromodoris coi (Risbec, 1956)	12, 13
Chromodoris elisabethina (Bergh, 1877)	1, 2, 3, 7, 8, 13-17, 20, 21, 22, 31, 35
Chromodoris sp. 1 (*C. elisabethina* complex)	17
Chromodoris sp. 2 (*C. elisabethina* complex)	16
Chromodoris sp. 3	31
Chromodoris sp. 4	22
Chromodoris striatella (Bergh, 1877)	37
Chromodoris tinctoria (Ruppell and Leuckart, 1824)	23
Glossodoris atromarginata (Cuvier, 1804)	9, 17
Glossodoris hikuerensis (Pruvot-Fol, 1954)	13
Family Colubrariidae	
Colubraria antiquata (Hinds, 1844)	15
Colubraria nitidula (Sowerby, 1833)	31
Colubraria souverbii (Reeve, 1844)	25
Family Columbellidae	
Mitrella albina (Kiener, 1841)	2, 3, 8, 9, 10, 20, 22, 23
Mitrella ligula (Duclos, 1840)	8, 16
Mitrella sp.	22
Pyrene deshayesii (Crosse, 1859)	25, 26, 27
Pyrene ocellata (Link, 1807)	10, 14, 17, 21, 32
Pyrene punctata (Bruguiere, 1789)	9, 10, 12, 15, 16, 17, 21, 22, 31, 32, 34, 35
Pyrene scripta (Lamarck, 1822)	4, 5, 6, 8, 10, 12, 14, 17, 21, 30, 31, 33
Pyrene testudinaria (Link, 1807)	2, 6, 10, 15, 17, 22, 24, 32, 33, 38
Pyrene turturina (Lamarck, 1822)	1, 7, 9, 10, 15, 16, 21, 24, 34, 35, 37
Family Conidae	
Conus arenatus (Hwass in Bruguiere, 1792)	3, 7, 8, 9, 10, 13, 23, 24, 32, 36, 38
Conus aulicus (Linnaeus, 1758)	1
Conus boeticus (Reeve, 1844)	29, 30, 31, 37
Conus capitaneus (Linnaeus, 1758)	6, 15, 23, 36, 38
Conus ceylanensis (Hwass in Bruguiere, 1792)	6, 7, 10
Conus cf. *striatellus* (Link, 1807)	24
Conus chaldeus (Roding, 1798)	10
Conus circumactus (Iredale, 1929)	10
Conus consors (Sowerby, 1833)	1
Conus coronatus (Gmelin, 1791)	1, 17
Conus distans (Hwass in Bruguiere, 1792)	10, 19, 23
Conus ebraeus (Linnaeus, 1758)	10, 17
Conus eburneus (Hwass in Bruguiere, 1792)	7
Conus emaciatus (Reeve, 1849)	10, 21, 37
Conus flavidus (Lamarck, 1810)	2, 9, 10, 17, 23, 34
Conus frigidus (Reeve, 1848)	2, 36
Conus furvus (Reeve, 1843)	5, 16, 17, 33, 36
Conus generalis (Linnaeus, 1767)	1
Conus glans (Hwass in Bruguiere, 1792)	4, 6, 8, 13, 15, 29
Conus imperialis (Linnaeus, 1758)	2, 3, 17, 38
Conus lividus (Hwass in Bruguiere, 1792)	10, 23, 30, 34
Conus magus (Linnaeus, 1758)	27
Conus marmoreus (Linnaeus, 1758)	4, 13, 15, 21, 32
Conus miles (Linnaeus, 1758)	8, 9, 13, 15, 17, 20, 23, 27, 30, 35
Conus miliaris (Hwass in Bruguiere, 1792)	10, 17, 38
Conus mucronatus (Reeve, 1843)	32, 37

SPECIES	SITES
Conus musicus (Hwass in Bruguiere, 1792)	2, 4, 6-11, 13, 15-19, 21-25, 27-32, 34, 37, 38
Conus mustelinus (Hwass in Bruguiere, 1792)	1, 8, 24, 25
Conus nussatella (Linnaeus, 1758)	22, 24
Conus obscurus (Sowerby, 1833)	17
Conus omaria (Hwass in Bruguiere, 1792)	28, 35
Conus parius (Reeve, 1844)	12, 13, 18, 22
Conus pulicarius (Hwass in Bruguiere, 1792)	8, 9, 10, 27, 32
Conus quercinus (Solander, 1786)	21
Conus rattus (Hwass in Bruguiere, 1792)	22
Conus sanguinolentus (Quoy and Gaimard, 1834)	3, 17
Conus scabriusculus (Dillwyn, 1817)	23, 24
Conus stercmuscarum (Linnaeus, 1758)	13, 34
Conus striatus (Linnaeus, 1758)	31, 34, 37
Conus terebra (Born, 1780)	2, 25
Conus textile (Linnaeus, 1758)	10, 15, 21, 23, 36
Conus vexillum (Gmelin, 1791)	3
Conus virgo (Linnaeus, 1758)	23, 27, 38
Conus vulpinus (Hwass in Bruguiere, 1792)	15
Family Coralliophilidae	
Coralliophila erosa (Roding, 1798)	7, 9, 20
Coralliophila pyriformis (Kira, 1954)	26
Coralliophila violacea (Kiener, 1836)	4-9, 12, 13, 15, 18, 21, 22, 24, 25, 29-34, 36
Latiaxis sp. 1	2
Latiaxis sp. 2	24
Rapa rapa (Gmelin, 1791)	7, 22, 29
Family Costellariidae	
Vexillum bernhardina (Roding, 1798)	12, 20
Vexillum cadaverosum (Reeve, 1844)	34
Vexillum cavea (Reeve, 1844)	27, 32
Vexillum crocatum (Lamarck, 1811)	32
Vexillum exasperatum (Gmelin, 1791)	12
Vexillum flexicostatum (Garrett, 1880)	7
Vexillum granosum (Gmelin, 1791)	12, 17, 37
Vexillum lautum (Reeve, 1845)	18
Vexillum microzonias (Lamarck, 1811)	21, 22
Vexillum mirabile (Adams, 1851)	5, 7, 8, 12, 16
Vexillum obeliscus (Reeve, 1844)	12
Vexillum pacificum (Reeve, 1845)	7, 23, 24
Vexillum patriarchialis (Gmelin, 1791)	21, 34
Vexillum rubocostatum (Habe and Kosuge, 1966)	17
Vexillum sculptile (Reeve, 1845)	21
Vexillum tankervillei (Melvill, 1888)	30
Vexillum unifascialis (Lamarck, 1811)	15
Vexillum vulpeculum (Linnaeus, 1758)	11
Vexillum zebuense (Reeve, 1845)	12
Family Crepidulidae	
Capulus liberatus Pease, 1868	29
Cheilea equestris (Linnaeus, 1758)	2, 18, 21, 30, 37
Family Cypraeidae	
Cypraea annulus (Linnaeus, 1758)	1, 2, 3, 4, 8, 9, 10, 12, 14, 17, 19, 31, 32
Cypraea arabica (Linnaeus, 1758)	16, 21
Cypraea argus (Linnaeus, 1758)	1, 31
Cypraea asellus (Linnaeus, 1758)	1, 2, 3, 9, 12, 13, 15, 21, 25, 32

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SPECIES	SITES
Cypraea caputserpentis (Linnaeus, 1758)	1, 3, 9, 20, 23
Cypraea carneola (Linnaeus, 1758)	5, 7, 16, 18, 24, 32
Cypraea cicercula (Linnaeus, 1758)	21
Cypraea cribraria (Linnaeus, 1758)	7, 9, 12
Cypraea cylindrica (Born, 1778)	2, 5, 6, 8, 12, 13, 18, 19, 21, 28, 32
Cypraea dayritiana (Cate, 1963)	37
Cypraea eglantina (Duclos, 1833)	1, 3, 6, 9, 10, 14, 18, 21, 23, 29, 30, 35, 37
Cypraea erosa (Linnaeus, 1758)	2, 5, 6, 15, 16, 20, 23, 24, 25, 38
Cypraea errones (Linnaeus, 1758)	21
Cypraea fimbriata (Gmelin, 1791)	30
Cypraea globulus (Linnaeus, 1758)	7
Cypraea hammondae (Iredale, 1939)	8
Cypraea helvola (Linnaeus, 1758)	1, 2, 3, 10, 13, 23, 24, 29, 35
Cypraea isabella (Linnaeus, 1758)	7, 9, 18, 24, 28, 29
Cypraea kieneri (Hidalgo, 1906)	18
Cypraea labrolineata (Gaskoin, 1848)	3, 9
Cypraea lynx (Linnaeus, 1758)	1, 3, 4, 6, 8, 9, 10, 12, 14, 15, 17, 18, 22, 23
Cypraea maculifera (Schilder, 1932)	31
Cypraea margarita (Dillwyn, 1817)	19
Cypraea microdon (Gray, 1828)	21, 32
Cypraea moneta (Linnaeus, 1758)	1, 2, 4, 6, 9, 14, 16, 18, 27
Cypraea nucleus (Linnaeus, 1758)	7, 8, 9, 10, 12
Cypraea pallidula (Gaskoin, 1849)	22
Cypraea punctata (Linnaeus, 1771)	2, 4, 17
Cypraea quadrimaculata (Gray, 1824)	22
Cypraea saulae (Gaskoin, 1843)	33
Cypraea staphylaea (Linnaeus, 1758)	22
Cypraea teres (Gmelin, 1791)	9, 10
Cypraea testudinaria (Linnaeus, 1758)	21
Cypraea tigris (Linnaeus, 1758)	3, 17, 24, 36, 37
Cypraea ursellus (Gmelin, 1791)	31
Cypraea vitellus (Linnaeus, 1758)	10, 14, 16, 23
Family Doridiidae	
Aphelodoris sp.	34, 35
Discodoris boholensis (Bergh, 1877)	10
Halgerda sp.	37
Janolus sp.	19
Jorunna funebris (Kelaart, 1838)	27
Platydoris scabra (Cuvier, 1804)	1
Family Elysiidae	
Elysia aff. *ornata* (Swainson, 1840)	35
Elysia sp.	13
Placobranchus ocellatus (van Hasselt, 1824)	2, 5, 6, 7, 8, 16, 26, 31
Thurdilla sp.	2, 8, 9, 10, 13, 16, 22, 27
Family Eulimidae	
Eulimid sp.	17
Family Fasciolariidae	
Dolicholatirus lancea (Gmelin, 1791)	21, 22, 35
Latirolagena smaragdula (Linnaeus, 1758)	20
Latirus craticularis (Linnaeus, 1758)	6, 34
Latirus gibbulus (Gmelin, 1791)	34
Latirus irus (Lightfoot, 1786)	15
Latirus kandai (Kuroda, 1950)	28
Latirus lanceolatus (Reeve, 1847)	21

SPECIES	SITES
Latirus nodatus (Gmelin, 1791)	20, 23, 30
Latirus polygonus (Gmelin, 1791)	2, 10
Latirus recurvirostris (Schubert and Wagner, 1829)	17
Latirus turritus (Gmelin, 1791)	5, 23, 30, 32, 33, 34
Peristernia incarnata (Deshayes, 1830)	28, 34, 35
Peristernia lirata (Pease, 1868)	24, 28
Peristernia nassatula (Lamarck, 1822)	23, 27
Peristernia philberti (Recluz, 1844)	4, 6, 10, 14, 17, 18, 19, 28
Pleuroploca filamentosa (Roding, 1798)	15, 17, 31, 34, 35
Pleuroploca trapezium (Linnaeus, 1758)	8, 9
Family Fissurellidae	
Diodora mus (Reeve, 1850)	22
Hemitoma panhi (Quoy and Gaimard, 1834)	21
Family Glaucidae	
Pteraeolidia ianthina (Angas, 1864)	9, 10, 15, 19, 28, 29
Family Haliotidae	
Haliotis asinina (Linnaeus, 1758)	2, 4, 8, 16, 19, 34, 35, 38
Haliotis glabra (Gmelin, 1791)	23
Haliotis ovina (Gmelin, 1791)	1, 2, 3, 17, 18, 24, 35
Haliotis planata (Sowerby, 1833)	4
Haliotis squamata (Reeve, 1846)	17
Haliotis varia (Linnaeus, 1758)	20
Family Haminoeidae	
Haminoeid sp.	4
Family Hipponicidae	
Hipponix conicus (Schumacher, 1817)	3, 10, 14, 15, 20
Family Littorinidae	
Littorina coccinea (Gmelin, 1791)	4, 10, 14
Littorina scabra (Linnaeus, 1758)	11, 37
Nodilittorina millegrana (Philippi, 1848)	1, 4, 14
Family Mitridae	
Cancilla filaris (Linnaeus, 1771)	8, 38
Cancilla praestantissima (Roding, 1798)	5
Imbricaria conovula (Quoy and Gaimard, 1833)	4, 7, 8
Imbricaria olivaeformis (Swainson, 1821)	22
Imbricaria punctata (Swainson, 1821)	23, 27
Mitra aurantia (Gmelin, 1791)	1, 14, 15, 17, 18, 20
Mitra aurora (Sowerby, 1874)	1
Mitra avenacea (Reeve, 1845)	12
Mitra chrysalis (Reeve, 1844)	27
Mitra coffea (Schubert and Wagner, 1829)	21
Mitra contracta (Swainson, 1820)	21, 29, 31, 35
Mitra coronata (Lamarck, 1811)	23
Mitra eremitarum (Roding, 1798)	12, 15, 21
Mitra fraga (Quoy and Gaimard, 1833)	2
Mitra luctuosa (A. Adams, 1853)	18, 23
Mitra lugubris (Swainson, 1821)	7, 34
Mitra paupercula (Linnaeus, 1758)	1, 24
Mitra rubritincta (Reeve, 1844)	7, 12
Mitra sp.	21
Mitra tabanula (Lamarck, 1811)	32
Mitra ticaonica (Reeve, 1844)	21
Neocancilla clathrus (Gmelin, 1791)	7

SPECIES	SITES
Neocancilla papilio (Link, 1807)	7
Pterygia crenulata (Gmelin, 1791)	21
Family Modulidae	
Modulus tectum (Gmelin, 1791)	1, 13, 15, 18, 24, 29, 32, 37
Family Muricidae	
Chicoreus axicornis (Lamarck, 1822)	5
Chicoreus brunneus (Link, 1810)	4, 8, 12, 13, 16, 17, 19, 21, 23, 32, 34, 38
Chicoreus microphyllus (Lamarck, 1816)	22
Chicoreus penchinati (Crosse, 1861)	1
Chicoreus rubiginosus (Reeve, 1845)	7, 21
Chicoreus trigonulus (Lamarck, 1816)	3
Homalocantha scorpio (Linnaeus, 1758)	12, 16, 19
Murex aduncospinosus (Beck, 1841)	11
Pterynotus barclayanus (A. Adams, 1873)	21, 24, 27, 29
Pterynotus bipinnatus (Reeve, 1845)	22
Family Nassariidae	
Hebra horrida (Dunker, 1847)	9
Nassarius albescens (Dunker, 1846)	1, 10, 12, 24
Nassarius arcularis (Linnaeus, 1758)	4
Nassarius coronatus (Bruguiere, 1789)	21
Nassarius dorsatus (Roding, 1798)	19
Nassarius glans (Linnaeus, 1758)	24
Nassarius papillosus (Linnaeus, 1758)	15
Nassarius pauperus (Gould, 1850)	10, 26
Nassarius vitiensis (Hombron and Jacquinot, 1853)	11
Family Naticidae	
Eunaticina papilla (Gmelin, 1791)	16
Globularia fluctuata (Sowerby, 1825)	9
Natica alapapilionis (Roding, 1798)	8
Natica euzona (Recluz, 1844)	24
Natica gualtieriana (Recluz, 1844)	14
Natica onca (Roding, 1798)	12, 16
Natica stellata (Hedley, 1913)	19
Polinices fibrosus (Souleyet, 1852)	30
Polinices melanostomus (Gmelin, 1791)	4, 8
Polinices sebae (Recluz, 1844)	8, 12, 32
Polinices sordidus (Swainson, 1821)	6
Polinices tumidus (Swainson, 1840)	1, 8, 12, 14, 26, 30
Family Neritidae	
Nerita albicilla (Linnaeus, 1758)	1, 4, 9, 10, 14, 17
Nerita balteata (Reeve, 1855)	37
Nerita costata (Gmelin, 1791)	4, 23
Nerita plicata (Linnaeus, 1758)	1, 21
Nerita polita (Linnaeus, 1758)	1, 10, 14
Nerita reticulata (Karsten, 1789)	13
Nerita undata (Linnaeus, 1758)	1, 4, 10, 14, 17, 27, 38
Family Olividae	
Oliva annulata (Gmelin, 1791)	1, 3, 4, 7, 8, 10, 12, 13, 15, 16, 21-23, 36
Oliva carneola (Gmelin, 1791)	5, 7, 8, 9, 12, 17, 24
Oliva oliva (Linnaeus, 1758)	9
Olivella sp. 1	8, 9, 30
Olivella sp. 2	15
Family Ovulidae	
Calpurnus lacteus (Lamarck, 1810)	22, 24

SPECIES	SITES
Calpurnus verrucosus (Linnaeus, 1758)	4, 8, 15
Ovula ovum (Linnaeus, 1758)	2, 8, 15, 17
Primovula pudica wilsoniana (Cate, 1973)	13
Family Patellidae	
Cellana grata (Gould, 1859)	23
Cellana rota (Gmelin, 1791)	23, 35
Patella flexuosa (Quoy and Gaimard, 1834)	1, 4, 14, 17
Patelloida saccharina (Linnaeus, 1758)	1, 4, 10, 14, 17
Patelloida striata (Quoy and Gaimard, 1834)	1, 4, 10, 14, 17
Family Phyllidiidae	
Phyllidia aff. *nobilis* (Bergh, 1869)	19, 23, 26, 31, 35
Phyllidia coelestis (Bergh, 1905)	7, 20
Phyllidia elegans (Bergh, 1869)	2, 3, 6, 22, 35
Phyllidia nobilis (Bergh, 1869)	9, 10, 16, 17, 19, 20, 23, 24
Phyllidia pustulosa (Cuvier, 1804)	1, 4
Phyllidia sp. 1	2, 10, 32
Phyllidia sp. 2	2, 4, 16, 17, 18, 20, 29
Phyllidia zeylanica (Kelaart, 1859)	6
Phyllidiopsis striata (Bergh, 1889)	10
Family Planaxidae	
Planaxis niger (Quoy and Gaimard, 1834)	21
Family Pleurobranchidae	
Pleurobranchus forsskali (Ruppell and Leuckart, 1828)	24
Pleurobranchus sp. 1	13
Pleurobranchus sp. 2	19
Family Polyceridae	
Nembrotha cf. *kubaryana* (Bergh, 1877)	17, 22
Nembrotha lineolata (Bergh, 1905)	6
Tambja affinis (Elliot, 1904)	6, 9, 10, 13, 14, 15, 17, 21, 22, 35, 36, 38
Tambja morosa (Bergh, 1877)	20
Family Pyramidellidae	
Otopleura auriscati (Holten, 1802)	5, 7
Otopleura glans (Reeve, 1843)	17
Pyramidella acus (Gmelin, 1791)	22
Pyramidella ventricosa (Guerin, 1831)	12
Family Ranellidae	
Cymatium gutturnium (Roding, 1798)	16
Cymatium hepaticum (Roding, 1798)	22
Cymatium labiosum (Wood, 1828)	7
Cymatium nicobaricum (Roding, 1798)	10
Cymatium pileare (Linnaeus, 1758)	33
Cymatium pyrum (Linnaeus, 1758)	4
Cymatium rubeculum (Linnaeus, 1758)	23, 35
Distorsio anus (Linnaeus, 1758)	10
Gyrineum bituberculare (Lamarck, 1816)	30
Gyrineum cf. *jucundum* (A. Adams, 1854)	9
Gyrineum gyrineum (Linnaeus, 1758)	3, 4, 7, 8, 16, 21, 22, 28, 29, 31-33, 35, 38
Linatella succincta (Linnaeus, 1771)	26
Septa vespacea (Lamarck, 1822)	1, 9
Family Rissoidae	
Rissoina reticulata (Sowerby, 1824)	22
Zebina gigantea (Deshayes, 1850)	7, 22

APPENDIX 3 Molluscs recorded during the RAP survey of the Calamianes Islands

SPECIES	SITES
Family Siliquariidae	
Siliquaria sp.	4
Family Stomatellidae	
Stomatella auricula (Lamarck, 1816)	20, 22
Stomatella papyracea (Gmelin, 1791)	22, 31, 34
Stomatella varia (Adams, 1850)	9, 17
Stomatia phymotis (Helbling, 1779)	10
Family Strombidae	
Lambis chiragra (Linnaeus, 1758)	2, 9, 13, 16, 18, 20, 29, 34, 35
Lambis lambis (Linnaeus, 1758)	1, 3-10, 12,14-16,18,19, 22, 24, 25, 27, 29-32, 34
Lambis millepedes (Linnaeus, 1758)	2, 6, 8, 9, 12, 24, 25, 27, 28, 29
Strombus aurisdianae (Linnaeus, 1758)	8
Strombus bulla (Roding, 1798)	8
Strombus canarium (Linnaeus, 1758)	5
Strombus dentatus (Linnaeus, 1758)	20, 22
Strombus dilatatus (Swainson, 1821)	5, 16, 30
Strombus fragilis (Roding, 1798)	31
Strombus gibberulus (Linnaeus, 1758)	38
Strombus lentiginosus (Linnaeus, 1758)	3, 9, 17, 24
Strombus luhuanus (Linnaeus, 1758)	1, 3-10, 14, 17, 27, 32, 33, 38
Strombus microurceus (Kira, 1959)	1, 6, 9, 10, 12, 22, 23, 24, 26, 32, 34
Strombus sinuatus (Humphrey, 1786)	20
Strombus terebellatus (Sowerby, 1842)	7
Strombus urseus (Linnaeus, 1758)	1, 2, 4-6, 8, 9, 12, 13, 19, 27, 33, 36, 37, 38
Terebellum terebellum (Linnaeus, 1758)	1, 3, 5, 9, 15, 18, 30, 31, 33, 37, 38
Family Terebridae	
Terebra affinis (Gray, 1834)	7, 10, 14, 16, 22, 24, 29
Terebra amanda (Hinds, 1844)	4, 7, 26
Terebra areolata (Link, 1807)	27
Terebra argus (Hinds, 1844)	29
Terebra babylonia (Lamarck, 1822)	27, 32
Terebra cumingi (Deshayes, 1857)	16, 17, 32
Terebra felina (Dillwyn, 1817)	10, 13
Terebra funiculata (Hinds, 1844)	12
Terebra guttata (Roding, 1798)	7, 22
Terebra jenningsi (Burch, 1965)	7
Terebra maculata (Linnaeus, 1758)	29
Terebra montgomeryi (Burch, 1965)	32
Terebra punctostriata (Gray, 1834)	1
Terebra quoygaimardi (Cernohorsky and Bratcher, 1976)	7
Terebra subulata (Linnaeus, 1767)	5
Terebra undulata (Gray, 1834)	13
Family Thaididae	
Cronia fenestrata (Blainville, 1832)	15
Cronia fiscella (Gmelin, 1791)	21
Cronia funiculus (Wood, 1828)	27, 32
Cronia margariticola (Spring) (Broderip, 1833)	10, 17, 26, 29, 32, 36
Drupa grossularia (Roding, 1798)	2, 3, 4, 13, 15-18, 20, 23, 24, 29, 30, 34, 36
Drupa morum (Roding, 1798)	22, 23, 35
Drupa ricinus (Linnaeus, 1758)	14, 16, 17, 18, 20, 22, 23, 30, 35
Drupa rubusidaeus (Roding, 1798)	3, 10, 14, 15, 16, 20, 22, 23, 30, 35
Drupella cariosa (Wood, 1828)	2, 8
Drupella cornus (Roding, 1798)	1-3, 7, 8, 10, 12, 14, 15,18,19, 20, 22, 24, 26-38
Drupella ochrostoma (Blainville, 1832)	2, 12, 13, 14, 15, 17, 21, 28

SPECIES	SITES
Drupella rugosa (Born, 1778)	4, 12, 15
Maculotriton serriale (Deshayes, 1831)	21, 32
Morula biconica (Blainville, 1832)	1, 14, 23
Morula granulata (Duclos, 1832)	1, 10
Morula nodicostata (Pease, 1868)	1, 14, 17
Morula parva (Reeve, 1846)	12, 23
Morula spinosa (Adams, 1855)	14, 17, 18, 21, 29, 30, 31, 34, 35
Morula uva (Roding, 1798)	3, 10, 17, 18, 23, 29, 30
Nassa francolina (Bruguiere, 1789)	15, 20
Pinaxia versicolor (Gray, 1839)	17
Purpura persica (Linnaeus, 1758)	23
Thais aculeata (Deshayes, 1844)	10, 27
Thais armigera (Link, 1807)	20
Thais kieneri (Deshayes, 1844)	30
Thais mancinella (Linnaeus, 1758)	20, 23, 27
Thais savignyi (Deshayes, 1844)	17
Thais sp.	4
Thais tuberosa (Roding, 1798)	18, 20
Vitularia milaris (Gmelin, 1791)	32, 36, 37
Family Tonnidae	
Malea pomum (Linnaeus, 1758)	9
Tonna allium (Dillwyn, 1817)	12
Tonna chinensis (Dillwyn, 1817)	22
Tonna galea (Linnaeus, 1758)	9
Tonna perdix (Linnaeus, 1758)	1
Tonna sp.	8
Family Triphoridae	
Triphora (pink lined)	21
Triphora sp. 1 (red)	17
Family Triviidae	
Trivia oryza (Lamarck, 1810)	2, 3, 13, 14, 15, 17, 18, 28, 31, 34
Family Trochidae	
Angaria delphinus (Linnaeus, 1758)	4, 8, 17, 20, 27
Cantharidus picturatus (Adams, 1851)	22, 31
Clanculus atropurpureus (Gould, 1849)	17, 22, 24, 30
Clanculus sp. 1	21
Clanculus sp. 2	15
Euchelus instrictus (Gould, 1849)	30, 31
Monilea nucleus (Philippi, 1849)	21
Tectus conus (Gmelin, 1791)	15, 17
Tectus fenestratus (Gmelin, 1790)	14, 17, 37
Tectus niloticus (Linnaeus, 1767)	8, 21, 27, 29, 31, 35
Tectus pyramis (Born, 1778)	1-3, 7-9, 12, 19, 21, 26-31, 34
Tectus triserialis (Lamarck, 1822)	4, 5
Trochus maculatus (Linnaeus, 1758)	14, 16, 17, 22, 26, 28, 32
Trochus sacellum rota (Dunker, 1962)	21, 37
Trochus stellatus (Gmelin, 1791)	21
Family Turbinidae	
Astraea haemotragum (Menke, 1829)	4, 18, 25, 26, 28, 31, 34, 35
Astralium calcar (Linnaeus, 1758)	8, 9, 24, 34, 38
Bolma erectospinosa (Habe and Okutani, 1980)	22
Bolma persica (Dall, 1907)	17
Monodonta callifera (Lamarck, 1816)	4, 10
Monodonta labio (Linnaeus, 1758)	9, 11, 14, 16, 17

APPENDIX 3 Molluscs recorded during the RAP survey of the Calamianes Islands

SPECIES	SITES
Phasianella aff. *solida* (Born, 1778)	21
Phasianella modesta (Gould, 1861)	24
Turbo argyrostomus (Linnaeus, 1758)	1, 2, 15, 16, 18, 19, 25, 27, 38
Turbo bruneus (Roding, 1798)	22
Turbo chrysostoma (Linnaeus, 1758)	4, 6,12, 15, 17,18, 20, 23, 24, 29-31, 34, 35, 38
Turbo cinereus (Born, 1778)	19, 36
Turbo petholatus (Linnaeus, 1758)	1, 2, 3, 5, 6, 7, 8, 9, 21, 22, 26, 28, 32, 34
Family Turridae	
Clavus lamberti (Montrouzier, 1860)	8
Clavus sp. 1	9
Clavus sp. 2	29
Clavus unizonalis (Lamarck, 1822)	22
Gemmula sp.	36
Lophiotoma acuta (Perry, 1811)	5
Turridrupa astricta consorbrina (Powell, 1967)	15, 21
Turridrupa bijubata (Reeve, 1843)	8
Turridrupa cerithina (Anton, 1839)	22, 27
Turris babylonia (Linnaeus, 1758)	12
Xenoturris cingulifera (Lamarck, 1822)	1, 7, 38
Family Turritellidae	
Archimediella sp.	1, 4, 19, 26, 32, 36
Family Vanikoridae	
Vanikoro cancellata (Lamarck, 1822)	12, 20, 21, 29, 30
Vanikoro helicoidea (Le Guillou, 1842)	32
Family Vasidae	
Vasum ceramicum (Linnaeus, 1758)	14, 18, 20, 22, 23, 32, 36
Vasum turbinellus (Linnaeus, 1758)	1-3, 8-10, 13, 16, 17, 18, 23, 29, 30, 34, 35
Family Vermetidae	
Serpulorbis colubrina (Roding, 1798)	1, 4, 9, 10, 13
Family Volutidae	
Cymbiola rutila (Broderip, 1826)	14, 15
Cymbiola vespertilio (Linnaeus, 1758)	10, 19, 36
CLASS POLYPLACOPHORA	
Family Chitonidae	
Acanthopleura gemmata (Blainville, 1825)	1, 4
Chiton sp. 1	13, 22
Chiton sp. 2	23
Family Cryptoplacidae	
Cryptoplax larvaeformis (Quoy and Gaimard, 1835)	32
Cryptoplax sp.	7, 25
Family Ischnochitonidae	
Ischnochiton sp. 1	14
Ischnochiton sp. 2	18
CLASS PULMONATA	
Family Onchidiidae	
Onchidium sp.	17, 21
Family Siphonariidae	
Siphonaria javanica (Lamarck, 1819)	4, 17
CLASS SCAPHOPODA	
Family Dentaliidae	
Antalis sp.	12
Dentalium sp.	13

Reef fishes recorded during the RAP survey of the Calamianes Islands (compiled by G. R. Allen).

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
DASYATIDIDAE			
Dasyatis kuhlii (Müller and Henle, 1841)	2, 4, 15, 17, 20, 28	Occasional.	2-50
Taeniura lymma (Forsskål, 1775)	30	Rare, a single individual sighted.	2-30
MOBULIDAE			
Manta birostris (Walbaum, 1792)	3, 20	Rare, two seen on the surface.	0-100
MORINGUIDAE			
Moringua microchir Bleeker, 1853	17	A single specimen collected with rotenone.	3-20
MURAENIDAE			
Echidna nebulosa (Thunberg, 1789)	14	Several small juveniles collected with rotenone.	1-10
Gymnothorax fimbriatus (Bennett, 1831)	14	A single specimen collected with rotenone.	0-30
Gymnothorax javanicus (Bleeker, 1865)	10, 24	Rare, only two adults seen.	0.5-50
Gymnothorax meleagris (Shaw and Nodder, 1795)	10	Rare, one individual seen.	1-40
Gymnothorax sp. 1	21	A single specimen collected with rotenone.	0-3
Gymnothorax sp. 2	34	A single specimen collected with rotenone.	10-20
Rhinomuraena quaesita Garman, 1888	35	Rare, one individual seen.	1-50
OPHICHTHIDAE			
Muraenichthys gymnotus Bleeker, 1864	17	A single specimen collected with rotenone.	0-5
Ophichthus sp.	21	One individual sighted with its head protruding from the sand.	10
CONGRIDAE			
Gorgasia sp.	10	Colony containing about 100 fish seen.	15-35
CLUPEIDAE			
Spratelloides gracilis (Temminck and Schlegel, 1846)	2-4, 7, 12, 14, 17	Abundant at several sites.	0-4
PLOTOSIDAE			
Plotosus lineatus (Thunberg, 1787)	2, 7, 10, 12, 22, 23, 26, 30, 32	Schools of juveniles occasionally seen.	1-20
SYNODONTIDAE			
Saurida gracilis (Quoy and Gaimard, 1824)	4, 6	Rare, only two seen.	1-135
Synodus dermatogenys Fowler, 1912	1, 3, 4, 6-8, 10, 12-15, 17-20, 22, 23, 25, 26, 28, 31-35, 38	Moderately common.	1-25
Synodus variegatus (Lacepède, 1803)	2, 3, 7, 9, 10, 24, 27, 30, 32, 33	Moderately common.	5-50
BYTHITIDAE			
Brosmophyciops pautzkei Schultz, 1960	34	A single specimen collected with rotenone.	5-55
Ogilbia sp.	17	Two specimens collected with rotenone.	0-5

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
ANTENNARIIDAE			
Antennarius dorehensis Bleeker, 1859	14	A single specimen collected with rotenone.	1-3
Histiophryne cryptacanthus (Weber, 1913)	27	A single specimen of this rare and unusual fish collected with rotenone.	1-30
GOBIESOCIDAE			
Diademichthys lineatus (Sauvage, 1883)	5, 16, 19	Rare, only three individuals seen.	3-20
ATHERINIDAE			
Hypoatherina temminckii (Bleeker, 1853)	14, 37	Common next to mangroves at Site 37.	0-1
PHALLOSTETHIDAE			
Neostethus borneensis Herre, 1939	37	Common among mangroves at one site.	surface waters
BELONIDAE			
Strongylura leiura (Bleeker, 1850)	9, 21, 36, 38	Occasional, several schools containing up to about 30 individuals seen.	surface swimmer
Tylosurus crocodilus (Lesuer, 1821)	1, 4, 6, 17, 22, 38	Occasional.	surface waters
HEMIRAMPHIDAE			
Hemirhamphus far (Forsskål, 1775)	22, 38	A school of 300-400 fish seen at site 22, otherwise rarely seen.	surface swimmer
Hyporhamphus dussumieri (Valenciennes, 1846)	5, 24	Occasional.	surface swimmer
Zenarchopterus dispar (Valenciennes, 1847)	26, 33, 37-39	Occasional on edge of mangroves or in brackish water.	0-2
HOLOCENTRIDAE			
Myripristis berndti Jordan and Evermann, 1902	20	Rare, about five seen.	8-55
Myripristis hexagona (Lacepède, 1802)	2-4, 17, 20-22, 24, 25, 28, 30, 31	Occasional.	10-40
Myripristis kuntee Valenciennes, 1831	1, 2, 14, 20-22, 29	Occasional.	5-30
Myripristis murdjan (Forsskål, 1775)	1, 17, 20, 22-24, 30, 31, 34	Occasional.	3-40
Myripristis violacea Bleeker, 1851	2, 7, 8, 10, 13-17, 20, 23, 27, 30, 31	Occasional.	3-30
Neoniphon opercularis (Valenciennes, 1831)	14	Rare, only five seen.	3-20
Neoniphon sammara (Forsskål, 1775)	1-3, 8, 10, 14, 29	Occasional.	2-50
Sargocentron caudimaculatum (Rüppell, 1835)	20	Rare, only one seen.	6-45
Sargocentron cornutum (Bleeker, 1853)	1, 14, 17, 22	Occasional.	6-50
Sargocentron diadema (Lacepède, 1802)	1	Rare, only one seen.	2-30
Sargocentron melanospilos (Bleeker, 1858)	1, 10, 13, 18, 34	Occasional.	3-18
Sargocentron rubrum (Forsskål, 1775)	12, 18, 21, 24, 30, 31, 33, 34	Occasional.	0-40
Sargocentron spiniferum (Forsskål, 1775)	4, 7-10, 22, 23, 31, 32, 34	Occasional.	5-122
AULOSTOMIDAE			
Aulostomus chinensis (Linnaeus, 1766)	1-4, 7, 10, 17, 20, 28		2-122

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
FISTULARIIDAE			
Fistularia commersoni Rüppell, 1835	9, 38	Rare, only two seen.	2-128
CENTRISCIDAE			
Aeoliscus strigatus (Günther, 1860)	4, 21	Rare, only about 10 seen on all dives.	1-30
Centriscus scutatus Linnaeus, 1758	27, 38	Two schools sighted, each containing 20-50 fish.	3-80
SYNGNATHIDAE			
Acentronura tentaculata Günther, 1870	12	A single specimen collected by hand.	2-12
Corythoichthys intestinalis (Ramsay, 1881)	26	Rare, one pair sighted.	1-25
Corythoichthys ocellatus Herald, 1953	32, 33	Rare, only five seen.	2-30
Doryrhamphus dactyliophorus (Bleeker, 1853)	19, 21	Rare, two individuals seen.	1-56
Hippocampus sp.	12	Rare, one specimen collected by hand.	2-10
Trachyrhamphus bicoarctata (Bleeker, 1857)	30	Rare, a single specimen captured with dip net during night dive.	1-15
SCORPAENIDAE			
Dendrochirus zebra (Cuvier, 1829)	8, 19, 24, 27, 29	Occasional.	1-20
Parascorpaena picta (Cuvier, 1829)	17, 31	Two specimens collected with rotenone.	0-15
Pterois antennata (Bloch, 1787)	4, 6, 10, 20, 21	Occasional and always in small numbers.	1-50
Pterois volitans (Linnaeus, 1758)	1, 8, 9, 25, 28-30, 32, 37, 38	Occasional and always in small numbers.	2-50
Scorpaenopsis oxycephala (Bleeker, 1849)	28	Rare, only one seen, but very difficult to detect.	1-40
Synanceja verrucosa Bloch and Schneider, 1801	14	One specimen collected with rotenone.	1-15
SYNANCEIIDAE			
Synanceja verrucosa Bloch and Schneider, 1801	14	One specimen collected with rotenone.	1-15
PLATYCEPHALIDAE			
Cymbacephalus beauforti Knapp, 1973	19	Rare, only one seen.	2-12
CENTROPOMIDAE			
Psammoperca waigiensis (Cuvier, 1828)	15	Rare, a single fish sighted.	2-20
SERRANIDAE			
Aethaloperca rogaa (Forsskål, 1775)	7, 10	Rare, only two seen.	1-55
Anyperodon leucogrammicus (Valenciennes, 1828)	5, 6, 8, 19, 26	Occasional.	5-50
Cephalopholis boenack (Bloch, 1790)	2, 4, 8, 9, 16, 18, 21-23, 26-38	Moderately common.	1-20
Cephalopholis cyanostigma (Kuhl and Van Hasselt, 1828)	1, 2, 4, 7, 10, 14, 22, 24, 26, 28, 34, 35, 38	Occasional.	2-35
Cephalopholis microprion (Bleeker, 1852)	4-6, 8, 10, 12, 14, 19, 22, 25-27, 31-34, 36-38	Moderately common.	2-20

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
Cephalopholis miniata (Forsskål, 1775)	7	Rare, only one seen.	[illegible]-150
Cephalopholis urodeta (Schneider, 1801)	9, 10	Rare, only two seen.	[illegible]
Cromileptes altivelis (Valenciennes, 1828)	28, 30, 31	Rare, less than six juvenile fish sighted.	2-40
Diploprion bifasciatum Cuvier, 1828	4, 6-10, 17-22, 26-32, 35-37	Common.	2-25
Epinephelus areolatus (Forsskål, 1775)	22, 30	Rare, only two seen.	6-200
Epinephelus corallicola (Kuhl and Van Hasselt, 1828)	7	Rare, only one seen.	3-15
Epinephelus fasciatus (Forsskål, 1775)	3, 9, 10, 13, 18, 20, 23, 24, 26	Occasional.	4-160
Epinephelus hexagonatus (Bloch and Schneider, 1801)	9, 10, 17, 20, 22	Rare, less than 10 seen.	3-10
Epinephelus merra Bloch, 1793	2, 3, 6, 10, 12, 13, 16, 17, 20, 22, 29	Occasional.	[illegible]
Epinephelus ongus (Bloch, 1790)	2, 4, 14, 16, 38	Rare, less than 10 seen.	[illegible]
Epinephelus spilotoceps Schultz, 1953	13	Rare, only one seen.	3-30
Epinephelus undulosus (Quoy and Gaimard, 1824)	30	Rare, a single adult seen during night div[illegible]	0-90
Grammistes sexlineatus (Thunberg, 1792)	20, 23	Rare, only two seen.	05-30
Plectropomus leopardus (Lacepède, 1802)	4, 6-8, 13-15, 17, 20, 21, 23-31, 34, 35	Moderately common, but only juveniles seen.	3-100
Plectropomus maculatus (Bloch, 1790)	1, 2, 16, 28, 37	Occasional, only juveniles seen.	2-30
Plectropomus oligocanthus (Bleeker, 1854)	3-5, 26	Rare, less than 10 seen.	4-40
Pseudanthias huchtii (Bleeker, 1857)	1, 2, 4, 7-10, 13, 14, 16, 20, 21, 23, 29, 31, 34, 35	Moderately common.	4-20
Pseudanthias hutomoi Allen, 1976	26	Rare, an aggregation of about 10 fish seen.	30-60
Pseudanthias hypselosoma Bleeker, 1878	[illegible]	Rare, only a few juveniles seen.	10-40
Pseudanthias pleurotaenia (Bleeker, 1857)	31	Rare, a solitary juvenile seen.	15-180
Pseudanthias squamipinnis (Peters, 1855)	20	Rare, an aggregation with about 10 fish seen	4-20
Pseudanthias tuka (Herre and Montalban, 1927)	2	Rare, several adults seen.	8-25
CIRRHITIDAE			
Amblycirrhitus bimacula (Jenkins [illegible]	[illegible]	[illegible] only one seen.	2-15
Cirrhitichthys falco Randall, 1963	23	[illegible] only one seen.	4-45
Cirrhitus pinnulatus (Schneider, 1801)	10, 13, 20, 21, 29	Rare.	0-3
Paracirrhites arcatus (Cuvier, 1829)	1-3, 9, 10	Rare.	1-35
Paracirrhites forsteri (Schneider, 1801)	3, 10	Rare.	1-35
PSEUDOCHROMIDAE			
Labracinus atrofasciatus (Herre, 1933)	19, 27	An extremely rare species known only from the holotype collected at Culion Island; about 10 individuals sighted during survey, primarily at site 19.	1-4

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
Labracinus cyclophthalmus (Müller and Troschel, 1849)	2, 7, 8, 13-15, 17-24, 26, 29-31, 38	Moderately common.	1-25
Pseudochromis bitaeniatus (Fowler, 1931)	1, 3, 4, 8, 17, 34	Occasional.	5-30
Pseudochromis cyanotaenia Bleeker, 1857	20	Rarely seen, but cryptic.	3-20
Pseudochromis diadema Lubbock and Randall, 1978	1-4, 8-10, 16, 17, 22-24, 26, 28-32, 34, 36-38	Moderately common around ledges at the base of slopes.	10-30
Pseudochromis fuscus (Müller and Troschel, 1849)	1, 2, 4-9, 12, 14, 16, 17, 21-25, 27, 30-35	Moderately common.	1-30
Pseudochromis moorei Fowler, 1931	2, 8	Rare, only two seen.	10-40
Pseudochromis perspicillatus Günther, 1862	5, 12, 16, 22, 30, 33	Occasional.	3-20
Pseudochromis ransonneti Steindachner, 1870	19, 28, 36, 38	Rare.	3-25
Pseudochromis sp. 1	18-22, 27-31, 36, 38	An undescribed species known only from the Calamianes Islands and the northwest tip of Panay Island. Common in rubble habitats below 20 m depth on the west side of the Calamianes.	15-40
Pseudochromis sp. 2	24	A single juvenile seen.	5-25
Pseudochromis tapeinosoma Bleeker, 1853	17	Several collected with rotenone.	0-8
Pseudoplesiops annae (Weber, 1913)	21, 34	Several collected with rotenone.	4-25
Pseudoplesiops knighti Allen, 1987	21	Several collected with rotenone.	5-35
PLESIOPIDAE			
Calloplesiops altivelis (Steindachner, 1903)	14, 19	Rare, only two seen.	3-45
Plesiops coeruleolineatus Rüppell, 1835	14, 17, 34	Several collected with rotenone.	1-12
OPISTOGNATHIDAE			
Opistognathus dendriticus (Jordan and Richardson, 1908)	2, 6-8, 14, 16, 17, 29, 30, 34	Occasional.	0-40
Opistognathus sp. 1	2, 3, 36	Rare.	10-30
Opistognathus sp. 2	19	Rare, only one seen.	10-30
PRICANTHIDAE			
Priacanthus hamrur (Forsskål, 1775)	7	Rare, only three seen.	5-80
APOGONIDAE			
Apogon bandanensis Bleeker, 1854	8, 16, 21, 26, 33, 36, 38	Occasional, but locally common.	3-10
Apogon cavitiensis (Jordan and Evermann, 1907)	19, 38	Rare, only a few seen.	2-25
Apogon ceramensis Bleeker, 1852	37	Moderately common in mangrove habitat at one site.	0-2
Apogon chrysopomus Bleeker, 1854	12, 14, 29-31, 36-38	Moderately common.	1-18
Apogon compressus (Smith and Radcliffe, 1911)	2, 5, 12, 14, 19, 21, 26, 27, 29, 31-33, 36-38	Occasional, but locally common.	2-20

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
Apogon cookii Macleay, 1881	14, 17, 29, 31	Several specimens collected with rotenone.	1-8
Apogon crassiceps Garman, 1903	17	Several specimens collected with rotenone.	0-15
Apogon doryssa (Jordan and Seale, 1906)	34	Several specimens collected with rotenone.	5-20
Apogon endektaenia Bleeker, 1852	28	Rare, about five seen.	3-30
Apogon exostigma Jordan and Starks, 1906	1, 4	Rare.	3-25
Apogon fleurieu (Lacepède, 1802)	7-9, 22, 31	Moderately common at some sites, but usually juveniles seen.	5-30
Apogon fraenatus Valenciennes, 1832	4, 7-9, 12, 15, 30, 32	Occasional.	3-35
Apogon fragilis Smith, 1961	5, 8, 12, 16, 24, 30	Occasional.	1-15
Apogon franssedai Allen, Kuiter, and Randall,1995	38	Rare, two specimens collected with multi-prong spear.	13-40
Apogon griffini (Seale, 1910)	28-30	Rare, about 10 seen.	1-4
Apogon guamensis Valenciennes, 1832	14, 17, 29	Several specimens collected with rotenone.	0-8
Apogon hartzfeldi Bleeker, 1852	24	Rare, only four seen.	1-10
Apogon hoeveni Bleeker, 1854	15, 21, 30	Occasional, but locally common in sand-rubble habitat at three sites. Mainly juveniles seen.	1-25
Apogon kallopterus Bleeker, 1856	1, 10, 30	Rare.	3-35
Apogon kiensis Jordon and Snyder, 1901	21	Rare.	5-35
Apogon lateralis Valenciennes, 1832	33	Rare.	05-2
Apogon leptacanthus Bleeker, 1856	5, 26	Occasional among branching corals.	1-12
Apogon margaritophorus Bleeker, 1854	32, 38	Occasional, close to shore among Sargassum clumps.	1-4
Apogon moluccensis Valenciennes, 1832	38	Rare.	3-35
Apogon multilineatus Bleeker, 1865	17	Several specimens collected with rotenone.	1-5
Apogon nanus Allen, Kuiter, and Randall, 1994	19, 21, 27, 28, 30, 33	Occasional, but locally common.	5-20
Apogon neotes Allen, Kuiter, and Randall, 1994	2, 4-6, 12, 15, 18, 24, 25, 27, 28, 32, 33, 36-38	Moderately common.	10-25
Apogon uninotatus Smith and Radcliffe, 1912		About five fish (approximately 4 cm SL) tentatively identified as the juvenile of species seen along the edge of Lake Cayangan.	1-30
Apogon nigrofasciatus Schultz, 1953	31	Rare, only one seen.	2-35
Apogon ocellicaudus Allen, Kuiter, and Randall, 1994	4	Rare, a group of about 10 seen.	11-55
Apogon parvulus (Smith and Radcliffe, 1912)	1, 5, 8, 12, 14-16, 21, 26-28, 30-33	Occasional, but locally common.	4-20
Apogon sangiensis Bleeker, 1857	24, 33, 37	Occasional, usually near or among seagrass.	05-15
Apogon sealei (Fowler, 1918)	4, 12, 15, 16, 26, 30	Occasional.	3-12

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
Apogon selas Randall and Hayashi, 1990	4, 7, 13, 16, 21, 22, 25, 28, 30, 32-34, 37, 38	Moderately common.	20-35
Apogon sp. 1	32, 33, 36-38	Occasional.	2-5
Apogon sp. 2	21	Rare, two specimens collected with rotenone.	12-25
Apogon taeniophorus Regan, 1908	17	Several specimens collected with rotenone.	05-2
Apogon timorensis Bleeker, 1873	17	Several specimens collected with rotenone.	0-4
Apogon trimaculatus Cuvier, 1828	1, 6, 14, 17, 18, 21, 23, 26, 30	Occasional.	2-10
Apogon ventrifasciatus Allen, Kuiter, and Randall, 1994	12, 15	Rare.	5-35
Apogon wassinki Bleeker, 1860	4, 7-9, 12, 15, 16, 21-24, 26, 28, 30-32, 34	Occasional.	3-40
Archamia biguttata Lachner, 1951	12, 31	Occasional.	5-18
Archamia fucata (Cantor, 1850)	4, 7, 12, 14, 16, 26, 27, 29, 34, 37, 38	Occasional, but locally common.	3-60
Archamia macropterus (Cuvier, 1828)	12	Rare.	3-15
Archamia zosterophora (Bleeker, 1858)	5, 7, 8, 12, 14, 16, 21, 26, 27, 29, 32, 33, 38	Occasional, but sometimes seen in large numbers sheltering among branching corals.	2-15
Cheilodipterus alleni Gon, 1993	1, 4, 21, 31	Rare.	1-25
Cheilodipterus artus Smith, 1961	4-6, 14-16, 21, 22, 24, 26, 28, 29, 31, 32, 38	Moderately common.	3-15
Cheilodipterus macrodon Lacepède, 1801	2-4, 8, 10, 12-15, 17, 18, 20, 22-24, 26, 28-32, 34, 36-38	Moderately common.	4-30
Cheilodipterus quinquelineatus Cuvier, 1828	1-10, 12-19, 21, 23-34, 36-38	Common, the most abundant species of cardinalfish in the Calamian Group; also present in Lake Cayangan.	1-40
Cheilodipterus singapurensis Bleeker, 1859	30	Rare, only one seen next to mangroves.	2-15
Cheilodipterus zonatus Smith and Radcliffe, 1912	4, 5, 7, 14, 19, 21, 24, 26, 28, 31-34, 36-38	Moderately common.	2-12
Foa brachygramma (Jenkins, 1903)	24	Rare, only one seen.	05-10
Fowleria aurita (Valenciennes, 1831)	27	Several specimens collected with rotenone.	0-15
Gymnapogon philippinus (Herre, 1939)	17	Two specimens collected with rotenone.	1-15
Pseudamia gelatinosa Smith, 1955	21	Several specimens collected with rotenone.	1-40
Pseudamia hayashi Randall, Lachner and Fraser, 1985	21	Several specimens collected with rotenone.	2-64
Rhabdamia gracilis (Bleeker, 1856)	4, 5, 8, 9, 14-16, 21, 37	Occasional.	5-20
Siphamia elongata Lachner, 1953	37, 38	Occasional.	5-35

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
Siphamia versicolor (Smith and Radcliffe, 1911)	29	Common at one site among spines of *Asthenosoma varium*.	5-35
Sphaeramia nematoptera (Bleeker, 1856)	5, 26, 27, 33, 36, 37	Occasional, but locally common, especially at sites 36-37.	1-8
Sphaeramia orbicularis (Cuvier, 1828)	33, 37, 38	Occasional among mangrove roots; common at site 37.	0-3
ECHENEIDAE			
Echeneis naucrates Linnaeus, 1758	30	Rare, only one seen.	0-30
CARANGIDAE			
Atule mate (Cuvier, 1833)	21	A school containing about 200 adults sighted.	2-50
Carangoides bajad (Forsskål, 1775)	8, 12, 20	Rare, and only small fish seen.	5-30
Carangoides ferdau (Forsskål, 1775)	8	One school containing six fish sighted.	2-40
Carangoides orthogrammus (Jordan and Gilbert, 1882)	3, 26	Two adults seen.	3-168
Carangoides plagiotaenia Bleeker, 1857	3, 4, 6, 8, 14, 26, 33, 36	Occasional, usually half-grown fish encountered.	5-200
Caranx ignobilis (Forsskål, 1775)	9	One sighted, about 100 cm length; the largest fish seen during the survey, except for manta rays.	2-80
Caranx melampygus Cuvier, 1833	17	Rare, only two adults seen.	1-190
Selar crumenophthalmus (Bloch, 1793)	26	A single school containing over 1000 half-grown fish seen.	1-170
LEIOGNATHIDAE			
Leiognathus sp.	37	Several juveniles of an undetermined species sighted in 20 depth.	1-25
LUTJANIDAE			
Aprion virescens Valenciennes, 1830	3	Rare, a single adult seen.	2-100
Lutjanus biguttatus (Valenciennes, 1830)	3-6, 8, 17, 21, 22, 24-30, 36-38	Moderately common.	3-40
Lutjanus bohar (Forsskål, 1775)	10, 12, 14	Rare, three juveniles seen.	4-180
Lutjanus carponotatus (Richardson, 1842)	6-8, 16-20, 23-30, 32, 35-38	Moderately common.	2-35
Lutjanus decussatus (Cuvier, 1828)	2-4, 6, 7, 9, 10, 12-19, 21-24, 26-38	Moderately common.	5-30
Lutjanus fulviflamma (Forsskål, 1775)	4, 7-9, 14, 15, 18, 21-24, 29, 30	Occasional.	1-35
Lutjanus fulvus (Schneider, 1801)	15	Rare, one adult seen.	2-40
Lutjanus gibbus (Forsskål, 1775)	24	Rare, one adult seen.	6-40
Lutjanus monostigma (Cuvier, 1828)	3, 13, 38	Rare, about six seen.	5-60
Lutjanus quinquelineatus (Bloch, 1790)	4, 8, 12, 21	Occasional, but locally common, although only small individuals seen.	5-30
Lutjanus rivulatus (Cuvier, 1828)	14	Rare, only one seen.	2-100
Lutjanus rufolineatus (Valenciennes, 1830)	13	Rarely seen, but aggregation of about 30 fish seen at one site.	12-50

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
Lutjanus russelli (Bleeker, 1849)	21, 30, 34, 37	Occasional.	1-80
Lutjanus vitta (Quoy and Gaimard, 1824)	33	Rare, only one seen.	8-40
Macolor macularis Fowler, 1931	2-4, 7, 9, 10, 14, 31	Occasional.	3-50
Symphorus nematophorus (Bleeker, 1860)	32	Rare, only one seen.	5-50
CAESIONIDAE			
Caesio caerulaurea Lacepède, 1802	8, 10, 14, 24, 28, 36	Occasional, but sometimes locally common; usually juveniles seen.	1-30
Caesio cuning (Bloch, 1791)	3-8, 12-16, 19-21, 23-32, 35-38	Common, usually seen in schools.	1-30
Caesio lunaris Cuvier, 1830	4	Rare, only a few juveniles seen.	1-35
Caesio teres Seale, 1906	9, 10	Occasional, two schools sighted.	1-40
Pterocaesio chrysozonus (Cuvier, 1830)	20	A single school with about 30 individuals encountered.	5-40
Pterocaesio digramma (Bleeker, 1865)	6, 20, 30, 31, 34, 35, 38	Occasional, but locally common.	1-25
Pterocaesio marri Schultz, 1953	1-3, 7, 10, 20	Occasional, but locally common.	1-35
Pterocaesio pisang (Bleeker, 1853)	4, 10	Two schools encountered.	1-35
Pterocaesio randalli Carpenter, 1987	38	Rare, several juveniles seen in 35 m depth.	5-35
Pterocaesio tessellata Carpenter, 1987	22	Rare, several seen at one site.	1-35
Pterocaesio tile (Cuvier, 1830)	1, 10, 20, 30	Occasional, four schools seen.	1-60
Pterocaesio trilineata Carpenter, 1987	10	A single school with about 20-30 fish seen.	1-30
GERREIDAE			
Gerres argyreus (Schneider, 1801)	32, 37	Occasional on sand bottoms.	0-5
Gerres oyena (Forsskål, 1775)	9	Rare, only three seen.	0-10
HAEMULIDAE			
Diagramma sp.	8, 12, 15-17, 36	Occasional.	4-30
Plectorhinchus chaetodontoides (Lacepède, 1800)	2, 10, 14, 15, 19, 21, 31	Occasional.	1-40
Plectorhinchus lessoni (Cuvier, 1830)	7, 8, 14, 22, 30, 31, 38	Occasional.	5-35
Plectorhinchus lineatus (Linnaeus, 1758)	7, 10, 14, 28	Rare, only five seen.	2-40
Plectorhinchus orientalis (Bloch, 1793)	14, 30	Rare, only two seen.	3-30
Plectorhinchus polytaenia (Bleeker, 1852)	28, 38	Rare, only two seen.	8-45
LETHRINIDAE			
Gnathodentex aurolineatus Lacepède, 1802	1, 14	Occasional, one aggregation containing 30-40 fish seen at Site 14.	1-30
Gymnocranius griseus (Schlegel, 1844)	1, 10, 30	Rare.	10-80
Lethrinus atkinsoni Seale, 1909	10, 16, 18, 19, 21, 30, 32, 37	Occasional, mainly juveniles seen.	3-15

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
Lethrinus erythracanthus Valenciennes, 1830	2	Rare, only one seen.	15-120
Lethrinus erythropterus Valenciennes, 1830	4-6, 8, 14, 18, 19, 21, 23, 25, 26, 28, 32, 36-38	Moderately common.	2-30
Lethrinus harak (Forsskål, 1775)	5, 6, 8, 9, 18, 24, 27, 33	Occasional.	1-20
Lethrinus microdon Valenciennes, 1830	16	Rare, only two seen.	5-0
Lethrinus obsoletus (Forsskål, 1775)	8, 15, 16, 38	Occasional.	2-30
Lethrinus ornatus Valenciennes, 1830	17, 32	Rare, less than five seen.	3-20
Lethrinus variegatus Valenciennes, 1830	8	Rare, but its habitat (sand-weed) not properly surveyed.	1-10
Monotaxis grandoculis (Forsskål, 1775)	1, 4, 6-9	Occasional.	1-100
NEMIPTERIDAE			
Pentapodus bifasciatus (Bleeker, 1848)	16, 19, 21, 32, 36-38	Occasional and always in small numbers.	2-12
Pentapodus setosus (Valenciennes, 1830)	1, 10, 22, 24, 28, 29	Occasional and always in small numbers.	2-40
Pentapodus sp. (see Russell, 1990, page 91)	1-4, 6, 7, 12-14, 17, 18, 22, 23, 29-31, 34-36	Moderately common.	3-25
Pentapodus trivittatus (Bloch, 1791)	1, 2, 5-7, 9, 10, 12-24, 26-34, 36-38	Moderately common.	1-15
Scolopsis affinis Peters, 1876	2, 4, 8-10, 15, 17-19, 22, 24, 26, 29-31, 38	Moderately common in sand-rubble environment.	3-60
Scolopsis bilineatus (Bloch, 1793)	1-10, 12-38	Common.	2-20
Scolopsis ciliatus (Lacepède, 1802)	4, 8, 12, 14-19, 21, 22, 24, 26-30, 32-34, 36-38	Common on silted reefs.	1-30
Scolopsis lineatus Quoy and Gaimard, 1824	1-3, 6, 9, 14-18, 22-24, 26, 28-31, 34	Common in very shallow water near shore in areas exposed to moderate surge.	0-10
Scolopsis margaritifer (Cuvier, 1830)	1-3, 5-8, 13, 14, 16-22, 24-30, 35-38	Common.	2-20
Scolopsis monogramma (Kuhl and Van Hasselt, 1830)	12, 15, 17, 24, 28, 30, 36	Occasional.	5-50
Scolopsis xenochrous (Günther, 1792)	17, 35	Occasional on mainly rubble bottoms, usually below 20 m depth.	5-50
MULLIDAE			
Mulloidichthys flavolineatus (Lacepède, 1802)	4, 6, 8, 12, 15, 16, 22, 32, 38	Occasional.	1-40
Mulloidichthys vanicolensis (Valenciennes, 1831)	13	Rare, only two seen.	1-113
Parupeneus barberinoides (Lacepède, 1801)	1, 2, 7, 14, 24, 28, 29, 32, 33, 38	Occasional, except relatively common at site 28.	1-20
Parupeneus barberinus (Lacepède, 1801)	1-7, 10, 13, 14, 16, 18, 20-22, 24, 26-32, 34, 35, 38	Moderately common.	1-100

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
Parupeneus bifasciatus (Lacepède, 1801)	2, 3, 9, 10, 22-24, 30, 31, 35	Occasional.	1-80
Parupeneus cyclostomus (Lacepède, 1802)	1-3, 8, 10, 13, 15, 16, 18, 20, 22, 29-31, 35	Occasional.	2-92
Parupeneus heptacanthus (Lacepède, 1801)	2, 21, 22, 24, 30, 31	Occasional.	1-60
Parupeneus indicus (Shaw, 1803)	8, 32, 38	Rare, about 10 seen.	1-20
Parupeneus multifasciatus Bleeker, 1873	1-10, 12-27, 29-36	Common.	1-140
Parupeneus pleurostigma (Bennett, 1830)	1-3, 9, 10	Occasional.	5-46
Upeneus tragula Richardson, 1846	4, 5, 8, 12, 16, 19, 21, 22, 28, 29, 32, 33, 36	Occasional.	0-30
PEMPHERIDAE			
Parapriacanthus ransonneti Steindachner, 1870	22	One aggregation of about 50 fish seen.	5-30
Pempheris oualensis Cuvier, 1831	3, 8, 10, 14, 16, 17, 20-22, 24, 29, 30, 31	Moderately common.	3-38
Pempheris vanicolensis Cuvier, 1831	1	Rarely seen, but probably more common; hides in crevices and caves during the day.	3-25
TOXOTIDAE			
Toxotes jaculatrix (Pallas, 1767)		Several seen in front of Bayside Divers Lodge at Coron.	0-2
KYPHOSIDAE			
Kyphosus bigibbus Lacepède, 1801	30	Rare, only one fish positively identified.	2-12
Kyphosus vaigiensis (Quoy and Gaimard, 1825)	13, 15, 18, 21-23, 29	Occasional in shallow water near shore.	1-20
CHAETODONTIDAE			
Chaetodon adiergastos Seale, 1910	2, 4-7, 9, 10, 16, 20, 30, 32, 38	Occasional.	1-25
Chaetodon auriga Forsskål, 1775	2-10, 12-23, 30, 33, 34		1-30
Chaetodon baronessa Cuvier, 1831	1-4, 6-10, 13-18, 20-24, 26, 27, 29-32, 34, 35, 38	Moderately common in rich coral areas.	2-15
Chaetodon bennetti Cuvier, 1831	1, 3, 5, 21, 26, 28	Rare, about eight seen.	5-30
Chaetodon citrinellus Cuvier, 1831	1, 2, 10, 13, 15, 17, 20-23, 35	Occasional in shallow coral-poor areas affected by surge, except relatively common at Site 10.	1-12
Chaetodon ephippium Cuvier, 1831	33	Rare, only one subadult seen.	1-30
Chaetodon kleinii Bloch, 1790	1-4, 7, 9, 10, 13-18, 20-24, 28-30, 34, 35, 38	Common, the second most abundant butterflyfish in the Calamian Group.	6-60
Chaetodon lineolatus Cuvier, 1831	7, 13, 15	Rare, only five seen.	2-170
Chaetodon lunula Lacepède, 1803	2-4, 7-10, 14, 15, 17, 18, 20-24, 31, 34	Occasional.	1-40

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
Chaetodon lunulatus Quoy and Gaimard, 1824	1-5, 9, 10, 12-22, 28, 29, 32, 34-36, 38	Moderately common in rich coral areas.	1-25
Chaetodon melannotus Schneider, 1801	1, 2, 5, 8, 9, 13-18, 20, 22, 24, 30, 34, 38	Occasional.	2-15
Chaetodon ocellicaudus Cuvier, 1831	28	Rare, only one seen.	1-15
Chaetodon octofasciatus Bloch, 1787	1, 2, 4-7, 13-19, 21-38	Common, the most abundant butterflyfish in the Calamian Group.	3-20
Chaetodon ornatissimus Cuvier, 1831	1, 7, 10, 15, 20	Rare, less than 10 seen.	1-36
Chaetodon oxycephalus Bleeker, 1853	5	Rare, one pair seen.	8-30
Chaetodon punctatofasciatus Cuvier, 1831	2, 9, 10, 13	Rare, about 10 seen and mainly confined to islands off NE Busuanga	6-45
Chaetodon rafflesi Bennett, 1830	2, 4, 7, 9, 10, 15, 18, 22-24, 26, 28, 32, 34, 35	Occasional.	1-15
Chaetodon speculum Cuvier, 1831	8, 15-18, 22, 24, 28, 31, 34, 38	Occasional.	3-20
Chaetodon trifascialis Quoy and Gaimard, 1824	1-4, 6, 7, 9, 10, 13-18, 20-23, 29, 35	Occasional.	2-30
Chaetodon ulietensis Cuvier, 1831	5, 10, 31, 33	Rare, about 8-10 seen.	8-30
Chaetodon unimaculatus Bloch, 1787	17	Rare, only one seen.	5-60
Chaetodon vagabundus Linnaeus, 1758	1-4, 6-10, 12-25, 27, 29, 30	Moderately common.	1-30
Chaetodon xanthurus Bleeker, 1857	1, 10, 13-15, 20, 23	Occasional.	10-40
Chelmon rostratus (Linnaeus, 1758)	7, 14, 16, 18-21, 25-28, 31-33, 35-38	Occasional.	1-15
Coradion chrysozonus Cuvier, 1831	1-6, 10, 16, 17, 20, 21, 26, 28, 29, 31, 35, 36, 38	Occasional.	5-60
Coradion melanopus (Cuvier, 1831)	2, 7	Rare, only two seen.	10-30
Forcipiger flavissimus Jordan and McGregor, 1898	3, 4, 10	Rare, about three pairs seen.	2-114
Heniochus acuminatus (Linnaeus, 1758)	5, 38	Rare, only two seen.	2-75
Heniochus chrysostomus Cuvier, 1831	1-4, 6-10, 12-18, 20, 22, 23, 26, 29-32, 34, 35, 38	Common.	5-40
Heniochus diphreutes Jordan, 1903	10	Rarely seen, only one aggregation containing about 30 fish encountered.	15-210
Heniochus singularius Smith and Radcliffe, 1911	4, 5, 7, 8, 14, 15, 22, 26, 28, 33, 35, 38	Occasional.	12-45
Heniochus varius (Cuvier, 1829)	1-4, 6-10, 12-18, 20-29, 31, 34, 35, 38	Moderately common.	2-30
Parachaetodon ocellatus (Cuvier, 1831)	5, 21, 28, 37	Rare, about six seen.	5-40

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
POMACANTHIDAE			
Centropyge bicolor (Bloch, 1798)	3, 10	Rare, only three seen.	3-35
Centropyge bispinosus (Günther, 1860)	1, 3, 4, 7, 9, 10	Occasional.	10-45
Centropyge nox (Bleeker, 1853)	1-3, 9	Moderately common, but seen at only a few sites on the NE side of Busuanga Island.	10-70
Centropyge tibicen (Cuvier, 1831)	1, 4, 8, 10, 16, 20	Rare, less than 10 seen.	3-40
Centropyge vroliki (Bleeker, 1853)	1-3, 7-10, 16, 20	Occasional, but most common off NE Busuanga.	3-25
Chaetodontoplus mesoleucus (Bloch, 1787)	1-3, 5-7, 9, 10, 13, 14, 16-38	Common, by far the most abundant angelfish in the Calamian Group.	1-20
Pomacanthus imperator (Bloch, 1787)	2, 14, 29	Rare, only three seen.	3-70
Pomacanthus semicirculatus Cuvier, 1831	2, 7, 17, 22, 24, 29, 31, 35	Occasional.	5-40
Pomacanthus sexstriatus Cuvier, 1831	17, 20, 26-28, 31, 37, 38	Occasional.	3-50
Pomacanthus xanthometopon (Bleeker, 1853)	14	Rare, one adult seen.	5-30
Pygoplites diacanthus (Boddaert, 1772)	1-4, 6-10, 13, 17, 18, 31, 34, 35	Moderately common at sites 1-10, but rare during remainder of survey.	3-50
POMACENTRIDAE			
Abudefduf bengalensis (Bloch, 1787)	1, 6, 14-18, 21, 27-31, 36	Occasional.	1-6
Abudefduf notatus (Day, 1869)	14, 21, 35	Rare, only three seen.	0-5
Abudefduf septemfasciatus (Cuvier, 1830)	9, 10, 18, 21-23, 28, 29, 31	Occasional.	1-3
Abudefduf sexfasciatus Lacepède, 1802	2, 4, 6, 8, 15, 16, 18, 21, 22, 24, 26, 29-31	Occasional.	1-15
Abudefduf sordidus Forsskäl, 1775	9, 10, 18, 21, 29, 31, 34, 35	Occasional.	1-3
Abudefduf vaigiensis (Quoy and Gaimard, 1825)	1-4, 9, 10, 13, 15-17, 20-23, 26, 29, 30, 31, 34, 35	Moderately common.	1-12
Acanthochromis polyacantha (Bleeker, 1855)	1-10, 12, 14-38	Common.	1-5
Altrichthys azurelineatus (Fowler and Bean, 1928)	1, 5, 6, 16, 19, 26-29, 36-38	Moderately common, locally abundant in sheltered areas with branching coral cover. Pairs guard nest of 10-40 young; no pelagic stage.	1-10
Altrichthys curatus Allen, 1999	5, 26, 27, 36, 37, 38	Moderately common, locally abundant in sheltered areas with branching coral cover. A recently described new genus and species discovered during the Calamianes RAP. Pairs guard nest of 10-40 young; no pelagic stage.	0-10
Amblyglyphidodon aureus (Cuvier, 1830)	1, 4, 26-28, 31, 38	Rare, less than 10 individuals seen.	10-35
Amblyglyphidodon batunai Allen, 1995	5, 6, 19, 24, 26-29, 32, 33, 36-38	Moderately common.	2-12

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
Amblyglyphidodon curacao (Bloch, 1787)	1-10, 12-38	Common.	1-15
Amblyglyphidodon leucogaster (Bleeker, 1847)	1-4, 6-10, 13-18, 20-24, 26-31, 34-36, 38	Common.	2-45
Amblyglyphidodon ternatensis (Bleeker, 1853)	5, 16, 19	Occasional, mainly juveniles seen.	2-12
Amblypomacentrus breviceps (Schlegel and Müller, 1839-44)	5, 15, 16, 19, 24, 30, 37	Occasional, in open sandy areas or sand patches among seagrass beds.	2-35
Amphiprion clarkii (Bennett, 1830)	1-3, 5, 9, 10, 13-17, 21-27, 30, 31, 34-36, 38	Occasional, but relatively common at Site 9.	1-55
Amphiprion frenatus Brevoort, 1856	1, 2, 7, 8, 10, 12, 13, 15-18, 22, 24, 28, 29, 34, 38	Occasional.	1-15
Amphiprion ocellaris (Cuvier, 1830)	4, 6, 8, 14-18, 25, 26, 29, 30, 32, 34, 36-38	Occasional.	1-15
Amphiprion perideraion Bleeker, 1855	2, 7, 15, 32, 35	Occasional.	3-20
Amphiprion polymnus (Linnaeus, 1758)	8, 12, 30, 31	Occasional, on open sand bottoms.	2-30
Amphiprion sandaracinos Allen, 1972	1, 17, 21, 29, 34, 38	Occasional.	3-20
Cheiloprion labiatus (Day, 1877)	9, 14, 18, 21, 24, 26-29, 34, 36, 37	Occasional, in rich areas of branching coral.	1-3
Chromis alpha Randall, 1988	3	Rare, only one seen.	18-95
Chromis amboinensis (Bleeker, 1873)	1-4, 9, 10	Occasional, but only seen on NE side of Busuanga Island and offshore islands.	3-65
Chromis atripectoralis Welander and Schultz, 1951	1-4, 7, 9, 10, 12-14, 16-18, 20, 21, 28-31, 34, 37, 38	Moderately common.	2-15
Chromis atripes Fowler and Bean, 1928	2, 9, 10	Occasional, but only seen on NE side of Busuanga Island and offshore islands.	10-35
Chromis cinerascens (Cuvier, 1830)	28, 31, 36	Occasional, but aggregation of approximately 100 adults seen at site 28, and another containing about 30 fish seen at Site 31.	3-25
Chromis elerae Fowler and Bean, 1928	4	Rare.	12-70
Chromis lepidolepis Bleeker, 1877	1-4, 7-10, 13, 15, 20	Occasional.	2-20
Chromis lineata Fowler and Bean, 1928	1, 9, 10	Occasional, but only seen on NE side of Busuanga Island and offshore islands.	2-10
Chromis margaritifer Fowler, 1946	1-3, 9, 10	Occasional, but only seen on NE side of Busuanga Island and offshore islands.	2-20
Chromis ovatiformes Fowler, 1946	1, 3, 4, 9, 10, 18, 24	Occasional, but mainly seen on NE side of Busuanga Island and offshore islands.	10-40

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
Chromis retrofasciata Weber, 1913	1-4, 8-10, 13, 17, 18, 24	Occasional.	5-65
Chromis ternatensis (Bleeker, 1856)	1-4, 7-10, 13, 14, 16-18, 21-23, 29, 31	Moderately common in rich coral areas.	2-15
Chromis viridis (Cuvier, 1830)	1-3, 7-10, 12, 14, 21, 24, 26, 28-31, 37, 38	Moderately common.	1-12
Chromis weberi Fowler and Bean, 1928	1-3, 10, 18, 20, 23, 31, 35	Occasional.	3-25
Chromis xanthura (Bleeker, 1854)	1-3, 7, 9, 10, 13, 20	Occasional, but mainly seen on NE side of Busuanga. Island and offshore islands.	3-40
Chrysiptera cyanea (Quoy and Gaimard, 1824)	2, 9, 16, 18, 24, 29, 31, 34	Occasional.	0-10
Chrysiptera leucopoma (Lesson, 1830)	2, 9, 10, 13, 15, 17, 18, 20-23, 29, 30, 35	Occasional.	0-2
Chrysiptera oxycephala (Bleeker, 1877)	5, 6, 8, 26, 32, 33, 37, 38	Occasional.	1-16
Chrysiptera parasema (Fowler, 1918)	6, 8, 12, 13, 14, 16-19, 21, 25-34, 36-38	Common in rich coral areas.	1-16
Chrysiptera rex (Snyder, 1909)	1, 2, 7, 9, 10, 13-15, 17, 18, 20-24, 29-31, 34-36	Moderately common in areas exposed to moderate surge activity.	1-6
Chrysiptera rollandi (Whitley, 1961)	1-4, 6-10, 12-37	Common on silty reefs.	2-35
Chrysiptera springeri Allen and Lubbock, 1976	1-9, 16, 18, 19, 21-34, 36-38	Common in rich coral areas.	5-30
Chrysiptera talboti (Allen, 1975)	2-4, 8, 9, 20, 21, 29, 31, 34, 35	Occasional.	6-35
Chrysiptera unimaculata (Cuvier, 1830)	2, 3, 9, 10, 14, 16, 18, 21, 22, 29, 31, 34	Occasional.	0-2
Dascyllus aruanus (Linnaeus, 1758)	1-4, 7-10, 12-18, 21, 24, 26, 27, 29-31, 33, 38	Moderately common.	1-12
Dascyllus melanurus Bleeker, 1854	9, 16, 18, 24, 27, 29	Occasional.	1-10
Dascyllus reticulatus (Richardson, 1846)	1-4, 7-10, 12-18, 20, 22, 23, 28, 30, 31, 34, 35	Moderately common.	1-50
Dascyllus trimaculatus (Rüppell, 1928)	1-4, 7-10, 12, 18, 21-36, 38	Moderately common.	1-55
Dischistodus chrysopoecilus (Schlegel and Müller, 1839)	6, 16, 19, 24, 26, 27, 29, 32, 33,	Occasional near shore in sand-weed areas.	1-5
Dischistodus fasciatus (Cuvier, 1830)	14, 16-18, 29, 32, 36, 38	Occasional near shore in sand-weed areas.	1-8
Dischistodus melanotus (Bleeker, 1858)	1, 2, 4, 6-9, 12, 13, 16, 18, 19, 21, 24, 26-29	Occasional.	1-10
Dischistodus perspicillatus (Cuvier, 1830)	5, 6, 12, 16, 19, 21, 24, 26, 29, 31-33, 37, 38	Occasional on sand bottoms.	1-10

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
Dischistodus prosopotaenia (Bleeker, 1852)	2, 5, 6, 12, 14, 16, 19, 21, 26, 27-29, 37, 38	Moderately common.	1-12
Dischistodus pseudochrysopoecilus Allen and Robertson, 1974	1, 9, 21, 24	Rare, less than 10 seen.	1-5
Hemiglyphidodon plagiometopon (Bleeker, 1852)	5, 6, 8, 12, 19, 26-29, 32, 33, 36, 38	Occasional, but locally common.	1-20
Neoglyphidodon melas (Cuvier, 1830)	1-4, 6-10, 12-38	Moderately common, but always in small numbers.	1-12
Neoglyphidodon nigroris (Cuvier, 1830)	1-4, 6-10, 12-38	Common.	2-23
Neoglyphidodon oxyodon (Bleeker, 1857)	6, 9, 13-19, 21, 22, 24, 29, 31, 34, 36	Occasional, but locally common.	0-4
Neoglyphidodon thoracotaeniatus (Fowler and Bean, 1928)	2, 4, 9, 18, 22	Occasional, but most seen on NE side of Busuanaga and offshore islands.	15-45
Neopomacentrus anabatoides (Bleeker, 1847)	8, 12, 14, 21, 26, 27, 30, 31, 34, 36-38	Moderately common.	2-15
Neopomacentrus bankieri (Richardson, 1846)	28, 38	Occasional, but locally common.	3-30
Neopomacentrus filamentosus (Macleay, 1833)	5, 19, 20, 26-28, 32, 33, 35-38	Moderately common.	5-15
Plectroglyphidodon dickii (Lienard, 1839)	1, 2, 4, 7, 9, 10, 13-15, 17, 20-24, 29-31, 34, 35	Moderately common among *Pocillopora* in areas exposed to mild wave action.	1-12
Plectroglyphidodon lacrymatus (Quoy and Gaimard, 1824)	1-3, 6-10, 12-27, 29-32, 34-36, 38	Moderately common.	2-12
Plectroglyphidodon leucozonus (Bleeker, 1859)	1, 2, 10, 13, 15, 17, 18, 20-23, 29-31, 34, 35	Common in shallow surge areas.	0-2
Pomacentrus adelus Allen, 1991	1-4, 6, 7, 9, 12, 14-19, 21, 24, 26-32, 35, 36, 38	Common.	0-8
Pomacentrus alexanderae Evermann and Seale, 1907	1-10, 12-38	Abundant, perhaps the most common fish in the Calamian Group.	5-30
Pomacentrus amboinensis Bleeker, 1868	1-4, 7-10, 12-38	Common on reefs with extensive sand-rubble habitat.	2-40
Pomacentrus armillatus Allen, 1993	5, 6, 8, 13-16, 19, 21, 24, 26-34, 36-38	Moderately common.	5-20
Pomacentrus bankanensis Bleeker, 1853	1-3, 7, 9, 10, 14-18, 20-24, 29, 31, 34, 35	Moderately common.	0-12
Pomacentrus brachialis Cuvier, 1830	1-3, 10, 12, 13, 16, 20, 23, 25, 26	Occasional, but common at sites around Tara Island.	6-40
Pomacentrus burroughi Fowler, 1918	4-6, 8, 14, 18, 19, 21, 24-34, 36-38	Common on sheltered reefs.	2-16
Pomacentrus chrysurus Cuvier, 1830	1, 3, 6, 9, 12, 14, 16-19, 21, 24, 29-31, 34	Occasional.	0-3
Pomacentrus coelestis Jordan and Starks, 1901	1-3, 7, 8, 10, 13-15, 17, 18, 20-25, 30, 31, 34, 35	Common.	1-12

Reef fishes recorded during the RAP survey of the C[illegible] Islands

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
Pomacentrus cuneatus Allen, 1991	12, 16, 19, 21, 26-30, 36-38	Moderately common, especially common at Sites 19, 27, and 28.	1-6
Pomacentrus geminospilus Allen, 1993	5, 6, 14, 18, 24-26, 31-33, 36-38	Moderately common.	4-30
Pomacentrus grammorhynchus Fowler, 1918	6, 28, 29, 34	Occasional.	2-12
Pomacentrus lepidogenys Fowler and Bean, 192[illegible]	1-4, 6-10, 12-27, 29-31, 34-38	Common.	[illegible]
Pomacentrus littoralis Cuvier, 1830	5, 16, 32	Occasional in silty near-shore habitats.	0-3
Pomacentrus moluccensis Bleeker, 1853	1-4, 6-10, 12-31, 34-38	Common.	1-14
Pomacentrus nagasakiensis Tanaka, 1917	1, 2, 4, 7-9, 15-18, 22, 24, 28-32, 34, 36	Moderately common on sand bottoms with scattered rock and coral outcrops.	5-30
Pomacentrus opisthostigma Fowler, 1918	32	Rare, only one seen.	4-12
Pomacentrus pavo (Bloch, 1878)	12, 24	Rare, only a few individuals sighted.	1-16
Pomacentrus philippinus Evermann and Seale, 1907	1-4, 6-10, 13-15, 17, 18, 20-24, 26, 29-31, 34, 35	Moderately common.	1-12
Pomacentrus simsiang Bleeker, 1856	5, 6, 12, 19, 26-29, 32, 33, 36-38	Moderately common, most abundant at Sites 33 and 37.	0-10
Pomacentrus smithi Fowler and Bean, 1928	8, 9, 12, 25, 26, 29, 30, 32, 34, 36, 38	Moderately common, but abundant at Sites 25 and 26.	2-14
Pomacentrus stigma Fowler and Bean, 1928	1-4, 6-10, 13-20, 22-24, 26-38	Common.	[illegible] 20
Pomacentrus tripunctatus Cuvier, 1830	16, 32	Occasional in very shallow wa[illegible]	0-3
Pomacentrus vaiuli Jordan and Seale, 1906	1-4, 7-10, 13, 15, 17, 20, 22, 23, 30, 31, 34, 35	Moderately common.	3-45
Premnas biaculeatus (Bloch, 1790)	5, 12, 27, 29	Occasional.	1-6
Pristotis obtusirostris (Günther, 1862)	30	Rare, a group of eight seen.	5-80
Stegastes fasciolatus (Ogilby, 1889)	1-3, 9, 10, 13-15, 22, 35	Occasional.	0-5
Stegastes lividus (Bloch and Schneider, 1801)	28	Rarely seen, one colony of about 30-40 individuals encountered.	1-5
Stegastes obreptus (Whitley, 1948)	8, 15-18, 21-24, 29, 30, 34, 35	Occasional.	2-6
CEPOLIDAE			
Acanthocepola abbreviata (Valenciennes, 1835)	21	Rare, one colony containing about 10 fish encountered in 20 depth.	12-25
LABRIDAE			
Anampses caeruleopunctatus Rüppell, 1828	8-10, 20, 30	Rare, only five seen.	2-30
Anampses geographicus Valenciennes, 1840	2, 8, 20, 24	Rare, only four seen.	5-25
Anampses melanurus Bleeker, 1857	1, 4, 10, 20	Rare, only four seen.	12-40
Anampses twistii Bleeker, 1856	1-3, 10	Rare, only five seen.	2-30
Bodianus axillaris (Bennett, 1831)	2, 3, 10, 17, 20, 24, 31	Occasional.	2-40
Bodianus loxozonus (Snyder, 1908)	20	Rare, one adult seen.	3-40

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
Bodianus mesothorax Schneider, 1801	1-4, 6-10, 13-18, 20-36	Moderately common.	5-30
Cheilinus chlorurus (Bloch, 1791)	1, 2, 16-18, 22-24, 26-32, 34-36, 38	Moderately common.	2-30
Cheilinus fasciatus (Bloch, 1791)	1, 3-7, 9, 12, 13, 16, 17, 20, 21, 24, 26-29, 31, 32, 34-36, 38	Moderately common.	4-40
Cheilinus oxycephalus Bleeker, 1853	2, 8, 18, 20-24, 29-31	Occasional.	5-25
Cheilinus trilobatus Lacepède, 1802	2, 6-10, 14, 15, 30, 31	Occasional.	1-30
Cheilinus undulatus Rüppell, 1835	33, 37, 38	Rare, about five seen, all juveniles less than 15 cm except one 50 cm individual at Site 38.	2-60
Cheilinus unifasciatus Streets, 1878	1, 10, 17, 20, 22	Rare, only five seen.	1-160
Cheilio inermis Forsskål, 1775	1, 3, 8, 16-19, 21, 24, 34	Occasional.	0-3
Choerodon anchorago (Bloch, 1791)	1, 3-6, 8-10, 12-38	Moderately common.	1-25
Choerodon jordani (Snyder, 1908)	2	Rare, one adult seen.	10-20
Choerodon oligocanthus (Bleeker, 1851)	12, 15, 16, 21, 22, 28, 29, 37, 38	Occasional.	2-35
Choerodon schoenleinii (Valenciennes, 1839)	16, 17, 32	Rare, about five subadults seen.	5-60
Choerodon zosterophorus (Bleeker, 1868)	3, 6, 10, 16, 17, 20, 22, 24, 28-31, 35, 36, 38	Occasional.	10-40
Cirrhilabrus cyanopleura (Bleeker, 1851)	1-4, 6-10, 13, 16-18, 20-23, 25-32, 34-37	Common.	5-30
Cirrhilabrus temmincki Bleeker, 1853	1, 2, 4, 9, 13, 17, 20, 22, 24, 25, 28, 31, 34, 35	Moderately common.	10-40
Coris batuensis (Bleeker, 1862)	1-4, 7-10, 12-18, 20-28, 30-36	Moderately common.	3-25
Coris gaimardi (Quoy and Gaimard, 1824)	1, 7, 9, 10, 17, 18, 20, 22-24, 31, 35	Occasional.	1-50
Coris pictoides Randall and Kuiter, 1982	19-22, 27, 28, 30, 31	Occasional.	8-30
Diproctacanthus xanthurus (Bleeker, 1856)	1-10, 12-38	Common.	2-40
Epibulus insidiator (Pallas, 1770)	1-10, 13-18, 20-36, 38	Moderately common.	1-30
Gomphosus varius Lacepède, 1801	1-4, 6-10, 13-18, 21-24, 29-31, 34, 35	Moderately common.	1-30
Halichoeres argus (Bloch and Schneider, 1801)	3, 6, 9, 12, 16, 18, 19, 21, 29, 31-33, 37	Moderately common.	0-3
Halichoeres bicolor (Bloch and Schneider, 1801)	5	Rare, only two seen.	1-8
Halichoeres biocellatus Schultz, 1960	35	Rare, only three seen.	6-35
Halichoeres binotopsis (Bleeker, 1849)	2	Rare, a single juvenile sighted.	2-20
Halichoeres chlorocephalus Kuiter and Randall, 1994	27	Rare, only one seen. A new record for the Philippines previously known only from Papua New Guinea.	10-20

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
Parapercis millepunctata (Günther, 1860)	23, 31, 32, 38	Occasional.	3-50
Parapercis sp. 1	16	Rare, about six seen.	2-25
Parapercis sp. 2	24, 26-29, 31, 36, 38	Occasional.	5-25
Parapercis xanthozona (Bleeker, 1849)	4, 21	Rare, about six seen.	1-15
PHOLIDICHTHYIDAE			
Pholidichthys leucotaenia Bleeker, 1856	1, 6, 7, 15, 17, 20, 22, 23, 29, 34, 38	Occasional, but sometimes in large numbers; mainly small juveniles seen, but "nesting" 10-12 cm fish encountered at Site 38.	1-40
TRIPTERYGIIDAE			
Enneapterygius hemimelas (Kner and Steindachner, 1866)	17	Collected with rotenone.	0-30
Enneapterygius minutus (Günther, 1877)	14, 17	Collected with rotenone.	0-5
Enneapterygius sp.	17	Rare, male and female.	0-5
Helcogramma fuscopinna Holleman, 1982	32	Collected with rotenone.	1-10
Helcogramma rhinoceros Hansen, 1986	22	Rare, only one seen, but relatively cryptic.	2-8
Helcogramma striata Hansen, 1986	35	Rarely seen, but relatively common at one site.	1-20
Ucla xenogrammus Holleman, 1993	8, 18, 30	Occasional.	2-40
BLENNIIDAE			
Andamia tetradactylus (Bleeker, 1858)	14	Several specimens collected with rotenone.	0-2
Atrosalarias fuscus (Rüppell, 1835)	21, 28, 31, 32, 34	Occasional.	1-12
Blenniella chrysospilos (Bleeker, 1857)	23	Rare, only one sighted, but cryptic and difficult to detect.	0-3
Cirripectes castaneus Valenciennes, 1836	17	Rare, only one positively identified, but probably more common.	1-5
Cirripectes filamentosus (Alleyne and Macleay, 1877)	10, 13, 18, 30, 34, 35	Occasional.	1-20
Cirripectes polyzona (Bleeker, 1868)	14	Rare, only one positively identified, but probably more common.	0-3
Cirripectes springeri Williams, 1988	3	Rare, only one positively identified, but probably more common.	1-18
Ecsenius bicolor (Day, 1888)	20, 23, 31, 34, 35	Occasional in surge-affected areas.	2-25 cm
Ecsenius kurti Springer, 1988	8, 12, 14, 15, 20, 21, 30, 31	Occasional.	1-10
Ecsenius lineatus Klausewitz, 1962	13, 23, 35	Occasional.	5-20
Ecsenius lividanalis Chapman and Schultz, 1952	29, 31, 34	Rare, about six seen.	2-10
Ecsenius monoculus Springer, 1988	22, 23, 30	Occasional.	2-8

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH(m)
Cetoscarus bicolor (Rüppell, 1828)	1, 2, 4, 7, 8, 15, 20, 21, 23, 24, 28, 31	Occasional.	1-30
Chlorurus bleekeri (de Beaufort, 1940)	2-10, 13, 16, 18, 21, 23-28, 30, 31, 35-38	Moderately common.	2-30
Chlorurus microrhinos (Bleeker, 1854)	1, 15, 28, 30	Occasional.	2-35
Chlorurus sordidus (Forsskål, 1775)	1-3, 6-10, 12, 15, 17, 18, 20-35	Common.	1-25
Hipposcarus longiceps (Bleeker, 1862)	1, 2	Rare, less than 10 seen.	5-40
Leptoscarus vaigiensis (Quoy and Gaimard, 1824)	34	Rare, one adult seen.	1-15
Scarus chameleon (Choat and Randall, 1986)	15, 20, 22	Rare, only three seen.	3-15
Scarus dimidiatus Bleeker, 1859	1-4, 6, 7, 9, 14, 15, 17, 19-24, 26-31, 34-38	Moderately common.	1-15
Scarus flavipectoralis Schultz, 1958	4, 6, 10, 24	Occasional.	8-40
Scarus forsteni (Bleeker, 1861)	1-4, 6-10, 14, 15, 17, 18, 20, 22-24, 30, 31, 34, 35	Moderately common.	3-30
Scarus frenatus Lacepède, 1802	1, 15, 17	Rare, less than 10 seen.	3-25
Scarus ghobban Forsskål, 1775	4, 8, 14-22, 26-33, 35-38	Occasional.	3-30
Scarus hypselopterus Bleeker, 1853	1, 17	Rare, only two terminal phase fish seen.	4-30
Scarus niger Forsskål, 1775	1-4, 7-10, 13, 15-18, 20, 28, 30, 31, 34, 35, 38	Occasional.	2-20
Scarus oviceps Valenciennes, 1839	18	Rare, several seen at one site.	1-12
Scarus prasiognathos Valenciennes, 1839	4, 7, 8, 17	Occasional.	2-15
Scarus psittacus Forsskål, 1775	7, 10, 17, 22, 24, 29, 38	Occasional.	4-25
Scarus pyrrhurus (Jordan and Seale, 1906)	7	Rare, only one terminal phase fish seen.	3-20
Scarus quoyi Valenciennes, 1840	1, 5, 6, 8, 12-17, 19, 21, 24, 26-38	Common, especially initial phase fish.	4-18
Scarus rivulatus Valenciennes, 1840	7, 8, 15, 17, 22, 30, 34	Occasional.	5-20
Scarus rubroviolaceus Bleeker, 1849	4, 35	Rare, three adults seen.	1-30
Scarus schlegeli (Bleeker, 1861)	20		1-45
Scarus spinus (Kner, 1868)	15, 17, 21, 24, 29	Occasional.	2-18
TRICHONOTIDAE			
Trichonotus setiger Bloch and Schneider, 1801	22, 32	Occasional.	3-15
PINGUIPEDIDAE			
Parapercis clathrata Ogilby, 1911	3	Rare, only one seen.	3-30
Parapercis cylindrica (Bloch, 1792)	5, 15, 16, 19	Occasional.	0-20
Parapercis hexophthalma (Cuvier, 1829)	1-3, 7, 8, 15, 20, 22, 24, 30, 31, 35	Occasional.	5-25

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
Leptojulis cyanopleura (Bleeker, 1853)	12, 24, 28, 30, 31, 36	Occasional, except common at sites 28 and 30, usually juveniles and initial phase fish seen.	5-25
Macropharyngodon meleagris (Valenciennes, 1839)	1-4, 7, 9, 10, 14, 15, 17, 18, 20, 22-24, 26, 27, 29, 31, 34, 35	Moderately common.	1-30
Macropharyngodon negrosensis Herre, 1932	9, 10, 13, 14, 31, 35	Occasional.	8-30
Novaculichthys taeniourus (Lacepède, 1802)	1, 2, 9, 17, 18	Rare, about six seen.	1-14
Oxycheilinus bimaculatus Valenciennes, 1840	2, 3, 5, 13, 22, 24, 26, 29	Occasional.	2-110
Oxycheilinus celebicus Bleeker, 1853	2-8, 14, 19, 21-38	Moderately common.	3-30
Oxycheilinus diagrammus (Lacepède, 1802)	4, 7, 10, 13-15, 17, 28	Occasional.	3-120
Oxycheilinus orientalis (Günther, 1862)	1, 2, 7-10, 13, 17, 22, 25, 29-31, 35	Occasional.	15-70
Parachelinus angulatus Randall and Lubbock, 1981	13, 32, 34	Occasional.	15-40
Parachelinus filamentosus Allen, 1974	1, 13, 17, 22, 24-29, 31, 35	Moderately common.	10-50
Pseudocheilinus evanidus Jordan and Evermann, 1902	1-3, 10, 24	Rare, less than 10 seen.	6-40
Pseudocheilinus hexataenia (Bleeker, 1857)	2, 3, 8, 10, 24, 25, 31, 32, 35	Occasional.	2-35
Pseudocoris yamashiroi (Schmidt, 1930)	3	Rare, about five seen.	10-30
Pseudodax moluccanus (Valenciennes, 1840)	3, 10	Rare, only two seen.	3-40
Pteragogus enneacanthus (Bleeker, 1856)	1, 2, 10, 21, 27, 31, 38	Occasional, but difficult to detect due to cryptic habits.	2-15
Pteragogus flagellifera (Valenciennes, 1839)	32	Rare, but difficult to detect due to cryptic habits.	1-10
Stethojulis bandanensis (Bleeker, 1851)	1-3, 9, 10, 12-18, 21, 23, 24, 26, 29-31	Moderately common.	0-30
Stethojulis strigiventer (Bennett, 1832)	6, 24, 29, 38	Occasional.	0-6
Stethojulis trilineata (Bloch and Schneider, 1801)	1, 2, 4, 6-9, 12-14, 16-18, 22, 24, 27, 29-31, 34-36	Moderately common.	1-10
Thalassoma amblycephalum (Bleeker, 1856)	1, 2, 10, 15, 17, 20, 23, 34	Occasional.	1-15
Thalassoma hardwicke (Bennett, 1828)	1-4, 6-10, 12-18, 20-24, 28-31, 34, 35	Moderately common.	0-15
Thalassoma jansenii Bleeker, 1856	34	Rare, one adult seen.	0-15
Thalassoma lunare (Linnaeus, 1758)	1-10, 12-31, 33-38	Common, one of most abundant wrasses in Calamian Group.	1-30
Thalassoma purpureum (Forsskål, 1775)	1, 34	Rare, only two seen.	2-20
Thalassoma quinquevittatum (Lay and Bennett, 1839)	9, 10, 13, 15, 17, 20, 22, 23, 31	Occasional in surge areas.	0-18
Xyrichtys aneitensis (Günther, 1862)	9	Rare, about six seen.	10-40
SCARIDAE			
Bolbometopon muricatum (Valenciennes, 1840)	20, 26, 38	Occasional, about 12 small adults (approximately 100 cm) seen at Site 38.	1-30
Calotomus carolinus (Valenciennes, 1839)	2, 7, 10, 17	Rare, about 6-8 fish seen.	4-30

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
Halichoeres chloropterus (Bloch, 1791)	4-7, 9, 12, 14, 16-19, 21, 24, 26-34, 36, 37	Moderately common.	0-10
Halichoeres chrysus Randall, 1980	2, 9, 24, 26	Rare, mainly juveniles seen.	7-60
Halichoeres hartzfeldi Bleeker, 1852	19, 22, 24, 26, 30	Occasional.	10-30
Halichoeres hortulanus (Lacepède, 1802)	1-4, 7-10, 13-15, 17, 18, 20, 22, 23, 34, 35	Occasional.	1-30
Halichoeres leucurus (Walbaum, 1792)	4, 12, 28	Rare, about eight seen.	2-15
Halichoeres margaritaceus (Valenciennes, 1839)	1-3, 9, 10, 13-18, 20-24, 29-31, 34, 35	Moderately common.	0-3
Halichoeres marginatus (Rüppell, 1835)	1-4, 6-10, 14-18, 22-24, 29-31, 34, 35	Occasional.	1-30
Halichoeres melanochir Fowler and Bean, 1928	1, 2, 4, 6, 7, 9, 10, 14-18, 20-26, 29-35	Moderately common.	0-15
Halichoeres melanurus Bleeker, 1853	1-7, 9, 10, 12-18, 20-24, 26-31, 34-38	Common, the most abundant wrasse.	2-15
Halichoeres miniatus Kuhl and Van Hasselt, 1839	34	Rarely encountered, but relatively common in shallows at one site.	0-8
Halichoeres nebulosus Valenciennes, 1839	16-18, 24, 29	Occasional.	1-40
Halichoeres nigrescens Bleeker, 1862	1, 6, 19, 21, 26-29, 31-34, 37, 38	Moderately common.	0-15
Halichoeres podostigma (Bleeker, 1854)	1, 2, 9, 17, 21, 24, 28, 29	Occasional.	1-8
Halichoeres prosopeion Bleeker, 1853	1-4, 7, 9, 10, 13, 15, 17, 18, 20, 22-24, 26-31, 34	Moderately common.	5-40
Halichoeres purpurescens (Bloch and Schneider, 1801)	2, 5, 6, 8, 16, 19, 21, 25-28, 32, 33, 36-38	Occasional.	1-20
Halichoeres scapularis Bennett, 1832	1, 3, 9, 10, 12, 14, 16-18, 24, 29, 31	Occasional.	0-15
Halichoeres schwarzi (Bleeker, 1849)	32, 37, 38	Occasional in shallow weed habitat.	0-5
Halichoeres sp.	32, 37	Occasional, but locally common.	1-5
Hemigymnus fasciatus Bloch, 1792	1-4, 10, 13-15, 17, 18, 20-22, 24, 28-31, 34-36	Moderately common.	1-20
Hemigymnus melapterus Bloch, 1791	1-4, 6-10, 12-31, 34-38	Moderately common.	2-30
Hologymnosus annulatus (Lacepède, 1801)	20, 35	Rare, about five seen.	5-30
Labrichthys unilineatus (Guichenot, 1847)	1-3, 7-10, 12-18, 20-24, 26-31, 34-38	Moderately common.	1-20
Labroides bicolor Fowler and Bean, 1928	1, 3, 7, 10, 24, 29	Rare, six seen.	2-40
Labroides dimidiatus (Valenciennes, 1839)	1-3, 4-10, 12-38	Moderately common.	1-40
Labropsis manabei Schmidt, 1930	1, 3, 7, 10, 15, 17, 24, 26, 31, 35	Occasional.	10-35

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
Ecsenius sp.	4, 5, 7, 8, 13-19, 21-34, 36-38	Common, apparently an undescribed species that may be restricted to the Calamians and N Palawan.	4-35
Ecsenius yaeyamensis (Aoyagi, 1954)	1, 2, 6, 8, 12, 22-24, 30, 31, 34, 35	Occasional.	1-15
Entomacrodus decussatus (Bleeker, 1858)	31, 34	Occasional.	0-2
Entomacrodus striatus (Quoy and Gaimard, 1836)	14	Several collected with rotenone.	0-2
Exallias brevis (Kner, 1868)	10	Rare, only one seen.	1-20
Istiblennius colei (Herre, 1934)	14	One adult collected with rotenone during the survey from rocky intertidal habitat. According to Springer and Williams (1994) "this species is known only from the type series of its two nominal synonyms, collected more than 50 years ago. Considering all the collecting activity that has occurred in the Philippines in the past 20 years, it seems amazing that this clearly shallow-dwelling, once common species has not been re-collected. We fear it may be extinct."	0-2
Istiblennius dussumieri (Valenciennes, 1836)	14	Possibly common; several collected from intertidal zone with rotenone.	0-2
Meiacanthus atrodorsalis (Günther, 1877)	2, 4-10, 15-17, 21, 24-28, 31-34, 38	Occasional.	1-30
Meiacanthus geminatus Smith-Vaniz, 1976	2, 3, 5, 8, 12, 13, 15, 18, 19, 21, 26, 28, 30-34, 36, 37	Moderately common.	2-20
Meiacanthus grammistes (Valenciennes, 1836)	1, 3, 9, 15, 22, 30, 34	Occasional.	1-20
Plagiotremus laudandus (Whitley, 1961)	2, 6, 34	Rare, only three seen.	2-35
Plagiotremus rhinorhynchus (Bleeker, 1852)	12, 21	Rare, only two seen.	1-40
Salarias fasciatus (Bloch, 1786)	6, 9, 14, 16-19, 21, 24, 27, 29, 31, 34, 35	Moderately common.	0-8
Salarias obscurus Bath, 1992	19, 24	Rare, only five seen.	1-5
Salarias patzneri Bath, 1992	16, 30	Occasional.	1-4
Salarias ramosus Bath, 1992	30	Rare, only one seen.	2-12
Salarias segmentatus Bath and Randall, 1991	21, 32, 33	Occasional.	2-30
CALLIONYMIDAE			
Anaora tentaculata Gray, 1835	5	Rare, noticed on only one occasion, but difficult to detect during visual survey work due to small size and cryptic habits.	0-5

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
Callionymus delicatulus Smith, 1963	[illegible]	Rare, noticed on only one occasion, but difficult to detect during visual survey work due to small size and cryptic habits.	5-20
Callionymus ennactis Bleeker, 1879	22, 27	Rare, noticed on only two occasions, but difficult to detect during visual survey work due to small size and cryptic habits.	2-20
GOBIIDAE			
Acentrogobius viganensis (Steindachner, 1893)	5	Rare, a single specimen in Lake Cayangan.	0-4
Amblyeleotris diagonalis Polunin and Lubbock, 1979	24, 30	Occasional, but not properly surveyed due to sand-dwelling habits.	6-35
Amblyeleotris fontanesii (Bleeker, 1852)	32, 37	Occasional, but not properly surveyed due to sand-dwelling habits.	5-25
Amblyeleotri[illegible] guttata (Fowler, [illegible]938[illegible]	[illegible]	[illegible]onal[illegible]t not properly surveyed due t[illegible] sand-dwelling habits.	[illegible]
Amblyeleotris gymnocephalus (Bleeker, 1853)	5, 36	Occasional, but not properly surveyed due to sand-dwelling habits.	5-20
[illegible]*leo[illegible]atifasciata* P[illegible]d [illegible] 979	[illegible]	[illegible] ot prop[illegible] surveyed [illegible] sand-dwelling habits.	[illegible]
Amblyeleotris periophthalma (Bleeker, 1853)	5, 8, 19, 28, 29, 36	Occasional, but not properly surveyed due to sand-dwelling habits.	8-15
Amblyeleotris steinitzi (Klausewitz, 1974)	1, 3, 9, 12, 15, 22, 27, 30, 33, 36	Occasional, but not properly surveyed due to sand-dwelling habits.	6-30
Amblyeleotris wheeleri (Polunin and Lubbock, 1977)	2, 9, 22, 23, 31, 34, 35	Occasional, but not properly surveyed due to sand-dwelling habits.	5-20
Amblygobius buanensis (Herre, 1927)	5, 33, 37, 38	Occasional.	1-5
Amblygobius decussatus (Bleeker, 1855)	1, 4, 8, 12, 15, 16, 19, 21, 22, 24, 26-33, 37	Moderately common.	3-20
Amblygobius hectori (Smith[illegible]	1, 2, 4-6, 8-10, 12-15, 17, 18, 21[illegible]	[illegible]	4-20
Amblygobius nocturnus (Herr[illegible] 1945)	5, 33, 37	[illegible]ccasio[illegible]	[illegible]-30
Amblygobius phalaena ([illegible] 1837)	6, 12, 16, 30	[illegible]ccasio[illegible]	1-20
Amblygobius sphynx (Valenciennes, 1837)	38	Rare, but typical seagrass habitat not properly surveyed.	1-6
Asterropteryx bipunctatus Allen and Munday, 1996	33	One specimen collected with rotenone.	15-40
Asterropteryx semipunctatus Rüppell, 1830	33	Rarely seen, but common in 1-2 m depth at one site.	1-10
Asterropteryx [illegible]riatus Allen and Munday, 199[illegible]	18, 21, 29	[illegible]casio[illegible]	[illegible]20
Bathygobius sp[illegible] (DFH sp. 9)	14	[illegible]eral s[illegible]mens colle[illegible] rot[illegible]	2[illegible]

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
Bryaninops amplus Larson, 1985	2, 7, 15, 17, 24, 35	Occasional.	10-40
Bryaninops loki Larson, 1985	27	Rarely seen, but no doubt more common; difficult to detect due to tiny size and camouflage.	6-45
Bryaninops natans Larson, 1986	1, 3, 4, 14, 17, 24, 25, 32	Occasional.	6-27
Bryaninops yongei (Davis and Cohen, 1968)	7, 36	Rarely seen, but no doubt more common; difficult to detect due to tiny size and camouflage.	3-45
Callogobius okinawae (Snyder, 1908)	14	Several specimens collected with rotenone.	0-3
Cryptocentrus cinctus (Herre, 1936)	5, 33, 37	Occasional, but not properly surveyed due to sand-dwelling habits.	2-15
Cryptocentrus fasciatus (Playfair and Günther, 1867)	5, 33, 36	Occasional, but not properly surveyed due to sand-dwelling habits.	1-5
Cryptocentrus leptocephalus Bleeker, 1876	1, 33	Occasional, but not properly surveyed due to sand-dwelling habits.	2-10
Cryptocentrus leucostictus (Günther, 1871)	23, 37	Occasional, but not properly surveyed due to sand-dwelling habits.	2-12
Cryptocentrus octofasciatus Regan, 1908	33	Rare, but not properly surveyed due to sand-dwelling habits.	1-5
Cryptocentrus sp. 1	35	Rare, but not properly surveyed due to sand-dwelling habits.	1-4
Cryptocentrus sp. 2	33	Rare, several seen.	2-10
Cryptocentrus sp. 3	5, 11, 21	Rare, less than 10 seen.	1-5
Cryptocentrus sp. 4	5, 11, 27, 36, 37	Occasional, but locally common.	1-5
Cryptocentrus strigilliceps (Jordan and Seale, 1906)	8, 12, 14, 19, 21, 22, 32, 33	Occasional, but not properly surveyed due to sand-dwelling habits.	1-6
Ctenogobiops crocineus Smith, 1959	6, 27	Occasional, but not properly surveyed due to sand-dwelling habits.	3-10
Ctenogobiops feroculus Lubbock and Polunin, 1977	4, 6, 12, 19, 26, 32, 34, 36-38	Moderately common.	2-15
Ctenogobiops pomastictus Lubbock and Polunin, 1977	8, 22, 30, 33	Occasional.	2-20
Eviota bifasciata Lachner and Karnella, 1980	1-7, 9, 10, 13-15, 21, 22, 24-27, 30-34, 36-38	Common.	5-25
Eviota guttata Lachner and Karanella, 1978	16, 30, 31, 34	Occasional, but no doubt more common; difficult to detect due to tiny size.	3-15
Eviota melasma Lachner and Karanella, 1980	1, 17, 18, 20, 21	Occasional, but no doubt more common; difficult to detect due to tiny size.	3-20
Eviota nigriventris Giltay, 1933	33, 38	Occasional.	4-20

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
Eviota pellucida Larson, 1976	4-6, 9, 16-18, 21-23, 25-33, 36, 37	Common.	3-20
Eviota prasina (Klunzinger, 1871)	14, 19	Two specimens collected with rotenone.	0-5
Eviota prasites Jordan and Seale, 190	9, 18	Occasional, but no doubt more common; difficult to detect due to tiny size.	3-15
Eviota sebreei Jordan and Seale, 1906	2, 8, 12, 17, 21-23, 28, 30, 32, 34, 35	Occasional.	3-20
Eviota sparsa Jewett and L[illegible]nc[illegible]983	[illegible]	Two specimens collected with roten[illegible]	3-25
Exyrias bellisimus (Smith, 19[illegible]9)	[illegible]5, 2[illegible], 26, 27, [illegible]2, 33, 36, 37	Occasional on silty reefs.	1-25
Exyrias sp.	32, 33, 36, 37	Occasional on silty reefs.	1-25
Fusigobius duospilus Hoese and Reader, 198[illegible]	21	Several collected with rotenon[illegible]	3-35
Fusigobius neophytus (Günther, 1877)	6, 26, 27, 34	Occasional.	2-15
Fusigobius signipinnis Hoese and Obika, 1988	1-4, 9, 10, 15, 17, 18, 20-22, 24, 29, 30, 32, 34, 35	Moderately common.	10-30
Fusigobius sp.	28	Rare, only one seen.	5-25
Gnatholepis cauerensis Bleeker, 1853	2	Rare, but no doubt more common; difficult to detect due to small size and cryptic habits.	3-30
Gnatholepis sp.	12	Rare, but no doubt more common; difficult to detect due to small size and cryptic habits.	1-25
Gobiid sp.	17	Rare, only one specimen taken with rotenone.	0-2
Gobiodon okinawae Sawada, Arai and Abe, 1973	32, 33	Occasional.	2-12
Gobiodon quinquestrigatus (Valenciennes, 1837)	35	Rare[illegible] one seen, but difficult to detect[illegible] cryptic habits.	2-12
Gobiopsis bravoi (Herre, 1927)	14, 17	Several collected with rotenone.	0-4
Heteroplopomus barbatus (Tomiyama, 1936)	17	Common on open sand at one site.	10-20
Istigobius decoratus (Herre, 1927)	19, 22, 23, 33	Occasional.	1-18
Istigobius decoratus (Herre, 1927)	19, 22, 23, 33	Occasional.	1-18
Istigobius goldmanii (Bleeker, 1852)	30, 31	Occasional.	1-5
Istigobius ornatus (Rüppell, 1830)	5, 6, 8, 12, 14, 21, 37	Occasional, also collected with rotenone at Site 14.	0-5
Istigobius rigilius (Herre, 1953)	15, 27, 32	Occasional.	0-30
Macrodontogobius wilburi Herre, 1936	5, 12, 21, 32, 37	Occasional.	2-15
Mahidolia mystacina (Valenciennes, 1837)	33, 37	Occasional, but not properly surveyed due to sand-dwelling habits.	4-20
Myersina nigrivirgata Akihito and Meguro, 1983	11, 33	Occasional, but not properly surveyed due t[illegible] sand dwelling habits.	2-15

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
Oplopomus oplopomus (Valenciennes, 1837)	5, 11	Occasional, but not properly surveyed due to sand-dwelling habits.	2-25
Pandaka pygmaea Herre, 1927	33, 37, 39	Moderately common, confined to mangrove habitat; also present in Lake Cayangan.	0-2
Paragobiodon echinocephalus Rüppell, 1830	35	Rare, only one seen, but difficult to detect due to cryptic habits.	4-12
Phyllogobius platycephalops (Smith, 1964)	1, 21, 28	Occasional.	2-18
Pleurosicya labiata (Weber, 1913)	28	Rare, only a few seen, but difficult to detect due to cryptic habits.	3-25
Pleurosicya mossambica Smith, 1959	21	Rare, only a few seen, but difficult to detect due to cryptic habits; observed specimens were commensal on stalked tunicates living on a bare sand slope in 18 m depth.	3-30
Signigobius biocellatus Hoese and Allen, 1977	4, 8, 12, 14, 15, 19, 27, 28, 33	Occasional.	2-30
Stonogobiops nematodes Hoese and Randall, 1982	21	Rare, only one seen.	10-25
Tomiyamichthys oni (Tomiyama, 1936)	30, 33	Rare, 3-4 pairs seen, but sand habitat insufficiently surveyed.	10-35
Tomiyamichthys sp.	33	Rare, one seen.	12-23
Trimma caesiura (Jordan and Seale, 1906)	15-18, 21, 22, 27, 30, 31, 34	Occasional.	2-12
Trimma grammistes (Tomiyama, 1936)	4	Rarely seen, but common in 30 m depth at one site.	15-40
Trimma griffithsi Winterbottom, 1984	6, 24, 25, 32	Occasional.	20-40
Trimma naudei Smith, 1956	21	Several collected with rotenone.	5-20
Trimma rubromaculata Allen and Munday, 1995	21	Rare, about 10 seen in 20 m depth.	20-35
Trimma sp. 1	21, 22, 24, 31, 32	Occasional, also collected with rotenone at Sites 21 and 22.	4-20
Trimma sp. 2 (DFH sp. 36)	21, 34	Several specimens collected with rotenone.	8-40
Trimma sp. 3	21	Several specimens collected with rotenone.	8-25
Trimma sp. 4	21	Several specimens collected with rotenone.	5-20
Trimma sp. 5 (DFH sp. 18)	21, 34	Several specimens collected with rotenone.	5-30
Trimma striata (Herre, 1945)	21	Several specimens collected with rotenone.	2-25
Trimma tevegae Cohen and Davis, 1969	4, 6, 9, 15, 17, 18, 21, 22, 24, 25, 31, 32	Moderately common.	8-45
Valenciennea bella Hoese and Larson, 1994	17, 18, 22, 31	Occasional on flat rubble bottoms between 20-30 m depth.	12-35
Valenciennea immaculatus Ni Yong, 1981	5	Rare, about 10 seen.	0-3
Valenciennea muralis (Valenciennes, 1837)	16, 31, 33	Occasional.	1-15
Valenciennea parva Hoese and Larson, 1994	21, 22, 30	Occasional.	1-15
Valenciennea puellaris (Tomiyama, 1936)	3, 15, 16, 22, 23, 27-33, 36, 38	Occasional.	2-30
Valenciennea randalli Hoese and Larson, 1994	5, 16-18, 21, 22, 27-29, 31, 33, 38	Occasional.	8-30

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
Valenciennea sexguttata (Valenciennes, 1837)	3, 5, 12, 24, 33	Occasional.	1-10
Valenciennea strigata (Broussonet, 1782)	1, 21, 24	Occasional.	1-25
Valenciennea wardi (Playfair, 1867)	21	Rare, a single pair seen in 25 m depth on sand slope.	15-40
Vanderhorstia ambanoro (Fourmanoir, 1957)	8, 21, 29, 32, 33	Occasional.	4-20
Vanderhorstia lanceolata Yanagisawa, 1978	33	Rare, but not properly surveyed due to sand-dwelling habits.	2-6
Vanderhorstia mertensi Klausewitz, 1974	21, 32	Occasional, but not properly surveyed due to sand-dwelling habits.	5-24
Vanderhorstia ornatissima Smith, 1959	11	Rare, but not properly surveyed due to sand-dwelling habits.	1-20
MICRODESMIDAE			
Aioliops megastigma Rennis and Hoese, 1987	5, 6, 8, 14, 16, 19, 24-29, 33, 38	Moderately common.	1-15
Gunnelichthys curiosus Dawson, 1968	10	Rare, only one seen.	2-30
Parioglossus palustris (Herre, 1945)	37	Rarely seen, but common in mangroves at one site.	0-2
Ptereleotris evides (Jordan and Hubbs, 1925)	3, 17, 24, 29, 30	Occasional.	2-15
Ptereleotris hanae (Jordan and Snyder, 1901)	16, 18, 21, 26, 27, 30, 31, 33, 34	Occasional.	3-43
Ptereleotris heteroptera (Bleeker, 1855)	35	Rare, only one seen in 20 m depth.	6-50
EPHIPPIDAE			
Platax boersi Bleeker, 1852	13, 21, 28, 31	Occasional, usually in small groups containing about 5-15 fish; a group of 15 subadults seen at Site 21.	1-20
Platax orbicularis (Forsskål, 1775)	9	Rare, a group of five fish seen.	1-30
Platax pinnatus (Linnaeus, 1758)	1, 2, 4, 14, 18, 20, 21, 23, 24, 35, 36, 38	Occasional, the most common batfish in the Calamians.	1-35
Platax teira (Forsskål, 1775)	4	Rare, only one seen.	1-40
SIGANIDAE			
Siganus argenteus (Quoy and Gaimard, 1824)	1-4, 7, 9, 13, 20, 24	Occasional.	1-30
Siganus canaliculatus (Park, 1797)	32, 33	Occasional, but typical seagrass habitat insufficiently surveyed.	0-50
Siganus corallinus (Valenciennes, 1835)	1-4, 7, 9, 13, 20, 24	Occasional.	4-25
Siganus guttatus (Bloch, 1787)	7, 36	Rare, about five seen.	1-15
Siganus punctatissimus Fowler and Bean, 1929	2-4, 6, 7, 15, 17, 20, 28, 31, 38	Occasional.	3-30
Siganus spinus (Linnaeus, 1758)	1, 3, 8-10, 15, 18, 22-24, 29-31, 34	Moderately common in shallow wave-affected areas near shore.	1-12
Siganus virgatus (Valenciennes, 1835)	3-10, 13-38	Common, the most abundant siganid in the Calamianes.	2-25
Siganus vulpinus (Schlegel and Müller, 1844)	1-10, 13-33, 35, 37, 38	Moderately common.	1-30

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH
ZANCLIDAE			
Zanclus cornutus Linnaeus, 1758	1-4, 6-10, 12-32, 34-36, 38	Common.	1-180
ACANTHURIDAE			
Acanthurus blochi Valenciennes, 1835	10, 14, 15, 23, 30	Occasional.	3-20
Acanthurus japonicus (Fowler, 1936)	3, 7, 10, 15, 17, 20, 23, 31	Occasional.	3-10
Acanthurus lineatus (Linnaeus, 1758)	1-3, 7, 9, 10, 13-15, 17, 18, 20-24, 29-31, 34, 35	Moderately common in wave affected shallows near shore.	1-15
Acanthurus mata (Cuvier, 1829)	4, 6, 24, 28	Occasional, mostly juveniles or subadults seen.	5-30
Acanthurus nigricaudus Duncker and Mohr, 1929	15, 26, 30	Occasional.	3-30
Acanthurus nigrofuscus (Forsskål, 1775)	1, 2, 7, 9, 10, 13, 14, 22, 35	Occasional.	2-20
Acanthurus nigroris Valenciennes, 1835	10, 15, 20, 22, 23, 30, 31	Occasional.	1-90
Acanthurus olivaceus Bloch and Schneider, 1801	7, 10	Rare, about eight seen.	5-45
Acanthurus pyroferus Kittlitz, 1834	1-3, 7, 9, 10, 13, 14, 22, 35	Occasional, more common on NE side of Busuanga and offshore islands.	4-60
Acanthurus triostegus (Linnaeus, 1758)	3, 9, 10, 15, 17, 18, 21-24, 29, 31, 34	Moderately common in wave-affected shallows near shore.	0-90
Acanthurus xanthopterus Valenciennes, 1835	18	Rare, a few subadults seen.	3-90
Ctenochaetus binotatus Randall, 1955	1-4, 6, 7, 10, 13-27, 29, 30, 34-36, 38	Common.	10-55
Ctenochaetus striatus (Quoy and Gaimard, 1824)	1-4, 6-10, 13-31, 34, 35	Common, the most abundant surgeonfish in the Calamians.	2-30
Naso lituratus (Bloch and Schneider, 1801)	2-4, 7-10, 12-23, 28-31, 35	Moderately common.	5-90
Naso lopezi Herre, 1927	3	Rarely observed, one school containing about 20 fish seen.	6-70
Naso minor (Smith, 1966)	2	Rarely observed, one school containing about 50 fish seen.	10-50
Naso unicornis Forsskål, 1775	6, 7, 15, 17, 22, 23, 28, 30-32, 36	Occasional.	4-80
Zebrasoma scopas Cuvier, 1829	1-4, 6-10, 13, 20, 22	Common on NE side of Busuanga and offshore islands, but occasional elsewhere.	1-60
Zebrasoma veliferum Bloch, 1797	5, 8, 14, 15, 18, 21	Occasional.	4-30
SPHYRAENIDAE			
Sphyraena acutipinnis Day, 1876	8, 9, 28, 32	Occasional.	1-25
Sphyraena barracuda (Walbaum, 1792)	14, 26, 31, 38	Rare, only 5-6 seen.	1-40
Sphyraena flavicauda Rüppell, 1838	4-6, 14, 26	Occasional, usually in schools of up to 100 fish.	1-20
SCOMBRIDAE			
Grammatorcynus bilineatus (Quoy and Gaimard, 1824)	8, 9	Rare, four individuals seen.	10-40
Rastrelliger kanagurta (Cuvier, 1816)	5	Rarely seen, but one school containing at least one hundred individuals encountered.	0-30

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
BALISTIDAE			
Abalistes stellatus (Lacepède, 1798)	13, 30	Rare, one adult and several juveniles seen.	10-120
Balistapus undulatus (Park, 1797)	1, 2, 10, 12-17, 23	Moderately common on NE Busuanga and offshore islands, but rarely seen elsewhere.	3-50
Balistoides conspicillum (Bloch and Schneider, 1801)	2	Rare, one adult seen.	10-50
Balistoides viridescens (Bloch and Schneider, 1801)	1, 3-7, 9, 10, 14, 15, 17, 18, 22, 23, 26-28, 30, 31, 36, 38	Moderately common, the second most abundant triggerfish in the Calamians.	5-45
Odonus niger Rüppell, 1836	9, 10, 24	Occasional.	3-40
Pseudobalistes flavimarginatus (Rüppell, 1828)	4, 8, 12, 15, 19, 21, 29, 31	Occasional.	2-50
Rhinecanthus aculeatus (Linnaeus, 1758)	18, 24	Rare, only four seen.	0-3
Rhinecanthus rectangulus (Bloch and Schneider, 1801)	2, 9, 10, 15, 17, 31	Occasional.	1-?
Rhinecanthus verrucosus (Linnaeus, 1758)	8, 9, 12, 14, 16, 21, 29, 31, 38	Occasional.	0-?
Sufflamen bursa (Bloch and Schneider, 1801)	1, 3, 4, 7, 9, 10, 24, 36	Occasional.	3-90
Sufflamen chrysoptera (Bloch and Schneider, 1801)	3, 6, 7, 9, 10, 14, 15, 17, 20, 22, 23, 24, 28-31, 34-36	Moderately common, the most abundant triggerfish in the Calamians.	1-35
Sufflamen fraenatus (Latreille, 1804)	9	Rare, only one seen.	15-40
MONACANTHIDAE			
Acreichthys tomentosus (Linnaeus, 1758)	19, 24, 26, 28, 36-38	Occasional.	0-3
Amanses scopas [illegible]	3, 4, 9, 13, 15, 21, 22, 24, 31	Occasional.	2-20
*Canitherines frontic*inctus (Günther, 1866)	1-3, 8-10, 13, 15, 17, 20, 22-24, 31, 34	Occasional.	2-40
Oxymonacanthus longirostris Bloch and Schneider, 1801	1-3, 21	Moderately common at Tara Island, rare elsewhere.	2-?
Paraluteres prionurus (Bleeker, 1851)	3, 8, 10, 28	Rare, about six seen.	2-25
Paramonacanthus japonicus (Tilesius, 1801)	8	Rare, only one seen.	1-20
Pervagor janthinosoma (Bleeker, 1854)	6, 13, 17, 20, 21, 23	Occasional.	2-18
Pervagor melanocephalus (Bleeker, 1853)	2, 20, 30, 34	Rare, only four seen.	10-40
Pervagor nigrolineatus (Herre, 1927)	10	Rare, only an adult pair seen.	2-15
OSTRACIDAE			
Ostracion cubicus Linnaeus, 1758	1, 2, 6, 8, 9, 15, 23, 24, 31	Occasional.	1-40
Ostracion meleagris Shaw, 1796	2, 3, 7, 10, 13, 18	Occasional.	2-30
Ostracion solorensis Bleeker, 1853	1	Rare, only seen.	1-20
TETRAODONTIDAE			
Arothron caeruleopunctatus Matsuura, 1994	38	Rare, one large adult seen sheltering under an *Acropora* plate.	5-30

SPECIES	SITE RECORDS	ABUNDANCE	DEPTH (m)
Arothron hispidus (Linnaeus, 1758)	32, 36	Rare, two adults seen.	1-50
Arothron manilensis (de Proce, 1822)	22, 37, 38	Rare, three adults seen.	1-20
Arothron mappa (Lesson, 1830)	4, 15, 16, 20	Rare, four adults seen.	4-40
Arothron nigropunctatus (Bloch and Schneider, 1801)	1, 4-10, 13-15, 17, 18, 21-29, 32	Moderately common, a few seen on most dives.	2-35
Arothron stellatus (Schneider, 1801)	31	Rare, one adult seen.	3-58
Canthigaster compressa Proce, 1822	30	Rare, one seen during night dive.	1-20
Canthigaster solandri (Richardson, 1844)	1-4, 6, 7, 10, 16, 21, 24, 26, 32	Occasional.	1-36
Canthigaster valentini (Bleeker, 1853)	1, 3, 12, 14, 15, 17, 18, 20-28, 30, 34, 35, 38	Occasional.	3-55
Chelonodon patoca (Hamilton-Buchanan, 1822)	29	Rare, one adult seen in 22 m depth, an unusual record considering it is usually associated with shallow mangrove habitat.	0-5

The phylogenetic sequence of the families appearing in this list follows Eschmeyer (Catalog of Fishes, California Academy of Sciences, 1998) with slight modification (e.g., placement of Cirrhitidae). Genera and species are arranged alphabetically within each family.

Terms relating to relative abundance are as follows: *Abundant* - Common at most sites in a variety of habitats with up to several hundred individuals being routinely observed on each dive. *Common* - seen at the majority of sites in numbers that are relatively high in relation to other members of a particular family, especially if a large family is involved. *Moderately common* - not necessarily seen on most dives, but may be relatively common when the correct habitat conditions are encountered. *Occasional* - infrequently sighted and usually in small numbers, but may be relatively common in a very limited habitat

In June 1998, bleaching occurred on several reefs throughout the Philippines, including reefs in Palawan (Chou, 2000). Some sites that were recommended for protection were briefly revisited over a two-day period in December 2000. The locality of these revisited sites are approximate as no GPS was available. Observations of these reef sites are reported below. Time constraints did not allow follow up visits to the other survey sites.

26. Twin Peak Islands, West Coron Island 12/10/00

Sedimentation stress was evident on the reef with suspended sediment in the water column as well as a layer of sediment covering the reef. Dead coral skeletons of *Porites*, *Acropora*, *Pavona*, mussids and fungiids (presumably as a result of bleaching) were overgrown with algae (mostly *Padina*), cyanobacteria, and the encrusting sponge *Terpios* sp. Other noted marine fauna included comb jellies, numerous aggregations (approximately 8) of the black spine sea urchin *Diadema setosum* and a school of Maori wrasse. Evidence of dynamite blasting and cyanide fishing was observed on the south end of the reef (confirmed by local dive shop operators).

38. Siete Pecados Islands, Coron Island/Pinnacles 12/10/00

Sedimentation stress was evident on the reef with suspended sediment in the water column as well as a layer of sediment covering the reef. Dead coral skeletons and reef substrata were overgrown with algae, mostly *Padina* and *Halimeda*. Numerous (approximately 7) aggregations of *Diadema setosum* noted on the reef. Cyanide and blast fishing noted on section of reef near shallows as well.

13. South side of Kalampisauan Island 12/11/00

No dead coral skeletons were observed as with Sites 26 & 38. This is possibly evidence that bleaching was not as extensive here as it was at Sites 26 & 38. Patches of *Padina* algae were only observed inshore (less than 0.5m depth). Other noted flora included cyanobacteria, *Terpios* sp. and red algae.

14. Buluang Bay, Bususanga Island 12/11/00

Large stands of branching *Porites* and *Acropora* skeletons (possibly a result of bleaching) were covered with algae, mostly *Padina* and cyanobacteria. Some overgrowth of the coral skeletons by the encrusting sponge *Terpios* noted as well. *Acropora* species noted to have tumors or neoplasms (calicoblastic epithelioma; see Peters *et al.*, 1986; Coles and Seapy, 1998).

15. West side of Gutob Peninsula, Bususanga Island 12/11/00

Mixed stands of branching *Acropora* and *Porites* skeletons (possibly due to bleaching) were overgrown with *Padina*. Living stands of *Acropora* and *Porites* noted as well with *Padina* growing over some portions of the coral tissue. White band disease was evident on several branching *Acropora* and *Porites*. Numerous blennies and juvenile groupers observed on the reef.

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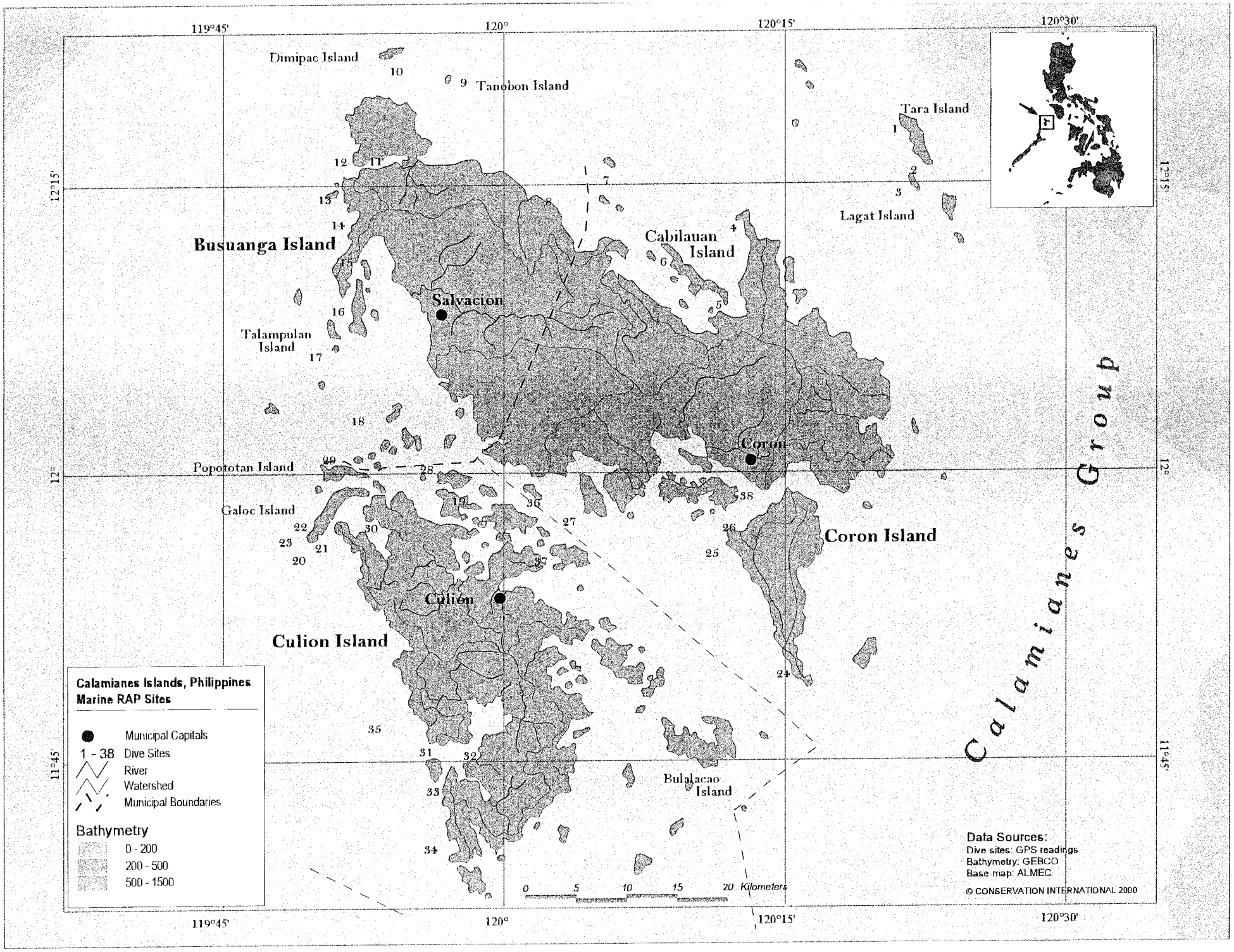
119°45'
120°
120°15'
120°30'
12°15'
12°
11°45'
Dimipac Island
Tanobon Island
Tara Island
Lagat Island
Busuanga Island
Cabilauan Island
Salvacion
Talampulan Island
Coron
Popototan Island
Galoc Island
Coron Island
Culion
Culion Island
Bulalacao Island
Calamianes Group
Calamianes Islands, Philippines
Marine RAP Sites
Municipal Capitals
1 - 38 Dive Sites
River
Watershed
Municipal Boundaries
Bathymetry
0 - 200
200 - 500
500 - 1500
0 5 10 15 20 Kilometers
Data Sources:
Dive sites: GPS readings
Bathymetry: GEBCO
Base map: ALMEC
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A Rapid Marine Biodiversity Assessment of the Calamianes Islands, Palawan Province, Philippines

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