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Contribution of Gleaning Fisheries to Food Security and Nutrition of Poor Coastal Communities in the Philippines

ABSTRACT

Gleaning for edible invertebrates on shallow reef flats is a chronic activity in the Philippines mainly for subsistence but also for supplemental family income. A case study carried out in five gleaning sites in the Visayas and Mindanao islands evaluated the contribution of reef gleaning to food security and nutrient adequacy of artisanal fishing households, among the poorest sectors in Philippine society. With a high proportion (38-75%) living in extreme poverty, dependence on gleaning as a source of energy and vital nutrients is very high. The typical diet of coastal households in the surveyed sites is mainly composed of rice (49%), fresh fish (10%) and gleaned invertebrates (14%). Individual members of coastal households consume an average of 930g of food daily, equivalent to energy (1891 kcal.day^{-1}) and protein (62.7 g.day^{-1}) intakes, exceeding national averages. Coastal communities have higher adequacy in protein (mean = 68%) than energy (mean= 43%), calcium (44%) and iron (29%) indicating diet of many households do not meet the daily recommended energy and nutrient intake (RENI). Significant contribution of gleaned seafood to protein intake of coastal families and highlight the need to formulate sound management policies to sustain the nutritional benefits from reef gleaning for marginal fishing communities.

Key words: *Reef gleaning, subsistence fisheries, food security, nutrient adequacy*

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INTRODUCTION

The Philippine archipelago is bordered by the third largest expanse of coral reef associated with a single nation (*Spalding et al. 2001*), thus, it is not surprising that majority of the country's population live in coastal areas whose livelihoods are almost invariably linked to the sea (*Wittingham et al. 2003*). Gleaning (or panginhas in the local dialect in Visayas and Mindanao) or the gathering of edible marine invertebrates and seaweed on shallow intertidal areas of the coral reef-seagrass-mangrove ecosystem complex during low tides is an ubiquitous, traditional activity among women, men and children in the Philippines (*Savina and White 1986; De Guzman 1990; McManus et al. 1992; LeBlanc 1997; Del Norte-Campos et al. 2004*), Southeast Asia, and the Pacific islands (*Johannes 1981; Chapman 1987; Starkhouse 2003*). Gleaning in the Philippines is carried out partly for supplemental income but mainly for family consumption as food (*LeBlanc 1997; Samonte-Tan et al. 2008; Cabanban et al. 2014; Palomares et al. 2014*). As catches from artisanal fishing activities decline as a consequence of overfishing and unsustainable fishing practices, coastal communities become increasingly dependent on reef gleaning for food and supplemental livelihood.

Despite the country's rich marine resources, small-scale or artisanal fishers of the Philippines remain the "poorest of the poor" (*Cervantes 2012*), with a large portion of the population living in extreme poverty (i.e. below the subsistence or food threshold). Official poverty statistics released by the Philippine Statistics Authority in 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%. For many poor coastal

communities in the Philippines reef gleaning that obtains a wide variety of invertebrates represents a cheap and reliable supply of seafood to meet the family's nutrient requirement.

Seafood is an excellent source of energy, protein and essential fatty acids (*Nesheim and Yaktine 2007*) as well as vital micronutrients for human health, structural development and metabolism, energy production and cell functions. Marine fish and invertebrates are an important part of the human diet, their contribution to nutrition is usually evaluated in terms of protein value which is of paramount importance to human subsistence (*Chapman 1987; Bene et al. 2007*). There is a growing awareness of the beneficial role of fish and other marine foods in human nutrition and over the decades there has been an increased preference for seafood, rather than meat, as the main source of high-quality dietary protein (*Edwards 1992*). Seafood is also the richest source of omega-3 fatty acids that have been shown to have a secondary protective role in coronary heart diseases (*Dahl et al. 2011*).

Despite the importance of reef gleaning in subsistence fisheries there is very little documentation on its contribution to food security and nutrition of coastal communities in the Philippines. On the other hand, a lot of work had been done on production and economic values from gleaning (*Samonte-Tan et al. 2008; Cabanban et al. 2014; Palomares et al. 2014; Kleiber et al. 2014*). *D'Agnes et al.* (*2010*) examined the impact of coastal resource management (CRM) and reproductive health interventions on health and food security status of coastal communities in Palawan, Philippines but did not focus on nutrient intakes from gleaned invertebrates. Their results strongly suggest that a combined CRM+RH approach yields a larger impact on human health and food security compared to the sectoral management approaches. A recent work by *Kleiber et al.* (*2014*) focused on evaluating the amount of women's gleaning output to subsistence of coastal households in Danajon Reef in the Bohol province but did not estimate its contribution to household nutrition. A closely related study by *Bell et al.* (*2009*) evaluated the fish consumption of Pacific Island countries and territories (PICTs) and its contribution to meeting the required dietary protein for good nutrition. They found that many rural communities in the PICTs depend heavily on fish: consumption was twice that in urban centers, fresh fish dominates the diet, and fish provides the majority of animal protein for coastal fishing communities.

The Food and Nutrition Research Institute (FNRI) of the Philippines' Department of Science and Technology (DOST) conducts a National Nutrition Survey (NNS) every five years to evaluate the nutritional status of Filipinos. Food security is an important factor in the nutrition and health of the household and is considered a proxy to poverty incidence (*FNRI 2015b*). Households are considered food secure when they have access at all times to sufficient, safe, and nutritious food needed to maintain a healthy and active life (*World Food Summit, 1990 cited in FNRI 2015b*). The Dietary Survey Component of the NNS provides information on the quality and quantity of food consumed by members of the Filipino household, and also calculates the amount of energy and nutrient intake by individuals. Comparing these values with reference values for energy and nutrient intakes (RENI) published by the *FNRI* (*2015a*) would determine nutrient adequacy or sufficiency of households and serve as guide for good nutrition and health.

A case study was undertaken in 2015 (*De Guzman et al. 2016*) to look at the economic and social values and potential environmental impacts of subsistence fisheries from reef gleaning in five sites in Mindanao and the Visayas in the Philippines. Gleaning on shallow reef flats, seagrass beds, and along the edges of the mangrove forest is almost a daily activity in all sites, involving men, women, and children of various ages. Dependence on reef gleaning by coastal communities for subsistence is very high, reaching 81-92% of respondents in the surveyed sites. More than 4,200 coastal residents in the five survey sites engage in gleaning either in full-time or part-time capacity (i.e., occasionally or mainly as a hobby). Gleaning produces an average daily yield of 367.4 kg of invertebrates, largely composed of univalve shellfish, clams, sea urchins and sea cucumbers (*De Guzman et al. 2016*). Average monthly incomes from fishing and other forms of livelihood indicate that poverty incidence among artisanal fishing population in the surveyed sites is much higher (39-83%) than the national poverty incidence among fisherfolk. A large portion (38-76%) of the coastal population in the survey sites lives in extreme poverty or below subsistence level, far exceeding the national average of 13.4%.

As a component of the case study this paper estimates the food consumption and nutrient sufficiency of coastal households in the study sites and evaluates the contribution of gleaning to the households' nutrient intake. This information is vital to the formulation of appropriate policy recommendations to regulate and sustain gleaning as an important component of subsistence fisheries and in ensuring food security in marginal coastal communities.

MATERIALS AND METHODS

Survey Sites

Assessment of the socio-economic benefits of reef gleaning was carried out in five sites across Mindanao and the Visayas covering ten coastal barangays, namely, Barangay Tubajon in Laguindingan, Misamis Oriental; Brgy. Poblacion and Kawit Oriental in Kauswagan, Lanao del Norte; Brgy. Biasong, Catipa, and Poblacion in Lopez Jaena, Misamis Occidental; Brgy. Tag-anongan Island and Mabahin in Cortes, Suriago del Sur and Bgry. Cabulijan and Batasan Island in Tubigon, Bohol (**Figure 1**). All sites have wide emergent reef flats with healthy and diverse seagrass beds that serve as habitats for a wide variety of invertebrate resources. In all sites gleaning mainly for invertebrates during low tides is a common, traditional activity among coastal residents.

Demographic and Nutritional Profile

This case study was designed as a rapid appraisal of reef gleaning as a chronic activity on shallow reef areas of many areas in Mindanao and the Visayas. The rapid appraisal technique appropriate in obtaining preliminary information on natural resources under a 'limited funding, time and manpower' scenario but tends to miss vital information on monthly variations in production and revenues. Nonetheless it is useful and cost-effective means of describing the state of an exploited resource or existing management system (*Pido et al. 1997; Berkes et al. 2001*).

Household surveys were conducted in the five sites between January to June 2015 to obtain demographic, nutritional, and health profiles of the coastal communities. 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 30-50 households in each site. A total of 225 households were surveyed across the five sites.

The standard and accurate method of dietary assessment or determination of the daily food consumption by a family used by the FNRI is household food weighing, where actual amounts of foods consumed by all members of the household are obtained by means of weighing each meal with the use of dietetic scales (*FNRI 2008*). Unfortunately, this method is time-consuming, expensive and manpower-heavy, requiring the researcher to spend a whole day in each household to conduct the assessment to cover breakfast, lunch, and supper.

In the present case study data on the amount of daily food consumption for each family were obtained from the household survey through a 24-hour food recall method due to time constraints. The 24-hour recall is also considered to be a valid instrument for the assessment of energy and nutrient intake and does not require too much time to collect. In 2015, FNRI used a 7-day recall method in updating the nutritional status of Filipino children and other population groups (*FNRI 2016*), using the Food Frequency Questionnaire Survey recommended by the World food Program (WFP) to determine Household Dietary Diversity (HDD) as a measure of food security.

Each respondent (usually the mother) was asked to itemize the kinds and quantities of food they usually eat in a day, including seafood from fishing and reef gleaning.

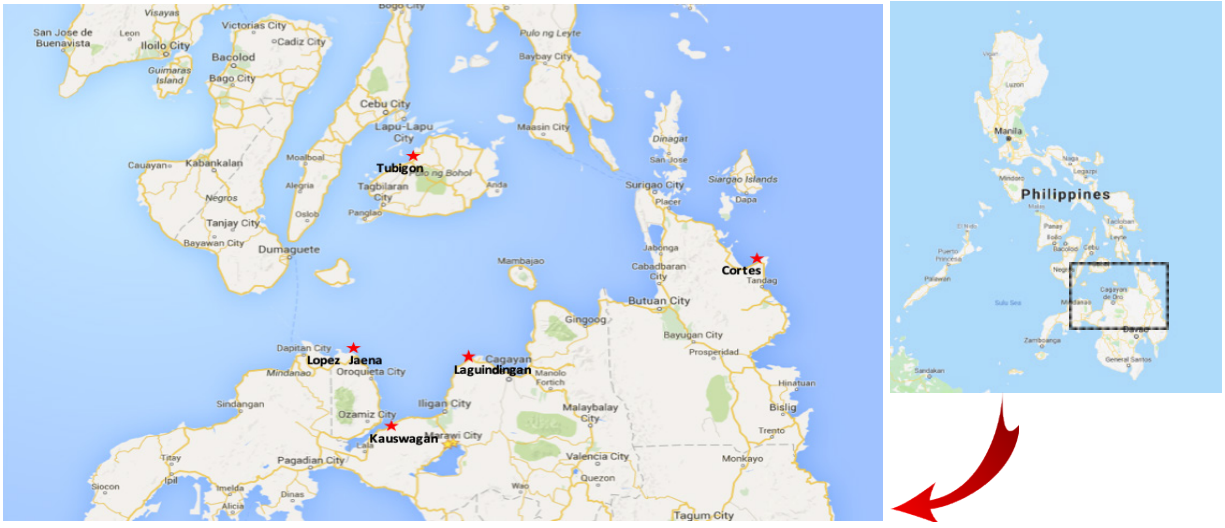

Figure 1. Map of northeastern Mindanao and central Visayas indicating location of survey sites (red stars).

Food items that are eaten occasionally (i.e., once a month or a few times in a year) were not included in the analysis.

Data Analysis

Quantities of all food items were expressed in their equivalent weights in grams and were compared with national averages obtained from national nutrition surveys (*FNRI 2008; FNRI 2015b*) to determine food adequacy among households. Energy and nutrient equivalents (namely protein, fats, and minerals) of each 100g of foodstuff were estimated based on the food composition table (FCT) for the Philippines (*FNRI 1997*) and from other sources in the case of certain seafoods or nutrients not listed in the FCT. The total protein (TP) obtained by each family, which is the sum of the protein equivalent (PE) from all food items, was computed as follows (*FNRI 1997*):

$$TP = \sum_{i-1}^{n} PE_i$$

then divided by the household size (i.e., number of family members excluding infants < 2 years old whose diet consists mainly of milk) to obtain per capita protein intake. Using the same procedure, per capita intake of other macronutrients (e.g., total amount of energy and fats) and selected micronutrients (e.g. ,calcium, phosphorous, and iron) of each household was determined. The amount of vitamins and other minerals from consumed food, however, were not estimated due to time constraint although these are important information to show micronutrient sufficiency (or deficiency) in each household. Moreover, data on nutrient intake were not segregated by sex or age groups due to data limitations.

Reference values for energy and nutrient intakes (RENI) published by the Philippines' Food and Nutrition Institute (*FNRI 2015a*) serve as guide for good nutrition and health. Recommended per capita daily intake of energy, protein, and other nutrients vary across physiologic groups, i.e., weight and age group (i.e., infants, children, and adults) and between male and female, pregnant, and lactating women (*FNRI 2015a*). Energy and nutrient sufficiency or adequacy is an important indicator of family nutrition and is expressed in two ways, namely, energy and nutrient adequacy of individuals and those of households in a given site. Nutrient adequacy or sufficiency (%) in each site was determined from the proportion of coastal households meeting the recommended energy and nutrient intakes (RENI) published by FNRI (*Barba and Cabrera 2008; FNRI 2015a*), averaged across age and sex groups. Households are considered to have adequate daily dietary energy (DDE) intake if they meet the 100% RENI while nutrient adequacy is based on households meeting at least the estimated average daily requirement (EAR) of 80% of RENI for protein and micronutrients such as vitamins and minerals (*FNRI 2008*).

Seafood is expected to be a significant component of the dietary composition of households living along the coast of archipelagic states such as the Philippines. The percentage share of seafood to the total energy and nutrient intake of each household was determined from food consumption data. Likewise, the contribution of reef gleaning to household nutrition was determined by calculating the percentage share of gleaned seafood to the energy and nutrient intake from all kinds of seafood including finfish. Nutrient intake and sufficiency were compared among gleaning and non-gleaning households across sites using appropriate statistics in the PAST software (*Hammer et al. 2001*). The Kruskal-Wallis non-parametric analysis of variance was used to compare nutrient intake and sufficiency across sites while the one-tailed t-test compared these values between gleaning and non-gleaning households.

Limitations of the Study

As a case study, this article has some limitations, including the assumption that food is equally shared/ distributed among household members. There is no gender and age segregations on the amount of food intake. The study also failed to capture seasonal variations in the availability and access to reef gleaning and consequently on food intake due to time and budgetary constraints.

RESULTS AND DISCUSSION

Gleaning Catch Composition

Gathering of edible seafood or gleaning from shallow reef areas in many parts of Mindanao and the Visayas is carried out by men, women, and children mainly for food or subsistence, however, many gleaners engage in this artisanal activity for supplemental income (*De Guzman et al. 2016*). Reef gleaning in five study sites obtains a diverse harvest of edible marine invertebrates, largely composed of echinoderms, echinoderms (sea cucumbers and sea urchins) and mollusks (gastropods and bivalves) (**Figure 2**). Sea urchins, mainly made up of two species (i.e., the short-spined *Tripneustes gratilla* and the black, long-spined *Diadema setosum*) are gathered for their ripe gonad or roe, a popular and exotic food item that is sold fresh in bottles in the local markets. Sea cucumbers are

Figure 2. Most popular kinds of seafood from reef gleaning in surveyed sites.

widely exploited and eaten as freshly pickled delicacy or traded for their dried body wall or trepang. Certain species of sea cucumbers e.g. *Holothuria scabra, Actinopyga* spp and *Stichopus*) are highly valued in the export market as beche-de-mer, and overharvesting of these commodities had led to the virtual disappearance of many species from shallow reef areas in the Philippines (*Choo 2008*). The most abundantly gathered gastropods are small conch shells locally called *aninikad* (commonly Canarium urceus) and the spider conch or *saang* (*Lambis* spp) while the most common bivalves are shallow-burrowing surf clams (*Katylesia hiantina* or *punaw*), blood clams (*Anadara* spp or *litob*), and deep-burrowing lucine clams such as *lambayang* (*Codackia tigerina*) and imbao (*Anodontia edentula*). An exotic component of the gleaner's catch in some sites is the edible egg string (locally called *lukot*) of the tropical sea hare *Dolabella auricularia* (locally known as *donsol*) that appear seasonally (March to April) in seagrass meadows.

Food Consumption of a Typical Coastal Household

On the average coastal households in selected sites of Mindanao and the Visayas consume about 3.9 kg of food daily. Households in Lopez Jaena, Misamis Occidental have the highest mean daily food consumption (4.7 kg day^{-1}) while those in Laguindingan, Misamis Oriental and Cortes, Surigao del Sur consume the lowest amounts of food (3.1-3.4 kg day^{-1}). Dividing these amounts by the average number of household members results in per capita food intake ranging from 617-1,153 g with a mean of 930 g (**Table 1**). This value is higher than the national average daily individual food intake (855 g) due to larger intake of rice and other cereals (mean = 446 g) and combined intake of fresh fish and invertebrate seafood (227g) among the coastal population. The typical daily diet of coastal households (**Figure 3**) consists largely of cereals (49%) mainly rice or corn, gleaned seafood (14%), fresh fish (10%), root crops (5%), fruits (4%), and vegetables (4%). Beverages represent a fair amount (5%) in the family diet, which mainly consist of coffee and milk and the occasional soda or softdrink. Other food items (9%) such as meat, canned goods, dried fish, and eggs are consumed at minimal amounts, possibly because they are more expensive than fresh fish and gleaned invertebrates.

These results differ to some extent from the findings of the 2008 (*FNRI 2008*) and 2013 National Nutrition Survey (*FNRI 2015b*) which showed that the typical diet of Filipinos is rice-vegetable-fish. In 2013, the average Filipino household had a per capita consumption of 855g of food each day, made up of 290g (33.9%) of rice and rice products, 114g (13.3%) of vegetables, 109 g (12.8%) of fish and fish products, and the rest (40%) made up of meat, poultry, milk, and miscellaneous food groups (*FNRI 2015b*). Expectedly, coastal households consume a significant amount of fresh fish and seafood from reef

Table 1. Typical dietary composition of the daily food intake of coastal households in five sites in Mindanao and the Visayas.

Food Groups	Average Daily Weight (kg)				
	Laguindingan, Misamis Or.	Kauswagan, Lanao del Norte	Lopez Jaena, Misamis Occ.	Cortes, Surigao del Sur	Tubigon, Bohol
Cereals (rice, corn)	1.7806	1.4841	2.2250	2.1143	1.7614
Root crops	0.0685	0.2310	0.2810	0.1040	0.1813
Meat (beef, pork, chicken)	0.0695	0.0473	0.1361	0.0398	0.0921
Canned goods	0.1353	0.0419	0.0674	0.0426	0.0960
Fresh fish	0.3528	0.3167	0.5786	0.1884	0.4338
Dried fish and fish paste	0.0507	0.0554	0.0772	0.0336	0.0658
Gleaned Seafood	0.3384	0.9727	0.4651	0.2233	0.7157
Vegetables	0.0836	0.1069	0.3821	0.1115	0.1064
Fruits	0.0863	0.2170	0.3262	0.0846	0.1421
Eggs	0.0584	0.1815	0.0716	0.0292	0.0706
Beverages (milk, coffee)	0.1399	0.5194	0.1167	0.0292	0.2020
Other Kinds	0.0756	0.0200	0.0000	0.1218	0.0214
Total daily HH Consumption (kg)	3.2396	4.1939	4.7269	3.1484	3.8884
Average No. HH Members	4.0	3.8	4.1	5.1	4.0
Per Capita Consumption (kg person day^{-2})	0.8032	1.1037	1.1529	0.6173	0.9298

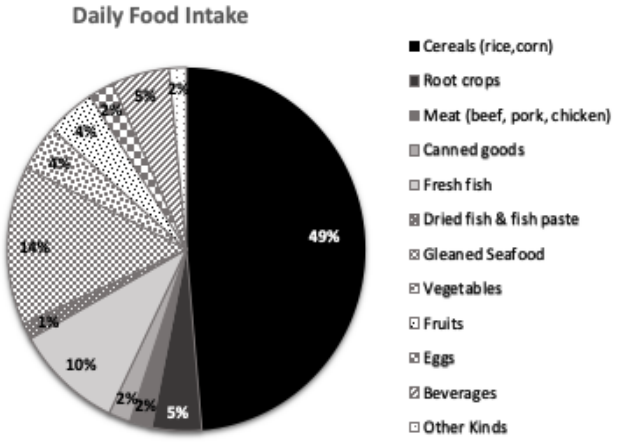

Figure 3. Typical daily dietary composition of coastal households across five sites in Mindanao and the Visayas.

gleaning since many of them are highly dependent on fishing as the main source of livelihood and subsistence.

Per capita rice consumption by coastal population in the five survey sites is also higher (391-543g) than the national average. On the other hand, this is consistent with the results of the 2013 NNS that rural households have higher intake of rice and products than their urban counterparts (*FNRI 2015b*). Fisherfolk have an active lifestyle and require a lot of energy on a daily basis. Rice as the staple food for Filipinos provides the main source of energy and food security among the poorer sectors. During the interviews gleaners declared that the meager income they obtain from reef gleaning is used to buy rice first as they can get viand from consuming a portion of their invertebrate catch.

Energy and Nutrient Adequacy among Coastal Households

Good nutrition requires a diet that provides the necessary amounts of energy and nutrients essential for good health. Energy requirement is the amount of food energy needed to balance energy expenditure in order to maintain body size, body composition, and metabolic functions (*FAO 2001*). A desirable mix of carbohydrates (55-70%), fats and fatty acids (20-40%), and protein (10-15%) contribution to total dietary energy is recommended for Filipino households (*Barba and Cabrera 2008*). Aside from being an important source of energy, protein is a vital macronutrient in growth and maintenance of the human body.

Estimates of per capita energy and nutrient intakes of households across five sites are highly variable, with many households obtaining high values due to large intake of rice and other cereals even exceeding national average energy intake. Majority of the surveyed households, however, have lower energy and nutrient intakes than national averages, particularly of protein, calcium, and iron. Average per capita energy intake from all food sources across five sites was estimated at 1,891 kcal day^{-1} (**Table 2**) which is higher than the national average of 1,810 kcal.day^{-1} based on the 2013 National Nutrition Survey (*FNRI 2015b*) and 1,865 kcal day^{-1} from the 2008

Table 2. Comparison of average per capita energy and nutrient intake (from all food types) among coastal households across five survey sites.

Survey Site	Energy (kcal)	Protein (g)	Fats (g)	Calcium (mg)	Phosphorus (mg)	Iron (mg)
Laguindingan	1,733.56	57.36	15.69	596.27	960.54	9.35
Kauswagan	1,812.17	68.10	13.08	883.73	985.28	10.43
Lopez Jaena	2,051.14	68.31	17.40	759.09	1,083.37	10.42
Cortes	1,868.68	51.82	7.26	456.57	872.10	9.02
Tubigon	1,991.45	67.77	11.92	1,039.47	1,164.25	11.78
Mean	1,891.40	62.67	13.07	747.02	1,013.11	10.20
S.E. (mean)	57.98	3.41	1.74	102.82	50.60	0.48

NNS (*FNRI 2008*). Average protein intake of 62.7 g day^{-1} across sites is also higher than the 2008 national average of 57.1 g day^{-1}. On the average, households in Lopez Jaena had the highest individual energy (2,051 kcal day^{-1}) and protein intake (68.3 g day^{-1}). Households in Laguindingan had the lowest intake in energy (1,734 kcal day^{-1}) while the lowest per capita protein intake was observed in Cortes (51.8 g day^{-1}). Variations in energy and protein intake across sites, however, are not statistically significant (Kruskal-Wallis test, $p > 0.05$, n=158). On the other hand, a comparison among households in each site showed that energy and protein intakes of households engaged in reef gleaning were significantly lower than non-gleaning households (t-test, $p < 0.05$, n=158).

Higher energy and protein intake among non-gleaning households is directly related to family income where many of them are either gainfully employed or operate small businesses. In all sites the average monthly income of non-gleaning households is higher than that of households that depend on subsistence fishing and gleaning for food and supplemental income (*De Guzman et al. 2016*). It was not possible to compare energy and nutrient intake between men, women, and children as the household survey did not delineate amounts of food intake across age and gender. Owing to their more active lifestyle, however, men require higher amounts of energy (2,378 kcal) and protein (71 g) than women (1,820 kcal; 62 g) (*FNRI 2015a*).

Cereals, particularly rice, are the main source of energy (mean of 80.8%) and protein (53.1%) among coastal households in the surveyed sites (**Figure 4**). This amount far exceeds the national average of 69% contribution of cereals to daily energy intake of Filipinos (*FNRI 2008*) and falls outside the desirable range of 55-70% contribution of carbohydrates to dietary energy (*Barba and Cabrera 2008*). The 2008 NNS survey showed that 70.5% of the average per capita energy intake of 1,867 $kcal.day^{-1}$ 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, 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. Rice has the largest share in energy (90.3%) and protein (68.4%) among households in Cortes while lowest in Kauswagan, however, households compensate for this by consuming a significant amount of starchy food (e.g. cassava, sweet potato) which is a cheaper source of carbohydrates. Fish and other kinds of seafood contribute a substantial amount (mean of 33.9%) to the total protein intake while providing a secondary source of dietary energy (7.3%) among coastal households.

On the average only 42.9% of coastal households across five sites met the daily energy RENI while 68.0% met the EAR for protein (**Table 3**). The proportion of households meeting the EAR for dietary calcium (44.3%) and iron (28.9%) are much lower. These values, however, are higher than national average values for energy (31.7%), protein (62.7%), calcium (15.2%) and iron (8.7%) reported in the 2013 NNS (*FNRI 2015b*) due largely to higher intake of cereals and seafood by coastal households than most urban and rural families across the country. Lower energy and nutrient adequacy across sites indicate that many coastal families do not eat enough, with many of them living below poverty and subsistence thresholds (*De Guzman et al. 2016*).

Iron is a common deficiency among most Filipinos, particularly women, and sufficiency can be reached by taking in iron-fortified foods or dietary supplements (*FNRI 2015a*). The 2013 statistics on energy and iron adequacy are lower than the 2008 NSS results but more households had higher protein and calcium adequacy than in 2008. Seafood is an excellent source of calcium and access to more seafood by coastal populations would explain higher adequacy of this nutrient across the study sites than in non-coastal areas. Intake of phosphorus, on the other hand, was high in all sites even exceeding the prescribed RENI values (**Table 3**). High levels of phosphorus intake > RNI, however, are not a cause for alarm as this nutrient is readily available from various

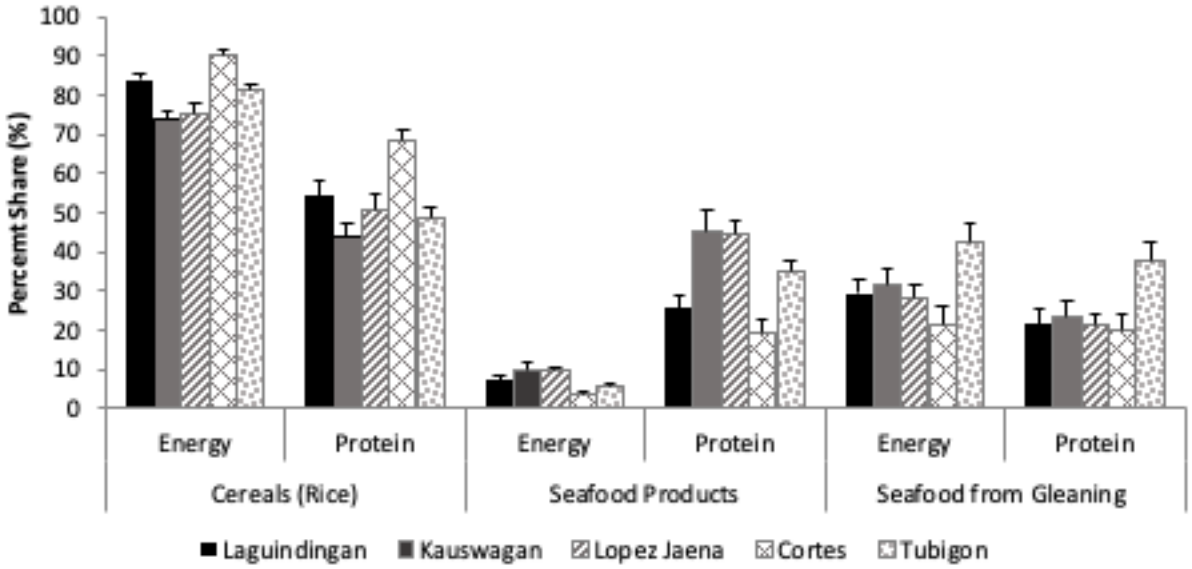

Figure 4. Percent contribution of cereals and seafood (from all sources and from gleaning) to energy and protein intake of coastal households in five survey sites (vertical bars are standard error values of mean estimates).

Table 3. Daily per capita energy and nutrient intake (DNI), contribution of consumed seafood from gleaners' catches averaged over five sites, and nutrient sufficiency of coastal households..

Survey Site	Energy (kcal)	Protein (g)	Fats (g)	Calcium (mg)	Phosphorus (mg)	Iron (mg)
Mean DNI from all food types	1891.4	62.7	13.1	747.0	1013.1	10.2
Mean DNI from all seafood	129.5	22.4	2.3	589.6	264.1	3.4
Mean DNI from gleaned seafood	47.4	6.0	0.6	445.7	44.7	2.3
Percent (%) share of all seafood	6.8	35.7	17.2	78.9	26.1	33.1
Percent (%) Share of gleaned SF	36.6	26.7	27.2	75.6	16.9	68.3
Mean Energy RENI & Nutrient EAR	1997.8	46.4	18.0	647.3	651.7	11.9
Proportion of HH meeting energy RENI and nutrient EAR	42.9	68.0	22.8	44.4	73.0	28.5

RENI values for energy intake are based on *FNRI* (*2015a*) averaged over age, gender, pregrant/lactating women
EAR values for nutrients based on assumed 80% RENI (*FNRI 2008*; *2015b*)

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 U.S. adult men and women average between 170-200% of the dietary reference intake (DRI) than they need each day (http://lpi.oregonstate.edu/). 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.

Energy and protein adequacy were also compared between households engaged in reef gleaning and those which were not. Across the survey sites gleaning households had lower energy (35-50%) and protein (50-75%) sufficiency than non-gleaning households (energy, 31-69%; protein, 70-88%) (**Figure 5**). An exception to this apparent trend is Kauswagan where gleaners had higher adequacy (35.3%) in energy than non-gleaners (30.8%). Being close to the government center and a bustling market, households in Kauswagan had the highest average monthly income among the five sites surveyed, with many of them either gainfully employed in the local government or engaged in small business enterprises. Moreover, many of these employees also participate in reef gleaning during weekends either as a recreational activity or to gather their favorite seafood. As with the other sites protein adequacy of gleaning households in Kauswagan was lower than those not engaged in reef gleaning. Households in Cortes, Surigao del Sur dependent on reef gleaning for food and supplemental income had the lowest energy (33.3%) and protein (50.0%) adequacy. Most of the surveyed households

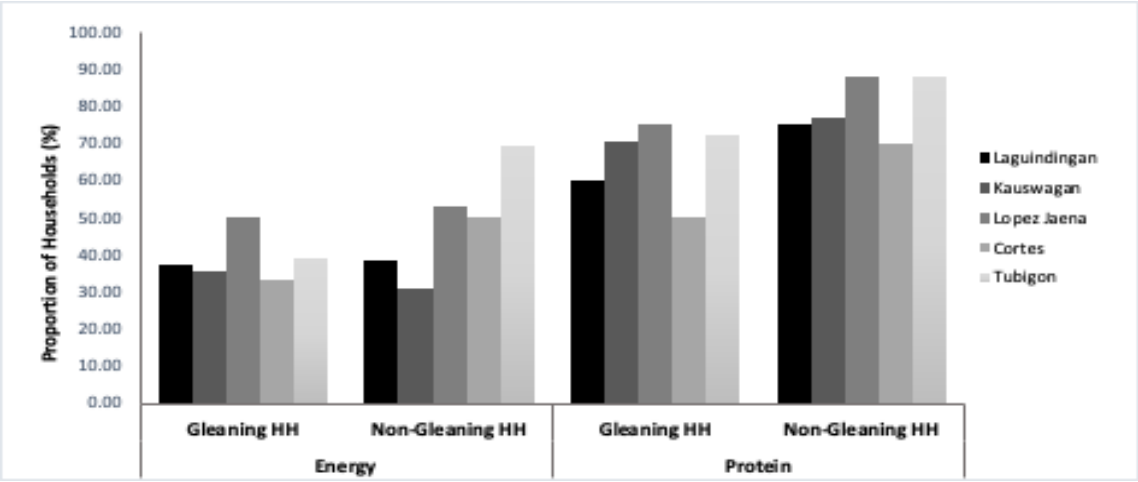

Figure 5. Comparison of energy and protein adequacy between gleaning and non-gleaning households (based on proportion of households in each survey site that meets the energy RENI and EAR for protein).

were in Tag-anongan Island, characterized by very wide seagrass-dominated sand flats and is a popular source of invertebrate seafood. Reef gleaning is pursued actively by residents as a regular income source by selling their invertebrate catch to middlemen or traders coming from markets in mainland Cortes, neighboring municipalities, and the provincial capital, Tandag City. More than half of the households surveyed in Cortes sell their gleaned catch rather than consume them (**Figure 6**), which would explain their very low consumption of gleaned seafood (**Table 1**) compared to other sites. Just like Cortes, most gleaners in Tubigon are residents of Batasan Island, which is of considerable distance from mainland Bohol, and are, therefore, highly dependent on the reef flats for food and source of income. As in other sites majority of the gleaners are women and children who actively gather invertebrate seafood during the day while men often dive mainly for sea cucumbers at night to augment the meager revenues they earn from the traditional gear fisheries.

Average energy (43.6%) and protein (72.6%) sufficiency of coastal households (both gleaning and non-gleaning HH) are higher than the national average adequacy for energy (33.1%) and protein (62.7%) based on the dietary component of the 2013 NNS (*FNRI 2015b; FNRI 2015c*). Variations in energy and protein sufficiency across sites are not statistically significant (Kruskal-Wallis, $p > 0.05$, n=158). Likewise, adequacy of dietary energy did not differ much between gleaning and non-gleaning households (t-test, $p > 0.05$; n=158), however, gleaning households were observed to have significantly higher adequacy in protein intake than non-gleaning households (t-test, $p < 0.005$), presumably due to larger intake of protein-rich seafood from gleaned invertebrates.

Contribution of Gleaning to Food Security and Household Nutrition

Utility of products (usually invertebrates) from reef gleaning varies among households and sites (**Figure 6**). About 17% of gleaners mainly sell their daily catch for supplemental income, 31% mainly consume this as food for the family, while a bigger proportion (52%) both sell and consume their invertebrate catch, depending on quality and economic value. Invertebrate species that are highly valued (such as selected univalve and bivalve mollusks, sea urchins, and sea cucumbers) are generally sold in the local market or to traders who bring them to nearby cities. In the 1980s-1990s high value invertebrates, such as sea cucumbers, sea urchins, and clams, were gathered by gleaners in large quantities which were sold in local markets or to local traders (or middlemen) and constituted a main source of family income (*De Guzman 1990; LeBlanc 1997*). Sea cucumbers are especially valuable as trepang (i.e. dried body wall) for the export market while sea urchin roe is a popular delicacy among Filipinos living along the coast. More important than supplemental source of family income is the role of reef gleaning in food security and in supplying the household's nutritional requirements, particularly energy, protein, and minerals needed for metabolism, muscle and skeletal growth, and other physiological functions of the human body. According to the Food and Agriculture Organization (*FAO 2003*), food security exists when all people have physical, social and economic access, at all times, to sufficient, safe and nutritious food which meets their dietary requirements for an active and healthy life. Food security is one measure of social well-being (*Weiant and Aswani 2006*), greatly affecting the nutritional and health status

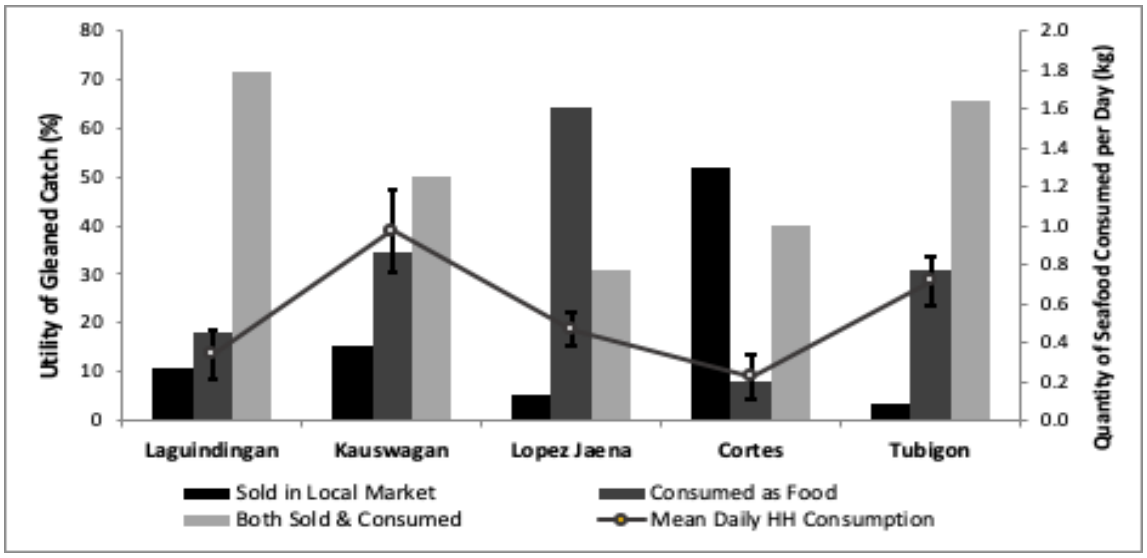

Figure 6. Utility of gleaned harvest as declared by gleaners (bars) and mean daily household consumption of seafood from gleaning (line) in five survey sites.

of the household members and also serves as a proxy indicator of poverty and their inability to access food.

Seafood invariably forms an important part of the gleaner's household diet and an essential source ofprotein and micronutrients that are vital to nutrition of poor coastal communities. The average per capita protein intake from all seafood products is moderate at 21.8 g day^{-1} and represents only 35.7% of the daily protein intake from all food types (**Table 3**). Protein from gleaned shellfish (mean = 6.0 g day^{-1}) contributes about 26.7% to protein intake from all seafood, which is rather low considering that a large portion of the coastal community (mean of 84%) engage in gleaning activities either for family consumption or supplemental income (*De Guzman et al. 2016*). Coastal residents do not consume enough seafood for their daily protein requirement, probably because many of them would rather sell their catch, if not to supplement income then to buy rice for the household's daily consumption. Many of the gleaners encountered on the reef flats declare that whatever they earn from selling their gleaned harvest is barely enough to buy a few kilos of rice each day. Higher protein sufficiency in Kauswagan, Lopez Jaena, and Tubigon is consistent with the amount of seafood consumed daily by gleaning households (**Table 1**).

Gleaning and health of coastal households

Gleaning activities obtain much needed seafood products to increase the energy and protein sufficiency of poor coastal communities in the Philippines. Across the surveyed sites energy and protein intakes from gleaned seafood were significantly higher (t-test; $p < 0.05$; n = 158) in households engaged in gleaning activity and, presumably consume more seafood, than those who are not (**Figure 7**). Most non-gleaning families obtained edible shellfish, sea urchins, and other seafood by buying from neighbors or from the local traders. Edible sea urchins frequently gathered by gleaners in all sites provide higher levels of energy, protein, and other nutrients that are vital to family nutrition than other commonly gleaned invertebrates. A 100-gram portion of sea urchins contains 172 kcal, 13.3 g of protein, 17 mg of zinc, and very little fat (*Ipatenko 2016*). Clams and gastropods are also excellent sources of dietary protein, calcium and phosphorus (*FNRI 1997*) while high levels of iodine are obtained from seaweed, fish, and crustaceans.

The average diet of a typical coastal household shows higher adequacy in terms of dietary energy requirement, protein, and important micronutrients than the average Filipino household as a result of their preference for seafood. Aside from high quality protein, gleaned products such as sea urchins and shellfish are good sources of calcium that is essential in building skeletal strength particularly for children and the elderly. Iodine is another important micronutrient in human health but was not included in determination of nutrient intake as a food conversion table is not available (FNRI 1997). Iodine is a key component of thyroid hormones, which are required throughout life for normal growth, neurological development, and metabolism (http://lpi.oregonstate.edu). 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

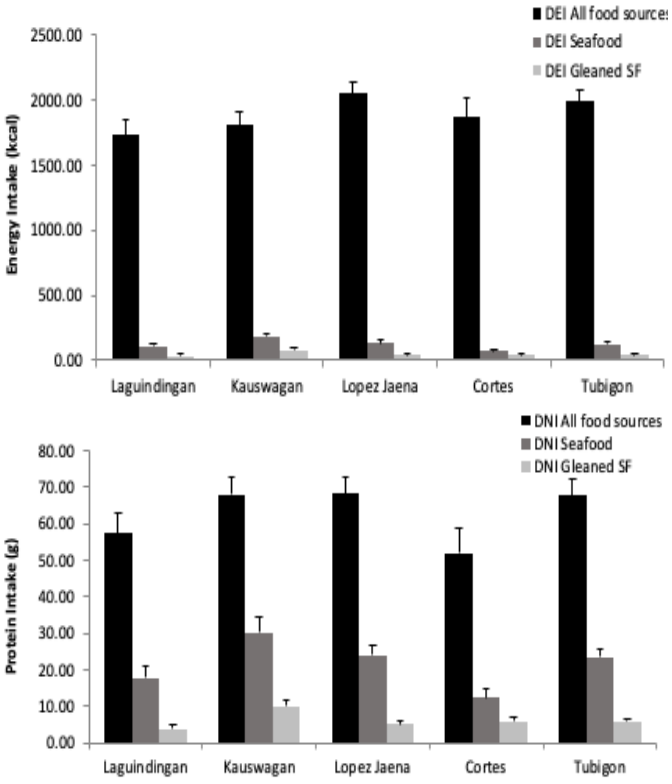

Figure 7. Average per capita daily energy (top) and protein (bottom) intake of coastal households in surveyed sites.

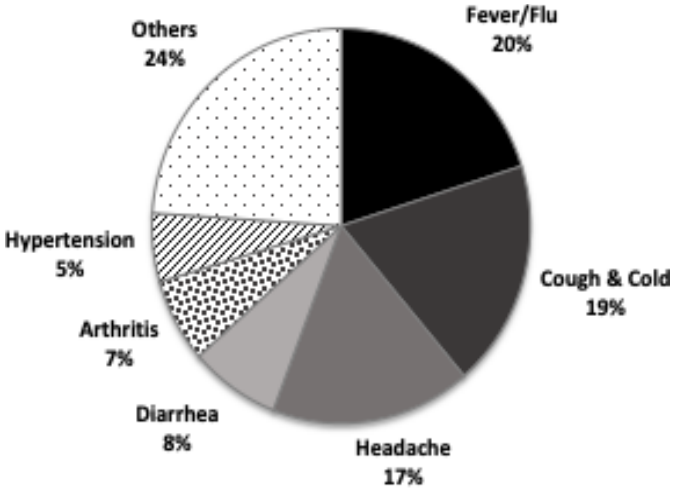

Figure 8. Most frequently experienced illnesses among coastal households in the surveyed sites.

severe physical and mental retardation (*Haldimann et al. 2005*). Products from gleaning activities, such as seaweeds and shellfish, are an important dietary source of iodine readily available for coastal communities, thus, 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 micrograms for both male and female while amounts above the tolerable upper intake level of 1,100 μg day^{-1} should be avoided to reduce the risk of thyroid disorders (http://lpi.oregonstate.edu).

Despite the high poverty incidence among small fisherfolk in the surveyed sites (*De Guzman et al. 2016*) members of coastal households in the surveyed sites are remarkably healthy. Common illnesses such as fever, cough and cold, and headache have the highest frequency among the 224 households surveyed in this case study (**Figure 8**) and only two cases of goiter and diabetes were declared. Hypertension, a common ailment among the middle-aged and elderly, has a low incidence (5%) among gleaners. During the interviews most gleaners declared that they are quite healthy, and while gleaning may not have improved their economic condition, it nonetheless provides them with enough food, energy, and nutrients to sustain their good health.

Women's contribution to household nutrition

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, family economy, and food security had not been properly evaluated (*Samonte-Tan 2008; Kleiber et al. 2014; Palomares, et al. 2014*). 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 (*Dye 1983 cited in Chapman 1987*). 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 the Philippines women have a high participation rate in invertebrate gathering, processing, and marketing of fresh catch or processed products (*Harper et al. 2013; Kleiber et al. 2014; Cabanban et al. 201*4). Gleaning in nearshore reef ecosystems is considered as an informal production sector (*LeBlanc 1997*) and not usually accounted for in mainstream capture fisheries production. Data on subsistence fisheries from gleaning are not included in official fisheries statistics (i.e. Countrystat of the Philippine Statistics Authority). Consequently, invertebrate gathering forms part of the globally under-reported fisheries production (or IUU fishing) being addressed by coastal states such as the Philippines through stricter policy (RA 10654 or the amended Philippine Fisheries code).

In marginalized coastal communities of Mindanao and Visayas women are considered resilient but "invisible" producers in shallow reef artisanal fisheries, withstanding the test of time and weather condition (*De Guzman 2019*). This case study showed that in most survey sites women often put in higher effort (i.e. longer hours) on gleaning and generally had higher yields or catch-per-unit effort than men (*De Guzman et al. 2016*). Earning very little income from conventional gear-based fisheries, male fishers now increasingly participate in invertebrate fisheries both for subsistence and supplemental income.

CONCLUSIONS AND RECOMMENDATIONS

Shallow reef flats and seagrass beds are important ecosystems for coastal communities in Mindanao and the Visayas providing food and supplemental income for small fisherfolk who earn marginal incomes from gear-based fisheries. For most 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. The vital contribution of reef gleaning as a form of subsistence fisheries to food security, nutrition and health of poor coastal communities in the Philippines has received scant attention in existing literature.

High dependence of coastal households on reef gleaning activities places a great toll on the invertebrate resources in all 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 an ubiquitous problem in subsistence fisheries. Indeed, small fishing communities have been labelled as the 'poorest of the poor', perpetually living on the margins of poverty. The 2013 Food Consumption Survey (FCS) by the Food and Nutrition Research Institute of the Department of Science and Technology (FNRI-DOST) showed that 69.3 percent or about 7 in 10 Filipino households do not meet their dietary energy requirement, or are suffering from "chronic food insecurity" or continuous scarcity of food (*FAO 2003*). The Food and Agriculture Organization of the United Nations (*FAO et al. 2015*) estimates that about 795 million people in the world are undernourished or "cronically hungry", most of which (98%) live in developing countries.

This case study has shown that reef gleaning plays a significant role in food security and nutrition of coastal families. The study also demonstrates that sustaining gleaning as a component of subsistence fisheries is crucial to the economic and nutritional well-being of poverty-stricken coastal communities in the Philippines. Concerted effort among national and local governments, non-government organizations, and the private sector must be harnessed to maintain health and production of coastal ecosystems and consequently, sustain productivity. Formulation and implementation of sound management policies are vital to saving what's left of the invertebrate resources in the reef flats and sustainably support food consumption and income needs of marginal fishing communities in the country.

This study also recommends that similar researches in the future should adopt the standard FNRI methodology in food consumption and nutrition surveys. Dietary assessment of coastal households through food recall conducted in this case study led to high variability and inconsistency in results. A number of dubious or erroneous data sets in each site had to be excluded from the analysis, thus, reducing sample size and increasing variance. There is need to refine the household dietary survey to reduce "recall error" by respondents, particularly in the amounts of food consumption, and also to improve the interviewer's ability to conduct the survey. Given the limitations of the food recall method, it is recommended that where possible actual food weighing as carried out by the *FNRI* (*2008*) be adopted to obtain more accurate data in evaluating the nutritional status of coastal households.

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