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Economics of Reef Gleaning in the Philippines: Impact on the Coastal Environment, Household Economy and Nutrition

Asuncion B. De Guzman, Zenaida M. Sumalde, Mariel Denerie B. Colance, Mierra Flor V. Ponce, Gemlyn Mar S. Rance

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Front cover photo credit: Gleaning in Batasan Island, Tubigon, Bohol, Philippines by Asuncion B. De Guzman

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ECONOMICS OF REEF GLEANING IN THE PHILIPPINES: IMPACTS ON THE COASTAL ENVIRONMENT, HOUSEHOLD ECONOMY AND NUTRITION

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EXECUTIVE SUMMARY

Gleaning for edible invertebrates on wide emergent reef flats and seagrass beds is a common activity in many sites in the Philippines. It involves men, women and children of various ages. Although an established and continual activity, there is very little documentation on the contribution of reef gleaning to household income and nutrition and its potential impact on the coastal environment. This case study was carried out in five important gleaning sites in Visayas and Mindanao to obtain a profile of subsistence fisheries in terms of gleaning effort, catch composition, catch-per-unit effort (CPUE) and revenues, and contribution of gleaning to food security and nutrition of coastal communities. The study also intended to obtain estimates of the potential environmental impact of gleaning activities on the reef ecosystem.

Overall, there are more male gleaners (n=263) than female gleaners (n=241) in the survey population, which is contrary to the common perception that gleaning is mostly carried out by women and children. Majority of the gleaners are 21–50 years old, have spent 10–40 years gleaning, and usually do so 2–5 days a week for 2–3 hours in a day. Across sites, dependence on gleaning as a source of income (whether primary or alternative) ranges from as low as 36% to as high as 72%. At least 86 kinds of seafood make up the gleaner's catch, where the most abundant are gastropod (38%) and bivalve (26%) mollusks, sea urchins (18%), and sea cucumbers (6%). Average CPUE ranges from 2.46 to 5.85 kg/gleaner per day and mean of 1.38 kg/gleaner per hour with women generally obtaining higher CPUE (4.59 kg/gleaner per day) than men (3.07 kg/gleaner per day). Considering that more than half of their catch is retained for household consumption (52%) and most prices are low, these CPUE values convert to very small average daily revenues of between PhP 26 to PhP 92/gleaner per day.

On average, the monthly income (from all sources) of coastal families in four out of the five sites surveyed ranges from PhP 4,598 (Cortes, Surigao del Sur) to PhP 7,316 (Tubigon, Bohol). With the exception of Kauswagan, Lanao del Norte, family income in all sites falls below the national poverty threshold of PhP 7,821/month (USD 175/month) for a family of five members, evidence that Filipino small-scale or artisanal fishers remain the "poorest of the poor". Poverty incidence among the coastal population (49%–83%) in the five survey sites is much higher than the national poverty incidence (39.2%) among fisherfolk. A large portion (38%–76%) of the coastal population in the survey sites lives in extreme poverty with subsistence incidence exceeding the national average of 13.4%.

Analysis of daily nutrient intake (DNI) of the typical gleaner's diet as compared to the required energy and nutrient intake (RENI) shows that women have higher sufficiency in energy and protein than men. Seafood represents 32%–36% of the gleaners' daily protein intake, of which 22%–27% comes from gleaned invertebrates.

Certain methods of gleaning are destructive to shallow coastal environments. Gleaners' continual reef trampling can potentially destroy reefs at a rate of 0.02–0.06 km^2/year. It is crucial that sound management policies be formulated and implemented to sustain both subsistence fisheries and the economic benefits of reef gleaning.

1.0 INTRODUCTION

1.1 Reef Gleaning as Subsistence Fisheries

The Philippine archipelago is bordered by the third largest expanse of coral reef associated with a single nation (Spalding *et al.* 2001) providing a vast and productive resource that supports a multi-gear, multispecies artisanal fisheries (De Guzman 2004). Most of the country's population live in coastal areas with livelihoods almost invariably linked to the sea.

Gleaning (or *panginhas* in the local dialect in Visayas and Mindanao) is the act of collecting or gathering marine resources found in shallow intertidal areas of coral reef-seagrass-mangrove ecosystem complex. It is a common and traditional activity among fishing communities in tropical countries like the Philippines. Wide seagrass meadows and reef flats in many parts of the Philippine archipelago support a high diversity of edible macroinvertebrates exploited for food and livelihood (Lopez 1986; De Guzman 1990; LeBlanc 1997; MBDA 2014). Gleaners are primarily women and children who flock to the reef flats during low tide to gather a wide variety of edible invertebrates, fish and seaweed (Johannes 1981; White and Savina 1987) either by simple handpicking or using minor implements such as knives, rakes, and spoons (De Guzman 1990). While most gleaning activities are concentrated on harvesting shellfish and echinoderms that are easily detected and accessible, certain deep-burrowing invertebrates require special tools and more muscle than what women and children have.

1.2 The Research Problem

Despite the importance of reef gleaning in subsistence fisheries (Palomares *et al.* 2014; Kleiber *et al.* 2014), its contribution to the economy of coastal communities and the role of women in this activity are generally undervalued and unreported (Chapman 1987; Harper *et al.* 2013). In fact, the omission of gleaning output from Philippine fisheries reports is now an important concern in the country's goal of addressing IUU (illegal, unregulated and unreported catches) in order to improve accuracy of fisheries statistics (Palomares and Pauly 2014).

While gleaning is commonplace in many Philippine shores, its contribution to household nutrition and economy as well as its physical and biological impacts on the coastal environment are not well-documented. Such an unregulated, continual activity can lead to overexploitation and damage to the physical environment—negative impacts that can threaten the sustainability of this important subsistence fishery. Heavy dependence on reef resources such as fish and invertebrates has been linked to high incidence of poverty in many coastal communities in developing countries (Whittingham *et al.* 2003). The frequency and effort involved in this activity can exert high fishing pressure on easily accessible parts of coastal habitats (i.e., mangroves, seagrass beds and shallow reefs) leaving many areas almost depauperate.

This research documents this important traditional fishing activity and evaluates how much women gleaners contribute to the economy and nutrition of the average coastal household in selected sites. Moreover, since women are often perceived to be more careful while on the reef, this research documents any current environment-friendly gleaning methods. Information generated from this research will have important implications for future development policies in subsistence fisheries as well as in giving women the opportunity to actively participate in formulating action plans to effectively manage and sustain the reef flat resources of their coastal area. In the process, the research hopes to contribute to the conservation of coastal subsistence fisheries.

1.3 Research Objectives

This case study hopes to generate vital information that will guide the formulation of appropriate policies and recommendations to regulate and sustain gleaning as an important component of subsistence fisheries. It also seeks to evaluate the role of women and children in this important traditional fishing activity and their contribution to the economy and nutrition of the average coastal household in selected sites. The following are the specific objectives of this research:

1) Provide a socio-economic profile of fishers involved in reef gleaning activities in selected sites, highlighting the role of women and children;
2) Provide an estimate of fishing effort and a spatial map of gleaning activities;
3) Determine the volume, catch-per-unit effort, catch composition, and monetary value of the gleaner's catch;
4) Identify the various gleaning practices and their impacts on the reef environment;
5) Determine the poverty incidence among gleaning communities;
6) Provide estimates of the contribution of gleaning to the households' protein intake; and
7) Recommend management measures for appropriate policy for sustainable subsistence fisheries in shallow coastal ecosystems.

1.4 Scope and Limitations

This research is limited by its short time frame; data gathering was done within six months only. As the five study sites are spread widely in Mindanao and the Visayas, surveys were conducted over a few days per site only. Thus, fewer respondents than desirable were covered, which limited the collection of more comprehensive data on reef gleaning. Additional catch and effort data, however, were obtained through the hiring of enumerators in each site, which allowed for more reliable estimates of CPUE from gleaning activities to be obtained.

Analysis of daily food consumption and composition relied on food recall (i.e., respondents were asked how much they eat within each major food group in a typical day) rather than the more reliable method of food weighing as adopted by the Philippine Food and Nutrition Research Institute (FNRI) in its periodic food and nutrition surveys. Nonetheless, the food recall surveys were useful in estimating nutrient intake from a typical diet of coastal households in the study sites.

Estimates of potential physical damage to the reef due to gleaning activities that were obtained in each site adopted the damage rate estimates of Salimo (1997 cited by Andréfouët *et al.* 2013) from a Caribbean reef as no such information is available for Philippine reefs. The present estimates, therefore, are indicative rather than accurate estimates of physical damage to the reef environment from gleaning.

2.0 LITERATURE REVIEW

2.1 Gleaning in Mindanao

There is very little documentation on the production and economics of reef gleaning activities in Mindanao or its contribution to household nutrition. The few reports available present data on fishing effort distribution (PCAMRD and MSU Naawan 2009; Rare-Philippines 2014), gleaners' demographic profile, and catch composition of gleaning harvests (MBDA 2014).

Day and night gleaning, collectively, is the most common subsistence fishing activity in the municipalities of Cortes, Surigao del Sur (Rare-Philippines 2014) involving 33% of fishers. Limited data on gleaning activities in Danao Bay, Misamis Occidental were reported by Heinen (2003) who noted that a gleaner's catch typically consists of 2.0 kg of sea cucumbers and an assortment of fish, sea urchins, anemones, crabs and shellfish of various sizes, some of which are sold but most of which end up as food for the family. De Guzman *et al.* (2009) reported that gleaning is commonly conducted in areas of extensive seagrass meadows in Lopez Jaena, Misamis Occidental wherein an assortment of shellfish, sea urchins and sea cucumbers occurs at very low densities as a result of unregulated harvesting.

Perhaps the most comprehensive work on reef gleaning in Mindanao was conducted in 2013–2014 by Xavier University on behalf of the Macajalar Bay Development Alliance (MBDA 2014). A broad-based profiling of gleaning activities was carried out in 12 coastal municipalities and two cities in Misamis Oriental and provided relevant socio-demographics, catch composition, and prevailing gleaning practices. The report presented gleaners' perceptions on policy needs and compliance with local government unit (LGU) statutes toward sustainable gleaning activities in Macajalar Bay. Unfortunately, the report does not provide information on catch-per-unit effort (CPUE) estimates, and gleaning's contribution to family economics and nutrition.

2.2 Gleaning Production in the Visayas

More comprehensive data on reef gleaning fisheries and revenues are available in the Visayas such as in: Negros Oriental and Bohol islands (White and Savina 1987); Banate Bay, Panay (Del Norte-Campos *et al.* 2005); Bantayan Island, Cebu (Freire *et al.* 1998 cited in Del Norte-Campos *et al.* 2005); Bais Bay (LeBlanc 1997); and Leyte (Schoppe *et al.* 1998).

Cabanban *et al.* (2014) calculated the weighted CPUE from gleaning in Banate Bay, Panay and Negros Island to be between 1.23 and 2.31 kg/gleaner per day. Much of the gleaners' catch is for subsistence and sharing with relatives, and any excess is sold to neighbors; although in a few instances, gleaning in Bais and Banate Bays are not only for subsistence, but also for livelihood. Annual gleaning catch in Bais Bay, Negros Island and Banate Bay, Panay Island is estimated at 58 t and 27 t in 2012 and valued at PhP 2.38 million (USD 59,500) and PhP 0.404 million (USD 10,100), respectively (Cabanban *et al.* 2014).

2.3 Gender Aspect

The role of women in artisanal fisheries is often overlooked (Matthews 1993) but is clearly demonstrated through gleaning on shallow reef flats, which is invariably carried out mostly by women and children. Not needing any boat, these women and children simply walk along exposed portions of the reef or tidal flats during low tide armed with minor implements to collect edible marine organisms in the hope of gathering anything of value to supplement the household income or simply to provide high quality protein source for the family. Women in subsistence fisheries of Oceania, for example, contribute significantly to marine food yields (Chapman 1987) and, by the regularity of these gleaning activities, are considered more reliable than men as suppliers of protein. In traditionally men-dominated cultures, however, their contribution is often underestimated (Johannes 1981) or belittled (Harper *et al.* 2013).

Recent work in the Danajon Bank in Bohol by Kleiber *et al.* (2014), which focused on women's participation in small-scale fisheries, maintains that the exclusion of women's output would alter production patterns of artisanal fisheries. Kleiber *et al.* (2014) found that women dominated the gleaning activities, engaging in them full-time, while men engaged in gleaning in addition to gear fisheries. Women also earned slightly higher CPUE from gleaning than that men obtained from fishing (Kleiber *et al.* 2014).

3.0 METHODOLOGY

3.1 Survey Design

The research was implemented between January and September 2015 and obtained both primary and secondary data on reef gleaning activities in five sites across Mindanao and the Visayas. A combination of survey approaches was applied in this research, described briefly in this section.

3.1.1 Survey sites

Five sites across Mindanao and the Visayas were surveyed, namely:

1. Barangay[1] Tubajon in Laguindingan, Misamis Oriental;
2. Barangays Poblacion and Kawit Oriental in Kauswagan, Lanao del Norte;
3. Barangays Biasong, Catipa and Poblacion in Lopez Jaena, Misamis Occidental;
4. Barangays Tag-anongan Island and Mabahin in Cortes, Suriago del Sur; and
5. Barangays Cabulijan and Batasan Island in Tubigon, Bohol.

All sites, indicated with a blue circle in Figure 1, have wide emergent reef flats with healthy and diverse seagrass beds that serve as habitats for a wide variety of invertebrate resources. Gleaning mainly for invertebrates is a common, traditional activity among coastal residents in all sites.

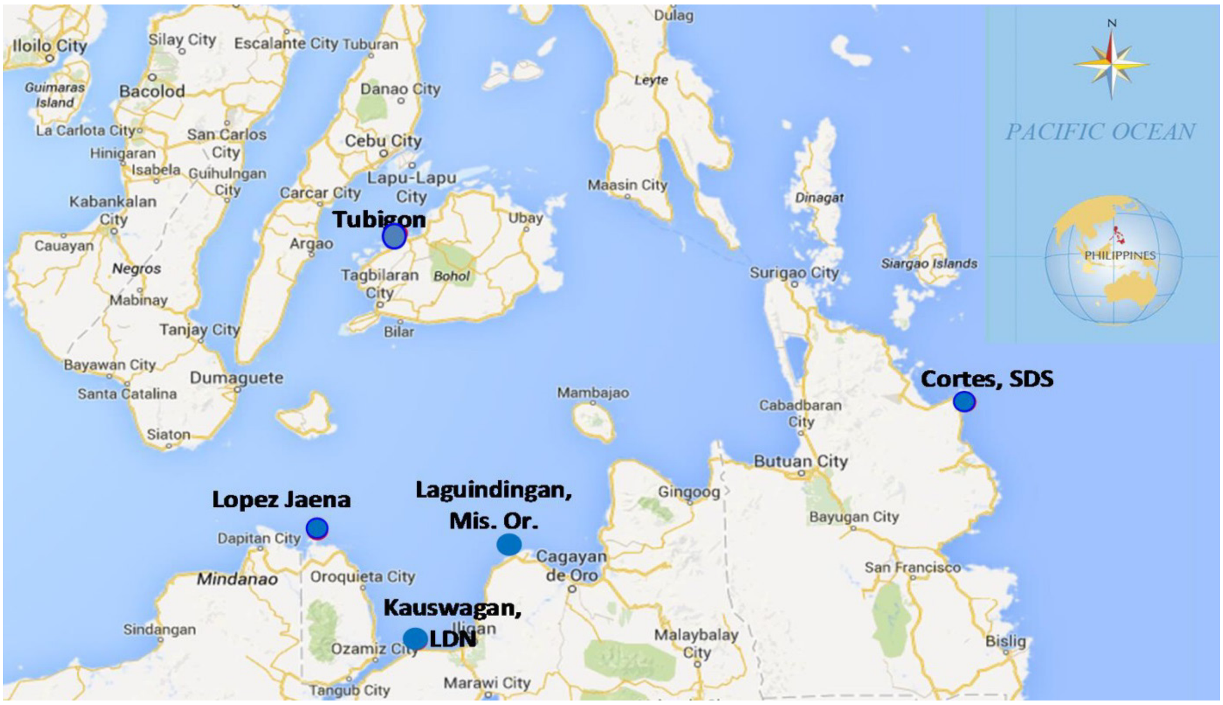

Figure 1. Map of northeastern Mindanao and central Visayas indicating survey sites

3.1.2 Catch composition, catch rates and revenues

A minimum of 30 gleaners (representing 20%–50% of the gleaners encountered on the reef) in each site were randomly surveyed during low tide over a period of 3–4 days. Species inventory of the gleaner's catch and estimation of volume (in kilograms) were carried out on-site as the gleaners depart for home. The gleaner's catch was classified by kind of invertebrate (Appendix 1) and weighed separately on a portable kitchen scale. Additional data on gleaners' catch and effort were obtained daily for one month by a local enumerator. A total of 504 gleaners were surveyed in five sites over a period of one month using a combination of on-site and enumerators' surveys.

[1] The "barangay" is the smallest administrative division in the Philippines and is the local term for a village.

3.1.3 Mapping of gleaning effort

All gleaners found on the reef at each sampling day were counted and the location of each gleaner was obtained using a global positioning system (GPS). An estimate of the area of gleaned reef or tidal flat was also determined using GPS. The GPS coordinates were plotted on the map of each site with the aid of the Garmin MapSource software. Map refinement was done using CorelDraw Graphic Suites X7.

Estimates of catch rates or CPUE were obtained from the catch inventory using the equation:

$$CPUE = \frac{\sum Ci}{\sum fi} = \frac{\overline{Ci}}{f} \qquad \text{Equation 1}$$

where C_i is catch in kilogram and f_i is fishing effort in one operation (Sparre and Venema 1992; Petrere *et al.* 2010).

3.1.4 Demographic and socio-economic profile

A household survey on relevant demographics, socio-economics and nutritional aspects of the family was conducted in each site. Since households in coastal areas typically occur in irregular clusters, the survey adopted a simple random design to cover at least 20% of the coastal village population or a minimum of 30 respondent households in each site. In nearer sites of Laguindingan, Kauswagan and Lopez Jaena, 50 households were surveyed. A total of 225 respondents were surveyed across the five sites.

3.2 Gleaner's Contribution to Household Income

Gross revenues from gleaning activities were determined from the sale of gleaner catch based on the current prices for each commodity. The value of the catch from reef gleaning was then calculated by multiplying the quantity of catch with the market price of the species, expressed as:

$$P_i \times Q_i \qquad \text{Equation 2}$$

where P_i represents the price (in Philippine pesos) of reef species *i* and Q_i is the quantity (in kilograms) of reef species *i*. The total value (V) of catch per gleaner is the sum of the values of the species caught, which was computed as follows:

$$V = \sum_{i=1}^{n} P_i \times Q_i \qquad \text{Equation 3}$$

This value represents the gross revenues that a gleaner derives from the sale of his daily catch. To determine the contribution of reef gleaning to the household's economy, the share of the total value (V) of catch to the total household income from all sources was estimated as follows:

$$Share = \frac{V}{THHI} \qquad \text{Equation 4}$$

where THHI is the total income of households from all sources, which includes income obtained by all earning members of the household. Income estimate was segregated by gender to determine the contribution of income from gleaning by women (including children) to the total household income.

3.3 Poverty Incidence

Estimates of total household income (from gleaning and other sources) in each site were compared to official poverty statistics in the Philippines in order to determine the poverty incidence of both gleaning and non-gleaning households. Data on per family and per capita poverty and subsistence (or food) thresholds by province were obtained from the National Statistics Coordination Board (NSCB 2013).

3.4 Gleaning's Contribution to Household Nutrition

Data on the amount of daily food consumption for each family were obtained from the household survey through food recall. Each respondent (usually head of the family) was asked to itemize the kinds and quantities of food they usually eat in a day, including seafood from fishing and reef gleaning. The contribution of seafood from gleaning to household nutrition was determined by converting the quantity of catch used for home consumption into equivalent protein and other essential nutrients and comparing them with the total nutrient intake from all sources. The total protein (TP) obtained from gleaning, which is the sum of the protein from species *i,* was computed as follows:

$$TP = \sum_{i-1}^{n} PE_i \qquad \text{Equation 5}$$

then divided by the household size (i.e., number of family members). The resulting value was then compared to the recommended daily dietary intake (RDI) to determine how much gleaning contributes to satisfying the individual protein requirement. Likewise, the contribution of gleaning to other macronutrient (e.g., energy and fats) and micronutrient (e.g., calcium, phosphorous, iron and zinc) requirements of each household was determined. Data on nutrient equivalent of various foodstuffs were obtained from the food composition table (FCT) for the Philippines (FNRI 1997) and from other sources, as in the case of certain seafood or nutrients not listed in the FCT.

3.5 Environmental Impacts of Gleaning Activities

The gleaning surveys also provided a description of the physical and other ecological impacts of current gleaning practices in each site. Secondary data on estimates of damage on reef flats and seagrass beds from human activities were obtained from literature. Together with data on existing gleaning practices from the present study sites, an estimate of the reef damage resulting from the stress of constant trampling by gleaners and other related activities was obtained. Photo and video documentation of gleaning practices, catches, and gleaner interviews were done in the five sites surveyed.

4.0 FINDINGS

Although much of the data analysis in this report is descriptive, it provides a snapshot of the economics of gleaning, its contribution to household nutrition and food security, the prevailing practices or methods of gathering, and potential impact on the reef environment. Patterns and values of production, poverty incidence, and nutrient intakes are compared with national and regional or provincial averages, where data are available.

4.1 Gleaning Demographics and Production

4.1.1 Effort distribution and gleaner profile

Reef gleaning is an almost daily activity in all five survey sites, is largely confined to reef flats (Figure 2), and involves men, women and children of various ages. Women and young children mostly glean in the shallow, generally sandy or rocky portions of the reef flat. Most areas have abundant wide emergent seagrass beds that are common habitats of marine invertebrates and fish.

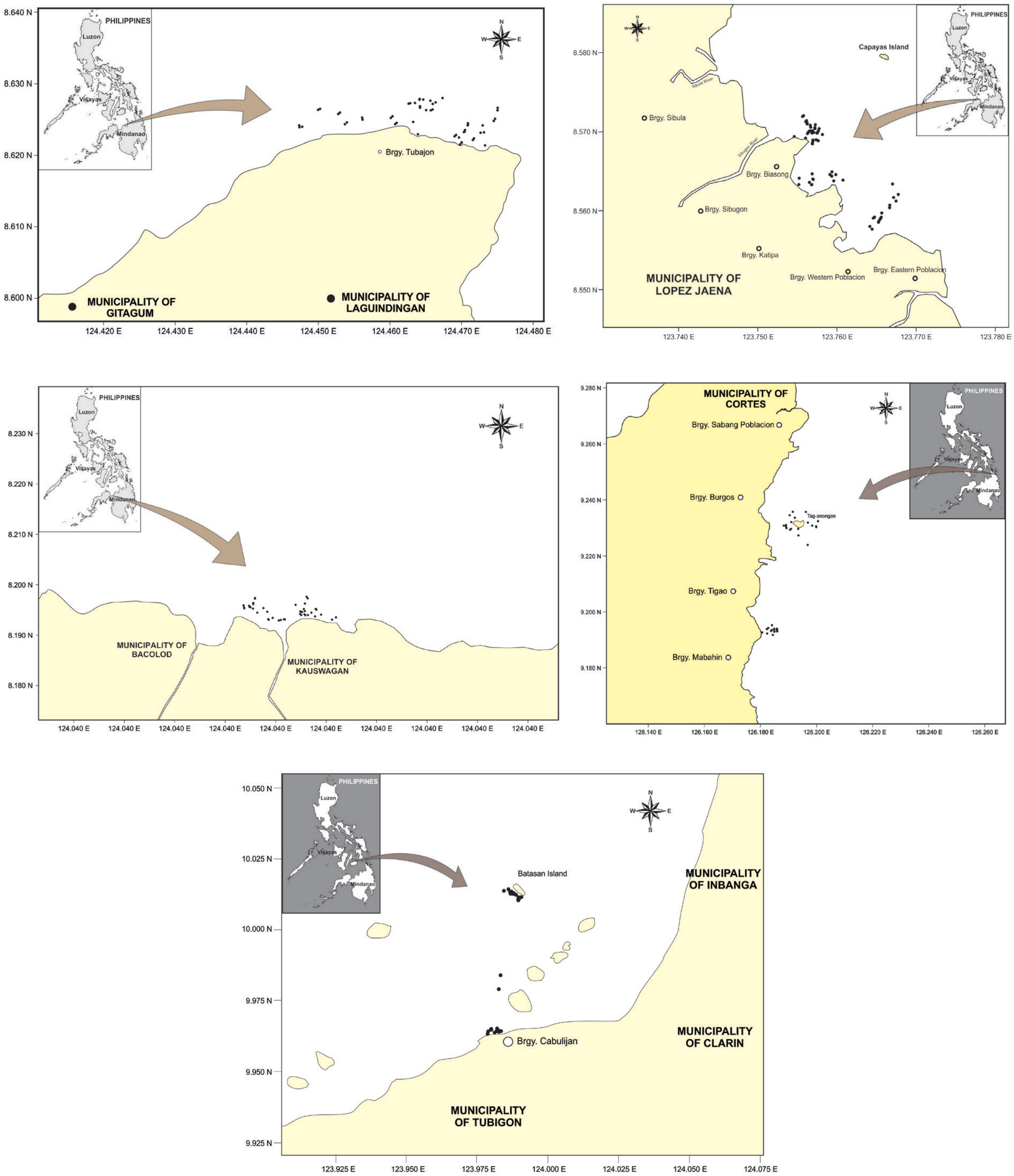

Figure 2. Maps of the five survey sites in Mindanao and the Visayas showing the concentration of gleaning effort on the shallow reef flats

The proportion of male and female gleaners varied in each site. Male gleaners exceeded female gleaners in Laguindingan, Kauswagan, and Cortes while a higher proportion of female gleaners was observed in Lopez Jaena and Tubigon (Figure 3). This observation is contrary to many reports that gleaning on shallow reef flats is carried out mostly by women and children (Chapman 1987; Matthews 1993; Harper *et al.* 2013). The increased participation of men in reef gleaning could be a consequence of declining catch from mainstream gear finfish fisheries or lack of viable employment or livelihood (LeBlanc 1997; Cabanban *et al.* 2014). For many coastal communities, reef gleaning provides a steady source of food, if not a reliable source of income, for the household.

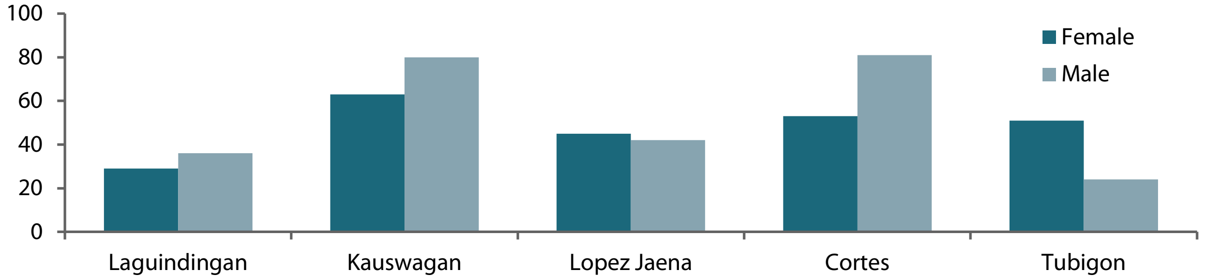

Figure 3. Number of gleaners surveyed in five sites in Mindanao and the Visayas

Reef gleaning in all sites is mostly carried out by adults aged 21–50 years (58.1%) but also involves elderly of 61 years and above (7.8%) and young children aged 10 years and below (Figure 4). Majority of males glean alone while women and children often glean in small clusters of 2–3 persons. Occasionally, a whole family (father, mother, and small children) gleans together and pools their catch. Most gleaners live within the surveyed village, although a few come from nearby towns where the reef flat is less productive. In aggregate, majority (52%) of the gleaners have spent between 10–40 years on this subsistence fishery although a significant proportion (35%) has gleaned for less than 10 years (Figure 5).

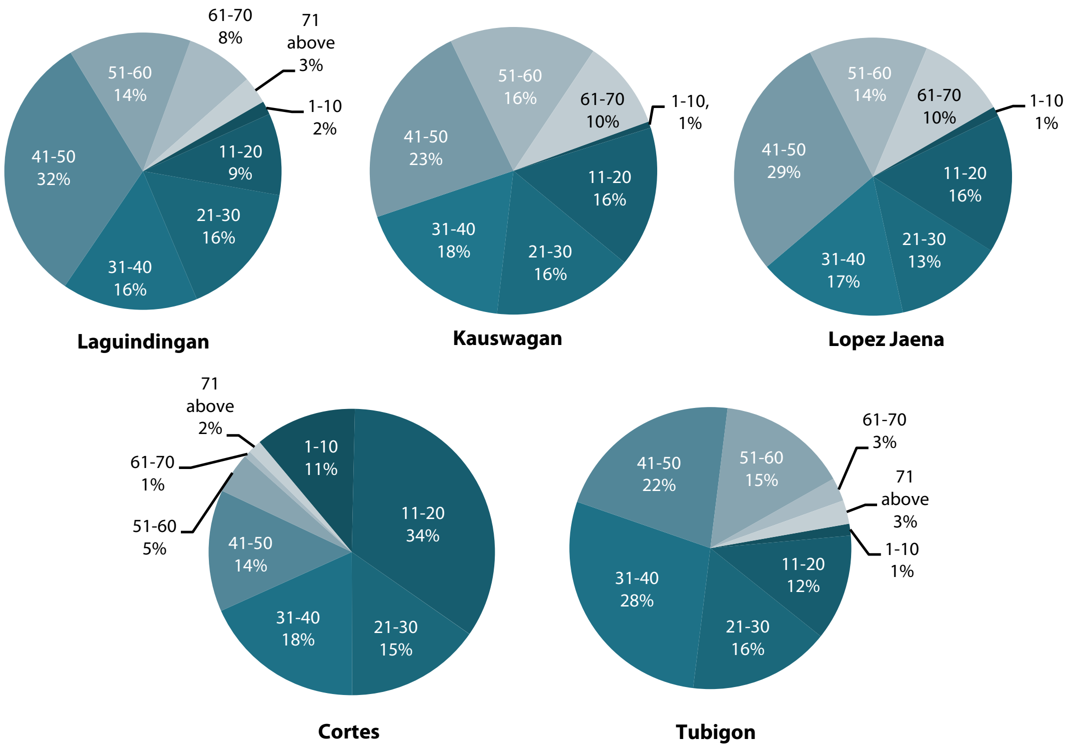

Figure 4. Age distribution of gleaners in surveyed sites

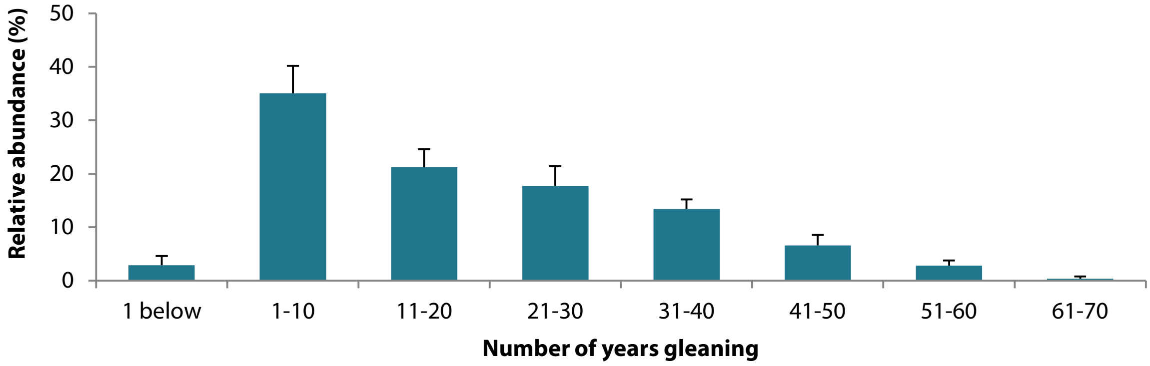

Figure 5. Respondents' average number of years spent on reef gleaning in surveyed sites

Most of the gleaners in Laguindingan and in Cortes spend an average of 4–5 days a week on the activity while those in Kauswagan, Lopez Jaena and Tubigon glean for no more than 2–4 days a week (Table 1). On the average, women spend more days gleaning than men except in Kauswagan where men slightly exceed female effort. Analysis of variance showed significant differences (one-way ANOVA, $p < 0.05$) across sites. However, the t-test did not show any significant variations ($p > 0.05$) in daily effort across gender (Table 2).

Table 1. Mean values of reef gleaning effort and catch rates from surveyed sites

Site	Fishing effort				Catch rates/CPUE			
	No. of days/week		No. of hours/day		CPUE (kg/gleaner/day)		CPUE (kg/g/hr)	
	Female	Male	Female	Male	Female	Male	Female	Male
Laguindingan	4.6 (29)	4.2 (36)	2.5	2.8	5.75	3.20	2.16	1.00
Kauswagan	2.7 (63)	3.2 (80)	1.9	1.9	2.71	2.22	1.07	1.03
Lopez Jaena	3.6 (45)	2.6 (42)	2.6	2.5	7.04	4.65	2.48	1.75
Cortes	4.1 (53)	4.2 (81)	2.5	2.2	3.18	2.85	0.79	0.81
Tubigon	2.7 (51)	2.4 (24)	2.1	1.9	4.28	2.45	1.57	1.16
Mean	**3.5**	**3.3**	**2.3**	**2.2**	**4.59**	**3.07**	**1.61**	**1.15**

Note: Values in parentheses are number of respondents (n).

Table 2. Results of statistical tests on gleaning effort, CPUE and gross daily income across sites and gender

Parameter	Comparison	Stat model	p value	Remark
Gleaning effort (days/week)	Across sites Between gender	One-way ANOVA t-test (one-tailed)	0.0102 0.1895	Significant difference No significant difference
Gleaning effort (hours/day)	Across sites Between seasons	One-way ANOVA t-test (one-tailed)	3.88E-06 1.33E-03	Significant difference Significant difference
CPUE (kg/gleaner/day)	Across sites Between gender	One-way ANOVA t-test (one-tailed)	0.3001 0.0295	No significant difference Significant difference
Gross daily revenue (PhP)	Across sites Between gender	One-way ANOVA t-test (one-tailed)	0.6127 0.4144	No significant difference No significant difference

Length of time spent on gleaning each day also varies across sites and periods of the year, such as during peak periods for gleaning (April to May and October to December) when the reef flat is exposed for long durations each day and lean months when the period of low tide is short. Gleaners in all five sites spend more hours on the reef during peak months (2.9 hours/day) than in lean months (1.7 hours/day) (Figure 6). The differences in daily duration of gleaning were shown to be statistically significant across sites (ANOVA, $p < 0.001$) and between periods (t-test, $p < 0.001$) (Table 2).

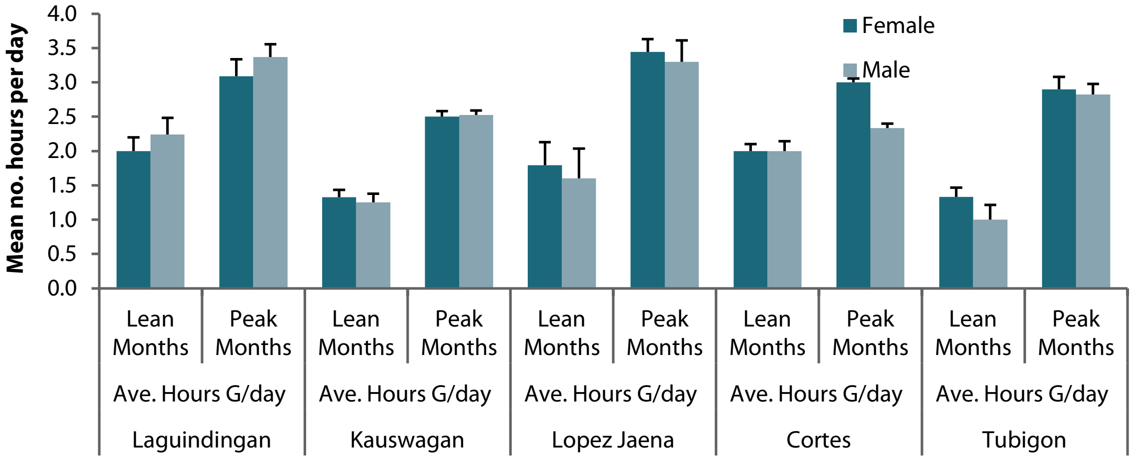

Figure 6. Duration of gleaning activities during lean and peak months in the surveyed sites

Observations on gleaning effort across sites suggest the high dependence of coastal residents on shallow reef flats as a diverse source of edible invertebrates, fish and seaweed. Wide emergent reef flats during very low tides open up opportunities to gather seafood at regular periods, particularly during full and new moon lunar phases when the tidal ranges are wider and the reef flats have maximum exposure.

4.1.2 Gleaning catch composition and production

At least 86 kinds of seafood composed of 23 species of bivalves, 25 gastropods, 12 sea cucumbers, 3 sea urchins, 14 finfish, and other invertebrates are gathered through gleaning across the five sites. Species variety of the gleaners' catch is highest in Cortes with 52 species of fish, mollusks, crustaceans and other groups while the least diverse catches are observed in Laguindingan and Kauswagan (Table 3).

Table 3. Comparative species richness or variety of gleaners' catch in surveyed sites

Group/Taxon	Number of species				
	Laguindingan	Kauswagan	Lopez Jaena	Cortes	Tubigon
Mollusks: Bivalves	5	6	14	12	17
Mollusks: Gastropods	6	13	11	19	10
Mollusks: Sea hare egg strings	-	-	1	1	1
Mollusks: Octopus	1	-	-	1	-
Crustaceans: Crabs	1	1	2	1	2
Crustaceans: Mantis shrimp	-	-	-	1	-
Fish: Finfish	9	3	3	4	2
Fish: Eel	1	1	-	1	-
Brachiopods: Lamp shell	-	-	-	-	1
Coelenterates: Jellyfish	-	-	-	-	1
Sipunculids: Peanut worm	1	1	-	1	1
Echinoderms: Sea cucumbers	6	2	6	5	4
Echinoderms: Sea urchins	2	2	3	1	-
Unidentified groups	2	1	-	5	2
Total	**34**	**30**	**40**	**52**	**41**

Shelled invertebrates (e.g., gastropod and bivalve mollusks) are by far the most diverse group of gleaned seafood in the five sites surveyed, as also reported in other sites in the Visayas (Del Norte-Campos *et al.* 2005; Nieves *et al.* 2010; Cabanban *et al.* 2014) and Mindanao (MBDA 2014). Echinoderms such as the short-spined sea urchin (*Tripneustes gratilla*) and sea cucumbers (Figure 7) are popular food items from healthy seagrass-dominated reef flats. Sea urchins are popular for their gonad or roe while sea cucumbers are widely exploited as *trepang* (dried body wall) or as freshly pickled delicacy. The most abundantly gathered gastropods are small conch shells locally called *aninikad* (commonly *Canarium urceus*) while the most common bivalves are shallow-burrowing surf clams *Katylesia hiantina* (*punaw*) and *Anadara inaequivalvis* (*litob*). Composition of gleaners' catches vary across sites (Figure 8) with sea urchins being the most relatively abundant catch in Laguindingan (61%) and Kauswagan (42%), bivalves in Lopez Jaena (47%) and Cortes (46%), and gastropods in Tubigon (45%). No seaweed was found in the gleaners' catches while fish were often tiny and rarely caught.

Other popular seafood items in a typical gleaner's catch are peanut worms (sipunculids), which are commonly gathered by male gleaners from sandy portions of seagrass beds in Kauswagan and Cortes and are popularly eaten in pickled form. An exotic component of the gleaner's catch in Lopez Jaena and Cortes is the edible egg strings (locally called *lukot*) of the tropical sea hare *Dolabella auricularia* (locally known as *donsol)* that appear seasonally (March to April*)* in seagrass meadows. In all sites male gleaners often gather a few target or high-value species of bivalves, such as deeply burrowing tiger lucine called *lambayang* (*Codackia tigerina*) and the mangrove mud clam called *imbao* (*Anodontia edentula)*. These bivalves are, however, becoming increasingly rare due to overharvesting.

Figure 7. Most popular kinds of seafood from reef gleaning in surveyed sites

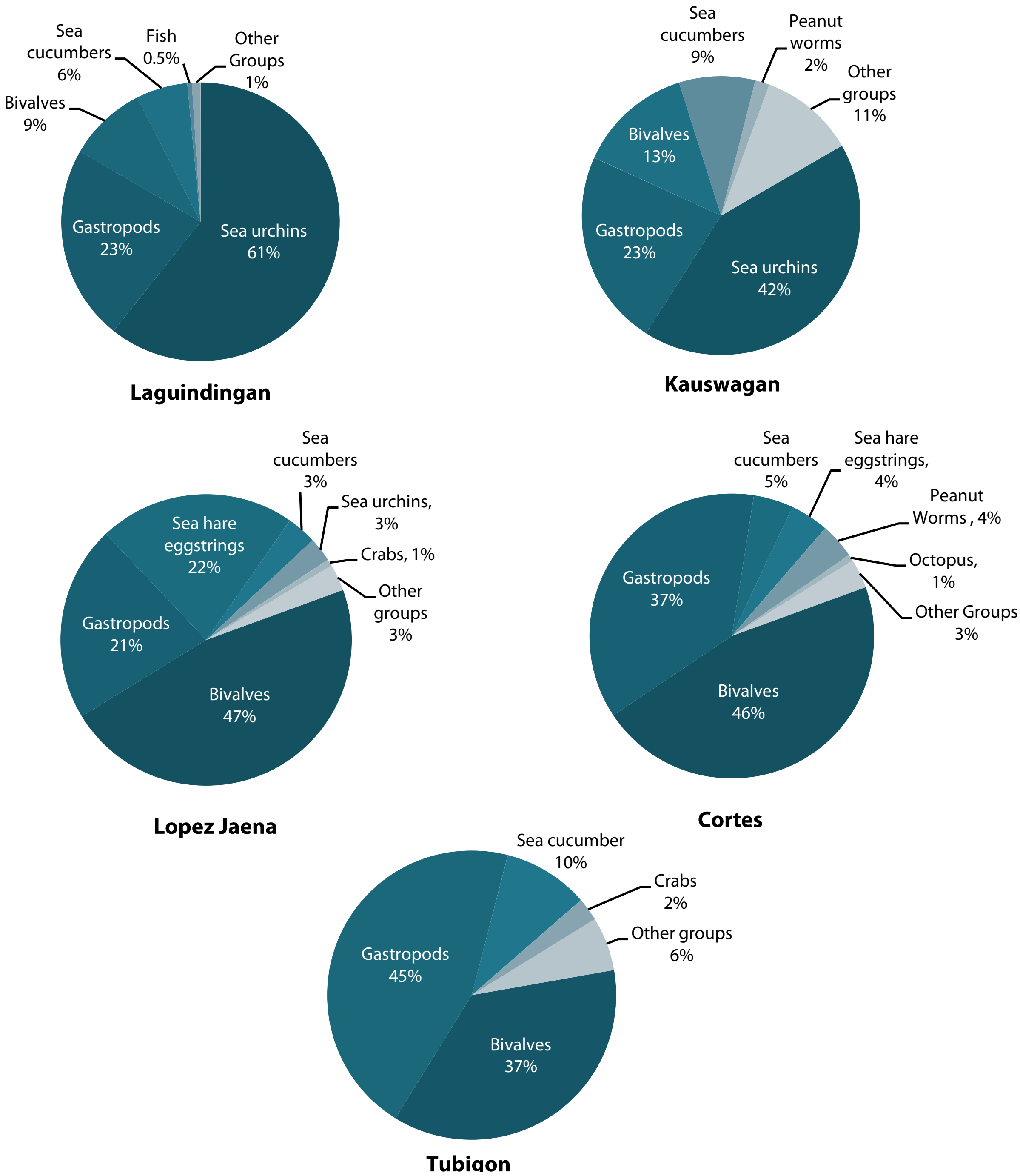

Figure 8. Composition of gleaners' catch in surveyed sites

Estimates of gleaners' total daily catch from reef flats were obtained by multiplying the amount of catch for each commodity by the number of gleaners collecting that in each site. Overall, univalve (or gastropod) mollusks are the most abundantly caught group of invertebrates reaching an aggregate daily catch of 692.14 kg (38%), largely contributed by Cortes and Lopez Jaena (Figure 9). Bivalves and sea urchins are also gathered in moderate abundance at a daily catch of 483.17 kg (26%) and 324.26 kg (18%), respectively. Overall, the daily gleaning output (Figure 10) is highest in Cortes (676.5 kg) due to higher effort while the lowest output is observed in Tubigon (196.0 kg). Much of this difference is due to the abundance of bivalves, gastropods, sea cucumbers and edible sea hare egg strings in Cortes at the time the survey was carried out in March 2015.

Mean estimates of catch rates, expressed as catch-per-unit effort (CPUE), vary across sites (Figure 11), with higher CPUE (5.85 kg/gleaner per day) obtained from Lopez Jaena than from the other sites (2.46–

4.48 kg/gleaner per day). Across sites, an average daily CPUE value of 3.83 kg/gleaner per day converts to a mean of 1.38 kg/gleaner per hour (Table 1) at an average duration of 2.3 hrs/gleaning day.

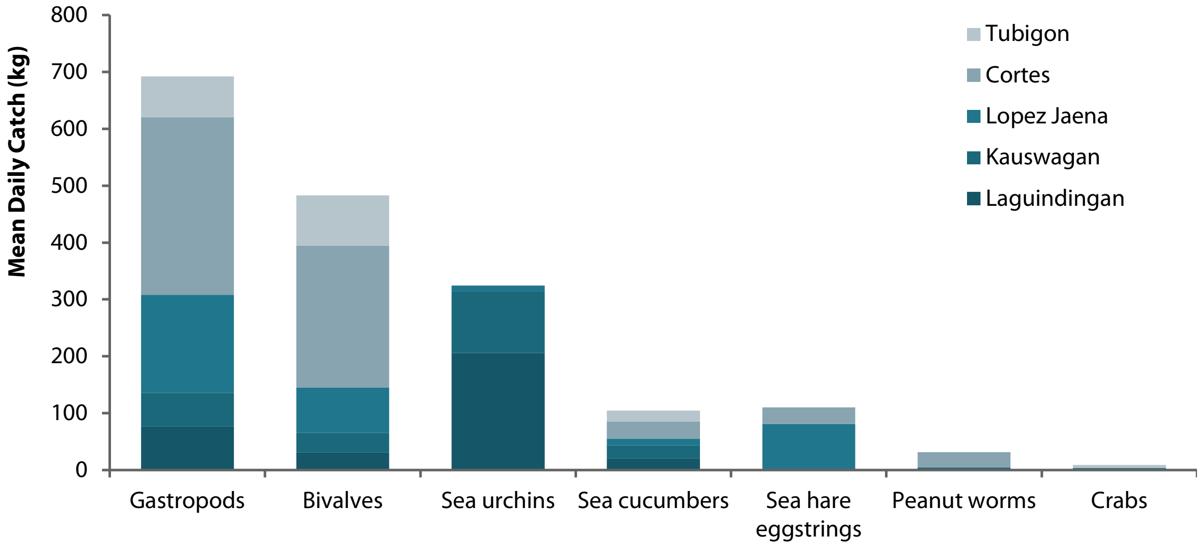

Figure 9. Most abundantly caught groups of seafood from reef gleaning in surveyed sites

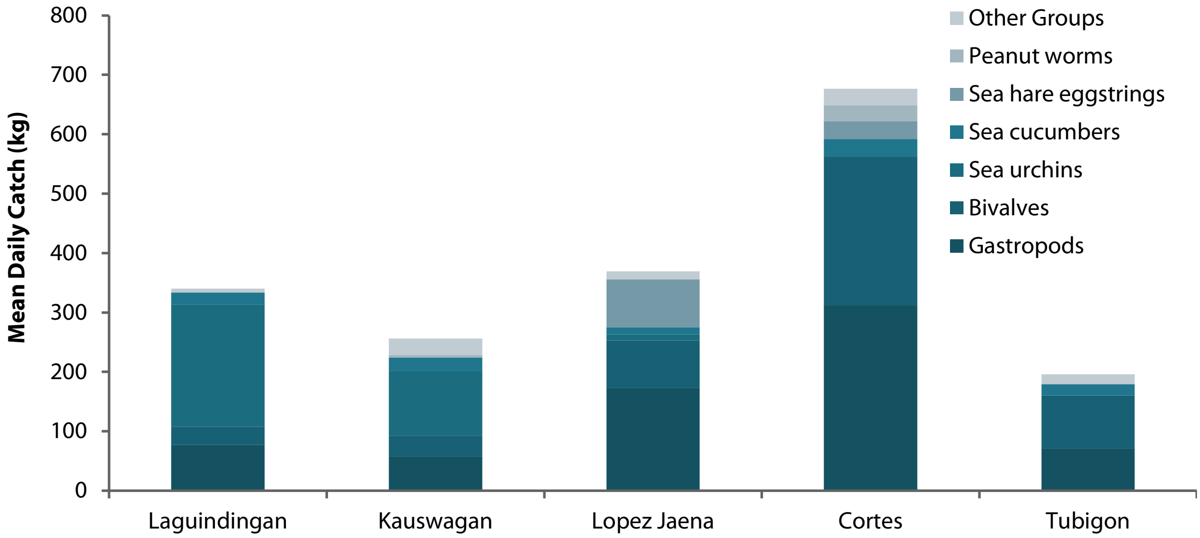

Figure 10. Comparison of gleaner's daily yield (in kilograms) across the surveyed sites

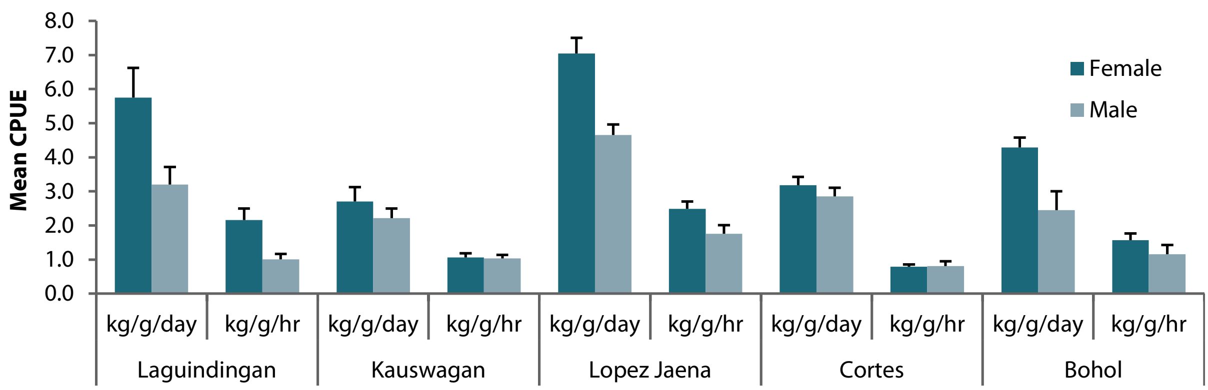

Figure 11. Comparison of catch rates (or CPUE) of male and female gleaners in surveyed sites

Women consistently obtained higher CPUE in all sites surveyed (2.71–7.04 kg/gleaner per day) than men (2.22–4.65 kg/gleaner per day). Variations in CPUE values between gender groups were shown to be statistically significant (t-test, $p < 0.05$) but not across sites (ANOVA, $p > 0.05$) (Table 2). Male gleaners often prefer to gather target or high-value species of bivalves, such as hard-shelled clams belonging to the genera *Codackia* and *Anodontia*, but CPUE values are often low as these commodities are already rare. On the other hand, many women prefer the gathering of the more abundant sea urchins, which are heavier when fresh and, thus, obtain larger CPUE values. Once shucked, however, sea urchins produce much smaller roe (or gonad). On the average, about 3–4 kg of fresh sea urchins can produce one small flat bottle (locally called *lapad*) of roe, which is sold in the local market or to households for PhP 50–60. Small sea cucumbers are often sold gutted, cleaned, and sliced for local consumption in pickled form (locally called *kinilaw*). Larger, high-valued sea cucumbers, quite rare on shallow reef flats due to sustained harvesting over the decades, are sold as dried *trepang* to local buying agents or middlemen (known locally as *compradors*).

Catch rates obtained in this study are comparable to those reported in the Bohol Marine Triangle (mean CPUE of 2.75 kg/gleaner per day) by Samonte-Tan *et al.* (2007). Cabanban *et al.* (2014) reported similar CPUE ranges in Negros (1.77–5.22 kg/gleaner per day) and Panay (1.7–6.5 kg/gleaner per day) islands while a lower CPUE (less than 2.0 kg/gleaner per day) was observed in Mabini, Batangas (Palomares *et al.* 2014). Invertebrate catches in these three areas, however, have been declining through the decades by as much as 50%–70% (Cabanban *et al.* 2014; Palomares *et al.* 2014). Gleaning for macroinvertebrates in Lagonoy Gulf obtained a wide range of CPUE values (1.73–9.28 kg/gleaner per day) in three sites (Nieves *et al.* 2010). Average CPUE estimate of 1.38 kg/gleaner per hour obtained in this case study is higher than reported in Danajon Bank at 0.97 kg/gleaner per hour for women and 0.77 kg/gleaner per hour for men (Kleiber *et al.* 2014).

4.2 Contribution to Household Economy

The proportion of households engaged in reef gleaning varies across the survey sites (Table 4). Coastal households in Laguindingan are highly dependent (72.0%) on the reef as the source of their livelihood and food as compared to other sites. The proportion of gleaning households is lowest in Tubigon, Bohol (36.4%) where majority of the respondents are residents of Barangay Cabulijan, a population center where more livelihood options are available. In contrast, all 14 respondents from the island barangay of Batasan in Tubigon are full-time gleaners. According to their village head, more than 90% of Batasan's 252 households are engaged in reef gleaning at variable intensities, depending on season and lunar cycle.

Table 4. Degree of dependence of coastal households on reef gleaning or subsistence fisheries

Survey site	Proportion (%) of HHs engaged in reef gleaning	Number of gleaning HHs	Estimated population engaged in reef gleaning
Laguindingan	72.0	491	737
Kauswagan	48.0	964	1446
Lopez Jaena	46.0	539	809
Cortes	60.0	380	612
Tubigon	36.4	280	661

Batasan Island is one of four islands in Tubigon that suffered from subsidence as an aftermath of the 7.2 magnitude earthquake on October 15, 2013, which devastated much of the Bohol province ("Four island barangays sinking" 2013). Following the quake, and even at the time of the survey, many homes were partly underwater during high tide. Accordingly, gleaning activities intensified following the earthquake as residents struggled to put food on the table. Residents complain that part of their reef flat had sunk (or subsided) by at least 0.5 m leaving their gleaning area much smaller and deeper than before.

Seafood items gleaned from the reefs in the surveyed sites are utilized in at least three ways: mainly consumed as food by the gleaner's household (mean = 31.1%); mainly sold in order to supplement family income (17.3%); and both eaten and sold (mean = 51.5%). Gleaners usually sell the abundant or high-value portion of their catch either to neighbors or to *compradors* while retaining the rest for family consumption. The proportions of gleaned products for household consumption and for selling often vary according to the quality of the catch. Small shellfish, sea cucumbers, and fish are usually eaten while sea urchins and bivalves are sold by bottle of roe and by piece or kilogram, respectively. On the average, only 17% of gleaners sell their catch, while 31% engage in gleaning mainly for household consumption; most gleaners both sell and consume their catch as food. Gleaners in Lopez Jaena retain the highest portion (64.1%) of the gleaned harvest for family consumption amounting to an average of 3.53 kg/day (Figure 12).

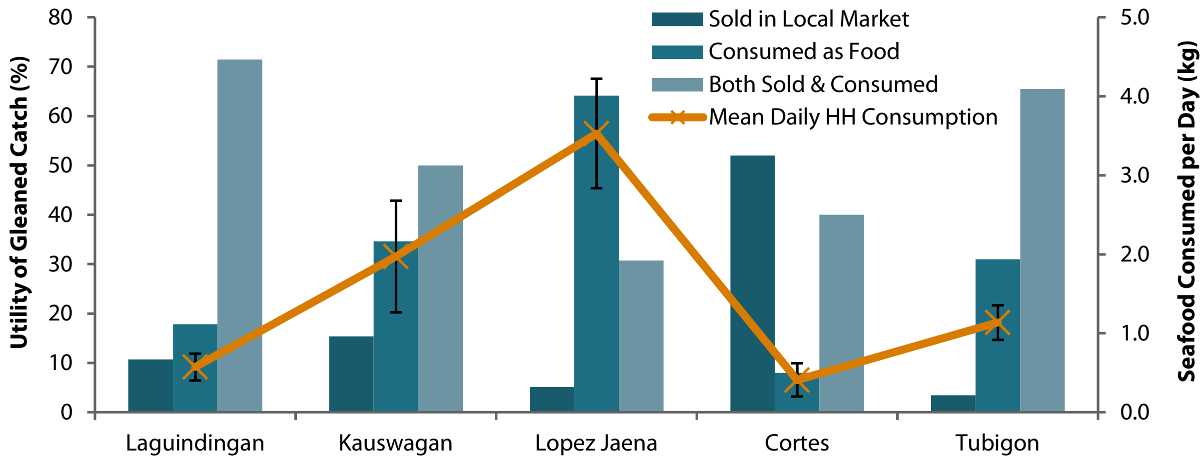

Figure 12. Utility of gleaning harvest and estimated quantity of seafood consumed in surveyed sites

Despite relatively moderate levels of CPUE (Table 1), estimates of daily gross revenues derived from 2–5 hours of gleaning for invertebrates and other reef flat resources are quite low (Figure 13) ranging from PhP 26 to PhP 92/gleaner across sites for both male and female gleaners. Average revenues (regardless of gender) is lowest in Kauswagan (PhP 32/gleaner per day) and highest in Cortes (PhP 68/gleaner per day). An overall average of PhP 54/gleaner across sites converts to a monthly income of PhP 883, which contributes a small fraction (15%) to the household economy. This is hardly surprising as most of the gleaner's catch is retained for the family's consumption, except in Laguindingan and Cortes where the bigger proportion is sold.

Daily revenues from sales of catch also tend to be small due to low prices for most items, such as small gastropods and bivalves (PhP 12–20/kg), which are the dominant groups gleaned. Women generally earn bigger revenues than men, particularly those involved in gathering and shucking sea urchin roe, which sells at PhP 50–60/bottle. Women are often less discriminating than men and gather a variety of sea urchins, shellfish, sea cucumbers and egg strings of sea hare, a popular local delicacy served as fresh salad. Men are more discriminating, seeking high-value bivalve species that are often more difficult to obtain. Differences in daily revenues from gleaning across sites (ANOVA, $p > 0.05$) and between gender (t-test, $p > 0.05$) are not significant (Table 2).

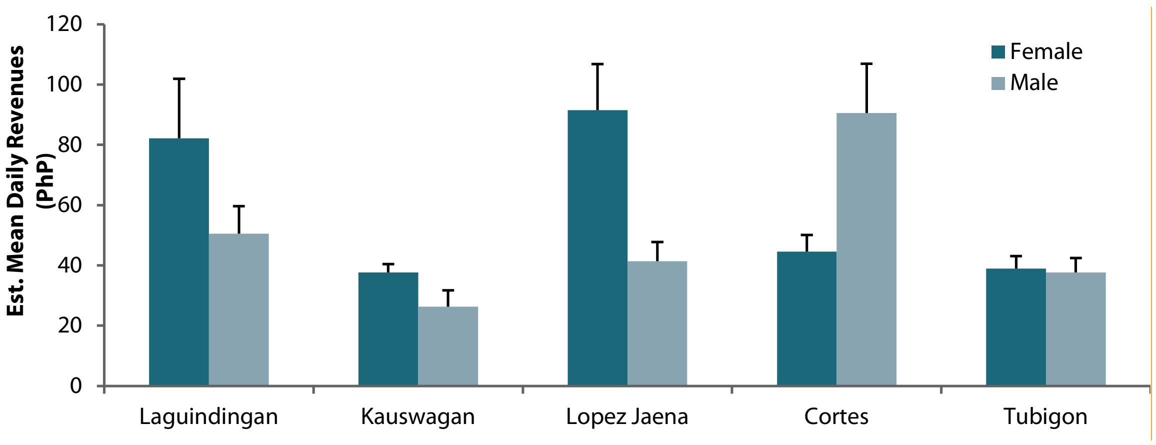

Figure 13. Estimated daily revenues from gleaning activities by men and women in surveyed sites

Income from gleaning and other sources (Table 5) seems much too low to cover the household's daily basic needs for food, medicine, and children's education. Revenues from gleaning represent only 6%–22% of the total monthly income of each family, contributing very little to the household economy. These values are much lower than what they would earn if they were to engage in other forms of livelihood (i.e., "forgone income"). Using the minimum wage rates in the Philippines for the respective provinces (from the National Wages and Productivity Commission), estimates of forgone income (or opportunity cost) of gleaners were obtained (Table 6). Resulting values indicate that gleaners lose from 66% to 91% of potential earnings as they continue to engage in less lucrative gleaning fisheries. On the other hand, there is little opportunity for employment in other labor sectors in many poor coastal communities. Thus, subsistence fisheries could be their last resort.

Table 5. Estimates of average monthly income of coastal households and contribution of gleaning to household income in surveyed sites

	Laguindingan	Kauswagan	Lopez Jaena	Cortes	Tubigon
Mean monthly income from all sources (PhP)	6,728	8,424	6,586	4,598	7,316
Mean monthly income from reef gleaning (PhP)	1,327	416	930	1,284	460
Contribution of gleaning to household income (%)	19.72	4.94	14.12	27.92	6.28

Table 6. Estimates of gleaners' forgone income if time were spent on other livelihoods

Site	Minimum wage rate* (PhP/day)	Mean revenues from reef gleaning (PhP/day)		Forgone income (PhP/day)	
		Female	Male	Female	Male
Laguindingan	291	82.12	50.57	208.88	240.43
Kauswagan	291	37.66	26.30	253.34	264.70
Lopez Jaena	291	91.47	41.34	199.53	249.66
Cortes	268	44.55	90.58	223.45	177.42
Tubigon	310	38.94	37.68	271.06	272.32

*Minimum wage rate (MWR) based on non-agriculture wage category (Source: National Wages and Productivity Commission, Department of Labor and Employment). MWR is about USD 5.99– 6.92/day (USD 1 = PhP 44.80 as of January 2015).

Average estimates of monthly revenues from gleaning in the five sites (Table 5) are slightly lower than the average monthly revenue of PhP 1,217 (USD 23) reported from the Bohol Marine Triangle (BMT) in central Philippines (Samonte-Tan *et al.* 2007); the estimated monthly revenue from Tubigon, Bohol (PhP 1,014/gleaner per month) is the closest to this BMT estimate. Hence, because of the lower estimate of aggregate household income in the BMT study (PhP 3,840), its results indicate a higher contribution of gleaning (31.7%) to total household income than in the surveyed sites in this case study. According to another recent study by Cabanban *et al.* (2014), in Negros island only 8%–21% of the respondents in the study's four sites sell part of their catch and earn PhP 175–420/gleaner per day while most gleaners in Bais Bay (90%) sell their invertebrate catch to earn a weighted average of PhP 94/gleaner per day. The same study indicates that in Banate Bay, Panay Island, 59% of gleaners sell their catch and earn a lower income of PhP 62.5/gleaner per day.

Estimates of annual yields from gleaning activities (Table 7), obtained using gleaning effort and catch rates, show that the wide reef flats of Lopez Jaena have the highest invertebrate yields of 66.22 mt compared to other sites. This is as a result of Lopez Jaena's larger average CPUE and a bigger reef area. Although total annual gleaning effort is higher in Kauswagan, lower CPUE and a smaller area for gleaning resulted in lower yields. Total annual revenues from reef gleaning range from PhP 7.50 million to PhP 19.53 million (USD 167,402 to USD 435,981). These values indicate the significant, yet unquantified, contribution of invertebrate resources to subsistence fisheries production as well as the economic value of shallow coastal ecosystems.

Table 7. Estimates of annual production from gleaning fisheries in the five survey sites

Site	Area of reef (km^2)*	No. of gleaners	Mean CPUE (kg/g/d)	No. of days/mo	Total annual effort (G-days)	Annual yield (mt)	Annual revenues (10^6 PhP)
Laguindingan	2.2	737	4.48	20	14740	66.02	15.07
Kauswagan	2.2	1446	2.46	13	18798	46.26	16.00
Lopez Jaena	6.4	809	5.85	14	11326	66.22	19.53
Cortes	6.9	612	3.02	19	11628	35.06	13.41
Tubigon	2.7	661	3.37	12	7932	26.71	7.50

*Area of reef refers to aggregate gleaning area in each site covered in the survey

4.3 Women's Contribution to Subsistence Fisheries

Women have been an iconic figure in the old tradition of sustenance fisheries in the Philippines and in the Asia-Pacific region, but until recently their contribution to coastal fisheries production and the family economy had not been properly evaluated (Kleiber *et al.* 2014). Women in subsistence fisheries of Oceania, for example, contribute significantly to marine food yields (Chapman 1987) and, by the regularity of these gleaning activities, are considered more reliable than men as suppliers of protein. According to Harper *et al.* (2013), women have a fundamental, but undervalued, role in food and nutritional security of a nation. In traditionally men-dominated cultures, such as in Asia and Oceania, women's contribution to fisheries is often underestimated (Johannes 1981) or belittled (Harper *et al.* 2013). The WorldFish Center (Weeratunge *et al.* 2010 cited by Harper *et al.* 2013) estimated that women represent between 5% and 73% of the total capture fisheries, aquaculture and postharvest workforce (both full-time and part-time) in nine major fish-producing countries.

While women may participate in conventional gear-based fisheries to a lesser degree than men, they have a high participation rate in invertebrate gathering, processing and marketing of catch and even form the bulk of laborers in seafood processing plants in the Philippines and other parts of Asia, Africa and the Pacific (Harper *et al.* 2013). Unfortunately, in most countries and regions, women's contribution to fisheries production is not recognized, quantified or reported in fisheries production statistics (Harper *et al.* 2013; Kleiber *et al.* 2014). Gleaning or subsistence fisheries in nearshore reef ecosystems is considered as an informal production sector (LeBlanc 1997) and not usually accounted for in mainstream capture fisheries production. As a result, subsistence gleaning fisheries form part of the globally under-reported fisheries production (or IUU fishing) being addressed by coastal states such as the Philippines (through RA 10654 or the amended Philippine Fisheries code).

In marginalized coastal communities of Mindanao and Visayas, women are considered resilient producers in shallow reef artisanal fisheries, withstanding the test of time and weather condition. The oldest gleaner encountered in the surveys conducted for this study is a 90-year old woman in Laguindingan, Misamis Oriental who gathers shellfish year-round and sells all her good catch in order to give her grandchildren some school allowance. At least eight elderly women (aged 60 and above) declared they have been gleaning for more than 50 years. In most survey sites, women put in more effort (i.e., longer hours) than men and even attain higher yields or CPUE (Figure 11). Male gleaners often collect high-value clams that involve laborious digging and require more muscle than what women and children have. The latter often gather sea urchins, sea cucumbers, bivalves and an assortment of gastropod shells, and other edible invertebrates by handpicking or using only small knives or sticks. Some women, however, target a certain kind of black sea urchin (*Diadema setosum*) whose gonad or roe is a popular delicacy but whose long spines require careful handling to avoid injury. On the average, women's catch represents 59.5% of the average daily harvest from gleaning in the five survey sites of this study, reaching the highest proportion in Tubigon, Bohol (78.7%) and Laguindingan, Misamis Oriental (66.0%).

4.4 Poverty Incidence among Gleaning Households

Despite the country's rich marine resources, small-scale or artisanal fishers of the Philippines remain the "poorest of the poor" (Cervantes 2012). Official poverty statistics released by the Philippine Statistics Authority (posted July 4, 2014) revealed that among the nine basic sectors of the country, the small-scale fisheries sector has the highest poverty incidence at 39.2%, which is higher than the national average of 27.9%.

Poverty statistics on the coastal communities of the five survey sites were estimated from data on family and per capita income of gleaning and non-gleaning households then compared with official poverty and food threshold values. On average, the monthly income (from all sources) of coastal families in four out of the five sites surveyed (PhP 4,753–6,902) fall below (by 8%–41%) the national poverty threshold of PhP 7,821/month (USD 175/month) for a family of five members; this is based on the 2012 first semester survey results released by the National Statistics Coordination Board (NSCB 2013). Average monthly family income in Kauswagan (PhP 8,424) is higher than that in the other sites as it includes income from business and other employment; 31.9% of respondents earn above PhP 10,000/month.

According to the NSCB survey, a family of five needs at least PhP 261/day to keep out of poverty and at least PhP 182/day (or PhP 5,458/month) to meet its basic food needs, also known as the subsistence level. Compared to provincial thresholds (NSCB 2013), estimates of daily household income from the survey sites indicate that many coastal families live below both the poverty line and the subsistence level (Table 8). Poverty incidence in coastal population (55%–82%) and families (49%–82%) are much higher than that indicated by the national poverty incidence of small fisherfolk. For instance, in the five survey sites of this study, a substantial portion (38%–75%) of the coastal population live in extreme poverty given that their subsistence incidence levels far exceed the national averages for subsistence incidence by population (13.4%) and by family (10%).

Table 8. Comparative poverty statistics among coastal households in the five survey sites

Poverty Parameter	Laguindingan	Kauswagan	Lopez Jaena	Cortes	Tubigon
Mean monthly income of gleaning HH (PhP)	5905.22	8229.00	6631.28	4740.00	5345.67
Mean monthly income of non-gleaning HH	7287.15	8619.26	7173.15	4765.33	7639.63
Mean monthly income of both gleaning & non-gleaning HH	6596.19	8424.13	6902.21	4752.67	6492.65
Poverty incidence (%) by family	62.79	48.94	70.21	82.14	69.05
Poverty incidence (%) by population	69.77	55.32	72.34	82.14	71.43
Subsistence incidence (%) by family	51.16	40.43	51.06	71.43	50.00
Subsistence incidence (%) by population	55.81	38.30	51.06	75.00	61.90

Small fisherfolk anywhere in the world who earn marginal incomes from the ocean, particularly in Asia and Africa, have all the characteristics that define poverty (Bene 2003). Fishermen as the "poorest of the poor" (Bailey 1988) is an endemic poverty perception in fisheries that follows the "vicious circle of poverty" paradigm; whatever fishers try to do, they will remain poor (Bene 2003). The conventional Malthusian poverty paradigm in artisanal or subsistence fisheries is mainly rooted in the open-access nature of fisheries as described by Gordon's (1954) bio-economic fishery model and reinforced by Hardin (1968) in his popular essay *The Tragedy of the Commons.* According to Gordon (1954), increased entry of fishers in the fishery sector can lead to economic and biological overfishing, resulting in the dissipation of economic rent and eventually leading to impoverishment of the fishing community. On the other hand, Bene (2003) believes that aside from resource-exploitation or environment-poverty relationships, social and institutional mechanisms inside and around the fisheries system play a very important role in poverty alleviation (or aggravation) in fisheries-dependent communities. In poor coastal communities, small-scale fisheries have been called the 'occupation of the last resort' (Onyango 2011; Neiland and Bene 2013). Trapped in poverty and faced with declining fishery resources and lack of viable livelihood options, subsistence fishing communities, such as those from which the reef gleaners in the Philippines' poorest coasts come from, have no other resort but to continue scouring the shallow reefs for any edible resources left after decades of this continual activity.

4.5 Contribution of Gleaning to Household Nutrition

Probably of more importance than as a supplemental income source for the family is the contribution of gleaning to the coastal household's nutritional requirements, particularly as a source of energy, protein and minerals for metabolism, muscle and skeletal growth, and other physiological functions of the human body. Seafood forms an important part of the gleaner's household diet and is an essential source of protein for poor coastal communities. Many gleaners gather invertebrates, fish and seaweed mainly for food (Cabanban *et al.* 2014; Palomares *et al.* 2014), although the gleaned harvest was primarily sold in local markets in the 1980s–1990s to supplement family income (De Guzman 1990; LeBlanc 1997). This study finds that gleaners in Lopez Jaena retain the highest portion (3.53 kg/day or 64.1%) of their gleaning harvest for family consumption (Figure 12) while majority (52%) of gleaners in Cortes sell their catch to *compradors* who visit the island almost daily. In turn, these local traders sell these seafood products at the town market or at the weekly *tabuan* (or local market days) of neighboring municipalities.

Figure 14 shows the most common seafood consumed by coastal households in the surveyed sites as well as the estimated amount of consumption for each type. Sea urchins are the most popularly consumed seafood by gleaning coastal households in Kauswagan (1.2 kg/household per day) and Laguindingan (1.1 kg/household per day). Bivalves (1.37 kg/household per day) and gastropods (0.8 kg/household per day) are more popularly consumed by such households in Lopez Jaena.

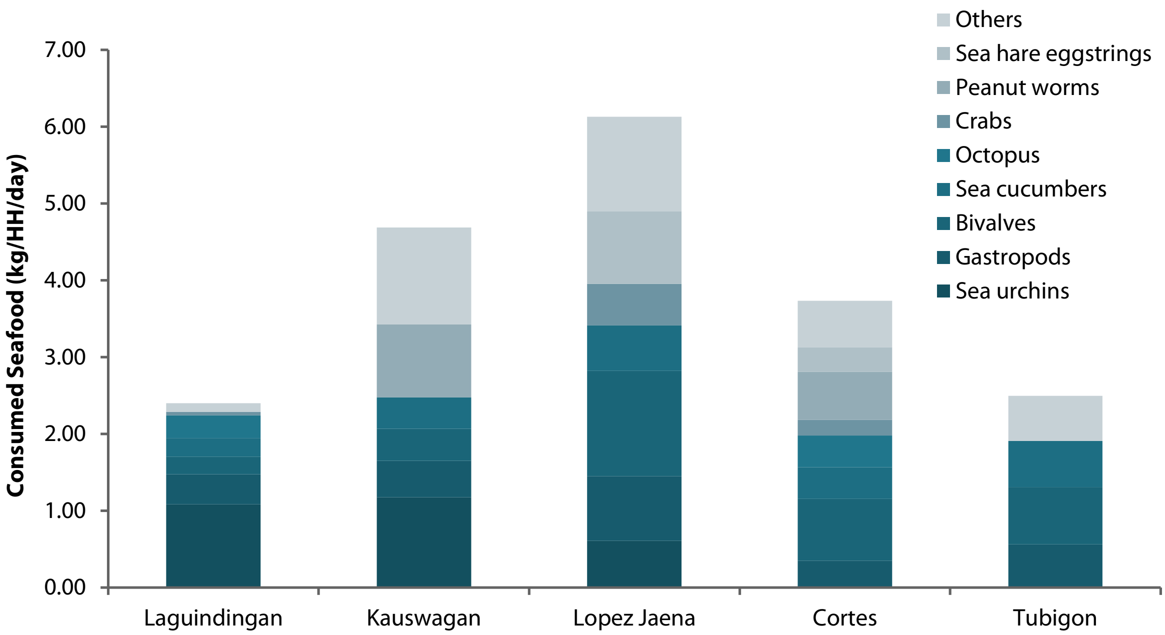

Figure 14. Comparative amounts of gleaned seafood commonly consumed by coastal households in the five survey sites

Edible sea urchins frequently gathered by gleaners in all sites comprise two species: the black-spine *Diadema setosum* and the short-spine *Tripneustes gratilla*. Compared to clams and other mollusks, sea urchins provide higher levels of energy, protein, and other nutrients that are vital to family nutrition. A 100-gram portion of sea urchins contains 172 kcal, 13.3 g of protein, 17 mg of zinc, and very little fat[2]. Clams and gastropods are also excellent sources of protein, calcium and phosphorus (FNRI 2015) while high levels of iodine are obtained from seaweed, fish and crustaceans.

Dietary reference intakes for energy, macronutrients and micronutrients have been published by the Food and Nutrition Research Institute (FNRI) of the Philippine Department of Science and Technology (DOST) to serve as a health and nutrition guide for Filipinos (FNRI 2015). Energy requirement is the amount of food energy needed to balance energy expenditure to maintain body size, body composition and

[2] *Source: Healthy Eating: Health Benefits of Eating Raw and Natural Food. 2015. http://healthbenefitsofeating.com/sea-food*

metabolic functions (FAO 2001). Protein is a macronutrient vital in the growth and maintenance of the human body and is also an important source of energy. Recommended per capita daily energy intake (REI) for children (aged 10-18 years) is higher (mean = 2,590 kcal for males, 2,143 kcal for females) than for adults aged 19-69 years (mean = 2,378 kcal for males, 1,820 kcal for females). Likewise, recommended daily nutrient intake of protein (or RNI) is higher for children (males = 2,590 g; females = 2143 g) than for adults (males = 71 g; females = 62 g). Recommended energy and nutrient intakes (RENI) are compared with actual energy and nutrient intakes based on consumed food types of each family to determine the energy and nutrient sufficiency of each household (FNRI 2015).

The food intake and the nutritional value of the different kinds of food consumed by gleaning households (including seafood) were analyzed for the five survey sites using the food composition table published by FNRI (1997) as basis for comparison. The daily nutrient intake (DNI) values in Table 9 were compared to REI and RNI values for the adult male and female to obtain nutrient sufficiency values. Results indicate that, on the average, female members of each family satisfy 96% of their daily energy requirement (mean = 1,750 kcal) and 93% of their protein requirement (mean = 53 g). Male family members satisfy only 77% and 79% of their energy and protein requirement, respectively. Owing to their more active lifestyle, men require higher amounts of energy (2,378 kcal) and protein (72 g) than women. Per capita energy intake (from all food sources) across the survey sites is similar (1,750–1,832 kcal) although protein intake is higher in Lopez Jaena (63 g) and Kauswagan (61 g) than in the other sites (Figure 15), largely due to their higher seafood intake.

The average amount of protein intake from all seafood products is moderate in both male (22 g) and female (23 g) respondents and represents only 32% and 36%, respectively, of their daily protein intake (Table 9). Average DNI of protein from gleaned seafood is higher in Tubigon, Lopez Jaena and Kauswagan (7–10g) compared to Laguindingan and Cortes (3–4 g) (Figure 15). Protein from gleaned shellfish contributes 22.5%–26.9% of seafood protein intake (Table 9), which is quite low considering that many of the household survey respondents (mean = 52.5%) engage in gleaning activities (Table 4).

Results suggest that coastal residents do not consume enough seafood for their daily protein requirement, probably because many of them would rather sell their catch to supplement household income in order to buy rice for the household's daily consumption. Among the surveyed sites, Cortes has the highest proportion (52%) of gleaners who sell their gleaned harvest to supplement family income (Figure 12). Many of the gleaners encountered on the reef flats shared that what they earn from selling their gleaned harvest is barely enough to buy a few kilos of rice each day.

Table 9. Daily nutrient intake of coastal household members (by gender) and contribution of gleaned seafood averaged over five sites

Nutrition Parameter	Energy (kcal)		Protein (g)		Calcium (mg)		Phosphorus (mg)		Iron (mg)	
	M	F	M	F	M	F	M	F	M	F
Mean DNI (all food types)	1832.0	1750.0	56.0	57.0	587.0	698.0	992.0	988.0	9.0	10.0
Mean DNI (from all seafood)	135.0	129.0	22.0	23.0	411.0	667.0	267.0	292.0	2.0	4.0
Mean DNI (from gleaned seafood)	41.0	49.0	5.0	8.0	288.0	483.0	40.0	64.0	2.0	3.0
Percent (%) share of all seafood	6.9	7.8	32.2	35.6	58.3	78.6	22.7	26.4	26.2	33.6
Percent (%) share of gleaned seafood	29.2	32.0	26.9	22.5	51.9	55.2	16.7	18.2	48.1	51.4
Recom. Nutrient Intake (RNI)	2378.0	1820.0	71.0	62.0	763.0	775.0	700.0	700.0	12.0	19.0
Nutrient Sufficiency (% of RNI)	77.1	96.2	79.3	92.6	77.0	90.1	141.7	141.1	71.9	50.2

Note: Recommended energy intake (REI) and recommended nutrient intake (RNI) values for energy, protein and micronutrients obtained from FNRI-DOST's 2015 Philippine Dietary Reference Index Tables.

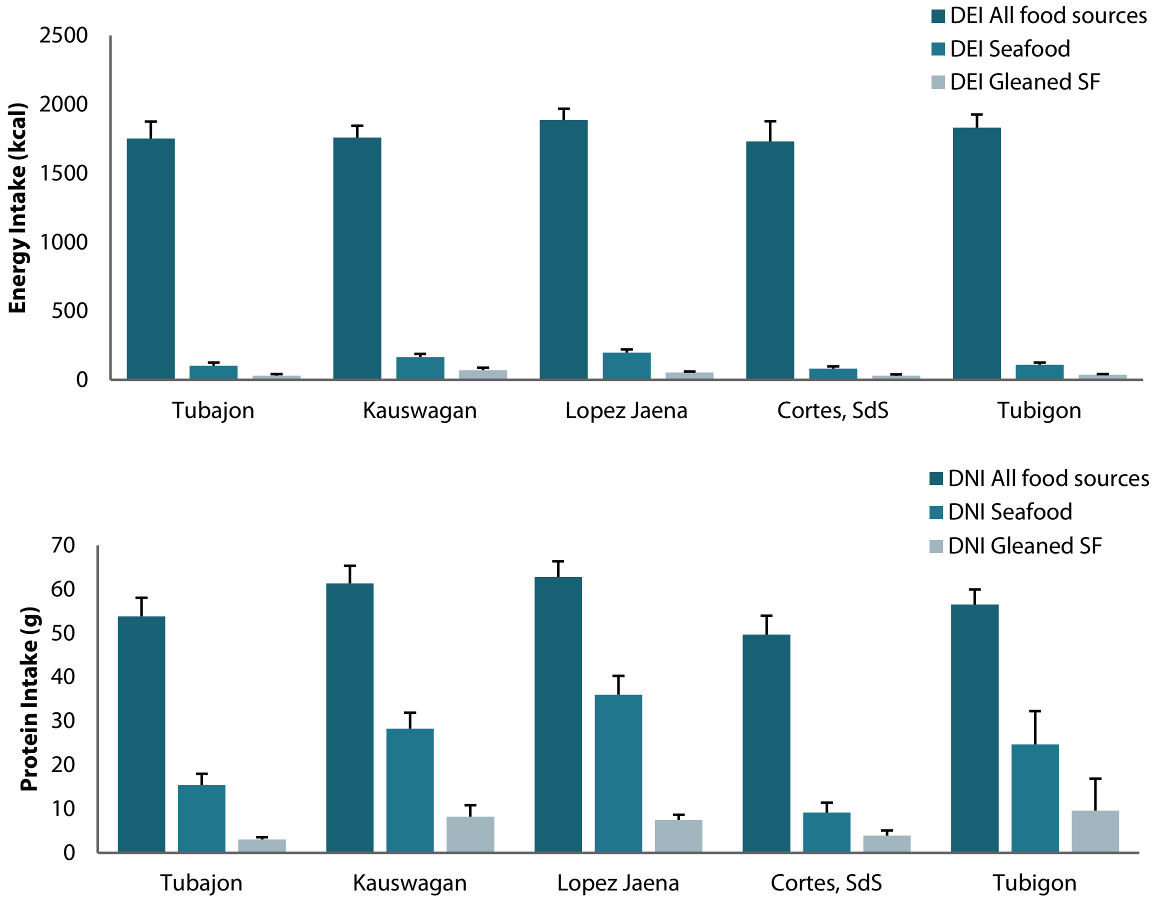

Figure 15. Average per capita daily energy (top) and protein (bottom) intake of coastal households in surveyed sites

Cereals, particularly rice, are the main source of energy (mean = 80.8%) among coastal households in the surveyed sites (Figure 16). This amount far exceeds the national average (69%) contribution of cereals to energy intake of Filipinos (FNRI 2008). The 2008 FNRI survey showed that of the average per capita energy intake (1,867 kcal/day), 70.5% comes from carbohydrates (cereals and other sources), 12.1% from protein, and 17.3% from fats. Rice is the most important staple in the Filipino diet and is consumed by 95% of households (FNRI 2008), particularly among poorer coastal communities where access to other sources of energy (such as meat) is often beyond their means.

A comparison across the five survey sites shows that coastal households in Cortes (90.3%) and Laguindingan (83.9%) have higher energy intake from rice (Figure 16). In the few cases where the proportion of rice in energy intake is lower (<40%), the households consume a significant amount of starchy food (e.g., cassava, sweet potato), which are cheaper sources of carbohydrates. Other common sources of energy among coastal households are eggs and fish, while very few households consume milk and fruits on a regular basis.

Cereals are also the main source of protein among coastal households (44%–68%) but fish and other kinds of seafood contribute a substantial amount (mean = 33.4%) to the total protein intake. On the average shellfish and other invertebrates obtained from gleaning make up 24.7% of protein from seafood, with the highest proportion (37.4%) in Tubigon, Bohol (Figure 16; see also Appendix 2). Results indicate that gleaning activities obtain much needed seafood products to increase the energy and protein sufficiency of poor coastal communities in the Philippines.

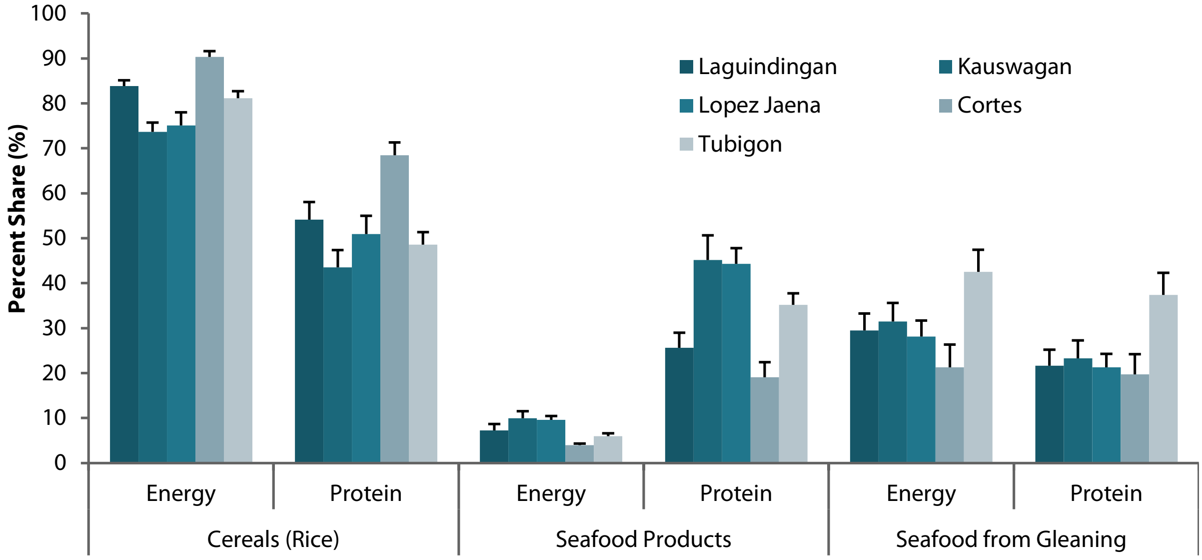

Figure 16. Percent contribution of cereals and seafood (both gleaned and from other sources) to energy and protein intake of coastal households in the five survey sites

The average diet of a typical coastal household also has variable sufficiency in terms of important micronutrients or minerals, such as calcium, iron and phosphorus. The average household diet meets only 77.0% and 90.1% of the required calcium intake (763–775 mg) for males and females, respectively, and more than half of this intake is obtained from consuming seafood (Table 9). Gleaned products such as sea urchins and shellfish are good sources of dietary calcium, essential in building skeletal strength particularly for children and the elderly.

Iron sufficiency among male members of the coastal household is higher (71.9%) than female members (50.2%), the latter having a higher daily requirement (10–28 mg, depending on age). Iron is a common deficiency among women and sufficiency can be reached by consuming iron-fortified foods or dietary supplements (FNRI 2015). The 2008 FNRI national nutrition survey shows that only 13.5% of Filipino households are able to meet 80% nutrient sufficiency in iron.

Intake of phosphorus, on the other hand, is high in all sites, even exceeding the prescribed RNI values (Table 9). High levels of phosphorus intake are not cause for alarm as this nutrient is readily available from various food sources, especially cereals, dairy, meat and processed food. Most seafood have high phosphorus content, thus a normal diet among coastal communities can easily have higher levels of this nutrient than the average daily requirement. Dietary survey data show that the average US adult male eats more than twice the amount of phosphorus than what is needed each day while women's average intake is 170% of the dietary reference intake (DRI) (LPI 2016). Phosphorus is an essential structural component of cell membranes and DNA/RNA and is also involved in bone development and metabolism, energy production and cell functions.

Iodine is another important micronutrient in human health but was not included in determining nutrient intake of the surveyed areas as a food conversion table was not available (FNRI 1997). Iodine is a key component of thyroid hormones, which are required throughout life for normal growth, neurological development, and metabolism (LPI 2016). Insufficient iodine intake impairs the production of thyroid hormones, leading to a condition called hypothyroidism. Iodine deficiency results in a range of adverse health disorders with varying degrees of severity, from thyroid gland enlargement (goiter) to severe physical and mental retardation.

Seafood is an important dietary source of iodine[3] and is readily available to coastal communities through fishing and gleaning. Products from gleaning activities such as seaweeds and shellfish are excellent sources of iodine, thus, the consumption of these seafood reduces iodine deficiency among coastal households. Only two cases of goiter were experienced among the 224 households surveyed in this case

[3] *Source: The World's Healthiest Foods. 2016. http://www.whfoods.com*

study while illnesses of the highest frequency are fever, cough and cold, and headache (Figure 17). On the other hand, overconsumption of these food items can also lead to excessive iodine intake, a condition called hyperthyroidism. The recommended daily intake level for iodine is 150 µg for both male and female while amounts above the tolerable upper intake level of 1,100 µg/day should be avoided to reduce the risk of thyroid disorders (LPI 2016).

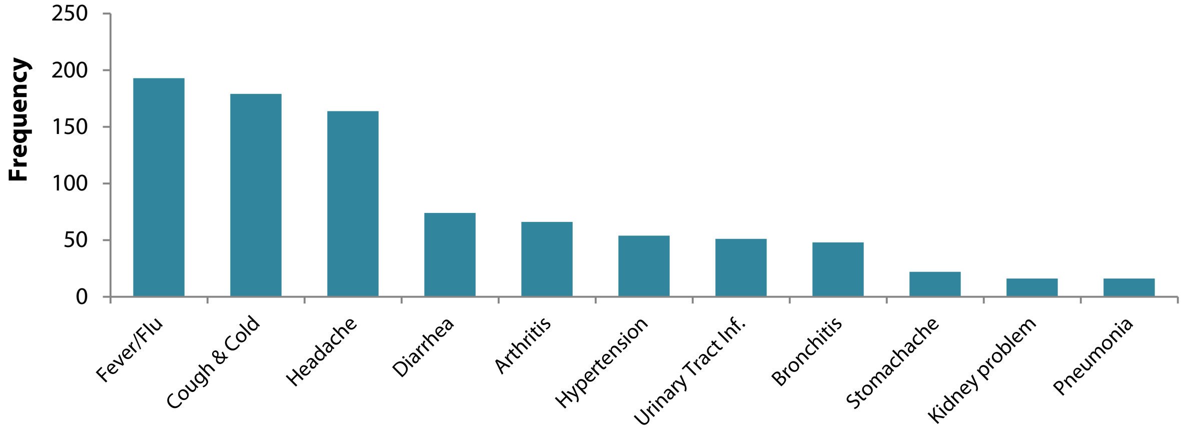

Figure 17. Most frequently experienced illnesses among coastal households

4.6 Potential Environmental Impacts of Gleaning

The most common methods of gathering edible organisms from reef flats range from simple handpicking to the use of minor implements such as knives, wooden stakes and digging blades to collect univalve shells, sea urchins, sea cucumbers and burrowing bivalves (Figures 18 and 19). Some gleaning practices are potentially damaging to the environment, such as rock overturning, using large digging blades, and gathering tiny or juvenile sea urchins and sea cucumbers. In Laguindingan and Kauswagan, men gather deep-burrowing bivalves (i.e., *Anodontia*) that are buried up to a meter deep in muddy bottoms near mangroves. This is done without tools but by simply feeling for the shellfish with their feet (Figure 20).

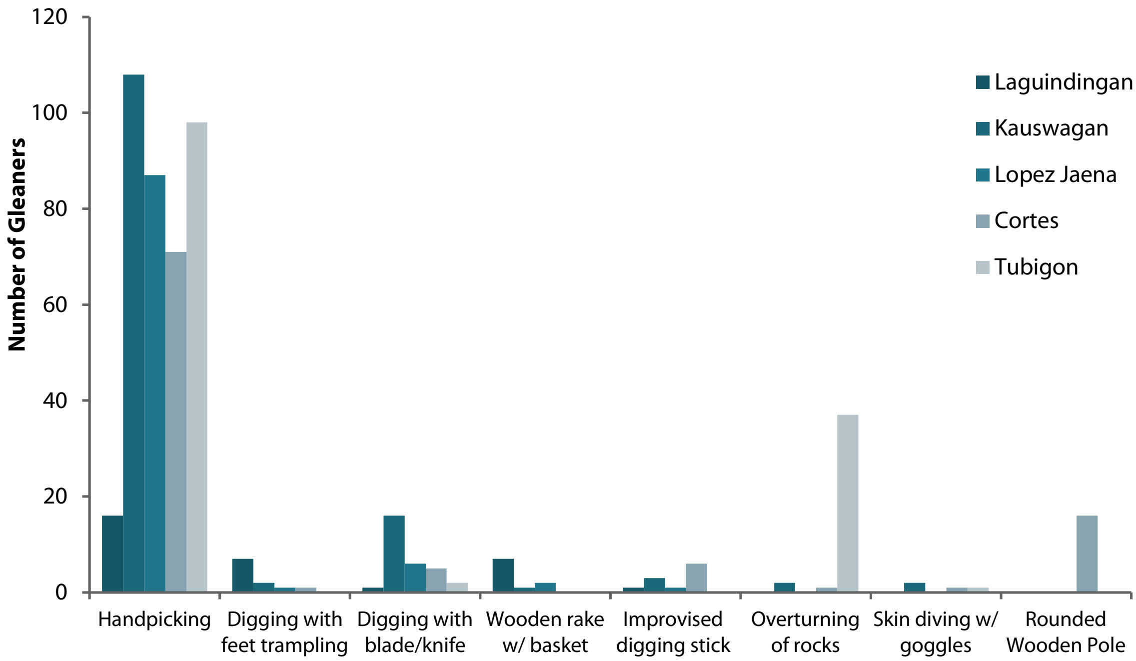

Figure 18. Common methods of gleaning practiced on the reefs in surveyed sites

Gathering black sea urchins using a tong or wooden rake.

"Swaki" (sea urchin) gathering with a bamboo stick and sack.

Small scoop net to collect shellfish or sea urchin

Gathering deep-burrowing bivalves with a stick fitted with a steel point or using a small knife or machete.

Simple handpicking and overturning of small rocks to gather shells and small fish.

Figure 19. Common methods and implements used in reef gleaning in different sites

Figure 20. Some potentially destructive gleaning practices in collecting burrowing bivalves in Tubajon, Laguindingan and Tag-anongan Island, Cortes

Most respondents, however, do not consider their gleaning practices destructive to the reef environment (Figure 21) while few admit that digging for bivalves can accidentally uproot seagrass and that reef trampling can destroy corals and other animals sheltering in the seagrass beds. Digging implements to collect deep-burrowing bivalves (e.g., *Codackia*) on seagrass beds vary among sites. In Laguindingan, the most commonly used is a flattened digging blade (about 3–4 inches wide) with a wooden handle (locally known as *duldugan*) while in Cortes the blade is replaced by a narrow, rounded steel point (locally called *panglantaka*). The impact of using these digging tools is perceived to be minimal as seagrass can recover quite fast due to its rhizomatous vegetative growth.

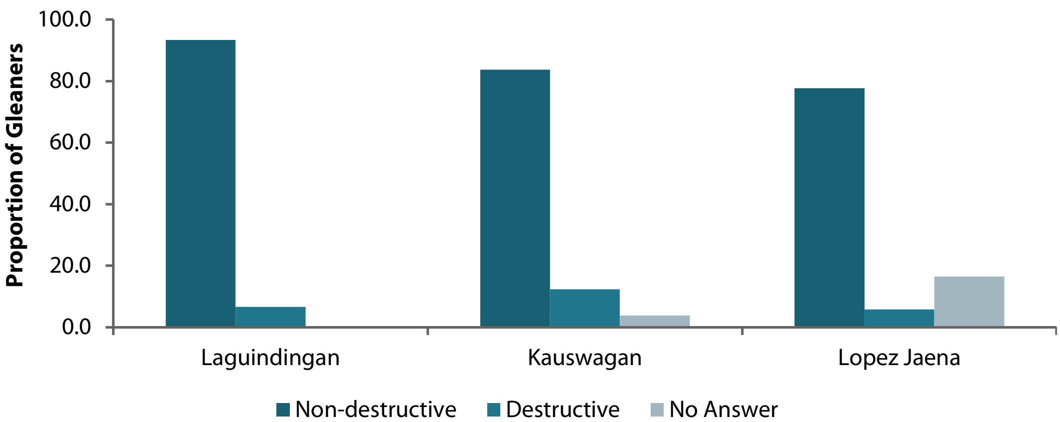

Figure 21. Perceptions of gleaners on environmental effect of their gleaning activities

The continuous trampling of soft mud along mangrove-seagrass edges to collect high-value clams can result in substantial damage to other bottom organisms. However, the gleaners argue that they do not return to the same gleaning spot for several weeks until a month so as to allow the clam stock to "recover". Such practice, however, may not be sufficient as a gleaning cycle of one month or less will not allow stock replenishment and will eventually lead to overharvesting. For instance, Geduspan (2013) found that the mud clam *A. edentula*, also called toothless lucine (SeaLifeBase 2016), which spawns throughout the year with the highest peak between April and May, needs several months to grow to an optimum size for gathering. *Mercenaria*, a similar mud clam species, usually reaches a shell length of 25–30 mm after a year, the same size by which *A. edentula* is often gathered in the Philippines (FAO 2016). Moreover, constant trampling and digging in mangrove habitats can lead to high mortality among young clam recruits. Gathering of *Mercenaria* clams in Panay and Guimaras islands in Central Philippines is reported to damage mangrove stands (Primavera *et al.* 2002).

One negative impact of continual reef gleaning is the progressive decline in yield from this subsistence fisheries and the decrease in species richness of shallow reef ecosystems. Focus group discussions (FGDs) held in Tubajon, Kauswagan, and Lopez Jaena revealed that daily catches from gleaning have gradually decreased over the decades. Historical trendlines of gleaning fisheries consolidated from the FGDs (Figure 22) show a drastic drop in CPUE (kilogram per gleaner per hour) since the 1970s for the most important gleaned resources.

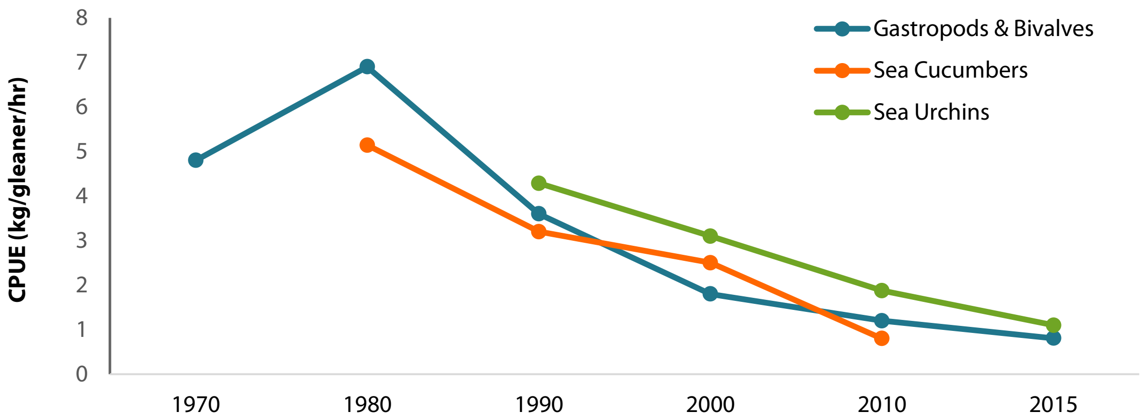

Figure 22. Catch trends of popularly gleaned seafood based on FGDs conducted in Laguindingan, Kauswagan and Lopez Jaena

Moreover, several high-value invertebrate species previously abundant in gleaning catches 10–20 years ago are already quite rare while others have disappeared (Appendix 3). The short-spined sea urchin *Tripneustes gratilla*, well favored for the exotic taste of its gonad roe, used to be abundant in the vast seagrass meadows of Tubajon, Kauswagan, and Lopez Jaena. Being harmless and easy to handle, overharvesting of this urchin has severely reduced its stock. As a result gleaners have shifted to gathering the black urchin *Diadema setosum* whose long spines can result in a mild sting and a few days of discomfort. High-value sea cucumbers also used to be abundant in shallow parts of the reef and were widely gathered for the national and global *trepang* trade. During the surveys, only small and low-value sea cucumbers were found to compose most gleaners' catches. Another previously abundant invertebrate on the reef flats of Laguindingan, Kauswagan and Cortes is the high-value clam *Codackia tigerina*, which is now quite rare as a result of overharvesting.

Studies on reef ecosystem damages resulting from gleaning activities are rare and none appear in the literature for the Philippines. Andréfouët *et al.* (2013) attributes the changes in reef flat habitats of the Grand Re´cif of Toliara (GRT in Southwest Madagascar) over the last fifty years to impacts of reef gleaning. An earlier study conducted by Salimo (1997 cited by Andréfouët *et al.* 2013) investigated the impacts of gleaning on reef flats on the GRT and suggests that chronic pressure of fishermen gleaning on reef flats using destructive tools is what mainly drives the observed changes in the reef flat environment. Salimo (1997) found that in addition to trampling live corals, on the average, one gleaner would overturn 31–49 boulders and coral heads per hour, resulting in the physical destruction of an estimated 7.7 m^2 of coral habitat per fisherman per hour. Using Salimo's (1997) estimates on level of frequentation (at 6.8 fishers per day per kilometer) and rates of destruction per fisher, Andréfouët *et al.* (2013) calculated that nearly 18,905 m^2 (0.018 km^2) of reef flats in the GRT is destroyed per year.

Based on the work of Salimo (1997) and Andréfouët *et al.* (2013), an estimate of reef damage by gleaning activities is a function of gleaner intensity (or density), frequency of visitation, duration of gleaning, and area of the reef. The potential environmental impact of gleaning in the various sites in this study in terms of reef flat damage was determined using Salimo's (1997) estimate of destruction rate of 7.7 m^2/gleaner per hour. The calculated values presented in Table 10 indicate that gleaning can potentially damage 0.02–0.06 km^2 of reef flat habitat per year.

These estimates are higher than those derived from the GRT (0.010–0.026 km^2/yr) by Andréfouët *et al.* (2013) as a result of higher gleaner density and frequency (i.e., number of days). Higher gleaner density in Kauswagan, Laguindingan and Tubigon is due to a smaller gleaning area than in Lopez Jaena (6.4 km^2) and Cortes (6.9 km^2). Moreover, the surveys conducted in Kauswagan, Cortes and Tubigon coincided with very low tide levels and, thus, several gleaners were found on the reef flat.

Table 10. Estimates of potential environmental damage from reef gleaning activities

Site	Gleaner intensity (No. of gleaners/km^2/day)	Destruction rate *Reef area destroyed*[a] (m^2/gleaner/hr)	Mean no. of hours *Gleaning per day* (hrs/gleaner/day)	Mean no. of days *Gleaning per month* (days/gleaner/mo)
Laguindingan	10	7.7	2.7	20
Kauswagan	26	7.7	1.9	13
Lopez Jaena	6	7.7	2.5	14
Cortes	8	7.7	2.3	19
Tubigon	15	7.7	2.0	12

Site	Estimated reef habitat loss (km^2/yr)	Estimated loss of reef value[b] (USD/km^2/yr)	Estimated area of reef gleaned (km^2)	Estimated annual net loss	
				USD/yr	PhP million/yr
Laguindingan	0.05	10,758	2.2	23,679	1.03
Kauswagan	0.06	13,459	2.2	29,340	1.28
Lopez Jaena	0.02	4,059	6.4	25,939	1.13
Cortes	0.03	7,559	6.9	52,179	2.27
Tubigon	0.03	7,654	2.7	20,751	0.90

Data Sources:
[a] Salimo (1997 cited by Andréfouët *et al.* 2013)
[b] Estimate of total net benefits from coral reefs of USD 2,227/ha or USD 222,700/km^2 from Samonte-Tan *et al.* 2007

Estimates of annual net revenues from coral reefs of the Bohol Marine Triangle were reported by Samonte-Tan *et al.* (2007) to sum up to USD 2,228/ha per year(USD 222,800/km^2 per year). This amount includes annual revenues from fisheries, tourism, research, and biodiversity value. Using the net revenue value from Samonte-Tan *et al.* (2007), estimates of annual net loss (i.e., forgone benefits) from reef flat habitat damage due to gleaning activities were derived for each of the survey sites. It is estimated that the annual net loss from reef flat damage as a result of gleaning activities ranges from USD 4,059 to USD 13,459/km^2 per year or amounting to USD 20,751–USD 52,179 (PhP 0.90million–2.27 million) for the gleaned areas. Present estimates of net economic loss from gleaning were derived only for coral reefs owing to lack of information on damage rate on seagrass and mangrove ecosystems. Samonte-Tan *et al.* (2007) estimated total annual benefits of USD 7,600/km^2 per year (PhP 410,000/km^2 per year) from both fisheries and invertebrate gleaning in seagrass beds and USD 98,300/km^2 per year (PhP 5.31 million/km^2 per year) from mangroves, including values from fisheries, invertebrate gleaning, erosion protection, nursery and biodiversity.

5.0 CONCLUSIONS AND MANAGEMENT IMPLICATIONS

Shallow reef flats and seagrass beds are important ecosystems to coastal communities in Mindanao and the Visayas. They provide small fisherfolk who earn marginal incomes from fishing with food and supplemental income. For most coastal households, gleaning for edible marine invertebrates provides very little additional income but, more importantly, gleaning is an essential source of high-quality seafood that provides energy, protein and other vital nutrients for the family.

Household surveys have shown that most coastal families are relatively healthy and exhibit low incidence of major illnesses associated with poor nutrition. A few full-time gleaners earn higher revenues from their gleaned harvest compared with others but their earnings are often just enough to satisfy their daily basic needs. Across sites, however, only families who have alternative income sources earn above the poverty threshold. Except in one site, poverty incidence in the coastal population exceeds 70% proving once again that small fisherfolk is the poorest of the poor sector in the Philippines. Even the subsistence incidence among the coastal population is high (mean of 56%) indicating that they are not earning enough to place sufficient food on the table. Supplemental income from gleaning, albeit small, and a steady supply of seafood obviously contributes to food security and better health among coastal fisherfolk.

High dependence (mean of 52%) of coastal households on reef gleaning activities places a great toll on the macroinvertebrate resources in all five survey sites. Increasing coastal population, open access and lack of regulation in effort and catches are considered drivers of the decline in yields, diversity, and value of subsistence reef gleaning fisheries observed in many areas. Progressive decline in CPUE values from gleaning has also been documented in other sites in the Philippines indicating that this is a ubiquitous problem in subsistence fisheries.

Gleaning used to be mainly an activity during low tide by children and women (Primavera *et al.* 2002) but decline in most small-scale or artisanal fisheries (McManus 1989), the physical demands of collecting certain kinds of invertebrates (especially deep-burrowing clams), and the lucrative prices for many target species have driven menfolk to engage in activities traditionally reserved for women in the Philippines. Until recently (Kleiber *et al.* 2014) the important contribution of women to subsistence fisheries in the Philippines has received little attention in existing literature. This case study has shown that women play a significant role in gleaning, generally exceeding effort and CPUE of men, and in ensuring the family's food security and nutrition.

Artisanal (i.e., municipal) fishers have been called the "poorest of the poor" (Bailey 1988). The 'poverty trap' experienced by many marginal fishers will induce even more ecosystem damage as gleaners continue to scour the reefs for remaining edible seafood. Andréfouët *et al.* (2013) showed that pressure in terms of human frequentation on reef flats has increased in the mid-1970s and 1980s and inferred that physical damage on the reef flats is largely due to gleaning activities. Estimates of potential damage on the reef habitat resulting from gleaning activities can range from 0.02–0.06 km^2/yr leading to annual economic losses or forgone benefits of PhP 0.9 million–2.27 million in fisheries, tourism, biodiversity value and other ecosystem services.

Work on valuing gleaning-induced damage to coral reef habitats, however, are quite rare and so far has not been reported in the Philippines. A similar assessment of potential damage from gleaning activities must also be made on seagrass and mangroves where most of the current gleaning effort is concentrated. This action becomes even more crucial amidst reports of dwindling catches from many popular gleaning areas in the country (Palomares *et al.* 2014; Cabanban *et al.* 2014; Nieves *et al.* 2010).

This case study has demonstrated that sustaining gleaning as a component of subsistence fisheries, not only in Mindanao and the Visayas but in the entire Philippines, is crucial to the economic and nutritional well-being of poverty-stricken coastal communities. Concerted effort among national and local governments, non-government organizations, and the private sector must be harnessed to maintain the health of coastal ecosystems and to sustain their productivity. Sound management policies must be formulated and implemented as these are vital to saving what is left of the invertebrate resources in reef flats as well as to sustainably support the food and income needs of marginal fishing communities in the country's coastal areas.

Focus group discussions and key informant interviews (Figure 23) in the five survey sites revealed the willingness of gleaners to participate in management efforts to sustain gleaning in their respective areas. Implementing a viable, long-term management plan for this subsistence fishery activity should maximize local participation to ensure the sustainability of economic, nutritional and environmental benefits from reef gleaning.

Figure 23. Focus group discussion with village officials in Tag-anongan Island, Cortes, Surigao del Sur (left) and Batasan Island, Tubigon, Bohol (right) to discuss the environmental impacts of gleaning practices and their policy implications

6.0 POLICY RECOMMENDATIONS

This study offers the following specific recommendations for policy formulation among LGUs across sites and other important gleaning areas in the Philippines:

1. Formulate local policies (i.e., municipal ordinances) to regulate gleaning effort and catches (e.g., registration and licensing of all resident gleaners), regulate entry of gleaners from other municipalities, and implement a viable "user fee" system for reef gleaning.

2. Establish a coastal zoning plan to identify areas for gleaning and reserve certain areas as "no entry" zones. This option will ensure that certain parts of the reef flat are protected as invertebrate reserves or sanctuaries to allow successful spawning and recruitment and, thus, sustain production for reef gleaning in adjacent areas.

3. Implement "size limits" for target species, such as high-value bivalves, sea cucumbers and sea urchins. Research on the biology of the mud clam or *imbao* (Geduspan *et al.* 2008) indicates that both male and female clams become sexually mature from 2.5 to 3.5 cm but recommends 4.0 cm as the minimum size for gathering to allow spawning and maintain stocks. Similar information on size-at-sexual maturity of other economically important macroinvertebrates should be available in literature to determine size limits for harvesting.

4. Encourage less destructive methods of invertebrate gathering. For example, instead of digging mud clam by feet, which requires much trampling in soft mud, as practiced in Laguindingan and Kauswagan, adopt the practice in Panay that involves locating the clam through the presence of 'holes' on the mangrove mud formed by the clam's inhalant tube or siphon then digging it by hand (Primavera *et al.* 2002). In Cortes, a digging stick with a narrow steel tip is used to "locate" tiger lucine on seagrass beds. This digging stick is a less destructive tool than the wide digging blade (*duldugan*) used by clam gatherers in Laguindingan.

5. Develop and provide viable alternative livelihood options, preferably non-fishery based, for women and children in order to enhance supplemental income and alleviate poverty among coastal households.

6. Implement a comprehensive information, education and communication (IEC) campaign among coastal communities as a collaborative action by LGUs, NGOs, private sector, (e.g., Smart Communication, Globe Telecom and other networks) and local academic institutions.

7. Make species inventory and catch assessment of gleaning harvest a part of the regular activity of the local fisheries division of the city or municipal agriculture office of coastal LGUs. Academic institutions and NGOs working around each site should be active partners in building local capacity for assessment of this largely ignored subsistence fishery.

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APPENDIX

Appendix 1. Taxonomic diversity of a typical gleaner's harvest compiled across five sites

Taxon/Group	Family	Local Name	Scientific Name	Common English Name
Mollusks				
Bivalves	Arcidae	Litob	*Anadara inaequivalvis*	Inequivalve ark
Bivalves	Cardiidae	Sulod-sulod	*Trachycardium flavum*	Golden cockle
Bivalves	Lucinidae	Lantaka; Tambayang	*Codackia tigerina*	Pacific tiger lucine
Bivalves	Lucinidae	Libuho; Imbao	*Anodontia edentula*	Buttercup lucine
Bivalves	Mactridae	Pulahan	*Mactra grandis*	Big brown mactra
Bivalves	Malleidae	Sungkod-sungkod	*Malleus malleus*	Black hammer oyster
Bivalves	Mytillidae	Sipi (Mussel-like)	*Musculista senhousia*	Asian date mussel
Bivalves	Ostreidae	Talaba	*Saccostrea cuccullata*	Hooded oyster
Bivalves	Pectinidae	Paypay	*Chlamys sp.*	Scallop
Bivalves	Pinnidae	Paya-paya, wasay-wasay	*Atrina pectinata*	Comb pen shell
Bivalves	Placunidae	Lampirong	*Placuna placenta*	Window pane oyster
Bivalves	Pteriidae	Tipay	*Pinctada sp.*	Pearl oyster
Bivalves	Solenidae	Tudlo-datu	*Pharella sp.*	Razor clam
Bivalves	Spondylidae	Tikod-amo; Tikod-tikod	*Spondylus sp.*	Thorny oyster
Bivalves	Tellinidae	Tagnipes	*Tellina sp.*	Tellin clam
Bivalves	Trochidae	Amahong	*Modiolus philippinarum*	Phil horse mussel
Bivalves	Veneridae	Unknown	*Anomalocardia squamosa*	Squamous venus clam
Bivalves	Veneridae	Balisala; Bisala	*Gafrarium pectinatum*	Comb venus clam
Bivalves	Veneridae	Bug-atan	*Gafrarium tumidum*	Tumid venus clam
Bivalves	Veneridae	Punaw	*Katylesia hiantina*	Hiant venus
Bivalves	Veneridae	Tuway	*Mercenaria mercenaria*	Quahog clam
Bivalves	Veneridae	Burnay	*Meretrix meretrix*	Asiatic hard clam
Bivalves	Veneridae	Kilos; Andres-andres	*Paphia textile*	Textile clam
Gastropods	Angariidae	Guba-guba (?)	*Angaria delphinus*	Common delphinula
Gastropods	Cerithidae	Tikod-tikod	*Cerithium nodulosum*	Giant knobbed cerith
Gastropods	Cerithidae	Daw-daw	*Terebralia sulcata*	Sulcate swamp cerith
Gastropods	Columbellidae	Unknown	*Mitrella scripta*	Music dove shell
Gastropods	Conidae	Kiboy; Kibul	*Conus sp.*	Cone shell
Gastropods	Cypraeidae	Bowawo; Bulalo	*Cypraea tigris*	Tiger cowrie
Gastropods	Cypraeidae	Sigay	*Monetaria (Cypraea) annulus*	Gold ring cowrie
Gastropods	Muricidae	Guba-guba	*Tenguella (Morula) granulata*	Mulberry shell
Gastropods	Naticidae	Bulan-bulan	*Polinices sp.*	Moon shell
Gastropods	Neritidae	Sihi	*Nerita sp.*	Nerite snail
Gastropods	Ranellidae	Unknown	*Cymatium pileare*	Common hairy triton
Gastropods	Strombidae	Aninikad	*Canarium (Strombus) urceus*	Little pitcher conch
Gastropods	Strombidae	Liswi	*Conomurex (Strombus) luhuanus*	Strawberry conch
Gastropods	Strombidae	Saang Baye	*Harpago (Lambis) chiragra*	Chiragra spider conch
Gastropods	Strombidae	Bongkaliw	*Laevistrombus canarium*	Dog conch
Gastropods	Strombidae	Saang	*Lambis lambis*	Common spider conch
Gastropods	Strombidae	Saang	*Lambis millepida*	Millipede spider conch
Gastropods	Strombidae	Tuka Manok	*Lentigo (Strombus) lentiginosus*	Silver conch
Gastropods	Strombidae	Aninikad	*Strombus gibberulus*	Gibbose conch
Gastropods	Strombidae	Aninikad	*Strombus labiatus*	Plicate conch
Gastropods	Trochidae	Amomongpong	*Trochus sp.*	Top shell
Gastropods	Trochidae	Amomongpong	*Trochus maculatus*	Maculated top (pink)
Gastropods	Trochidae	Amomongpong	*Trochus hanleyanus*	Lined top
Gastropods	Trochidae	Amomongpong	*Tectus fenestratus*	Fenestrate top
Gastropods	Turbinidae	Taktakon	*Turbo bruneus*	Brown Pacific turban
Sea hare	Aplysiidae	Donsol	*Dolabella auricularia*	Wedge sea hare
Sea hare eggstrings	Aplysiidae	Lukot	*Dolabella auriculata*	Wedge sea hare

Taxon/Group	Family	Local Name	Scientific Name	Common English Name
Echinoderms				
Sea cucumber	Holothuridae	Balat Mani-mani	*Actinopyga echinites*	Deep-water redfish
Sea cucumber	Holothuridae	Manapaw	*Actinopyga sp*	Redfish
Sea cucumber	Holothuridae	Balat Mat-an	*Bohadschia argus*	Leopardfish/ Tigerfish
Sea cucumber	Holothuridae	Balat tagukan	*Bohadschia marmorata*	Brownspotted sandfish
Sea cucumber	Holothuridae	Balat batunan	*Holothuria albiventer*	Marten's sea cucumber
Sea cucumber	Holothuridae	Balat uwak	*Holothuria atra*	Lollyfish
Sea cucumber	Holothuridae	Balat batuli	*Holothuria impatiens*	Impatient sea cucumber
Sea cucumber	Holothuridae	Balat pisot	*Holothuria leucospilota*	Shy black sea cucumber
Sea cucumber	Holothuriidae	Balat Uking	*Holothuria rigida*	Rigid sea cucumber
Sea cucumber	Holothuriidae	Balat Kagisan/Putian	*Holothuria scabra*	Sandfish
Sea cucumber	Stichopodidae	Balat Meroy/hanginan	*Stichopus horrens*	Dragonfish
Sea cucumber	Stichopodidae	Balat Paa sa Dalaga	*Thelenota anax*	Amber fish
Sea urchin	Diadematidae	Tuyom	*Diadema setosum*	Longspine black sea urchin
Sea urchin	Temnopluridae	Dapaw-dapaw	*Salmacis sphaeroides*	Green spine sea urchin
Sea urchin	Toxopneustidae	Swake	*Tripneustes gratilla*	Short-spined sea urchin
Finfishes				
Eel	Muraenidae	Bakasi	*Gymnothorax sp.*	Moray eel
Fish	Apogonidae	Ibis	*Apogon sp.*	Cardinalfish
Fish	Chaetodontidae	Alibangbang	*Chaetodon sp.*	Butterfly fish
Fish	Gobiidae	Bunog	*Not identified*	Goby
Fish	Gobiidae	Tambasakan	*Not identified*	Mudskipper
Fish	Labridae	Lupit	*Choerodon sp.*	Tuskfish
Fish	Labridae	Taad; talad	*Cheilio inermis*	Cigar wrasse
Fish	Labridae	Labayan	*Not identified*	Wrasse
Fish	Pomacentridae	Palata	*Chromis sp*	Damselfish
Fish	Scaridae	Bontog	*Leptoscarus sp.*	Parrotfish
Fish	Scorpaenidae	Bantol	*Not identified*	Stonefish
Fish	Siganidae	Danggit	*Siganus canaliculatus*	Mottled spinefoot
Fish	Siganidae	Kitong	*Siganus guttatus*	Golden Spinefoot
Fish	Synodontidae	Tiki-tiki	*Synodus sp.*	Lizardfish
Other Groups				
Brachiopods	Lingulidae	Ugpan	*Lingula unguris*	Common lamp shell
Crabs	Portunidae	Lambay	*Portunus pelagicus*	Blue swimming crab
Crabs	Portunidae	Kasag	*Thalamita crenata*	Crenate swimming crab
Jelly Fish	Cassiopeidae	Bokya	*Cassiopoeia sp.*	Upside-down jellyfish
Octopus	Octopodidae	Tabugok	*Octopus sp.*	Octopus
Peanut worm	Sipunculidae	Saypo; Salpo	*Sipunculus sp.*	Peanut worm
Stomatopods	Gonodactylidae	Mantaha, Manlilitik	*Gonodactylaceus sp.*	Mantis shrimp

Note: Species identification of invertebrates has been verified using the World Register of Marine Species (WoRMS) (www.marinespecies.org) and SeaLifeBase (www.sealifebase.org) databases. Fish identification was done with the help of Allen *et al.* 2003. For items without specimens or photos, identification was limited to Genus or Family level.

Appendix 2a. Summary of per capita daily nutrient intake by coastal residents in Tubajon, Laguindingan, Misamis Oriental

Nutrition Parameter	Energy (kcal)		Protein (g)		Fat (g)		Calcium (mg)		Phosphorus (mg)		Iron (mg)	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Mean DNI from all food types	1881	1624	53	55	10	12	515	607	1047	903	11	8
Mean DNI from all seafood	97	112	15	16	2	3	253	403	221	201	3	2
Mean DNI from gleaned seafood	24	39	3	3	1	2	123	244	33	26	2	2
Percent (%) share of all seafood	7.0	7.5	25.6	25.5	24.0	24.0	55.3	56.8	20.5	21.0	24.0	23.7
Percent (%) Share of gleaned seafood	29.2	29.7	22.3	21.0	41.5	33.3	39.5	53.8	19.7	14.2	44.0	50.2
Recommended Daily Intake (RNI)	2,393	1,846	67	58	35	35	864	943	738	738	14	23
Nutrient Sufficiency (% of RNI)	**79.1**	**89.2**	**73.9**	**89.3**	**28.3**	**35.6**	**67.5**	**78.3**	**149.5**	**129.0**	**93.6**	**40.3**

Codes or acronyms used: DNI = Daily Nutrient Intake; HH = Household; SF = Seafood; RDI = Recommended Nutrient Intake (also known as Required Dietary Allowance or RDA).

Appendix 2b. Summary of per capita daily nutrient intake by coastal residents in Kauswagan, Lanao del Norte

Nutrition Parameter	Energy (kcal)		Protein (g)		Fat (g)		Calcium (mg)		Phosphorus (mg)		Iron (mg)	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Mean DNI from all food types	1962	1553	66	56	17	12	634	763	1204	909	8	9
Mean DNI from all seafood	143	188	25	31	3	3	390	1011	297	352	2	5
Mean DNI from gleaned seafood	47	93	5	12	0	1	299	854	26	78	1	4
Percent (%) share of all seafood	8.0	11.8	41.2	49.1	19.9	30.1	69.4	139.1	28.7	33.9	31.2	51.4
Percent (%) share of gleaned seafood	23.2	39.7	32.9	13.7	10.1	26.6	54.7	66.3	6.2	21.8	44.4	61.7
Recommended Daily Intake (RNI)	2,393	1,846	67	58	35	35	864	943	738	738	14	23
Nutrient Sufficiency (% of RNI)	**74.8**	**97.3**	**91.6**	**117.7**	**37.3**	**44.8**	**65.1**	**124.3**	**140.2**	**151.3**	**54.3**	**47.1**

Appendix 2c. Summary of per capita daily nutrient intake by coastal residents in Lopez Jaena, Misamis Occidental

Nutrition Parameter	Energy (kcal)		Protein (g)		Fat (g)		Calcium (mg)		Phosphorus (mg)		Iron (mg)	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Mean DNI from all food types	1773	1998	64	62	17	16	626	636	999	1059	10	10
Mean DNI from all seafood	283	115	51	21	7	2	806	418	553	234	4	2
Mean DNI from gleaned seafood	77	31	11	4	2	0	501	281	83	27	3	1
Percent (%) share of all seafood	11.2	8.0	47.3	41.3	27.0	21.3	64.5	66.7	28.8	28.0	33.8	24.8
Percent (%) share of gleaned seafood	25.5	30.7	20.2	22.4	22.0	17.3	58.4	49.8	14.2	14.3	51.8	49.7
Recommended Nutrient Intake (RNI)	2393	1846	67	58	35	35	864	943	738	738	14	23
Nutrient Sufficiency (% of RNI)	**74.6**	**109.8**	**89.8**	**99.8**	**48.1**	**46.4**	**82.1**	**82.1**	**142.8**	**151.3**	**81.4**	**50.5**

Appendix 2d. Summary of per capita daily nutrient intake by coastal residents in Cortes, Surigao del Sur

Nutrition Parameter	Energy (kcal)		Protein (g)		Fat (g)		Calcium (mg)		Phosphorus (mg)		Iron (mg)	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Mean DNI from all food types	1802	1661	54	45	9	7	526	440	945	823	7	8
Mean DNI from all seafood	81	83	6	13	1	1	126	485	64	153	1	3
Mean DNI from gleaned seafood	24	38	3	5	0	0	213	414	16	35	1	2
Percent (%) share of all seafood	4.0	3.9	13.9	24.3	7.6	17.6	30.8	60.0	9.2	17.7	12.5	28.2
Percent (%) share of gleaned seafood	20.4	22.1	17.2	22.2	12.6	18.4	47.0	54.7	9.1	14.3	39.0	39.1
Recommended Nutrient Intake (RNI)	2393	1846	67	58	35	35	864	943	738	738	14	23
Nutrient Sufficiency (% of RNI)	**75.8**	**91.3**	**76.4**	**72.8**	**25.4**	**20.2**	**69.0**	**56.8**	**135.0**	**117.6**	**57.2**	**42.7**

Appendix 2e. Summary of per capita daily nutrient intake by coastal residents in Tubigon, Bohol

Nutrition Parameter	Energy (kcal)		Protein (g)		Fat (g)		Calcium (mg)		Phosphorus (mg)		Iron (mg)	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Mean DNI from all food types	1742	1917	45	68	5	12	635	1044	863	1244	7	13
Mean DNI from all seafood	73	149	13	36	1	4	479	1016	201	522	2	10
Mean DNI from gleaned seafood	32	43	5	15	0	1	305	619	44	153	1	8
Percent (%) share of all seafood	4.1	7.7	32.8	37.5	26.2	26.4	71.7	70.2	26.2	31.3	29.6	40.0
Percent (%) share of gleaned seafood	47.4	37.6	41.7	33.1	43.6	31.9	59.8	51.6	34.2	26.4	61.3	56.4
Recommended Nutrient Intake (RNI)	2393	1846	67	58	35	35	864	943	738	738	14	23
Nutrient Sufficiency (% of RNI)	**73.3**	**105.3**	**63.1**	**110.1**	**14.2**	**35.7**	**83.3**	**134.7**	**123.3**	**177.7**	**56.16**	**68.2**

Appendix 3. Consolidated results of perception survey on catch trends and income, family nutrition and environmental effects of reef gleaning from focus group discussion and key informant interviews in Laguindingan, Kauswagan and Lopez Jaena (May-June 2015)

Parameter/Concern	Perceived Change	Reasons for Changes & Other Observations
Amount of catch or harvest	Decreased	Too many gatherers; Stock has decreased since started gleaning (around 1980's)
Biodiversity or variety of harvested invertebrates	Decreased	Some kinds or species of shellfish that used to be abundant are now very rare or are no longer found
Price of gleaned items	Increased	Smaller catch; Most high-value invertebrates are very rare; In earlier years catch was bartered for root crops (sweet camote, etc.)
Daily income from reef gleaning	Decreased	Smaller catch; Most of daily income from gleaning only enough to buy rice
Number of gleaners	Increased	Decline in fishing catch and income drives men to also engage in gleaning; Many children also glean
Amount of seafood from gleaning consumed by family	Decreased	Recently most of catch is sold in order to buy rice; Any items of value are sold (e.g., sea cucumber, sea urchin, *aninikad*, bivalves) Only those with little value or few in numbers are retained for family consumption
Is amount consumed from reef gleaning enough for the family?	Not enough	Catch is mostly sold rather than eaten
Effect on family nutrition	None	Family is still healthy even with small amounts of seafood eaten; No major ailments in the family who eats seafood from gleaning
Environmental impacts of gleaning	Yes	Chronic/daily activity caused decline in resources; Decrease in diversity (some species have either disappeared or are very rare); reef trampling destroys seagrass and other animals
Destructive gleaning practices	Yes	Uprooting of seaweed; destruction of seagrass by push net (*sudsud*) before it was banned in 1995; overturning of rocks; trampling on mangroves/seagrass by digging for mud clams (*libuho* or *imbao*)
Suggestions for sustainable gleaning fisheries		Continue to implement ban of *libuho* gathering (Municipal ordinance in Laguindingan); Impose a size regulation on gleaned items (e.g., sea urchin, shells, sea cucumbers); Government to provide livelihood to fishers and women in coastal areas

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