# Territorial use rights in fisheries to manage areas for farming coral reef fish and invertebrates for the aquarium trade

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ABSTRACT

Reef fish, corals, and other marine invertebrate species associated with coral reefs need to be managed in a sustainable manner to halt destructive fishing in the Philippines and other Southeast Asian countries. As part of the Coastal Communities Empowerment Project, the International Marinelife Alliance (IMA) plans to implement Territorial Use Rights in Fisheries (TURFs) to help manage municipal waters; while creating alternative livelihoods for small-scale fishermen and their families. Changes to the Local Government Code allow Philippine municipal councils to regulate fishing and mariculture in waters within 15 km from shore. The councils can lease TURFs to local fisherfolk and prevent their use by those outside the community. The IMA plans to help create several types of TURFs. These include TURFs used by aquarium-fish collectors, for rearing giant clams, and for farming live rock and coral fragments. The TURFs are part of a larger strategy to conserve marine biodiversity, protect and restore marine habitats, and promote sustainable use of marine resources by local people. Fish and invertebrates harvested from the TURFs will be used in programs to restore marine habitats and to generate income from exports that supply the aquarium trade.

## INTRODUCTION

Coral reefs throughout Southeast Asia and associated fish and invertebrate fauna are being destroyed by the use of explosives, poisons such as sodium cyanide, muro-ami and kayakas fishing (corals smashed with rocks or poles to drive fish into nets), and trawling inshore (Rubec, 1988a; Barber and Pratt, 1997; Hinrichsen, 1998). The destruction of coral reef habitats results in reduction of sustainable yields of reef fisheries. Healthy coral reefs can produce as much as 37 metric tons per square kilometer per year; while degraded reefs produce less than 5 t/km$^2$/yr (Alcala *et al.*, 1987; Alcala and Russ, 1990). The International Marinelife Alliance (IMA), formed in 1985, was one of the first organizations to sound the alarm about the impacts of destructive fishing on coral reef ecosystems.

Sodium cyanide is being used throughout Southeast Asia to capture food fish and marine-aquarium fish (Rubec, 1986; Del Norte *et al.*, 1989; Johannes and Riepen, 1995; Barber and Pratt, 1997, 1998). The fishers squirt cyanide on the

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fish hiding in and around coral heads. It was estimated that 50% of the exposed marine-aquarium fish die from acute doses on the reef and that more than 80% of the remainder die through the chain from collector to retailer (Rubec, 1987a, 1988b). Studies demonstrate that cyanide use kills coral heads (Rubec, 1987b; Johannes and Riepen, 1995; Jones, 1997; Jones and Steven, 1997; J. Cervino, University of South Carolina, personal communication 1999). Cyanide fishing results in dead reefs, which are devoid of fish (Robinson, 1984, 1985a,b; McLarney, 1986; Rubec, 1988a).

Blast fishing, used by small-scale fishers to gather food fish, is also widespread throughout Southeast Asia. The long-term use of explosives has reduced many coral reefs to rubble in the Philippines (Rubec, 1988a). About 48,000 metric tons of sun-dried coral heads were harvested in the Philippines during 1984, part of which was illegally exported to support the curio and aquarium trades (Alvarez and Fleras, 1985; Rubec, 1988a). The volume of dead coral exported from the Philippines has declined, but is believed to be greater than recently published estimates (Green and Shirley, 1999).

Within the past ten years, the keeping of minireef aquaria has led to a growing demand for living corals, marine invertebrates, and live rock (Fenner, 1998). The trade in stony corals from most countries is regulated under the United Nations Convention on International Trade in Endangered Species of Flora and Fauna (CITES-Appendix II). Live rock is still being legally imported to the U.S.A. from countries such as Fiji, Indonesia, Vietnam, Forum Island Countries, Samoa, Marshall Islands, and Tonga.

Most live stony corals imported originate from Indonesia, Fiji, and the Solomon Islands; which still issue CITES export permits. The unsustainable trades in fish, corals, and other reef invertebrates may lead to bans in the trade of coral reef organisms by either exporting or importing countries (Rubec, 1988a, 1997; CRTF, 2000). There were several unsuccessful efforts to completely ban the export of living marine organisms from the Philippines during 1997. During May 1997, the U.S. House of Representatives Subcommittee on Fisheries Conservation, Wildlife & Oceans reviewed House Resolution 87, which condemned fisheries harmful to coral reef ecosystems (Rubec, 1997). The U.S. Coral Reef Task Force (CRTF) has been holding hearings to consider regulation of the aquarium trade to protect coral reefs (CRTF, 1999). A ban on U.S. imports has been proposed to regulate the trade in corals and other reef invertebrates originating from countries lacking sustainable management plans (CRTF, 2000).

## COASTAL COMMUNITIES EMPOWERMENT PROJECT

The IMA has played a key role, in conjunction with the World Resources Institute (WRI), in developing policies and strategies to deal with destructive fishing. An integrated Destructive Fishing Reform Program (DFRP) was developed (Barber and Pratt, 1997, 1998). This holistic approach seeks to create alternative livelihoods for small-scale fishermen and their families in the Philippines. Funding was recently obtained to expand DFRP fishermen training programs to other Southeast Asian countries (IMA-WRI, 1999).

In September 1997, the United States Agency for International Development/Philippines (USAID) awarded funding for IMA to implement the Coastal Communities Empowerment Project (CCEP) in the Philippines. The CCEP is coordinated with the Coastal Resource Management Project (CRMP) also sponsored by USAID (CRMP, 2000). The essence of the CCEP-DFRP program is to empower coastal communities to cease non-sustainable destructive fishing traditions. It is envisioned that the fishermen will become responsible stewards of the resources, on which they depend for their daily living. The program seeks to transform coastal dwellers into resource managers through a mix of education, skills training, enterprise development, information and communication programs, government policies, well-crafted laws and regulations, and enhanced law enforcement efforts.

The CCEP is similar in some ways to other programs in the Philippines involving Community-Based Coastal Resource Management (Alcala, 1998). The program begins through coordination with local government units (LGU) and other local non-government organizations. Once agreements are reached, the DFRP team discusses the initiative with local village (barangay) officials, who in turn call for a meeting. The reform program is discussed with the fishermen to define their situation, needs, aspirations, and expectations using DFRP assistance. In the reform process (Figure 1) destructive fishermen generally give a high priority to their economic needs. Ways to increase income either from fishing or other alternative livelihoods are discussed. Sustainable use of natural resources is addressed through the community-education component of the DFRP. Local management options are considered such as limiting access, policy enforcement, or sanctuary development. It also includes assisting the community with implementing natural resources management. In addition to education and training for adults, children are being taught to protect marine resources for use by future generations.

### *Education*

Village-level education programs play a key role in changing the perceptions of fisherfolk. The IMA has created education materials and training manuals, published in several languages. The Coral Reef Education for Students and Teachers (CREST) manual is being used for teaching coral reef conservation to school children in grades 5–6. Posters, coloring books, and REEF Kits (wooden boxes containing coral reef materials, crayons, scissors, magnifying lens, maps, video tapes) were also created and distributed to assist teachers. During 1998, more than 5000 teaching materials were distributed to schools and partner agencies in government and the private sector (IMA, 1999a). During 1999 the program was implemented in 186 schools reaching 10,416 students (IMA, 1999b).

### *Skills training*

The IMA has been training cyanide fishermen to use non-destructive capture methods in the Philippines (Barber and Pratt, 1997) and Indonesia (Barber and Cruz,

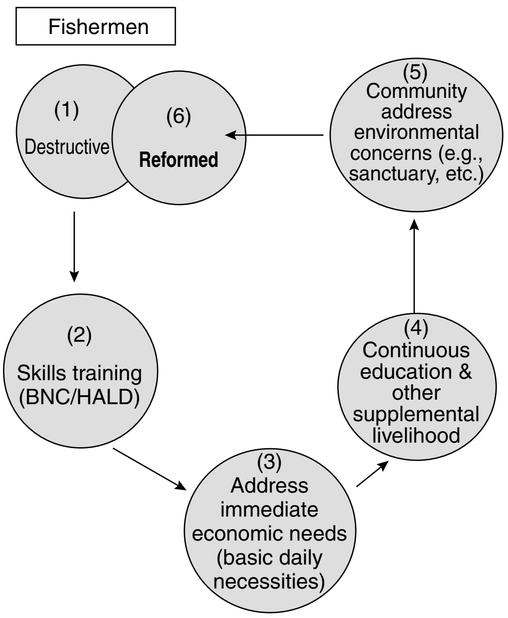


*Figure 1.* Destructive fishing reform process associated with the Coastal Communities Empowerment Project involving Barrier Net Collection (BNC) training or Hook-And-Line, Decompression (HALD) training.

1998). During 1998–1999, 20 Barrier-Net Collection (BNC) training sessions were held that trained 620 aquarium-fish collectors and 151 fishermen obtained Hook-And-Line, Decompression (HALD) training for the capture of live groupers and snappers sold as food fish (IMA, 1999a).

*Law enforcement*

During 1998, 101 fishermen were trained as fish wardens to help enforce laws concerning destructive fishing at the village level (IMA, 1999a). The IMA negotiated with the municipalities of Santa Cruz (Davao Gulf, Island of Mindanao) and Puerto Princesa (Island of Palawan) to exempt aquarium-fish collectors from bans on the use of hookah apparatus (compressed air pumped from surface to diver through plastic tubing) by demonstrating that the divers had received training in diver-safety and BNC methods.

Compliance Certification developed by the Province of Palawan can act as a model for other parts of the Philippines (IMA, 1999b). Amendment No. 332 to provincial ordinance No. 29 promulgated by the Province and the City of Puerto Princesa banned collection of the Polkadot grouper (*Cromileptes altivelis*) a live food fish, and aquarium fish species in the family Balistidae. Exempted were aquarium fish species in the families Pomacanthidae, Pomacentridae, and Chaetodontidae. Harvest of the Napoleon wrasse (*Cheilinus undulatus*) belonging to the family Labridae was restricted to 3–7 inch fish for rearing as food fish in cages. The ordinance requires the shipper to obtain a Certificate of Origin from the local Barangay Captain that states fish were collected and/or cultured without the use of cyanide or other destructive fishing methods. A Certificate of Compliance is also issued by the LGU upon recommendation by the municipal Fisheries and Aquatic Resources Management Council (FARMC). The ordinance states that in areas with a cyanide detection laboratory run by IMA for the Philippine Bureau of Fisheries and Aquatic Resources (BFAR), no fish shipment or trading is allowed without clearance from the laboratory.

*Enterprise development*

Community organizing is being used to help form Fishermen Associations (FAs) and other cooperatives to facilitate marketing marine resources, handicrafts, and other local village products. The goal is to give the fishermen, their wives and other family members business-skills and technical training, such as species identification, handling, packing, shipping, book-keeping, and marketing to help them sell their products.

In 1993, the fishermen on Canipo Island in Northeastern Palawan, Philippines formed a cooperative called Kawii Amianam-Filipino for hook-and-line collecting of groupers (Barber and Pratt, 1997). The IMA helped train the fishermen in better techniques for deflating the swimbladder of the fish to restore their buoyancy in the water. Cyanide testing by the BFAR/IMA laboratories helped the fishermen obtain a higher price for groupers sold in Hong Kong as food fish, since they could demonstrate they were cyanide-free.

In the village of Tumbak, situated in North Sulawesi, Indonesia, the IMA assisted aquarium-fish collectors form a FA and market their fish to Europe (Barber and Cruz, 1998). Under the Philippine DFRP, IMA trained 262 fisherfolk in 15 villages in the Central Visayas concerning micro-enterprise methods during 1998 (IMA, 1999a). The fisherfolk were trained to properly decompress fish at the collection site, transport them to the home village, and in holding, packing, and shipping methods. In the province of Davao Del Sur on the Island of Mindanao, the IMA helped form the Badjao Community Association (BCA) and the Bato Fishermen Livelihood Association, Inc. (BFLFI). The BCA and BFLFI formed partnerships with a Filipino export company. The BCA successfully marketed about five shipments to Zurich, Switzerland from October 1998 to March 1999 (IMA, 1999a). Since then, twelve FAs in the southern Philippines have exported marine-aquarium fish, which were marketed in the U.S.A. and Canada.

The Tagaytay Neighborhood Association in San Vicente on Olango Island is composed 50% of IMA-trained aquarium-fish collectors and 50% other community members. They created a small store in February, 1999. Prior to the creation of the store, the people in the village were dependent on middlemen for all their supplies including food, gas, water, and cyanide for fish collection. This is somewhat surprising considering their proximity to Lapu-Lapu City on neighboring Mactan

Island. Creation of the store has helped to break the middlemens' control of the fish collectors.

## MARICULTURE

It is generally recognized that there are too many small-scale fishermen in the Philippines and in other Southeast Asian countries. It is estimated that there are over 4,000 aquarium-fish collectors (Anonymous, 1998) and about 770,000 small-scale fishermen catching food fish in the Philippines (Rubec, 1988a). Hence, the IMA is interested in implementing alternative-livelihood programs that shift fishermen to other occupations.

Different kinds of mariculture were considered (Lacanilao *et al.*, 1991). The culture of marine mollusks, crustaceans, fish, and marine algae in coastal areas of the tropics has great potential for expansion (Corbin and Young, 1997). McManus (1995) noted that small-scale mariculture should be developed as a species-diverse enterprise, within the framework of integrated coastal zone management. Artisanal mariculture systems lend themselves to the integration of multiple products in a single farm (Newkirk, 1993). Doty (1981) listed 35 species that can be grown in various combinations on reef flats. Mariculture methods utilized by fisherfolk in India could be applied throughout Southeast Asia (Rengarajan, 1996).

One problem is the low profitability of the cultured products intended for human consumption, within underdeveloped countries (McManus, 1995). A second problem is that many types of mariculture require technical expertise and funding that often are not available to fisherfolk. A third problem is obtaining the right to use coastal areas for mariculture. Shrimp farming by interests outside local communities, led to the destruction of mangrove habitats in the Philippines with little benefit for local people (Rubec, 1988a). Hence, the present program emphasizes the use of areas for mariculture controlled by the municipality.

## TERRITORIAL USE RIGHTS IN FISHERIES

An economically viable approach may be the harvest of marine-aquarium fish and the culture of marine invertebrates for the marine-aquarium trade through Territorial Use Rights in Fisheries (TURFs). Christy (1982) and Panayotou (1984) introduced the concept of the community allocating the use of areas (TURFs) for management of fisheries, mariculture, and the conservation of coral reefs. Community-control of the means of production using TURFs has the potential of resolving user-conflicts and reducing fishing effort in specified areas (Smith and Panayotou, 1984; Ferrer, 1989, 1991; Bojos, 1992; Siar *et al.*, 1992). In the Philippines, the legal basis for TURF management already exists. Changes in the Local Government Code in 1991 granted municipalities the exclusive right to license fisheries and other uses of municipal waters within 15 km from the coastline

(Agbayani, 1995). Hence, municipal governments through FARMCs can regulate the implementation of TURFs.

Corals and other reef-invertebrate species reared on TURFs for export could become an important source of revenue for local communities. It may be possible to halt the destruction of coral reefs, by demonstrating that reef invertebrates can be reared profitably for the aquarium trade (Young, 1997; Franklin *et al.*, 1998). This should be tied to programs to convert small-scale fishermen to TURF farmers.

### *Geographic information systems*

As part of the CCEP, the IMA has provided assistance and training to BFAR offices and selected LGUs to use geographic information systems (GIS) technology as a tool for decision-making, and management of coastal resources (IMA, 1999a). The IMA has been developing a GIS database to map shorelines, coastal habitats, bathymetry, ocean currents, temperature, salinity, and the distribution of fish stocks for eleven barangays on Olango Island in the Central Visayas, and for three barangays situated in the Davao Gulf in southern Mindanao. Municipal boundaries are also being defined following guidelines set in the Local Government Code issued in 1991, the new Fisheries Code of 1998, and Fisheries Administrative Order No. 196, Series 2000. The IMA plans to delineate the boundaries of marine sanctuaries and TURFs through consultation with FARMCs, LGUs, BFAR, and the fishermen (IMA, 1999a). The GIS database will be used to assist with this planning process.

## PROPAGATION OF REEF ORGANISMS

Improvements in high-intensity lighting and filtration have made it feasible to culture reef invertebrates under aquarium conditions indoors (Riddle, 1999; Headdlee and Headdlee, 1999). The Waikiki Aquarium in Honolulu cultured over 57 species of corals and distributed fragments to marine hobbyists (Yates and Carlson, 1992; Atkinson *et al.*, 1995). Within the last five years, commercial companies have been formed to culture corals and other marine organisms indoors or in green houses at various locations in the U.S.A. and elsewhere (Fenner, 1998). These companies have high costs to establish and maintain their facilities.

Most marine invertebrates sold by the aquarium trade are harvested from the wild. It seems likely, that it is more economic to culture sessile marine invertebrates in the ocean (in cages or placed on racks) in the tropical countries where the species naturally occur. There is less need to create expensive hatchery or rearing facilities, because of the natural presence of suitable water quality conditions and strong sunlight needed by the organisms. There are fewer legal complications with rearing invertebrate species on TURFs established on reef flats or in other coastal habitats. Many reef-invertebrate species can be cultured and reared with limited investment and technical expertise. A number of species have high potential profitability. Giant clams (*Tridacna* spp.), soft and stony corals, and many other reef invertebrate species presently sell wholesale in the United States for over $15 each (Green and Shirley, 1999; M. Middlebrook, Marine Specialties International, personal communication 1999).

*Giant clams*

Traditionally, giant clams were harvested by coastal communities for their meat and their shell (Heslinga and Fitt, 1987; Mingoa-Licuanan and Gomez, 1996). Most populations of the nine species of giant clams are over-fished throughout Southeast Asia. In the Philippines, three species (*Tridacna gigas, T. deresa, and Hippopus porcellanus*) have been depleted and are no longer harvested. Populations of *Hippopus hippopus* are still abundant in certain localities. *Tridacna squamosa*, *T. maxima*, and *T. crocea* are the most abundant species. All species of giant clams in the Philippines are protected, except *T. crocea* which is collected from the wild for export. Giant clams are considered good mariculture species because of their high fecundity, short planktonic larval stage, and autotrophic nutrition. Brood stock for the seven species listed above exist at the University of the Philippines.

Giant clams are considered endangered species and are protected under CITES. A valid export permit is needed to be able to export giant clams in countries that have ratified the convention (Knop, 1996). The CITES permit provides a survey of the traded numbers of individuals for each species and controls the trade. The countries receiving shipments can only import giant clams accompanied by a CITES permit.

A considerable amount of research has been conducted on culturing giant clams for the purpose of restoring their natural populations (Trinidad-Rao, 1989; Mingoa-Lincuanan and Gomez, 1996; Knop, 1996). Techniques were perfected for breeding and culturing giant clams in Palau (Heslinga *et al.*, 1981). Likewise, both the University of the Philippines and Silliman University developed methods for induced-spawning and rearing giant clams in the Philippines during the 1980s. Following spawning and larval settlement, the clam spat can be reared in cages placed in coastal areas (Heslinga and Fitt, 1987).

Knop (1996) pointed out that most of this research was funded through foreign-aid programs. Unfortunately, aid programs are usually short-term. Hatcheries that support giant clam restocking programs can only survive in the long-term if the hatcheries can sell a certain percentage of their product. The International Center for Coastal Living Aquatic Marine Resources Management (ICLARM) Coastal Aquaculture Research Center (situated in the Solomon Islands) came to the realization that the sale of giant clams for the aquarium trade could help finance restoration of natural giant clam populations. The Association of Farmed Aquarium Clam Exporters (AFACE) was formed to create standards that promoted the sale of the more colorful clams to the aquarium trade. The Mariculture Demonstration Center in Palau was one of the first hatcheries to obtain CITES permits that allowed them to sell giant clams to the aquarium trade in the early 1990s.

It generally takes 3–5 years to grow giant clams to a size at which they can be harvested for food in the host country or for export of their adductor mussel

(Heslinga and Fitt, 1987). Clam species, like *T. gigas* and *T. deresa*, attain a shell length of 30 mm within 6 months, while *T. crocea* attains a shell length of 20 mm in 1 year (Knop, 1996). These species are currently being marketed to the aquarium trade in the U.S.A. Less time is required to rear clams for the aquarium trade than for food consumption. Hence, export of giant clams to the aquarium trade can provide more immediate economic returns.

Several countries already are exporting farmed giant clams to the U.S.A and Canada for the aquarium trade. A private company presently exports six species of giant clams (*T. gigas*, *T. crocea*, *T. maxima*, *T. deresa*, *H. porcellanus*, and *H. hippopus*) from the Solomon Islands (D. Palmer, Aquarium Arts, personal communication 1999). *Tridacna crocea* and *T. maxima* are being farmed and exported both from Palau (L. Sharron, Belau Aquaculture, personal communication 1999) and Vanuatu (J. Armitage, Aqualife Exports, personal communication 1999).

The IMA plans to create a giant clam hatchery in the Philippines. Clam spat will be distributed to coastal communities where they will be reared on TURFs for restoration of wild populations and for export to the aquarium trade.

*Live rock*

The harvest of live rock (rocks coated with encrusting red algae [*Limnothamnion* sp.] and/or other sessile marine invertebrates) increased since 1986 to supply aquarium hobbyists maintaining minireef aquaria in the U.S.A. This led to a ban on the collection of live rock from Florida state waters in 1991, and in federal waters of the Atlantic coast in 1996, and the Gulf of Mexico during 1997 (Haddad, 1997). Since then, several companies obtained leases in state and federal waters to culture live rock off the coast of Florida. The companies exploit natural recruitment mechanisms by allowing invertebrate larvae to colonize bare rock placed at the lease sites, in order to produce live rock (Young, 1997).

The Florida live rock does not have a large selection of encrusting invertebrate species. Much of the live rock presently being imported to the U.S.A. comes from Fiji, Indonesia, or Vietnam. Fiji is now considering a ban on the harvest of live rock from the wild. Other countries may follow in banning the harvest of live rock, due to environmental concerns about damage to coral reef habitats. A viable alternative may be to culture live rock in coral reef habitats situated in Indo-Pacific countries, where the invertebrate species in demand by aquarium hobbyists naturally occur.

An innovative approach for producing artificial live rock was proposed by Headdlee and Headdlee (1998a,b). This involves mixing aragonite sand with concrete and molding it into various shapes. The product is called Aragocrete®. The Aragocrete® rocks have holes in the center. These 'Socket Rocks' can be attached to rocks with posts called 'Reef Plugs' (R. Headdlee, Geothermal Aquaculture Research Foundation, personal communication 1999). These structures allow the marine hobbyist to build an artificial reef of live rock in the home aquarium. The concept is analogous to the use of children's building blocks.

The IMA plans to work with the Headdlees to train Filipino fishermen to create Aragocrete®. The Socket Rocks will be deployed on TURFs in coral reef areas, where they can be colonized by marine invertebrates. After about a year, the farmers will be able to harvest their live rock for export to the marine-ornamental trade.

*Hard and soft coral fragments*

Coral reef scientists have developed techniques for transplanting corals and culturing fragments attached to artificial substrates, as part of efforts to rehabilitate damaged coral reefs (Lindahl, 1998; Franklin *et al.*, 1998). Between 1990 and 1995, scientists at the Mariculture Demonstration Center in Palau developed reliable protocols for the mass cultivation of stony coral fragments, intended for export to the United States marine-aquarium trade (Heslinga, 1998). The coral fragments were propagated while attached to artificial substrates mounted on racks situated on reef flats. Hard and soft corals now are being cultivated by similar methods in the Solomon Islands, Guam, Tanzania, Vanuatu, Palau, and the Philippines. Table 1 summarizes some of the genera of corals being cultured for the aquarium trade.

The University of San Carlos, situated in Cebu City on the Island of Cebu, recently initiated coral farming. With funding from the German government and the assistance of German aquarium hobbyists (Knop, 1999), Heeger and Sotto *et al.* (2000) established a coral farm in Barangay Caw-oy on Olango Island. An environmental training center was established to train local fishermen in the basic skills of coral farming. This includes the methods for selection of donor corals, fragmentation techniques, care during grow-out, and marketing of the fragments. Ecotourism is also being promoted at the coral farm with the creation of an underwater trail for divers.

The IMA has initiated projects to rehabilitate coral reef areas, and expand training in coral farming to other barangays on Olango Island, on the Island of Bohol, and in the Davao Gulf. Using corals purchased from the community of Caw-oy, the IMA created a coral farm to support reef rehabilitation in a marine protected

*Table 1.* Some coral and zoanthid genera currently being cultured for the aquarium trade

| Hard corals | | Soft corals | Mushrooms/Polyps |
|---|---|---|---|
| *Acropora* | *Pachyseris* | *Capnella* | *Actinodiscus* |
| *Anacropora* | *Pavona* | *Cespitularia* | *Briareum* |
| *Blastomussa* | *Pocillopora* | *Cladiella* | *Clavularia* |
| *Caulastrea* | *Porites* | *Heteroxenia* | *Gorgonia* |
| *Euphyllia* | *Psamacora* | *Lithophyton* | *Pachyclavularia* |
| *Galaxea* | *Seriatopora* | *Lobophytum* | *Palythoa* |
| *Hydnopora* | *Stylopora* | *Nephthea* | *Parazoanthus* |
| *Millepora* | *Tubastrea* | *Sarcophyton* | *Ricordea* |
| *Montipora* | *Tubipora* | *Sinularia* | *Rodactus* |
| *Nemenzophyllia* | | *Xenia* | *Tubipora* |
| | | | *Zoanthus* |

*Source:* Mary Middlebrook, Marine Specialties International, personal communication (2000).

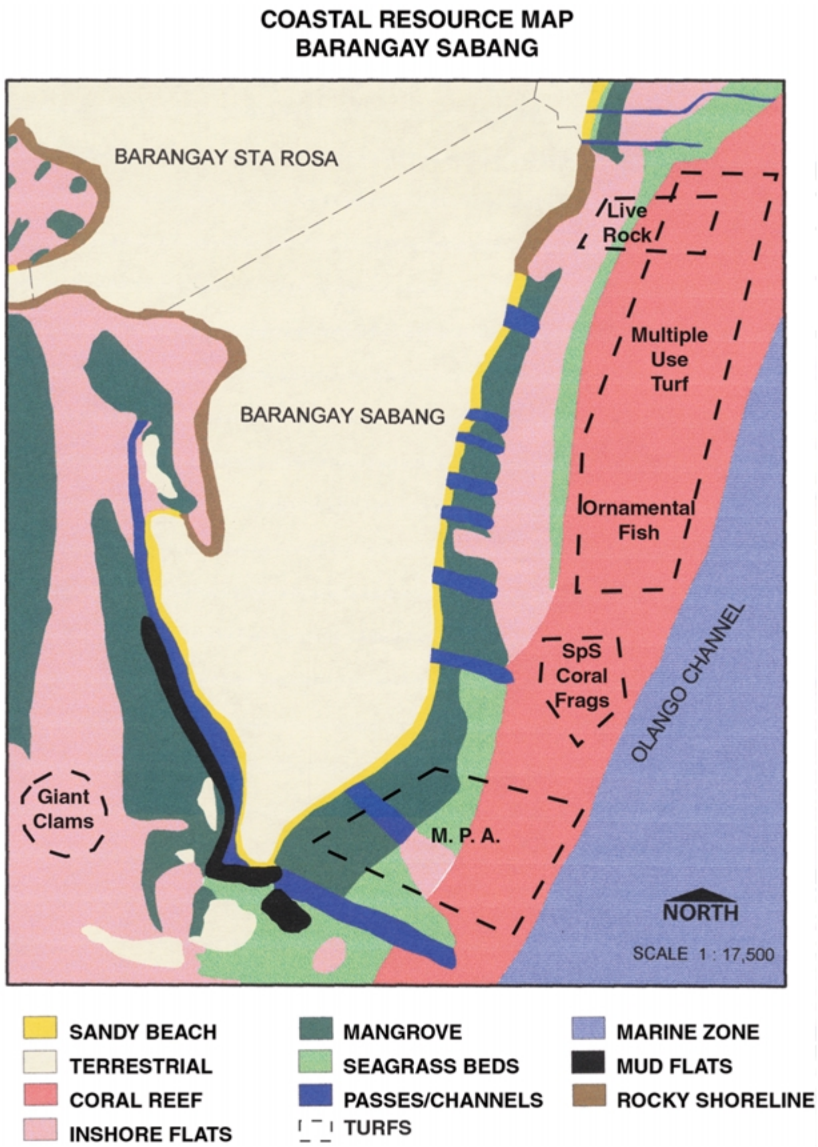


*Figure 2*. Marine resource map of Barangay Sabang on Olango Island depicting hypothetical locations of a marine protected area, a TURF for collecting ornamental fish, and TURFs for the culture of gaint clams, coral fragments, and live rock. MPA: marine protected area. SPS: small polyp stony corals.

area (MPA) situated at Barangay Consuelo on Camotes Island in the northeastern part of Cebu Province (Ravenhill, 2000). The IMA is assisting the community to obtain CITES permits from the Philippine government. These permits will allow the export of cultured coral fragments to the aquarium trade. The goal is to shift fishermen away from destructive fishing by demonstrating the economic benefits of coral farming, while raising coastal community awareness of the need for conservation of coral reefs.

*Marine-aquarium fish*

The IMA is assisting collectors trained to use nets with the creation of TURFs for marine-aquarium fish on coral reefs in the Davao Gulf. Underwater surveys to determine fish species abundance will be used to determine the number of collectors that each reef can sustain. By educating the fishermen to protect the reefs, sustainable yields of aquarium fish are expected to increase over time. Periodic surveys should allow the FARMCs to adjust fishing pressure on the reefs.

## CONCLUSION

The IMA is working in cooperation with LGUs, FARMCs, and BFAR to plan the placement of TURFs. Hypothetical examples for siting TURFs, using GIS in coastal areas of Barangay Sabang on Olango Island, are depicted (Figure 2). Fairly large areas (>2 $km^2$) are needed for marine protected areas (MPAs) and for fish-collecting TURFs to protect coral reefs and their associated biodiversity. Smaller TURFs allocated to FAs or other groups should be suitable for culture of giant clams, live rock, and coral fragments.

For TURF farming to become a reality, there is a need to develop integrated strategies, including village-level training and loan programs, that assist local communities to create hatcheries and other infrastructure. Scientists need to become involved in training programs to transfer their knowledge to the fisherfolk. The use of GIS can assist in determining suitable locations of TURFs for mariculture, fishing, and fisheries management (Kam, 1989; Rubec *et al.*, 1998; Rubec, 1999; Arnold *et al.*, 2000). Certification is one way to verify that the organisms exported to other countries are produced by sustainable means without damaging coral reefs.

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