PROFILE OF THE BAIS BAY BASIN

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INTRODUCTION

General Profile

Bais Bay is located on the eastern side of Negros Island (123° 9' E long. 9° 34' N lat.) facing Tañon Strait in Central Philippines, 45 km north of Dumaguete City. It occupies an area of about 54 km² (5,430 ha), naturally divided into North Bais Bay and South Bais Bay by Daco or Dewey Island. Near the center of North Bais Bay stands the smaller Olympia Island or Polundyot (also called Diutay Island) which unlike Daco Island has no road connection to Bais City. Both islands are coral rocks with a very thin layer of about 1-2 inches of topsoil (Cadeliña, 1983) and are populated.

Three rivers, Panambalon, Alangilanan, and Lutao (or Tamogong), empty into North Bais Bay. Only one river, the Panamangan, supplies fresh water to South Bais Bay.

Figure 1 shows that Bais Bay actually belongs to three municipalities. The northern end of North Bais Bay belongs to the municipality of Manjuyod. The greater portion of this and a large part of the northern portion of South Bais Bay belong to Bais City while the remaining small part of South Bais Bay belongs to Tanjay.

North and South Bais Bays each has a pier and a fishing port. The pier in South Bais Bay, located in Luca, Tanjay, was built by Central Azucarera de Bais (CAB) in 1925; the one in North Bais Bay, located in Campuyo, Manjuyod, was constructed by the Universal Robina Sugar Milling Company (URSUMCO) in 1974. Both piers accommodate foreign cargo ships (British, Japanese, Greek and Swiss) which enter the bay during and after sugar milling seasons (November to May) to purchase sugar and molasses from the two sugar factories. The two fishing ports, one located in Hindungawan, South Bais Bay, the other in Canibol North Bais Bay, both belong to Bais City. A new pier was constructed in Capiñahan in 1993.

Importance of Bais Bay

Bais Bay has long been a source of food for the local populations of Bais and neighboring towns, including Dumaguete City. Because of this, it has generated inter-

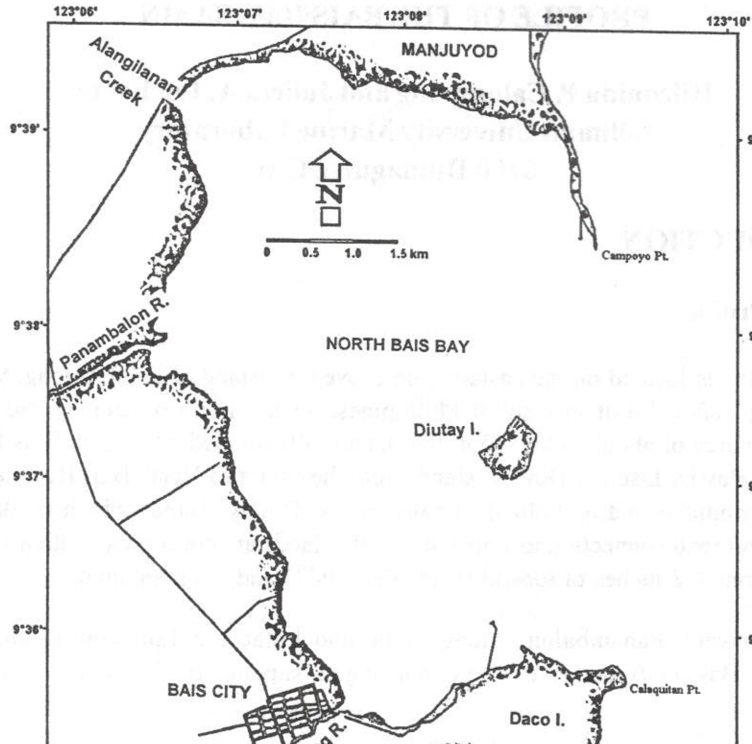

Figure 1. Map of Bais.

est for many scientific investigations, especially by students and scientists from Silliman University and abroad. Among these are important studies on the primary productivity of mangroves (de Leon, *et al.*, 1991a) and seagrasses (Estacion and Fortes, 1988); litter production and exportation (de Leon, *et al.* 1991b; Oñate, 1991; Calumpong, 1992a); listing and quantification of economically-harvested species (Alcala, 1979; Alcala and Alcazar, 1984) and associated fisheries (Dolar and Lepiten, 1991; Dolar, *et al.*, 1991); structure and ecology of benthic invertebrates (Maravilla, 1975; Notosoedarmo, 1977; Estacion and Oñate-Pacalioga, 1990; Calumpong, 1979; Pauly and Calumpong, 1984); environmental (Alcala and Ortega, 1976); pollution (Lowrie and Anfone, 1980; Lowrie, *et al.*, 1979; Ng, 1978); plankton (Alcazar, 1983) and energetics (Calumpong and Serate, 1994).

This report incorporates data from these biological and chemical studies. Additional information was gathered from government agencies such as the Department of Agriculture (DA), Bureau of Fisheries and Aquatic Resources (BFAR), and Department of Environment and Natural Resources (DENR). In organizing this paper, we drew much inspiration from the work of Tagarino, *et al.* (1985) on their analysis of Lake Buhi.

SYSTEM HIERARCHIES: THE BAIS BAY MARINE SYSTEM

Bais Bay Subsystems

Figure 2 gives an idea of the system hierarchies existing in the Bais Bay Basin. These systems are both natural and political. At the very top of this hierarchy is the Bais Bay Basin, naturally divided into the North and South by Daco Island. North Bais Bay occupies an area of about 32 km^2, the rest is occupied by South Bais Bay. The third level of hierarchy is a political one, placing the Bay under three jurisdictions: part of the North Bais Bay Basin belonging to the municipality of Manjuyod, a small part of the South Bais Bay belonging to the municipality of Tanjay, and a major part of both Bays belonging to the city of Bais. Within each of these municipalities are subsystems contributing to the overall basin ecosystem, namely the watershed, the farmlands, the industrial and urban areas, rivers, coasts and the bay itself with its distinct but interconnected ecosystems. Figure 3 shows the different ecosystems in Bais Bay.

Bais Bay Ecosystems

The most recent report by Calumpong and Serate (1994) reveals that Bais Bay covers a total area of 5430 ha including the outermost reef margins. In

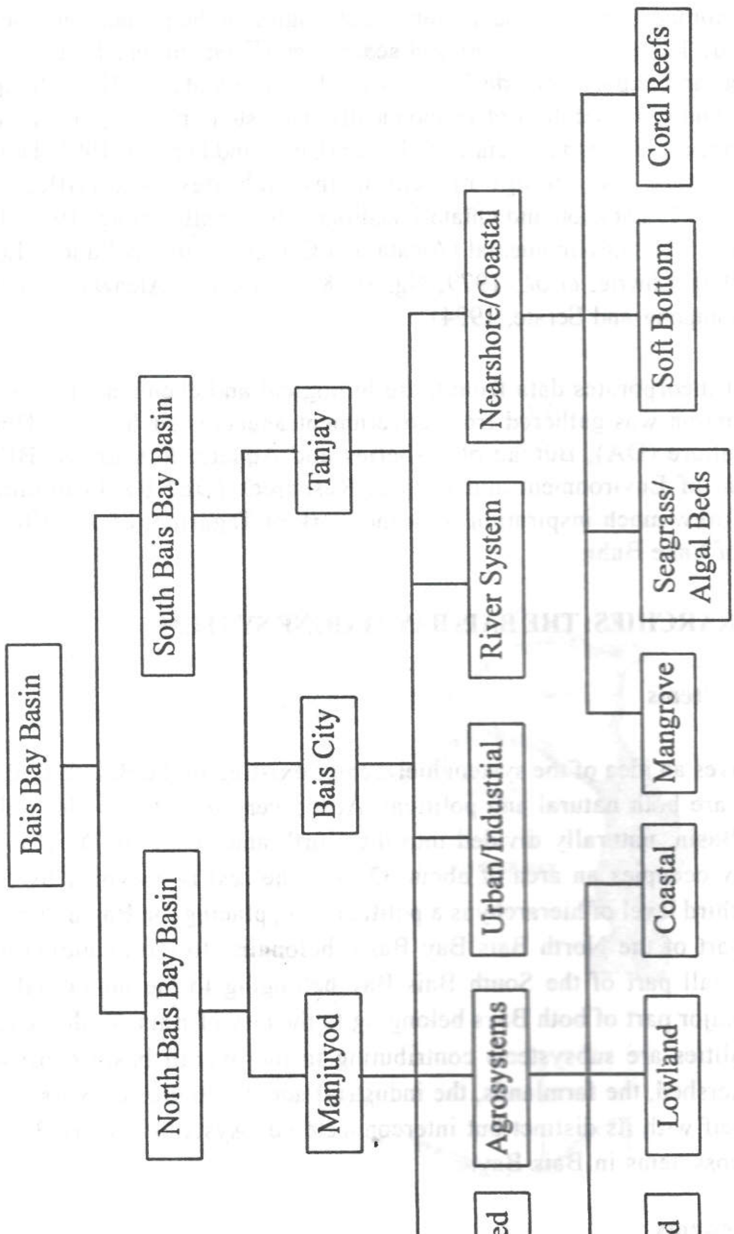

Figure 2. System hierarchies of the Bais Bay Basin.

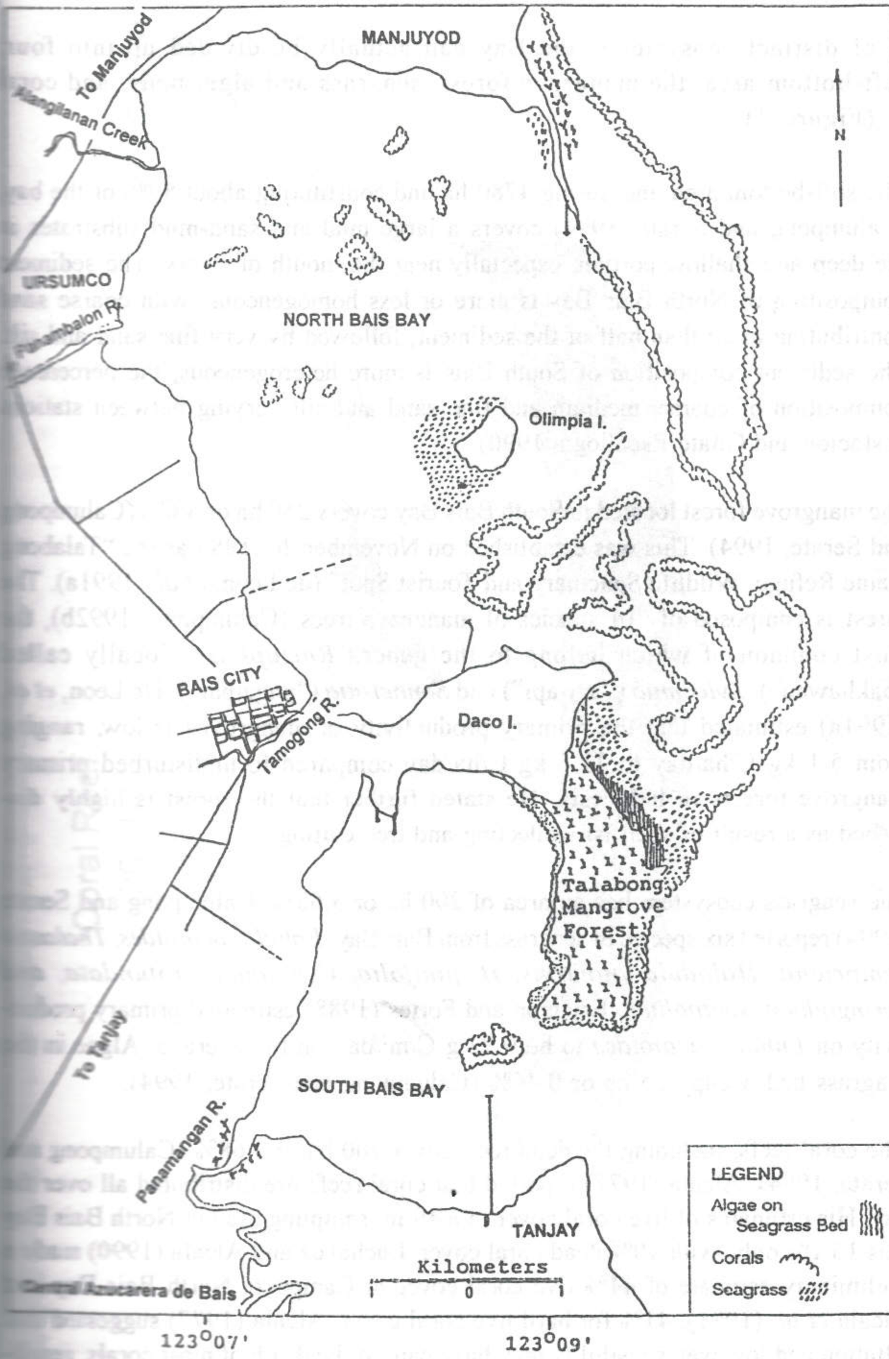

Figure 3 Ecosystems in Bais Bay.

terms of distinct ecosystems, the Bay can actually be divided up into four: the soft-bottom area, the mangrove forest, seagrass and algal beds, and coral reefs. (Figure 4).

1. The soft-bottom area, measuring 4780 ha and constituting about 87% of the bay, (Calumpong and Serate, 1994) covers a large mud and sand-mud substrates in the deep and shallow portion, especially near the mouth of rivers. The sediment composition of North Bais Bay is more or less homogeneous, with coarse sand contributing more than half of the sediment, followed by very fine sand and silt. The sediment composition of South Bais is more heterogeneous, the percentage composition of coarse, medium and fine sand and silt varying between stations (Estacion and Oñate-Pacalioga, 1990).

2. The mangrove forest located in South Bais Bay covers 250 ha or 4.6% (Calumpong and Serate, 1994). This was established on November 26, 1985 as the "Talabong Game Refuge, Wildlife Sanctuary and Tourist Spot" (de Leon, *et al.*, 1991a). The forest is composed of 14 species of mangrove trees (Calumpong, 1992b), the most common of which belong to the genera *Rhizophora* (locally called "bakhawan"); *Avicennia* ("api-api") and *Sonneratia* ("pagatpat"). De Leon, *et al.* (1991a) estimated that the primary productivity of mangroves is low, ranging from 5.1 kg C/ha/day to 11.6 kg C/ha/day compared to undisturbed primary mangrove forests in Indonesia. He stated further that the forest is highly disturbed as a result of shellfish collecting and tree cutting.

3. The seagrass ecosystem has an area of 200 ha or 3.68%. Calumpong and Serate (1994) reported six species of seagrass from Bais Bay: *Enhalus acoroides, Thalassia hemprichii, Halodule uninervis, H. pinifolia, Cymodocea rotundata, and Syringodium isoetifolium*. Estacion and Fortes (1988) estimated primary productivity on *Enhalus acoroides* to be 0.92 g C/m^2/day on the average. Algae in the seagrass bed occupy 25 ha or 0.46% (Calumpong and Serate, 1994).

4. The coral reefs, including the dead reef, cover 200 ha or 3.68% (Calumpong and Serate, 1994). Alcala (1977) reported that coral reefs are distributed all over the bay. His estimates of live coral cover in a 49 m^2 sampling area in North Bais Bay was 16.1% only, with 40% dead coral cover. Luchavez and Alcala (1990) made a preliminary estimate of 44% live coral cover in Campuyo, North Bais Bay and Alcala *et al.* (1991), 41% for hard live coral cover. Alcala (1977) suggested that siltation and low water visibility may have caused the death of most corals, resulting in very low live coral cover.

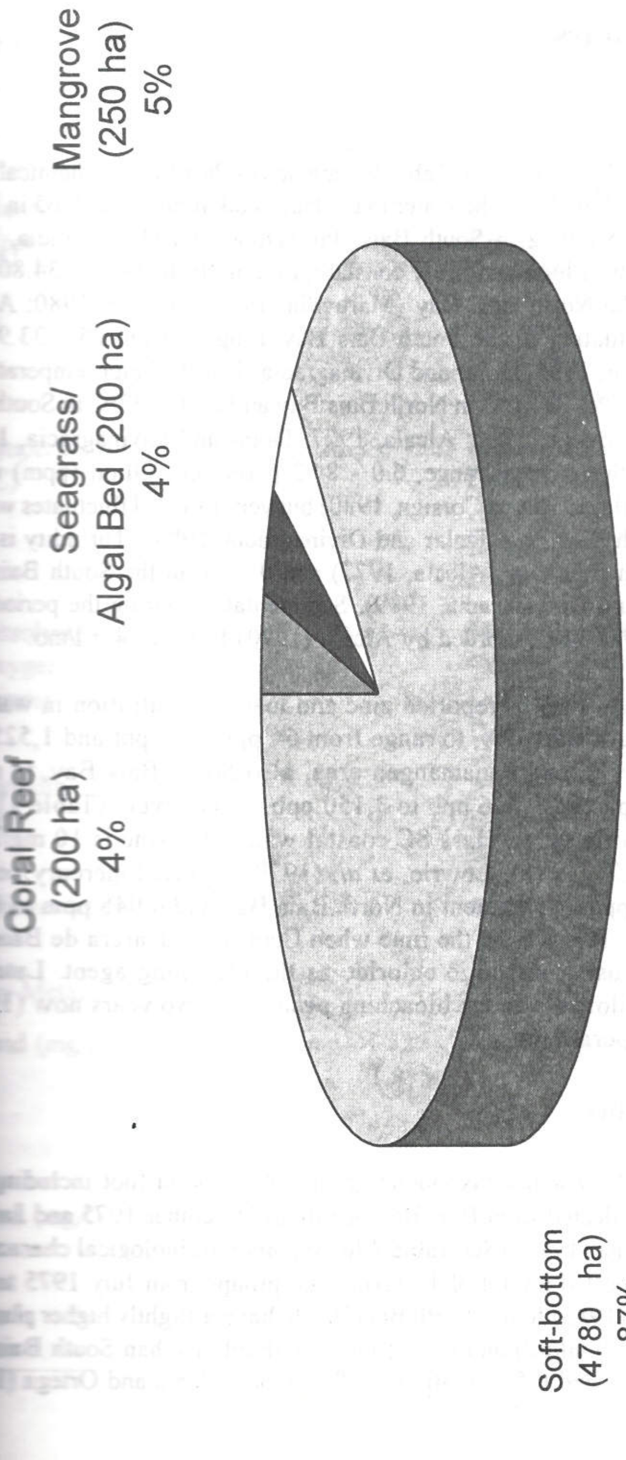

Figure 4. Bais Bay Ecosystems

SPATIAL RELATIONSHIPS

Water Quality

Physico-chemical Characteristics. Table 1 summarizes the physico-chemical characteristics of the water in Bais Bay. The water in the Bay is alkaline, pH is 8.65 in North Bais Bay and from 7. 25 - 9.12 in South Bais Bay (Dolar and Divinagracia, 1989; Maravilla, 1975). Salinity is high and fairly constant, ranging from 34.19 - 34.80 parts per thousand (ppt), in the North Bais Bay (Maravilla, 1975; Corsiga, 1980; Alcala, 1977) but low and fluctuating in the South Bais Bay, ranging from 25 - 33.90 ppt (Maravilla, 1975; Alcazar, 1983; Dolar and Divinagracia, 1989). Water temperature is variable, ranging from 25°C - 31.2°C in North Bais Bay and 26°C - 33°C in South Bais Bay (Maravilla, 1975; Corsiga, 1980; Alcala, 1977; Dolar and Divinagracia, 1989). Dissolved oxygen is within normal range, 6.0 - 8.92 parts per million (ppm) in the North Bais Bay (Maravilla, 1975 and Corsiga, 1980) but very low and fluctuates widely, 0 - 5.6 ppm, in the South Bais Bay (Dolar and Divinagracia, 1989). Turbidity is 1.3 - 13.0 meters in the North Bais Bay (Alcala, 1977) and 0 - 3.0 in the South Bais Bay (Alcazar, 1983; Dolar and Divinagracia, 1989). Sedimentation during the period November 1987 to June 1988 was recorded by Alcala (1990) to be 1.84 g/l/mo.

Heavy Metals. Reyes (1986) reported zinc and lead concentration in water in Hindungawan area, South Bais Bay, to range from 64 ppt to 91 ppt and 1,525 ppb to 1,875 ppb, respectively, and Panamangan area, also South Bais Bay, to range from 136 ppb to 452 ppb and 1,516 ppb to 3,150 ppb, respectively (Table 1). The maximum allowable levels set on class SC coastal waters for zinc is 10 mg/l and for lead 0.5 mg/l (NPCC, 1982). Lowrie, *et al.* (1979) reported mercury content of 0.027 ppm to 0.046 ppm in sediment in North Bais Bay and 0.048 ppm to 0.063 ppm in South Bais Bay. This was at the time when Central Azucarera de Bais was operating a paper mill using mercuric chloride as the bleaching agent. Later the paper mill shifted to Chlorox(R) as the bleaching agent. For two years now (1992), the mill has not been operational.

Biological Characteristics

Plankton. A total of 19 major taxonomic groups of plankton (not including fish eggs and larvae) were collected from Bais Bay in July to December 1975 and January 1976 by Alcala and Ortega (1976) (See Table 2 for summary of biological characteristics). Alcazar (1983) reported a total of 11 taxonomic groups from July 1975 to July 1976. Although Alcazar (1983) found North Bais Bay to have a slightly higher plankton volume in day (0.49 - 0.90 ml/m^3) and night (0.60 - 0.98 ml/m^3) than South Bais Bay (0.46 - 0.59 ml/m^3 for day and 0.51 - 0.80 ml/m^3 for night), Alcala and Ortega (1976)

Table 1. Physico-chemical characteristics of Bais Bay.

	North Bais Bay	South Bais Bay	Source	NPCC Std. Coastal Waters
1. Salinity (ppt)	34.19-34.8	25.00-33.9	Maravilla, 1975 Corsiga, 1980 Alcala, 1977	
2. pH	8.65	7.25-9.12	Maravilla, 1975 Dolar and Divinagracia, 1989	5.5-9
3. Temperature (°C)	25-31.2	26-33	Maravilla, 1975 Corsiga, 1980 Alcala, 1977 Dolar and Divinagracia, 1989	not>40°C
4. Dissolved Oxygen (ppm)	6-8.92	0-5.6	Maravilla, 1975 Corsiga, 1980 Dolar and Divinagracia, 1989	DO = not<5 BOD in mg/l =250
5. Turbidity (m)	1.3-13	0-3	Alcazar, 1983 Dolar and Divinagracia, 1989	
6. Sedimentation	184mg/l/mo	-	Alcala, 1990	suspended solids = 200 mg/l
Heavy Metal Concentration				
1. Lead (mg/l)	- Hindungawan area	- 1.525 1.875	Reyes, 1986	0.5 mg/l
	- Panamangan area	- 1.516 3.150		
2. Zinc (mg/l)	- Hindungawan area	- .064 .091	Reyes, 1986	10 mg/l
	- Panamangan area	- 0.136 0.452		

did not find apparent differences in the average plankton volumes in the two bays. However, the total number of species and the total number of plankton groups were slightly higher in South Bais Bay than those in North Bais Bay, indicating a possible enrichment of the South Bais Bay (Alcala and Ortega, 1976 and Alcazar, 1983).

Mangroves. In 1979, Biña estimated the mangrove patches in Bais Bay to occupy a total of 811.6 ha using land satellite data. Now the area has decreased to about 250 ha (Calumpong and Serate, 1994) due to its conversion into brackish water fishponds. The density of mangrove trees was estimated by de Leon, *et al.* (1991a) to be 627/ha for trees > 7 cm diameter at breast height (dbh). Forty percent of these belong to the genus *Avicennia*. Saplings (those with dbh of < 4 cm and height > 1 m) had a density of 2,920/ha, 62% of which belong to genus *Rhizophora*. The seedlings (those which are <1 m in height), 81% of which are *Rhizophora*, had a density of 37,000/ha.

Seagrasses. The seagrass distribution in the bay is patchy. In some areas, especially in the subtidal, are pure beds of *Enhalus acoroides* while in the 200-ha seagrass bed in the intertidal in front of the Talabong mangrove forest are found six species. Biomass for the two most common species was estimated by Oñate *et al.*, (1991) to range from 30-144 g dry weight/m^2 (gdwm^{-2}) for *E. acoroides* in mixed beds and 189-345 gdwm^{-2} for pure beds and 19-317 gdwm^{-2} for *Thalassia hemprichii*.

Algae. Although algae are found in all the four ecosystems, the majority are found in the seagrass bed in front of the Talabong mangrove forest. Calumpong (1991) listed 19 species in South Bais Bay, two of which were mangrove algae and two common in the coral reefs. Standing crop during a one-year period (May 1990 to May 1991) varied from 22 gdw/m^2 to 202 gdw/m^2 .

Corals. Live hard coral cover in shallow and deep parts of Campuyo Reef, North Bais Bay, range from 37 to 47.6% (Alcala, 1990). The rest of the substrate consists of dead corals, soft corals, algae, sand, rubble and rock. During the period August 1987 to September 1988, live coral cover of Bais Bay was found to decrease from 47% to 40%. This was attributed to increase in fishing activities and dynamite blasting (Luchavez and Alcala, 1988).

Soft-bottom Fauna. A total of 191 species belonging to four groups constitute the fauna of soft-bottom communities in South Bais Bay (Estacion and Oñate 1991). More than half of the species are polychaetes (105 species), followed by molluscs (33), crustaceans (21), unknown organisms (17), nematodes (9), chordates (3), echinoderms (2) chaetognath (1).

Table 2. Biological characteristics of Bais Bay.

	North Bais Bay		South Bais Bay	Source
1. Plankton Composition				Alcazar, 1983
Ave. vol. (ml/m^3) day	0.49-0.90		0.46-0.59	
Ave. vol. (ml/m^3) night	0.60-0.98		0.51-0.80	
No. of species	76		77	
No. of taxonomic groups	9		10	
2. Fish				
Coral reef	1 41			Luchavez & Alcala, 1990
Seagrasses		53		Dolar & Lepiten, 1991
Mangroves		30		Dolar & Lepiten, 1991
3. Molluscs		27*		Alcala & Alcazar, 1984
4. Sea Cucumber		16		Alcala, 1979
Sea Urchins		5		
5. Mangroves			9	Calumpong, 1992b
% productivity			5-11.5 kg C/ha/day	De Leon, et al. (1991a)
Density: > 7 cm dbh			627/ha (40% *Avicennia*)	
Sapling: < 4 cm dbh and > 1 m ht			2,920/ha (62% *Rhizophora*)	
Seedlings: 1 m ht			37,000/ha (81% *Rhizophora*)	
6. Seagrasses	6		6	Oñate et al. (1991)
Biomas:(gdwm^{-2})				
E. acoroides	189-345		30-144	
T. hemprichii	19-317			
7. Algae			19	Calumpong, 1991
Standing crop			22-202 gdw/m^2	
8. Corals: Live coral cover	37-47%			Alcala, 1990
9. Soft-bottom fauna				
Polychaetes		105		Estacion and Oñate, 1991
Crustaceans		21		
Mulluscs		33		
Others		32		

* harvested

Fishery Resources

Bais Bay fishery resources include fish, molluscs, holothurians and sea urchins, crustaceans, and seaweeds. Table 3 and Figure 5 give the amounts harvested and peso values of these organisms.

Fish. Luchavez and Alcala (1990) gave a preliminary estimate of 141 species (28 families) of fish in Bais Bay coral reefs in 1989 and 1990, with pomacentrids (or damselfishes) as the most abundant. They also reported that intense fishing (including the use of dynamite, poison and spearfishing with SCUBA) probably reduced the abundance and standing stock of fish in Bais Bay coral reef.

In seagrass beds, 53 species were sampled by Dolar and Lepiten (1991) with *Siganus canaliculatus* as the most abundant species. Alcala (1979) reported five species of juvenile siganids and noted that fry (about 1-3 months old) of *Siganus canaliculatus* were abundant from January to November and those of *S. spinus* from February to September.

In the mangroves, Dolar and Lepiten (1991) sampled 30 species (15 families) of juvenile fishes in May to November 1990. Using seine net, they found that majority of the catch, both by number and by weight, consists mainly of fishes belonging to family Apogonidae (45% and 34%, respectively). This is followed by the siganids (locally called "danggit") and mugilids ("gisaw"). Alcala and Alcazar (1984) reported that *Siganus guttatus* fry were abundant from January to September in the mangroves. Dolar, *et al.* (1991) found that mangroves serve as nursery ground to most of the coral reef fishes.

Cadeliña (1983) reported that fishermen in Daco and Polundyot Islands use different fishing techniques and gears which he considered low-energy-using technology. These gears include: *pukot, pamana, katay, bunsod, pasul, bubo, panggal, sahid, panulo, tapsay, sudsud, patuloy, sarap, sabinit, sikpaw* and *kubkub*. He also mentioned the operation of illegal and destructive fishing such as blasting and poisoning with "tuble" (fish poison from bark of a mangrove species), or commercialized chemicals, and muro-ami by fishermen from Cebu who regularly come to fish in Bais Bay. There was, however, no data on fish catch for these gears.

Molluscs. A survey of the edible molluscs harvested by local fishermen in Bais Bay (Alcala and Alcazar, 1984) included 27 species of bivalves and gastropods found in either seagrass beds, sand-coral rubble with little mud and/or sand-mud substrates (Table 4). They reported 12,000 kg per year (wet weight) in 267-ha shell areas, exclusive of *Modiolus metcalfei* (which is farmed), with an esti-

Table 3. Important marine fishery of Bais Bay.
(Values from Alcala, 1979 and Alcala and Alcazar, 1984).

	Species	Est. Harvest (kg/yr)	Est. Value (Pesos)
1.	Cultured danggit 0.7 ha fish pen	770	11,550
2.	Shellfish, exclusive of tahong (*Modiolus metcalfei*)	12, 000	24,000
3.	Tahong (*Modiolus metcalfei*)	500	1,000
4.	Lukot (*Dolabella auricularia* egg masses)	1,000-2,000	4,800-8,000
5.	Sea cucumbers	1, 300	2,800
	Dried sea cucumbers (Trepang) in 1980	600	9,000
6.	Shrimps	2, 111	31,000
7.	Mud crabs (*Scylla serrata*)	2, 356	15,000

mated value of P24,000 and that most species were exploited from January to December while other species were gathered from 5 to 10 months.

Alcala (1979) also estimated that about 1,100 to 2,000 kg egg masses of sea hares (*Dolabella auricularia)* or "donsol," valued at P4,800 to P8,000, were harvested from the Bay during a one-year period. Pauly and Calumpong (1984) reported that spawning and recruitment of this species occur throughout the year, with peaks in May to July and September to October.

Holothurians and Sea Urchins. Sixteen species of edible sea cucumbers were distributed in an area of about 110 ha at the seaward (eastern) edge of Daco Island and in Talabong Mangrove Forest (Alcala and Alcazar, 1984). Their preliminary data indicate that about 108 kg per month (1.3 tons per year) were gathered for local consumption, valued at about P2,800 per year. Alcala (1979) reported five species of sea urchins common in Bais Bay. All species are edible but the favorite species is "salawaki" or *Tripneutis gratilla* which is usually gathered during full moon when their gonads are ripe.

Crustaceans. Several species of crustaceans in the families Gecarcinidae, Penaeidae, Portunidae and Grapsidae were found to be harvested for food in Bais Bay but no quantitative data are available (Alcala, 1979).

Snakes and Turtles. Alcala (1979) reported that there were three species of snakes in North Bais Bay which have not been exploited as yet. Neither have their biomass been quantified. These have potentials as sources of skins for the manufacture of leather and of meat for animal or human consumption.

Alcala (1980) estimated the biomass yield of the Pacific hawksbills in North Bais Bay and vicinity (area of approximately 20 km^2) for January to June, 1977 (six months) to be 122 kg (14 animals) and for January to October 1978 (10 months) 167 kg (25 animals), or an average yield of 10.02 kg to 20.20 kg per km^2 per year for 1977-1978.

Fish and Shellfish Culture

Figure 6 shows the fishing gears and mariculture techniques employed in Bais Bay, namely, fish pens, fish corrals, *Eucheuma* farms, mussels and oyster farms.

A total of four fish pens were introduced to Bais Bay from 1983 to 1993, two of which were owned by cooperatives. The first one was constructed in Okiot, South Bais Bay, in 1983, covering an area of 0.7 ha. The second fish pen was constructed in Capiñahan, South Bais Bay, in 1986, covering an area of one hectare

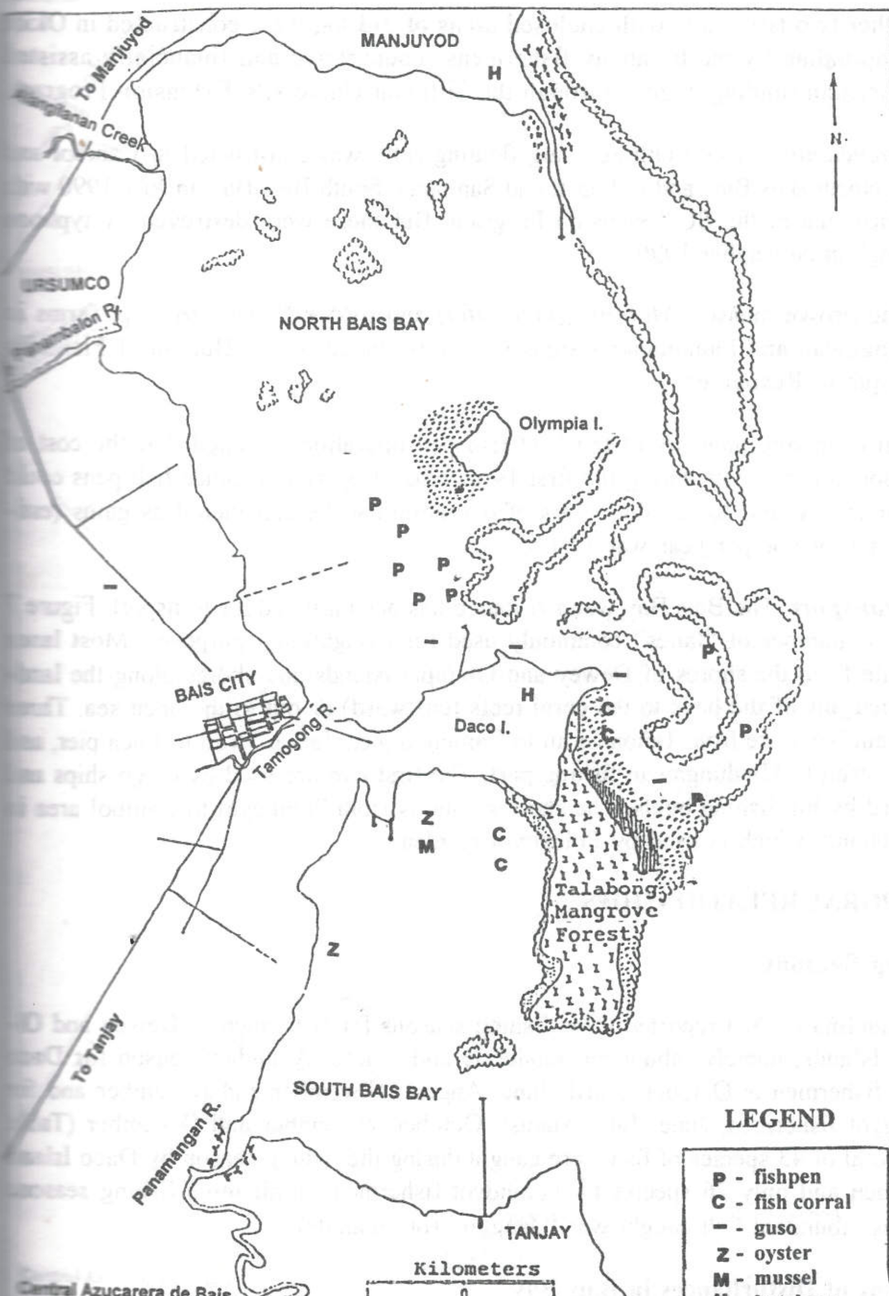

Figure 6. **Fishing gears and mariculture techniques in Bais Bay.**

The other two fish pens, with enclosed areas of 2-3 ha, were constructed in Okiot and Capiñahan by the barangay fishermens' cooperative and financially assisted by a German funding agency through the Silliman University Extension Program.

Eucheuma ("guso") culture using floating rafts was constructed in Canibol and Okiot, North Bais Bay, and in Lag-it and Sanlagan, South Bais Bay, in July 1990 with the assistance of the SU Extension Program. But these were destroyed by typhoon "Ruping" in November 1990.

The brown mussel (*Modiolus metcalfei*) and oyster *Crassostrea* sp. farms in Hindungawan and Panamangan areas were introduced by the Bureau of Fisheries and Aquatic Resources.

An economic analysis of the first fish pen operation revealed that the cost of operation was paid off during the first 14 months of operation. Since fish pens could last for four years, succeeding years of operation can be considered as gains (estimated net income per year was P10,550).

Transport. The Bais Bay water resource has been utilized for transport. Figure 7 shows a number of "lanes" commonly used for navigational purposes. Most lanes originate from the shores of Dewey and Olympia islands and shores along the landward margins of the bays to the coral reefs (eastward) or out to the open sea. Three important lanes are from Tañon Strait to Campuyo pier, Tañon Strait to Luca pier, and Tañon Strait to Hindungawan fishing port. The first two are used by cargo ships and the third by big fishing boats. The shortest lane is from Polundyot to Canibol area in Daco Island, which is used by Polundyot residents.

TEMPORAL RELATIONSHIPS

Fishing Seasons

Cadeliña (1983) reported three fishing seasons for fishermen in Dewey and Olympia Islands, namely: abundant, moderate and scarce. Abundant season for Daco Island fishermen is October, April, June, August, November and December and for Polundyot fishermen, June, July, August, October, November and December (Table 5). A total of 43 species of fish were caught during the fishing season by Daco Island fishermen and only 26 species by Polundyot fishermen. In all three fishing seasons the most abundant fish caught was "danggit" (or siganids).

Patterns of Disturbances in Bais Bay

Natural and man-made disturbances disrupt Bais Bay. Natural disturbances include northeast monsoon ("amihan"), which hit during the months of Novem-

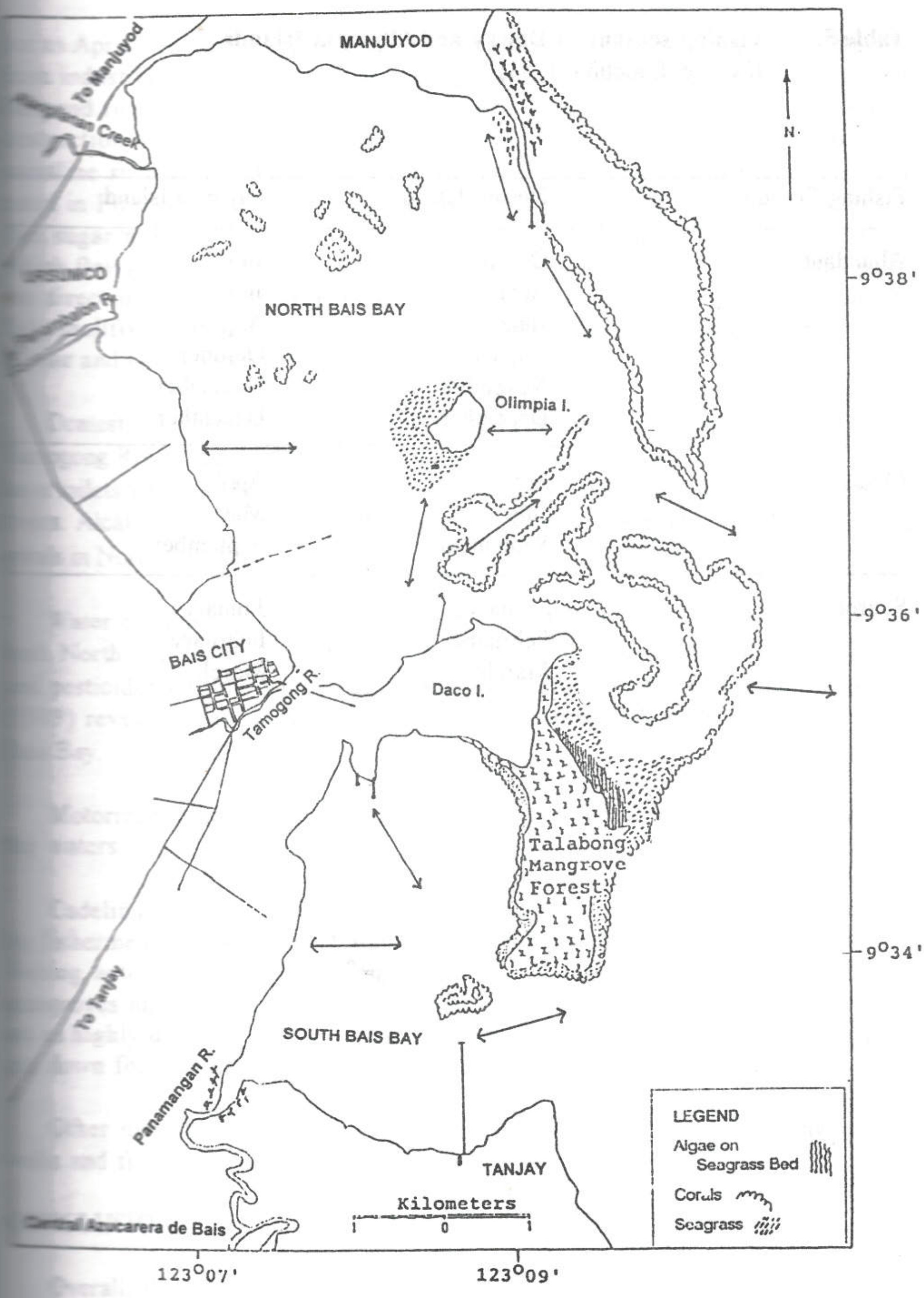

Figure 7. Navigational lanes in Bais Bay.

Table 5. Fishing seasons in Dewey and Olympia Islands.
(Source: Cadeliña, 1983)

Fishing Season	Dewey Island	Olympia Island
Abundant	October April June August November December	June July August October November December
Moderate	March July September	April May September
Scarce	January February March	January February March

ber to April, and occasional typhoons. Man-made disturbances include effluents from industrial plants, domestic sewage, silt due to deforestation, agricultural and fishpond run-off, dynamiting and fishing with poisons, oil from boats and ships, destruction of mangroves for fish and other forest products, and alteration of coastline such as building of sea walls. Sources of such disturbances are indicated in Figure 8. The most important source of pollution is the effluent from the two sugar mills and the pulp and paper factory of Central Azucarera de Bais which flows into the South Bais Bay through the Panamangan River. In the past, the direct discharge of effluent into the bay had caused massive mortalities of fish, shellfish and other invertebrates by depleting dissolved oxygen in the water (Dolar and Divinagracia, 1989).

Domestic sewage pollution comes from Bais City (into North Bais Bay through the Tamogong River) and from Daco and Polundyot Islands. (Many houses in Daco Island have toilets which open directly into the water.) Silt comes into the bays through the rivers. Alcala (1979) suspected siltation as the possible "culprit" in the death of most corals in North Bais Bay.

Water outflows from agricultural fields and fishponds at the western side of both North and South Bais Bays bring agricultural chemicals such as fertilizers and pesticides into the bays' waters. Report received by Dolar and Divinagracia (1989) revealed that pesticides were used in cleaning fishponds in Dawis, South Bais Bay.

Motorized fishing boats and cargo ships have contributed to oil pollution to the waters.

Cadeliña (1983) reported that blast fishing and "tuble" poisoning are employed by fishermen of Daco and Diutay islands in harvesting fish from coral reefs. Fishing activities like gleaning and shellfish collection are also reported in the mangroves and seagrasses. De Leon *et al.*, (1991a) described the mangrove forest as highly disturbed as a result of shellfish collection. Mangrove trees are also cut down for fuel and other forest products and for fishpond construction.

Other disturbances include alteration of coastline with the building of sea walls and fishing ports and piers.

CONCLUSION

Overall, the status of the Bais Bay Basin as it exists today (1993) is shown in Figure 8. From this figure it is obvious that the properties of the bay, namely produc-

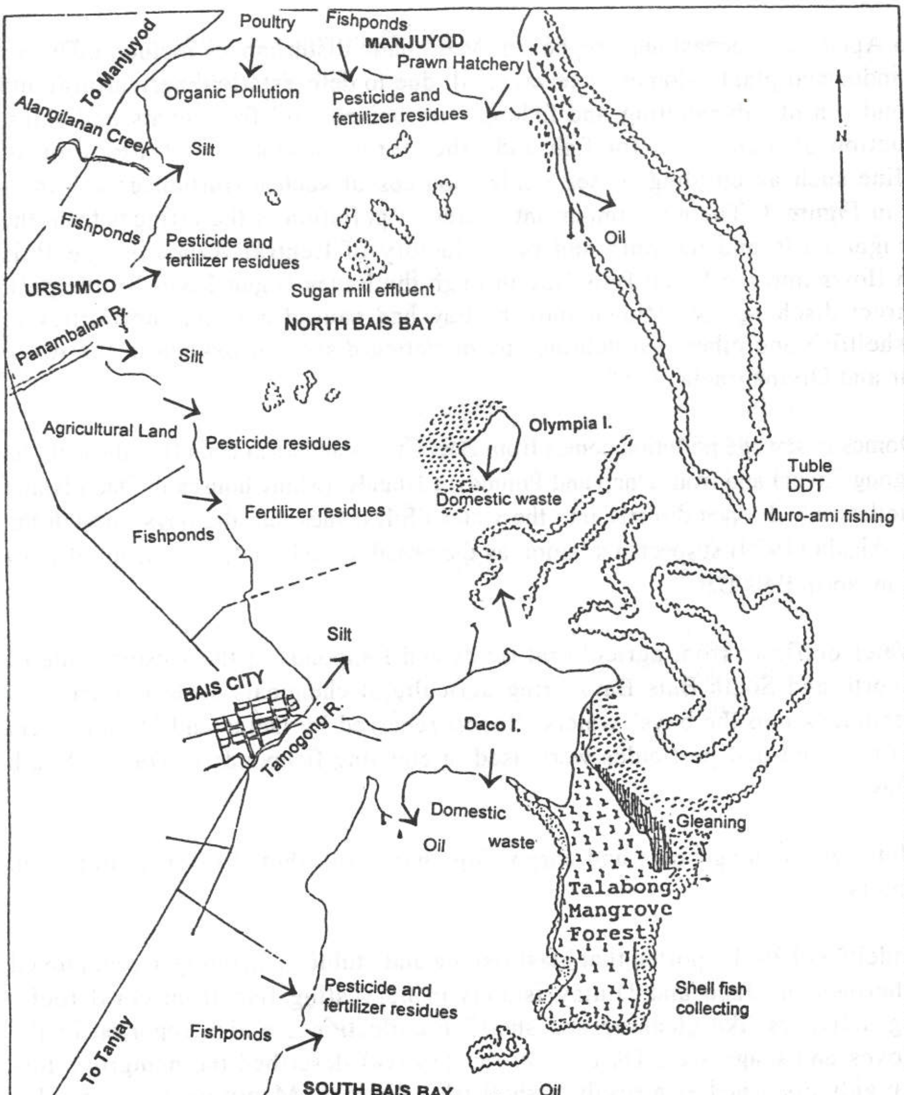

Figure 8. **Sources of disturbances in Bais Bay.**

tivity, stability, sustainability and equitability (Tagarino, *et al.* 1985) are affected positively and negatively by many factors impacting on the bay, both natural and man-made.

Efforts to increase productivity of the bay have been undertaken, which include seaweed, oyster, and mussel farming; installation of fish pen/corrals and mangrove reforestation. However, some factors impact on the Bay that seem to decrease productivity, including siltation; pollution; destructive fishing and the destruction of mangrove, seagrass beds and coral reef. Trends are difficult to discern from the data presented because of the lack of long-term monitoring. For example, in terms of mangrove and seagrass productivity, we cannot show whether these have stayed the same throughout the years or have increased or decreased, as the data gathered were only for a period of one year. The same can be said of the water quality of the bay and the state of the coral reefs and other ecosystems. The most that can be done is compare these ecosystems with undisturbed ones.

More importantly, long-term assessment of the fishery has not been done. Most glaring is the siganid fishery, the most important fishery of the Bay. As of 1995 no data exists as to the total siganid catch from the bay, or more importantly, whether this fishery is over-exploited.

Much data have since been gathered that have added to our knowledge of what exists in Bais Bay. More are needed to help us assess the trends in order that the sustainability and stability of Bais Bay can be maintained.

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REFERENCES

Alcala, A.C. 1977. Possible effects of water pollution on coral reefs of Negros Island, Philippines. Proceedings, 4th Regional Seminar on Biological and Agricultural Research, National Research Council of the Philippines, Bicutan, Taguig, Metro Manila, pp. 54-67.

Alcala, A.C. 1979. Ecological notes on rabbitfishes (Family Siganidae) and certain economically important marine animals in southern Negros and environs, Philippines. Silliman Journal 16 (2-3): 115-133.

Alcala, A.C. 1980. Observations on the ecology of the Pacific hawksbill turtle in the Central Visayas, Philippines. Fisheries Research Journal of the Philippines 5: 25-45.

Alcala, A. C. and S. Alcazar. 1984. Edible molluscs, crustaceans and holothurians from North and South Bais Bay, Negros Oriental, Philippines. Silliman Journal 31: 25-45.

Alcala, A.C. and E. P. Ortega. 1976. Environmental studies of north and south Bais Bays, Negros Oriental. Proceedings, 3rd Regional Seminar on Biological Research, National Research Council of the Philippines: Bicutan, Taguig, Metro Manila, pp. 78-83.

Alcala, A.C., M.S. Dy-Liacco and L.C. Alcala. 1991. Benthic lifeform composition of two coral reef sites in the Central Visayas, Philippines. Proceedings of The Regional Symposium on Living Resources in Coastal Areas, 30 January to 1 February 1989, Manila, Philippines. Marine Science Institute, Diliman, Quezon City, Philippines, pp. 69-74.

Alcala, L. C. 1990. Benthic Lifeforms. Annual Report, Living Resources in coastal Areas, Phase II. June 1990.

Alcazar, S. 1983. A comparative study of plankton in north and south Bais Bay with a proposed teaching module in ecology for the enrichment of Science II Biology teaching. M.S. Thesis, Silliman University, Dumaguete City.

Cadeliña, R. 1983. A survey of fishermen's living condition and assessment of their development potentials in Olympia and Dewey Islands on Bais Bay, Negros Oriental, Philippines. University Research Center and University Extension Program, Silliman University, Dumaguete City.

Calumpong, H. P. 1979. Some aspects of the ecology of the sea hare, *Dolabella auricularia* (Lightfoot), in the central Visayas, Philippines. Silliman Journal 26: 134-146.

Calumpong, H. P. 1992a. Standing crop and litter production and exportation in Bais Bay, central Philippines. Proceedings of the 2nd National Symposium in Marine Science. Nov. 6-7, 1992. Mindanao State University, Bongao, Tawi-tawi, pp. 126-139.

Calumpong, H. P. 1992b. Vegetation of the Talabong Mangrove Forest Reserve: suggestions for rehabilitation. Silliman Journal 36(1): 123-128.

Calumpong H. P. and E. Serate. 1994. Carbon dynamics in Bais Bay, central Philippines. Proceedings of the ASEAN-Australia Third Symposium on Living Coastal Resources, Chulalongkorn University, Bangkok, Thailand. 16-20 May, 1994. C. R. Wilkinson S. Sudara and L. M. Chon (eds.) 2: 691-695.

Corsiga, C. G. 1980. The structure of intertidal macrobenthic communities in north Bais Bay, Negros Island, Philippines prior to the discharge of sugar mill effluents into the bay with a proposed module for the enrichment of Science II Biology teaching. M. S. Thesis, Silliman University, Dumaguete City.

De Leon, R. O. D., A. C. Alcala and R. J. Raymundo. 1991a. Potential levels of primary production and community structure of the Talabong mangrove forest, Negros Oriental, Philippines. Proceedings of the Regional Symposium on Living Resources in Coastal Areas, 30 January to 1 February 1989, Manila Philippines. Marine Science Institute, University of the Philippines, Diliman, Quezon City, Philippines, pp. 453-458.

De Leon, R. O. D., J. Nuique and R. Raymundo. 1991b. Leaf litter production, tidal export and decomposition of *Rhizophora apiculata* Blume, R. *mucronata* Lamk., *Avicennia marina* (Forssk.) Vierh and *Sonneratia alba* J. Sm. from the Talabong Mangrove Forest in Bais Bay, Negros Oriental, Philippines. Annual Report, Coastal Living Resources Project, Philippines. Phase II. June 1991.

Delar, M. L. and M. F. Divinagracia. 1989. Letter to Dr. Delfin Ganapin, Director, Pollution Adjudication Board on Dec. 30, 1989.

Delar, M. L. and M. V. Lepiten. 1991. A study on the mangroves, seagrass and coral reef fishes of North Bais Bay, central Philippines. ASEAN - Australia Marine Science Project Connection 26-30 August 1991. Living Coastal Resources Mangrove fisheries and Workshop Report No. 5. Tambun Inn, Ipoh Perak, Malaysia.

Dolar, M. L., A. C. Alcala and J. Nuique. 1991. A survey on the fish and crustaceans of the mangroves of North Bais Bay. Proceedings of the Regional Symposium on Living Resources in Coastal Areas, 30 January to 1 February 1989, Manila, Philippines. Marine Science Institute, Diliman, Quezon City, Philippines, pp. 367-377.

Estacion, J. S. and J. A. Oñate. 1991. Soft-bottom fauna of Bais Bay, Negros Oriental, Philippines. Proceedings of the Regional Symposium on Living Resources in Coastal Areas, 30 January to 1 February 1989, Manila, Philippines. Marine Science Institute, Diliman, Quezon City, Philippines, pp. 253-259.

Estacion, J. S. and M. D. Fortes. 1988. Growth rates and primary production of *Enhalus acoroides* (L.f.) Royle from Lag-it, north Bais Bay, Philippines. Aquatic Botany 29: 347-356.

Lowrie, S. F. W. and A. B. Anfone. 1980. Levels of heavy metals from silt in Negros Oriental. Silliman Journal 27(2 and 3): 136-142.

Lowrie, S. F. W., D. R. Erum and I. A. Loma. 1979. Total mercury levels in sediments and shellfish from Bais Bay, Negros Oriental, Philippines. Silliman Journal 26(4): 232-238.

Luchavez, T. F. and L. C. Alcala. 1990. Reef fish distribution pattern in Campuyo reef, Bais, Negros Oriental, Philippines. Progress Report, Living Resources in Coastal Areas, Philippines, Phase II. Dec. 1990. Silliman University Marine Laboratory, Dumaguete City.

Maravilla, C. D. 1975. The structure of intertidal macrobenthos communities in north and south Bais Bays, Negros Island, Philippines, in relation to the combined effluents from the sugar and the paper mills, with a resource unit on ecology for high school biology. Masteral Thesis, Silliman University, Dumaguete City.

Ng, J. J. Jr. 1978. Determination of total mercury on edible algae from south Bais bay using flameless atomic spectrophotometer. B. S. Thesis, Silliman University, Dumaguete City.

Notosoedarmo, S. 1977. A comparative study of the population density and biomass of internal zoomacrobenthos on the soils of mangroves and grassland in the southern part of south Bais bay, Negros Oriental. Masteral Thesis. Silliman University, Dumaguete City.

Oñate, J. A., J. S. Estacion and J. Nuique. 1991. Survey on seagrasses and their associated economically important invertebrates in north Bais Bay and Siquijor

Island, Philippines. In: A. C. Alcala (ed.), Proceedings of the Regional Symposium on Living Resources in Coastal Areas. Manila Philippines. pp. 379-384.

Oñate, J. A. 1991. A preliminary study on seagrass litter production and exportation in Bais Bay, Negros Oriental, Philippines. Annual Report, Coastal Living Resources Project, Philippines. Phase II. June 1991.

Pauly, D. and H. P. Calumpong. 1984. Growth, reproduction and mortality of the sea hare, *Dolabella auricularia* (Gastropoda: Aplysiidae) in the central Visayas, Philippines. Marine Biology 79: 289-293.

Reyes, J. A. 1986. Comparative determination of lead and zinc levels in mussels, water and sediments collected from Panamangan River and south Bais Bay. B. S. Thesis, Silliman University, Dumaguete City.

Tagarino, R. N., M. L. Cardenas and Z. B. Catalan. 1985. 4.2 Lake Buhi. In: Conway, G.R. and P.E. Sajise (eds.), The agrosystems of Buhi: Problems and opportunities. Report of a workshop held at Naga City, Bicol, Nov. 14-18, 1985, pp. 112-166.