



Sea Cucumber Fishery and Trade in Sta. Cruz, Davao Del Sur, Philippines: Supply Chains and Cost-Benefit Analyses

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Abstract

In the country, sea cucumbers are exploited almost exclusively for export. It is harvested in three ways; commercial fishing, artisanal fishing and gleaning. These methods provide disproportionate economic benefits to these players in the supply chain. In this study, sea ranching, a new culture system for sea cucumber was analyzed in terms of its economic and commercial viability. Under the sea ranching system *Holothuria scabra* (sandfish) is the species being raised mainly due to its high economic value. Under the traditional method, labor comprises the largest share in the total cost, while the cost of juvenile and labor (monitoring cost) accounts to almost 87% in the sea ranching system. Based on the results of the study, selling dried sandfish would gain positive net profit, while selling wet sandfish will incur a net loss. A significant difference in income was also observed between fishers who rely on traditional method and those who will adopt the new system. Sea ranching system is a very promising method that is expected to be beneficial both to the community and the environment. However, high capital requirement, uninformed community and the lack of support from the government and concerned agencies remains to be a big challenge.

Keywords: Cost-benefit analysis; net margin analysis, value chain analysis, sea cucumber; sea ranching

Introduction

Sea cucumbers (Class Holothuroidea) are marine animals that are fished worldwide but over-exploited in most countries (Lovatelli, Conand, Purcell, Uthicke & Hamel, 2004). As a matter of fact, sandfish (*Holothuria scabra*) is just currently

classified under the “Endangered” list of the International Union for Conservation of Nature and Natural Resources (IUCN) (Hamel et al., 2013). These echinoderms are highly nutritious and an ideal tonic food due to its low fat content and are good source of protein. These are also valued as an exotic delicacy and a flavorful condiment for soups, noodles and other dishes in different countries. These creatures processed product form is commonly called “beche-de-mer” and

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“tre pang” (Tacio, 2009). Aside from being delicious and nutritious, sea cucumbers are also used for their medicinal properties. Agron (2010) stated that sea cucumbers are also used in Chinese medicine as they are good for nourishing the blood and vital essence, kidney disorders, reproductive organ problems, debility of the aged, constipation due to intestinal dryness, and problem of frequent urination. Because of these, sea cucumbers are now being commercially exploited worldwide. The fact that sea cucumber population grows very slowly and are very easy to catch because they are highly visible and slow moving in nature (Villanueva, 2005) aggravated its already threatened condition.

In the Philippines, it was reported that sea cucumber trade started in the late 18th century. As a matter of fact, the country has been a major exporter of processed sea cucumbers in the last century (Akamine, 2001). The country is naturally blessed with a high diversity of sea cucumber species that inhabit in its wide sea grass beds, soft bottom areas, and reefs. There are about 100 known species of sea cucumber, 33 of which are being exploited commercially (Choo, 2008). In terms of market preference and commercial value, sea cucumber species are classified into four categories: High value: Sandfish (*Holothuria scabra*), White teatfish (*Holothuria fuscogilva*), Black teatfish (*Holothuria nobilis*); Medium value: Stonefish (*Actinopyga lecanora*), Surf redfish (*Actinopyga lecanora*), Greenfish (*Stichopus chloronotus*); and Low value: Brown sandfish (*Bohadschia vitensis*), Lollyfish (*Holothuria atra*), Pinkfish (*Holothuria edulis*), Elephant trunkfish (*Holothuria fuscopunctata*), Amberfish (*Thelenota anax*) and Tigerfish (*Bohadschia argus*) (Gamboa, et al., 2004).

Sea cucumbers in the country are mainly harvested in three ways: commercial fishing targeting solely sea cucumbers; artisanal fishing where sea cucumbers are by-catch; and gleaning (Choo, 2008).

Commercial fishing is the most organized among the three (Gamboa, Gomez & Nievaes, 2004, as cited in Choo 2008). These commercial fishers harvest sea cucumbers in the deeper waters and involves the use of motorized vessels. These fishers spent several weeks out at sea and dive for sea cucumbers with the use of hookah. On the other hand, artisanal fishing is being done by the traditional fishers who target fishes and mollusks and sea cucumbers are only caught when encountered. The last gathering method is gleaning which is done in intertidal reef flats during low tide. Most of the gleaners are women and children which utilize only their bare hands and has very minimal or no equipment in collecting sea cucumbers. According to Mills, Duy, Juinio-Menez, Raison, and Zarate (2012), these methods have a dual impact of increasing pressure on wild stock of sea cucumber. These types of fisheries provide disproportionate social benefit, as they have no capital requirement and sea cucumbers are very accessible to catch making these resources highly vulnerable.

Presently, there are concerns about the sustainability of the world's capture fisheries at the current total level of 96 million tons per year. The warning signals are an increase in the proportion of depleted or recovering stocks, from about 10% in 1974 to 28% in 2004, and a corresponding decrease of under to moderately exploited stocks from about 40% to 24% (Bartley, Bell, Lorenzen & Loneragan, 2008). The current methods of harvesting sea cucumbers in the country will likely to produce less in the years to come. This may affect families in coastal areas who are also relying on the resource.

In order to replenish selected sea cucumber population, several organizations, such as the Australian Center for International Agricultural Research (ACIAR) and the Southeast Asian Fisheries Development Center (SEAFDEC), have been conducting researches on developing sea ranching and

pond culture of sandfish as an alternative livelihood for people in coastal communities. The successful sandfish hatchery developed by UP Mindanao and UP Marine Science Institute opened possibilities for more advanced researches on sandfish sea ranching.

With this, the study's main objective is to determine the socio-economic benefits of adapting sea ranching of sandfish in Barangay Bato, Sta. Cruz, Davao del Sur as an alternative to traditional harvesting methods. Specifically, the study aims to map out the supply chain of sea cucumber trade in the area; determine the economic viability of the sea ranching system by using Cost-Benefit Analysis; and compare the economic benefits between the traditional harvesting method and the sea ranching system.

Sea ranching of sandfish

Sea ranching as defined by Mills, *et al.* (2012), is essentially a 'put and take' activity where the cultured juveniles are released into an area of natural habitat and harvested when they reach a commercially optimal size. In this culture system, the level of care that can be offered to sandfish throughout the growth process is reduced, and survival will be considerably lower. In addition, property rights issues are less straightforward and the social dimension of culture systems becomes as critical as the biophysical dimensions.

In the study of Purcell (2012), he presented a diagram showing the steps of sea ranching which is presented in Figure 1. When applied in Brgy. Bato, the process starts from acquiring the rights to operate from the Local Government Unit on the suitable area for sea ranching activity. In the absence of a personal hatchery, juveniles will be purchased from UP Mindanao's hatchery. The juveniles are then released in the ranching area and harvested when they reach the optimum marketable size. After which, another batch of juveniles will be released, thus completing a cycle.

Communication among stakeholders is also very important which involves the hatchery operators, the sea ranch main proponents, the local government units, and the community where the area of sea ranching is located. The stakeholders play a vital role in the success of sea ranching.

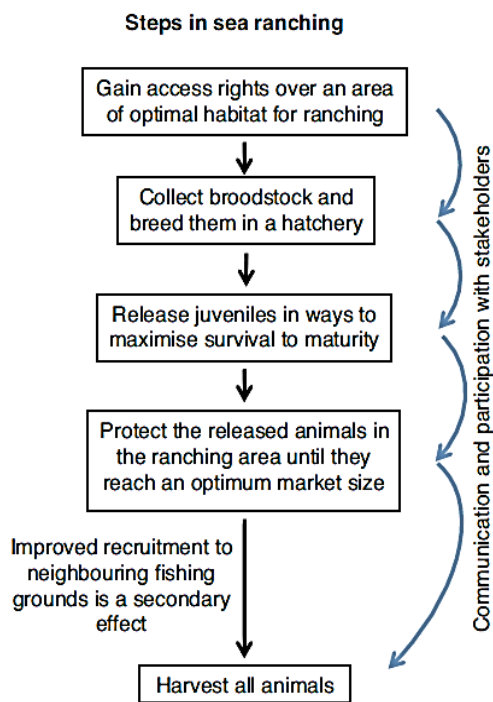


Figure 1: Steps in sea ranching
Source: Purcell (2012)

In choosing the area for sea ranching, it is important to know the characteristics of the environment, as well as the behavior and natural habitat of sandfish. According to Mercier *et al.* (2000), sandfish larvae appear to settle on sea grass blades, and juveniles are known to inhabit shallow sea grass beds. Thus, sea ranching would be ideal for sites with sea grass beds and with current or previous history of hosting the species. Even though some sites were never really home to the species of sea cucumber, nevertheless they could serve as good stocking sites; however, this will generally be rare. Moreover, sites with widely varying

environmental conditions like areas periodically subjected to freshwater deluges and those which may be vulnerable to pollutants should be avoided.

Challenges of sea ranching

Based from the experience in the pilot sea ranch project of Junio-Meñez *et al.* (2012) in Bolinao, Pangasinan, the researcher discussed some of the highlights. In their study, poaching is considered to be one of the biggest challenges. In order to eliminate poaching, permanently manned guardhouses have been established at pilot sites. However, this represents a considerable cost on the part of the group owners. The length of time of harvest was also an issue such that income will likely be realized at least 12 months and possibly closer to 18 months. On a positive note, once the first batch of released juveniles have reached harvestable size, regular harvests will be possible assuming that some have already spawned before being harvested. Pressure from participants to harvest at smaller sizes needs to be resisted in order to optimize returns from the sea ranch. The engagement of strong and respected local institutions and the presence of appropriate habitat were identified as essential preconditions for successful sea-ranching operations. A lot of enthusiasm to engage in sea-ranching activities was also noted; however a lot of energy and goodwill can be wasted if the appropriate conditions are not present. Lastly, the researchers noted the effects of the physical environment to the viability of sea ranching. The shallow inshore areas generally used for sea ranching are susceptible to physical damage and severe salinity drops. In addition to damage to ranching infrastructure and possible mortality of stock, it appears that stripping of rich organic surface layers from the sediment resulted in substantial negative growth of standing stock.

Methodology

This study utilized primary and secondary data. For the cost-benefit analysis, only interviews with key informants were conducted as information necessary for this analysis will only be based from the sea ranching project of UP Mindanao. Respondents were identified through purposive sampling. Thus, the large number of divers in the sample was basically because divers mainly dominate the area and they were available during the site visits. Furthermore, the number of samples for each actor is not predetermined but is based on the availability of the respondents.

Conceptual framework

In identifying the current status of sea cucumber trade in the area, a value chain analysis was first conducted. The species that was included under the traditional harvesting method is the *Stichopus Horrens*. Cost structure, net margins and marketing options were acquired from key informant interviews. The results showed how profitable the current harvesting methods and how abundant the species are in the area. A cost-benefit analysis on the sea ranching of sandfish was also conducted. In the said analysis, *Holothuria scabra* is the subject. A comparison of economics benefits between and among types of harvesting methods is also presented. A detailed conceptual framework is presented below.

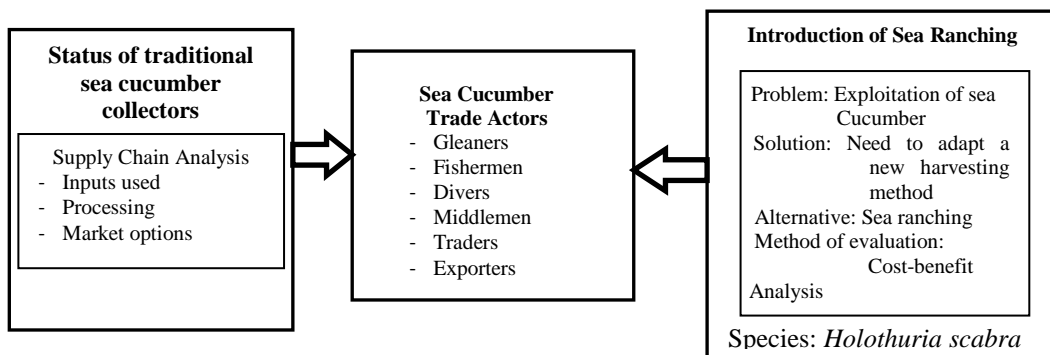


Figure 2: Conceptual framework of the study

Supply chain analysis

Beamon (1998) defines supply chain as an integral process wherein a number of various business entities (i.e., suppliers, manufacturers, distributors, and retailers) work together in an effort to: (1) acquire raw materials, (2) convert these raw materials into specified final products, and (3) deliver these final products to retailers. For this study, the analysis highlights on the interaction between key players in the sea cucumber supply chain in Sta. Cruz, and Davao del Sur.

Cost-benefit analysis

Bill Johnston’s bio-economic model was used in the computation of the growth estimates of sandfish which is an input to the cost-benefit analysis of sea ranching. Costs were quantified based on the data given by the Sea Ranching Project personnel. Each cost and capital items were briefly explained. Furthermore, the proponents also included the cost of own labor in determining the total cost. On the other hand, the benefits were derived from the current prices of both dried and wet sandfish. The production of sandfish was based on the survival rate, which is at 39%, in the experiment conducted by Juinio-Meñez *et al.* (2012). Furthermore, Return on Investment (ROI) and break-even analyses were also employed in this study.

Identification of Costs

Identifying the nature of the cost items is also necessary. In general, costs were

differentiated either as fixed cost, variable cost or opportunity cost. Fixed costs are the costs that do not vary or depend on the unit or quantity of output. On the other hand, variable costs are the costs that vary depending on the number of output while opportunity cost is the benefits that could have received by taking an alternative action. Total cost was computed by adding the fixed, variable and opportunity costs.

Calculation of revenue

Revenue generated from the sea cucumber trade is simply the product of price (paid by the buyer) multiplied by quantity (amount of dried or wet sea cucumbers sold).

Calculation of profit

Profit analysis was performed to determine if sea cucumber trade is economically beneficial or otherwise. Profit was derived by subtracting the total cost from revenue.

Return on investment

Return on investment (ROI) is one way of considering profits in relation to capital invested. It is also used to measure per-period rates of return on money invested in an economic entity. The formula used for return on investment is shown below.

$$\text{Return on Investment} = \frac{\text{Net Profit}}{\text{Cost of Investment}} \dots\dots\dots (1)$$

Break-even analysis

Break-even is a calculation of the approximate sales volume required to cover the costs. Furthermore, it is the point where cost is equal to revenue, thus, profit is zero. It focuses on the relationship between fixed cost, variable cost, and profit.

$$\text{Break – even} = \frac{\text{Fixed Cost}}{\text{Net Margin Contribution}} \dots (2)$$

Respondents

Purposive sampling was used in identifying the respondents and were interviewed based on their willingness and availability. The respondents for the net margin analysis were the sea cucumber gleaners, divers, fishers, middlemen and traders. There were also other actors in the supply chain that were interviewed like laborers, owlers and operators. These actors provided information that was relevant in understanding the entire supply chain and in the computation of the net margins per different marketing levels.

Table 1: Summary of the respondents interviewed

Actors	Gleaners	Fishermen	Divers	Middleman	Traders	Total
No. of Resp.	4	7	24	2	4	41
Location	Barangay Bato, Sta. Cruz			Davao & Digos		

Results and discussion

Under the traditional sea cucumber gathering method, thirty-five respondents were interviewed. They are composed of 4 gleaners, 7 fishermen and 24 divers. Fishing of sea cucumber in Barangay Bato is primarily done by males. Diving with the aid of compressor remains rampant despite the implementation of an ordinance banning its use. It is even linked to numerous accidents and to the 22 recorded deaths of divers in the area (Molina, 2013).

There are only few divers who own a boat and only 40% process sea cucumber. For

the fishermen, they all own a boat and 85% process sea cucumber. Moreover, the fishermen also got the highest income from sea cucumber trade which is up to PhP 1,175 per month on the average, followed by divers at PhP 1,123. On the other hand, gleaners have the smallest income with only PhP 618 per month. Nevertheless, it should be noted that the fishermen, divers and gleaners also catch fish and mollusks which adds up to their total monthly income. The share of sea cucumber income to the total monthly income is at 20%, 23% and 9%, respectively.

Table 2: Summary of the average socio-demographic features of the respondents

	Age	Experience	Monthly Family Income	Family Size	Compress or (in %)	De Mano (in %)	Boat (in %)	Process
Gleaners	25	7	619	7	0	0	0	50%
Fishermen	39	9	1081	9	0	100%	85%	85%
Diver	34	5	807	5	100%	0	29%	21%
All Obs	34	5	1977	5	66%	23%	37%	40%

Supply Chain Analysis

A supply chain map of sea cucumber trade is presented in Figure 3. Based on the interviews conducted, there are five

important chain actors. These are; the gleaners, fishermen, divers, middlemen, traders, and exporters. The chain starts with the gleaners, fishermen and divers. There are

at least 216 fishermen in the said community. These fisher folks are mainly responsible for the harvesting of sea cucumbers. The harvested sea cucumbers are sold either wet (live) or dried (trepang). Trepang commands higher prices than the

wet sea cucumbers. Majority of these sea cucumbers are sold to middlemen in the barangay or to traders in Digos City and Davao City while some are sold and consumed by the locals.

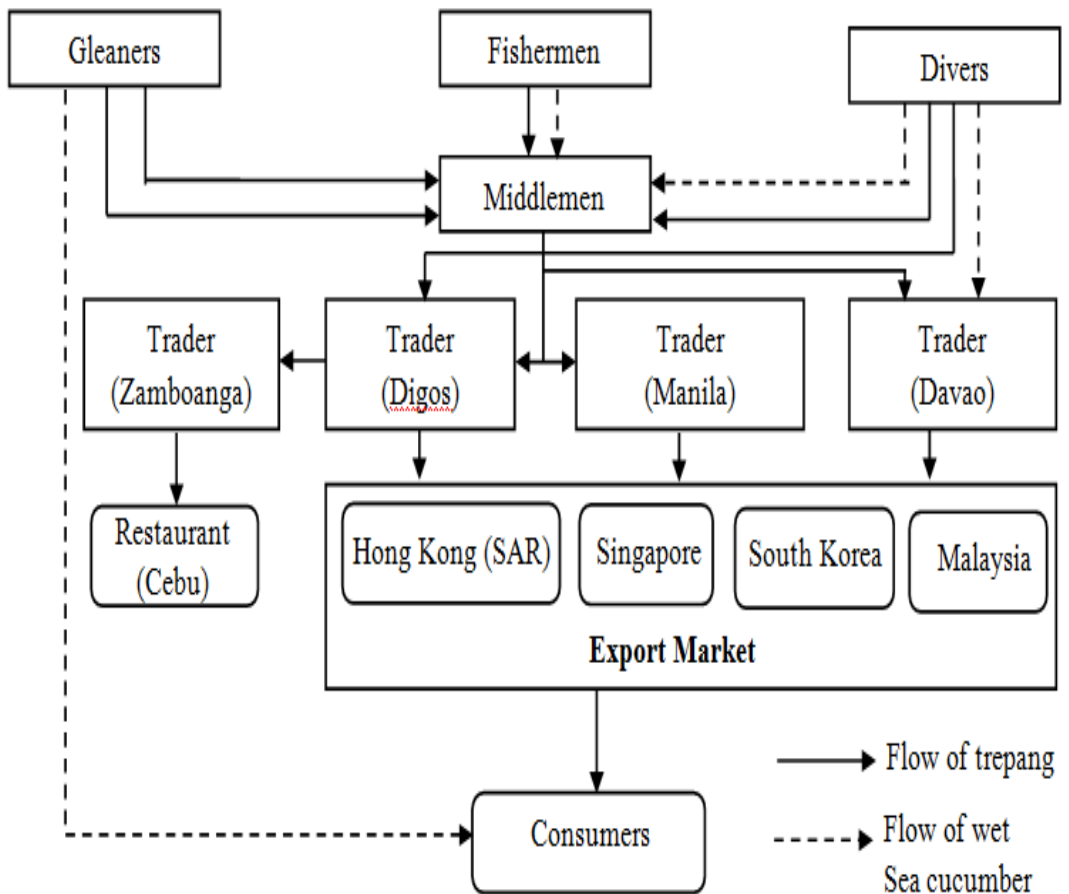


Figure 3: Supply Chain of sea cucumber in Barangay Bato
 Source: Survey Data, 2013

There were two identified market chains of sea cucumber in the area; the processed (trepang) and wet sea cucumber chains (Figure 4). The actors of the sea cucumber supply chain in Sta. Cruz, Davao del Sur were identified based on key informant interviews, and through survey-questionnaires.

Gleaners

From the three gleaners interviewed, two of them sell trepang to the middlemen who live nearby while the other one sells it wet in a nearby village. This gleaner deguts his catch, packs it in individual cellophanes and then sells it. Aside from sea cucumbers, this gleaner also sells mollusks.

Divers

Divers fish together in a group. With the use of a compressor they are able to reach the depths of up to 90 feet. These groups usually consist of five (5) to six (6) fishermen, which are composed of two (2) to three (3) divers, an overseer (locally known as owl) and an operator. Divers mainly sell wet and trepang to the middlemen in the barangay or directly sell sea cucumbers to a trader in Digos. Most of these divers process sea cucumber, as they know that they would earn more by drying it.

Fishermen

Fishermen are those who collect sea cucumber through skin diving, which is also considered a traditional way of collecting sea cucumber, together with gleaning. These fishermen sometimes go alone when fishing. Most fishermen own a non-motorized boat or 'de mano'. Skin diving method is very hard, as divers need to dive at depths up to 30 feet without the aid of compressor. This is very time-consuming and tiring, as fishermen would have to go up once in a while to take a breath. The fishermen often sell dried or wet sea cucumbers to the middlemen in the area or to the traders in Digos. Moreover, most of these fishermen do not process sea cucumber since they find it tiring and a lot of them spend their time in the morning sleeping.

Middlemen

There are two middlemen in the barangay and both buy wet sea cucumbers and trepang. They buy wet sea cucumbers by piece and trepang are bought in kilograms. They compete mainly by offering higher prices or additional services such as the provision of a cash advance. The first middleman sells trepang to a Davao Trader and sometimes ships directly to a trader in Manila. Her suppliers of wet sea cucumbers are from Sta. Cruz, Sta. Maria, Malalag and Digos. This middleman provides cash advances to the suppliers, which is a way to entice them to supply more as well as serving as an assurance for a regular supply. On the other hand, the second middleman buys wet sea cucumbers from local gatherers and processes them as trepang. He operates under a trader in Digos. The capital he used in buying and processing is provided by the trader.

Middlemen are very particular with the moisture content of the trepang that they buy, so much that they termed it as "stone dry" in order for it to qualify as good quality. Trepang is classified according to size; large, medium, small and extra small where large commands the highest price.

Traders

The traders include those who buy wet sea cucumbers and trepang. Except for the Zamboanga trader who sources trepang from a trader in Digos, the other traders also get their supply of trepang from the two middlemen in the area while the Davao trader also purchase wet sea cucumbers from a diver in the area. Aside from Barangay Bato traders also buy from gleaners, divers and fishermen from different coastal communities in Samal Sta. Cruz, and Sta. Maria to name a few. Most traders provide cash advance to suppliers without interest in exchange for the commodity. Some would finance middlemen while some would visit identified areas of suppliers and buy directly from them. Furthermore, most of these traders finance the shipment or the delivery cost of trepang to export buyers in South

Korea, Hong Kong and Malaysia. Traders are stricter in terms of the quality of trepang that they buy. Like the middlemen, prices of sea cucumbers are based mainly on the species, size and quality of the sea cucumbers. Traders may also re-process trepang which does not qualify to the standard moisture content set by the exporters.

Exporters

Philippines are one of the top exporters of trepang in the world. The trepang’s top export markets are Hong Kong which is a special administrative region of China, Singapore, South Korea and Malaysia. In this chain, the standards are set by the export markets; dictating the price at the local level.

Cost-benefit analysis of sea ranching

Barangay Bato has a very good potential for sea ranching considering that sandfish was once abundant in the area. Moreover, large scale production could also be possible considering that Sta. Cruz has an estimated sea grass area of about 140 hectares, 70% of which (90 hectares) are abundantly growing in Barangay Bato. The sea ranch should be on an area covered with sea grass beds, which could be 50 to 100 meters away from the shore. Markers, using plastic drums as buoys, should also be put up in order to have proper markings of the site (Figure 4). To minimize poaching, a guard house should also be put up. The size of the sea ranch could also be determined by the number of juveniles to be released.

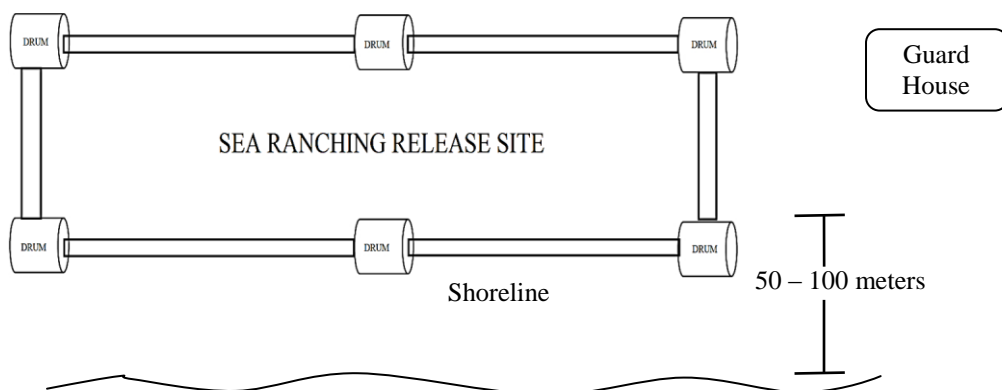


Figure 4: Sketch of a sea ranch site
 Source: Adapted from Purcell (2012)

Capital requirement

The greater bulk of fixed capital is expended on structures which would minimize or eliminate poaching, such as putting up floating markers and a floating guard house. The cost of purchased juveniles is also the biggest item under variable cost. Currently, there is only one hatchery of sandfish in Mindanao, and this is the Alson’s Aquaculture Corporation which is located in Toril, Davao City. It is 20 to 40 minute bus ride from Barangay Bato. In recent projections, this hatchery will sell juveniles with an average size of 5 grams by PhP 10 to PhP 20 per piece. The transportation of these

juveniles also play an important role in the success of sea ranching. Thus, proper protocol on transporting juveniles should always be followed. For this study, the researchers suggest that the number of juveniles to be released would be 2,000 pieces which would require a total area of 4,000 sq. m. with stocking density of one juvenile per 2 sq. m., as suggested by Junio-Meñez, *et al.* (2012).

Labor will also play an important role in the success of sea ranching which is generally guarding the area day and night in order to eliminate poaching. Thus, the effort of these

fisher folks should also be compensated; making labor cost necessary in sea ranching. At present, the fisher folks in the area do not really compute for the opportunity cost of their labor while fishing. Hence, they do not consider the next possible livelihood option in computing for their income, such that they would equate their net income to their labor cost.

This has a very big impact in determining whether their current livelihood is indeed

more economically rewarding than the next best option. Thus, for this study, labor cost is imputed as an opportunity cost which uses the average daily wage rate (less transportation cost) of manual laborers in a nearby manufacturing plant. On the other hand, the wage rate for the night shift was calculated differently using the average net income of fishermen for two weeks and divided by 14 in order to get the daily average. A summary of the total capital requirement is presented below.

Table 3: Summary of capital requirement

	Quantity	Unit Cost	Semi total (PhP)
Fixed Capital			56,000
• Guardhouse	1 unit	30,000	30,000
• Boat	1 unit	10,000	10,000
• Buoys/Marker	1 set	10,000	10,000
• Flash light	2 units	500	1,000
• Goggles	2 units	500	1,000
• Petromax	1 unit	4,000	4,000
Working Capital			85,770
• Juveniles	2,000 pcs	20	40,000
• Transportation	2 times	1,000	2,000
• Labor (monthly)	10 months	4,180	41,810
• Harvesting	1 time	1,000	1000
• Processing	10 days	96	960
Total			141,770

Quantifying the costs of sea ranching operation

The summary of costs acquired in sea ranching for one harvesting period is presented in Table 4. Total cost is comprised mainly of five items which are cost of juveniles, labor cost, harvesting cost, processing cost and depreciation cost.

Interestingly, both juvenile and labor costs constitute most of the cost of sea ranching activity with percentage share of 42% and 44% respectively, regardless whether the end product is trepang or sold directly as wet. This shows that processing cost (2% only) is almost insignificant compared to the total cost.

Table 4: Cost-structure and profit for the dried sandfish – one harvest cycle

COST ITEMS	DRY			WET		
	Cost	Cost/kg	Percentage	Cost	Cost/pc	Percentage
Juveniles	40000	2051.28	42.44	40000	51.28	42.41
Labor	41810	2144.10	44.36	41810	53.60	44.33
Harvesting	1000	51.28	1.06	1000	1.28	1.06

Transportation	2000	102.56	2.12	2000	2.56	2.12
Battery	204	10.46	0.22	204	0.26	0.22
Depreciation Cost						
Guardhouse	6000	307.69	6.37	6000	7.69	6.36
Boat	1000	51.28	1.06	1000	1.28	1.06
Markers	1000	51.28	1.06	1000	1.28	1.06
Flash light	250	12.82	0.27	250	0.32	0.27
Goggles	250	12.82	0.27	250	0.32	0.27
Petromax	800	41.03	0.85	800	1.03	0.85
Processing-trepang						
Salt (kg)	200	10.26	0.21			
Firewood (bundle)	210	10.77	0.22			
Papaya (kg)	576	29.54	0.61			
Processing cost	960	49.23	1.02			
Total	96,260	4,936.40	100	94,314	120.90	100

Quantifying the benefits of sea ranching

In the calculation of benefits, the prices for the dried and wet sandfish are based on the average current price set by the traders and middlemen. The number of harvested sandfish, which is 780 pieces, is derived from the survival rate (39%) and the total number of released juveniles (2,000 pieces). The harvested sandfish will be 500 grams on the average after 10 months. After processing, it will have a recovery rate of 5%, which is equivalent to 19.5 kgs. of trepang. A comparison of profit between

trepang and wet sea cucumber trade is presented in Table 5.

A computation of the Return on Investment (ROI) and break-even point are also done comparing processing and selling of wet sea cucumber. It can be observed that selling trepang would be the most beneficial option which will provide an ROI of 21.6% compared to a loss when it is sold wet. The break-even point is at production rate of 16.04 kgs. of trepang which is equivalent to 1,646 pieces of juveniles that should be released

Table 5: Profit comparison between trepang and wet sea cucumber trade using sea ranching

	Quantity	Price (PhP)	Total Revenue	Total Cost	Profit	ROI (%)
Trepang	19.5 kgs.	6,000/kg	117,000	96,260	20,740	21.60
Wet	780 pcs	100/pc	78,000	94,314	-16,314	-16.99

Traditional versus sea ranching method

Traditional harvesting method of sea cucumber which consists of gleaning, fishing and diving will be compared with the sea ranching system using the following parameters: production, and economic costs and benefits. A summary of the general comparison is presented in Table 6.

Production Comparison

At present, there is no policy regulating the harvest of sea cucumbers, such that there is an observed decline of the marine resource

over time. Harvesting is also done almost daily where income is greatly dependent on the quantity of catch. There are also accounts from the area that species which has no economic value before are now bought but at a lower price. The use of compressor added pressure on wild stocks considering that mature sea cucumbers, which are mostly found in deeper parts of the area, are also harvested. The traditional method is undoubtedly unsustainable and threatens the survival of the species.

On the other hand, the sea ranching system promises to be a good alternative to the current practice. Nonetheless, there are still a lot of challenges that need to be confronted and first on the list is the problem of poaching. Guarding the sea ranch area is therefore critical in ensuring profitability. However, this accounts for almost half of the cost of sea ranch operation. The length of time before harvest will also test the patience of the fishers who would adopt the new system, considering that they are used to receiving income immediately after harvesting and selling their catch. Suppliers of the juveniles are only crucial in the initial operation since the succeeding source of juveniles can come from the mature sandfish which have already spawned when they are 6 months old. This may also relate to the sustainability of the new system.

For production level comparison, an illustration on the difference between the four methods is presented where production levels are pegged on a monthly basis. The traditional methods' production levels are scaled up since they harvest almost daily, while for sea ranching it is scaled down since harvest is done after 10 months.

Cost comparison

The traditional method uses very low capital for gathering sea cucumbers. As a matter of fact, gleaning can be done by using only bare hands and household tools such as a pail for container. The cost of own labor is also significant for the calculation of total cost. When computing for labor cost using the opportunity cost as defined previously,

the percentage of labor cost to total would range from 61% - 68% for gleaning, 44% - 47% for fishing, 39% - 56% for diving and about 46% in sea ranching. Moreover, the initial capital requirement is quite large in sea ranching such that it may hinder the fisher folks to invest, leaving big companies to take advantage of this opportunity.

Benefit comparison

Pricing of either trepang or wet sea cucumber is highly dependent on its size; however buyers do not reject the product even if it is considered to be too small. Again, this would link to the over exploitation of the marine resource since the mindset of the gatherers is to catch whatever comes their way, big or small, since the person next to him will catch it anyway.

There is also a big disparity in the price between trepang and wet sea cucumber. For the species *Stichopus horrens*, the price range is PhP 92 – PhP 110 per piece for wet and PhP 1,300 – PhP 1,700 per kg. for trepang. On the other hand, *Holothuria scabra* (Sandfish) commands a better price at PhP 6,000 per kg. Compared to only PhP 100 per piece if sold wet. However, even though selling trepang would be more profitable, it would be very costly to process only a few kilograms considering the amount of time and effort it requires. Majority of the traditional gatherers would opt to sell wet sea cucumbers since they only catch a few and they also have a problem with regards to meeting the standard quality of trepang. Hence, it is the middlemen and traders who usually process sea cucumbers.

Table 6: Summary of the quantitative comparison of sea ranching and traditional methods (with cost of own labor)

	Gleaners		Divers		Fishermen		Sea Ranching	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Production	0.4	10	0.95	11	0.85	12	1.95	78
Revenue	520	920	1615	1137	1445	1320	11700	7800
Total Cost	402	404	575	462	489	346	9626	9431
Net Income	118	516	1050	674	956	974	2074	-1631

ROI	-	-	-	-	-	-	21.6%	-17%
Break-even	-	-	-	-	-	-	16.04kgs	-

Conclusion

Sea cucumbers are being exploited commercially because of their nutritional and medicinal properties. Because of the increasing demand and price of processed sea cucumber or trepang, harvesting them in the wild has put pressure in the existing stock. In general, there are three traditional harvesting methods of sea cucumber in the Philippines which also represent as the main source of production.

The following are gleaning, commercial fishing and artisanal fishing. Consequently, they are linked to a more complex connection with middlemen and traders who ultimately sell to exporters in Hong Kong and Singapore to name a few. The sea cucumber industry is considered a very lucrative business considering the revenue generates and the very high price that it offers to its processed form trepang. Unfortunately, there is an alarming trend of declining sea cucumber catch or production in the country. Hence, there is a need for new and sustainable methods of production. One of these options is sea ranching of sandfish. With this, the study aims to determine the socio-economic benefits of adapting sea ranching vis-à-vis the traditional methods.

In order to set the parameters used in the computation of economic and financial analysis, bio-economic data were employed from previous studies, notably by Junio-Meñez *et al.* (2012) and the sea ranching project of UP Mindanao.

To start a sea ranching operation, finding the ideal area is key. Characteristics like wide sea grass beds, history of habitation by sandfish species in the area, and a hatchery operating nearby are very crucial. It is also important to note the standing policies and

regulations set by the local government unit regarding any business operation in their coastal area.

With regards to monitoring and maintaining the sea ranch, it only requires minimal skills. Harvesting can also be done easily as these creatures can be captured almost effortless since they are highly visible and are slow moving in nature. However, if harvesting is done during the night where sea cucumbers are more active, harvesting becomes more challenging. Based on the study, there is also no problem in terms of marketing the product considering that there are buyers who even visit the place of suppliers.

One of the most pressing problems in sea ranch operation is poaching. In order to minimize this, capital items such as putting up a guardhouse, setting up a demarcation line using buoys as markers, and monitoring by personnel were considered necessary. These items constitute most of the costs in sea ranching operation. Another significant cost for sea ranching is the purchase of juveniles which can be about 42% of the total cost. Indeed, sea ranching requires high capital, however it is also the most promising in terms of profit generation compared to the traditional methods.

The largest profit was recorded in the dried sandfish under sea ranching with PhP20, 740 net incomes after 10 months (PhP 2,074 per month). However, if the sandfish is sold wet, which is not recommended, a net loss is incurred and would be the most unprofitable among all the methods. Results also showed that gleaners are better off if they will sell their catch directly rather than process them. The total cost was also the largest for sea ranching operation. Nevertheless, its return of investment is very attractive at 21.6%, using a conservative forecast. Moreover, in order to generate a positive net income at least 1,646 pieces of juveniles should be

released in the sea ranch, which would produce 16.04 kgs. of trepang.

Sea ranching is indeed a very promising method in conserving and utilizing the marine resource at the same time. Nonetheless, it is hard to discount the challenges that this novel method had encountered and will face in the future. Therefore in order to make this venture a success, a more informed and concerned community is necessary, with empowered fisher folks as sea ranch operators, and a government that is more than willing to extend its help to the stakeholders of the industry.

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