Chapter 3
NATURAL RESOURCES

MINERAL RESOURCES

Mineral deposits in Bohol consist mainly of copper, manganese, phosphate and guano (PPDO 1993a). Bohol is historically known for a certain permissiveness regarding mineral exploitation, which could lead to widespread excavation, destruction of habitat and watershed, and erosion. A classic example of this was the quarrying of the tourist-attracting Chocolate Hills, now declared as a national monument area where all forms of extraction have been averted.

In the profile area, Getafe and Buenavista are reported as containing deposits of copper, manganese and silica sand. In fact, Getafe is reported to have a positive reserve of 53,900 mt of clay silica. Buenavista is also known for siliceous clay. Clarin and Inabanga both have guano and phosphate deposits, while Tubigon is a source of red burning clay. Loon has deposits of limestone and silica. The province uses 4 major sites as sources for construction project materials (PPDO 1993a). These are Lapacan Quarry, Inabanga; Cawayan River, Inabanga; Macaas Quarry, Tubigon; and Calunasan River, Calape.

There have been reports of sand quarrying in Clarin and Tubigon to be used as beach filler on Mactan Island, Cebu. This has resulted in the alleged disappearance of several small islands and beaches in the profile area, which contributes to coastal erosion, loss of habitat for both wildlife and humans, and loss of potential revenue from tourism.

FOREST RESOURCES

Based on the data gathered by the Provincial Planning and Development Office (PPDO), there are no major forest resources within the municipal boundaries of the profile area. The only exception are mangrove stands under the land classification of "protection forest".

COASTAL RESOURCES

Mangroves

The overall mangrove coverage in the profile area is approximately 4,196 ha (SUML 1997). The largest single area appears to be in Clarin, with a reported coverage of 318.61 ha. Much of the observed mangroves are secondary growth. A total of 27 different species of true mangroves and associated species belonging to 15 families have been observed in the area (Table 3.1).

Fourteen different species were identified in Calape, while Inabanga and Clarin each have 12 species. Getafe has 10 different species and Tubigon has 9. There is no confirmed species identification for Buenavista; however, an estimated 400-500 ha of mangrove cover occurs within the municipality. Overall, the mangrove habitat in northwestern Bohol can be rated as fair to good, even though most is secondary growth.

The densest overall mangrove saplings reported by Silliman University Marine Laboratory (SUML) are in the Clarin-Tubigon area. Clarin has a density of 9,735 stems of *Lumnitzera littorea* per ha; 8,125 stems of *Avicennia alba* per ha and 3,750 stems of *Ceriops decandra* per ha. Tubigon and Inabanga have mean sapling densities of 5,520 and 9,375 stems of *A. marina* and *R. mucronata*, respectively, per ha. The SUML sample site with the highest density of seedlings is on Pangangan Island, Calape, with 90,000 stems of *Rhizophora* per ha. This extremely high seedling density is indicative of a massive reforestation effort. Bohol is well known for its community-based mangrove reforestation efforts, where "...traditional or non-destructive fishing within mangrove areas is still important...".

Getafe's Banacon Island has an extremely high number of stems/ha (11,350) and an overall basal area of <5 - 40 cm. Massive reforestation has occurred here by the local community with assistance from the DENR, DA and the Central Visayas Regional Project - I (CVRP-I).

The reforestation began in the late 1950s, when an inhabitant of Banacon -- Mr. Denciong Paden -- began planting *Rhizophora* as a livelihood endeavor. By the 1980s, the island had already achieved recognition for the national and international significance of its mangrove cover. At that time, the DENR, DA and CVRP-I all began operations in the area. Mr. Paden was later sponsored by the DENR as the Philippine winner of the 1991 "Trees for Life" Award for the largest reforestation project in Southeast Asia (covering over 250

Table 3.1. Mangrove and associated species in the profile area (SUML 1997).

Families/Scientific Name	Common Name	Distribution*				
		Ca	Tu	Cl	In	Ge
1. RHIZOPHORACEAE						
Rhizophora mucronata	*bakhaw baye*	x	x	x	x	x
Rhizophora apiculata	*bakhaw lake*	x			x	x
Rhizophora stylosa	*bakhaw tigre*					x
Ceriops tagal	*tungog, tangal*					x
Ceriops decandra	*hangalay, lapis-lapis*	x	x	x	x	x
Bruguiera gymnorrhiza	*busaing*		x			x
2. AVICENNIACEAE						
Avicennia marina	*piyape baye*	x	x	x	x	x
Avicennia officinalis	*piyape lake*		x	x	x	
Avicennia alba	*piyape lake*			x	x	
Avicennia lanata	*piyape*		x	x		
3. SONNERATIACEAE						
Sonneratia alba	*pagatpat*	x			x	
Sonneratia caseolaris	*pedada*				x	x
4. COMBRETACEAE						
Lumnitzera littorea	*mayoro*		x		x	
Lumnitzera racemosa	*sagasa*				x	
Terminalia catappa	*talisay*	x				
5. MYRSINACEAE						
Aegiceras corniculatum	*saging-saging*			x		x
6. PALMAE						
Nypa fruticans	*nipa*		x	x	x	
7. EUPHORBIACEAE						
Excoecaria agallocha	*alipata, buta-buta*	x	x	x	x	x
8. MELIACEAE						
Xylocarpus granatum	*tabigi*	x		x		
Xylocarpus moluccencis	*piyagaw*			x		
9. LYTHRACEAE						
Pemphis acidula	*bantigi*	x				
10. MYRTACEAE						
Osbornia octodonta	*tualis*	x				
11. BIGNONIACEAE						
Dolichandrone spathacea	*tui*	x				
12. LECYTHIDACEAE						
Barringtonia asiatica	*bito-bitoon*	x				
13. FABACEAE						
Prosopis vidaliana	*aroma*		x			
14. GOODENIACEAE						
Scaveola frutescens		x				
15. PANDANACEAE						
Pandanus sp.	*pandan*	x				

**Ca - Calape; Tu - Tubigon; Cl - Clarin; In - Inabanga; Ge - Getafe*

ha). Even though Mr. Paden recently passed away, he will always be remembered by the island's beautiful winding boat canal dubbed "Paden's Pass."

Avicennia marina, Rhizophora mucronata, Ceriops decandra and *Exoecaria agallocha* are the most commonly occurring species in the area. Additionally, many of the mangrove stands are inter-planted with *nipa* (*Nypa fruticans*). *Nipa* is locally used for making roof thatch.

Local uses of mangroves are for poles for fencing and fish weirs, as well as for charcoal and firewood. While wood is cut for the construction of *bancas* (boats) and houses, there is little or no extraction of timber by commercial establishments. The fruits, bark and leaves are used for food, medicine and animal fodder. Fish and crustaceans are captured in the fringes of mangrove areas and some areas within the habitat are used for the illegal construction of fishponds, especially for milkfish and prawns. Additionally, many fishing communities realize the importance of mangrove stands as a buffer against coastal erosion caused by incoming waves, especially during the peak typhoon season of September-January.

Mangroves help to sustain coastal fisheries by providing feeding, breeding and nursery grounds for fish and for invertebrates such as shrimp and mollusks. Detritus and nutrients that accumulate from litter of decaying plants are consumed by marine organisms, or exported by tides to nearby aquatic ecosystems. In addition, silt and sediments are trapped as they come from the land and help prevent erosion of the shoreline (B2DMP 1997). Mangroves also support reptiles, amphibians and other wildlife, and serve as a potential source of materials for the production of pharmaceuticals. Invertebrates in the mangrove areas are gleaned during low tide.

Mangrove-associated flora in the profile area consists of 2 species of algae (*Bostrychia* and *Padina*) and 6 species of seagrasses. Mangrove soils are basically sandy and of various grades; therefore, *Rhizophora* is the dominant vegetation. Sand contributes to the majority of mangrove soils in the Bohol profile area. The deposition of this substrate type is attributed to the tidal inundation of the weathered fragments of corals and other materials from the seabed.

In the past, white herons, wild honeybees, Philippine cockatoos, bats and monkeys used to inhabit the mangroves. Now, the increasing encroachment of humans into mangrove areas has driven most of these animals away.

Seagrass and Algal Beds

The nearshore area is mainly a seagrass zone. Even the intertidal areas between small offshore islands are generally composed of seagrasses, followed by *Sargassum* beds and/or coral patches and reefs. Seagrasses favor sand and silt substrates, while the *Sargassum* usually colonizes degraded or dead corals and limestone.

Seagrass beds in the profile area comprise approximately 555 ha found at depths of 0 to 3 m (SUML 1997). Six species of seagrasses have been identified in the profile area. These species are: *Cymodocea rotundata, Enhalus acoroides, Halophila ovalis, Halodule pinifolia, Halodule uninervis* and *Thalassia hemprichii. Sargassum* beds dominate at deeper depths with a biomass of approximately 37.25 g dry weight/m^2. It is seasonal and most abundant from April to October.

Forty-nine different species of algae in 16 families also inhabit the area. Twelve species are green algae (*Chlorophyta*),20 are red (*Rhodophyta*),15 are brown (*Phaeophyta*) and 2 blue-green (*Cyanophyta*).

Vegetation is generally determined by substrate, which partly explains the differences in dominance patterns and species composition within a given area. Seagrasses favor sand and silt substrates, while *Sargassum* is more prevalent in areas with limestone or dead corals.

Thalassia hemprichii and *Cymodocea rotundata* are the 2 most dominant species of seagrasses on the northern side of the profile area. The largest and most dense seagrass bed noticed is off Getafe on Banacon Island. This area has a mean cover per m^2 of 35.3 percent of *Thalassia hemprichii*, 12.28 percent of *Enhalus acoroides* and 10.55 percent of *Cymodocea rotundata* (SUML 1997).

Calape has the greatest diversity of algae, with 35 species, while Getafe has the least diversity with 8 species. Seaweeds such as *Eucheuma* species, *Gracilaria* species, and other algae are typically sold to middlemen from Cebu at PhP 3 - 9/kg (dried) depending on species, demand and season. Within the area, *Sargassum* is typically used to feed hogs and other livestock.

Density and coverage is important because seagrass and algal beds are rich sources of macroinvertebrate secondary life. The majority of these are not economically important but have important ecological roles. A total of 110 species of macroinvertebrates belonging to 6 phyla are identified as inhabiting the profile area (SUML 1997). The phyla are: *Porifera* (sponges), *Annelida* (worms), *Mollusca* (mollusks), *Arthropoda* (arthropods), *Echinodermata* (sea urchins and seastars) and Mytiloida (mussels/pen shells).

The municipality of Inabanga reportedly has the richest species diversity, with 34 macroinvertebrates, along with Calape (30 species). Economically important species (such as the bivalves *Septifer* and *Pinctada*) are found in the intertidal areas of Inabanga.

Nearshore

The majority of the nearshore area is a soft-bottom community, with an estimated area of 7,463 ha. Sites on the mainland are primarily composed of fine textured sand with grain sizes of less than 125 μm, while island sites are composed of coarse sand (SUML 1997).

In general, the soft-bottom areas are dominated by polychaetes. Other organisms include crustaceans. Of the polychaetes, spionids are the most represented family in terms of number of species (6) and density (as many as 108 organisms/0.02 m^2).

Open Waters

Plankton composition of open waters off the area is dominated by zooplankton (62.28 percent).The zooplankton community consists of tintinnids, nauplii, copepods, larvaceans, gastropods and bivalves. Other groups include diatoms (31.35 percent), dinoflagellates (7.13 percent) and other algae (0.24 percent).

The phytoplankton community is mainly made up of diatoms, blue-green algae and dinoflagellates. The diatoms are composed of 58 species, of which *Coscinodiscus*, *Rhizosolenia* and *Thalassionema* are the most abundant. A blue-green algae, *Trichodesmium*, is also common in the area.

Forty-seven species of dinoflagellates belonging to 20 genera are present. These include some species known to be toxic in causing red tide such as: *Alexandrium*, *Ceratium*, *Dinophysis*, *Gambierdiscus*, *Gonyaulax*, *Noctiluca*, *Peridinium*, *Protoperidinium* and *Pyrodinium*. These toxic algae are potentially detrimental to human health when they affect bivalves and other marine organisms commonly eaten (SUML 1997).

While most of the identified dinoflagellate species are not toxic, their potential blooms can result in the lowering of water quality. Even a non-toxic bloom still results in an enormous amount of organic matter decomposing in the water. Large amounts of organic matter decomposition can cause anoxia (deoxygenation) due to high biochemical oxygen demand by the decomposing life forms. Once the level of dissolved oxygen drops below 5 mg/L, fish and other marine species become stressed and may die. The blooms also increase the ammonia level (a by-product of decomposition) in the water. Such algal blooms are sometimes triggered by increased sediment or nutrient loads from shoreline run off.

Corals

Except for those in Danajon Bank, the majority of the coral reefs of northwestern Bohol are fringing reefs with widths from 100 to 200 m. Substrate composition is defined by rubble, sand and rock, while seagrasses flourish at the shallower portion of the reefs. One hundred twelve identified species of scleractinian corals belonging to 14 families abound in the municipal waters of the profile area. Eleven species of non-scleractinian and certain soft corals are also present in limited areas (SUML 1997). There are large areas that have not yet been sampled.

Through random quadrat surveys in selected sites, a mean live hard coral (LHC) cover of 31.35 percent has been determined. Rating the coral habitat in profile area waters, one would have to give it an overall rating of fair to poor only.

High LHC cover can be found in Inabanga (58.75 percent; good condition) and Tubigon (40 percent; fair condition). The lowest values are in Buenavista and Calape (15.3

percent for both), where the sand composes a distinct portion of the reef (25.38 percent relative cover). Coral habitats in Buenavista and Calape are rated as poor.

Good coral growth appears to be concentrated on the reef slopes. The reefs also have an overall cover of 4.05 percent of seagrasses, 10.2 percent of other fauna (sea ferns, seaweeds, sponges), 15.57 percent of rubble, 15.64 percent of sand, 4.48 percent of silt and 14 percent of rock.

Coral diversity in the profile area, coupled with overall coral growth, provides a nurturing habitat for over a hundred different species of fish. Inabanga and Tubigon have the highest recorded number of coral species (65 and 63). Calape has 53 species, while Getafe and Buenavista have 45 and 31 species, respectively (all low by Philippine standards).

The relatively low coral diversity plus the high coral rubble indicates physical destruction of the reef from various destructive fishing methods, and other natural factors such as typhoons. The local term for corals is *"bato"*, which means "stone". This misconception illustrates the people's perception of a coral as non-living and that it has little biological or economic value. People use corals for construction purposes. Indeed, most piers in the profile area are made of collected coral heads (such as Buenavista's). In the past, families attending Sunday Mass were told to bring at least 1 coral head to church to help build the massive churches which now stand proud in every town of the profile area. In Loon, where a garments industry is well established, there have been reports that corals are used in a process called stone-washing to create a faded look for denim pants.

Fish Diversity and Abundance

With respect to fish standing stock, SUML conducted a visual census of 130 species belonging to 26 families. All the species were either reef, or reef-associated. Inabanga has the most with 52 species in 16 families. Getafe has the least with 24 species in 12 families, as well as the lowest species richness and lowest average abundance. These numbers are all low by Philippine standards because of heavy fishing pressure and generally poor coral cover noted above.

According to SUML surveys, the 2 families of fish with the most number of species are Pomacentridae (damselfish; 33 species) and Labridae (wrasse; 20 species). Both families are fairly common in coral reefs and are generally small in size. They are typically not targeted as food by fisherfolk as they have little food value. Pomacentrids belong to the lower trophic levels, where they feed mostly on benthic algae and plankton. Labrids range in size from 5 to 229 cm. They also belong to lower trophic levels, feeding on benthic invertebrates, coral polyps, small fish and detritus. Occasionally, some labrids may grow large enough to be desirable subsistence food. Apparently, the depleted state of the coral reefs along northwestern Bohol has turned the attention of fishers to these less desirable species as an available source of food.

The only large predatory species observed was *Lutjanus decussatus* of the family *Lutjanidae* (snapper). Its density was very low (less than 1 per 500 m^2), which indicates extreme overfishing in the area. These large predatory fish are highly priced, and vulnerable to various fishing gears including hook and line, traps and spearfishing. Because of this, they are regarded as good indicators of fishing pressure on coral reefs.

Other fish desired by fisherfolk include 24 target species, most of which are reef-associated. The average biomass, as estimated by SUML, of these target species was 203.32 g. The highest biomass (524.86 g) was found off Inabanga, which had the highest percentage of coral cover in the profile area. On the other hand, Getafe had the lowest biomass (15 g), as well as the lowest species richness and density of reef-associated fish. It should also be noted that Getafe has a relatively low coral cover. This limited incidence out of 24 target species is troubling, because it means that almost all of the target species are missing, which is yet another indicator of overfishing in the area. This number of target species is very low compared to healthy coral reefs not being overfished.

The absence of other large predators, such as families of grouper (Serranidae), bream (Lethrinidae) and jacks (Carangidae) may be due to the reputedly rampant illegal fishing. Dynamite and cyanide fishing is still prevalent in the whole profile area, with residents of Getafe and Calape reporting dynamite blasts of up to 18 per day. This method of fishing takes advantage of high fish density, but harms the relatively high coral cover found there. The use of trawls which drag on the substrate is another destructive fishing method which is very efficient and contributes to the overall degradation of habitat and lowering in fish stock.

During test-fishing (gill net) surveys by SUML, most of the species of fish measured less than their respective commonly-caught sizes. They were also shorter than their respective maximum lengths. This is another indication of intense fishing pressure in the area, where even the small, young fish are captured. While this may provide a current source of food and market income, it threatens to lower fish catch (and human welfare) in the future. Even now, the small fish sold in the market command low prices, which is beginning to disrupt local income patterns. Catching young fish is very inefficient. It wastes the fish and disallows them from spawning to produce the next generation.

Results of Participatory Coastal Resource Assessment (PCRA)

The results of barangay and municipal level PCRAs in 1997 and 1998 for the 7 municipalities from Loon to Getafe are presented in Figures 3.1 to 3.8. Important habitats are mapped as well as resources, uses and issues. It is noted that coral reefs and seagrass beds are dominant features of this coastline. The resources and their uses are similar throughout the 7 municipalities. Management issues persist with major concerns being overfishing, use of destructive methods, poor law enforcement and others as noted. The maps in Figures 3.1 to 3.8 can serve as a baseline for habitat management in the area and are generated by a geographic information system (GIS) for future updates and use.

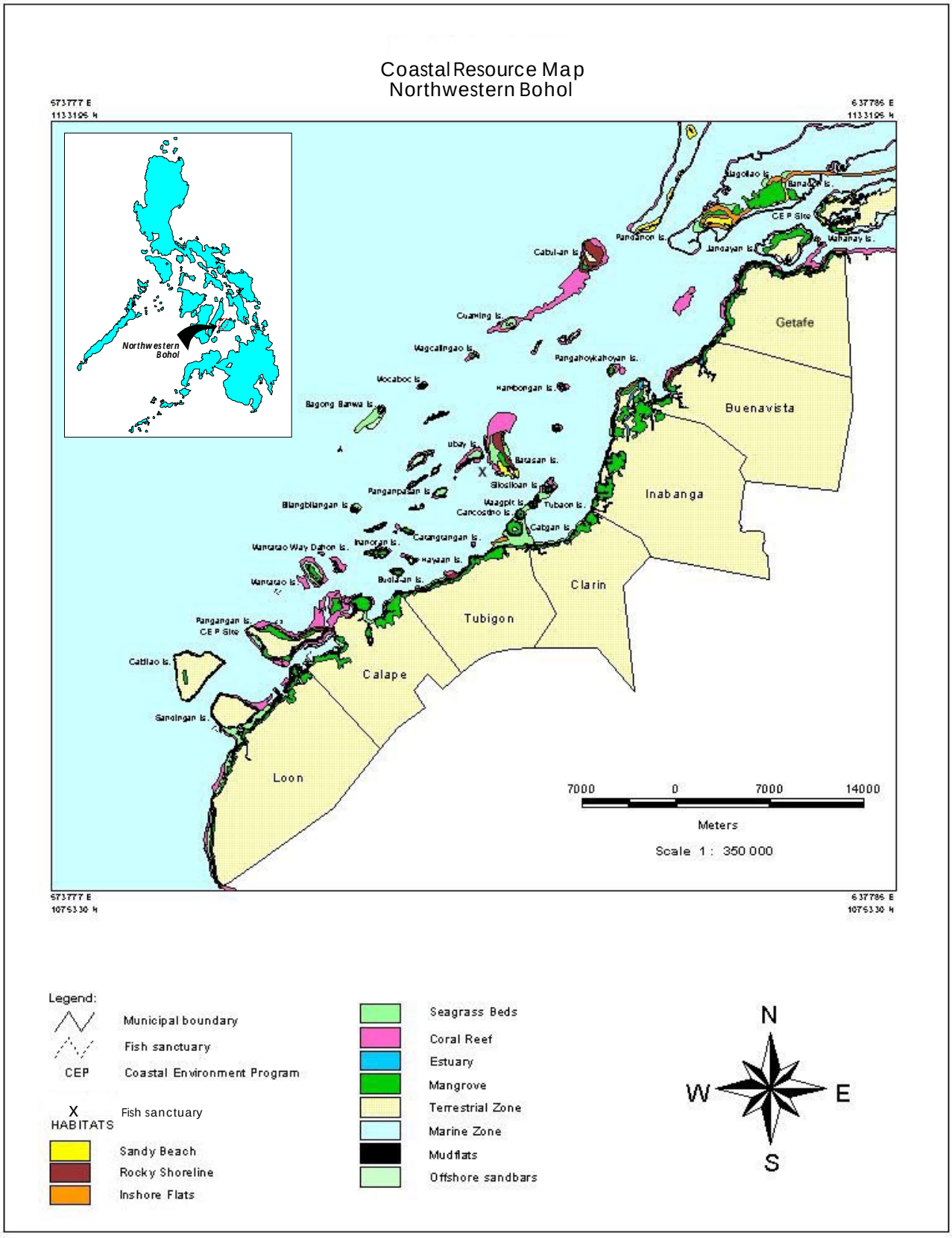

Figure 3.1. Coastal resource map of northwestern Bohol.