

RESOURCES AND ECOLOGY OF PANGUIL BAY:
AN EXECUTIVE SUMMARY OF THE
TERMINAL REPORT ON THE
RESEARCH PROJECT, "RESOURCE
AND ECOLOGICAL ASSESSMENT
OF PANGUIL BAY"

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Panguil Bay in the Northwestern Mindanao is a shared resource of Lanao del Norte (Region 12, southeast coast), Misamis Occidental (Region 10, northwest coast), and Zamboanga del Sur (Region 9, southwest coast). An imaginary line drawn across the mouth of the Bay from Maigo, Lanao del Norte to Clarin, Misamis Occidental defines the east boundary.

The Bay is shaped like a canine tooth with widths of 1.70 km at the narrowest portion and 11.5 km at the mouth. Its irregular coastline measures 112 km, a total length of 41 km measured straight from the upper reaches to the mouth, and an estimated water area of 18,000 ha. The bottom contour is also irregular, with greatest and average depths of 55 m and 15.4 m, respectively. The total volume of its water is estimated at 3.30 km³.

The catchment area of 309,738 ha. in the Gurain mountain range in the southwest side and Malindang mountain range in the northwest constitute the Bay's watershed area. From these high lands 29 rivers and 46 minor tributaries carry freshwater and transport nutrients and sediments into the Bay.

The Bay's climatic condition is characterized by a fairly warm and an even distribution of rainfall year-round. The mountain flanks of the Bay protect it from the direct effect of tropical cyclones, and its tributaries further enrich the Bay with land-based nutrients enabling it to support a wide variety of aquatic life. Moreover, the tidal change which flushes volumes of water in and out of the Bay allows it to constantly renew and stabilize its ecosystem.

In recent times it has become apparent that the natural productivity and capacity of the Bay to replenish itself has been threatened by a confluence of factors arising from varied human activities and which exert pressures on its ecology and resources. To identify these pressures the DA-funded Research Project on Resources and Ecological assessment was conducted. The Project was also aimed to evaluate the status of the Bay's ecology and resources, and to update the scientific information base needed to develop a management plan for a suitable resource utilization of Panguil Bay.

The project is composed of 14 distinct studies, namely: Demographic and Economic Pressures in Panguil Bay; Hydrography and Siltation; Chemical Characteristics; Plankton and Meiofauna; Biological Pollution; Pesticide Residues; Heavy Metals; Finfish Resources; Crustacean Resources; Mollusks Resources; Seaweed Resources; Coral Reefs, Seagrass Beds and Artificial Reefs; and Soft Bottom Communities. The results obtained from these studies are briefly presented below.

Demographic and Economic Pressures in Panguil Bay

There are 8,107 municipal fishermen residing and operating along the coastal zone of Panguil Bay. An annual increase of 11.5% of the fishermen population is attributed to inward migration and to the growing number of fishermen children who have become fishermen themselves for lack of other employable skills and economic opportunities in their villages. More fishermen go fishing with non-motorized boats than with motorized ones. Various gears are employed in fishing operations. The stationary gears, which are generally prohibited or modified from banned ones, yield

more catch-per unit-effort (CPUE) than any other gears.

The fisherman in Panguil Bay is generally young (about 39 years old) with hardly an elementary education. He has approximately five children and earns income from various sources the aggregate of which is way below the poverty line.

In their own way, a great number of fishermen are keenly aware of the critical resource and ecological condition of Panguil Bay. They are for the strict implementation of government-sponsored conservation and rehabilitation programs, but are wary and quite critical of the way these programs are being pursued and managed.

Aside from the pressure exerted by the teeming fishermen population and their varied activities, other economic enterprises continue to pose a threat to the general well-being of Panguil Bay. These activities include, among others, the intensified activities and operations invariably employed in agriculture; logging and sawmill; manufacturing; mining and quarrying; and other minor industrial activities whose wastes, effluents or tailings ultimately find their way into the coastal water of the Bay.

To rehabilitate the resources of the Bay and secure the future of those people dependent on it for survival, the following are recommended: trimming down of fishermen population; regulating fishing intensity and eliminating illegal fishing operations; zoning the Bay for proper land and water use; seeding of established fish sanctuaries; and developing and expanding community resource-based livelihood and employment opportunities.

Hydrography and Siltation

The current system of the Bay were mainly influenced by tidal force and, to some extent, by strong seasonal monsoon winds. The average water velocity in a tidal cycle was 0.57 m/s and 0.47 m/s,

respectively at ebb and flood tides. Residual reflux at 0.09769 m/s was due to tributary outflows which number about 46 creeks and 29 rivers. The strength of the water current follows the deep bathymetric configuration of the Bay. The Misamis Occidental side of the Bay has a deeper bottom configuration and therefore has stronger current velocities. The Lanao del Norte coast has shallow and silty to muddy bottom due to weaker flood and ebb current except at the Tubod-Silanga section where currents are generally strong due to effects of constriction. The water exchange, which is estimated at 0.160 km³ at mean tidal range and 0.238 km³ per cycle during diurnal tides flushes out the Bay water in 14 days. Residence time of Bay water is further reduced to 9 days due to freshwater contribution by numerous tributaries.

Eddies were observed along Solaton Is. during peak periods of flood and ebb tides. Monsoonal winds generate wind waves in the Bay. During southwest monsoon the inner portion of the Bay is relatively calm but generally rough along Ozamiz-Kolambogan and Maigo-Clarín sections. During Northeast monsoon the whole area is relatively rough.

Siltation rate was found high in the southern portion where the principal tributaries, Migpangi and Maranding Rivers, drain 53,017 tons silt/year. Twenty-five percent (25%) of the suspended solids were deposited along the shore up to the Matampay-Bocator segment of the Bay and 75% remained suspended throughout the Bay.

Chemical Characteristics

The monitored physical characteristics of the Bay were depth, temperature, salinity and pH. Likewise, nitrate, ammonia, and phosphate were monitored for the chemical characterization of the Bay.

The depth profile of Panguil Bay shows a decline from the mouth of the Bay towards the inner portion. The deep waters off Maigo-Clarín has a mean depth of 60m and the shallow area in Maranding-Bonifacio portion has a mean depth of 2.53m.

For the offshore and the river temperature, May 1991 recorded the hottest month with a mean of 30.86°C and January 1992 the coolest with the mean temperature of 25.97°C.

As expected, the horizontal gradient of salinity gradually increased from freshwater in the innermost portion (Maranding-Bonifacio) to seawater salinity towards the mouth of the Bay (Maigo-Clarin).

The pH values of the offshore and river stations ranged from 7.19 to 8.41 and from 7.13 to 8.32, respectively.

From February to June 1991 the range of dissolved oxygen values in all offshore points was 5.63-8.75 mg/l. However, starting July to August and October to November 1991, there was a sharp decrease of DO levels with the range of 3.54-5.51 mg/l. The water sampling during these periods was usually done early in the morning when the Bay was generally calm. This may explain the decreased concentration of dissolved oxygen.

The higher concentrations of nitrate were always confined to the inner portions of the Bay, decreasing by distance towards the mouth. This may have been caused by the discharges brought about by the tributaries.

Nitrate varies in concentration from 0.000 to 37.682 ug N/l and 0.000 to 52.271 ug N/l in the offshore and river stations, respectively.

Sharp peaks of ammonia concentration ranging from 741.67 ug N/l to 849.33 ug N/l were observed during the month of April and higher concentrations were also noted from November 1991 to January 1992. Concentrations of ammonia in other river stations were higher compared to the offshore stations.

Significant amounts of phosphate concentrations observed were 180.567 and 395.667 ug P/l for the offshore and river stations, respectively.

In general, the nutrient levels (nitrite-N, nitrate-N and phosphate-P) in all offshore and river stations were within the acceptable DENR standards.

Plankton

A total of 205 taxa were identified in the Bay. *Chaetoceros spp* dominated the phytoplankton in the mouth portion of the Bay while *Coscinodiscus spp* dominated the inner portion.

The dominant red- and blue-tide causing organisms were dinoflagellate, *Noctiluca spp* and the blue-green micro-algae, *Trichodesmium spp*. The other red-tide causing organisms were *Ceratium spp*, *Peridinium spp*, and *Gonyaulax spp*. These are considered probable species to cause future red tide outbreaks in Panguil Bay. Red tide cysts were not found in the sediment and in the dissected guts of the bivalve samples.

The permanent zooplankters were dominated by the calanoid copepods, *Pseudocalanus spp*. The larval zooplankters were dominated by the nauplii of crustaceans. No larval zooplankters were enumerated in fish coral catches; only the juveniles of both pelagic demersal fishes were found. Significant population peaks were obtained in all stations. The significant peaks could probably be due to the characteristic water circulation of the Bay and the presence of river tributaries which made the nutrients necessary for plankton population growth available.

The total permanent zooplankton biomasses were 261.7124 (surface) and 1962.7063 (bottom) $\mu\text{g l}^{-1}$ while the total larval zooplankton biomasses were 265.6705 (surface) and 707.9042 (bottom) $\mu\text{g l}^{-1}$.

The presence of the larval zooplankters throughout the year with different peak months implies that spawning of fishes and invertebrates occur throughout the year.

Meiofauna

A study on the month fluctuation of an intertidal meiofauna community was conducted from February 1991 to January 1992. Eleven taxa were identified. The dominant taxonomic groups were the nematodes

(50.8%), copepods (19.56%) and turbellarians (16.11%). Polychaetes, ostracods, oligochaetes, tardigrades, amphipods, kinorhynchs, decapod larvae (shrimps and crabs) and bivalvia larvae occurred in less than 5% composition.

The monthly mean population density of the total meiofauna range from 10 (April:Migpangi) to 41,880 ((April:Malaubang) individuals per 10 sq cm and the corresponding biomass ranged from 4.48 (April:Migpangi) to 76,740.84 (April:Malaubang) ug per 10 sq. cm. The nematode dominated in terms of annual density and the ostracods dominated in terms of annual biomass. No significant difference was obtained in the total mean density during the northeast and the southwest monsoons; however, there is significant difference in the total mean population density in all stations except Migpangi.

Significant population density fluctuations in the different stations are attributed to high benthic diatom density, interstitial water and carbon contents of the sediment and most of all to grain-size types. No correlation was obtained between total mean population density of the meiofauna and the sediment temperature and salinity.

Areas with high meiofauna abundance in terms of population density and biomass are indicative of rich macro-benthic fauna, which include the crustaceans, demersal fishes, bivalves, echinoderms and the bait fishery resources (polychaetes and nematodes), particularly, in Maigo-San Antonio and Malaubang-Tubod-Baroy fishing grounds (Acuna et. al. in this compilation). Comparison with the studies conducted in other areas revealed that Panguil Bay supports a high meiobenthic fauna population except in the inner portion of the Bay, particularly, Migpangi area. The low population density and biomass of meiofauna in Migpangi could be due to the heavy metals and pesticides pollution, which were detected in the sediments of rivers and tributaries within the area (Daitia in this compilation; Roa and Roa in this compilation).

Biological Pollution

The coliform group of bacteria is a widely accepted indicator of the presence of pathogenic microorganisms. Where they are always present, pathogenic organisms are likely to be present also. When they multiply, it is assumed that pathogenic organisms do so, too.

The study has shown that Panguil Bay waters in some areas contain a fairly large amount of coliform bacteria. There are several sources of the coliform group of bacteria in a water body. In Panguil Bay, it appears that human feces is a big contributor, if not the major one, because density was consistently found highest in coastal areas where large number of households do not have toilets.

In the present study, coastal areas of Panguil Bay were classified as to their public uses, according to the presence and density of coliform bacteria defined in the DENR criteria. Some areas were classified as unsuitable for shellfish propagation because of the presence of too many coliform bacteria which, in turn, indicates the presence of pathogenic micro-organism.

The sampling area that satisfactorily qualify for the different activities/uses of its water is Kolambugan. Rau-an and Tubod waters conditionally qualify for the propagation, survival and harvesting of shellfishes because of the presence of fecal coliforms but satisfactorily qualify for the use of their waters for public bathing, etc. The waters of Ozamiz City, Malaubang, Tangub City, Maquilao, Migpangi and Daromawang are not suitable for the propagation, etc. of shellfish because the geometric mean values for total coliform exceeded the set DENR standard and also because of the presence of fecal coliforms. On the other hand, Migpangi water conditionally qualify for bathing, swimming, and skin diving activities because the mean coliform values exceeded a little that of the set standards. Despite all these findings, however, shellfish gathering in the Bay could still be safe and healthy mariculture is also possible because of the dilution effect of dynamic Bay waters and other factors than can thin down the bacterial contaminant.

Pesticides Residues

The study was conducted from Feb-Dec. 1991. A total of 171 samples which are collected and analyzed consisted of 102 waters, 37 sediment and 33 bivalve specimens. Majority of the water samples were collected from the major tributaries located in the inner portion of the Bay while the corresponding sediment

samples were obtained at the mouth of each river. Bivalve specimens were obtained at Daromawang Pt. and Rau-an Pt.

Most of the water samples indicated "no detection" of pesticide residues while five showed minute residues of aldrin in Matampay, Daromawang and Margos Rivers and lindane in Rau-an, and Tagolalo Rivers but not inside the Bay. Levels obtained did not exceed the water criteria established by DENR for coastal and marine waters. Four sediment samples showed positive residues such as 0.052 ppm diazinon in Maranding River; 0.018 ppm heptachlor epoxide, Daromawang Pt.; 0.011 ppm lindane, Cabgan River, and 0.003 ppm endosulfan, Rau-an Pt. Data of sediment residues are sometimes suspected as cause of the low productivity of sedentary species but there are no criteria similar to water assessment. One brown mussel and two hard clam samples obtained in Daromawang Pt. showed positive residues of heptachlor epoxide and DDT, respectively, ranging from 0.008 to 0.082 ppm. This range of concentration is too small to harm the adult organisms, as compared to critical concentration of 5 ppm DDT in flesh fish.

Heavy Metals

This study investigated the apparent concentrations of Zn, Ni, Cr, Hg, Cu, Pb, Cd, and Fe in Panguil Bay and in the five rivers which flow directly to the Bay. Among the nine heavy metals, only Zn and Cr were detected in the water while Pb, Cr, Zn and Hg were found present in the sediments of the river.

Based on the maximum tolerable limits of DENR standard (1990), only Cr exceeds the tolerance concentration while Zn is far below the limit. Cabgan River had the highest concentration (0.30 ppm Cr), while the lowest was at Kolambogan-Maningol station (0.037 ppm Cr). Since DENR has not determined the permissible limits for metals in the sediments, the data obtained are presented for documentation purposes only.

Heavy metals are naturally present in the aquatic environment to a certain concentration which are not detrimental to the aquatic resources. Cr concentration in the Bay is already beyond tolerable limit (0.05 ppm) but still less than the lethal concentration of most organism (18-200 ppm).

Finfish Resources

A total of 145 species of fish were identified from the collection. These species were distributed among 73 families and 109 genera. All species were classified under Class Osteichthyes except for *Dasyatis kuhlii* and *Carcharhinus spallanzani* which belong to Class Chondrichthyes.

Finfishes in Panguil Bay were exploited by a total of 11 different types of gear which are classified as municipal gears. These gears were fish corral, bottom set gill net, bottom set longline, multiple handline, stationary lift net, filter net, boat seine, drag seine, drive-in-net, motorized scissor net and spear. The stationary lift net had the highest catch-per-unit-effort value of 2.19 kgs per trip.

A total catch estimate of about 177.8 tons was captured from January to December 1991 based on 22 fish landing areas within the Bay. This estimate is remarkably reduced from the reported catch of 909.5 tons by Sanguila *et al.* in 1984. The reduction of catch may be attributed to the effective implementation of the banning of filter net or "*sanggab*." This type of gear is efficient yet destructive for catching finfishes in the Bay. The number of fish species caught in the Bay likewise reduced from 201 species in 1984 to only 145 species in this study. The major species in their order of relative abundance were: *Arius maculatus*, *Stoleporus heterolobus*, *Sardinella nigricaudata*, *Upeneus sulphureus*, *Stoleporus*

commersonii, *Liza macrolepis*, *Therapon jarbua*, *leiognathus equulus*, *Johnius vogleri* and *Sphyraena flavicauda*.

The growth of major species is allometric and these species are mostly slow growers. Species such as *Epinephelus sexfasciatus*, *Leiognathus equulus*, *Therapon jarbua*, *Gerres filamentosus*, *Sphyraena flavicauda*, *Sillago sihama*, *Sardinella nigricaudata* and *Scatophagus argus* have no definite seasonality in abundance.

The mean finfish biomass of 548.3 tons was computed based on virtual population analysis of 5 economically important species, viz.: *Upeneus sulphureus*, *Gerres filamentosus*, *Leiognathus equulus*, *Therapon jarbua* and *Epinephelus sexfasciatus*. The total mortality rates of these species varied between 1.058 and 2.949 per year. *Therapon jarbua* had the highest total mortality while the *E. sexfasciatus* had the lowest mortality value. The lower value corresponds to the time between monsoon periods and the higher value to the monsoon period. The broad recurrence of values in the corresponding months could probably be due to size-dependent migration resulting in a variability in the vulnerability of the different size groups to the gear (John, 1984).

Crustacean Resources

Panguil Bay is an estuarine body of water known to be a sanctuary of crustacean. Penaeid prawns and shrimps and portunid crabs abounded in this Bay long before the advent to the prawn industry.

Minor fishing exists along the coast with traditional gears such as gill nets, fish corrals, cast nets, push nets, scoop nets, lift nets, crab lift nets (*bintols*) and crab pots (*bobo*). These gears operate 6 to 12 ours per fishing per day.

The crustacean fishery is entirely supported by *Penaeus merguensis*, *P. indicus*, *P. monodon*, *P. semisulcatus*, *P. latisulcatus*, *Metapenaeus ensis*, *M. dalli*, and *Acetes* sp. for shrimps and *Macrobrachium rosenbergii* for prawn. For crabs, *Scylla serrata*, *Portunus pelagicus*, *P.*

sanguinolentus, *Charybdis feriata*, and *Thallamita crnata* support the fishery. Of these species, only *M. ensis*, *P. merguensis*, *P. monodon*, and *S. serrata* are commercially abundant. Shrimp and crab fishing is carried throughout the year with peaks on May and July for shrimps and February and May for crabs.

The study was conducted for one year and the results show high values of fishing mortality (F) and low values of natural mortality (M), indicating that fishing tends to be directed towards younger and smaller crustaceans and that mortality is attributed to fishing pressure rather than to natural causes.

A great number of fishing gears are operating in the Bay. Among these, the fish corrals (*bungsod*= 144, *tower*=680, *panira* = 154), gill nets (*pukot*= 840, *patuloy*= 270) and crab lift net (*bintol*= 2120) dominate the Bay in number of units. Due to their numerous quantity, the CPUE of these gears are very low with a catch of less than one kilogram of shrimps/crabs per gear per day.

The total recorded landed catch of shrimps and prawns in Panguil Bay was 213.435 tons while the estimated catch was 244.787 tons. This was dominated by *M. ensis* (49.85%) and *P. merguensis* (21.39%). For crabs, the total recorded landed catch was 178.172 tons, while the estimated catch was 410.992 tons, with *S. serrata* dominating the catch (70.20%).

A theoretical projection showed an estimated yield of crustaceans to be 655.779 tons, with a corresponding biomass of 401.723 tons, which is only 47.21% of the original stock. The projection indicates that the crustacean fishery is over-exploited.

Mollusc Resources

A total of four species of cephalopods, 23 bivalves and three gastropods were found to be commercially exploited mollusks in Panguil Bay in 1991. The broad-finned squid *Sepioteuthis lessoniana* was the most abundant cephalopod while the brown Bay mussel *Modiolus metcalfei*

(*amahong*) was the most abundant bivalve. The occurrence of the brown mussel and the clam *Meretrix (burnay)* was more restricted to the Matampay-Daromawang area, whereas the clams *Katelsia (punao)*, *Anadara (litob)* and *Psammotea (kalaykay)* were more widely distributed.

Cephalopod fisheries in the Bay are not substantial, with a total landed catch of only 7.25 tons in 1991. A total of seven gears comprise the artisanal fishery, with the squid jigs and fish corral contributing to the bulk of the catches. The bivalve gathering forms the bulk of the mollusc fishery in Panguil Bay, with a total landed catch of 721.28 t or a monthly average of 60 t. The fishery largely involves handpicking during low tides, although some gatherers employ scoop nets, bamboo dredges and other minor implements to improve the efficiency of catch.

The data indicate that the mollusc stocks in the Bay are already overexploited. Long-term yield predictions showed that the annual yields for the cephalopods was 7.12 t, with the maximum yield at 7.55 t. Annual yield for bivalves was 720.08 t, with an estimated maximum yield of 725.42 t. The maximum values may be considered the allowable level of catch to maintain the fishery for a long time. Analysis of yield of seven major species of mollusc has shown that the annual yields exceed the allowable level of effort, except with the squid *Loligo sp.* The data suggest that the molluscan stocks in the Bay are generally overexploited. Data analysis also suggests that the mollusc fishery in the Bay is no longer profitable at the current level of fishing effort.

Seaweed Resources

A total of 105 species of seaweeds were identified broken down into 44 red, 24 brown, 23 green and four blue-green algae. A number of species is presently harvested from natural stock, but only *Gracilaria* and *Sargassum* are harvested in sizable quantity with an estimated potential yield of 18.6 and 58.6 tons dry wt., respectively.

Results of the one year survey done in 10 stations along Panguil Bay showed a mean standing crop ranging from 2.76 to 123 gm m⁻², with

highest in Hulaw-hulaw and lowest in Polot, Ozamis City. The brown algae, represented by *Sargassum* and *Turbinaria*, generally dominates the Bay in terms of abundance and biomass. Growth phases of *Sargassum* indicates high fertility during February and March, coinciding with peak abundance. *Gracilaria* resources generally occur in river mouths and low saline waters exhibiting seasonality in abundance.

Sargassum and *Gracilaria* are abundant as natural stock in Panguil Bay. Alginate and agar are extracted from these resources, respectively, which demands a high price in the world market. They could provide alternate source income if managed properly.

Coral Reefs, Seagrass Beds and Artificial Reefs

A total of 56 species of corals, 50 coral reef fish, 24 artificial reef fish, and 8 seagrasses were identified. Associated seaweeds and invertebrates of these communities gave a total of 105 and 69, respectively.

The coral reefs of Panguil Bay are either fringing or patch reefs covering approximately six percent of the total coastline of the Bay. Most of the reef areas are shallow and are generally poor to fair conditions (10-40% live coral cover), except for deep stations, off Hulaw-hulaw marine sanctuary, with a standing live coral cover 64%. The massive type *Porites* dominates the corals; Pomacentrids among the coral reef fish; Apogonies among the artificial reef fish; *Enhalus acoroides* among the seagrasses. Production rate of seagrasses ranged from 120 to 657 gm m⁻²y⁻¹ dry wt with a turnover time ranging from 10 to 31 days.

Diversity and productivity in coral and artificial reefs are generally low, although seagrass shows moderately high production. High siltation and man-made disturbances are inferred to be the causal factors in the present conditions of these habitats.

Mangrove Resources

Mangrove communities of Panguil Bay were investigated for one year. Results have shown that about 72% of the estimated mangroves of the Bay based on the 1950 estimate is lost due to its conversion into fishponds and settlement areas, cutting of mangrove trees for lumber, staking material and fuel, and due to erosion and denudation. What remains is about 3,623 hectares out of the 12,590 hectares in 1950.

Eight species of mangrove trees were identified in the area. This group is dominated by *Sonneratia caseolaris* (pagatpat) followed by *Sonneratia alba* (perara). *Nypa fruticans* (nipa) is found throughout the Bay with greater concentration at the interior portions. Average number per hectare for trees, sapling and seedlings is 617,822, and 457, respectively. Nipa palm has a mean of 1083 palm per hectare. Mean basal area is 9.082 square meters per hectare while the mean wood volume is 44.53 cubic meters per hectare. Per cent cover ranges from 81 to 100 with a mean of 92.4. Net primary productivity ranges from 7.17 to 11.95 kg. carbon per hectare per day with mean of 10.67 kg. carbon per hectare per day. Soil type is predominantly clay-silt; soil pH ranges from 6.45 to 7.58; soil redox potential ranges from - 154.0 to 238.0; soil temperature is generally high from 28-34°C; soil salinity ranges from 5.00 to 45.00 ppt. Mangrove topography indicates general submergence in most areas during high tides. Commercially important aquatic macrofauna in mangrove area consist of at least 7 species of crustaceans, 4 species of mollusc, and 6 species of finfishes.

Soft-bottom Communities

A survey of soft bottom communities was conducted by using a PVC corer from February 1991 to December 1991 and an Ockelmann sledge from January 1992 to February 1992. There were 10 meiobenthic and 50 macrofauna taxa identified.

The predominance of the meiobenthic (51.87%) over the macrobenthic (48.13%) fauna was recorded in the PVC corer samples.

The nematodes, copepods, polychaetes, turbellaria, ostracods, oligochaetes, amphipods, shrimp larvae, crab larvae, kinorhynchs, and tardigrades comprised the meiobenthic fauna, while the macrobenthic fauna included young crabs, *Lingula* larvae, bivalves and gastropods and bigger nematodes. The Ockelmann sledge samples yielded the occurrence of macrobenthic faunae, such as shrimp juveniles and adults, crab megalopae, juveniles and adults, demersal fish juveniles, polychaetes, echinoderm juveniles and adults, bivalve juveniles and adults, gastropod juveniles, and mantis shrimp juveniles and adults.

The population peaks for the cored samples was 43,465 individuals per 0.1 sq. m for the meiofauna and 510 individuals per 0.1 sq. m for the macrofauna. For the Ockelmann sledge samples, the mean abundance varied in nearshore (2-1,629 individuals per 300 sq m) and in the offshore (26-73 individuals per 300 sq m) stations. For the cored samples, the highest biomass for the meiofauna was 0.6870 g per 0.1 sq m during the northeast monsoon and 0.6727 g per 0.1 sq m during the southeast monsoon and for the macrofauna, the highest biomass was 1,340.86 g per 0.1 sq. m during the northeast monsoon.

The nearshore stations were richer than the offshore stations. Grain size distribution and the monsoons seemed to affect the total mean population density of both meio- and macrofauna. The macro- and meiobenthic nematode dominated in the cored samples while the shrimp juvenile, demersal fish juveniles and bivalves dominated in the sledge samples. The *Phascolosoma spp* and the *Lingula spp* resources of the Bay indicated catches of small sizes.

Recommendations for Coastal Resources Management

Panguil Bay is dynamic ecosystem and a valuable resource which is subjected to various ecological and exploitative pressures. As an ecosystem, Panguil Bay is endowed with numerous tributaries that maintain a brackishwater environment favorable to breeding and growth of pelagic and demersal species. The current system is also quite efficient in flushing out contaminants and excess organic load from runoff waters, thus,

preventing possible Bay-wide or localized eutrophication.

As a resource, Panguil Bay is a rich municipal fishing ground. Its fishery is dominated by crustacean resource but it is also teeming with other species of fish life. Its water is very rich in nutrient and its primary productivity is definitely sufficient to support high fishery production.

Unfortunately, a large number of people are dependent upon the Bay directly or indirectly. Among them are poor fishermen in the coastal barangays whose population is increasing alarmingly with hardly an alternative livelihood to increase income. And those who have the means or opportunity are resorting to regular illegal fishing activity which is detrimental to themselves economically.

Siltation of the Bay is a serious phenomenon that could bring about significant changes in the configuration of the shoreline and the contour of bottom habitat. But more important is the potential problem of pollution. Workers engaged in the coastal economic activity seem to care less about the environmental effect of dumping pollutive effluents into Panguil Bay. Moreover, fishermen who are living in abject poverty in coastal communities do not have means for proper disposal of domestic waste.

In short, Panguil Bay is a rich fishing ground whose fishery resource is generally overfished and whose ecology is being subjected to pressure from destructive and illegal fishing activity and pollution. Unless something is done to alleviate the present situation, it is not farfetched that the Bay will soon lose its value as an important fishing resource.

Based on the findings of the research on the resources and ecology of Panguil Bay, recommendations are outlined for the various uses of the Bay as a fishery ground, for the guidelines for use of suitable fishing gears to enhance the overall fish productivity of the Bay.

It is also recommended that the fishing gears used in the Bay be regulated in terms of mesh size, number of units and gear type. The recommendation is basically the reiteration of the general call for implementation and effective enforcement of existing laws governing the

proper exploitation of our fishery resources.

Pollution is a reality in Panguil Bay, yet an appropriate environmental management program is nonexistent. It is recommended that a program for monitoring the status of pollution in the Bay be put in place to check critical environmental parameters such as biological pollution in the water and filter-feeding sessile organisms, pesticide residue and heavy metal contamination in water, sediment and sessile organisms, nutrient level of the water and the occurrence of plankton blooms that cause red and blue tides.

Concluding Remark

To rehabilitate the resources of the Bay and secure its future and those of the people dependent on it for survival, a more comprehensive recommendation with supportive action programs for the people requires commitment and political will from the government, multisectoral groups of inter-governmental agencies, development organizations, the business sector, and the people in the coastal villages themselves.

Research Team Composition

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Crustacean Resources

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Mollusc Resources

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Seaweed Resources

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Coral reefs, seagrass beds and artificial reefs

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Mangrove Communities

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Soft bottom Communities

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