A Survey of Macro-invertebrate Gleaning in the Banate Bay Intertidal Area, Eastern Panay Island

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ABSTRACT

The gleaning fishery on the intertidal areas of Banate Bay, eastern Panay was surveyed monthly from February 2002 to January 2003, to derive information on species composition, catch, catch rates, and annual value. Total biomass, gleaning and turnover rates were determined from a fishery-independent survey conducted in June 2005. Catches of the fishery consisted of a total of 17 species, comprised of mollusks, crustaceans and a brachiopod. The bivalves *Katelysia hiantina, Scapharca inaequivalvis*, and *Gafrarium tumidum* were the top three species, together comprising 88.79 % of the total catch. The total mean daily catch per gleaner for all species was equivalent to 73.75 g/m^{-2}/gleaner^{-1}. Catch rate and catch volume for the mollusks were highest between May-July and November-December, coinciding with the southwest and northeast monsoons, respectively. The large riverine inputs to the area, together with the mangrove-derived organic matter, periodically resuspended by the tidal fluctuations, are seen as responsible for increasing organic matter content of the substrates and abundance of the species. Total annual catch of the fishery is estimated to range from 20,988.7 to 43, 527.62 kg, with a median value of 31,205.6 kg. This latter value divided by the estimated total biomass in the area of 2,441. 03 kg gives a turnover rate of 12.8. The total annual catch for the entire fishery is equivalent to a total value of PhP 421T to 897T/yr^{-1}. The latter correspond to an annual income of PhP 14,043.90 to 29,904.67/gleaner^{-1}/yr^{-1}, small amounts which may be sustainable due to the high turnover rate of the system.

Keywords: Gleaning, benthos, species composition, catch, catch rates, biomass, turnover rate

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INTRODUCTION

Macro-invertebrates make up a significant portion of different kinds of fisheries in the country. Many of them are commercially important species (del Norte-Campos et al. 2000), that have become the target of many fishing gears such as the trawl (del Norte-Campos et al. 2003a). One of the most important methods of gathering invertebrates is gleaning on intertidal areas. Gleaning on these highly-accessible fishing grounds is a form of fishing requiring the least of implements, and as such, is a highly favored fishing method for coastal communities. Despite its importance, there is a general lack of information in the country on this type of fishing method except for the works of de Guzman (1990) on the reef flats of Bolinao, Pangasinan, Schoppe et al. (1998) on the Cuatro Islas, Leyte and del Norte-Campos et al. (2003a) on Malalison Island, Antique. These papers cover areas that are on or contiguous with coral reefs. However, aside from reefs, gleaning is also conducted in other types of habitats, such as sandy-muddy intertidal areas with nearby mangrove stands. Further, gleaning can also be of two types: 1) general, where species are collected as encountered, and 2) specific, where there is/are certain target species.

One example of a gleaning fishery on sandy-muddy intertidal (non-reef) areas is that existing on Banate Bay, eastern Panay Island, which has not been documented at all. This paper aims a) to characterize the general gleaning fishery on the sandy-muddy intertidal zone of Banate Bay in terms of species composition, volume of catch (kg) by species, and catch rate (kg/gleaner/hr), and b) to derive preliminary estimates of biomass (kg/km^2) and gleaning rate. Gathering these baseline data is the first step in formulating proper utilization guidelines to ensure sustainable harvesting of the resources.

MATERIALS AND METHODS

The study was conducted for one year, from February 2002 to January 2003, on the intertidal areas of Bgy. Tinurian, Banate Bay, eastern Panay Island (Fig. 1). The area is fully exposed during ebb tides and inundated at high tide. The seaward part of the area has a predominantly sandy substrate, interspersed with small to medium-sized rocks and boulders. The landward part which has a muddy substrate, is bordered with mangroves particularly *Sonneratia alba, Avicennia rumphiana* and *Rhizopora apiculata*.

The monthly gleaning fishery survey consisted of following/accompanying 3-4 gleaners at work for the purpose of determining the total area covered by each gleaner. Gleaning by the observed group was observed to be restricted to a very specific area, i.e. in the remains of what used to be a fishpond dike with measurable dimensions of about 900 x 10 m. The gleaners in the area usually work in groups that pool their catches at the end. From these pooled catches, species composition, along with numbers and weight (kg) of the catch by species were determined. Type specimens were also collected and brought to the laboratory for proper identification, using FAO (1978) as basis, except for one crab species which was sent to the National Museum, Carcinology Division. Data collection was supplemented with informal interviews with gleaners, specifically to gather information on gleaning practices, gleaner profiles and markets for species. Prices for each species were determined by getting the corresponding weights (in kg) of piles ("tumpok"), normally used in selling.

To determine biomass, (B_S) a fishery-independent sampling was conducted in June 2005. All the macroinvertebrate biota from a total of 15 2 x 2 m quadrats (4 m^2), dug 5-6 inches into the sand/mud were sampled and sorted. The quadrats were laid in 4 transect lines parallel to the general orientation of the gleaned area, with 1 line (Transect 4) located 3-5 m *away* from the remains of the dike, and the other 3 lines (Transects 1-3) located *within* a 5-10 m belt covering the entire length of the remains of the dike. The biota were sorted into species and weighed. The total gleaning area was measured with the use of a GPS. During this sampling date, the catch (C_S in g/m^{-2}) of the gleaners was also averaged and then divided by the mean biomass (B_S in g m^2) taken from the quadrats to estimate gleaning rate (GR in %).

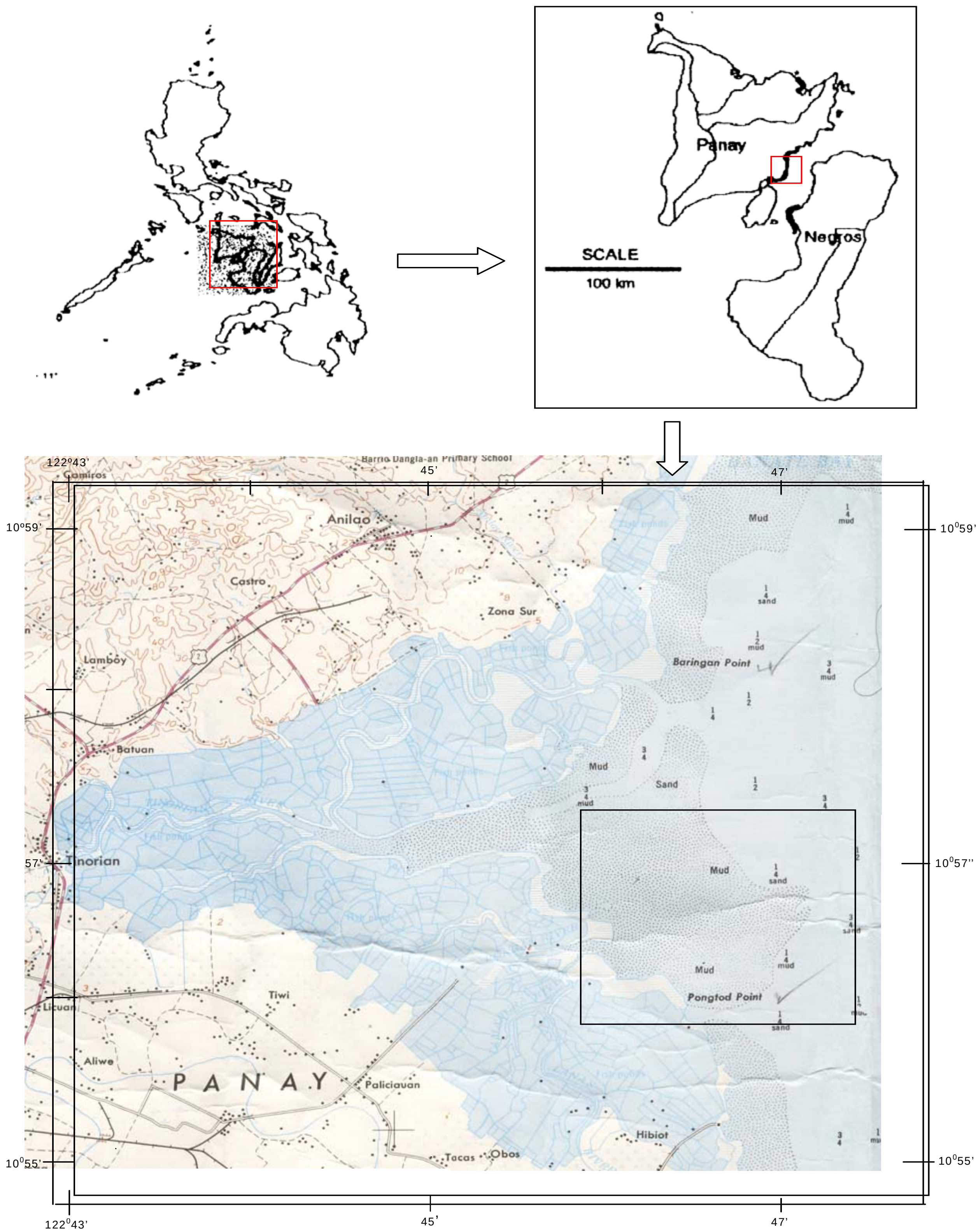

Figure 1. Map showing the study area, sandy-muddy flats of Banate Bay (inset).

Volume of the catch (g/m^{-2}/gleaner^{-1}) was computed by month and averaged for the entire year by species. Individual mean catches by species were summed to get the mean catch (C_F in g m^{-2} gleaner^{-1}) over the year. Species importance was then based on the corresponding percentages of the mean daily catch volume values. The mean annual standing stock (B_{ANN}) was computed by dividing the mean catch (C_F) computed from the fishery by the gleaning rate (GR). This resulting (B_{ANN}) value was multiplied by the area of gleanable habitat (A in m^2) to get the total biomass (B_{TOT} in kg). Total annual catch (C_{TOT} in kg) was derived by multiplying the mean catch (C_F) per gleaner with the number of gleaners in the area, the number of gleaning days over the entire year and the area covered per gleaner. The estimated total annual catch (C_{TOT} in kg) was then divided by the total biomass (B_{TOT} in kg) to get the turnover rate (T).

Total annual catches (kg) per species were multiplied with the corresponding selling price (PhP kg^{-1}) to derive the total annual value (PhP) by species. Total annual value (PhP) was then derived by adding the total annual values (PhP) for all species. Catch rates (kg/gleaner^{-1}/hr^{-1}) of the most abundant group were also plotted against months.

RESULTS

Gleaning Practices/Profile

Gleaning in Banate comes in two forms: general and specific. The latter involves collection primarily of the small short razor clam *Azorinus abbreviatus*, which is mostly found in the muddy substrates of the mangrove areas. Both forms of gleaning on the Banate intertidal flats are conducted daily, during daytime low tide, i.e. when the area is either partially or fully exposed. The gleaners are usually entire families, consisting of the father and mother, in general ranging from 30-50 yrs. old, as well as their children usually in their early teens. They are mostly residents of Bgy. Tinurian, Barotac Nuevo, Iloilo, from where they usually travel on non-motorized boats down the river to the gleaning site, a distance requiring a travel time of ~1 hr. For most of these groups, gleaning is the main source of livelihood, although usually supplemented with fishing in the river for shrimps and crabs, using net traps.

Species Composition and Importance

A total of 17 species was recorded during the survey (Tab. 1). Mollusks constituted the most abundant group with 13 species (12 bivalves and 1 gastropod), whereas the rest of the catch was composed of 3 crustacean species, and 1 brachiopod. The top three species are the hiant venus *Katelysia hiantina* ("punaw"), the inequivalve ark *Scapharca inaequivalvis* ('litob"), and the tumid venus *Gafrarium tumidum* ("bug-atan"), together comprising 88.79% of the total catch volume. Aside from these three, other bivalve species likewise gathered were the rock edible oyster (*Crassostrea echinata*), small short razor (*Azorinus abbreviatus*), the boxlike tellin (*Merisca capsoides*), the decussate ark (*Barbatia foliata*), the granular ark shell (*Anadara granosa*), the pill ark shell (*A. pilula*), the mussels *Perna viridis* and *Modiolus metcalfei* and the Japanese dosinia (*Dosinorbis japonica*). These species belong to 6 bivalve families namely, Veneridae (3 spp.), Arcidae (4 spp.), Mytilidae (2 spp.), and 1 species each for Family Solecurtidae, Ostreidae, and Acropagiinae. Aside from the bivalves, the three species of crabs (Malacostraca: Decapoda) represented in the catch were, the blue swimming crab *Portunus pelagicus*, the crenate swimming crab *Thallamita crenata* and the eriphiid stone crab *Ozius rugulosus*. The dog conch *Strombus canarium* (Gastropoda), as well as the lamp shell *Lingula unguris* of Phylum Brachiopoda make up the rest of the catch.

Catch Rates, Volume and Annual Value

Catch rates of the most abundant group (mollusks) showed the highest values in April, July, and November 2002 and January 2003 (Fig. 2). Mean catch rates for the individual species likewise follow the trend shown by species importance. Thus, catch rates for the top three species were also the highest, namely: *K. hiantina* = 0.548 kg/hr, *S. inaequivalvis* = 0.366 kg/hr, and 0.193 kg/hr for *G. tumidum.*

Trends in the catch volume of the abundant group (Fig. 3) appear to coincide with those of the catch rates (Fig. 2), i. e., values were higher between May-July 2002 and also between November 2002 and February 2003.

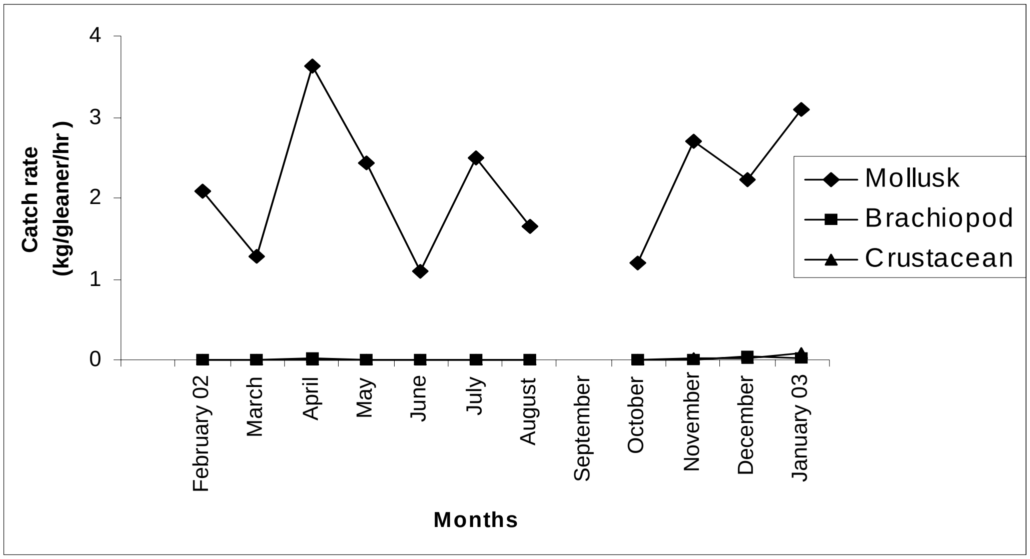

Figure 2. Catch rate (kg/gleaner/hr) of the most abundant groups gleaned on the intertidal areas of Banate Bay, February 2002 to January 2003.

There are reportedly 40 gleaners in the area, although it is unlikely that all of them are always active. Thus, the annual catch (C_{TOT}) ranges from 20,988.7 kg for 20 gleaners and 264 days of gleaning to a maximum of 43,527.62 kg for 30 gleaners and 365 days. The median value of 31,205.6 kg is taken to be the most reasonable estimate of annual catch. Most of the 14 species have commercial value, whereby the prices are higher when sold in the city (Tab. 2). This is especially the case for *A. abbreviatus*, thus explaining the existence of the specific type of gleaning primarily for this species. The total annual value of the annual catch is equivalent to PhP 421,047.11 when species are merely sold in the barangay, and PhP 897,140.00 when sold in the city. If computed for a total of 30 gleaners this brings a total annual income of PhP 14,034 gleaner^{-1} yr^{-1} and PhP 29,904.67 gleaner^{-1} yr^{-1}, respectively.

Gleaning Rate, Biomass and Turnover Rate

The gleaning survey showed that the mean overall biomass (BS) estimates are more consistent when only 12 out of the 15 quadrats are taken (Table 3). The 12 quadrats are those situated within the dike remains (Transects 1-3) or the ones that are truly representative of the biomass of the gleaned area, as this is where gleaning is mostly confined. Using the mean biomass (38.38 g m-2) from these 12 quadrats, the estimated gleaning rate (GR) is 62.7% (Tab. 4). At this rate, the total biomass (B_{OTT}) is estimated to be 2,441.03 kg. Using the median annual catch value (C_{TOT}) of 31,205.6 kg, the turnover rate (T) is 12.8.

DISCUSSION

The importance of gleaning in the country has generally been underestimated (Schoppe et al., 1998). This is due to several factors, foremost of which is the difficulty in monitoring catches in such non-organized artisanal fisheries (Lopez 1986), and the generally lower regard for invertebrates which form the bulk of the catches in this type of fishing. However, this form of fishing being highly accessible and of low capital investment (McManus 1989) may actually play a bigger role in the livelihood of fishers considering the decline of most artisanal/municipal fisheries in the country (Campos et al. 2002; Barut et al. 2004).

Species Composition

The mollusks, specifically bivalves, dominate the catch of the gleaning fishery in the Banate sandy intertidal areas, as these represent a more suitable habitat for these burrowing and suspension-feeding species. *Azorinus abbreviatus,* on the other hand, is largely

Table 1. Species composition of gleaned macro invertebrates ranked according to mean catch (g/m2/gleaner) in Banate Bay, eastern Panay, sampled from Feb 2002-Jan 2003. (Identification and names of most species were based on FAO, 1998).

	Species			Mean catch	
	Scientific Name	Common Name	Local Name	(g/m^2 gleaner)	%
1.	*Katelysia hiantina* (Mollusca: Bivalvia)	Hiant Venus	"punaw"	31.74	43.04
2.	*Scapharca inaequivalvis* (Mollusca: Bivalvia)	Inequivalve Ark	"litob"	22.82	30.94
3.	*Gafrarium tumidum* (Mollusca: Bivalvia)	Tumid Venus	"bug-atan"	10.92	14.81
4.	*Crassostrea echinata* (Mollusca: Bivalvia)	Rock Edible Oyster	"sisi"	2.44	3.31
5.	*Azorinus abbreviatus* (Mollusca: Bivalvia)	Small Short Razor	"tikhan"	1.50	2.03
6.	*Merisca capsoides* (Mollusca: Bivalvia)	Boxlike Tellin	"agrutan"	1.49	2.02
7.	*Barbatia foliata* (Mollusca: Bivalvia)	Decussate Ark	"kiwi-kiwi"	1.30	1.76
Crabs *(Crustacea: Malacostraca):*				0.53	0.72
8.	*Portunus pelagicus*	Flower Crab, Blue	"kasag"		
9.	*Thallamita crenata*	Crenate Swimming Crab	"dawat"		
10.	*Ozius rugulosus*	Stone Crab	"kumong"		
11.	*Lingula unguris* (Brachipoda)	Lamp Shell	"ugpan"	0.29	0.39
12.	*Strombus canarium* (Mollusca: Gastropoda)	Dog Conch	"sikad"	0.22	0.30
13.	*Anadara granosa* (Mollusca: Bivalvia)	Granular Ark Shell	"bacalan"	0.18	0.25
14.	*Anadara pilula* (Mollusca: Bivalvia)	Pill Ark Shell	"litog-litog"	0.10	0.14
15.	*Modiolus metcalfei* (Mollusca: Bivalvia)	Yellow-banded Horse Mussel	"bahong"	0.09	0.12
16.	*Dosinorbis japonica* (Mollusca: Bivalvia)	Japanese dosinia	"agihis"	0.08	0.11
17.	*Perna viridis* (Mollusca: Bivalvia)	Asian Brown Mussel	"green shell"	0.05	0.07
			TOTAL(C_F)	**73.75**	**100.00**

limited to the mangrove areas, thereby preferring the muddy/silty substrate type. This species thus shares the same habitat and habit as the mud clam *Anodontia edentula* (Primavera et al. 2002). In these intertidal areas as in others, distribution of species is closely correlated with substrate characteristics and variability, as well as the dominant vegetation (de Guzman 1990). The relationship of species distribution to the observed distribution patterns can further be elucidated by zonation studies. Compared to the species composition of gleaned species on the Malalison reef flats in Antique where gastropods predominate (del Norte-Campos et al. 2003a), the burrowing habit of the bivalves is appropriate in the Banate intertidal areas which are openly subjected to tidal exposure. The Malalison gastropods on the other hand, are able to take shelter provided by the existing coral cover.

The blue swimming crab *Portunus pelagicus* is poorly represented in the catch, as it is caught more by traps and trawl (del Norte-Campos et al. 2004), than by gleaning. The ones found here are smaller-sized juveniles, utilizing these shallower areas as nursery grounds. *Lingula unguris* ("ugpan"), the brachiopod, turns out to be a commercially important species in Panay: it was seen sold in markets, e.g. Pontevedra, Capiz (del Norte-Campos et al. 2000), and also harvested in Malalison Island (del Norte-Campos et al. 2003b). More are however, caught in Capiz since the species is usually found along river bank systems

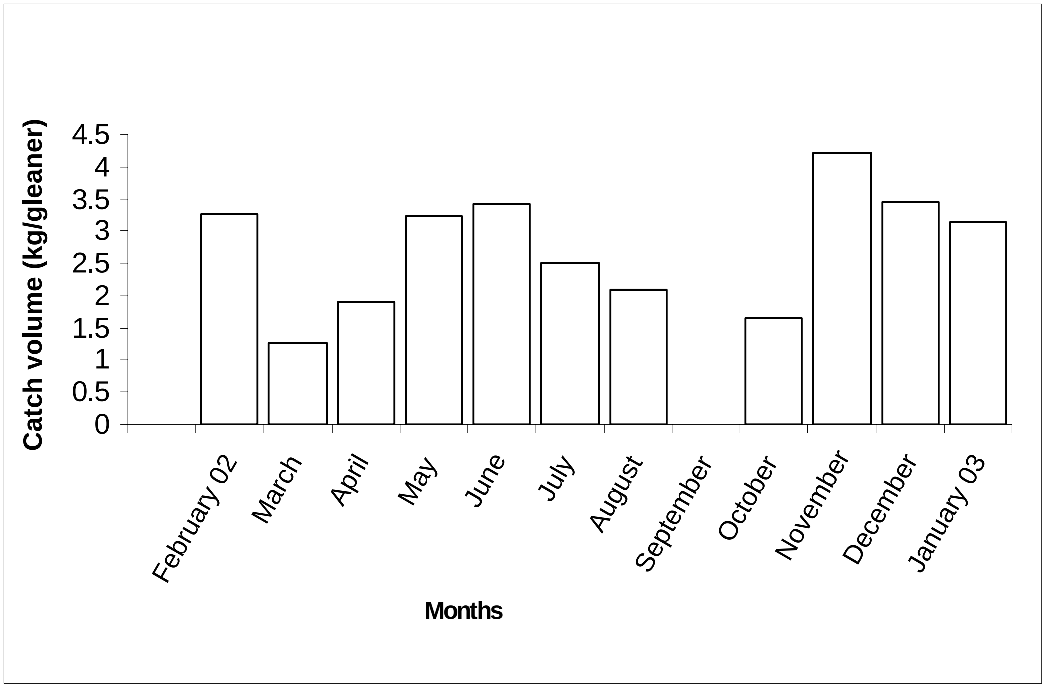

Figure 3. Volume of catch (kg gleaner-1) of the most abundant group (mollusks) on the intertidal

Table 2. Total annual catch (kg), price (PhP/kg) when sold in the barangay and in Iloilo City by species, and total annual value (PhP) of gleaned macro-invertebrates from the intertidal flats of Tinurian, Banate Bay, eastern Panay.

Species	Total Annual catch (kg)	Price (PhP/kg^{-1})		Total Annual Value (PhP)	
		Bgy.	City	Bgy.	City
1. *Katelysia hiantin*	13,430.48	15.00	40.00	201,457.20	537,219.20
2. *Scapharca inaequivalvis*	9,655.55	13.00	30.00	125,522.15	289,666.50
3. *Gafrarium tumidum*	4,621.04	8.00	A	36,968.32	-
4. *Crassostrea echinata*	1,031.35	18.00	30.00	18,564.30	30,940.50
5. *Azorinus abbreviatus*	632.86	20.00	60.00	12,657.20	37,971.60
6. *Merisca capsoides*	630.39	B	B	-	-
7. *Barbatia foliata*	550.47	13.00	A	7,156.11	-
8. *Portunus pelagicus*	224.12	60.00	B	13,447.20	-
9. *Thallamita crenata*		B	B		-
10. *Ozius rugulosus*					
11. *Lingula unguris*	121.43	20.00	A	2,428.60	-
12. *Strombus canarium*	94.69	B	B	-	-
13. *Anadara granosa*	77.70	18.00	A	1,398.60	-
14. *Anadara pilula*	42.31	15.00	A	634.65	-
15. *Modiolus metcalfei*	36.71	13.00	A	477.23	-
16. *Dosinorbis japonica*	34.12	C	C	-	-
17. *Perna viridis*	22.37	15.00	60.00	335.55	1,342.20
TOTAL	**31,205.60 (C_{TOT})**			**421,047.11**	**897,140.00**

A = not sold in the city
B = not sold due to low abundance
C = not eaten

Table 3. Biomass estimates (g/m^{-2}) from the quadrats sampled along 4 transects during the fishery-independent survey on the gleaned intertidal area in Tinurian, Banate Bay, June 2005.

Quadrat No.	Biomass (g m^{-2}) Transects				Overall Mean Biomass (g m^{-2})	Overall Mean Biomass (B_S) (g m^{-2})
	1	**2**	**3**	**4**		
1	17.8	20.5	28.1	4.7		
2	8.5	23.5	13.7	2.3		
3	34.7	99.4	49.0	4.6		
4	110.1	19.9	35.4	-		
					Transects 1-4	Transects 1-3
Mean	42.75	40.79	31.56	3.87	**31.47**	**38.38**
SD	46.17	39.13	14.73	1.32	**32.5**	**31.52**
N	4	4	4	3	**15**	**12**

In addition, catches of some species have been noted to dwindle over the years. Foremost of these species are the windowpane shells *Placuna sella* and P. placenta, which used to be abundant in the area. Nowadays, *P. sella*, locally known as "bay-ad" is still collected in Banate Bay and in northeastern Panay (Declarador & del Norte-Campos 2004) but primarily through compressor diving in subtidal areas. *P. placenta* on the other hand, has not been observed in any part of Panay, although SEAFDEC has had restocking efforts for this species in some parts of Panay.

Species Value

Marketing of the species in the city is dictated by two factors, namely: market appeal and abundance. The higher price of the small short razor *A. abbreviatus* ("tikhan") in the city explains the existence of specific gleaning for this species. According to the gleaners, higher prices for this species in the city are best achieved when they are peddled to the Chinese who favor them more. Due to the lower catches of blue crabs, on the other had, they are not sold anymore in

Table 4. Data parameters, formula input values and computations to calculate the turnover rate (T).

Parameters	Input Values	Remarks
Mean catch (CF)	73.75 g m-2 gleaner-1	(see Tab. 1)
Total annual catch (CTOT)	31,205.6 kg.	(see Tab. 2)
Mean Biomass (BS)	38.38 g m-2	(see Tab. 3)
Area of gleaning habitat (A)	20,753.5 m-2	(actual measure using a GPS)
Mean catch (CS)	24.07 g m-2	(observed and computed)

Computations

Gleaning rate (GR)	=	C_S/B_S
	=	24.07 g m^{-2} / 38.38 g m^{-2}
GR	**=**	**0.627 or 62.7%**
Mean annual biomass (B_{ANN})	=	C_f/GR
	=	73.75 g m^{-2} gleaner^{-1}/0.627
(B_{ANN})	**=**	**117.62 g m^{-2}**
Total Biomass (B_{TOT})	=	B_{ANN} X A
	=	117.62 g m^2 X 20,753.5 m^2
(B_{TOT})	**=**	**2,441,026.6 g or 2,441.03 kg**
Turnover Rate (T)	=	C_{TOT}/B_{TOT}
	=	31,205.6 kg/2,441.03 kg
(T)	**=**	**12.8**

the city. In addition, due to the low quantities of the ark shells *Anadara pilula* and *A. granosa*, they are in practice mixed with *S. inaequivalvis* when sold and thus, prices shown here are if and when sufficient quantities of the 2 species are available.

Biomass and Turnover Rates

Though the gleaners claim that there are no seasons in the catches, it appears that there are two periods with higher catch rates and resultant catches. These higher catches can be attributed to the higher abundances of the species. The two peaks in the volume of the catch and catch rates for the top three species may be related to their reproductive cycles. For *Scapharca inaequivalvis*, for example, the two observed peaks in Aug 2002 and Jan 2003 coincide with what has been reported as the main periods of gonad activity of the species in the area (Ledesma-Fernandez & del Norte-Campos 2004). Gonad activity was correlated with the monsoon periods, especially the southwest monsoon that coincides with the rainy months and thus, higher levels of terriginous inputs and food.

The biomass and resulting turnover rate estimates are here considered preliminary until a more extensive survey over a longer duration can be conducted. Just the same, how meaningful is a gleaning rate of almost 13 x that translate to a biomass replenishment (i.e. turnover) of about a month? Although this turnover rate appears to be high, such rates may be possible considering factors such as the inherent location of the area and the high growth rates of tropical mollusks, which make up the bulk of the catches. These intertidal areas are subjected to periodic tidal fluctuations that serve to provide the means to transport and distribute a high organic load from the bordering mangrove areas, as well as the adjacent river system (Odum 1968). The growth rate of the ark shell *S. inaequivalvis,* one of the top two species of the harvested bivalves in the area, for example, has been initially estimated to be 0.21 mm day-1(del Norte-Campos & Villarta, unpubl.), a rate consistent with high turnover rates, esp. when considered that the species matures at small sizes (Ledesma-Fernandez & del Norte-Campos 2004), and thus at a young age. In a study on the snail *Telescopium telescopium*, the similar organically-enriched fishpond environments were pointed out as responsible for an even higher growth rate of 0.69 mm day^{-1} (del Norte-Campos et al. 1998), thus making the derived turnover rates quite possible. Thus the estimated turnove rate indicates a stronger trend towads the sustainability of these gleaned resources.

Together with the present study, more studies on the reproduction and feeding patterns of these species, as well as the ecological impact of this activity are clearly necessary. Above all, there is a need to examine the growth of organisms in more detail, and to derive seasonal estimates of biomass and gleaning rates.

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