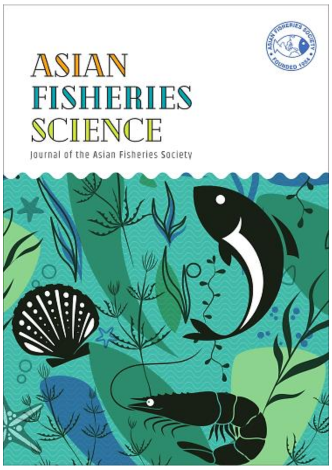

Reassessment of the Mollusc Gleaning Fishery in Malalison Island, Antique Province, West Central Philippines

KAREN VILLARTA*, ANNABELLE GLENDA DEL NORTE CAMPOS, LORELIE BURGOS-NUÑEZA
Division of Biological Sciences, College of Arts and Sciences, University of the Philippines Visayas, Miagao, Iloilo 5023, Philippines

*E-mail: kavillarta@up.edu.ph | Received: 22/05/2021; Accepted: 31/08/2021

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Abstract

Gleaning activity in Malalison Island in Culasi, Antique, Philippines, was revisited and monitored monthly from May 2018 to April 2020 to compare with results from a previous investigation in 2003. Overall, slight differences were noted in the daily catch, effort, and catch rates between 2003 and 2020, whereas substantial differences were observed in the monthly and annual catches. A total of 26 species of molluscs were recorded, which was slightly lower than the previous number (= 30), dominated by the gastropods, *Nerita albicilla* Linnaeus, 1758, *Nerita polita* Linnaeus, 1758, *Canarium urceus* (Linnaeus, 1758), *Conomurex luhuanus* (Linnaeus, 1758), and *Angaria delphinus* (Linnaeus, 1758) which represented 79 % of the catch. The mean daily catch was 1.15 kg.gleaner^{-1} with catch rates ranging from 0.8 to 1.6 kg.day^{-1}.gleaner^{-1}, was slightly lower than the estimates in 2003 (0.9 to 2.5 kg.day^{-1}). The observed mean monthly catch (29.6 kg) was considerably higher than the 2003 estimate (6.1 kg), which subsequently resulted in a higher estimated annual catch (1,867–2,178 kg), value (USD2,352–2,783), and gleaner income (USD392–464) in 2020 compared to estimates in 2003. Despite the changes in the catch, effort, and value estimated for the gleaning fishery in the island since 2003, locals continue to supplement their household incomes through gleaning. Nonetheless, additional investigations into the reproductive and population biology of the different species may be needed to understand further the dynamics of this fishery and its impacts on the species' ecologies.

Keywords: gastropods, bivalves, catch composition, catch rate, intertidal

Introduction

Shallow reef flats, mudflats, and seagrass beds support a diverse group of invertebrates targeted by gleaners when exposed during low tides. Many coastal communities favour gleaning as a fishing method in various intertidal habitats. Gleaning does not require expensive or elaborate gear and the people involved are mostly women and children. Gleaning may either be general, where gleaners collect whatever catch is encountered, or specific, where gleaners target certain species (del Norte-Campos et al., 2005). While most gleaners target macroinvertebrates which are usually dominated by molluscs such as bivalves and gastropods (del Norte-Campos et al., 2003, 2005; Nieves et al., 2015; Furkon et al., 2019), others may specifically collect echinoderms, especially sea cucumbers (Schoppe, 2000; Conand and Muthiga, 2007; Choo, 2008; Garciano, 2013; Tanduyan et al., 2013). In the Philippines, many of these gleaned macroinvertebrates are commercially important species (del Norte-Campos et al., 2000, 2019) and several are regular entities in markets and restaurants. Despite this, most of the gleaning activities in the Philippines remain undocumented, resulting in an obvious lack of information about gleaning practices and very little fisheries catch data reported in the country (Palomares et al., 2014a). The role of women in this fishery sector, which is disproportionately high in many parts of the world, is also often overlooked (Chapman, 1987; Harper et al., 2013; Kleiber et al., 2014; Al Rashdi and McLean, 2014; De Guzman et al., 2019;

Furkon et al., 2019). Studies in the Philippines remain rare, incomplete, or rather outdated. The few published records on these activities include those observed in the islands off the shore of Inopacan, Leyte (Schoppe et al., 1998), the intertidal reef flats of Malalison Island in Antique (del Norte-Campos et al., 2003), the muddy to sandy flats in Banate Bay, Iloilo (del Norte-Campos et al., 2005), the seagrass meadows in Eastern Samar (Ciasico et al., 2006), and the coastal sites of Lagonoy Gulf on the Albay side (Nieves et al., 2010) and the Catanduanes side (Nieves et al., 2015).

In Malalison Island in Antique, gleaning has long been a tradition of many locals. Although gleaning is carried out mainly for personal consumption, these activities also support households by providing a supplementary income (De Guzman et al., 2019). Based on an earlier study (del Norte-Campos et al., 2003), catches from gleaning on the island consist mainly of gastropods which are either sold for a low price or consumed by households. In recent years, the island has gained popularity and has become a popular island destination for tourists. As such, many members of the community have shifted from regular fishing to tourism. Some boats are now used to carry tourists to, from, and around the island and several houses converted to homestay accommodations.

Given these changes in the locals' daily activities, this study reassessed the gleaning fishery in the intertidal reef flat in Malalison Island, Antique previously investigated by del Norte-Campos et al. (2003). This recent assessment allowed for updating fishery profiles, fishing effort, catch composition, catch rates, and estimates of catch volume and annual value and provided a comparison of the gleaning fishery status on the island between 2003 and 2020. In addition, this study highlighted the importance of gleaning in the locals' livelihood, especially in poor fishery households. Gleaning is a readily accessible source of income and, considering the little investment required, the income can still be significant even if little money is earned.

Materials and Methods

The study site was on Malalison Island, located off the coast of Culasi, Antique, west-central Philippines (Fig. 1). The island, which has a total land area of 65 ha (Amar et al., 1996), is surrounded by fringing reefs and has intertidal flats with sandy-coralline substrates. Monthly catch monitoring was conducted for a period of two years, from May 2018 to April 2020.

Gleaners from Malalison Island were interviewed in February 2018 to get a preliminary update on the status of the mollusc fishery in the area. A general fishery profile was constructed from the interviews and included a number of gleaners, species gleaned and their corresponding price, and duration and frequency of gleaning. A field assistant was hired to record the daily catch of representative gleaners from the area. Catch data of gleaned species were logged daily from

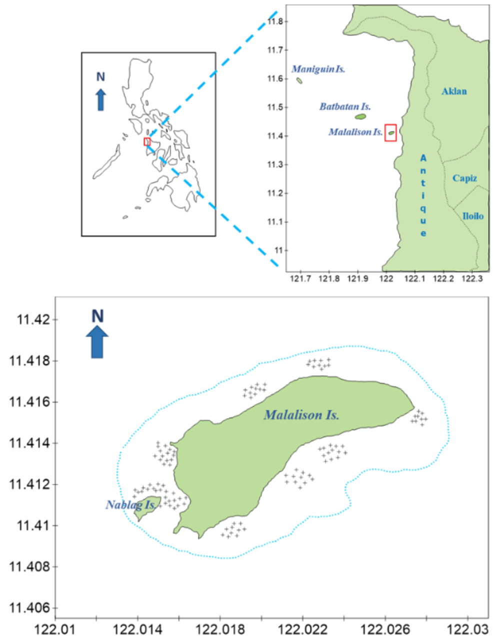

Fig. 1. Map showing the location of Malalison Island in Culasi, Antique, west central Philippines.

a fixed number (five) of regular gleaners for two years. These five gleaners, all women, were consistently monitored daily and if any of them did not go out to glean on a certain day, a corresponding note would be written in the field assistant's logbook to indicate why. The total number of gleaners who went out to glean was recorded daily. Gleaners' data consisted of their total daily catch (kg) by species, the number of hours spent gleaning (fishing effort), and the site on the island where the gleaning was conducted. These data were analysed to attain values for overall mean daily catch (kg), mean fishing effort (gleaning hours in a day and gleaning days in a month), and mean catch rate (kg.h^{-1}) per gleaner. The mean monthly catch (kg.mo^{-1}) was computed by multiplying the mean daily catch (kg.day^{-1}) by the number of days gleaned per month. The total monthly catch (mean daily catch per species × no. of gleaners × number of days gleaned per month and summed for all species) was computed for each year to derive estimates of the total annual harvest (kg.yr^{-1}). These were then multiplied by the price per kg to estimate the annual cash value of the entire catch for each year on the island. The annual value was divided by the total number of gleaners on the island to calculate the annual income per gleaner. In addition, the daily catch value was computed to illustrate how much the daily gross income (DGI = daily catch rates per species × price of the species per kilogram) of gleaners varied within months and across months in a year.

Results

Species composition and relative importance

A total of 26 molluscs (Table 1), consisting of 19 gastropods (73 %), 6 bivalves, and one cephalopod, were recorded in the gleaning catch on the island during the study period. It is important to note that 12 out of the 30 previously reported species (see del Norte Campos et al., 2003) were missing in the present study, including eight gastropods, three bivalves, and one echinoderm. Nevertheless, six new species were recorded in the catch (Table 2). Of the 18 recurring species, the species identification of eight had changed, and the updated identifications were thus utilised in this study (see Table 2 for detailed notes on species composition and changes in species ID).

The current catch was dominated by gastropods (19 species), which represented 96.3 % (kg) of the total catch (see Table 1). The top five species were all gastropods and included the blotched nerite, *Nerita albicilla* Linnaeus, 1758, the polished nerite, *Nerita polita* Linnaeus, 1758, the black-lipped conch snail, *Canarium urceus* (Linnaeus, 1758), the strawberry conch, *Conomurex luhuanus* (Linnaeus, 1758), and the common delphinula, *Angaria delphinus* (Linnaeus, 1758). Based on the mean monthly catch (Table 1) these five gastropods comprised 79.2 % (kg) of the catch for all species combined. The dominant species *N. albicilla* (mean monthly catch = 8.32 kg) has overtaken the previously reported number one species *C. luhuanus* (mean monthly catch = 3.39 kg), which slipped to number four in terms of catch and species importance.

Of the 26 recorded species, only six were bivalves with a mean monthly catch of 0.91 $kg.mo^{-1}$ or 2.8 % (kg) of the total species catch (Table 1). These six bivalves were identified as the hiant venus clam, *Marcia hiantina* (Lamarck, 1818), the compact ark *Anadara compacta* (Reeve, 1844), the abraded tellin, *Scutarcopagia scobinata* (Linnaeus, 1758), the sharp razor clam, *Pharella acutidens* (Broderip & Sowerby, 1829), the mangrove clam, *Geloina expansa* (Mousson, 1849), and the blood cockle, *Tegillarca granosa* (Linnaeus, 1758). The latter three were new records in the catch, two of which, *G. expansa* and *T. granosa*, are not sold or are considered by locals as by-catch and contributed only 0.1 % of the total catch. In addition to gastropods and bivalves, gleaners in the island also collect the Philippine octopus, *Callistoctopus nocturnus* (Norman and Sweeney, 1997) (mean monthly catch = 0.18 kg), which is a new record in the gleaning catch composition on the island. Although this species is often caught at night with the aid of lamps or flashlights and triggered spear, a few individuals are caught (as gleaning by-catch) during daytime low tides.

The recorded number of gleaned species was higher in 2018 (max = 20 spp.) than in 2019 (max = 15 spp.). This also varied among months, with the lowest number of species recorded in July 2019 and the highest number of species recorded during the NE monsoon, particularly in November and December, of both years (Fig. 2).

Table 1. Overall ranking and importance of gleaned species based on mean monthly catch (kg) Malalison Island, Culasi, Antique from May 2018 to April 2020.

Class	Scientific name	Mean monthly catch (kg)	%
Gastropoda	*Nerita albicilla* Linnaeus, 1758	8.32	28.1
Gastropoda	*Nerita polita* Linnaeus, 1758	5.18	17.5
Gastropoda	*Canarium urceus* (Linnaeus, 1758)	4.83	16.3
Gastropoda	*Conomurex luhuanus* (Linnaeus, 1758)	3.39	11.5
Gastropoda	*Angaria delphinus* (Linnaeus, 1758)	1.72	5.82
Gastropoda	*Euprotomus aurisdianae* (Linnaeus, 1758)	1.16	3.91
Gastropoda	*Turbo chrysostomus* Linnaeus, 1758	1.15	3.88
Gastropoda	*Lambis millepeda* (Linnaeus, 1758)	1.05	3.55
Gastropoda	*Conus caracteristicus* Fischer von Waldheim, 1807	0.76	2.57
Gastropoda	*Monodonta confusa* Tapparone Canefri, 1874	0.51	1.74
Bivalvia	*Marcia hiantina* (Lamarck, 1818)	0.37	1.24
Bivalvia	*Anadara compacta* (Reeve, 1844)	0.25	0.84
Bivalvia	*Pharella acutidens* (Broderip & Sowerby, 1829)	0.19	0.66
Cephalopoda	*Callistoctopus nocturnus* (Norman and Sweeney, 1997)	0.18	0.60
Gastropoda	*Clypeomorus bifasciata* (G.B. Sowerby II, 1855)	0.12	0.41
Gastropoda	*Cypraea tigris* Linnaeus, 1758	0.09	0.32
Gastropoda	*Umbonium vestiarium* (Linnaeus, 1758)	0.09	0.32
Bivalvia	*Scutarcopagia scobinata* (Linnaeus, 1758)	0.07	0.24
Gastropoda	*Trochus maculatus* Linnaeus, 1758	0.05	0.15
Bivalvia	*Geloina expansa* (Mousson, 1849)	0.02	0.08
Gastropoda	*Distorsio anus* (Linnaeus, 1758)	0.02	0.07
Gastropoda	*Patelloida striata* Quoy & Gaimard, 1834	0.02	0.07
Gastropoda	*Conus litteratus* Linnaeus, 1758	0.02	0.05
Gastropoda	*Patelloida saccharina* (Linnaeus, 1758)	0.01	0.04
Bivalvia	*Tegillarca granosa* (Linnaeus, 1758)	0.003	0.01
Gastropoda	*Conus textile* Linnaeus, 1758	0.002	0.01
	Total	29.6	100.0

Table 2. Updates in species identifications (del Norte-Campos et al. 2020) between the current study and that of del Norte-Campos et al. (2003).

Group	Species identification		Common name
	Current study (Villarta et al.)	del Norte-Campos et al. (2003)	
Bivalvia	*Anadara compacta* (Reeve, 1844)	*Scapharca inaequivalvis* (Bruguière, 1789)	Compact ark
Gastropoda	*Angaria delphinus* (Linnaeus, 1758)		Common delphinula
Cephalopoda	*Callistoctopus nocturnus** (Norman and Sweeney, 1997)		Philippine octopus
Gastropoda	*Canarium urceus* (Linnaeus, 1758)	*Strombus urceus* (Linnaeus, 1758)	Black-lipped conch shell
Gastropoda	*Clypeomorus bifasciata* (G.B. Sowerby II, 1855)	*Cerithium* sp. (Bruguière, 1789)	Morus cerith
Gastropoda	*Conomurex luhuanus* (Linnaeus, 1758)	*Strombus luhuanus* (Linnaeus, 1758)	Strawberry conch
Gastropoda	*Conus caracteristicus* Fischer von Waldheim, 1807		Characteristic cone
Gastropoda	*Conus litteratus* Linnaeus, 1758		Lettered cone
Gastropoda	*Conus textile* Linnaeus, 1758		Textile cone
Gastropoda	*Cypraea tigris* Linnaeus, 1758		Tiger cowrie
Gastropoda	*Distorsio anus* (Linnaeus, 1758)		Common distorsio
Gastropoda	*Euprotomus aurisdianae* (Linnaeus, 1758)	*Strombus aurisdianae* (Linnaeus, 1758)	Diana conch
Gastropoda	*Lambis millepeda* (Linnaeus, 1758)		Millipede spider conch
Bivalvia	*Marcia hiantina* (Lamarck, 1818)	*Katelysia hiantina* (Lamarck, 1818)	Hiant venus clam
Gastropoda	*Monodonta confusa* Tapparone Canefri, 1874		Toothed top shell
Gastropoda	*Nerita albicilla* Linnaeus, 1758		Blotched nerite
Gastropoda	*Nerita polita* Linnaeus, 1758		Polished nerite
Gastropoda	*Patelloida saccharina* (Linnaeus, 1758)		Pacific sugar limpet
Gastropoda	*Patelloida striata* Quoy & Gaimard, 1834		Streaked limpet
Bivalvia	*Pharella acutidens** (Broderip & Sowerby, 1829)		Sharp razor clam
Bivalvia	*Geloina expansa** (Mousson, 1849)		Mangrove clam
Bivalvia	*Scutarcopagia scobinata* (Linnaeus, 1758)	*Tellina scobinata* (Linnaeus, 1758)	Abraded tellin
Bivalvia	*Tegillarca granosa** (Linnaeus, 1758)		Blood cockle
Gastropoda	*Trochus maculatus** Linnaeus, 1758		Maculated top shell
Gastropoda	*Turbo chrysostomus* Linnaeus, 1758	*Turbo chrysostoma* (Linnaeus, 1758)	Gold mouth turban
Gastropoda	*Umbonium vestiarium** (Linnaeus, 1758)		Common button top

*New record.

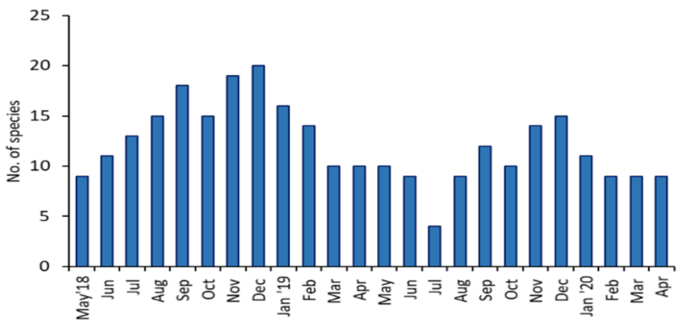

Fig. 2. Number of mollusc species collected by gleaners in Malalison Island, Culasi, Antique from May 2018 to April 2020.

Fishery profile

The gleaners in Malalison Island are mostly women (23 of 30 gleaners) who are homemakers not engaged in other fishing activities. Gleaners usually bring bolo knives to help collect molluscs and mesh bags, baskets, or buckets to store their catch. Diving goggles/lenses are sometimes used to collect in the deeper areas (2.5 to 3 m). In some cases, gleaners go out at night with the aid of a flashlight to collect the Philippine night octopus, *C. nocturnus*, along with a few other molluscs. However, the information for this catch was limited and therefore was not included in this study. Gleaning activities are conducted on the intertidal flats on the west-southwest and northern sides of the island, with minimal activities observed in the south and no seasonal shifts among gleaning sites.

Based on the preliminary interviews, there are 30 gleaners in the area, but based on the daily records, only 3–10 gleaners (mean = 6) go out to glean per day (Fig. 3). The mean number of gleaners per day was highest in December for both years (10 gleaners.day^{-1}). Gleaning was conducted for relatively consistent amounts of time, between 2.3 and 3.3 hours per day (mean = 2.9 ± 0.2 h.day^{-1}), but the number of gleaning days per month was variable, ranging between 18 and 31 (mean = 26 ± 3.3 days.mo^{-1}) depending on the duration of daytime low tides and favourable weather conditions (Fig. 4). The highest number of gleaned days were observed in August 2018 to January 2019 (26–30 days.mo^{-1}) and in April to May 2019 (30–31 days.mo^{-1}). The lowest numbers of fished days were recorded in June 2018 (18 days.mo^{-1}) and August 2019 (20 days.mo^{-1}). Although there was no clear seasonal pattern, gleaning days were relatively high during the NE monsoon (November to February) and low during SW monsoon (June to September).

Catch per unit effort and catch volume

Mean daily catches ranged from 0.81 to 1.59 kg.day^{-1}.gleaner^{-1} (mean = 1.15 kg.day^{-1} gleaner^{-1}) with fluctuations observed between months (Fig. 5). A similar pattern was observed in computed hourly catch rates (kg.h^{-1}gleaner^{-1}; Fig. 6). In Year 1 (May 2018 to April 2019) the peak catches were observed in May (0.70) and June (0.48 kg.h^{-1} gleaner^{-1}), with a minor peak in December (0.44 kg.h^{-1} gleaner^{-1}). In Year 2 (May 2019 to April 2020), the peaks were observed in August and September 2019 (0.50-0.52 kg.h^{-1} gleaner^{-1}). Low catch rates were observed in July (0.30 kg.h^{-1} gleaner^{-1}) in both years, although the lowest value (0.27 kg.h^{-1} gleaner^{-1}) was recorded in February 2020.

For both years, the total monthly catch (Fig. 7) was highest in December (December 2018 = 348.5 kg; December 2019 = 273.4 kg), which corresponded with the peak in the fishing effort both in terms of gleaning days and number of gleaners collecting molluscs per day (Figs. 3 and 4). The month of October was considered lean (October 2018 = 106.5 kg.mo^{-1}; October 2019 = 91.6 kg.mo^{-1}).

Annual harvest, value and income, and daily gross income

The gleaning record showed that a range of 3 to 10 gleaners (mean = 6) actively gleaned each day on the island. The total monthly catch was calculated as the mean number of gleaners multiplied by the mean daily catch and number of gleaning days. By taking the sums of the total monthly catches for Year 1 (Y1 = May 2018 to April 2019) and Year 2 (Y2 = May 2019 to April 2020) independently, the total annual catches for Y1 and Y2 were obtained. These translated to total annual catches of 2,178 kg for Y1 and 1,867 kg for Y2, which were equivalent to PHP133,002 (USD2,783) and PHP112,339 (USD2,350), respectively (exchange rate:

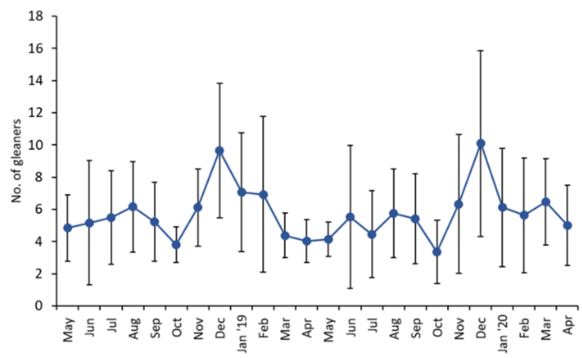

Fig. 3. Mean number of gleaners observed in Malalison Island, Culasi, Antique from May 2018 to April 2020.

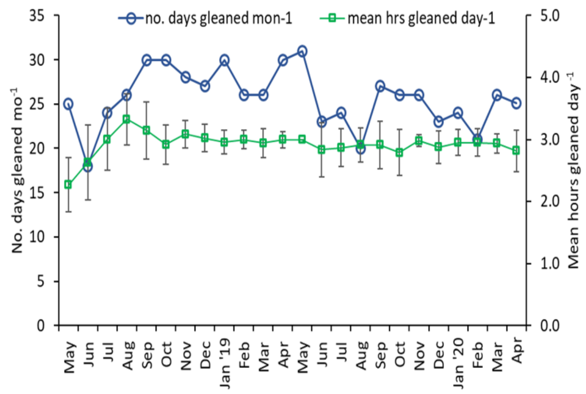

Fig. 4. Monthly mean fishing effort (days and hours) of gleaners in Malalison Island, Culasi, Antique from May 2018 to April 2020.

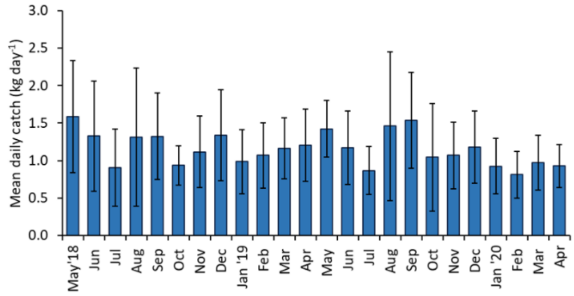

Fig. 5. Mean daily catch rates (kg.day-1 gleaner-1) of gleaned mollusc species in Malalison Island, Culasi, Antique from May 2018 to April 2020.

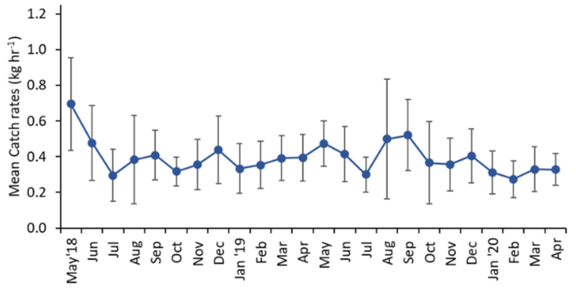

Fig. 6. Mean catch rates (kg.h-1 gleaner-1) of gleaned mollusc species in Malalison Island, Culasi, Antique from May 2018 to April 2020.

PHP1.0 = USD0.020921). As such, each gleaner earned an annual income of PHP22,167 (USD464) in 2019 and PHP18,733 (USD392) in 2020 (Table 3). The total annual catch, however, could potentially have been as high as 11,343 kg (PHP694,948 or USD14,539) in Y1 and 9,961 kg (PHP604,984 or USD12,657) in Y2, if calculated using the estimated total number of gleaners (30) on the island with an annual income of PHP23,165 (USD485) and PHP20,166 (USD422) gleaner^{-1}yr^{-1} for Y1 and Y2, respectively.

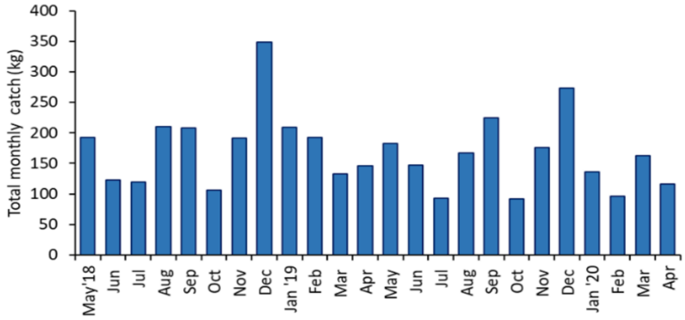

Fig. 7. Total monthly catch (kg) of gleaned mollusc species in Malalison Island, Culasi, Antique from May 2018 to April 2020.

Table 3. Annual catches (kg) and annual values (PHP and USD) of gleaned molluscs in Malalison Island Culasi, Antique, for the period between May 2018 and April 2020.

Species	Y1 Annual catch (kg)	Y2 Annual catch (kg)	Local price (PHP.kg^{-1})	Y1 Annual value (PHP)	Y2 Annual value (PHP)	Y1 Annual value (USD)	Y2 Annual value (USD)
Nerita albicilla Linnaeus, 1758	440.6	652.3	60	26,435.4	39,136.3	553.1	818.8
Canarium urceus (Linnaeus, 1758)	380.8	323.7	80	30,460.9	25,896.9	637.3	541.8
Nerita polita Linnaeus, 1758	385.3	312.6	60	23,116.1	18,757.1	483.6	392.4
Conomurex luhuanus (Linnaeus, 1758)	315.3	125.0	100	31,533.4	12,504.0	659.7	261.6
Angaria delphinus (Linnaeus, 1758)	120.5	122.3	20	2,410.3	2,446.8	50.4	51.2
Turbo chrysostomus Linnaeus, 1758	118.3	56.0	25	2,958.7	1,399.5	61.9	29.3
Euprotomus aurisdianae (Linnaeus, 1758)	92.3	58.7	20	1,846.7	1,173.7	38.6	24.6
Lambis millepeda (Linnaeus, 1758)	84.4	57.3	100	8,435.3	5,734.3	176.5	120.0
Conus caracteristicus Fischer von Waldheim, 1807	49.4	54.3	30	1,481.0	1,630.5	31.0	34.1
Monodonta confusa Tapparone Canefri, 1874	42.2	20.7	20	844.2	414.2	17.7	8.7
Marcia hiantina (Lamarck, 1818)	30.3	25.4	25	758.1	634.7	15.9	13.3
Anadara compacta (Reeve, 1844)	26.6	14.0	20	531.9	279.4	11.1	5.8
Pharella acutidens (Broderip & Sowerby, 1829)	17.6	11.9	25	439.8	298.3	9.2	6.2
Callistoctopus nocturnus (Norman and Sweeney, 1997)	0.6	23.5	80	48.4	1,882.4	1.0	39.4
Cypraea tigris Linnaeus, 1758	13.1	4.6	25	326.8	113.9	6.8	2.4
Clypeomorus bifasciata (G.B. Sowerby II, 1855)	14.3	1.8	25	356.5	45.4	7.5	0.9
Umbonium vestiarium (Linnaeus, 1758)	13.6	0.0	25	339.8	0.0	7.1	0.0
Scutarcopagia scobinata (Linnaeus, 1758)	11.7	0.0	25	292.2	0.0	6.1	0.0
Trochus maculatus Linnaeus, 1758	6.4	0.8	25	160.1	20.7	3.3	0.4
Geloina expansa (Mousson, 1849)	4.6	0.0		0.0	0.0	0.0	0.0
Distorsio anus (Linnaeus, 1758)	3.8	0.0	25	94.6	0.0	2.0	0.0
Patelloida striata Quoy & Gaimard, 1834	2.1	1.0	20	42.9	20.6	0.9	0.4
Patelloida saccharina (Linnaeus, 1758)	1.6	0.5	20	32.3	10.1	0.7	0.2
Conus litteratus Linnaeus, 1758	1.8	0.0	25	46.0	0.0	1.0	0.0
Tegillarca granosa (Linnaeus, 1758)	0.6	0.0		0.0	0.0	0.0	0.0
Conus textile Linnaeus, 1758	0.4	0.0	25	10.7	0.0	0.2	0.0
Total	2178	1867		133,002.1	112,398.8	2782.6	2351.5
Mean no. of gleaners				6	6	6	6
Annual income per gleaner				22,167	18,733	464	392

Y1 = May 2018 to Apr 2019; Y2 = May 2019 to Apr 2020). Annual income (PHP and USD) per gleaner is also calculated. Exchange rate: PHP1.0 = USD0.020921.

Based on the computed daily catch values and expressed as daily gross income (DGI), a gleaner earned PHP70 (USD1.50) per day on average between 2018 and 2020. The lowest income, PHP10 (USD0.21), was recorded in June 2018 whereas the highest income, PHP301 (USD6.30), was documented in August. Based on overall mean daily gross income per month, relatively high revenues were observed during May–June (PHP76–103; USD1.6 to 2.1) and August–September (PHP81–95; USD1.7 to 2.0) in 2018 and 2019. Over the two-year study period, the DGI followed the pattern illustrated in the mean daily catch rate (Fig. 5). However, this was expected as the DGI values were derived from the daily catch rates per species multiplied by the corresponding species' price.

Discussion

The gleaning of shellfish in intertidal areas has long been a practice in coastal communities, not just in the Philippines but along coasts worldwide. This study observed that the people involved in gleaning in Malalison Island were mostly women, which was also reported in the previous investigation by del Norte-Campos et al. (2003), as well as in other gleaning studies (Chapman, 1987; Nieves et al., 2010, 2015; De Guzman et al., 2019; Furkon et al., 2019). This demonstrates the importance of women in this fisheries sector and what they contribute to the fisheries catch. However, the influence of women in fisheries remains largely unnoticed (Siason, 2001) despite them directly providing food security and nutrition or additional income to the household via gleaning.

Overall, the current catch composition of gleaned molluscs on the island differed only slightly from 2003, but much higher monthly catches were estimated in the current study (Table 4). A total of 26 species of molluscs were recorded in the gleaning catch on the island during the study period, which was slightly lower than the previous number (30). As in the study of del Norte-Campos et al. (2003), gleaning catch in the island of Malalison was predominated by gastropods (96.3 %), which can be largely attributed to the substrate types (coralline sand to rubble) in the area. There was, however, a considerable difference in monthly catches between 2003 (5.7 kg) and 2020 (28.5 kg). Of the 26 recorded molluscs, bivalves constituted only 2.8 % of the total catch compared to the previously reported 6.5 % in 2003. Nevertheless, the mean monthly catch of the six bivalves (0.91 kg) was higher than that reported (0.4 kg) by del Norte-Campos et al. in 2003 (Table 4). It must be noted, however, that a few bivalves were missing from the present catch, namely the giant clam *Tridacna gigas* (Linnaeus, 1758), the black-lipped pearl oyster *Pinctada margaritifera* (Linnaeus, 1758), and the mussel *Septifer excisus* (Weigmann, 1837), which contributed 1.5 % of the mean monthly catch in 2003. The increase in the monthly catches for gastropods and bivalves in the island may indicate an improving fishery, but further investigations are needed to fully understand such changes as no existing local ordinances regulating the gleaning fishery in the island to support this observation.

In addition to the observed differences in monthly catches between 2003 and 2020, a change in species dominance was also evident. It was notable that the two nerite species, which ranked 6th and 11th in 2003, now ranked in the top two in terms of importance, whereas the bigger and formerly dominant gastropods (e.g., conches) ranked lower. Based on informal interviews, locals have targeted bigger gastropods in recent years as demands from visitors to the island increased. However, it is not possible to say whether disproportionate collection efforts resulted in a general decrease of conches or bigger species had been overfished. While big gastropods were still present in the catch, the top two smaller nerites predominated in the current study as indicated by their high mean monthly catch (13.5 kg), which comprised 45.6 % of the total catch. Nonetheless, the three big gastropods in the top five (mean monthly catch = 9.94 kg) contributed 33.62 % of the total catch. This suggested a shift towards a collection of smaller species since 2003.

In the Caribbean, the rarity and small size of the west Indian top shell *Cittarium pica* (Linnaeus, 1758) on sheltered shores have provided circumstantial evidence for overfishing because sheltered shores are more accessible for fishers (MacFarlan et al., 2014). In Malalison, the preference for smaller species, such as the dominant nerites, may be attributed to their abundance and accessibility as these are mainly found in nearby rocky intertidal habitats as opposed to bigger gastropods that inhabit relatively deep areas. Nonetheless, gastropods as a group remained in the top 10, demonstrating their substantial contribution to the gleaning catch as reported at several sandy-rocky intertidal flats (Palomares et al., 2014b; Nieves et al., 2015) and seagrass beds (Furkon et al., 2019).

Gleaning practices on the island are no different from other coastal communities, where daytime low tides are ideal, and collection lasts for ~3 h. Furthermore, unlike del Norte-Campos et al. (2003), who reported changes in gleaning sites between seasons, i.e., gleaning was focused on the northern part of the island during the SW monsoon and the southern portion during the NE monsoon, this study did not detect any such patterns.

The higher number of gleaning days observed during the NE monsoon may have been due to more favourable tides during this season, as low tides fall in the daytime, compared to the SW monsoon when low tides occur towards dusk, night-time, or dawn. In addition, weather conditions may be more adverse during the SW monsoon. The island of Malalison is located off the coast of the western part of Panay, so it is more heavily influenced by the prevailing SW

Table 4. Comparison between the current study and del Norte-Campos et al. (2003) in terms of species composition and mean monthly catch (kg) of gleaned species in Malalison Island.

Group	Scientific name	Mean monthly catch (kg)	
		Current study	del Norte-Campos et al. (2003)
Gastropoda	*Angaria delphinus* (Linnaeus, 1758)	1.72	0.896
Gastropoda	*Canarium urceus* (Linnaeus, 1758)	4.83	0.848
Gastropoda	*Cantharus undosus*[b] (Linnaeus, 1758)		0.0001
Gastropoda	*Charonia tritonis*[b] (Linnaeus, 1758)		0.002
Gastropoda	*Clypeomorus bifasciata* (G.B. Sowerby II, 1855)	0.12	0.071
Gastropoda	*Conomurex luhuanus* (Linnaeus, 1758)	3.39	1.108
Gastropoda	*Conus caracteristicus* Fischer von Waldheim, 1807	0.76	0.102
Gastropoda	*Conus litteratus* Linnaeus, 1758	0.02	
Gastropoda	*Conus pulicarius*[b] (Hwass, 1792)		0.197
Gastropoda	*Conus textile* Linnaeus, 1758	0.002	
Gastropoda	*Cypraea moneta*[b] (Linnaeus, 1758)		0.001
Gastropoda	*Cypraea tigris* Linnaeus, 1758	0.09	0.213
Gastropoda	*Distorsio anus* (Linnaeus, 1758)	0.02	0.019
Gastropoda	*Euprotomus aurisdianae* (Linnaeus, 1758)	1.16	0.144
Gastropoda	*Lambis millepeda* (Linnaeus, 1758)	1.05	0.373
Gastropoda	*Monodonta confusa* Tapparone Canefri, 1874	0.51	0.013
Gastropoda	*Nerita albicilla* Linnaeus, 1758	8.32	0.619
Gastropoda	*Nerita plicata*[b] (Linnaeus, 1758)		0.001
Gastropoda	*Nerita polita* Linnaeus, 1758	5.18	0.125
Gastropoda	*Nerita squamulata*[b] (Le Guillou, 1841)		0.0001
Gastropoda	*Patelloida saccharina* (Linnaeus, 1758)	0.01	0.003
Gastropoda	*Patelloida striata* Quoy & Gaimard, 1834	0.02	0.025
Gastropoda	*Thais hippocastanum*[b] (Linnaeus, 1758)		0.0001
Gastropoda	*Trochus maculatus*[a] Linnaeus, 1758	0.05	
Gastropoda	*Turbo chrysostomus* Linnaeus, 1758	1.15	0.904
Gastropoda	*Umbonium vestiarium*[a] (Linnaeus, 1758)	0.09	
Gastropoda	*Vasum tubiferum*[b] (Anton, 1838)		0.014
Subtotal: Gastropoda		28.5	5.7
Bivalvia	*Anadara compacta* (Reeve, 1844)	0.25	0.171
Bivalvia	*Marcia hiantina* (Lamarck, 1818)	0.37	0.072
Bivalvia	*Pharella acutidens*[a] (Broderip & Sowerby, 1829)	0.19	
Bivalvia	*Pinctada margaritifera*[b] (Linnaeus, 1758)		0.051
Bivalvia	*Geloina expansa*[a] (Mousson, 1849)	0.02	
Bivalvia	*Scutarcopagia scobinata* (Linnaeus, 1758)	0.07	0.042
Bivalvia	*Septifer excisus*[b] (Wiegmann, 1837)		0.001
Bivalvia	*Tegillarca granosa*[a] (Linnaeus, 1758)	0.003	
Bivalvia	*Tridacna gigas*[b] (Linnaeus, 1758)		0.038
Subtotal: Bivalvia		0.9	0.4
Cephalopoda	*Callistoctopus nocturnus*[a] (Norman and Sweeney, 1997)	0.18	
Subtotal: Cephalopoda		0.18	
Echinodermata	*Tripneustes gratilla*[b] (Linnaeus, 1758)		0.009
Subtotal: Echinodermata			0.009
Total		29.6	6.1

[a]New record; [b]Not recorded in the current study.

monsoon, which brings moisture-laden winds to the area, potentially disrupting gleaning activities during daytime low tides. This was also evidenced by the larger number of gleaners observed during the NE monsoon in both years.

The greater number of species recorded during the NE (15–20 species) than in the SW monsoon was consistent with the peaks in both the number of gleaners and gleaning days in a month. This may, yet again, be attributed to the more favourable conditions during these months. Consequently, total monthly catches were also the largest during this time. The extremely low number of species recorded in July 2019 (<5 species), which also coincided with very low catch rates, can be explained by the inclement weather during this month. The Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA) recorded three tropical depressions and one tropical storm which entered the

Philippine Area of Responsibility (PAR) in July 2019. Based on the recorder's notes, very few gleaners went out to glean during the month because of constant rain, in addition to the shorter duration of daytime low tides. During July 2019, the most collected species were *N. albicilla* and *N. polita*, although some days *C. urceus* and *M. hiantina* were reported in the catch, albeit in lower numbers. The nerites can be found in relatively higher shore areas than some other species, making them more accessible to gleaners despite higher tide levels during daytime. While the number of species and total monthly catches were much higher in this study, the seasonal patterns were consistent with the findings of del Norte-Campos et al. (2003).

The computed catch rate (0.8 to 1.6 kg.day^{-1}) in this study was slightly lower than in that of del Norte-Campos in 2003 (0.9 to 2.5 kg.day^{-1}) and no strong seasonal patterns were observed. These estimates were similar to the catch rates computed for gleaners in Lagonoy Gulf, on the Catanduanes side, which ranged from 0.5 to 1.5 kg.day^{-1} (Nieves et al., 2015), but were much lower compared to the Albay side where catch rates ranged from 1.7 to 9.3 kg.day^{-1} (Nieves et al., 2010). It should be noted, however, that the Lagonoy Gulf catch rates were based on rapid resource assessment techniques using questionnaires as their main data collection tool. Furthermore, their gleaning sites and, consequently, catch compositions were also broad rather than specific and, therefore, not directly comparable to Malalison Island. Unfortunately, no other studies have similar data sets, i.e., long-term data from daily records of gleaners, apart from investigations by del Norte-Campos and colleagues in Malalison (2003) and Banate Bay (2005). Catch rates for Banate Bay, expressed in terms of kg.gleaner^{-1}h^{-1}, were reported only for the most abundant groups where catch rates for the top bivalves ranged from 0.19 to 0.55 (del Norte-Campos et al., 2005). The higher catch rates observed for bivalves in Banate Bay may be an effect of the soft substrate type in the area as compared to the sandy-coralline substrate in Malalison Island.

The observed mean monthly catch (29.6 kg) was considerably higher than the 2003 estimate (6.1 kg) despite the lower catch rates. In addition, substantial differences in the annual harvest and annual income between 2003 and 2018/2019 were noted. Gleaners in the island earned about PHP18,700–22,200 per year (USD391–464) based on their daily catches during the two study years, whereas a much lower estimate, PHP730 yr^{-1} (USD15), was reported in the previous investigation based on a total number of 35 gleaners with an annual catch of 2,551.5 kg and an annual value of PHP25,500 or USD533 (del Norte-Campos et al., 2003). Upon scrutiny of the data sets, the substantial differences can be attributed to the low number of gleaning days, ~2–6 days.mo^{-1}, utilised in the calculations for monthly catches and, subsequently, low annual harvest for the 2003 data. This low number of gleaning days was ascribed to fewer daytime low tides in a month, but the available data could not verify this. Additionally, it appears that the number of gleaning days was taken as the mean of all gleaner's gleaning days in a month.

In contrast, the current study used the actual number of gleaning days, i.e., when gleaners went out to glean (18–31 days.month^{-1}), based on daily records, hence the disparities. In Lagonoy Gulf, gleaning frequencies can vary from 8–10 days on the Catanduanes side (Nieves et al., 2015) or 6–20 days on the Albay side (Nieves et al., 2010). These values were still higher compared to the 2003 Malalison estimates but lower than the current study. For comparison purposes, the current values were calculated using the same method (mean no. of gleaning days instead of count) as in del Norte-Campos et al. (2003), and this gave each gleaner an annual income of PHP7,087–9,715 per year (USD148–203). This still showed higher annual income in 2019/2020 than previously reported in 2003.

Despite the changes in catch and effort of the gleaning fishery in Malalison Island since 2003, many locals continue to augment their household incomes through gleaning. The portion of gleaned catch consumed by the households (0.01 to 0.04 %) is an insignificant amount and would have a negligible effect on the estimate of the total annual catch. This suggests that the gleaning fishery in the area may not be a subsistence type of fishery but that locals glean for income. Gleaning will continue to be a tradition of many locals, but if unregulated, it may lead to overfishing which may threaten the biodiversity in the area. It is important to conduct additional studies on the biology and population dynamics of the various molluscs, especially of the most sought-after species, to better understand the fishery dynamics and ecology of these species.

Further ecological investigations to obtain biomass and density estimates are also recommended. Ecological studies are essential considering that 12 previously recorded species in Malalison Island were no longer found in the present catches. These included the black-lipped oyster, the giant triton, and the giant clam, *T. gigas*, which is listed as 'vulnerable' in the IUCN red list of threatened species (Wells, 1996). Additionally, a socio-economic profiling of the gleaners in the area can be rendered to compare with existing studies in the country. Ultimately, available relevant information can be used as a basis in crafting guidelines for the sustainable utilisation of the various resources in Malalison Island.

Conclusion

The current estimated values for catch, catch rates, and value provided an update on the status of the gleaning fishery in Malalison Island. Overall, catch composition and corresponding daily catch rates did not differ much between estimates in 2003 and 2020. Gastropods continue to dominate the catches, although an increase in the collection of smaller gastropods was observed. The discrepancies in the number of gleaning days per month between 2003 and 2020 contributed to substantial differences in the estimates for the monthly catch, annual catch, and annual value, which were much higher in 2020 and subsequently resulted in higher estimated generated income in 2020 from this fishery. The shift in many locals' activities from fishing to tourism between 2003 and 2020 did not appear to negatively affect the catch and value of the fishery, but it is not conclusive whether this shift contributed to the change in the most abundant species from bigger to smaller gastropods. Much more information is needed to understand how the fishery, and other related activities, can impact the macrobenthic communities. Nonetheless, this study highlighted the importance of gleaning as it continues to be a tradition by many locals. It also suggests how a highly diverse ecosystem, such as Malalison Island, may be able to withstand the pressures of fishing. Due to the high biodiversity, the various resources may be exploited without exerting the same level of stress on all species simultaneously. As such, resources that were heavily gleaned in the past may be given time to recover now as locals shift their focus to other resources. However, it is still best to collect more information to understand the intricacies of this fishery so that proper management policies may be promulgated to help maintain the diversity in the habitats and, at the same time, promote sustainability for local livelihoods.

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