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Panguil Bay Fisheries over the Decades: Status and Management Challenges

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ABSTRACT

The diverse and productive fisheries of Panguil Bay have been exploited for decades by a large fishing population using a wide variety of gears. Total landed catch based on recorded catches of various gears from April to December 2005 was to 201.12 t, with finfish comprising 40.8% (82.14 t), mollusks 34.8% (69.94 t) and crustaceans 24.4% (49.04 t), which by extrapolation amounted to an estimated total annual production of 1,660.54 t. The present report showed that yields of finfish, crustacean and mollusk resources from the bay have generally declined over the years as fishing effort continued to climb. Landed catch in 2005 comprised 135 finfish species belonging to 71 families, 21 crustaceans and 15 mollusks. Ten species made up 62.3% of the total landed catch of finfish, four shrimp and four crab species comprised 86.4% of total crustacean harvest while four bivalve species represented 79.8% of the total mollusk production from the bay in 2005. As many as 9,323 fishers owning more than 5,000 boats depend on the municipal fisheries of Panguil Bay for their livelihood in 2005. Thirty-two gear types are operated in Panguil Bay where the most popular (i.e., with more than 50 units each), are bottom set gill net (349), cast net (174), simple hook and line (117), modified fish corral (96), drift gill net (79), and crab lift net (61). The highest catch rates of finfish and crustaceans were obtained from drift gill net in San Antonio (58.17 kg gear^{-1} d^{-1}), while the scoop net used in gathering the bivalve *Donax sp.* ("agihis") in Migpangi, Bonifacio obtained the highest mean CPUE value (267.25 kg gear^{-1} d^{-1}). While a few fishing gears obtained large CPUE values, extremely high fishing effort naturally resulted in very small daily catches in most types (< 1.0 kg gear^{-1} d^{-1}). The "alimango" fishing industry is still thriving in the inner part of Panguil Bay despite its progressive decline. Conservation and management measures are now in place to protect bivalve and other fishery resources in the bay, however, the continued presence and operation of highly efficient and destructive fishing gears remain a persistent threat to the fishery resources of the bay. Gonadal maturity and length-frequency analysis indicate the occurrence of biological overfishing on major fish stocks in Panguil Bay.

Key words: Fish stock assessment, exploitation, annual production, biological overfishing.

INTRODUCTION

Panguil Bay is a small but rich fishing ground that supports the livelihood of thousands of small-scale fishers in northwestern Mindanao. Flanked by 10 municipalities and two cities belonging to three provinces (Lanao del Norte, Zamboanga del Sur, and Misamis Occidental) and three administrative regions (Regions 9, 10 and 12), such complex jurisdictional structure calls for an integrated management framework for the sustainable development of the bay's fishery resources. Unfortunately, over the decades Panguil Bay has been subjected to fragmented governance systems, multiple resource uses, and short-lived interventions. The lack of a holistic resource and environmental management program still poses the greatest challenge for the sustainability of this shared, natural resource and the livelihood of poor fisherfolk.

The municipal fisheries of Panguil Bay is a multi-gear, multispecies system that has sustained high levels of exploitation through a diverse fishing gear technology and unregulated growth in fishing effort. Like any vulnerable ecological system, fishery production has gone through a cycle of decrease and increase as a response to changes in resource and environmental governance. The earliest assessment of Panguil Bay fisheries was conducted by MSU Naawan in 1982, followed by a series of assessments in 1990-91, 1995-96 and 2005 under the Fisheries Sector Program (FSP) and Fisheries Resource Management Project (FRMP) of the DA-BFAR. A review of these works reveals that some significant changes in the Bay's fisheries have occurred in the past years.

METHODS

This paper presents the results of monitoring the municipal fisheries production in Panguil Bay from April 2005 to December 2005 which were then compared to the results of the 1990-91 and 1995-96 assessments. Regular monitoring of landed catch and fishing effort was conducted following standard sampling procedures for fish stock assessment and using standard Resource and Ecological Assessment (REA) data forms as recommended by the National Fisheries Information System (NFIS).

Fish landing surveys were made in ten monitoring stations across the three provinces of Lanao del Norte (Segapod, Maigo; Rebucon, Kolambugan; Raw-an Pt, Baroy; Darumawang, Lala; and Margos, Kapatagan), Zamboanga del Sur (Lintugop, Aurora and Angeles, Tambulig), and in Misamis Occidental (Migpange, Bonifacio; Maquilao, Tangub City and San Antonio, Ozamiz City). Two research assistants assisted field enumerators in monitoring the daily catches of fishermen for a minimum of 20 days per month. *In-situ* sampling determine population abundance of target bivalve species were conducted quarterly using the standard transect-quadrat sampling technique. On-board fishing for commonly used fishing gears and trawl fishing were also conducted in order to validate the results of fish landing surveys. Measurements of biological parameters such as length, weight, sex ratios and maturity stages of selected major fish and invertebrate stocks were also obtained.

Data from the surveys were presented as landed catch by species, gear type and locality, estimate of total fishing effort, and catch rates or CPUE by gear type. Length-frequency data were analyzed using the FiSAT software (ver. 1.0.0) to estimate parameters of growth, mortality, and recruitment of major fish stocks.

RESULTS

Major harvested fish stocks

Three main groups of fishery resources were commercially harvested in Panguil Bay: finfish, crustaceans and mollusks, with finfish showing the highest diversity in catch composition. Landed catch in 2005 comprised 135 finfish species belonging to 71 families, 21 crustaceans (10 crabs, 8 shrimps and 3 freshwater prawns), and 15 mollusks (10 bivalves, 2 gastropods and 3 cephalopods). Ten species made up 62.3% of the total landed catch of finfish, four shrimp and four crab species comprised 86.4% of total crustacean harvest while four bivalve species represented 79.8% of the total mollusk production from the bay in 2005. Distribution of major finfish resources is shown in Figure 1, while the distribution of crustacean and mollusk resources in Panguil Bay is in Figure 2.

Total landed catch based on recorded catches of various gears from April to December 2005 amounted to 201.12 t (Table 1), with finfish comprising 40.8% (82.14 t), mollusks 34.8% (69.94 t) and crustaceans 24.4% (49.04 t). Raising this value to 12 months results in an estimated total annual production of 1,660.54 t, which is slightly higher than the fish production reported in 1991 (1,633.70 t) but considerably lower than in 1995-96 (3,486.00 t, Fig. 3).

Table 1. Landed catch (tons) by monitoring stations in Panguil Bay between April and December 2005.

Station	Finfish	Crustaceans	Mollusks	Total
Segapod	12.55	0.45	1.35	14.36
Rebucon	11.73	0.17	0.10	12.00
Darumawang	8.07	10.63	3.68	22.38
Raw-an Pt.	1.26	2.83	45.79	49.88
Margos	8.77	4.13	0.00	12.90
Lintugop	0.68	3.40	0.00	4.08
Angeles	0.10	3.52	0.00	3.62
Migpange	8.92	11.30	18.81	39.03
Maquilao	5.52	10.46	0.00	15.98
San Antonio	24.52	2.15	0.21	26.88
Total	**82.14**	**49.04**	**69.94**	**201.12**

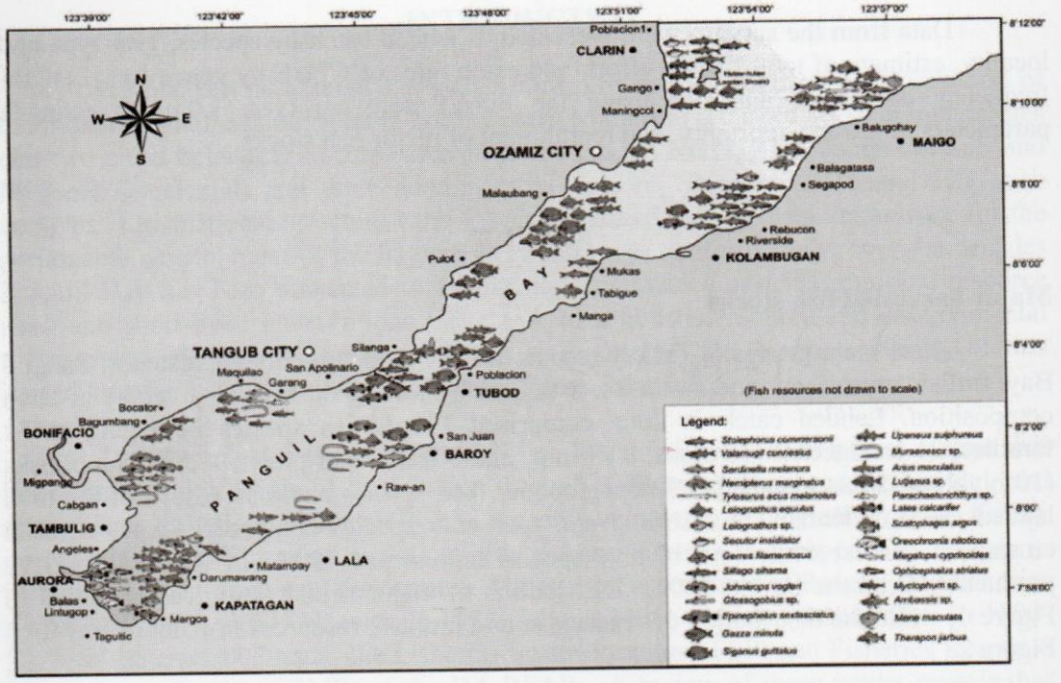


Figure 1. Distribution of finfish resources in Panguil Bay in 2005.

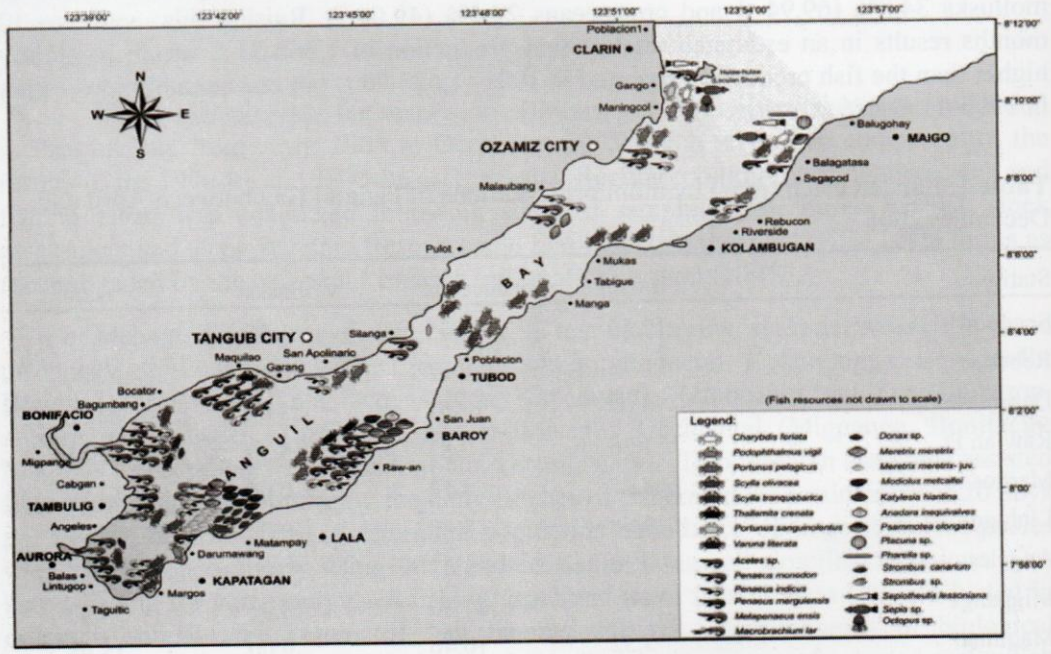


Figure 2. Distribution of crustaceans and mollusks in Panguil Bay in 2005.

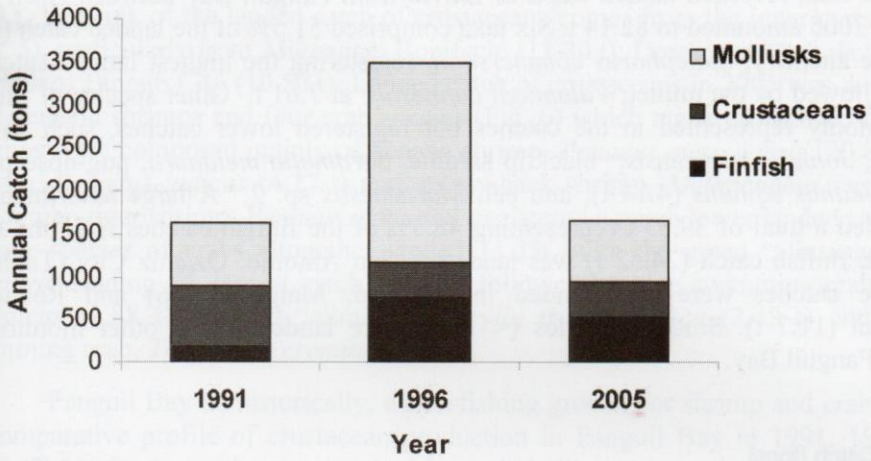


Figure 3. Comparative estimates of total fish production in Panguil Bay.

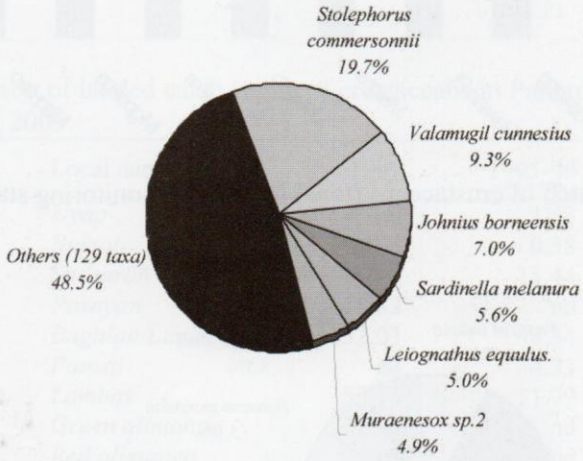


Figure 4. Catch composition of finfish in Panguil Bay in 2005.

The estimated finfish production in 2005 (535.6 t) is lower than that reported in 1995-96 (763.8 t) but higher than in 1991 (177.8 t) (Fig. 3). The same pattern is apparent in mollusk resources where production in 2005 (720.6 t) is considerably lower than in 1995-96 (2,314.5 t) and slightly lower than in 1991 (728.5 t). On the other hand, the volume of crustacean production shows a decreasing trend from 1991 (727.4 t) to 1995-96 (407.7 t) and 2005 (404.3 t).

The total recorded landed catch of finfish from Panguil Bay between April and December, 2005 amounted to 82.14 t. Six taxa comprised 51.5% of the landed catch (Fig. 4), with the anchovy, *Stolephorus commersonii,* registering the highest landed catch at 16.15 t, followed by the mullet, *Valamugil cunnesius,* at 7.61 t. Other species of finfish were commonly represented in the catches but registered lower catches, such as the croakerfish, *Johnius borneensis*, blacktip sardine, *Sardinella melanura*, pug-nose pony fish, *Leiognathus equulus* (4.14 t), and eel, *Muraenesox* sp. 2. A large assortment of finfish landed a total of 39.83 t representing 48.5% of the finfish catches from the bay. Most of the finfish catch (24.52 t) was landed in San Antonio, Ozamiz City (Table 2) while large catches were also landed in Segapod, Maigo (12.56) and Rebucon, Kolambugan (11.7 t). Smaller catches (< 10 t) were landed in the other monitoring stations in Panguil Bay.

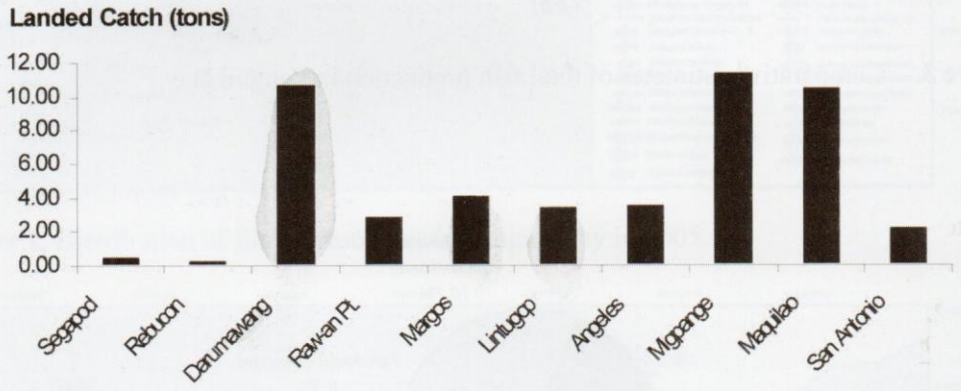


Figure 5. Landed catch of crustaceans (tons) in various monitoring stations in Panguil Bay.

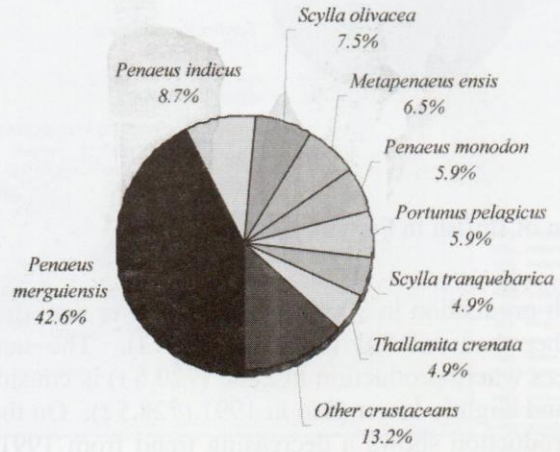


Figure 6. Relative abundance of major crustacean resources in Panguil Bay in 2005

The recorded landed catch of crustaceans in Panguil Bay in 2005 amounted to 49.0 t. The bulk of the landed catch of crustaceans comes from the inner parts of the bay (Fig. 5), particularly from Migpange, Bonifacio (11.30 t); Doromawang, Lala (10.6 t) and Maquilao, Tangub City (10.50 t). Landed catch of crustaceans in 2005 was dominated by four penaeid shrimps and four crab species (Fig. 6) which made up 86.8%. The penaeid shrimps were composed mainly of banana shrimp, *Penaeus merguiensis* (20.87 t), white shrimp, *Penaeus indicus* (4.27 t) and greasy-back shrimp, *Metapenaeus ensis* (3.19 t). The jumbo tiger shrimp, *Penaeus monodon,* registered a much lower landed catch of 2.90 t. Four species of crabs altogether landed 11.35t, with the green "alimango", *Scylla olivacea,* landing the largest catch (3.66 t), followed by blue swimming crab, *Portunus pelagicus* (2.88 t), the red "alimango", *Scylla tranquebarica* (2.42 t) and the small swimming crab, *Thallamita crenata* (2.40 t).

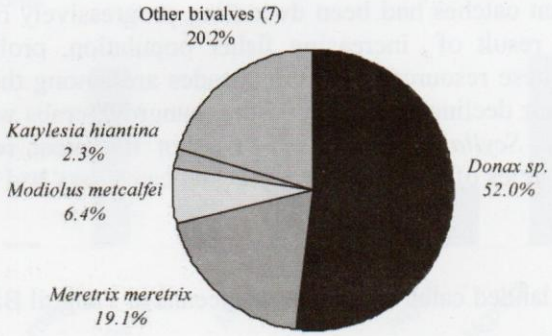
Panguil Bay is, historically, a rich fishing ground for shrimp and crab resources. A comparative profile of crustacean production in Panguil Bay in 1991, 1995-96 and 2005 (Table 3) shows that catches had been dwindling progressively over a span of 14 years. Overfishing as a result of increasing fisher population, proliferation of gear varieties, and export of these resources over the decades are among the most important factors contributing to their decline. Before 2005 the mangrove crabs were misidentified as *Scylla sp* (1991) and *Scylla serrata* (1995-96), but the most recent assessment identified at least three species of the mangrove crab and catch data had been accordingly reported.

Table 2. Comparison of landed catch (tons) of crustaceans in Panguil Bay between 1991, 1995-96 and 2005.

Species	Local name	1991	1995-96	2005
Acetes sp.	*Uyap*	nd	1.83	1.65
Macrobrachium lar	*Buktot*	nd	0.38	1.26
Metapenaeus ensis	*Sudsuron*	nd	13.44	3.19
Penaeus indicus	*Pasayan*	15.52	nd	4.27
P. merguiensis	*Bagalan/Lunhan*	152.03	43.34	20.88
P. monodon	*Pansat*	nd	4.73	2.90
Portunus pelagicus	*Lambay*	50.26	11.79	2.88
Scylla olivacea	*Green alimango*	nd	nd	3.66
S. tranquebarica	*Red alimango*	nd	nd	2.42
S. serrata	*Alimango*	nd	11.69	nd
Scylla sp.	*Alimango*	125.08	nd	nd
Thallamita crenata	*Kasag*	nd	nd	2.40
Varona literata	*Kamangkas*	nd	nd	1.84
Other shrimps		45.89	0.28	0.13
Other crabs		2.83	0.66	3.98
Total		**391.61**	**88.15**	**49.04**

Remark: nd means no data available

Four species of bivalves dominated the landed catch of mollusks (Fig. 7), namely, the wedge clam, *Donax* sp., locally called "agihis" (43.7 t), Asian hard clam, *Meretrix meretrix,* locally called "burnay" (12.4 t), brown mussel or "amahong", *Modiolus metcalfei* (5.4 t), and the surf clam or "punaw", *Katylesia hiantina* (1.9 t). The razor clam, *Pharella* sp. ("tudlo datu") listed the smallest landed catch, at 20 kg. Cephalopods, composed mostly of the squid *Sepioteuthis* sp., cuttlefish, *Sepia* sp, and octopus, registered a combined total landed catch of only 1.1 t. The cephalopods were caught mostly in the outer part of Panguil Bay, particularly in Maigo and Ozamiz City. A comparison of annual mollusk production among three assessments (Fig. 8) shows a generally declining trend except in the squid *Sepioteuthis* where an increasing pattern is seen over the years. Among the bivalve resources, only *Psammotea elongata* and *Meretrix meretrix* obtained higher landed catch in 2005 while the others landed smaller catches than in 1995-96 assessment.



.**Figure** 7. Relative abundance of major bivalve resources in Panguil Bay in 2005.

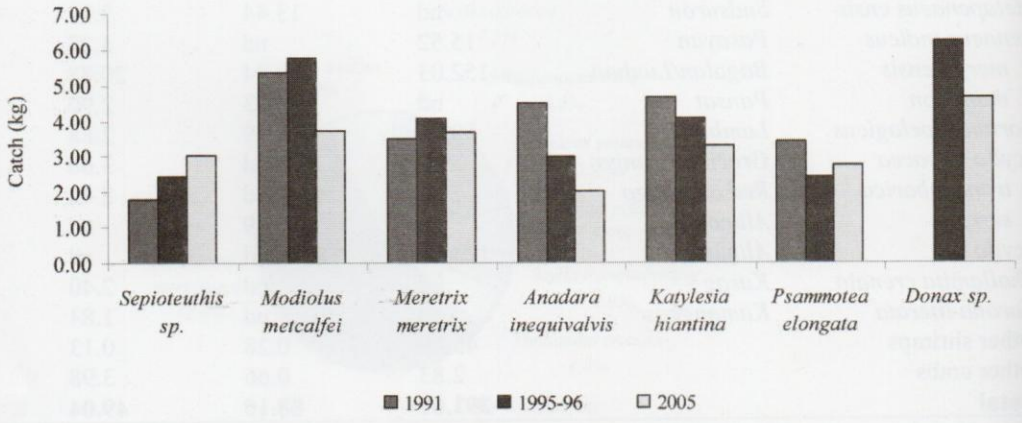


Figure 8. Comparative landed catches of mollusk in Panguil Bay in 1991, 1995-96 and 2005 (values are log-transformed).

Fishing Effort and Gear Efficiency

Compiled data from municipal profiles and reports by local research partners indicate that as many as 9,323 fishers are involved in the municipal fisheries of Panguil Bay (Table 3). The highest number of fishers was recorded in Kolambugan (1,327), Tubod (1,311), and Lala (1,253). The towns of Baroy (453), Bonifacio (326) and Clarin (160) registered the lowest number of fishers. Of the more than 5,000 boats in the entire bay, non-motorized bancas or paddleboats (63%) outnumbered the motorized boats (37%).

Among the coastal cities or municipalities around Panguil Bay, Tangub City had the most number of motorized and non-motorized boats (830), followed by Aurora (567) and Kapatagan (520). Comparison across the different assessment period shows that the number of fishing boats in 1991 was much higher (6,345) than in 1995-96 (2,187) and 2005.

Thirty-two gear types operating in Panguil Bay were monitored in 2005. Six gears dominated in terms of number (i.e., with more than 50 units each), namely, bottom set gill net (349), cast net (174), simple hook and line (117), modified fish corral (96), drift gill net (79), and crab lift net (61). Among the monitored gear types, three are considered illegal gears (i.e., beach seine, electric fishing and boat seine) while one incidence of blast fishing was recorded in April 2005.

Table 3. Distribution of fishers and fishing boats among municipalities and cities around Panguil Bay in 2005.

Municipality/Province or City	Number of fishers	Number of Boats		
		Motorized Boats	Non-motorized Boats	Total
Maigo, Lanao del Norte	577	55	197	252
Kolambugan, Lanao del Norte	1,327	95	279	374
Tubod, Lanao del Norte	1,311	59	246	305
Baroy, Lanao del Norte	453	129	243	372
Lala, Lanao del Norte	1,253	179	270	449
Kapatagan, Lanao del Norte	455	144	376	520
Aurora, Zamboanga del Sur	1,134	193	374	567
Tambulig, Zamboanga del Sur	660	152	268	420
Bonifacio, Misamis Occidental	326	130	179	309
Tangub City	749	473	357	830
Ozamiz City	918	199	276	475
Clarin, Misamis Occidental	160	40	88	128
Total	9,323	1,848	3,153	5,001

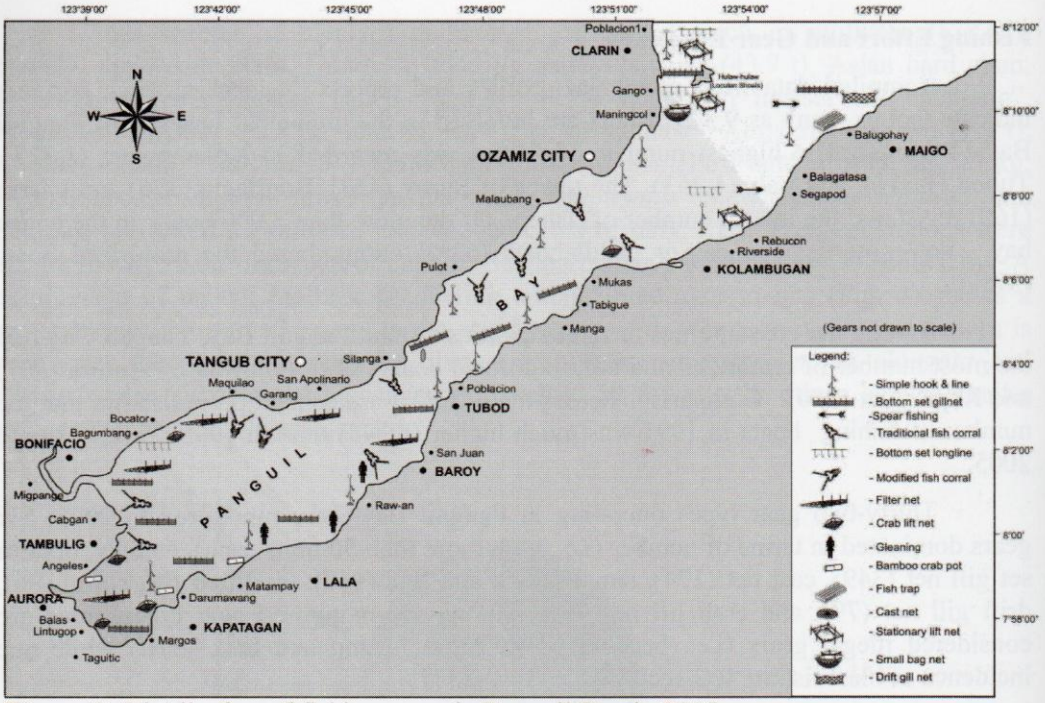


Figure 9. Distribution of fishing gears in Panguil Bay in 2005.

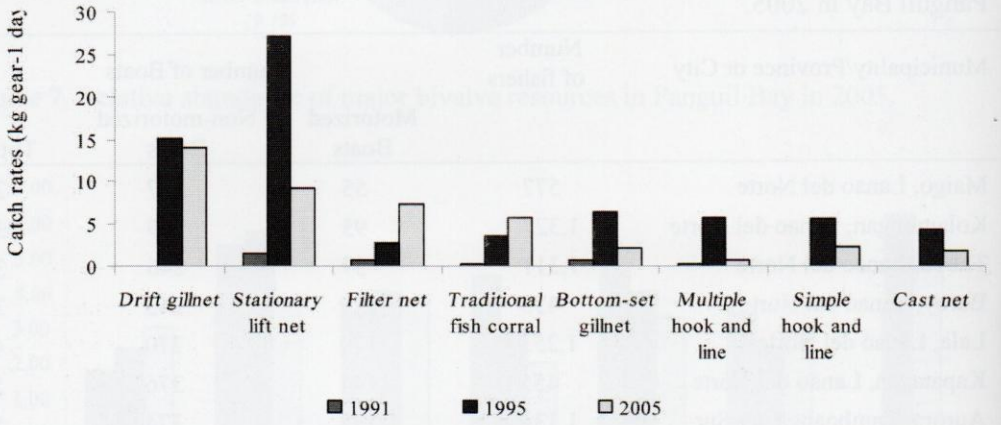


Figure 10. Landed catch (tons) of ten dominant gears in Panguil Bay in 2005

Diversity and abundance of fishing gears operated in Panguil Bay has increased since 1991, with some gear types becoming more popular, such as crab lift net, simple handline, bottom-set longline, and bamboo crab pot. The declining trend in mudcrab production may be attributed to the phenomenal increase in the number of crab-specific gears, particularly of the newly operated bamboo crab pot or "sugong" that reached 13,094 units in 2005 but was unknown in 1991 and 1995-1996. Another gear, the

modified fish corral or 'tower", was not reported earlier but has now proliferated in the inner part of the bay where the most number of stationary gears occur. The present bay-wide distribution of these fishing gears in is shown in Fig. 9.

Ten major fishing gear types contributed 94.8% of the total landed catch of finfish, crustaceans, and cephalopods. The bottom-set gillnet produced the highest landed catch of 39.6 t, while an aggregate catch of 4.85 t was landed by an assortment of 18 gear types (Fig. 10).

Monthly variations in the catch-per-unit-effort (CPUE) values for the various gear types were observed in each station. The scoop net used in gathering the bivalve *Donax sp.* ("agihis") in Migpangi, Bonifacio obtained the highest mean CPUE value (267.25 kg gear^{-1} d^{-1}) while simple hook and line in Segapod, Maigo got the lowest mean value of 0.34 kg gear^{-1} d^{-1}. The highest catch rates of finfish and crustaceans were obtained from drift gill net in San Antonio (58.17 kg gear^{-1} d^{-1}) followed by the filter net operated in Migpangi (19.10 kg gear^{-1} d^{-1}) and stationary lift net in San Antonio (13.77 kg gear^{-1} d^{-1}). Two other gears registered catch rates of more than 10 kg gear^{-1} d^{-1}, namely traditional fish corral in Migpangi (13.09 kg gear^{-1} d^{-1}) and spear fishing in Margos (12.00 kg gear^{-1} d^{-1}). Except for filter net and traditional fish corral, the mean catch rates of selected fishing gears in Panguil Bay in 2005 showed a decreasing trend since the previous assessment in 1995-96 (Fig. 11).

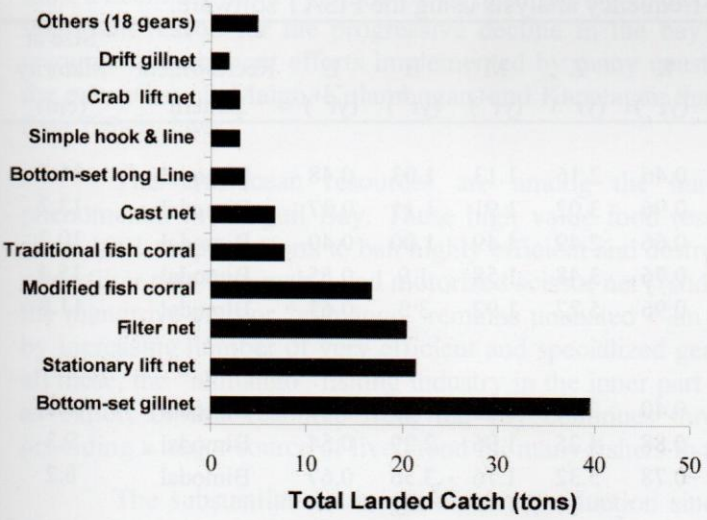


Figure 11. Comparative mean catch rates (kg gear^{-1} d^{-1}) of selected gear types in Panguil Bay in 1991, 1995-96 and 2005.

Bivalve stock density

Bivalves are among the most abundant resources in Panguil Bay particularly in the inner portions. Stock densities of various commercially important bivalves in Darumawang, Lala exhibited generally higher densities than in Raw-an Pt., Baroy. Two

bivalve species, namely, *Modiolus metcalfei* and *Meretrix meretrix* occurred at densities of over 500 indiv. m^{-2} in Darumawang while densities of *Donax* sp. exceeded 700 indiv. m^{-2} in Raw-an Pt. A natural bed of *M. meretrix* juveniles was found near the river mouth in Raw-an Pt. mixing with two other bivalve species, namely *Psammotea elongata* and *Donax* sp.

Biological Parameters of Major Fish Stocks

Length-frequency analysis on seven species of finfish, five crustaceans and four bivalves caught by various gears and methods indicated that many species were caught at very small or juvenile sizes. Majority of the specimens analyzed were sexually immature (56-92%), particularly of the penaeid shrimps where immature individuals made up 99-100% of the sample. Estimates of parameters of growth (L_∞ and K), mortality (Z, M and F), and exploitation rate (E = F/Z) are shown in Table 4. Recruitment patterns are generally bimodal with unequal pulses, indicating that spawning occurs at least twice a year at varying intensities. High mortality (Z = 1.58-5.32 yr^{-1}) and exploitation rate estimates (E = 0.37-0.67) indicate that many of the economically important fish stocks are already overexploited. These results suggest that growth and recruitment overfishing of the fish stocks in Panguil Bay occur, threatening the sustainability of these resources and the livelihood of thousands of fisherfolk.

Table 4. Population parameters of selected economically important fishery resources in Panguil Bay derived by length-frequency analysis using the FiSAT software.

SPECIES	L_∞ (cm)	K (yr^{-1})	Z (yr^{-1})	M (yr^{-1})	F (yr^{-1})	E (yr^{-1})	Recruit-ment pattern	Size at Maturity (cm)
Fish								
1. Leiognathus equulus	26.6	0.46	2.16	1.13	1.03	0.48	Bimodal	11.7
2. Vagamugil cunnesius	22.8	0.96	3.02	1.91	1.11	0.37	Bimodal	13.2
3. Johnius borneensis	22.75	0.66	2.49	1.49	1.00	0.40	Bimodal	10.7
4. Gerres filamentosus	25.94	0.76	3.48	1.58	1.9	0.55	Bimodal	15.4
5. Upeneus sulphureus	22.2	0.96	5.22	1.92	3.3	0.63	Bimodal	11.8
Crustaceans								
1. Penaeus indicus	14.9	0.40	2.05	0.82	1.23	0.60	Bimodal	9.5
2. Scylla tranquebarica	16.7	0.88	4.25	1.96	2.29	0.54	Bimodal	9.3
3. Scylla olivacea	18.8	0.78	5.32	1.76	3.56	0.67	Bimodal	8.2
Bivalves								
1. Meretrix meretrix	4.45	0.8	4.13	1.6	2.53	0.61	Unimodal	2.2
2. Katylesia hiantina	6.48	0.54	3.25	1.08	2.17	0.67	Bimodal	2.7
3. Modiolus metcalfei	5.57	0.78	4.14	1.56	2.58	0.62	Bimodal	1.8
4. Psammotea elongate	6.26	0.52	1.58	0.78	0.8	0.51	Bimodal	2.8

DISCUSSION

Trends in Panguil Bay fishery production

The diversity of finfish, crustacean, and mollusk resources (171 spp) of Panguil Bay in 2005 appears to be higher than in the 1995-96 assessment (142 spp) but lower in 1991 (182 spp). Some species identified in the present study were not recorded in the 1995-96 assessment, either because these were too few or not caught by the monitored gears. On the other hand, many species of mollusks reported in 1991 were not listed in 2005. Differences in species variety of fish resources among the three periods may also be attributed to changes or progress in taxonomic identification (e.g. FishBase) of fish resources especially in finfish and crabs. In particular, the *Scylla* species ("alimango") erstwhile lumped into *Scylla serrata* in 1995-96 Post-RSA report, were classified in 2005 as either *S. olivacea, S. tranquebarica* or *S. serrata*. The goby, *Glossogobius sp.* caught in some parts of the bay in 2005, albeit in small amounts, was previously not recorded.

The downtrend in the annual fish production of Panguil Bay can be attributed to several factors, namely, overfishing due to excessive effort, poor recruitment of major stocks, and declining environmental quality of the bay. Assessment of water quality conducted in 1991 and 1995-96 had shown that the bay is progressively being polluted and heavy siltation is contributing to the shallowing of the bay in its inner reaches. Siltation and the continued use of destructive fishing methods have degraded the coral reefs in the Loculan Shoal and other areas, in turn, contributing to reduced fish catch and thus, a declining trend in the CPUE of most fishing gears operated in the bay. Yet another important reason for the progressive decline in the bay's fisheries is the half-hearted resource management efforts implemented by many coastal LGUs around the bay, with the exception of Maigo, Kolambugan, and Kapatagan that have been actively enforcing their fishery laws.

The crustacean resources are among the hardest hit by the overfishing phenomenon in Panguil Bay. These high value food resources have declined abruptly since 1991 despite efforts to ban highly efficient and destructive fishing gears such as the giant filter net ("sanggab") and motorized scissor net ("sudsud"). Unregulated catching of the mangrove crab or "alimango" remains unabated - an alarming situation engendered by increasing number of very efficient and specialized gears for crab collection. Despite all these, the "alimango" fishing industry in the inner part of Panguil Bay is still thriving as export of this resource from the bay continues through the local market chain, providing a major source of livelihood for many fishers in the inner part of the bay.

The substantial decline in bivalve production since its 1995-96 level is largely due to the reduced abundance of three species, namely, *Donax sp, Modiolus metcalfei,* and *Katylesia hiantina.* Landed catch of the hard clam *Meretrix meretrix,* however, increased slightly in 2005, probably due to improved recruitment as evidenced by the abundance of juveniles in Darumawang, Lala and Raw-an Pt, Baroy. Coastal residents of Raw-an Pt. reported on mass mortalities of *K. hiantina* and *M. meretrix*. Participatory conservation and management measures have been implemented in 2005 in some parts of the bay, such as in the coastal barangays of Darumawang, Camalan, and Raw-an Point.

Transplantation of bivalve juveniles, effort control, regulation of gathering bivalves, and the establishment of an "amahong" sanctuary in Darumawang are some of the communal efforts to sustain the bivalve fishery in Panguil Bay.

Changing trends in catch rates

With the exception of filter net ("sanggab") and traditional fish corral ("bungsod"), the catch rates of major fishing gears in Panguil Bay had progressively declined across time periods. The steepest decline was obtained by the stationary lift net ("new look") possibly due to the reduced catch of the anchovy, *Stolephorus commersonii*, and those of other schooling small pelagic fish (e.g. sardine). The scoop net, which obtained the highest CPUE among all the gears, is simply an accessory gear to gather the tiny "agihis" which formed the bulk of bivalve catch. The high catch rate of filter net ("sanggab") and traditional fish corral in the present assessment is attributed to the large volume of the crustacean, *Varona literata* ("kamangkas"), recorded in July 2005 from Migpange. Moreover, the total landed catch of filter nets in 2005 is higher than in 1995-96, largely due to the abundance of the banana shrimp, *Metapenaeus ensis* ("bagal"), recorded in Raw-an Pt. It is also possible that the reduced number of filter nets (45) in 2005 as compared to that in 1995-96 (239) had improved the catches.

Biological Overfishing

The abundance of juvenile, sexually immature catches of sardines, anchovies, shrimps, and bivalves in 2005 suggests that many fish resources of Panguil Bay are biologically overfished. Growth overfishing (i.e., the catching of tiny or pre-adult fish) in sardine and anchovy is particularly alarming, as these fishes form the bulk of the small pelagic catch around the mouth of the bay. A worse scenario is seen in the catching of juvenile shrimps, namely, *Penaeus merguiensis, P. indicus* and *Metapenaeus ensis,* which were mostly sexually immature by highly efficient, fine mesh nets in the inner parts of the bay. The continued harvesting of small, juvenile organisms can severely threaten their future recruitment, and eventually, the sustainability of the bay's fishery resources.

MANAGEMENT IMPLICATIONS AND RECOMMENDATIONS

A decade after the last resource and ecological assessment in 1995-96, the fishery resources of Panguil Bay have declined in terms of volume and catch rates. The decline is primarily caused by high fishing effort, illegal and destructive fishing methods, such as dynamite fishing and the continued operation of filter nets. The degradation of the environment (e.g. mangroves being converted to fishponds and pesticides from fishponds dumped into the bay), compounded by the ever increasing number of people living on its resources, have also contributed to this decline. Results of the present study imply that there remains a great challenge to the national and local government, resource management organizations, and the fisherfolk communities to accelerate efforts to save the dwindling resources of Panguil Bay.

The fish resources of Panguil Bay have contributed enormously to income, employment, nutrition, and economic activities of the inhabitants around the bay. These resources, however, are continuously being reduced due to unregulated fishing, destruction of habitats, and the ever-increasing population dependent on the bay.

The following are some recommendations to properly conserve and manage the fish resources in Panguil Bay:

1. Implement all pertinent laws and ordinances regarding the proper use of the resources of the Bay as embodied in national legislations (i.e. Section 3, Local Government Code of 1991 or RA 7160; Philippine Fishery Code of 1998 or RA 8550).
2. Reactivate the dormant Panguil Bay Development Council to implement appropriate conservation and management of the bay's resources through a stronger political will among the concerned government officials to effect change in the present mode of environmental governance.
3. All concerned agencies within the LGUs should prepare feasibility studies on value-added post-harvest initiatives for the exploited resources in the bay, including approaches to optimize their utilization the whole year round and the infrastructure needed (e.g. ice plants, processing plants, etc.).
4. Plan and implement an efficient marketing scheme for harvested bivalve resources.
5. Implement more strictly regulated harvesting of "alimango" and bivalves, particularly of juvenile or pre-adult populations.
6. Provision of viable alternative livelihood for fishers as an adaptation measure against diminishing fish resources.

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