OPEN ACCESS

1st World Sustainability Forum
1-30 November 2011

www.wsforum.org

Article

Economic Value Assessment of Small-Scale Fisheries in Elmina, Ghana

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Received: / Accepted: / Published:

Abstract: Although recent studies in Ghana show that overall poverty in coastal areas is decreasing, considerable challenges still face government and communities in their bid to improve living conditions in fishing communities. In order to achieve the goal of sustainable fishing livelihood in fishing communities, the economic conditions and actual benefits accruing to fishermen from small-scale fishing needs be assessed as part of broader fisheries management agenda. This paper presents reference data for addressing these issues relative to long term sustainability of fishing from an economic perspective. The specific objectives were to conduct an economic assessment of the small-scale fisheries to determine major fish species of economic importance at the Elmina landing beach. Secondly, estimate the net economic benefit to the fishermen and suggest possible conservation or management interventions. Questionnaires were administered randomly among a total of 60 fishermen at the landing beach for a period of four weeks between February 6 and March 6, 2010. The economic benefits derived from the fishery activities were estimated based on monetary gains from quantities of fish caught, the market prices

and their investment costs. The results indicate that *Sardinella aurita* constituted the most dominant fish species caught by majority of the fishermen (16%) followed by *Dentex angolensis and Epinephelus aeneus* each represented by 15.43% of the fishermen. *Caranx crysos* and *Sepia officinalis* were among the least common fish species caught. The most valuable fish species landed include *Epinephelus aeneus, Sparus caeruleostictus*, *Dentex angolensis*, and *Lutjanus goreensis* valued at US$2.97, US$2.87, US$2.85 and US$2.63 per kilogram respectively. The least valuable species include *Dasyatis margarita, Pseudotolithus senegalensis, sadinella aurita* and *Caranx crysos* valued at US$0.34, US$0.62 and US$0.66 per kilogram respectively. We recommend that efforts should be made at improving the value through processing of heavily caught but less valuable fish species such *Sardinella aurita.* Studies should be instituted into the biology (reproduction and growth) of the highly valuable species for aquaculture purposes and to explore the economic feasibility of culturing these valuable species since their present economic value could drive their over-exploitation.

Keywords: Small-scale fisheries; economic assessment; fishing livelihoods; Elmina

1. Introduction

Small-scale fishing or artisanal fishing is a dynamic activity that can range from sedentary to migrant fishers or communities, from part-time to full-time fishing activity, from subsistence to commercial fishing, from non-advanced and non-differentiated to highly differentiated and specialized form of fishing[1]. Globally, small-scale fishers operate in some of the biologically richest and most sensitive waters on earth, often in tropical coastal zones where interactions with coral reefs and land-based ecosystems introduce complex interdependencies[2]. In small-scale fishing, coastal or island ethnic groups use traditional techniques such as rod and tackle, arrow and harpoons, throw nets and drag nets and mostly traditional fishing boats which are often but not always less intensive and less stressful on fish populations than modern industrial fishing techniques[1]. The activities of the small-scale fisheries sector both inland and coastal fisheries conducted full- or part-time or just seasonally, are often aimed at supplying fish and fishing products to local and domestic markets and also for household consumption[3]. The small-scale fishing sector provides direct employment to millions of people, and indirect employment to millions more (many of them women involved in fish processing) and 90 percent of fishing jobs worldwide come from small-scale fishing with approximately 45 percent of the world's fishery and nearly a quarter of the world's catch derived from this sector[2].

It is estimated that fish provides about 19 percent of the protein intake in developing countries. This figure, however, represents an average at a global level and does not reflect the very large heterogeneity at the national or, even more importantly, at the local level [4]. In Africa, small-scale fishery activity accounts for the majority of fish catches. Fish caught by small-scale fishers likely contribute to a quarter of the total protein in-take and small-scale fishing communities play a vital role in nutrition, trade, and economic activity[5]. The basic technologies used by small-scale fishers in Africa distinguish them from large-scale commercial fishing operations. Small-scale fishers have

generally smaller boats and gears, and land smaller quantities of fish than large-scale commercial fishing boats. Along the coast of West Africa, the craft frequently used by small-scale fishers is a large dug-out wooden canoe. Small-scale fishers in Africa likely also share other socio-cultural, geographic, demographic, and institutional characteristics such as higher rates of fertility and population growth which can be linked to the heavy demands of labor in fishing and the role played by kin-based labor and lower incomes and income instability due to wide seasonal fluctuations in the availability of fish, although this characteristics may vary widely from country to country and community to community[5]. Ghana has a long history as a small-scale fishing country since the1700s and 1800s when Fante fishers from Ghana introduced ocean fishing to the communities along the coast of the country [6][7]. The small-scale or artisanal fishery in Ghana is characterized by the use of several gears. These include purse seine nets, beach seine net, set nets, drifting gillnets and hook and line. These gears are operated from dug-out canoes. There are over 11 200 canoes and more than 124 000 fishers operating actively from over 300 landing sites located along the entire 550 km length of the coastline. About 50 percent of these canoes are powered by outboard motors with engine power of up to 40 hp[8].

The fishing sector in Ghana not only employs 2.5% of the total population but also about 20% of the total labour force[9]. Small-scale fishers in Ghana provide the majority of the national fisheries catch with the marine sub-sector delivering more than 80 percent of the total catch making it the most important source of local fish production in the country (Marquette *et al.*, 2002). Fish is a cheaper and an appreciated source of protein, thus, fishing holds an important place in the national economy because of the jobs it creates[10]. Although small-scale fishing provide the larger part of the total fish catch, evidence from three rounds of Ghana living-standards surveys, which rely on expenditure levels persistently revealed that coastal fishing communities in Ghana are among the poorest in the country, hence the need for a socio-economic value assessment of the small-scale fishery sector[5]. This study aimed to carry out an economic value assessment of the small-scale fishery sector in Elmina in the Central region of Ghana, highlighting possible management and conservation measures for sustainability of the stocks. The specific objectives were to conduct an economic assessment of the small-scale fisheries to determine major fish species of economic importance. Secondly, to calculate the economic value of fish species landing sites on the beach. Thirdly to estimate the net economic benefit accruing to the fishermen with reference to specific species and suggest possible conservation or management measures.

2. Methods

The study was conducted at Elmina (5.5′0″N 1.21′0″W), a fishing community in the Central region of Ghana, located about 2 km due west of the regional capital, Cape Coast. Data was collected through interviews using questionnaire designed with questions relating to a range of issues relevant to the study: details regarding fishing operations (e.g. fishing gear, species landed etc.), sales, operating cost, capital and observation in the study area. These were expected to give an understanding of the small-scale fishery sector. Survey data was collected randomly for a total of 60 respondents, comprising both sexes, at the landing site for a period of four weeks from February 6 to March 6, 2010 on a twice a week basis. The benefits that the community derives directly from the fishery sector in terms of the

fish species caught were assessed using the Direct Use Value technique which quantifies the monetary gains of a resource based on knowledge of the quantity of resource harvested in a defined time frame, the market price offered for the commodity and the cost that goes into harvesting and processing the commodity. The technique follows traditional market methods and estimates value according to the prevailing market forces (demand and supply). The data got by the questionnaire and interview approach was processed to extract the information on the quantity of different fish species harvested per fishing trip, expenditure and the market price of the various fish species caught.

Hence, the economic value of various fish species was assessed using the formula[11]:

$$\mathrm{DUV} = \sum_{i=0}^{n} (Pi * Qi - Ci)$$

Where:

DUV = Direct Use Value

P_i = Price

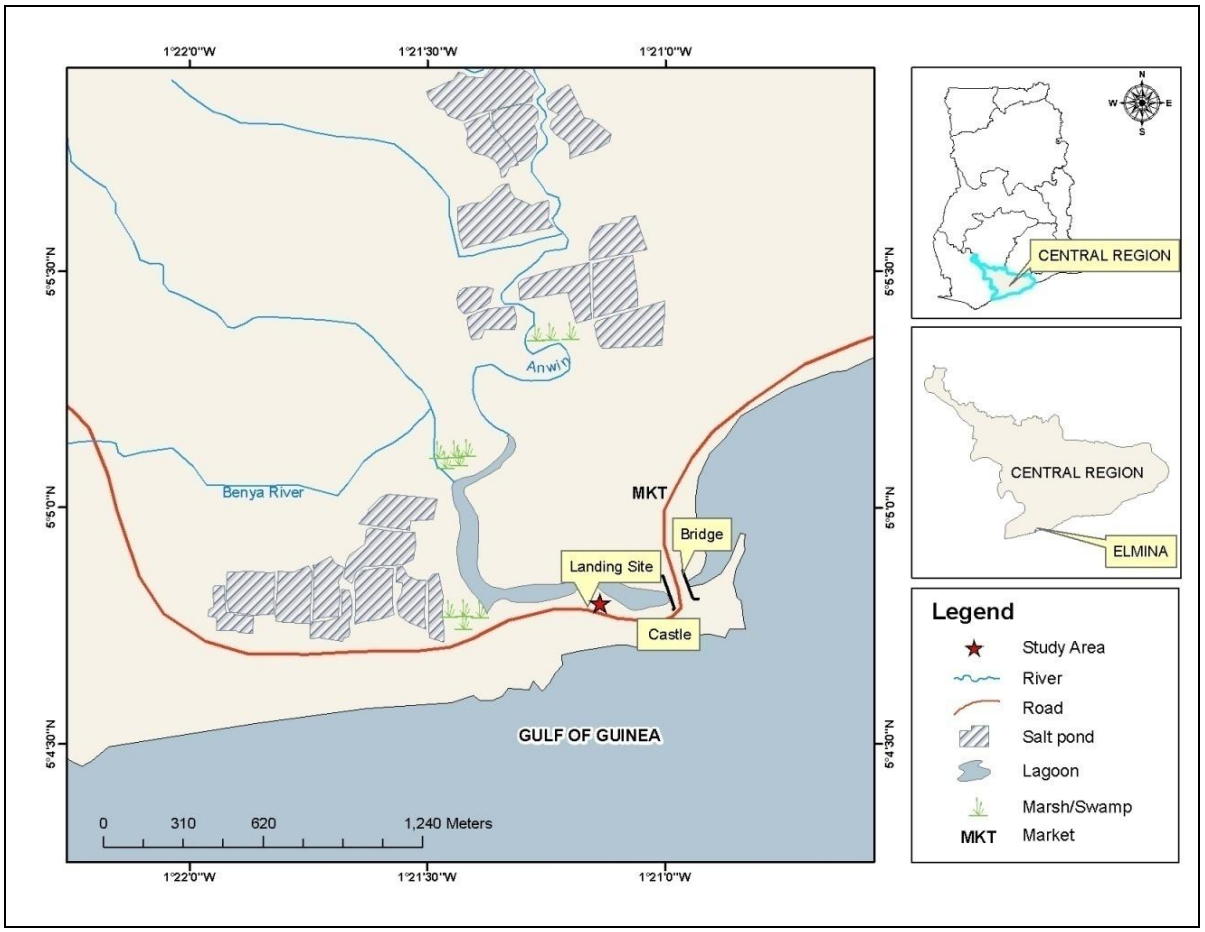
Q_i = Quantity collected

C_i = Cost collection

i refers to the item under description (various fish species in this contest)

n = Total number of respondents

Figure 1. Map of study area indicating fishing landing site at Elmina, Ghana (Source: Department of Geography and Regional Planning, University of Cape Coast, Ghana).



3. Results and Discussion

3.1. Fish Species Caught and Fishermen Involvement

The analysis reveals that *Sardinella aurita* constituted the most dominant fish species caught by majority of the fishermen (16%). This was followed by *Dentex angolensis and Epinephelus aeneus* each represented by 15.43% of the fishermen. *Caranx crysos* and *Sepia officinalis* were among the least common fish species caught by the fishermen. Comparing the number of fishermen hauling particular fish species and the amount of fish caught, the *Sardinella* species appears as the most attractive species because it is the most hauled fish species. However, in terms of its value per quantity, it is one of the bottom 50% valuable species.

Table 1. Quantities of fish species caught per month and number of fishermen in the fishery *.

Fish species	No. of fishermen	Percentage of fisherman	Quantity of catch/Kg	Percentage of catch
Auxis thazard	6	3.43	1925	1.96
Brachydeuterus auritus	6	3.43	5200	5.3
Caranx crysos	1	0.57	500	0.51
Dasyatis margarita	3	1.71	825	0.84
Dentex angolensis	27	15.43	10400	10.6
Dentex congoensis	9	5.14	3125	3.19
Elegatis bipinnulata	13	7.43	4100	4.18
Epinephelus aeneus	27	15.43	9950	10.15
Galeoides decadactylus	4	2.29	3000	3.06
Lutjanus goreensis	7	4	2275	2.32
pagellus bellotti	7	4	2800	2.85
Psuedotolithus senegalensis	12	6.86	9500	9.69
Sardinella aurita	28	16	30275	30.87
Sepia officinalis	1	0.57	7550	7.7
Scomberomorus tritor	8	4.57	125	0.13
Sparus caeruleostictus	16	9.14	6525	6.65
Total		100	98075	100

* data is based on multiple responses.

The observed catches of *Sardinella aurita* in very high quantities by most fishermen probably resulted from the local upwelling (minor upwelling) at the time of the study. In addition, the commercial abundance of the species may also have impacted on its value making it an affordable source of protein. During these upwelling seasons, *S. aurita* are in abundance and most often means of preservation, apart from smoking, is not available and if it is not sold at lower price, the catch would remain and end up in waste.

3.2. Economic Assessment of the Fishery

The direct use value analysis was applied to estimate the market price value per kg and incomes (gross and net incomes) of some fish species landed at Elmina. Table 2 shows the expenditure, income

and value per kilogram of fish species caught. The most valuable fish species landed include *Epinephelus aeneus, Sparus caeruleostictus, Dentex angolensis,* and *Lutjanus goreensis* valued at US$2.97, US$2.87, US$2.85 and US$2.63 per kilogram respectively (Table 2). The high value of these groups of fishes may be probably due to higher demand by consumers combined with their generally low volumes of catch. *Auxis tharzard, Elegatis bipinnulata, Pagellus bellottii* and *Sardinella aurita* could be classified as being among moderately valuable fish species, valued at US$2.11, US$2.06, US$1.89, and US$0.85 per kilogram respectively. These fish species are harvested in high quantities probably due to lower market demands, prices, or seasonal effects. *Sepia officinalis* was the least patronized fish species with only 0.6% of the total respondent catching this species representing 0.1% of total fish catch for the month (Table 2). The economic values of some fish species caught by the fishers were not dependent on the availability or patronage (demand and supply) of consumers but probably on the quality (i.e. taste) of the fish and cost of the fishing gear.

Table 2. Expenditure, income and value per kilogram of fish caught.

Fish species	Income (US$/kg)	Expenditure (US$/kg)	Value (US$/kg)
Auxis thazard	2.32	0.21	2.11
Brachydeuterus auritus	0.92	0.05	0.86
Caranx crysos	0.71	0.06	0.66
Dasyatis margarita	0.52	0.18	0.34
Dentex angolensis	3.09	0.24	2.85
Dentex congoensis	2.75	0.18	2.57
Elegatis bipinnulata	2.32	0.26	2.06
Epinephelus aeneus	3.20	0.23	2.97
Galeoides decadactylus	0.70	0.09	0.61
Lutjanus goreensis	2.90	0.28	2.63
Pagellus bellottii	2.16	0.27	1.89
Pseudotolithus senegalensis	0.70	0.08	0.62
Sardinella aurita	0.90	0.05	0.85
Scomberomorus tritor	0.81	0.06	0.75
Sepia officinalis	3.14	0.71	2.43
Sparus caeruleostictus	3.10	0.23	2.87

The species with the most return per kg was the *Epinephelus aeneus*; which was valued at US$ 2.97/kg followed by *Sparus caeruleostictus* with US$ 2.87/kg (Table 2). These are the white grouper and sea bream respectively and are considered high grade fish, hence the high return. The least valuable species landed include *Dasyatis margarita, Pseudotolithus senegalensis* and *Caranx crysos* valued at US$0.34, US$0.62 and US$0.66 per kilogram respectively (Table 2). These species were generally characterized by low return on investment and probably resulted from high investment cost and low market demand of these species. This is probably because most consumers did not patronize this species, hence they were sold at give- away prices to consumers ready to buy to avoid wastage.

The Ghanaian fishery is characterized by the open-access system. With this form of fisheries, the individual receives all of the economic benefits accruing from the fisheries, while the resulting stock depletion are shared among all resource user, this eventually resulting in the tragedy of the commons

[12]. The consequences of such system are that fishermen will continue to enter the fishery sector as long as revenues minus costs remain above zero, until ultimately the net revenue of the entire fleet is zero — the bionomic equilibrium[13]. At this equilibrium the resource is depleted as far as economics will allow and fishermen will move to alternative fisheries, resulting in the sequential depletion of fish stocks[14]. The relationship between the cost and income made on the harvest of fish and the type of net used was examined. The distribution is as shown in Table 3. However, on the part of fishermen, there is the risk that higher investment may not necessarily lead to higher income (Table 3) due to the weak negative correlation observed between investment and income made. This information strongly suggests that target fishing of these high value species using the hook and line method is likely to be unsustainable. However, both *A. tharzard* and *P. bellottii* were hauled using drift net and line fishing respectively with both showing negative correlation between investment and returns, suggesting that the higher the investment on this species the lower the return made. *A. tharzard* showed a strong negative correlation between investment and returns, indicating that for a unit increase in investment the return also decreased by the same amount and vice versa. Also, at the bionomic equilibrium, any stock that has low harvest costs compared with revenues will be overexploited and overcapitalized or, in extreme cases, will become commercially extinct[12]. Although the *S. aurita* is ranked as one of the bottom 50% valuable species, the fishermen still concentrated on it since it appeared to bring in more revenue due to its abundance and cheaper fishing method (purse seine or watsa) compared to line fishing and the readily available consumer market for this species. The correlation between fish catch and fishermen appeared positive when compared (Table 2 & 3). A typical case of more fishers chasing fewer fish stock; effort has increased to catch quantity otherwise caught by fewer fishers previously. This probably indicates declining fish catches or overfishing since fish catch statistics have indicated in recent years[9].

3.3. Analysis of Cost and Income Relative to Gears Used

For *Sardinella aurita* and *Elegatis bipinnulata*, investments made using the purse seining correlates positively with income made (Table 3). This suggests that the higher the investments the higher the returns and vice versa. This may be attributable to the mode of fishing, i.e. purse seining which targets shoal of fish occurring in large quantities. For example, the *Sardinella aurita* (flat sardine) was harvested in high quantities by 16% of the respondent (Table 1) representing 30.87% of total respondent catch (Table 2). Both *D. Margarita* and *P. senegalensis* showed weak negative correlation between investment and returns, indicating that the higher the investment the lower the return made but *C. crysos* showed positive correlation between investment and returns (Table 3). The observation suggests that *C. crysos* is least valuable and scarce fish species. *D. margarita* showed very low value and was one of the fish species hauled by the bottom trawl method with weak negative correlation of 0.1 (Table 3), that is, the higher the cost, the lower the income made on the harvest. It constituted 0.8% of the total catch with 1.7% of respondent hauling this species.

Table 3. Relationship between the cost and income per fish species relative to type of gears used.

Type of net	Fish species	Correlation between cost and income
Purse seine net	*Sardinella aurita*	
	Elegatis bipinnulata	0.809
	Caranx crysos	
Hook & line	*Dentex angolensis*	
	Epinephelus aeneus	
	Dentex congoensis	-0.0601
	Lutjanus goreensis	
	Sparus caeruleostictus	
	Pagellus bellotti	
Bottom trawl	*Psuedotolithus senegalensis*	
	Dasyatis margarita	
	Galeoides decadactylus	-0.1089
	Brachydeuterus auritus	
	Sepia officinalis	
Drift	*Scomberomorus tritor*	
	Auxis thazard	-1

The correlation between the cost and income of fish species harvested (Table 3) with the purse seine net was 0.809.This means that there was a strong positive association between the cost and income made on these types of fishes. That is, the higher the cost incurred on the harvest, the higher the income made. The *Sardinella* species was among this group of fishes. Bottom trawl net and the hook and line showed a weak negative correlation between the cost and income of the species, that is, the higher the cost, the lower the income made on the harvest. The *Epinephelus aeneus* was hauled by the hook and line method. But for the drift net, there was perfect negative correlation between the cost and the income meaning that anytime the cost increased by a unit, the income decreased by a unit and vice versa.

4. Conclusions

Studies have shown that trading of products from small-scale fisheries is largely focused on the domestic markets[12]. Therefore, it is important to address locally relevant intervention measures that limit exploitation of species in the wild and look into options for value addition of least exploited and exploited but less valuable fish species. Our study points to the urgent need for management of specific fish stocks e.g. *Epinephelus aeneus*, *Sparus caeruleostictus*, *Dentex angolensis*, and *Lutjanus goreensis* due to their very high economic returns for fishermen and high market value. Their high market value and demand could drive their massive exploitation and therefore the need to engage in scientific feasibility studies that assesses the potential of the high value fish species for aquaculture (focusing on biology and growth) is critical. Serious efforts should also be made into looking at value addition through processing of least valuable species such as *Dasyatis margarita*, *Pseudotolithus senegalensis* and *Caranx crysos* to increase the net return per effort to fishermen hauling them in.

Conflict of Interest

The authors declare no conflict of interest.

References

1. Demuynck K. & DETMAC Associates. The Participatory Rapid Appraisal on Perceptions and Practices of Fisher-folk on Fishery Resource Management: In an Artisanal Fishing Community in Cameroon, **1994,** Cotonou. 32pp.
2. Schorr K. D. Artisanal Fishing: Promoting Poverty Reduction and Community Development through New WTO Rules on Fisheries Subsidies. An Issue and Options Paper. **2005,** 50pp.
3. FAO. Strategies for Increasing the Sustainable Contribution of Small-Scale Fisheries to Food Security and Poverty Alleviation. Committee on Fisheries, Rome, Italy, 24-28 February **2003**, COFI/2003/9.
4. FAO. Increasing the Contribution of Small-Scale Fisheries to Poverty Alleviation and Food Security. FAO Technical Guidelines for Resposible Fisheries. **2005,** No. 10. Rome, FAO. 79pp.
5. Marquette M.C.; Koranteng A.K.; Ragnhild O & Bortei-Doku A.E. Small-Scale Fisheries, Population Dynamics and Resource Use in Africa: The case of Moree, Ghana. *Ambio journal* **2002**, 31**,** 324-336.
6. Lawson, R.M.; Kwei, E.A. African Entrepreneurship and Economic Growth: *A Case Study of the Fishing Industry in Ghana*. Accra: Ghana University Press, **1974**, 262pp.
7. Jorian, P. Going Out or Staying Home: Seasonal Movement and Mitigation Strategies among Xwla and Anlo-Ewe Fisherman. *Journal of Maritime Anthropological Studies* **1998**, 1, 129-155.
8. Amador, K.; Bannerman, P.; Quartey, R.; and Ashong, R. Marine Fisheries Research Division, Ministry of Fisheries, Ghana Report on Ghana Canoe Frame Survey, **2006**; No. 34, 43pp.
9. Atta Mills, J.; Alder, J.; and Sumaila R.U. The Decline of a Regional Fishing Nation: The Case of Ghana and West Africa. *Journal of Natural Resources Forum* **2004,** 28, 13-21.
10. Odotei, I. The Migration of Ghanaian Women in the Canoe Fishing Industry. *Journal of Maritime Anthropological Studies* **1992,** 5, 88-95.
11. Aheto, D. W. Valuation of Communal and Private Ownership of Mangrove Resources along the Western Coast of Ghana. In *Opoku-Agyeman, K. (2011) Culture, Science and Sustainable Development in Africa*. The First University of Cape Coast and University of Ilorin Joint Conference . University Press, Coast Cape, Ghana. **2011**; pp.464-477.