PHUKET AND SURROUNDING ISLANDS

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For

โครงการจัดการทรัพยากรชายฝั่งทะเลประเทศไทย

THAILAND COASTAL RESOURCES MANAGEMENT PROJECT

The University of Rhode Island

United States Agency for International Development, USA

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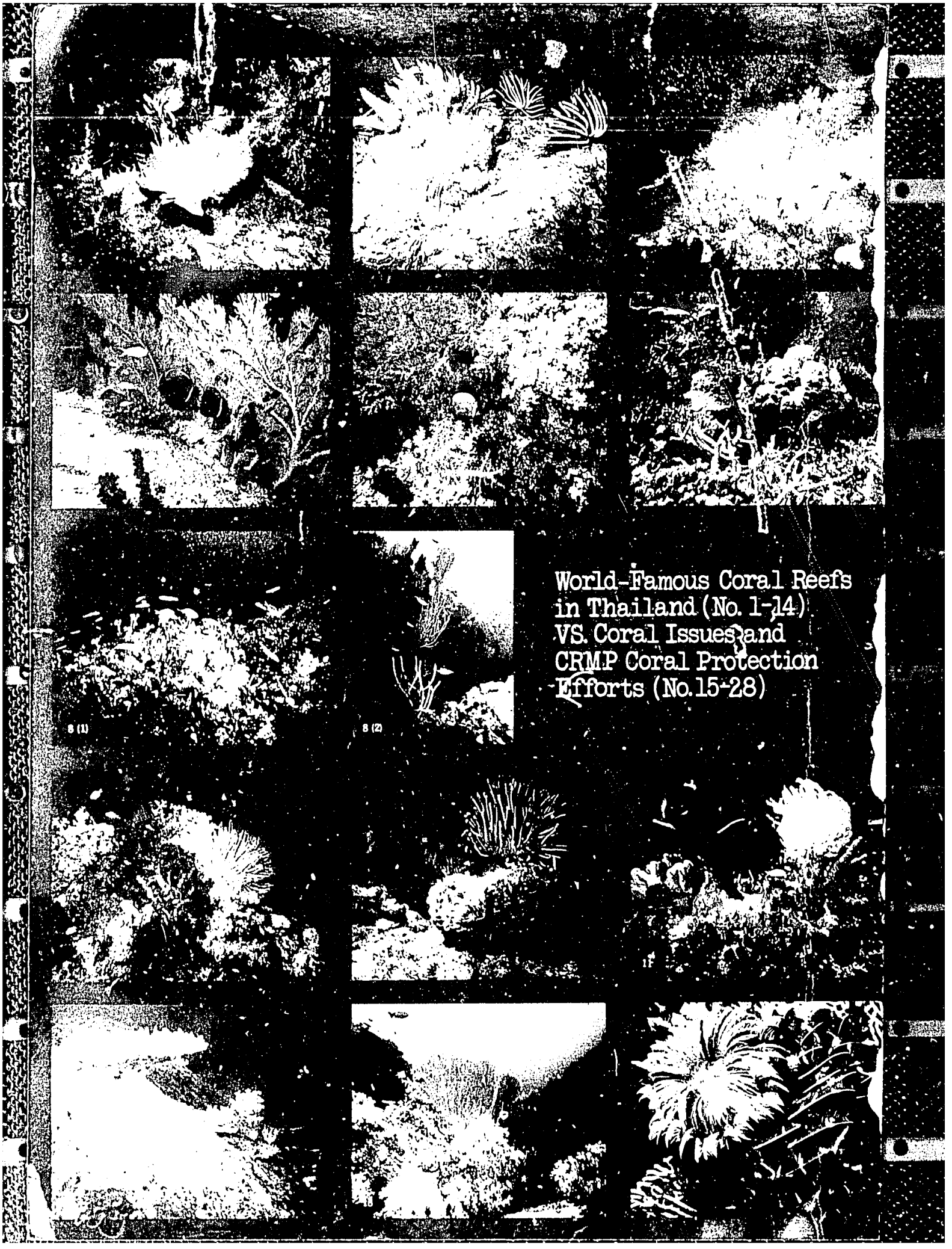

World-Famous Coral Reefs in Thailand (No. 1-14) VS. Coral Issues and CRMP Coral Protection Efforts (No.15-28)

CORAL REEF PROTECTION STRATEGY
FOR PHUKET AND SURROUNDING ISLANDS

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CRMP No. TR-T 02

Cover design: Thailand CRMP
ISBN 974-86933-0-9

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- URI/AID Coastal Resources Management Project, Coastal Resources Center, University of Rhode Island. RI 02882 USA.

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"This work has been funded through a cooperative program between the United States Agency for International Development and the Royal Thai Government."

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"The opinions, findings, conclusions, or recommendations expressed in this report are those of the authors and do not necessarily reflect the official view of the Office of the National Environment Board or the Agency for International Development."

FOREWORD

The Coastal Resources Management Project (CRMP) was launched in Thailand in June 1987 as a collaborative effort of the Royal Thai Government and the Government of the United States. Thailand was one of three countries selected for the project, with the others being Ecuador in South America and Sri Lanka. The project is aimed at creating and implementing programs for integrated coastal resources management.

A demonstration project was started in Phuket province in September 1987 as part of Phase I of the Thailand CRMP. The project stresses the early testing of management techniques that can be implemented at the local level and that are directed at selected coastal problems.

Coral reef protection in Phuket province and its surrounding areas was selected as a priority for the demonstration project because it met several criteria:

- ☐ Phuket's coral reef habitat is considered significant locally and nationally in terms of economic benefits as well as ecological values;
- ☐ There is consensus for the need to manage coral reefs;
- ☐ Reef conditions and the sources of damage are documented;
- ☐ Techniques for controlling certain impacts are known, technically feasible, and relatively inexpensive; and
- ☐ Coral reef protection calls for the integration of other factors such as tourism, maintenance of water quality, and the regional network of marine protected areas.

This strategy is a collection of practical ideas for more efficient use of reef resources, for reducing unnecessary damage, and increasing public appreciation for coral reefs. Local involvement in on-site management, cooperation among different government agencies, partnerships with the private sector, and the focus on clearly-defined issues are key features of the strategy. The recommendations were discussed at a Workshop on Coastal Resources Management held in Phuket, 1-4 March, 1988. Priority initiatives were selected for implementation in Phuket and incorporated into the marine national park planning project. In time, implementation of this habitat management program will yield essential experience for managing Phuket's other coastal habitats.

Pravit Ruyabhorn
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Thailand CRMP Co - Director

EXECUTIVE SUMMARY

Throughout Phuket's history, its residents have depended on coral reefs for food and income: Today, nearshore fisheries are still a source of income for local fishermen. And the coral reefs of offshore islands such as the Phi Phi, Racha, and Similan Islands have become popular tourist destinations for diving and snorkeling. Like the island's spectacular beaches, Phuket's coral reefs play an important role in the local economy. However, the combined impacts of increasing use and nearby coastal development has had an impact on the study area's reefs, and brought on a need for concerted management.

Purpose and Objectives

The purpose of the CORAL REEF PROTECTION STRATEGY is to identify and help implement measures to better manage the coral reefs of Phuket and surrounding islands so that these areas can be used on a sustainable basis to support coastal tourism, fisheries and other activities. To help achieve this purpose, specific objectives are provided in the STRATEGY. An important objective is that management programs should generate benefits for the local community, and thus offer incentives for public involvement.

Distribution and Significance

Fringing reefs occur within 1.5 km of shore at Nai Yang and within 1 km of shore along the west and south coasts of Ko Phuket. Fringing reefs and other benthic communities are also found along offshore islands such as the Phi Phi and the Similan Islands. In all, more than twenty percent of all coral reefs in Thailand are encompassed in the study area, including some of the country's most diverse and relatively undisturbed coral reefs.

General Patterns in Reef Conditions

Reef conditions in Phuket vary considerably with the degree of exposure to the southwest monsoon. Coral communities in protected bays and northeastern shores have a higher percentage of live coral cover than reefs in open bays. However, intensive use and nearby developments have also altered reef conditions.

Based on observations of coral cover, water quality, and reef fish populations, the following patterns in reef conditions are apparent. The study area includes:

- ☐ Reefs that are extensively damaged (i.e., with dead coral found over extensive areas) because of anchor damage, siltation from offshore tin dredging, crown-of-thorns **(Acanthaster planci)** infestations, and storm damage (e.g., North Patong Bay, Maya Bay, Bang Tao Bay, Chalong Bay);

- ☐ Reefs that are in fair condition with moderate damage in many localized areas because of anchor damage, reef blasting, and crown-of-thorns infestations (e.g. Kata Beach, Nai Han, North Bay of Phi Phi Don);

- ☐ Reefs that are in relatively good condition with limited damage in a few localized areas (e.g., Karon, Ko Kaeo, Ko Dok Mai, Ko Raja Yai); and

- ☐ Reefs that are in very good condition with little or no reported damage to the corals (e.g., Ko Raja Noi, Ko Bida).

Changing Uses and Economic Significance

Major user groups of Phuket's coral reefs include:

Traditional fishermen	Coral and shell collectors
Thai and foreign divers	Tour boat operators
Sightseeing tourists	Escort guides
Aquarium fish dealers	Dive equipment operators
Souvenir shops	Hotel operators
Shell/coral wholesale dealers	

Tourism and Recreational Use

An estimated 7.4 percent of all tourists coming to Phuket report diving and snorkeling as a leisure activity. In 1985, this would have represented 25,000 visitors of which 5,000 were SCUBA divers. In addition, an estimated 100,000 tourists may see the reefs during sightseeing excursions to the offshore islands, making this the largest user group. Daily boat excursions are operated between Phuket and Ko Hae, Phuket and Phi Phi, and Phuket and the Similan Islands.

While there are no data on overall economic benefits generated by tourism use of coral reefs, revenues from tour boat operations to Phi Phi and Ko Hae, an estimated 40 million bahts, provide one indication of the economic value of these habitats. This estimate is a conservative one to which can be added revenues from excursions to other sites, revenues from equipment rental and the sale of souvenirs made from shells.

Fisheries

Reef fisheries account for a small proportion of marine fisheries in Phuket. Species of high commercial value are harvested locally from reefs such as lobster, grouper, snapper, other finfish, and mollusks. Fishing techniques used in reefs include long-line, traps, gill-nets, and reef blasting. While some residents fish for subsistence, others sell their catch to restaurant and hotel businesses in Patong and Phuket town.

Probably no more than 500 long-tail boats (less than 14 m) are used in the artisanal fishery, but this activity has important cultural significance.

An estimated 1500-2000 residents are employed part-time in small-scale reef fisheries, compared to 8,000-10,000 people employed full-time in the offshore trawling fishery. Fishermen report that they must travel further offshore to remote reefs for their catch.

Shell and Coral Collection and Trade

Marine shells and coral are collected from reefs in the study area for the souvenir trade. The major collection sites are the Racha and Similan Islands.

An estimated 400 to 500 Rawai residents participate part-time in the collection of shells and coral, and shell collection features prominently in the local culture. Residents of Ko Sire and Phi Phi Don also participate in the trade but the number of collectors are unknown. Shells and coral are sold to wholesalers in Rawai and Phuket who clean and sell the products to local tourists or ship them to Bangkok and abroad. The wholesalers also supply souvenir shops in Phuket town, Patong, and Kata and local hotels and restaurants that use shells and coral for ornamental purposes. The total value of the local trade is unknown. The value of the harvest on the export market may exceed 8 million bahts but the value to the local sea people who collect the shells is considerably less.

Aquarium Fish Trade

Village residents from the west coast also collect reef fish for a small aquarium fish trade based in Phuket. Colorful juvenile fish are collected from the Racha and Similan Islands. The value of the harvest is unknown, but most of the fish are shipped to Hong Kong and Singapore for the export market.

Reef Management in Phuket

Coral reef management in Phuket, as in all of Thailand, rests on two statutes: the Fisheries Law of 1947 and the National Park Act of 1961. The Fisheries Act governs marine fisheries and the conservation of selected marine species. Rules and regulations have been issued pursuant to the Act prohibiting the collection and export of coral; the use of poisons or explosives for fishing; and trawling or push-net operations within 3000 meters from shore.

Marine Protected Areas established under the National Park Act and the Fisheries Act encompass more than 50 percent of all coral reefs in the study area. These protected areas include Hat Nai Yang, Mu Ko Similan, and Mu Ko Phi Phi Marine National Parks and the PMBC Protected Area. The extent to which the National Park Act does encompass the management of marine resources is currently under review.

Overall Management Approach

The most effective strategy for managing coral reefs is to prevent damage while allowing sustainable uses to take place with reasonable controls. Recognizing this, the CORAL REEF PROTECTION STRATEGY focuses on clearly defined issues that represent avoidable sources of damage. The lack of information for tourists and local residents, anchor damage, limited agency coordination, siltation caused by offshore tin mining, and lack of an enforcement capability in nearshore waters are among the issues identified for immediate attention.

Specific recommendations are built around an analysis of the significance of these issues in terms of urgency, extent, feasibility, and community impact. Criteria used in selecting recommended projects were that projects had to provide clear incentives for the community, strengthen commitment to local stewardship of resources, and result in measurable improvements in the habitat. In addition, the STRATEGY calls for non-regulatory measures such as community-based projects, education, and cooperation between the public and private sector.

Management Programs for Recreation and Tourism

The main issues associated with recreation and tourism are:

Lack of awareness among tourists, guides, and tour boat operators of the impacts of improper recreational use;

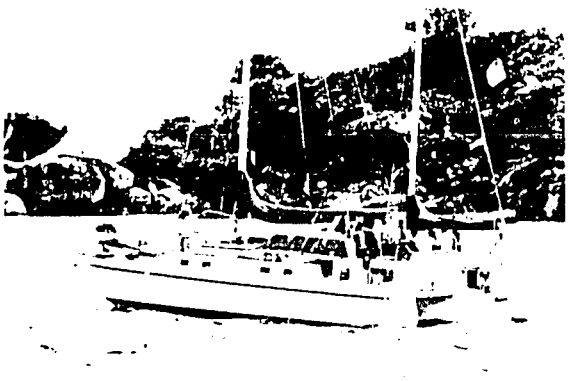
Anchor damage of reefs that are popular year-round destinations for tour boats;

Inadequate diving and snorkeling safety provisions;

Littering and casual collection of reef organisms; and

Lack of guidelines for the expansion of tourist services at offshore islands and reefs.

Recreational users and the tourism industry represent the largest user group and one with clear incentives for protecting underwater resources. To a considerable extent, anchor damage,



Littering and other visitor use damage are associated with a lack of awareness about the impacts of recreational activities on coral reefs. By combining better information services and training of escort guides with techniques to control anchor damage, some of the visible and immediate impacts could be controlled. In the long term, the STRATEGY calls for environmentally sound guidelines for the expansion of tourist services at offshore reefs and a comprehensive public education and community action program.

The suggested strategy for INFORMATION AND VISITOR SERVICES is to:

Expand information services for tourists and operators to include audio visual materials on coral reefs, other coastal resources, diving and snorkeling safety;

Expand training of escort guides taking tourists to reefs;

Initiate a formal certification program for escort guides and tour boat operators;

Improve signs and begin interpretive programs at access point to marine protected areas.

The strategy for the PREVENTION OF ANCHOR DAMAGE is to:

Install demonstration mooring buoys, both in an area outside a marine national park (Ko Hae and Patong) and in a national park (Phi Phi and Similan Islands);

Prepare a mooring buoy plan for all popular tour sites;

Designate no anchoring zones in particularly sensitive areas within existing protected areas.

The strategy for PUBLIC EDUCATION AND COMMUNITY ACTION is to:

Develop a school curriculum using local examples for course topics and class activities;

Initiate a local media program;

Expand interpretive services on coral reefs at the Phuket Aquarium and local marine parks;

Involve local dive groups and others in special community projects such as cleanup campaigns.

The suggested strategy for VISITOR SAFETY is to establish a cooperative emergency response program for diving and snorkeling accidents and to designate safety zones.

The suggested strategy for the PLANNING OF FUTURE TOURIST SERVICES AT OFFSHORE REEFS is to use a set of general guidelines and a use zoning scheme to determine appropriate levels of development at selected reefs in the study area.

Management Programs for Sustainable Fisheries

The main issues associated with the management of sustainable reef fisheries are:

Reef blasting;

Physical damage caused during collection of corals, shells, and aquarium fish;

Lack of fisheries and catch statistics; and

Declining catches of selected reef species including lobster and uncommon shell species.

The most visible impacts of reef fisheries have been associated with destructive techniques such as the use of explosives. However reef stocks important to the local artisanal fishery are now threatened by the absence of any controls on the harvest. Unfortunately, there are little or no data available to assess this problem. With the current focus on offshore fisheries, few agency resources are available for habitat management. The STRATEGY calls for maintaining sustainable yields from coral reefs with better management practices focused on selected problems and progression towards a fishery habitat protection policy.

Specific recommendations are to:

Appoint marine conservation officers for the study area;

Establish size, catch and season limits for commercially harvested species and prohibitions for uncommon species;

Improve enforcement of illegal fishing practices;

Prohibit export of aquarium fish and depleted shells;

Monitor exports of all reef organisms.

Programs for Water Quality Maintenance

Coral reefs require clear water for growth. Suspended sediments affect coral growth by reducing light penetration and smothering living corals. Excessive nutrients from sewage discharges cause the eutrophication and die-off of reefs.

The major sources of pollution affecting reefs in the study area are:

Siltation of reefs caused by localized offshore tin mining operations;

Siltation of reefs caused by coastal erosion and improper watershed management practices;

Increasing nutrient discharges in proximity to reefs.

In addition to its current and localized impact in Ao Bang Tao, offshore tin mining is significant as a potential threat for the future. Increasing sediments loads in areas such as Patong have degraded the fringing reefs and reduced their aesthetic quality for snorkeling and SCUBA diving.

The strategy for maintaining good water quality is to:

Minimize the potential impacts of tin mining through a multiple use zoning scheme for near-shore waters;

Incorporate standards for coral reef protection in the coastal watershed management program.

Research and Monitoring

Management-oriented research will continue to play an important role in implementing the strategy. Some investigations are of immediate priority because they are closely related to the projects listed above. These projects are:

Establish an anchor damage and general reef condition monitoring program at popular tourist sites;

Establish a water quality monitoring program at selected reefs.

Laws, Policies and Institutional Coordination

The main issues associated with institutional context are:

Inadequate laws and regulations for habitat protection;

Limited coordination among the agencies responsible for protecting marine resources and those responsible for controlling use and visitor services;

Absence of a mechanism to involve community groups and the private sector in resource conservation;

Lack of enforcement capability in nearshore waters;

Shortages of skilled personnel.

A key constraint in implementing this habitat management program will be the institutional scope of existing resource agencies which are governed by narrowly defined sectoral objectives. This narrow scope is reflected in existing laws, which do not acknowledge the multiple uses associated with coastal habitats such as coral reefs. It is also reflected in the lack of coordination in on-site management, and the shortage of skilled personnel that can be assigned to habitat protection. There is also a need to build the capabilities of local groups and NGO's and provide more opportunities for community involvement in resource management.

The solution lies in broadening existing laws and regulations administered by the Department of Fisheries, the Royal Forestry Department, the National Environment Board and other agencies to incorporate a habitat perspective. Other recommended projects include:

Developing a workable cooperative patrolling program for nearshore waters and offshore islands that integrates safety, habitat management, and fisheries management priorities;

A comprehensive and workable use zoning scheme for nearshore waters;

A community support program aimed at strengthening the involvement of local groups (mini-grant program);

A cooperative habitat management training program.

Getting Started: Priorities for Implementation

Nine projects are recommended for immediate implementation as part of the Thailand CRMP. Included are projects that are relatively inexpensive and feasible such as a short training course for escort guides and an information campaign. Several projects are recommended because they can be implemented by local groups. Also included are more complex initiatives which are urgently needed and could have a broad impact on the way coral reefs are managed such as the zoning scheme and the cooperative enforcement plan. Funding and phasing of these priorities as well as the other long-term projects are discussed in the strategy.

Applying the Lessons to Other Coastal Habitats

This STRATEGY has been developed with the view that coral reef protection is a building block for preparing additional management strategies for Phuket's other important coastal habitats, such as mangroves and seagrass beds. The latter areas are vital feeding and breeding areas for reef dwellers and, like coral reefs, are the basis for several economic activities. General guidelines derived from the STRATEGY -- reliance on local management and community-based projects, private/public partnerships, are recommended for these other coastal habitats.

A. INTRODUCTION

Coral reefs are highly complex and productive living communities. Healthy coral reefs provide a number of important benefits including the following:

- ☐ Habitat for fish and shellfish populations upon which commercial and traditional fisheries depend;
- ☐ Local recreation and tourism opportunities;
- ☐ Habitat for rare and threatened species;
- ☐ Buffering of shorelines from the full impact of storms and a source of sand for beach nourishment; and
- ☐ An outdoor classroom and laboratory for research and environmental education.

As current development trends continue over the next decade, the demands on Phuket's coral reefs for tourism and fisheries are likely to increase. There is a concern for ensuring that coral reefs can maintain their productive role in the island's economy. This concern extends to all coastal habitats that are the basis for economic development in Phuket.

A strategy provides a way of focusing attention on potential problems and rallying support for habitat management. This STRATEGY is part of a process where local residents, users, businesses, and managing agencies are participating in deciding what should be done to improve the management of Phuket's coral reefs. This document is one outcome of this on-going process.

The purpose of the STRATEGY is to identify, through local consultation, measures that can be implemented to better manage the reefs so that these areas can be used on a sustainable basis for coastal tourism, fisheries, education, and other activities that are the foundation of Phuket's coastal economy.

The activities incorporated in the STRATEGY are designed to meet the following objectives:

- ☐ Manage coral reefs so that they can support multiple uses, including traditional activities on a sustainable basis;
- ☐ Encourage local appreciation for the benefits associated with the area's coral reefs and other coastal habitats;
- ☐ Demonstrate the importance of community action in carrying out successful habitat management programs;

- ☐ Reduce destructive uses and outside sources of damage using non-regulatory measures where possible;
- ☐ Minimize potential conflicts among uses of coral reefs;
- ☐ Protect substantial examples of coral reefs in undisturbed state to maintain diversity; and
- ☐ Protect rare, depleted, or threatened species and reefs of special significance.

Another important objective underlying the preparation of the STRATEGY is to gain experience and formulate general guidelines which can be used to prepare management strategies for Phuket's other coastal habitats, including mangroves, beaches, seagrasses, and offshore islands.

In many ways, the STRATEGY is closely related to other initiatives being carried out as part of the Thailand Coastal Resources Management Project. These elements include projects on water quality and coastal watershed management, the economics of tourism, and the preparation of management plans for marine national parks. Together, these elements represent the foundation for integrated coastal area management in Phuket. For an overview of all elements, readers may wish to refer to **Initial Findings of Fact and Recommendations for Action: Phuket Coastal Resources Management Project** (National Environment Board, 1988).

B. PHUKET'S CORAL REEFS

B.1 The Reef Environment Today

Effective management of Phuket's coral reefs depends on an understanding of these communities and their current status. The following synopsis draws from past research conducted at the Phuket Marine Biological Center and is intended to highlight some of the important physical and biological features of coral reefs in the study area.

For a thorough description of coral reef conditions, readers are referred to **Status and Trends in the Condition of Phuket's Coral Reefs** (Chansang, in prep.), the background paper prepared to complement this STRATEGY.

Distribution and Significance

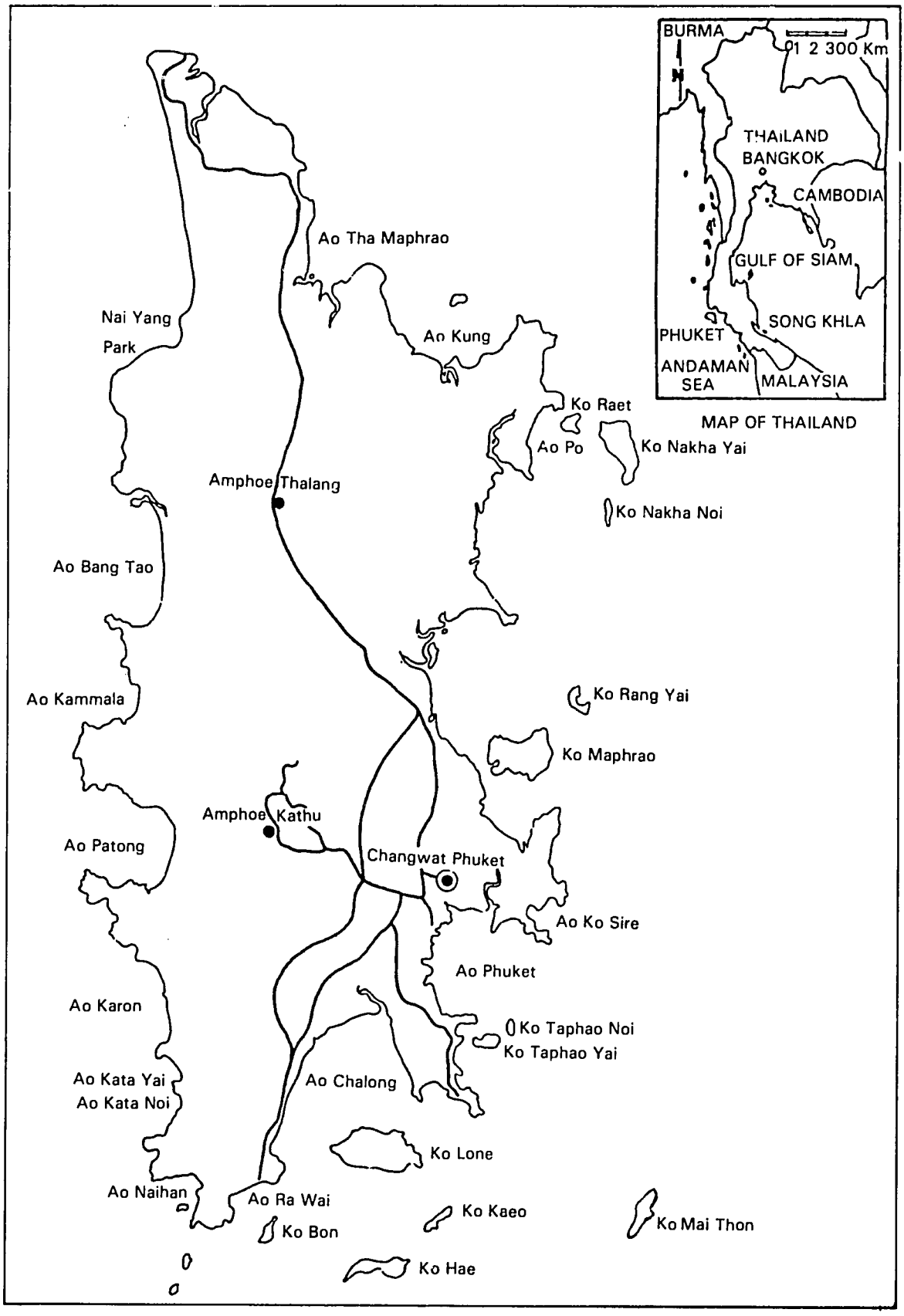
Located in the tropical waters of the eastern Andaman Sea (8 N; 98 20'E), Phuket offers ideal conditions for the growth of coral reefs. Fringing reefs occur within 1.5 km from shore along 50 km of the west and south coasts of Phuket island (Chansang et al., 1985). Reefs also extend along the north eastern side of islands at the southern tip of Phuket such as the islands of Kao, Raja, Hae, Bon, Lone, and Dok Mai where there is some protection from the southwestern monsoon. (Figure 1).

Fringing reefs and related types of benthic communities occur along several offshore islands which are also included in the study area. The most extensive reef formations found at the Phi Phi Island (45 km from Phuket) and the Similan Islands (80 km from Phuket).

The reefs off Phuket and the surrounding islands are among the most diverse coral reef communities in Thailand. More than 200 species of stony corals belonging to 75 genera have been recorded in the study area, in comparison with 60 species in the Gulf of Thailand (Ditlev, 1976, 1980; Chansang, 1984). In a regional context, the study displays similarities with the highly diverse reefs of the Indo-Pacific (UNESCO, 1984; UNEP, 1985). The reefs are listed in IUCN's Directory of coral reefs of international significance (IUCN, in prep.).

FIGURE 1.

PHUKET AND SURROUNDING ISLANDS



A Combination of Habitats

There are marked variations in features among the coral reefs of the study area. Four groups or types have been established based on distinctions in dominant species, morphology, and coral cover (Chansang et al., 1985):

1) Reefs in the sheltered bays of the south and southeast coasts (Locations: Ko Taphao Yai, Ko Lone, Laem Phan Wa, Rawai);

2) Reefs of the southwest coast and satellite islands (Locations: Ko Bon, Ko Hae, Ko Dok Mai, Ko Kaeo);

3) Reefs in the bays along the northwest coast (Locations: Ao Patong to Nai Yang); and

4) Coral communities in the relatively exposed areas of the west coast and offshore islands (northern part of Ao Patong, reef at northern edge of Ao Bang Tao, Raja and Similan Islands).

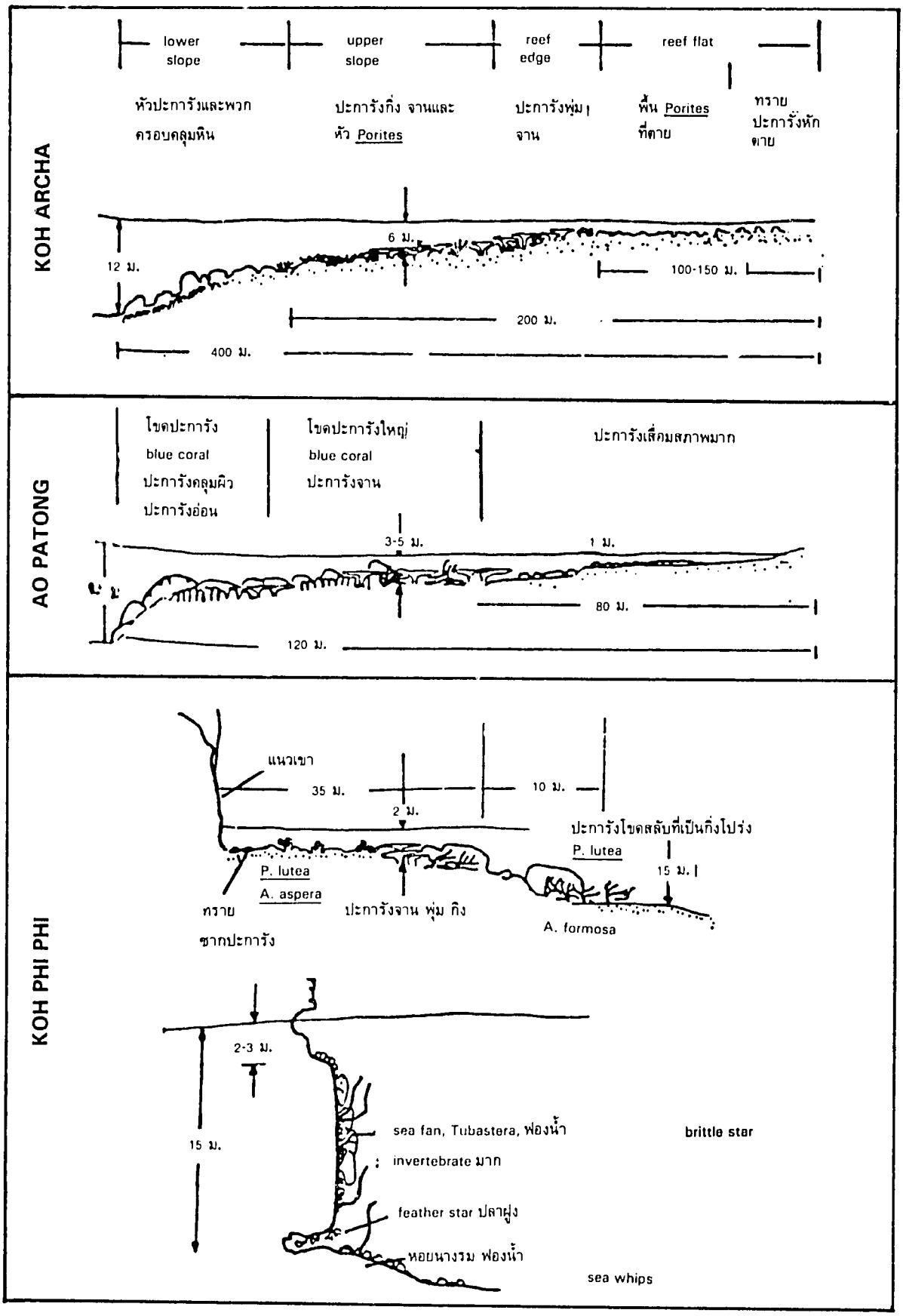
Representative cross-sections are shown in Figure 2. Reefs representative of the first category show the most developed zonation. These reefs are also the most likely to be affected by land-based activities, since they are adjacent to coastal watersheds extending further inland.

The percentage of live coral cover in Phuket's coral reefs varies considerably with the degree of exposure to wind and wave action of the southwest monsoon (Chansang et al., 1983 and 1985; Brown and Holley, 1984). In relative terms, coral communities in the first category (sheltered bays of the south and southeast coast) are the most sheltered and have the highest percentage of coral cover (up to 98%). The other three categories represent increasing degrees of exposure and therefore lower live coral cover under normal conditions.

General Patterns in Reef Conditions

Common indicators used to evaluate the health or condition of coral reefs are the relative extent of live coral cover, water quality parameters, and evidence of decreased populations of reef organisms (Kenchington, 1984; Salvat, 1987). Although observations spanning several years are limited for the study area, there is evidence that these conditions have been deteriorating in some locations (Chansang, et al., 1983; Chansang, et al., in press; Boonyanate, et al., 1986) (Table 1).

FIGURE 2.


KOH ARCHA
lower slope
upper slope
reef edge
reef flat
หัวปะการังและพวก ครอบคลุมหิน
ปะการังกิ่ง จานและ หัว Porites
ปะการังพุ่ม จาน
พื้น Porites ที่ตาย
ทราย ปะการังหัก ตาย
6 ม.
12 ม.
100-150 ม.
200 ม.
400 ม.
AO PATONG
โขดปะการัง blue coral ปะการังคลุมผิว ปะการังอ่อน
โขดปะการังใหญ่ blue coral ปะการังจาน
ปะการังเสื่อมสภาพมาก
3-5 ม.
1 ม.
80 ม.
120 ม.
KOH PHI PHI
แนวเขา
35 ม.
10 ม.
2 ม.
ปะการังโขดสลับที่เป็นกิ่งโปร่ง
P. lutea
15 ม.
P. lutea
A. aspera
ทราย ซากปะการัง
ปะการังจาน พุ่ม กิ่ง
A. formosa
2-3 ม.
15 ม.
sea fan, Tubastera, ฟองน้ำ
invertebrate มาก
brittle star
feather star ปลาฝูง
หอยนางรม ฟองน้ำ
sea whips

Aside from the southwest monsoon, coral cover is locally affected by infestations of the crown-of-thorns starfish **(Acanthaster planci)**. Localized outbreaks of crown-of-thorns were first observed at Rok and Phi Phi Islands in 1982 (Chansang, et al., in press). **A. planci** have since caused extensive damage to the reefs at the northern end of Patong Bay, Phi Phi Don and Phi Phi Le. Less than 45% of the reef areas surveyed at Phi Phi Islands between 1984-86 were still in good condition (>50% live coral) due to a combination of crown-of-thorns and reef blasting. Only moderate damage due to crown-of-thorns was reported at the Raja and Similan Islands and the south coast of Phuket (Chansang et al., in press).

Damage to hard coral cover has also been associated with dynamite or blast fishing, siltation, trampling, and anchor damage (Chansang, 1984; Changsang, 1988; Boonyanate et al., 1986) (see Table 1). A detailed discussion of these issues and their management implications is provided in Chapters D and E.

Intertidal reef flat at Laem Pan Wah, Phuket (Photo: M. Lemay)

Although generally good, coastal water quality in the vicinity of Phuket's reefs is locally affected by sediment discharges from coastal watersheds, resuspended tin mining spoils, and inadequately treated domestic wastewater (National Environment Board, 1986 and 1988; Chansang, 1988). There are reports of siltation and coral die-off due to siltation in Ao Bang Tao, Patong, Ko Hae, and Laem Pan Wah (Chansang et al., 1981; Brown and Holley, 1981; Chansang et al., 1983: Chansang et al., 1985; Chansang, 1988; Brown et al., 1986). Water quality conditions in other locations along the west coast, the satellite and offshore islands are generally good. The management implications of the various sources of pollution for coral reef protection are discussed in Chapter F.

Data on the status of reef fish and invertebrate populations in the study area are limited. There are reports of reduced populations of some species such as lobster **(Panulirus longipes** and **P. penicillatus;** Bhatia, 1974) and gastropods collected for the souvenir trade (Tantanasiriwong, 1978). Relatively lower fish

densities are reported for locations such as Patong, Kata, Ko Hae, Ko Racha Noi and Ko Phi Phi Le (Boonyanate, et al., 1986). Reef fish are still reported as abundant at Ko Dok Mai, Ko Racha Yai, Ko Phi Phi Don and the Similan Islands. However, these represent isolated observations, and systematic reef fish surveys are not known for the study area.

In summary, the following general patterns in reef conditions are apparent. The study area includes (Table 1):

- ☐ Reefs that are extensively damaged (i.e., with dead coral found over extensive areas) because of anchor damage, siltation from offshore tin dredging, crown-of-thorns infestations, and storm damage (e.g., North Patong Bay, Maya Bay, Bang Tao Bay, Chalong Bay);
- ☐ Reefs that are in fair condition with moderate damage in many localized areas because of anchor damage, reef blasting, and crown-of-thorns infestations (e.g., Kata Beach, Nai Han, North Bay of Phi Phi Don);
- ☐ Reefs that are in relatively good condition with limited damage in a few localized areas and in some cases fair water quality (e.g., South Patong, Karon, Ko Kaeo, Ko Dok Mai, Ko Raja Yai); and
- ☐ Reefs that are in very good condition with little or no reported damage to the corals although the status of reef fish populations may be unknown (e.g., Ko Raja Noi, Ko Bida).

B.2 Uses and Economic Significance of Coral Reefs

The coral reefs of Phuket and surrounding islands support a broad range of activities carried out either by local residents or occasional visitors. Major user groups include:

Local Thai fishermen	Sea people
Sightseeing tourists	Tour boat operators
Foreign SCUBA divers	Escort guides
Thai SCUBA divers and dive clubs	Shell/coral wholesale dealers
Souvenir shops	Aquarium fish dealers
Dive equipment shops	Hotel operators

Rough estimates of the number of individuals involved in each group are provided in Table 2.

Recreation and Tourism

The major recreational activities associated with coral reefs in the Phuket area are snorkeling, SCUBA diving, sightseeing from glass-bottom boats, and sport fishing. Both the fringing reefs of Ko Phuket and the offshore islands are popular for snorkeling. Divers tend to prefer the better visibility at offshore reefs such as the Similan and Racha Islands, Dok Mai, and the Phi Phi Islands. The major year-round destinations for sightseeing (with glass-bottom boat tours) are the Phi Phi Islands and Ko Hae.

Table 1. Summary of Reef Conditions Around Phuket and Surrounding Islands

SITES	CONDITIONS			
	Very Good	Mod. Good	Fair	Poor
1. Nai Yang Beach		■		
2. Bang Tao				■
2a South Nai Yang Beach		■		
3. Laem Son			■	
4. Patong Beach South Bay		■		
5. Patong Beach North Bay				■
6. North Karon Bay		■		
7. Kato Beach (Ko Pu)			■	
8. Kata Noi Beach		■		
9. Nai Harn Beach (Ao Son)		■		
10. Nai Harn Beach (Ko Man)			■	
11. Ko Kaeo Yai		■		
12. Tip of Western Hae Island		■		
13. Tip of Eastern Hae Island		■		
14. Ko Hae (Northeastern shore)		■		
15. East Ko Dok Mai	■			
16. West Ko Dok Mai		■		
17. Ko Racha Yai - Mid - South Bay			■	
17a Ko Racha Yai - Cape - South bay	■			
18. Ko Racha Noi - Flank West Bay	■			
18a Ko Racha Noi - North South Channel		■		
19. East Ko Racha Noi	■			
20. Ko Phi Phi Don South Bay 1		■		
20a Ko Phi Phi Don South Bay 2	■			
20b Ko Phi Phi Don South Bay 3			■	
20c Ko Phi Phi Don North Bay			■	
21. East Ko Phi Phi Don		■		
22. East Ko Phi Phi Le		■		
23. Ao Maya (Phi Phi Le)				■
24. Hin Pita Ni	■			
25. Hin Pita Nok	■			
26. Ko Yoong		■		

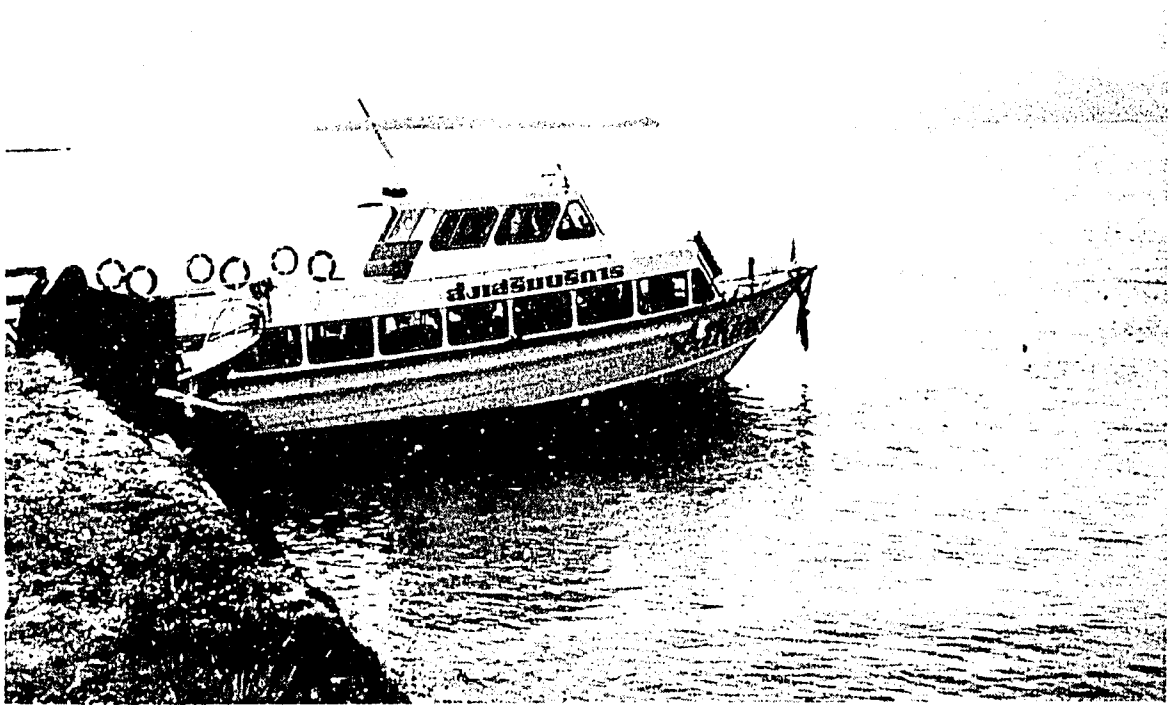
Today, tourists (both Thai and foreign) represent the single largest user group of the study area's coral reefs. An estimated 7.4 percent of all tourists (Thai and foreign) coming to Phuket report diving and snorkeling as a leisure activity (Tourism Authority of Thailand, 1986). In 1985, this would have represented 25,000 visitors of which 5,000 were SCUBA divers. The percentage of diving and snorkeling use may be even higher for foreign tourists. In a survey conducted by Mahidol University, 29.5 percent of the tourists from the U.S. reported diving (snorkeling and SCUBA) as an activity (Mahidol University, 1986).

To these estimates can be added the thousands of tourists that take glass-bottom boat tours during sight-seeing excursions to the offshore islands. Daily boat excursions are operated year-round between Phuket and Phi Phi, Phuket and Ko Hae; and from November through April to the Similan Islands. Sight-seeing day tours were first introduced to the Similan Islands during the 1987 season. In the past, excursions to the Similan Islands were part of 4-7 day packages which often included the Surin Islands. There has been a trend towards increasing the number of boat tours and offshore destinations (mainly coral reef islands) available from Phuket.

The advent of tourism in the last decade has heralded a new dependence of local businesses on coral reefs. There are about 32 tour companies in Phuket town and Patong, with most offering year-round boat excursions. Approximately 12 operators run vessels from Phuket to Phi Phi Don and Ko Hae. Passengers are offered snorkeling equipment for a small fee during the trip.

At some locations, long-tail boats converted to glass-bottom boats take tourists to see nearby reefs. In addition, 18 other businesses rent snorkeling and diving equipment and offer specialized SCUBA diving tours (Lemay, 1987). About 100 souvenir shops on the island sell shell and coral artifacts to tourists (Chulalongkorn University, 1988).

While there are no data available on the overall economic benefits generated by tourim use of coral reefs, revenues from tour operations to Phi Phi and Ko Hae, an estimated 40 million bahts, provide one indication of the economic value of these habitats. This estimate is a conservative one to which can be added revenues from excursions to other sites, revenues from equipment rental, and the sale of souvenirs from shells.



Tour boat leaving Makham Bay for Phi Phi (Photo: M. Lemay)

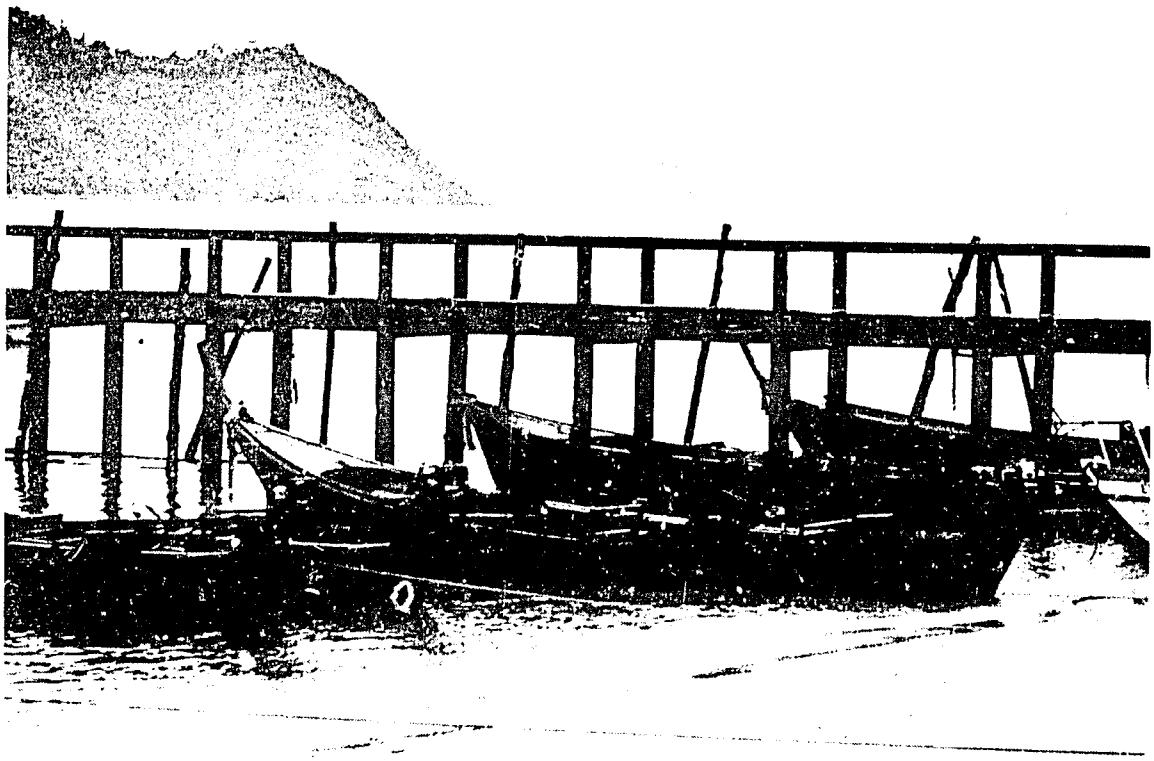
Table 2

ESTIMATED NUMBER OF CORAL REEF USERS BY CATEGORY		
CATEGORY	**BUSINESSES**	**INDIVIDUALS**
Fishing, Harvesting and Commercial Trade		
Artisanal fishermen (total)	-	1500 - 2000
Shell/coral collectors	-	500 +
Aquarium fish collectors	-	100 +
Shell/coral wholesale shops	5	(owners + employees)
Aquarium fish operations	6	(owners + employees)
Recreation and Tourism		
SCUBA Diving (Intl + Thai)	-	5,000/year
Snorkeling tourists	-	20,000/year
Offshore sightseeing (excluding above)	-	10,000/year +
Tour companies (total)	32	(owners + employees)
Boat operators	12 +	(owners + employees)
Souvenir shops	40 +	(owners + employees)
Dive equipment shops	11 (18 ?)	(owners + employees)
Education and Research		
School children visiting Aquarium	-	10,000/year
Tourists visiting Aquarium	-	34,000/year
Local residents visiting Aquarium	-	5,000/year

Artisanal Fisheries

In the past, the fringing reefs of Phuket supported a traditional subsistence fishery carried out by sea people living in Ko Sire, Rawai, and Chalong Bay (Fraser, 1966; Boulbet, 1984). Today, reef fisheries predominate along the west coast of Phuket, but not the east coast where small-scale fisheries are associated with other coastal habitats.

Reef fisheries are carried out from the traditional long-tail boats in villages around Ko Phuket and Phi Phi Don. The main fishing villages for this reef fishery are Ko Sire, Chalong Bay and Rawai, and Phi Phi village. There is also a limited long-tail boat fishery out of the bays of Karon, Kata, Patong, Kamala, Bang Tao, and Nai Yang.



Traditional long-tail boats, Chalong Bay (Photo: M. Lemay)

Fishing techniques still used in reefs today include various types of traps, hook-and-line, and cast nets. Gill-nets (set nets, drift nets, corrals) with monofilament nylon are also used in the nearshore fishery. Although illegal, explosives are also used to fish pelagic species in close proximity to reefs (Chansang, 1984).

Species harvested from reefs include grouper and sea bass (Serranidae), snappers (Lutjanidae), grunts (Haemulidae), and lobster. Residents in Rawai and Ko Sire also free dive and use surface air supply to collect shellfish. While some fish for subsistence, most villagers sell their catch to restaurant and hotel businesses in Phuket town and Patong.

Based on the available data, reef fisheries account for only a small proportion of all marine fisheries in Phuket province (Department of Fisheries, 1987). Approximately 500 long-tail boats are currently used in the artisanal fishery, compared to 1,321 otter board trawls. An estimated 1500-2000 residents are employed part-time in small-scale fisheries, compared to the estimated 8,000 - 10,000 people employed in pelagic fisheries (1982). However, the income made by villagers from part-time participation in the nearshore fishery may be significant particularly in the rural areas (Panayotou, et al., 1985). The percentage of Phuket's total marine fisheries production attributable to reef fisheries is unknown. Stony corals (Order SCLERACTINIA) are harvested by sea people in Rawai, and to a lesser extent Ko Sire

Coral Collection and Trade

and Phi Phi village. Collection of corals for sale is illegal in Thailand however the enforcement of existing regulations hass been difficult. Coral specimens are collected from the west coast of Phuket (Nai Yang), the Racha and Phi Phi Islands and, to a lesser extent from the Similan Islands. Species harvested range from Acropora, Porites, Faviids, blue corals and the more ornamental, branching species. Black corals are not harvested extensively for sale at this time.

Unworked coral specimens are sold by sea people to agents in Rawai and Phuket town. Coral represents only a small proportion of the wholesale coral and shell trade in Phuket, accounting for less than 20 percent of the inventory in shell shops. Coral specimens are sold cleaned but unworked to tourists and collectors and for ornamental use in local hotels and restaurants. The export of coral from Thailand is illegal however there have been problems with the enforcement of the regulation. While there are still some illegal exports, the volumes are small compared to exports from neighboring countries such as the Philippines (Wells, 1981; Lemay, 1987).

Marine Shell Collection and Trade

Marine shells are harvested by local sea people in Rawai, Ko Sire, and Phi Phi Don. Originally, mollusks were collected for food (Tantanasiriwong, 1987). While mollusks are still part of the diet of island residents, the main reason for collection is to provide specimens for the souvenir trade and pearl farming.

Shell species collected from reefs for the souvenir trade include **Trochus niloticus, Turbo marmoratus, Charonia tritonis, Conus sp., Pinctada sp., Tridacna sp., Chiroreus ramosus, Strombus sp., Cypraea sp.** and **Conus sp.** (Lemay, 1987). These are also among the most commercially valuable species.

Local residents collect shells by gleaning reef flats and by diving at the reef edge and slope. Most large specimens of shells are now collected from the offshore islands with the Racha and Similan Islands being major collection sites. Collection also occurs in Nai Yang but the reefs along Rawai have largely been depleted (Lemay, 1987).

Approximately 400-500 villagers in Rawai participate part-time in the collection of marine shells (Lemay, 1987). Numbers are not available for the other villages. The vessels and equipment are usually owned by agents to whom the sea people sell their harvest. Common raw shells are sold by the kilo (10 bahts/kg or $US 0.40/kg) but the rare or large ornamental species are sold individually for higher prices. Shells are sold to about four wholesale operations in Rawai and two wholesale operations in Phuket town.

Wholesale shops sell cleaned specimens and shell artifacts for the local tourist market. They also supply souvenir shops in Phuket town, Kata and Patong and local hotels and restaurants that use shells and coral for ornamental purposes. More than half of the inventory observed in shell shops were reef and reef flat specimens (Lemay, 1987).

Collecting shells along the reef flat (Photo: M. Lemay)

The wholesale operations ship and export large volumes of marine shells to Bangkok, Singapore, Hong Kong, the EEC and the U.S. (Lemay, 1987). Species such as **Trochus niloticus** are used for the mother-of pearl, button-making, and jewelry trade whereas uncommon species are highly priced by European and American collectors (Wells, 1980 and 1981).

Data are not available on volumes of marine shells being exported directly from Phuket. However marine shell exports from Thailand do provide an indication of the volume of trade in marine shells. Since 1980, Thailand has exported an annual average of 20 metric tons of unworked marine shells to the U.S. alone for a wholesale value of U.S. $500,000 - 750,000 (National Marine Fisheries Service, misc. years). Shell products and items of shells represented another $200,000 in exports to the U.S.

Aquarium Fish Collection and Trade

Reef fish are collected for sale by sea people in Rawai. There are approximately ten households or 100 villagers in Rawai participating in this activity during 5-6 months of the year. Villagers in Ko Sire and Nai Yang also collect reef fish.

Fishermen use set nets to collect fish in reef flats and at the reef edge. The techniques used to bring the fish to the surface are similar to those described in Sri Lanka (Wood, 1985) and Hawaii (Randall, 1987). Unlike in the Philippines, cyanide or other types of poison are not commonly used in Phuket since these techniques are thought to damage and reduce the value of the fish (Lemay, 1987). The Racha Islands and the Similan Islands are reported as major collection points, although survival rates are higher for fish collected from the Racha Islands. Species collected include angelfishes, butterflyfishes, anemone-fishes, triggerfishes (O. Bhatia, pers. comm.). Juveniles, rather than adults are taken because of better survival rates.

Collectors sell the live fish to four dealers in Rawai, one in Phuket town and another in Nai Yang. Two of the six dealers are foreign-owned and their inventory is destined solely for the export trade. Fish are shipped to Bangkok, Hong Kong, the EEC and the U.S. There are no estimates available on the volume of sales and exports from Phuket. The collection, holding, and export of marine ornamental fish in Thailand are not regulated at this time.

B.3 Reef Management in Phuket

Coral reef management in Phuket province, as elsewhere in Thailand, rests on a set of laws and regulations for marine fisheries and a network of protected areas.

Fisheries Laws and Regulations

The Fisheries Act of 1947 establishes the regulations governing marine fisheries in Thailand's coastal and offshore waters. The Act establishes four types of waters: Protected Areas, Reserved Areas, Leased Areas, and Public Areas.

All coral reefs within the study area are classified as "Public Areas" except for the protected area at Ko Lone. Protected areas are sanctuaries where fishing is not permitted (Phasuk, 1985).

Several Ministerial Regulations and Notifications have been issued pursuant to the Fisheries Act including:

- ☐ Prohibition of the use of explosives, toxic substances, or electricity for fishing;
- ☐ Prohibition of sale of fish caught by illegal practices;
- ☐ Prohibitions of the collection and export of corals;
- ☐ Prohibition of the collection of sponges;
- ☐ Prohibition of the collection of sea turtle eggs and sea turtles except by permit; and
- ☐ Prohibition of trawling and push-net operations within 3 kilometres from shore.

Spearguns are not specifically prohibited under these regulations. There have been problems with the enforcement of these regulations particularly due to limitations with offshore patrolling (Chansang, 1984). The Department of Fisheries has officers based in the Muang and Thalang districts (but not the Katu district) for shorebased monitoring of catches. Patrols and surveillance in coastal and offshore waters are limited at this time. Other than the regulations listed above, there are no size, catch or season limits in effect for reef fisheries. There have been recommendations for establishing such limits for the lobster fishery of Phuket (Bhatia, 1974). However, new regulations for the protection of several reef mollusks and fish are now under consideration by the Department of Fisheries.

Protected Areas

There are four marine protected areas designated in the study area either under the National Park Act of 1961 or the Fisheries Act:

Hat Nai Yang - 9,000 ha (6,800 ha marine)
Mu Ko Similan - 12,800 ha (11,400 ha marine)
Hat Nopharat Thara Mu Ko Phi Phi - 32,596 ha marine
PMBC Protected Area

Approximately 50 percent of the study area's coral reefs are included in existing marine protected areas (either in marine national parks or fisheries protected areas).

While the provisions of the Fisheries Act apply to all protected areas, the extent to which the National Park Act applies to marine areas is currently under review (Seri Vejaboosakorn, pers. comm.). According to the National Park Act, it is unlawful to take or collect any natural resource for commercial purposes or to willingly degrade natural resources. However, the law was designed primarily to prohibit hunting in terrestrial parks and may not apply to marine resources.

Kasetsart University recently completed an assessment of national parks in Thailand. Operational problems include conflicts between traditional land tenure and park boundaries, inadequate planning of infrastructure, lack of enforcement capability, shortages of trained staff, and limited quality educational programs. These problems are compounded in marine national parks due to difficult access during the monsoon season, unlimited entry, and lack of seaworthy and rapid vessels (Kasetsart University, 1987).

The National Park Office does not regulate tour boat operations in marine national parks at this time. Visitations to Phi Phi national park increased more than twofold between 1985 and 1987 (National Environment Board, 1988). Visitations to Nai Yang and Similan Islands also increased dramatically, forcing the construction of park infrastructure in the absence of any management plan. Research, interpretive programs, and resource management activities focusing on the coral reefs resources of the marine national parks are limited.

Similan Marine National Park (Photo: Courtesy of TAT)

C. A COMPREHENSIVE APPROACH TO CORAL REEF MANAGEMENT

C.1 Overall Management Framework

The most effective strategy for coral reef management is to prevent damage while still allowing sustainable uses to take place with reasonable controls. Recognizing this, the CORAL REEF PROTECTION STRATEGY focuses on clearly defined issues that represent avoidable sources of damage. Specific recommendations are then built around an analysis of these issues in terms of their ecological and economic implications and other community impacts. Perhaps most important, the recommendations stem from the observations and judgements of long-time residents of Phuket as to what are workable solutions for the area. These recommendations are made both for coral reefs within protected areas (where there is some existing jurisdictional authority) and for coral reefs outside any protected area.

Since an important goal of the process is to generate local involvement in management, non-regulatory initiatives are favored over strictly regulatory measures. This approach is the best way to reinforce the linkage that this so important to Phuket -- the linkage between productive coastal resources, multiple use, economic growth, and community well-being.

Having provided a foundation for the STRATEGY in the analysis of issues, the next step is to establish priorities for a **community-based habitat management program.** The following are the basic elements of the STRATEGY presented in the next several chapters:

1. Programs for Tourism, Recreation and Education aimed at reducing recreational impacts and enhancing public appreciation for coral reefs;

2. Programs for Sustainable Fisheries aimed at maintaining the productivity of the habitat;

3. Programs for Water Quality Maintenance aimed at limiting pollution impacts from developments adjacent to coral reefs;

4. Research and Monitoring Programs aimed at improving scientific understanding of coral reef management;

The STRATEGY makes repeated references to the legal revisions, cooperative arrangements, and zoning needed to better manage coral reefs in Phuket. These legal and institutional aspects have been consolidated into the final chapter of the STRATEGY in order to clearly convey where coordination is necessary not only for coral reef management but also for the management of other coastal habitats.

C.2 The Focus on Issues

A crucial step in developing the STRATEGY was the selection of issues which should be given immediate attention in order to better manage Phuket's coral reefs. The threats and sources of avoidable damage were defined by local experts and local residents knowledgeable of the resource and its economic uses.

Most of the recommendations made in the remaining sections relate to the following issues for coral reef management:

ANCHOR DAMAGE
LITTERING AND MARINE DEBRIS
CASUAL COLLECTION AND TRAMPLING
LACK OF AWARENESS AMONG RECREATIONAL USERS
RAPID EXPANSION OF OFFSHORE TOURIST SERVICES
LACK OF AWARENESS AND INVOLVEMENT OF LOCAL RESIDENTS
SILTATION FROM OFFSHORE TIN MINING
SILTATION FROM LAND-BASED SOURCES
REEF BLASTING
PHYSICAL DAMAGE CAUSED DURING COMMERCIAL COLLECTION
ILLEGAL COLLECTION AND POACHING
LIMITED MANAGEMENT OF HARVESTABLE STOCKS
UNCLEAR JURISDICTION IN PROTECTED AREAS
LACK OF ENFORCEMENT CAPABILITY

As part of this analysis, the ecological, economic and social implications of each management concern were evaluated. The relative significance of issues was assessed in terms of urgency, scope of extent, feasibility, community impact and visibility (Table 3).

It is important to note that not all problems identified are of equal significance. As in many areas of Southeast Asia (Gomez, 1988; McManus, 1988; White, 1987), the greatest contributors to reef stress in Phuket are siltation and destructive fishing techniques. Tourism impacts (such as anchor damage and trampling) are still localized but increasing in step with tourism growth in Phuket. The limited public awareness of Phuket's coral reefs and the lack of successful enforcement go hand in hand and are at the root of many tourism and fisheries-related problems.

The results of the analysis summarized in Table 3 demonstrate that some issues can be categorized as relatively simple, "tractable" yet with sufficient community impact to be visible. Anchor damage, trampling and littering, illegal collection and poaching are good examples of such problems. These problems are good starting points for a community-based management strategy since the impacts are visible, technical solutions are readily available, and the target users are easy to reach through local channels. Tourism-related problems represent a sound investment in community efforts, since future trends suggest that the current expansion in the tourism sector will continue (National Environment Board, 1988).

Table 3. Summary Analysis of Issues for Coral Reef Protection

ISSUES	URGENCY	SCOPE	FEASIBILITY	COMMUNITY	VISIBILITY
Anchor Damage	▲	▲	▲	△	▲
Littering	△	▲	▲	▲	▲
Casual Collection	△	△	▲	△	▲
Awareness among Recreational Users	▲	▲	▲	▲	▲
Awareness among Local Residents	▲	▲	▲	▲	▲
Recreational Safety	△	△	▲	△	▲
Rapid Expansion of Offshore Services	▲	▲	△	△	△
Siltation from Land-based Sources	▲	U	△	▲	▲
Siltation from Offshore Tin Mining	U	U	△	▲	▲
Reef Blasting	▲	△	△	△	▲
Physical Damage from Collection	U	△	△	△	▲
Depletion of Rare Species	U	U	▲	△	▲
Limited Management of Harvestable Stocks	▲	▲	△	▲	▲
Inadequate laws for Habitat Protection	U	▲	△	▲	△
Limited Coordination among Agencies	▲	▲	△	△	△
Lack of Opportunities for Local Involvement	▲	▲	▲	▲	▲
Lack of Enforcement Capability	▲	▲	△	U	▲
Shortages of Trained On-site Staff	▲	▲	▲	▲	▲

High ▲
Moderate △
Undetermined U

Other issues are also urgent and visible but much more complex such as reef blasting, siltation, the lack of management of harvestable stocks, and the rapid expansion of tourist services at offshore reefs. Solving these problems requires both sustained local cooperation and a long-term commitment by national agencies to implement solutions. These considerations entered in the phasing and final selection of priority projects (see Chapter I.GETTING STARTED: PRIORITIES FOR IMPLEMENTATION).

C.3 Criteria for Selecting Projects

The projects which make up the Strategy fall under three basic approaches:

- Projects for increasing public appreciation and understanding of the coral reef resource and sustainable use;
- On-site projects for directly encouraging compatible use, reducing and controlling on-site damage; and
- Research projects for increasing the scientific understanding of the status and management of coral reefs.

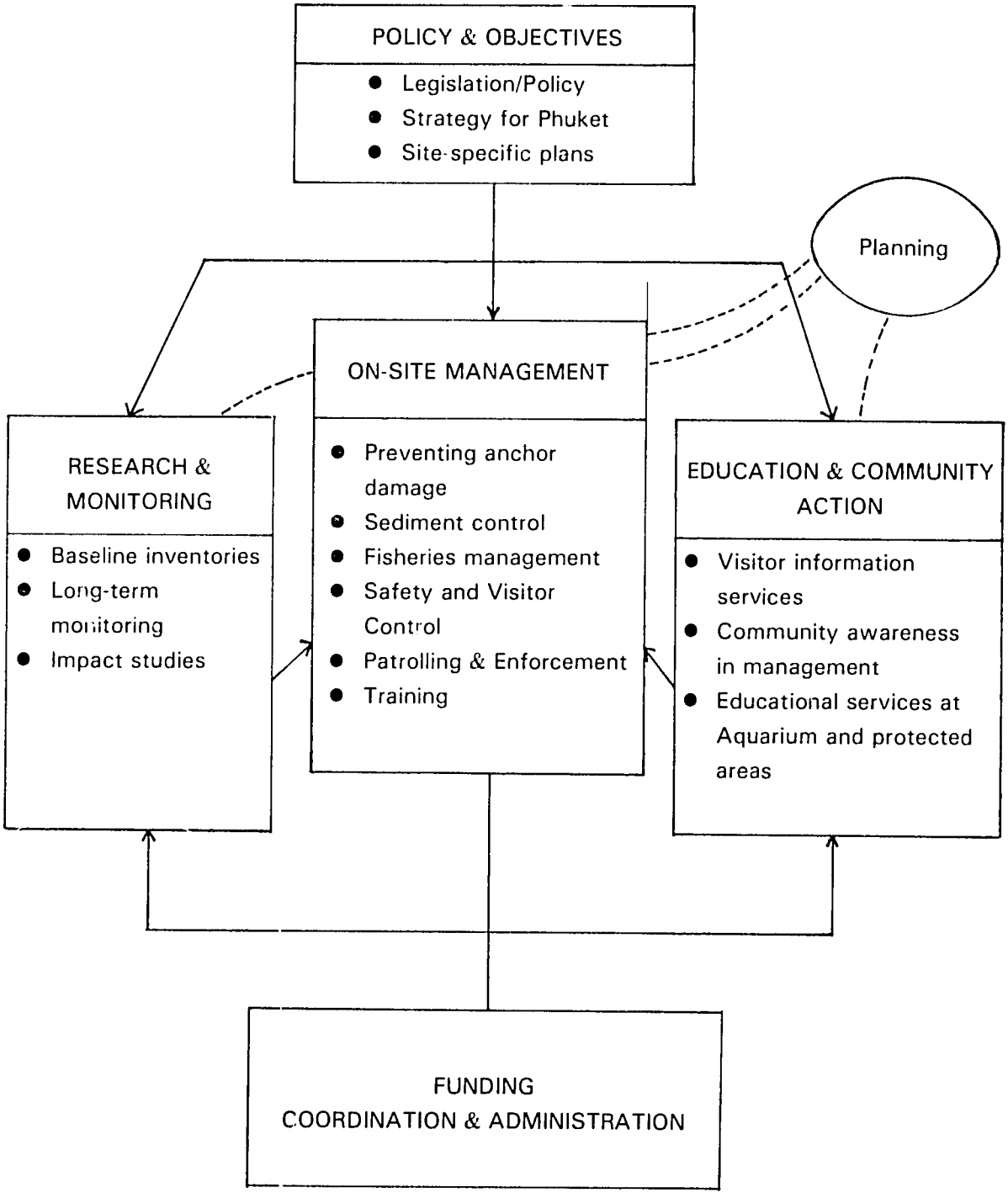
Figure 3 illustrates the management framework and the linkages needed between on-site mangement, public awareness, and applied research.

The following criteria were used to select projects for a **community-based habitat management program** in Phuket:

- Projects have to result in measurable improvements in the coral reef resource;
- There has to be a clear incentive and benefits for the community;
- Implementation has to involve local residents and encourage partnerships between private and public sectors;
- It should be feasible to carry out the projects through exisiting local community groups, volunteers, and managing agencies with some on-site training;
- Projects have to build on existing institutional responsibilities and capabilities; and
- Projects have to strengthen local commitment to local stewardship of resources.

In general, the STRATEGY encourages local management, volunteer activity, and partnerships between managing agencies and user groups.

FIGURE 3. SUMMARY OF OVERALL MANAGEMENT FRAMEWORK



Adapted From Lemay 1987, Planning for Marine Protected Areas, **Proceedings of the International Marine Protected Area Management Seminar**

D. PROGRAMS FOR RECREATION, TOURISM AND PUBLIC EDUCATION

D.1 Selected Management Issues

With the recent increases in water-based recreation and tourism in Phuket and nearby islands, some reefs are showing signs of overuse due to anchor damage, trampling, littering (submerged debris), and casual collection. The problems are most severe at tourist sites in the vicinity of beach resorts such as Patong or tourist sites used year-round such as Maya and Tonsai Bay (Phi Phi) and Ko Hae. While the impacts of recreational activities are still localized, their significance could increase dramatically over the next decade with the projected threefold increase in tourism (National Environment Board, 1988). To a large extent, visitor use damage reflects a lack of awareness among recreational users which can easily be corrected with well-designed and targeted information.

D.1.1. Anchor Damage

Excursion vessels tend to go to the same offshore reefs with protected anchorages at Ko Hae, Phi Phi, Patong and the Similan Islands. Since there are few permanent moorings, the vessels have to anchor close to and often in coral.

The ecological impacts of anchor damage are associated with the breakage of coral heads, crushing, and abrasion caused by the anchor line. Once broken, coral takes several years to recover so that the impact of anchor damage is cumulative (Davis, 1977). Anchor damage from charter boats is recognized as a serious problem in other tropical regions where coral reefs are a tourism asset (Davis, 1977; Jaap, 1984; Rogers, 1985; Halas, 1985; Rogers, et al., 1987). In time, the deterioration could reduce the diving potential of the most popular reefs.

D.1.2. Marine Debris and Trash

Popular tour sites are littered with trash on the sea floor, including glass bottles, cans, and other containers. Submerged debris and plastic containers washing up onshore are reported as an increasing problem in Patong and the offshore islands. Much of the submerged debris results from the disposal of refuse by tour boat operators and their customers (Lemay, 1987). This problem reflects in part the fact that there are few provisions for waste disposal at the offshore sites. As the numbers of tour boats and visitors continue to increase, the problems of litter and marine debris at the offshore islands are also expected to gain magnitude.

The impacts of marine debris are both ecological and aesthetic. Submerged debris can abrade and damage coral as it shifts with currents. Sea turtles get entangled in marine debris, which is suspected to be a cause

of mortality in some areas. Littered sites lose much of their pristine quality and appeal for divers. And finally, most of the plastic thrown overboard eventually washes up on the area's shores. Litter beaches and mangroves not only lose their scenic appeal but are also a clue to a more serious waste disposal problem common to small islands worldwide (OTA, 1987; Beller; 1987).

D.1.3. Casual Collection and Trampling

It is not uncommon for novice divers and snorkelers to take coral and shell specimens, particularly while diving over shallow reef flats. Coral specimens are collected as souvenirs both outside and within marine national parks, despite the fact that coral collection is illegal. Few tourists are aware or ever notified of existing prohibitions of coral collection during the course of their visit (Lemay, 1987).

The ecological impacts of these activities are probably minimal when compared to other sources of disturbance. Collection and trampling disturbs the substrate and can involve the removal of rare specimens. However, the control of casual coral collection has a symbolic importance. The ban on commercial coral trade will continue to be difficult to enforce if tourists are allowed to collect coral.

D.1.4 Lack of Information to Recreational Users

Almost every instance of recreational damage is associated with a lack of awareness among users of coral reefs, their value and what constitutes damage. Informal questioning of tourists and tour guides indicates that key user groups are usually unaware of the damage they may be causing. For example, little or no information is provided to sightseeing tourists at the major access points for offshore excursions (Makham Bay) or at landing sites. Escort guides are not trained to inform novice snorkelers of proper conduct or even to explain the significance of the reefs that are protected in the marine national parks. Boat operators have limited access to information concerning navigation and mooring in proximity to the popular reefs. At the marine national parks, there are too few park naturalists and rangers with the training and experience necessary to interpret coral reefs and other marine resources and to monitor visitor use (Kasertsart University, 1987).

This problem will grow in significance if existing tourism trends continue. Each year, an increasing number of excursion vessels transport greater numbers of uninformed tourists to undisturbed offshore reefs such as the Similan Islands. Environmental information services have not kept pace with the expansion of offshore recreation. In time, the recreational carrying capacity of even the most pristine reefs could be exceeded, as it has been in other heavily visited areas worldwide (Salm, 1986; Tilmant, 1987).

D.1.5 Recreational Safety

The limited on-site management capabilites at popular offshore locations could have serious repercussions for visitor safety. First-time snorkelers and divers receive little or no information concerning basic water safety either at the Phuket resorts or at the marine national parks. Few park personnel and escort guides

are trained in water safety procedures. Even the heavily visited marine national parks do not have the transport and radio communication equipment for rapid response in the event of emergencies. Local dive instructors and guides have also expressed concern for the lack of nearby medical and treatment facilities to deal with diving accidents.

The Tourism Authority of Thailand has recognized all aspects of offshore safety, including vessel seaworthiness, and operator training, as an important concern.

D.1.6 Expansion of Tourist Services at Offshore Reefs

Proposals for the expansion of offshore services have increased dramatically in the last five years, mainly in response to the growth of the tourism sector in Phuket. The Royal Forestry Department has had to step up the construction of camping facilities at Phi Phi and the Similan Islands (Noppadol Briksavan, pers. comm.). Construction has placed a heavy demand on park staff, leaving too little resources for interpretive services and resource management. Most recently, proposals for new services at the offshore islands have ranged from offering daily "low-budget" excursions to previously inaccessible reefs, to hydrofoils and underwater towers. There are no guidelines for determining if, where, and when such developments might be appropriate. The extensive reefs found along offshore islands now exist in a "policy vacuum" with little direction as to how best distribute the growing demand for offshore recreation. There is a need to understand how projected tourism growth in Phuket over the next decade will affect coral reefs at the offshore islands.

D.2 Recommended Programs

Education and community action are an important part of the long-term solution to managing Phuket's coral reefs for tourism and recreation. Effective information services will help users understand the relation between the benefits they derive from reefs and the resource's health. Informed users are more likely to care and support management measures including zoning.

Community activities get local residents involved in solving resource management problems and build a constituency not simply for coral reefs but all coastal resources including mangroves, beaches, seagrass beds, and estuaries. Such activities also help focus the attention of local and national decision makers.

D.2.1 Information and Visitor Services

The most urgent priority is to inform recreational users and the tourism industry of damage that is avoidable. These represent the single largest user group and ones with clear incentives for supporting better management and services for coral reef recreation. Worldwide experience indicates that where local operators and tourists have been well informed of regulations and appropriate use, the incidence of damage is reduced (Halas, 1985).

SUGGESTED ACTIVITY: Expanded Tourist Information Materials

This activity entails developing printed materials to raise the awareness of tourists concerning Phuket's coral reefs, other coastal habitats, recreational activities, and the area's marine national parks. Materials should include a series of simple but attractive brochures describing the natural coastal habitats of Phuket, with special emphasis on protected areas. It should warn against taking coral or buying shells that are protected. The brochure should also include safety precautions and availability of snorkeling and SCUBA diving instruction. The brochure should be available in Thai, English and Chinese and distributed at the airport, hotels, other access points, and through tour companies.

Other materials targeted to tourists include a coral reef poster; a video that could be made available to offshore excursion operators (many have a video monitor on board for such purposes); and coral reef postcards. Wherever feasible, the tourist information materials should be developed as part of the cooperative education program described below (see D.2.3 Public Education and Community Action).

IMPLEMENTATION: Tourism Authority of Thailand, Department of Fisheries, Royal Forestry Department (National Parks) with possible sponsorships from tour companies.

SUGGESTED ACTIVITY: Formal Training and Certification of Escort Guides, Tour Companies and Boat Operators

The activity entails the creation of a formal training program on interpreting Phuket's coastal environment to tourists. The training program would be offered to escort guides and tour agents that accompany tourists on offshore excurisions and National Park staff. The guides are an important factor in ensuring that tourists understand the need for protecting the reefs and support coastal management. The training course could be designed to complement the existing program offered to guides by TAT at the Community College. The emphasis of the program would be on the significance of Phuket's coral reefs, snorkeling safety instructions, cautions against damaging the coral, and emergency procedures. A slightly modified program emphasizing water safety, navigation, and anchoring could be offered to tour boat operators.

A certification program for escorts guides and boat operators accompanying tourists to national parks and the PMBC protected area is also recommended. Certification would be given to those guides and operators that have successfully completed the training course. At first, certification would be voluntary. It could eventually be used to control illegal operators in marine national parks (see registration program below). Similar programs are in place and are operated with the full support of the local tourism industry in other marine protected areas (e.g., Galapagos National Park).

IMPLEMENTATION: Tourism Authority of Thailand, Community College, Tour Guide Association, Department of Fisheries, Business Associations, Royal Forestry Department (National Parks).

SUGGESTED ACTIVITY: Signage for Major Offshore Access Points

This activity entails producing and installing wayside signs at the major access points to the coral reefs that are major tourist attractions. The signs could locate and describe the area's reefs and protected areas, and caution visitors against damaging or collecting coral. At minimum, signs should be located at

Makham Bay (departure point to Phi Phi and Ko Hae), Patong, Tonsai Bay, Nai Yang and Ko Miang (Similans).

IMPLEMENTATION: Tourism Authority of Thailand, Royal Forestry Department, and Department of Fisheries with business sponsorship and international support.

D.2.2 Prevention of Anchor Damage

There are technologies available to prevent the physical damage associated with anchoring. In other parts of the world, these technologies have proven to be a good investment for the tourism industry even over the short term.

SUGGESTED ACTIVITY: Demonstration Mooring Buoys
This activity entails the installment of permanent mooring buoys at selected sites on an experimental basis. These mooring buoys are devices permanently anchored to the bottom by various means allowing vessels to attach to the buoys rather than drop anchor, thereby reducing damage.

Mooring buoys designed for recreational passenger vessels have received widespread support from the diving community and the charter boat industry in the Caribbean, Florida and Hawaii (Halas, 1985; Rogers and Zullo, 1987; Robinson, 1987).

The steps in getting mooring buoys installed in Phuket are:

Select a mooring buoy design. Several designs are available that vary in cost, ease of installation and maintenance. The success of designs used locally (Surin Islands, Koh Samui) should be verified as part of the demonstration project.

Select locations with the active participation of tour boat companies and local divers. Among the suitable sites for a demonstration project are Ao Patong, and Phi Phi.
The demonstration sites should be carefully selected to guard against vandalism and theft.

Acquire the installation equipment and supplies possibly with the sponsorship of local businesses.

Develop arrangements for surveillance and maintenance.

Conduct a trial installation.

The demonstration will be an opportunity to train volunteer divers in installation procedures and develop a cooperative program for buoy patrol and maintenance.

The demonstration project should also include a program directed at tour boat operators to familiarize

them with the use of the buoys. It is important to encourage tour boat companies to provide regular feedback on the mooring buoys. The familiarization program could be incorporated into the training workshops discussed above.

IMPLEMENTATION: Tourism Authority of Thailand, Tour boat companies, Business Association, Department of Fisheries and PMBC, National Park Division (Phi Phi), Marine Police, Thai dive clubs.

SUGGESTED ACTIVITY: Mooring Buoy Development Plan and no Anchoring Zones
Once experience has been gained installing mooring buoys at the demonstration sites, a mooring buoy plan will be developed for all reefs that are priority management areas (see site-specific management plans below). This has to be a cooperative effort with the tour companies, escort guides, local divers and the Marine Police. The mooring buoys will be installed in "no anchoring" zones of protected areas. The number, location and spacing of buoys depends on depth, substrate, and visitor use patterns.

IMPLEMENTATION: as above

D.2.3 Public Education and Community Action

The sustainable use of Phuket's coral reefs requires support from all sectors of the community. Businesses, local clubs, teachers, as well as political and religious leaders can take an active part in promoting environmental awareness and taking charge of conservation projects. Cooperation is more likely if people are given relevant information about coastal habitats and if they see an opportunity to strengthen Phuket's future.

SUGGESTED ACTIVITY: Local Awareness Campaign
This activity entails developing awareness campaigns tailored to the interests and needs of the various villages and communities in Phuket. The success of these campaigns depends on identifying target audiences, formulating messages that are relevant to local people and give them incentives to support coastal resource management, and getting local groups involved in the education planning process.

Messages are most effective when they are tailored to the interests and needs of major audiences. Therefore, an important aspect of the campaign will be the characterization of various target audiences within the Chinese, Chao Lae (sea people), and Muslim communities of Phuket. For the coral reef campaign, there is an opportunity to develop messages that build on the Buddhist respect for life and the notion that coral is a living animal. There may be opportunities to design an awarness campaign around the traditional spiritualism of the sea of the Chao Lae. For other audiences sush as the business community, the central message may be the strong link between healthy coral reefs and tourism.

Other key audiences for the coral reef education program are:

Thai tourists (snorkelers)	Escort guides
Foreign tourists (snorkelers)	Tour agents
Thai SCUBA divers	Boat operators
Foreign SCUBA divers	Shell shops
Village fishermen	Shell collectors
Business Associations	Community groups
Local media	Schools
Local Government	Local leaders

Whereas the Tourism Authority of Thailand, Phuket Provincial Government and other Departments will take the lead in preparing press kits and disseminating information to local newspapers and radio, other aspects of environmental awareness campaigns should be initiated and conducted by community groups and schools in Phuket town, Patong, Rawai, and other towns. Some of the activities could include:

Science fairs and exhibitions organized around a coastal theme or a special activity kiosk at one of Phuket's traditional festivals;

Community projects such as beach clean-ups, volunteer surveys, or mooring buoy installation;

Awareness raising activity sponsored by local businesses such as art contests, regatta, or a lecture series.

In some areas, local schools may be interested in organizing a special "Coast Day" or organizing special events related to coral reefs during local festivals. The ceremonies organized for the turtle release program and the traditional Thai New Year are an example of such an opportunity.

IMPLEMENTATION: Community groups and clubs, Teacher's College, Tourism Authority of Thailand, National Environment Board.

SUGGESTED ACTIVITY : School Curriculum

There is growing interest in providing local teachers at the grade and high school levels with materials that would enable them to conduct class activities that sensitize children to coral reefs and other coastal habitats. This interest originates partly from the cultural importance of the sea and sea people in Phuket history. School materials explaining the role of Phuket's coastal and marine environment in its past, present, and future are likely to be welcome by local teachers and would represent a good long-term investment in environmental education in Phuket.

This activity would entail developing curricula and teachers' kits for various grade levels. Once again, it is important to draw on the creativity and experience of local teachers in designing the curricula. Similar kits developed for other countries could be used as a starting point however the content and

issues should reflect the situation in Phuket (WWF, 1986 ; Hernandez, 1984 ; Griffith and Williams, 1985).

IMPLEMENTATION : Phuket Aquarium and Teachers' College

SUGGESTED ACTIVITY : Phuket Aquarium Activities

The Phuket Aquarium is a first-rate interpretive facility that has considerable potential but is underused. The Aquarium offers many advantages for an environmental education program since it is a regular stop on sightseeing tours and the destination for many school excursions. It has a small but experienced staff committed to environmental education.

This activity calls for making the Aquarium one of the focal points for a coastal education program in Phuket. The initiative entails the production of coral reefs exhibits, printed materials, and special programs in cooperation with the Teacher's College and the Royal Forestry Department.

Preliminary plans for some exhibits have been drafted and could be produced relatively inexpensively. Among the exhibits that should be considered for immediate production are a coral reef exhibit and a coastal pollution interactive exhibit. The exhibits should be designed in concert with the other educational activities described in this section. The initiation of an exchange program with similar aquaria in the United States that have coastal awareness programs is recommended. These aquaria could provide assistance in fundraising for exhibits, training, and information exchange.

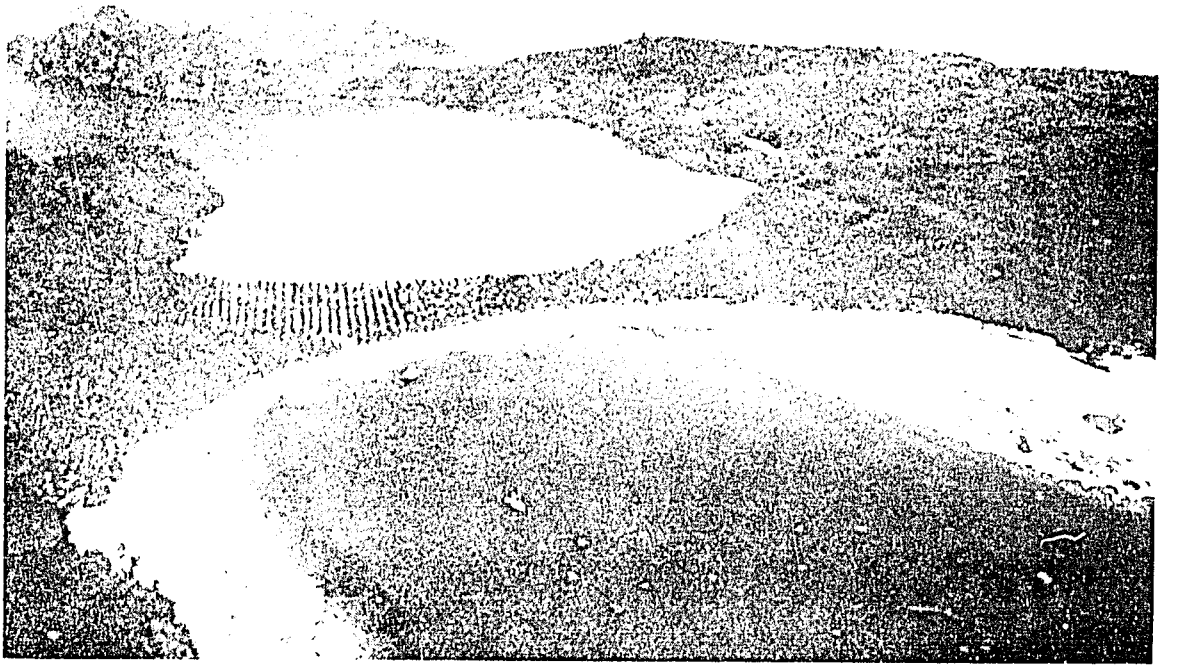
IMPLEMENTATION : Phuket Aquarium, Department of Fisheries with international assistance, Teacher's College.

SUGGESTED ACTIVITY : National Marine Park Activities

Much like the Phuket Aquarium, the marine national parks in the vicinity of Phuket offer an excellent opportunity to sensitize large numbers of people about the area's reefs and other coastal resources. There are already some interpretive activities at both Nai Yang and Phi Phi marine national parks but the services should be greatly expanded given the visitation.

This activity entails the creation of well-balanced and relevant marine educational programs at Phi Phi, the Similan Islands and Nai Yang. Each park receives different types of visitors and the educational programs should reflect these differences. The interpretive programs should introduce coral reefs, other coastal habitats, their cultural significance, the benefits of coastal management and marine protected areas.

The educational programs should be designed as an integral part of the management plans currently under preparation. A variety of techniques should be used including guided tours, coastal trails, outdoor exhibits, printed materials, community extension programs, special events and skill development. Low-cost programs developed in marine protected areas worldwide may provide a starting point in designing programs for Phuket (Foster and Lemay, 1988).



Phi Phi Marine National Park (Photo: Courtesy of TAT)

Training of park staff in all aspects of marine protected area management (including marine education) is needed. The training should be equally divided between resource management techniques, interpretation, administration and enforcement. It should be given through a combination of on-site workshops and seminars and "on-the-job training" in tropical coastal protected areas that already have fully operational programs. National Park staff will also be involved in the training workshops for escort guides that accompany tourists to Phi Phi and the Similan Islands (see above). In fact, part of the training could be offered at one of the parks in order to familiarize escort guides with marine park resources, regulations and services.

IMPLEMENTATION : Royal Forestry Department in cooperation with TAT and Department of Fisheries

D.2.4 Visitor Safety

SUGGESTED ACTIVITY : Cooperation Emergency Response Program and Diving Safety Network

This activity entails the development of an offshore emergency response program for the Phuket area. The program would require that a network of local representatives from the public and private sector devise procedures for emergency communications, volunteer search and rescue, and transport to the closest decompression chamber. Free training of volunteer divers and medical personnel would be provided.

As a corollary to this activity, a diving safety network responsible for promoting safe diving guidelines in Phuket should be set up. International guidelines and diving safety networks operating in other countries could provide assistance establishing in the network.

IMPLEMENTATION : Thai dive clubs, Marine Police, Navy, Business Association, District officers, local dive instructors.

SUGGESTED ACTIVITY : Safety Zoning
This activity refers to the designation of "recreational safety zones" at heavily used tour sites. The zones would stipulate maximum vessel speeds and through corridors designed to prevent vessel collisions with divers and snorkelers. These zones would be delineated and established in the site-specific management plans for Ko Hae and Phi Phi but eventually may be necessary at all tour sites.

IMPLEMENTATION : Navy, District government, Marine Police

D.2.5 Planning and Control of Future Tourist Services at Offshore Reefs

SUGGESTED ACTIVITY : Guidelines for Offshore Services
There is a need to incorporate the offshore islands and reefs into a provincial coastal development strategy (either a provincial land use scheme or a special area management plan). Decisions need to be clearly formulated concerning which islands should be developed (for tourism), the type and level of services provided at each offshore island, and whether some island reefs should be set aside for artisanal fisheries or as strict reserves within marine national parks. This is discussed further in the context of zoning schemes and site management plans for marine national parks in Chapter G.

SUGGESTED ACTIVITY : Tour Boat Registration at NMP and PMBC Protected Area
It will become necessary to monitor and control the number of tour boats anchored in the marine national parks of Phuket if existing trends continue. There are several registration systems that have been used elsewhere including permits for passenger vessels anchored in an area for more than a few days and reservation systems. The advantage of such systems is that they can be tied to user fees and generate operational funds for the protected area.

The feasibility of tour registration systems should be determined during the development of the site-specific management plans.

IMPLEMENTATION : Royal Forestry Department, Tourism Authority of Thailand

E. MANAGEMENT PROGRAMS FOR SUSTAINABLE FISHERIES

The goal of the fisheries management program presented in this section is to maintain and enhance the natural productive capacity of Phuket's coral reefs to support fish and shellfish populations at levels necessary to sustain the island's nearshore and artisanal fisheries and marine recreation.

From a local perspective, an improved fisheries management program for coral reefs will yield many benefits :

1. It will help maintain artisanal fisheries as a source of income ;

2. It will preserve the cultural values associated with the artisanal fishery ;

3. A greater diversity of local fisheries products will be available for islands residents and tourist consumption ;

4. It will maintain the scenic attraction of underwater resources for diving and snorkeling and productivity for recreational fishing ;

5. It will maintain recruitment areas important for other nearshore fishery stocks.

The selection of fisheries management projects is based on the analysis of key issues and consideration of these potential long-term benefits.

E.1 Selected Management Issues

Coral reefs are very productive fisheries habitats. However, some harvesting techniques can reduce the reefs' productivity. The following are the issues that need to be addressed to ensure that reef fisheries in Phuket are sustainable.

E.1.1 Reef Blasting and Destructive Fishing Techniques

There are several reports of the use of explosives in the nearshore fishery (Chansang, et al., 1983 ; Boonyanate, et al., 1986). Although prohibited under current law, the practice still causes severe damage to reef habitat. Local practice is to use small charges at 10-30 m depths just off the reef slope.

The target species are large pelagic fish that aggregate at these depths and around large boulders colonized by soft corals. Reef blasting is reported in offshore locations where enforcement is difficult such as the Similan, Racha, and Phi Phi Islands (Chansang, 1984). The ecological impacts include the

uprooting and destruction of corals, sponges and other sessile organisms. Reefs that have been blasted tend to support fewer fish (Alcala and Gomez, 1987).

The use of poisons and toxics to collect aquarium fish is not reported in the study area. This practice is also banned by law. There are reports of the use of "muroami" at the Phi Phi Islands and in the Gulf of Thailand. In this technique, which is used at an industrial scale in the Philippines, fish are herded across a reef by dozens of swimmers and driven into large nets (Munro and Williams, 1985). The muroami technique is considered highly destructive of reefs as the fish are driven out of crevasses by boulders tied to ropes which are repeatedly dropped onto the reef surface (Munro and Williams, 1985). Muroami is not prohibited under current law.

E.1.2 Physical Damage Caused During Collection of Corals, Shells and Aquarium Fish

Traditional techniques used by villagers to collect shells, coral, and aquarium fish cause some damage to reef flats particularly where coral heads/boulders are moved to collect fish and invertebrates (Wells, in press). This is of immediate concern for heavily harvested reefs such as the Racha Islands, Nai Yang and Similan Islands.

Shallow intertidal reefs that are gleaned at low tide can be damaged by trampling, overturning of coral heads, and disturbance of the substrate. The shallow reefs flats at Rawai and Laem Pan Wah have been partly destroyed by trampling and gleaning.

E.1.3 Depletion of Commercial Stocks and Removal of Species of Special Concern

There are a few reliable reports that certain species of marine invertebrates are depleted due to overharvesting in the study area. Except for corals, the commercial harvest of most of these species is unregulated at this time.

Stony corals (Scleractinia) are still harvested for sale at shell and coral shops in Phuket, even though coral collection is illegal. Unlike other marine organisms or plants, corals have very slow growth rates and limited potential for harvest on a sustainable basis (Oliver and McGinnity, 1985). At this time, the problem appears to be the difficulty of enforcing the coral collection ban in offshore areas. The problem is compounded by the fact that possession and local sale of corals have not been banned. Tourists, often unaware of the ban, continue to purchase ornamental corals in the souvenir shops.

Coral used for ornamentals in indoor garden (Photo : M. Lemay)

There is evidence that lobster stocks (**Panulirus** sp.) have been reduced due to overharvesting (Bhatia, pers. comm.). Tantanasiriwong (1978) reports that several cowries (Cypraeidae) and cone shells (Conidae) which were formerly common were becoming rare due to heavy collection in the area. In addition, large specimens of giant clams (**Tridacna sp.**) and green turban snail (**Turbo marmoratus**) are reported to be quite rare, but were formerly abundant (Lemay, 1987).

Some species are of special concern to the Department of Fisheries because of their role in the reef food chain or their value to other commercial operations. For example, giant trumpet snail (**Charonia Tritonis**) is one of the few known predators of crown-of-thorns. Natural stocks of pearl oyster Shell (**Pinctada sp.**) also deserve special attention because of the need for a steady supply of juvenile shells for the pearl culture on the eastern coast of Ko Phuket.

Finally, there are shell species harvested in large volumes such as **Trochus niloticus** and **Chicoreus ramosus** for which not sufficient is known to establish the ecological implications of the harvest. Selective removal of target species and large specimens could affect the recruitment of stocks.

There have not been systematic reef fish surveys to determine whether some species collected for the ornamental aquarium fish trade are depleted. Fish densities on Phuket's reefs are reported low in some locations (Boonyanate, et al., 1986). It is also known that juveniles are usually preferred because of their better survival rates and handling. The selective removal of juvenile fish, species that undergo a sex change, or otherwise unsuitable species could be having an impact on breeding of certain species (Whitehead, et al., 1986). The selective capture by fishermen of specimens of highest value such as clown

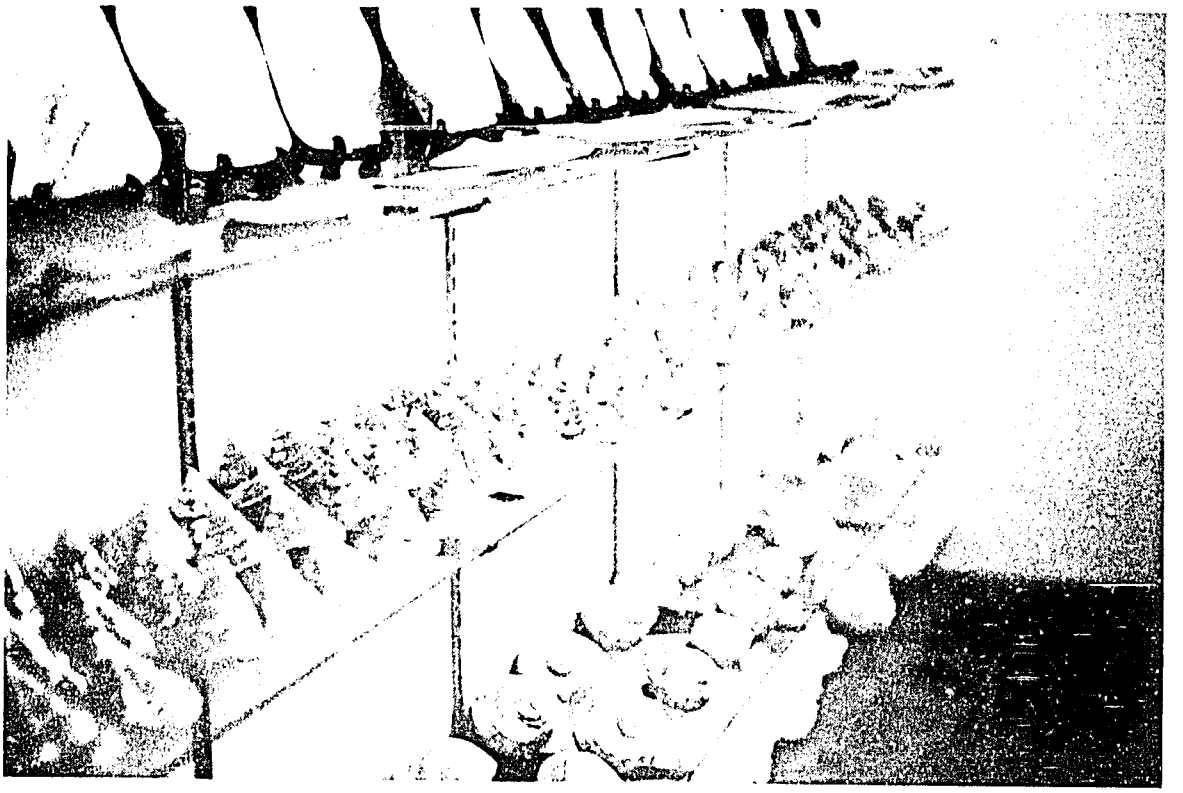
Pearl oyster shell (Pinctada sp.) from Ko Sire (Photo : M. Lemay)

triggerfish may also be accelerating the depletion of fish already uncommon or rare. The aquarium fish industry is known for high mortality rates of live fish during holding and shipping which can be as high as 80 percent (Whitehead, et al., 1986 ; Wood, 1985). This means that less than 20 percent of the reef fish collected in Phuket will actually survive for use in aquaria.

E.1.4 Limitations in Fisheries Management Regulations and Policies

There are weaknesses in the laws and regulations governing fisheries management in general and reef fisheries in particular. Several inconsistencies have already been alluded to with reference to specific fisheries. In summary, the regulatory concerns are :

- ☐ Collection and export of coral are banned but not monitored at international ports of departure ;
- ☐ Local sale and possession of coral are not banned ;
- ☐ There are no catch, size, or season limits for all other marine invertebrates collected from reefs including lobster and all shells ;
- ☐ Exports of shells, including species listed under CITES are not monitored ;
- ☐ The collection, holding, trade and export of aquarium fish are not regulated ; and
- ☐ Existing laws focus on single species instead of recognizing the overall productive value of the habitat.



Polished shells sold at a local shop in Rawai (Photo: M. Lemay)

While the Department of Fisheries is moving towards the refinement of fisheries management regulations in Thailand, most of the revisions are a species-by-species approach, with the large offshore stocks being given priority. The task is formidable given the number of species of concern (shellfish and finfish) and the on-site research that will be required to determine appropriate size and catch limits.

Single species management may not be effective in maintaining productive coral reef habitat in Phuket. Fisheries management agencies worldwide are rapidly recognizing that the control of single fisheries does not ensure the proper management of critical nearshore fisheries habitat that serve multiple functions such as coral reefs, mangroves, estuaries, and coastal wetlands.

E.2 Recommended Programs

Sustainable yields of coral reefs could be maintained or increased with an expanded fisheries management program, more comprehensive enforcement of the commercial coral and shell trade, and improved management of strict reserves within existing marine protected areas. The STRATEGY calls for maintaining sustainable yields from coral reefs with better management practices focused on selected problems and progression towards a habitat protection policy.

The basic objectives of the tentative fisheries management provisions listed below are to :

Prevent or limit damages caused by fishing gear and collection techniques on coral reefs ;

- ☐ Reduce harvesting pressure on coral and commercially threatened species ; and
- ☐ Improve recruitment and increase stocks.

In addition, it is recommended that current efforts to refine "fisheries management" regulations pertaining to reef fisheries broadened and re-examined in the context of a fisheries habitat policy.

SUGGESTED ACTIVITY : Establish a fishery management scheme for a commercially threatened species that is reef-dependent and important to the nearshore artisanal fishery
This activity entails the formulation and approval of a consistent set of regulations for a reef fishery that is clearly under pressure. The lobster fishery of Phuket is recommended as the focus for this project.

This activity is highly recommended because it is an opportunity to develop workable management schemes for a nearshore artisanal fishery that is dependent on a coastal habitat (In fact, it is dependent on several habitats). The experience gained implementing such a scheme could be applied to other nearshore fisheries and estuarine habitats.

The Department of Fisheries has already started to examine possible regulations but not necessarily in the context of enhancing an artisanal fishery and the coastal habitat upon which it depends.

With respect to the lobster fishery, size limits, catch quotas, and seasonal closures should be established for all species. Similar regulations are enforced for lobster fisheries worldwide including Florida, the Caribbean and South America (Jaap, 1984 ; Munro and Williams, 1985 ; Boulon, 1987). It may be necessary to conduct further scientific investigations in Phuket to confirm the reproductive period of the various species as a basis for a seasonal closure. There may also be sufficient grounds to initiate a limited entry system (annual permits or permanent licenses) for the lobster fishery. There should be zones within the PMBC Protected Area and the National Marine Parks strictly enforced as closure areas (see sitespecific management plans).

The appointment of a marine conservation officer that could serve as a local liaison officer for the artisanal fishery is considered critical to the success of this project (see below).

In addition to the lobster fishery program, consideration should be given to a parallel program for the collection of **Trochus niloticus** and **Chicoreus ramosus**, and possibly cowries (**Cypraea sp.**) which are collected in large quantities. Many countries now have legislation for their mother-of-pearl fisheries. For example, Papua New Guinea has a minimum size limit for **Trochus niloticus** and New Caledonia has established a permit system and minimum size limit (Wells, 1981 and 1982).

IMPLEMENTATION : Department of Fisheries

SUGGESTED ACTIVITY : Comprehensive enforcement of commercial coral and shell trade and illegal fishing techniques.
This activity entails the development of a more comprehensive approach to enforcing the current ban

on the coral trade and the ban on destructive fishing techniques. With reference to the coral trade, the ban should be extended to include the possession and sale of coral. Enforcement would also be more effective if it were complemented by an educational campaign to caution tourists against buying coral in Phuket.

With reference to the shell trade, the ban on commercial trade and exports should be extended to include species that are endangered or depleted according to international definitions. Candidate species include **Tridacna sp., Turbo marmoratus, Charonia tritonis** and **Pinctada sp.** These species are widely recognized as suitable protected species regionally and internationally (i.e. according to the Convention for International Trade in Endangered Species or CITES).

With reference to other illegal fishing techniques (particularly reef blasting), there is a need to initiate a community extension program for village fishermen (see marine conservation officers below). The program would help establish the socioeconomic factors underlying reef blasting in Phuket.

IMPLEMENTATION : Department of Fisheries

SUGGESTED ACTIVITY : Appoint marine conservation officers

Marine conservation officer (s) should be appointed for the west coast of Phuket to help promote coral reef habitat protection for fisheries and tourism.

The officer would serve as liaison for artisanal fishermen and shell collectors along the west coast. The officer would help promote the use of improved or more compatible fishing gear. The officer would also monitor compliance with regulations against reef blasting, use of poisons, and collection of protected species. Working with village leaders, the officer could encourage village-based marine conservation projects such as experimental mariculture projects (for the mother-of-pearl industry) or improvements in the shell products industry.

The officer would also serve as the Department of Fisheries local liaison with the National Park Division, TAT and the tourism industry. Working with these partners, the officer could encourage cooperative projects for reducing anchor damage and casual collection of protected shell species for example.

IMPLEMENTATION : Department of Fisheries

SUGGESTED ACTIVITY : Establishment of strict reserves or sanctuary zones within marine national parks

This activity entails the establishment and enforcement of recruitment zones for reef fish and invertebrates within existing marine national parks. The zones, to be established in the park management plans after close consultation with island residents (see Chapter G), would encompass remote and undisturbed reefs within the parks where collection and harvesting would be prohibited. The zones would serve as replenishment areas designed to provide recruits to adjacent waters. Observations of a reserve maintained over a decade in the Philippines indicate that, with adequate management, sanctuary zones within Phuket's marine national parks could help maintain high fish abundances in the parks and support high fish yields in adjacent areas (Alcala, 1988). However the success of this approach would depend on active local participation of islands residents in management (White, 1986).

F. WATER QUALITY MAINTENANCE & MONITORING

Coral reefs require clear water with optimum salinity and temperature levels for growth. Light is probably one of the most significant environmental considerations controlling coral reef development in general (UNESCO, 1982). Thus, any disturbance that reduces light penetration (increases turbidity) is likely to have a significant impact. Suspended sediments have been shown to slow coral growth, smother the live coral tissue, and reduce diversity.

Water quality is also an important aesthetic factor for underwater sports. Clear, highly transparent water contributes significantly to the attraction of coral reefs for snorkeling and diving.

Unlike the impacts associated with recreation and tourism, pollution impacts can originate some distance from coral reefs. Indeed, in the case of Phuket, the major sources of reef pollution are associated with developments beyond the immediate reef area. Hence, the program for maintaining water quality in coastal waters needs to be closely associated with land use planning efforts in Phuket.

The water quality program consists of :

PERFORMANCE STANDARDS

ZONAL MANAGEMENT

WATER QUALITY MONITORING

This component of the STRATEGY is designed to complement and be integrated with the pilot WATER QUALITY MANAGEMENT project being undertaken for Phuket.

F.1 Selected Management Issues

The two important concerns relating to pollution are siltation from land-based sources and siltation from offshore tin dredging. Excessive nutrient levels from coastal domestic effluents may be an additional concern for reefs along the west coast.

F.1.1 Siltation from Land-based Sources

Increasing volumes of sediment are being discharged into nearshore waters from coastal watersheds along Phuket's south and west coasts.

Sediments being washed away from roads (Photo: M. Lemay)

Siltation is linked to cut and fill operations for road construction, quarrying for fill material, gullying along steep roads and road cuts, and filling of lowland paddy fields in the Patong watershed for example (Dr. S. Luesatja, pers. comm.) In other areas, the causes for increased sediment discharges include clearing for agriculture, tailings from land tin mining operations (Bang Tao) and construction of the deepwater port (Laem Pan Wah).

The coral reefs most threatened by land-based sources of pollution are the fringing reefs along the western and southern coast of Ko Phuket immediately adjacent to watersheds undergoing rapid coastal development. These include the reefs of Ao Patong (North and South), Karon, Kata, Kamala, Nai Han, Rawai and Laem Pan Wah. The reefs of Ko Lone and Ko Hae and also susceptible to heavy siltation due to their proximity to Chalong Bay.

In addition to affecting coral reef growth, increased turbidity along the west coast could potentially reduce the scenic quality and SCUBA diving potential of the area.

F.1.2 Siltation from Tin Dredging Operations

Offshore tin dredging along the west coast of Phuket has been shown to affect coral reefs in Ao Bang Tao (Chansang, et al., 1981). Dredging is the method used to remove tin ore from shallow waters down to about 30 meters.

Aside from direct physical destruction, tin dredging causes a suspension of bottom sediments which increases turbidity in the vicinity of reefs, reduces coral growth, and smothers benthic sessile organisms (Chansang, 1988). Changes in community structure have also been linked to siltation (Brown, et al. 1986). These effects are localized and depend on the size of the operation, distance from the dredges, water circulation, and reef exposure to wind and wave action (Chansang, 1988).

Follow-up observations indicate that coral reefs in selected locations along the west coast have partially recovered where natural turbulence during the monsoon season has removed the layer of sediments (Chansang, 1988). This research confirms that corals can regenerate once optimal water quality conditions have been restored (Chansang, 1988).

Dredging activities along the west coast were greatly reduced after 1983 due to the collapse of tin prices and the depletion of deposits. The only active leases on the west coast are in Ao Bang Tao. There is also active dredging offshore of Pangnga and in Phuket Bay but these concessions are distant from coral reefs. Dredging is currently prohibited from Ao Patong and Nai Yang. Any new concessions will have to comply with the National Environment Board standards for marine water quality in Phuket.

In addition to its current and localized impact in Ao Bang Tao, offshore tin mining represents a significant threat to the coral reefs of Phuket's west coast. While there are existing mechanisms to prevent further impacts, it remains to be seen whether these (including the ONEB water quality standards) will be sufficient to keep tin mining operations adequate distances from the coral reefs.

F.1.3 Other Pollution Sources

Domestic effluents discharged into coastal bays may be increasing the nutrient loading of fringing reefs along the west coast (National Environment Board, 1987). Based on the experience of other tropical countries, eutrophication and algal blooms can lead to a die-off of fringing reefs (Maragos et al., 1985). Although yet unconfirmed, this represents a problem for reefs in areas with slow flushing rates and limited circulation such as the southern part of Ao Patong.

F.2 Recommended programs

SUGGESTED ACTIVITY : Incorporate coral reef water quality standards in the coastal watershed management program

Coral reefs have among the strictest requirements for good water quality conditions. As such, they set high standards for water quality in nearshore waters. This activity calls for using coral reefs of Phuket's west coast identify priority areas for sediment control in the watershed management component of the Thailand CRMP. The priority areas for sediment control would be defined as those watersheds tha are discharging directly into nearshore areas that contain extensive coral reefs. There may also be value in designating reefs as special discharge control zones.

These areas would be among the first to have to comply with the water quality standards for coral reefs as defined by ONEB. Any new coastal development would have to comply with the standards through preventive measures such as holding ponds at construction sites, proper road cut and gradient designs, and minimal construction along shores that are adjacent to reef flats. Where sediment discharges could not be controlled, mitigation measures might be required.

IMPLEMENTATION : See Water Quality Management Strategy

SUGGESTED ACTIVITY : Establish buffer zones to minimize the impacts of offshore tin mining on coral reefs :
This activity takes into account the possibility that offshore tin mining operations could expand to areas of the west coast of Phuket other than Ao Bang Tao.

The recommended solution would be to identify those reefs that should not be disturbed by tin mining operations under any circumstances as well as those areas where tin mining could occur under specific circumstances. An offshore zoning scheme would delimit protected reefs and buffer zones where mining could occur at strict minimum distances from reefs. Establishment of minimum distances between protected reefs and tin dredge operations would require detailed nearshore circulation and water mass studies (Chansang, 1988). For a complete discussion of the zoning scheme, see CHAPTER G: LAWS, POLICIES AND INSTITUTIONAL COORDINATION.

F.3 Priorities for Monitoring

The problem analysis which is the foundation of this strategy is based on fifteen years of management-related research conducted at the Phuket Marine Biological Center. Over the years, this research has provided an accurate characterization of the reefs. It has also helped scientists and managers understand the impacts of the recent crown-of-thorns outbreaks and offshore tin dredging. As uses of the reefs and coastal development intensify in Phuket, the impacts on reefs will change. Hence, management-oriented research and monitoring will continue to play an important role in implementing the STRATEGY.

An expanded monitoring program should be established along the west coast of Phuket and at offshore reefs. The program should build upon the existing monitoring activities carried out by the Phuket Marine Biological Center. The program would involve permanent monitoring stations (existing PMBC stations could be used) where various water quality parameters would be recorded periodically and compared with reef conditions (i.e. coral cover, regrowth, crown-of-thorns infestations).

The parameters recommended for a coral reef monitoring program are similar to those selected for long-term monitoring programs of other reef areas where recreational and pollution impacts are an on-going concern (Jaap, 1984; Rogers, 1988; Kenchington, 1984). Parameters recommended for Phuket province and the nearby marine national parks are:

Environmental parameters
Temperature
Salinity
Nutrients
Transparency, light, sedimentation

Benthic surveys
Live/dead coral cover
Presence of rare or uncommon species
Predation (Crown-of-thorns)
Disease
Breakage/abrasion (anchor damage)
Algal overgrowth
Sediment smothering

Reef fish surveys
Visual censuses
Presence of rare or uncommon species

Recreational impacts
Littering
Recreational use

The Phuket Marine Biological Center has been working towards developing a standard monitoring protocol for application throughout the study area, including the marine national parks. Ideally, observational methods that could be easily taught to park personnel should be selected.

G. LAWS, POLICIES & INSTITUTIONAL COORDINATION

An important factor in implementing the coral reef management STRATEGY will be the scope and limitations of existing laws, policies, and the institutional scope of resource agencies. This chapter consolidates recommendations made in earlier chapters to strengthen the institutional context for coral reef management.

G.1 Selected Management Issues

The main institutional issues for the implementation of the STRATEGY are:

- ☐ Limitations of existing laws and regulations for habitat protection (including coral reef habitat protection);
- ☐ Limited coordination among agencies responsible for protecting marine resources and those responsible for planning for development and visitor services;
- ☐ Lack of an enforcement capability in nearshore waters;
- ☐ Shortages of trained personnel for habitat protection;
- ☐ Limited opportunities for involvement of local community groups and the private sector in resource conservation.

G.1.1 Limitations in Laws and Agency Mandates

Coral reefs and coastal habitats have not traditionally fallen under the jurisdiction of a single government agency in Phuket or in Thailand. Nor are there policies in effect for habitat management, particularly when these habitats lie in nearshore waters.

The limitations of the Fisheries Law and its enabling regulations are as follows:

- ☐ The focus on species and harvesting does little to address the varied sources of damage to coral reefs (physical damage caused by collection, siltation, anchor damage).
- ☐ The "protected area" designation under the Fisheries Act has not been fully developed or implemented (e.g., PMBC protected area). There is a need to formulate clear habitat policies and regulations in order for these protected areas to serve as effective protection for fisheries habitat.

- Existing fisheries policies are restricted to stock and catch management, and gear regulations for offshore fisheries. Regulations affecting nearshore small-scale fisheries and particularly reef fisheries in existing protected area were developed with limited consideration of socio-economic conditions of these fisheries (Panayotou, et al., 1985) and are difficult to enforce.

Limitations of the National Park Law and existing regulations are as follows (S. Chettamart and S. Vejaboosakorn, pers. comm.; Kasetsart University, 1987; ASEAN Expert Group on the Environment, 1986; National Environment Board, 1988) :

- The jurisdiction over marine resources is unclear (Tarutao workshop, 1988) ;

- There are conflicts between traditional land tenure in Nai Yang and Phi Phi and marine national park boundaries. National park policies do not allow settlement within park boundaries but, in reality, villagers such as the sea people have traditionally occupied these areas.

- At present, resource protection regulations in effect in marine national parks, such as the prohibition of all fishing, are unrealistic and cannot be enforced in areas used for artisanal fisheries. Fisheries are seldom banned in marine protected areas worldwide, except in limited zones carefully selected in consultation with fishing communities.

- There is a need to clearly define appropriate levels of visitor services and infrastructure that are compatible with coral reef habitat protection and maintaining the nature-oriented tourism experience in the marine national park system.

- The current emphasis is on accommodating visitor demand for access to offshore islands and reefs without reference to a long-term policy for growth at each park.

- Most agency resources are devoted to the administration of tourism at marine national parks, contravening stated policy that two-thirds of agency resources should be devoted to resource protection and education/research.

- Provincial plans and policies for tourism development in Phuket are developed without sufficient consideration of carrying capacity of the marine national parks, despite the fact that the Tourism Authority relies heavily on parks such as Phi Phi for promoting tourism.

Limitations of existing policies of the Tourism Authority of Thailand:

- The emphasis is on increasing visitation through marketing underwater resources without taking into account the physical and environmental carrying capacity of offshore reefs.

- There are no policies for maintaining opportunities for nature-oriented tourism in Phuket province despite the fact such opportunities are what attract many tourists to the area.

G.1.2 Limited Agency Coordination

The weaknesses in existing laws and regulations of line agencies are compounded by a lack of coordination among agencies that have a mandate for resource protection (including coral reef protection) and those agencies that administer and approve activities and developments at offshore reefs.

For example, the decision process that is followed to permit additional offshore excursions and new itineraries to offshore islands and reefs is made regardless of the status of coral reefs in the area. Decisions to expand services at offshore locations including existing protected areas are taken without a regional frame of reference for keeping some reefs relatively undeveloped.

G.1.3 Lack of Enforcement Capability and Staff Shortages

Due to accelerated technological development and increasing pressures in the fishing industry, the Department of Fisheries has had to focus its efforts on managing commercial offshore trawling fisheries (U. Boonprakob, Deputy Director General, Department of Fisheries, pers. comm., 1987; Sudara, 1981; Thai Development Research Institute, 1987). There are only three fisheries officers assigned to Phuket and no patrol vessels are stationed on the island.

While there are existing regulations that provide some protection to coral reefs (Phasuk, 1985), few trained personnel or agency resources are available to devote to habitat management. The limited capability for on-site enforcement is of immediate concern. It is one of the reasons for the limited success of the bans on reef blasting and coral collection.

Similar constraints apply to the National Parks Division of the Royal Forest Department which has had to cope with dramatic increases in visitor use and an expanded network of marine parks since 1985 (Kasetsart University, 1987). The expansion has not been matched by an increase in trained personnel or agency resources for marine national parks (Kasetsart University, 1987).

The Provincial Government of Phuket, the Tourism Authority of Thailand, and the Marine Police each have important responsibilities for coastal development, tourist services and offshore safety. These areas of institutional responsibility directly affect the quality of natural coastal resources (including coral reefs) and levels of sustainable use.

Some agency representatives recognize the linkages between Phuket's natural amenities (many of which are coastal in nature) and the viability of the tourism industry. In 1986 for example, the Tourism Authority of Thailand and Mahidol University held a workshop to examine the importance of underwater resources for tourism (Mahidol University, 1986). However, most agencies have yet to acknowledge that underwater resources need to be carefully managed to sustain tourism growth. Nor is there a recognition that the carrying capacity of coral reefs to sustain quality recreational diving depends on controlling all sources of damage including reef blasting and siltation. In addition, there have been few opportunities for these agencies to cooperate in managing coastal resources including coral reefs. Lack of clear jurisdiction and stated policy for habitat protection and visitor safety in nearshore waters, lack of resources for on-site management including trained personnel, in the absence of agreed priorities for protection have been major constraints.

The same problems exist in the business sector even though there should be strong economic incentives for maintaining healthy reefs along the west coast of Phuket in proximity to the major beach resorts. The level of concern seems low among travel agents, hotel operators, and souvenir shop owners (Lemay, 1987). In large part, the problem appears to be associated with a lack of targeted information on the importance of nature-oriented tourism in Phuket and a lack of opportunities for private sector involvement in resource management.

G.2 Recommended Programs

SUGGESTED ACTIVITY: Revisions to existing laws and policies to include habitat protection objectives

The Fisheries Law and its enabling regulations should be carefully evaluated to determine whether the goal of habitat protection is adequately embodied in the law. Policies pertaining to "protected areas" designated under the Fisheries Law should also be assessed to determine if they are adequate and whether these can be used to designate "sanctuary zones" in marine national parks.

There is a need to determine whether and how a national policy for coastal habitat protection could be formulated, probably as part of a national coastal policy. Several countries are now moving towards the development of national policies for fisheries habitat protection and management. These policies recognize the importance and economic role of an entire coastal habitat (as opposed to individual species) such as wetlands (in the U.S., Canada, and the European Economic Community), estuaries (U.S., Australia, and Canada), and coral reefs (Australia). Of special interest are recent national policies developed for nearshore habitats under the jurisdiction of various Departments of Fisheries (Canadian Department of Fisheries and Oceans, 1986; National Marine Fisheries Service, 1987). These policies bring under one framework national goals for important habitats and spell out objectives for on-site management, habitat restoration and enhancement, environmental impact assessment, and species protection. Where they exist, these policies have also provided an opportunity to integrate habitat management with other national priorities such as tourism, industrial expansion and diversification, and the maintenance of traditional lifestyles.

Legal authority for the protection of coral reefs in marine national parks needs to be clarified. Marine national park regulations should be enforceable and created in consultation with park residents and fishermen. Fishery closures (sanctuary zones) should apply only to carefully selected reef areas that can be patrolled.

SUGGESTED ACTIVITY: Multiple use zoning scheme for marine national parks and designated special management zones

A zoning scheme can be a simple and effective means of ensuring a balance among multiple uses and reducing conflicts between tourism, offshore mining, fisheries, and other activities. The scheme described below consolidates recommendations made earlier with respect to the zonal management of recreational use, fisheries, and sediment discharges. While zoning is not the solution to all coral reef management problems in Phuket, it can help establish priorities among reefs. Zoning can also focus the management effort in specific and well-publicized areas. And where all users groups are

involved in the process, zoning can be an acceptable means of minimizing conflicts between tourism and fisheries or offshore mining and tourism for example.

There is a need for a consistent zoning system that would apply to all marine national parks of the study area, but eventually could be expanded to apply to all protected areas. Based on experience in other marine protected areas, simple systems (with 3-4 levels of protection/use) work best. The scheme could include three general levels of multiple use as follows:

SANCTUARY OR NATURE RESERVE ZONE (CORE AREAS) : This would represent the highest level of protection, applied to relatively undisturbed reefs of the highest quality or to special natural areas such as sea turtle nesting beaches. Primary objectives would be to maintain representative coral reefs in a natural state, provide replenishment areas for fisheries, and to provide opportunities for scientific research, environmental monitoring, and nature appreciation. All fisheries and collection would be prohibited. These reefs would have to be located furthest away from mining operations.

RECREATIONAL ZONE: This would represent an intermediate level of protection, applied to reefs used heavily for underwater recreation. Primary objectives would be to provide quality interpretive and recreational services compatible with minimizing damage to the coral. This zone would be the focus for glass-bottom boat tours and diving tours. Commercial fishing would be precluded from this zone, however sport fishing would be allowed. Commercial tour boats would be required to follow established routes in proximity to reefs and use permanent mooring buoys in no anchoring areas. Reefs would have to be located at a certain minimum distance from offshore mining operations.

GENERAL USE AREAS: All other areas where general fisheries regulations and water quality standards continue to apply. All recreational and commercial activities are permitted.

SUGGESTED ACTIVITY: Preparation of site-specific management plans

Implementation of the STRATEGY will be easier and more effective if efforts are focused on selected reef areas designated as priorities for management. As experience is gained in carrying out on-site projects and skilled personnel become available, techniques can be applied to other reefs.

This activity entails the development of site-specific reef management plans for Phi Phi marine national park, the Similan Islands marine national park, the PMBC Protected Area, and Patong Bay. It is anticipated that development of these plans could be concurrent with implementation of some the immediate activities listed as part of the strategy (In other words, it need not delay implementation of urgent projects).

Based on experience in other marine (coral reef) protected areas, the scope of the site-specific plans should include at least the following (Foster and Lemay, 1988) :

Applicable rules and regulations
General use and development policies
Zoning plan
Programs and cooperative initiatives for information, and education activities
Programs for the active involvement of local groups, residents and non-government organizations
Special resource protection initiatives (e.g. such as the installation of mooring buoys)
Patrol and enforcement program
Safety provisions and emergency response
Scientific research and monitoring program
Agency coordination
Staff Training
Measure for financing on-going operations at marine national parks, including measures for generating revenues.

SUGGESTED ACTIVITY: Cooperative patrol and enforcement program

None of the resource management agencies operating in Phuket have the capability to conduct offshore patrols on a regular basis. Such patrols are essential for the enforcement of protective regulations that apply to all reefs and special rules and regulations that apply to protected areas. The patrols are also an important safety factor. With proper training, patrol officers can help prevent damage and work closely with tour boat operators to ensure the voluntary compliance to reasonable regulations.

Providing a capability for on-site patrolling is a matter of priority for coral reef management in Phuket. To make best use of equipment and trained staff, it is recommended that a cooperative program be established. This should be a cooperative effort of the Department of Fisheries (Marine Fisheries Division), the Royal Forestry Department (National Park Division), the Navy, the Marine Police, district and provincial governments. An administrative mechanism needs to be developed as a basis for the cooperation.

The specifics of the patrol and enforcement program should be developed as part of the site-specific management plans. Falling within the scope of the program would be:

Consistent training of enforcement personnel
Agreement on priority sites for on-site patrols
Enforcement posture, interpretation of regulations
Consistent reporting requirements
Patrol schedule
Patrol vessel acquisition and maintenance

The two most urgent elements of the cooperative program are the training of personnel in offshore patrols and the acquisition of a patrol vessel. Without these, many of the resource management provisions described above will be futile.

H. GETTING STARTED: PRIORITIES FOR IMPLEMENTATION

H.1 Projects for Immediate Implementation

Nine projects are recommended for immediate implementation as part of the Thailand CRMP. These projects represent a selection of the highest priorities described under each component of the STRATEGY (i.e., Recreation and Education, Sustainable Fisheries, Water Quality, and Coordination). Included are projects that are relatively inexpensive and feasible as well as more complex initiatives which are urgently needed and could have a broad impact on the way coral reefs are managed.

The initial selection of the projects was based on the general criteria for **community-based habitat management projects** presented in Chapter C: A Comprehensive Approach to Coral Reef Management. The final selection of projects took into consideration the relative significance of issues (see Chapter C) and feasibility.

In order to place these projects in the context of the overall STRATEGY, the relationship between each project, the issues addressed by the project, the uses or activities involved, and responsibility for implementation are summarized in Table 4.

The following projects are recommended as priorities :

Development of information materials on coral reefs for tourists and a local awareness campaign (Chapter D).

Development of curriculum materials and the design of a short course for escort guides and tour operators (Chapter D).

Installation of demonstration mooring buoys (including selection of pilot sites appropriate technology, cooperative maintenance arrangements) at Patong and Phi Phi (Chapter D).

Design and production of a coral reef exhibit and interpretive activities at Phuket Aquarium (Chapter D).

Expansion of marine interpretation activities at Nai Yang, Phi Phi and Similan Islands national parks (Chapter D).

Development of a multiple use zoning scheme (including the selection and definition of zoning categories) for application in existing marine protected areas and at other selected reefs (Chapter G).

Background studies and baseline inventories to establish new regulations to protect depleted or uncomon species (e.g., selected shell and aquarium fish species). Background study to determine the feasibility of lobster fishery management program (i.e., size, catch,season limits) (Chapter E).

Initiate administrative procedures for the appointment of a local marine conservation officer (Chapter E).

Initiate a cooperative enforcement program and training of on-site habitat management staff for DOF and NPD (Chapter G).

H.2 Applying the Lessons to Other Coastal Habitats

This STRATEGY has been developed with the view that coral reef protection is a building block for preparing additional management strategies for Phuket's other important coastal habitats, such as mangroves and seagrass beds. The latter areas are vital feeding and breeding areas for reef dwellers and, like coral reefs, are the basis for several economic activities. General guidelines derived from the STRATEGY -- reliance on local management and community-based projects, private/public partnerships, are recommended for these other coastal habitats.

Table 4: Relationship between Priority Projects, Issues and Economic Activities

PRIORITY PROJECT	ISSUES	AFFECTED USES	IMPLEMENTATION
Information materials for tourists	Lack of awareness	Tourism Recreation	Cooperative w/ DF, NP, TAT, TC Thai NGO
Curriculum & training for escort guides	Lack of awareness Anchor damage Littering etc...	Tourism Recreation	Cooperative w/ DF, NP, TAT, TC Business Association Guide Association
Demonstration buoys	Anchor damage Lack of opportunity for local involvement	Tourism Recreation	Cooperative w/ DF, NP, TAT, Dive clubs Business Association Volunteers
Coral reef exhibit	Lack of awareness	Public Education	DF, TC Volunteers
MNP interpretive activities	Lack of awareness Local involvement	Public Education	NP, DF, TC, TAT
Zoning scheme	Siltation from tin mining Siltation from land Rapid expansion of offshore facilities	Mining Coastal dev.	ONEB, DF, RFD,
Regulations for rare species	Depletion of rare species	Fisheries	DF, RFD, Customs
Lobster mgt scheme	Depletion of harvestable stock	Artisanal fisheries	DF Fishing community
Marine conserv. officer	Limited agency coordination Staff shortage Limited enforcement	Fisheries Tourism	DF, RFD, TAT, Prov. Gov.
Cooperative enforcement and training	Limited agency coordination Limited enforcement Visitor safety	Fisheries Tourism Safety Vessel transport	DF, RFD, Navy Marine police

DF = Department of Fisheries
NP = National Parks Division
TAT = Tourism Authority of Thailand
TC = Phuket Teacher's College
RFD = Royal Forestry Department

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A NOTE OF THANKS

The authors and management of Thailand CRMP hereby express their appreciation for the supports and cooperation given to the Project by individuals and institutions mentioned throughout the STRATEGY. However, special thanks go to US and Thai personalities who helped in every way put every fabric of CRMP to work, making this STRATEGY one of the outcomes. In the mind of the Project Management, the following names are highly placed : W.A. Brown (Ex-US Ambassador to Thailand), J.Eriksson (USAID/THAILAND Director), L. Twentyman, D.Clark, D.Delgado, M.Philley (USAID/THAILAND), N.Berwick (USAID S&T/FENR), E.Eddy (President-URI), R.Duce (Vice Provost-Marine Affairs and Dean of GS Oceanography-URI), Charoenchit Na Songkhla (MOI-RTG), Wanchai Siriratana (DTEC-RTG), and Kosit Panpiemras (NESDB-RTG).

The marketability of this coral reef protection strategy, in Thailand and other parts of the world, depends significantly upon the authoritative and professional contributions of all collaborators. Contributions of colorful and informative photos herein contained are particularly recognized in this note of thanks.

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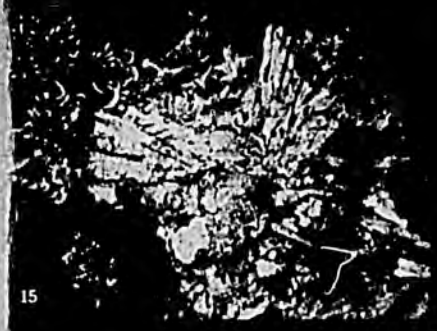
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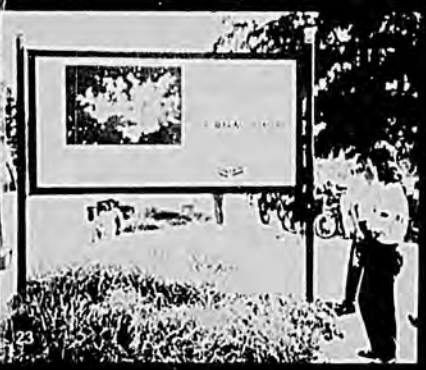
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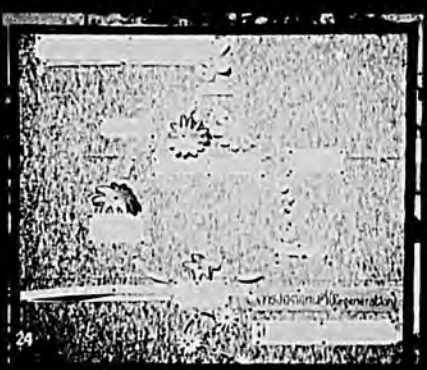
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