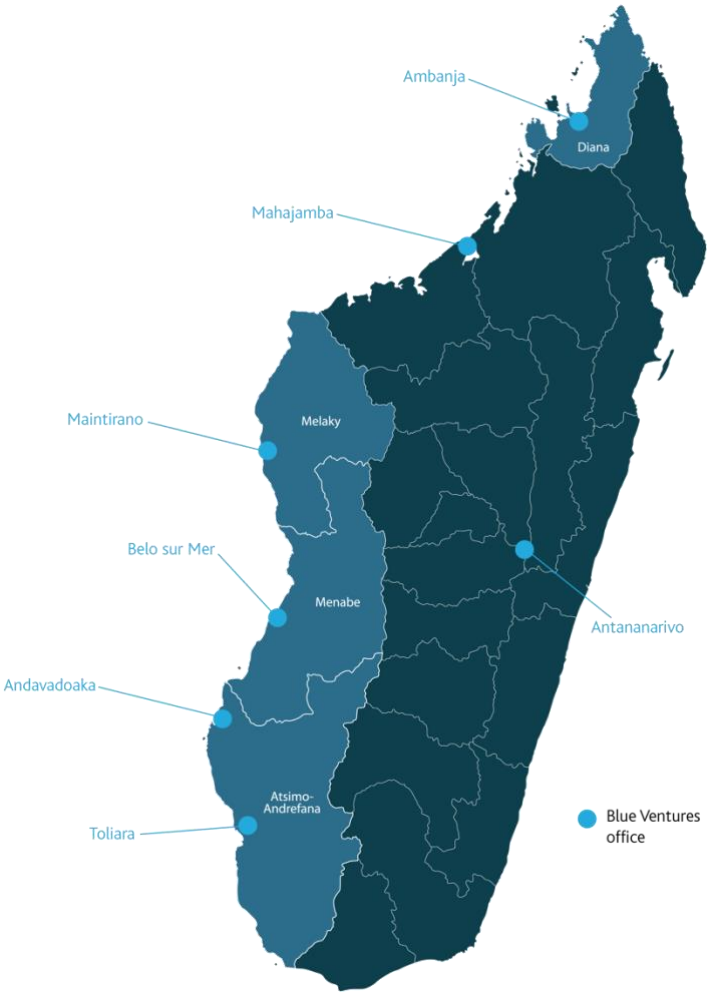
Value Chain Analysis

The wild capture mud crab fishery of Madagascar's Menabe region

blue ventures
beyond conservation

Contents

Executive Summary



Madagascar's fishers are some of the poorest people in the world. In some regions, such as Menabe, around 41% of the adult population in coastal communities is reliant on fishing as their primary source of income or protein. The mud crab (*Scylla serrata*) fishery in this region is an important source of income for many fishers, as it requires minimal investment to catch and sell crab, and there is consistent demand, driven primarily by international markets. However, despite the lucrative market for mud crab, fishers are unable to capture the majority of financial benefits and are instead often locked in cycles of debt and poverty. This study presents an analysis of the mud crab value chain, with the aim of better understanding market issues and the challenges faced by different stakeholders. This report also makes recommendations about how these can be overcome.

Although the fishery only accounts for a small proportion of local employment, it is associated with high levels of dependence by its key stakeholders. Of the 98 crab fishery stakeholders interviewed, 90% of crab fishers, 81% of market vendors, 89% of local collectors and 100% of regional collectors were reliant on mud crabs for the majority of their income.

This study found that mud crabs are sometimes consumed by the fishers' families, but more often stored in mud and sold to a range of buyers. Fishers primarily reported selling to local collectors based in the community (96% of those surveyed), and a smaller proportion also selling to local hotels. The reliance fishers have on a single buying group has encouraged a buyers' market, where local collectors dictate prices. This imbalance in market power is compounded by the advanced pay used to purchase crabs, creating a cycle of debt that further entrenches the dependence fishers have on local collectors. At each subsequent level in the value chain, routes to market diversified and dependence between stakeholder groups became less pronounced.

The value of crab increased as it moved along the value chain. Grading (paying a higher price for better quality crabs) was the only mechanism used to add value to crabs, practiced almost solely by collectors. Within the value chain it was more common for value to be lost than added. Mortality and damage during storage and transportation represent the largest losses in the value chain, with an estimated cost for fishers and local collectors equal to around 21% of their total profits. Although it was not possible to calculate the cost of this loss to regional collectors, again mortality and spoilage increased in frequency at every stage in the value chain. It is therefore likely that this cost is even greater for regional collectors than for local collectors.

At present, demand for mud crab outstrips availability. This highlights a market appetite for higher volumes of crab, including value added products, and presents the greatest opportunity to increase the value within the value chain. However, this imbalance also presents the greatest threat to sustainability of the fishery. Higher levels of exploitation are the obvious tool to meet demand, but are likely to exacerbate the current level of over-exploitation. This could result in reduced crab availability and even stock collapse. If demand could instead be met by reducing mortality and spoilage, the value of this currently wasted portion of the catch could be realised within the value chain. Recommendations made in this report include assessing opportunities for freezing, ranching and fattening of crabs, in addition to exploring more direct routes to market for local fishers.

1. Introduction

Madagascar's marine environment supports globally important and threatened biodiversity and provides livelihoods and food to over 500,000 people.[1] The country's fishers include some of the poorest people on earth[2], and many coastal communities have no alternative livelihood to fishing. The island is ranked among the tropical coastal nations with the lowest adaptive capacity and highest vulnerability to climate change.[3]

This study is focused on the Morondava district within the Menabe region of Madagascar, an isolated, arid area on the west coast of the island. Levels of formal education are very low in the region and income for many households is below the international poverty line of $1.90 (purchasing power)[4]. A recent census[5] conducted by Blue Ventures found that 42% of the adult resident population (>15 years old) depends on fishing as a primary source of food and/or income. It is also common for people in other occupations to fish, as a means to diversify their source of income and food.

Mud crabs (*Scylla serrata*) are opportunistic scavenger feeders, living in burrows in the mangroves that fringe much of the coast within the study area (Figure 1). A local fishery has developed around this particular species, which supports around 12% of the local fishing community as their primary source of income.[6] This is a small-scale, artisanal fishery, based around traditional fishing methods, with fishers operating on foot or from small dugout canoes in mangrove forests. Collectors and most sellers operate locally, often within informal markets, selling their produce to a range of buyers including seafood exporters. Most of the catch is ultimately destined for foreign markets[7], particularly China (receiving 70% of exports in 2016[8]) and the European Union[9] (France received 21% of mud crab exports in 2016).

High international demand for mud crab and the minimal barriers to entering the fishery, due to expansive low-tech local supply chains, have resulted in the fishery becoming critical to a large number of poor, mangrove-dependent communities. However, fishers have to-date been unable to take advantage of the lucrative mud crab market. They operate within an unpredictable local market, where prices fluctuate greatly over the year, and in some cases even over a single week. At the bottom of the supply chain, fishers have very little power to secure better value for their product. Instead, they are often forced to catch more, and increasingly smaller, mud crabs, just to generate enough income to provide food for their families. This is a contributing factor to crab fisher households being some of the poorest in the region and often in debt.

Fisheries management and historic information on the fishery in the region is very limited. A legal minimum landing size of 10 cm was introduced in 2010, and this was subsequently increased to 11 cm in 2014 as a management measure for the fishery. However, compliance is low and undersized crabs are a

common sight at local markets. Recent work by Blue Ventures[10] and Smartfish[11] has found that the stock is showing signs of overfishing, with observed declines in Catch Per Unit Effort (CPUE) and crab size in recent years. If left unchecked, this could potentially lead to complete collapse of the mud crab stock, fishery, and the value chain that has grown around it, within the next few years.

Value chain analysis was identified as a tool to better understand the specific barriers to improving value along the chain, in order to design new strategies for incentivising marine conservation and fisheries management. Value chain analysis looks at every step in the chain that a fisheries "product" goes through, from the raw materials to the eventual end user. The process identifies the value flows through the chain, and specifically, areas where value is added and lost. The main aims of this study are to identify the key stakeholders involved in the value chain and understand the relationships (e.g. the flow of payment) and linkages between them.

2. Methodology

2.1 Framework

The value chain is the full spectrum of activities that take place as a product is brought from production, through intermediary stakeholders and actors, to its delivery with the final customer.[12] This is driven by the market-oriented interactions between key stakeholders such as commodity producers (fishers in this study), producers, processors and buyers. Although these stakeholders hold varying levels of market power, they are all intrinsically involved in the processes that produce and add value to the product. In this report, fishers are those people who declared themselves as fishers, or are designated by the community as fishers (unless otherwise noted, for example, in the census data).

This value chain analysis was carried out for the wild capture mud crab fishery in the Menabe region of Madagascar. This is a descriptive process that charts the flow of products and related services along the value chain, in both directions.[13] Value chain analysis separates the activities in the value chain, making it possible to identify areas where value is added and lost. This helps to foster a better understanding of the constraints and opportunities for each stakeholder group, within each stage of the value chain.

A four-part process for the value chain analysis was used for this study. These steps are as follows:

1. **Preparation**

Preparatory work was undertaken to determine and outline the objectives of the value chain analysis, the timeline, and the resources requirements and availability.

2. **Desk research and preliminary value chain mapping**

Research was carried out to understand what is already known about the value chain and what will need to be determined using primary research techniques including semi-structured interviews and questionnaires. Subsequently, an initial value chain map was produced for later refinement. This included a list of known stakeholders, such as exporters, traders, retailers, hotels, resorts, restaurants and villages in the region that are active in the fishery.

3. **Primary data collection and research**

Building on the results of the previous two steps, a questionnaire was produced targeting the various stakeholders identified throughout the chain. After translating and pre-testing the questionnaires, data collection was piloted. Following pilot surveys, the team met again to discuss any problems with the questionnaires and refined them accordingly. Once the pilot was complete, the main research phase began.

4. Mapping, analysis and write up

Primary data collected in stage three were analysed and combined with the results from step two, to produce the value chain analysis and refine the initial value chain map. A key component of this stage involved the analysis of constraints and opportunities for upgrading the chain, and the priorities and recommendations for doing so.

The final questionnaires (Appendix A) provided a framework for collecting quantitative data necessary to answer five critical questions (adapted from a previous value chain analysis[14]):

1. Who are the key stakeholders in the value chain, what role does each play and what relationships do they have with each other?
2. What and where in the chain are the activities that add value to the crab product?
3. What are the buyer requirements for the crab products (volume, grades, packaging etc.)?
4. What is the flow of payment along the value chain and how are prices determined?
5. What are the challenges faced by different stakeholders (especially fishers) along the value chain and how can these can be overcome?

All prices are in Malagasy Ariary (MGA), unless otherwise stated. At the time of writing, £1 GBP was worth approximately 4400 MGA (September 2018).

2.2 Study area

The value chain analysis questionnaires were conducted over a 31-day period, between the 18th of June and 18th of July 2018, in six villages in the Morondava district of Madagascar's Menabe region, and in Morondava city. Listed north to south, these were Morondava, Antsatsabo, Andika, Mokotra, Andranolava, Belo sur Mer and Antanimanimbo, respectively (Figure 1). In total, over 100 people throughout the value chain were interviewed, consisting of 59 fishers, 11 market vendors, 14 local collectors, three regional collectors and 14 hotel representatives. In addition, an exporter employee was informally interviewed to get the perspectives of the exporters (exporters themselves refused to be surveyed). Mainly because of this limitation, we focused on the value chain within Madagascar and specifically the Morondava district, despite the fact that many mud crabs passing through the value chain are exported.

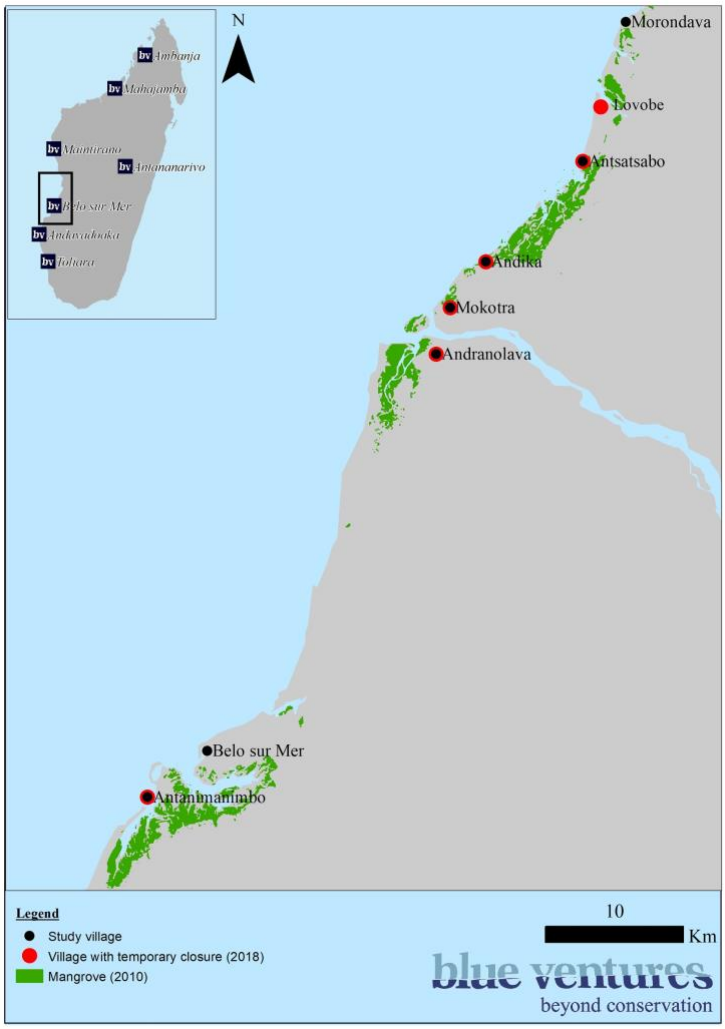


Figure 1. A map of the Morondava district and its position within Madagascar. This map shows the location of all villages included in this study and the extent and location of all mangrove forest within the district (2010).

3. Results and Discussion

3.1 Value chain

3.1.1 Key stakeholders

The value chain mapping identified six key stakeholders in the local mud crab value chain: fishers, local collectors, regional collectors, market vendors, hotels and exporters. The first four stakeholders were defined as follows:

- Fishers include those people who declared themselves as crab fishers, or those designated by the community as crab fishers.
- Local collectors operate solely within the local district of Morondava. This work is associated with a "mareyeur" (local collectors) license.
- Regional collectors operate within the wider Menabe region or national market and typically hold a “permis de collecte” (collection permit).
- Market vendors include both the more formal market in Morondava as well as informal markets in Belo sur Mer and Mokotra. The informal markets involve fishers in the two latter towns selling some crabs directly to other consumers. In both cases, however, the crabs sold are those that cannot be sold to collectors or exporters, sometimes called “reject” crabs, and opportunities for increasing value to the fishers will be the same. Hence, we have combined them into one stakeholder group for this study.

There is some overlap between stakeholder groups. For example, regional collectors often export crabs but not all regional collectors are also exporters, and likewise, some exporters also operate as regional collectors (though all require a collection permit). It was not possible to obtain information from any stakeholders who were acting solely as exporters, with the exception of one employee of an exporter, so regional collectors represent the upper limit of this value chain analysis. Specific notes from the interview with the employee of the exporter are mentioned in this report, where appropriate.

Key stakeholders were interviewed in five villages, plus Morondava town, Menabe region’s capital, which is the main commercial centre in the region. It is also home to the largest and only formal mud crab market, the majority of hotels, and all of the regional collectors of the district/region (Table 1). All other villages identified in Table 1 are principally fishing villages with varying levels of commercial diversification. Belo sur Mer, with several hotels and local collectors, is the second most commercially diverse village in the value chain. It is around 65 km south of Morondava.

Table 1: Key stakeholders in the value chain interviewed for this study, listed according to village from north to south.

		Number of key stakeholders interviewed				
	Village	Fishers	Market vendors	Local collectors	Regional collectors	Hotels
North	Morondava	-	11	-	3[15]	8
	Antsatsabo	10	-	3	-	-
	Andika	11	-	2	-	-
	Mokotra	6	-	-	-	-
	Andranolava	10	-	5	-	-
	Belo sur Mer	10	-	3	-	5
South	Antanimanimbo	10	-	1	-	-
	Total	57	11	14	3	13

Although the mud crab fishery only accounts for a small proportion of the local employment, it is associated with high levels of dependence by its stakeholders. While the majority of fishers reported having supplemental income, 90% of fishers, 81% of market vendors, 89% of local collectors and 100% of regional collectors interviewed were reliant on mud crabs for the majority of their income.

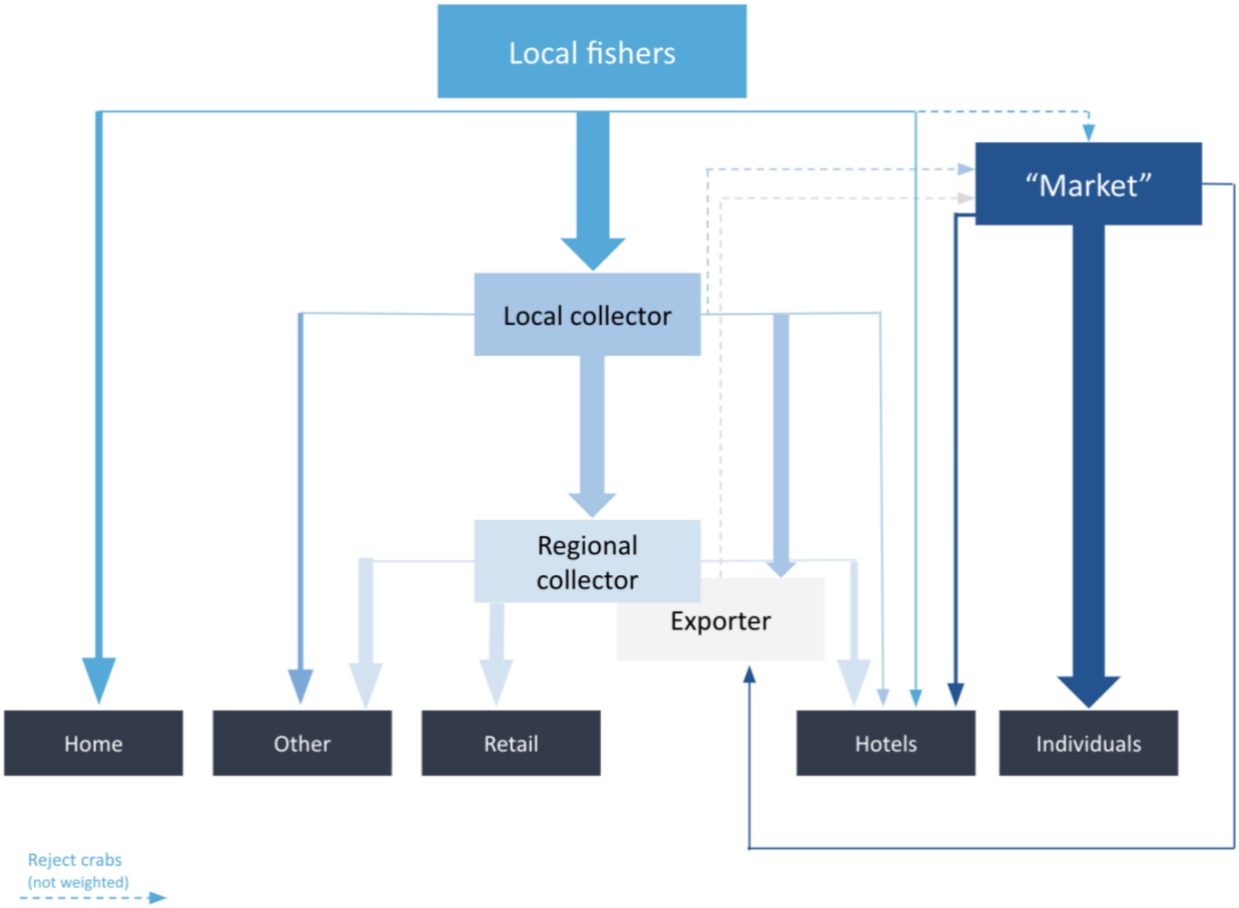


Figure 2. The mud crab fishery value chain of Madagascar's Menabe region. Arrows are weighted by relative sale flow. "Markets" include both the more traditional or formal market in Morondava and the consumer markets in Mokotra and Belo sur Mer. The group labelled "Other" includes buyers abroad and processing factories within Madagascar.

3.1.2 Stakeholder interactions

The key stakeholders involved in the mud crab value chain and the proportional sales flow between the different groups are shown in Figure 2. This reveals value chain interactions and the dependencies that exist between stakeholder groups.

Fishers have three available routes for sale; local collectors, hotels and informal markets. However, despite the presence of alternative customers, fishers are heavily dependent on local collectors for the sale of their crabs. This is shown by the majority of fishers (96%) reporting their primary buyers being local collectors, and stating that they would sell crab 85% of the time.

The heavy reliance fishers have shown for a single customer group (local collectors) helps to maintain a buyers' market. Here, local collectors leverage their position in the supply chain to dictate the price of crab at source, an arrangement reported by all fishers surveyed. The position of stronger market power

displayed by local collectors when dealing with fishers is compounded by the advanced pay used to purchase crabs, where collectors offer money in advance of future catches that fishers accept in order to keep their families solvent during seasonal dips in crab abundance. This creates a cycle of debt, and further entrenches the dependence fishers have on collectors.

At each subsequent level in the value chain, stakeholders take greater advantage of the various routes to market and their dependence on any one buyer becomes less pronounced. Local collectors have two main buyers – regional collectors and exporters – who represent 53% and 38% of sales respectively, while regional collectors sell their crabs across a relatively diverse portfolio of buyers, none accounting for more than 40% of sales. Regional collectors and local collectors are known to sell crabs to the market, but this represents only the sale of otherwise rejected crabs (that is, otherwise unsold, for reasons including but not limited to quality or size).

3.2 Stakeholder groups

3.2.1 Fishers

The average fisher income from mud crab (by village) was found to rise with increasing proximity to Morondava (Figure 3). The fishers surveyed in Antsatsabo, the village closest to Morondava, represent only 17% of those in the study, yet account for 42% of the total earnings reported. This is a stark comparison to the 17% of fishers in this study that come from Antanimanimbo. This is the village furthest from Morondava, and fishers here account for only 9% of the earnings reported by all fishers in this study. Note that percentages reported are only for those interviewed in this study, and may not represent the population exactly.

Fisher income is dependent on the volume of crabs caught and sold, the price received per kilogram, expenses and, to a lesser extent, pre-sale crab mortality. All of these metrics were found to be highly variable between individual fishers and between villages. However, when analysed by proximity to Morondava, some clear patterns emerged.

The volume of crab caught on an average day ranged from 2.5 kg to 17.5 kg with an average of 7 kg, though more extensive data collection in the field carried out over several years did not provide a consistent trend in catch volume between the villages over the study period.[16] The costs associated with fishing, however, were found to decrease with increasing proximity to Morondava (Figure 4). This might be partially explained by the villages closer to Morondava having a shorter transport time and subsequent lower transport cost to reach buyers (Figure 5). The shorter transport time could also result in higher quality crabs reaching the buyers and thus could explain the observed trend of fishers in villages closer to Morondava receiving a higher average price per kilogram (Figure 6). The veracity of this potential link between transport time, quality, and therefore price, requires further investigation.

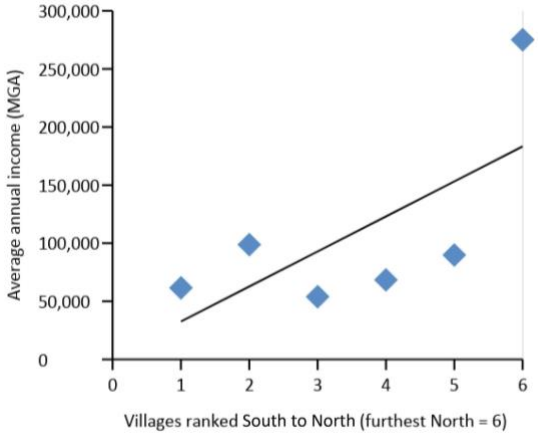


Figure 3. The average fishers annual income (MGA) by village. Villages are ranked from south to north with 1 being the furthest south, and so furthest from Morondava.

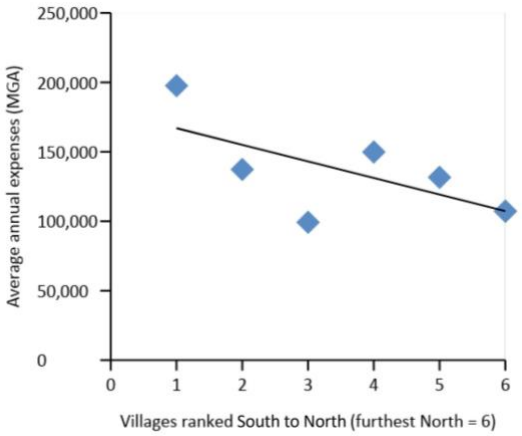


Figure 4. The average annual mud crab fishing related expenses (MGA) by village. Villages are ranked from south to north with 1 being the furthest south, and so furthest from Morondava.

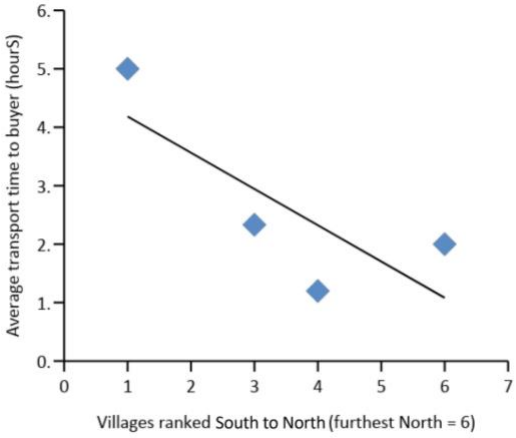


Figure 5. The average transport time to the buyer (hours) by village. Villages are ranked from south to north with 1 being the furthest south, and so furthest from Morondava.

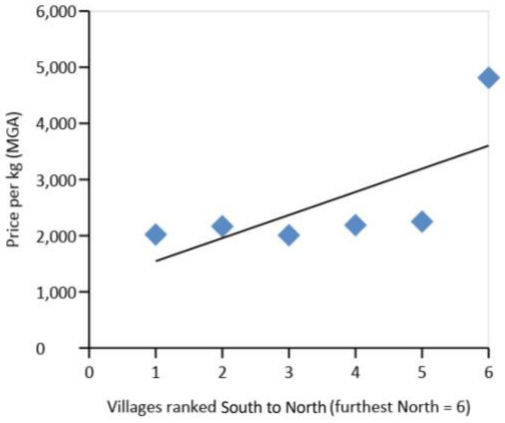


Figure 6. The average price per kg (MGA) of mud crab by village. Villages are ranked from south to north with 1 being the furthest south, and so furthest from Morondava. There was one notable exception which may have skewed the last data point - a fisher from Antsatsabo sold his crabs for 3.7 times the average rate, and was one of only two fishers to sell the more highly prized "whole/full" grade.

While there is a pattern for fishers earning more money in villages closer to Morondava, Figure 7 shows that there is huge variation in fisher annual incomes across all villages. Of the fishers surveyed, 74% had annual earnings of between 1.50 million and 9 million MGA. However, when combined, these earnings are almost 100 million MGA lower than that of the remaining 26%, who had an average annual income of 18.99 million MGA.

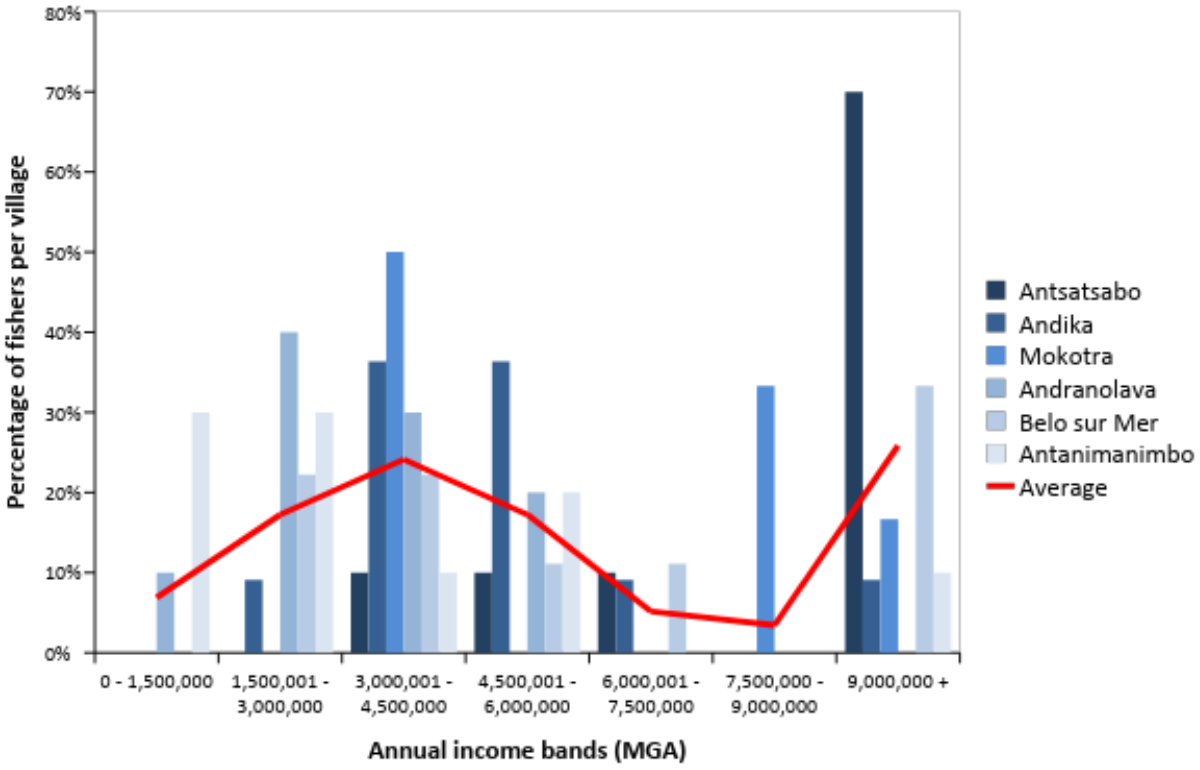


Figure 7. The income profiles of fishers within each village, by income band. The average for the entire group is displayed as a line.

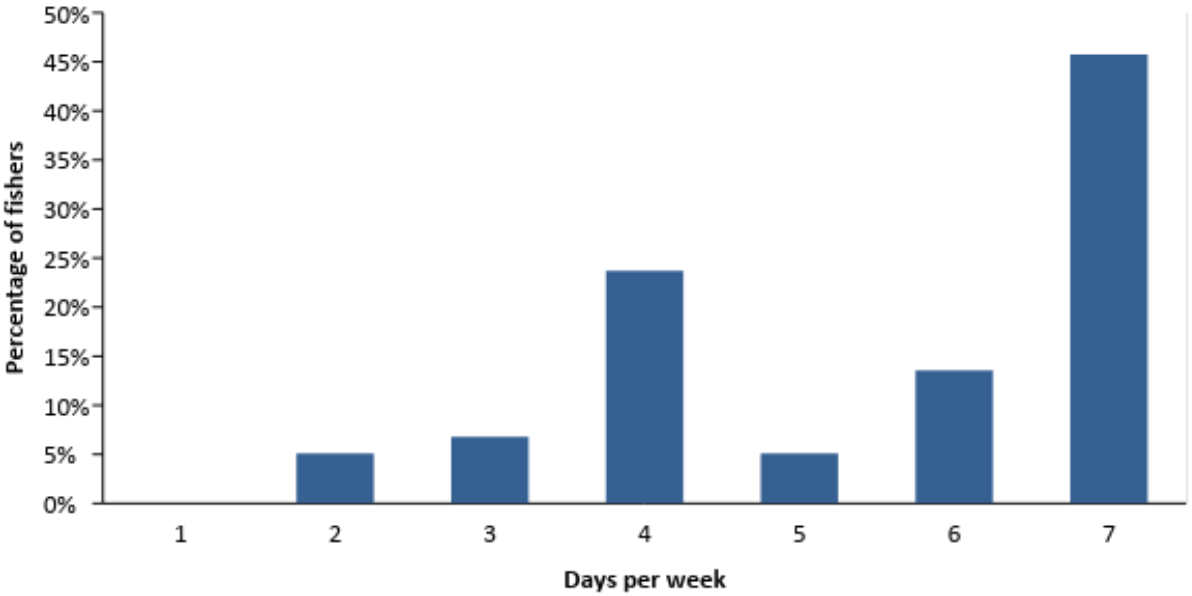


Figure 8. Shows the percentage of fishers that recorded fishing crabs a certain number of days per week.

Surprisingly, although the number of days spent fishing crabs per week varied between fishers (Figure 8), fishing days were not found to have a strong effect on income.

Of the 59 fishers that were interviewed, only 12 reported that they owned a license to fish crabs, and 59% reported having received a training on mud crab biology, life cycle or management from either Blue Ventures or Smartfish. Neither possessing this education nor the license seemed to have an influence on income. There was, however, a link between licenses and training, and only one fisher held a license without having received any training. This link requires further examination to determine a cause.

3.2.2 Market vendors

Grading, the practice of separating crabs into groups based on quality and size, is not common for market vendors who sell only the lowest value grade of mud crabs (mixed grade). Mixed grade crabs include all qualities and often all sizes (see Table 2 for other grade definitions). Generally, market vendors sell crabs by the pile (toko – an arbitrary unit used locally as a measure for crab), with a very low operating profit margin. They sell primarily to individual buyers (representing around 81% of their business), and two even stated that they sometimes sell directly to hotels and exporters.

Anecdotal evidence (from all market vendors interviewed and from the one exporter employee interviewed) along with other field experience, suggests that mixed crabs, including those that are broken, are sent to the market by stakeholders throughout the value chain as a last resort for sale. Markets are

also known to buy and sell crabs below the minimum legal landing size, despite 73% of vendors stating that they were aware of the legal limit of 11 cm. Crabs as small as 6 cm are reportedly sold at the market at a lower price per kilogram than crabs above the minimum landing size.

3.2.3 Local collectors

Local collectors purchase mud crabs directly from fishers and sell mainly to regional collectors and exporters, with some sales to local hotels (Figure 2). This is the first stage in the value chain where crabs are routinely graded by quality and size, and where sustainability of the catch becomes potentially marketable (Table 2). This potential was stated directly by one local collector from Andranolava, who said that he would be willing to pay an extra 500 MGA per kg for crab from a sustainably managed source.

Mortality and damage (broken or not whole) were reported at a higher rate by the five license-holding local collectors when compared to those without a license. This finding requires further examination to determine the cause, although our experience in the field suggests that local collectors with licenses tend to be better educated. This would leave them better placed to quantify, and therefore report, loss through mortality and damage.

Table 2. All grades of crab identified in the value chain analysis and their descriptive characteristics.

Grade	Description
Mixed	Mixed quality
Light	Crabs with little meat
Full	Crabs with lots of meat
Part	Broken crabs
Whole	Whole crabs

3.2.4 Regional collectors

There are 12 regional collectors in the Morondava area that purchase mud crabs directly from local collectors, selling their crabs to retailers, hotels, exporters and to "other" buyers (Figure 2). Although sales data is limited for regional collectors, it appears that crabs are being graded further once they reach this stage. This is, for example, the first time that a differentiation is made between broken and unbroken crabs being sold.

Two of the three regional collectors surveyed stated a willingness to pay a premium for crabs from a sustainably managed source. One regional collector put this premium at an additional 1100 MGA per kg.

Other regional collectors stated that they freeze some or all of their crabs prior to sale. Our surveys showed about 15%, by weight, of all crab sold by collectors in the Morondava area is frozen. This presents a potential opportunity as a new market for fishers. If fishers could sell frozen crabs directly to collectors, especially Sopemo (the main seller of frozen crabs[17]), this could provide a higher value alternative to the existing market for damaged stock.

3.2.5 Hotels

Hotels are only found in Morondava and Belo sur Mer. They source mud crabs from all other stakeholders interviewed for this report, including regional collectors, local collectors, markets and, in Belo sur Mer only, fishers.

Dishes made with whole crabs could demand a higher price than those that used a mixed grade, with prices ranging from 3,000 to 20,000 MGA for mixed and 8,000 to 50,000 MGA for whole crabs. However, the range in purchase price for mixed and whole crabs was the same, 2,500 to 4,000 MGA per kg.

Some hotels stated that they use frozen crab meat for some of their dishes. If frozen and shelled, otherwise rejected crabs could be sold here and provide a higher value alternative to the market. Additionally, over 60% of hotel representatives responded that they would pay a premium for crabs from a sustainable source, although none were prepared to state an exact value.

3.3 Buyer requirements

None of the stakeholders interviewed expressed strong requirements for purchasing, such as a minimum quantity, male or female (although some field experience suggests that female crabs were better for the export market). All regional collectors stated that the minimum size they would purchase was 11 cm (the minimum landing size). This was also the case for some local collectors and market vendors; however, others were willing to purchase crabs at much smaller sizes.

3.4 Seasons

Menabe has three distinct seasons; Asara (December to April), Asotry (May to August) and Faosa (September to November). Asotry is the low season for catching mud crab (by volume). Around a quarter of fishers stated they catch the most crabs during Faosa, and the remaining three quarters catch the most during Asara (Figure 9). This pattern is fairly consistent across all villages and coincides with the lowest price received by fishers for their mud crabs (Figure 10), as prices drop due to increased availability. From field experience we know that other factors may play a role (e.g. tourist season for selling to hotels), but we do not yet have data to support these correlations.

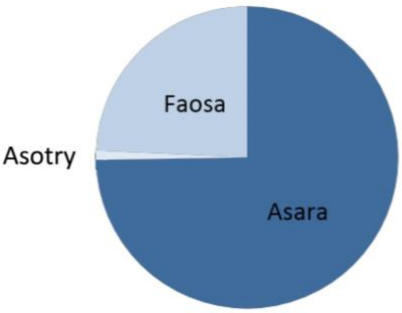


Figure 9. Seasons in which fishers reported catching the most crabs.

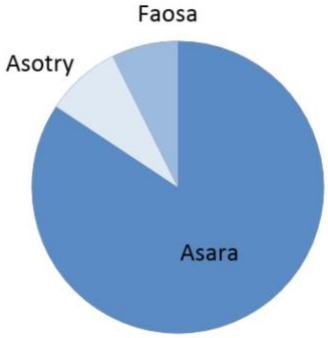


Figure 10. Season in which fishers reported receiving the lowest price for their crabs.

3.5 Adding value

In general, as crabs moved through the supply chain their value increased (Figure 11). The median sale price of crab was 2000 MGA per kg for fishers and market vendors, 3500 MGA per kg for local collectors and 4200 MGA per kg for regional collectors.

The only process for adding value to mud crabs currently used in the supply chain is grading. Grading leads to stratification of prices, as higher value grades can be sold at an increased markup compared to those of a lower value grade.

Fishers and market vendors were not observed grading their crabs or carrying out any other practices that added value to their goods. This is illustrated by the low variance in value for crabs among these stakeholders (Figure 11). For these fishers and market vendors, prices remain fairly consistent and they offer mainly mixed or ungraded crabs. One notable exception is a fisher from Antsatsabo who sold his crabs for 3.7 times the average rate. He was one of only two reported fishers to sell the more highly prized "whole/full" grade. Local and regional collectors, by contrast, routinely separate crabs into multiple grades based on quality and size. This has the effect of adding value to crabs in the new premium grades while

having little to no effect on the price of crabs of low quality, creating the greater variation in price between products.

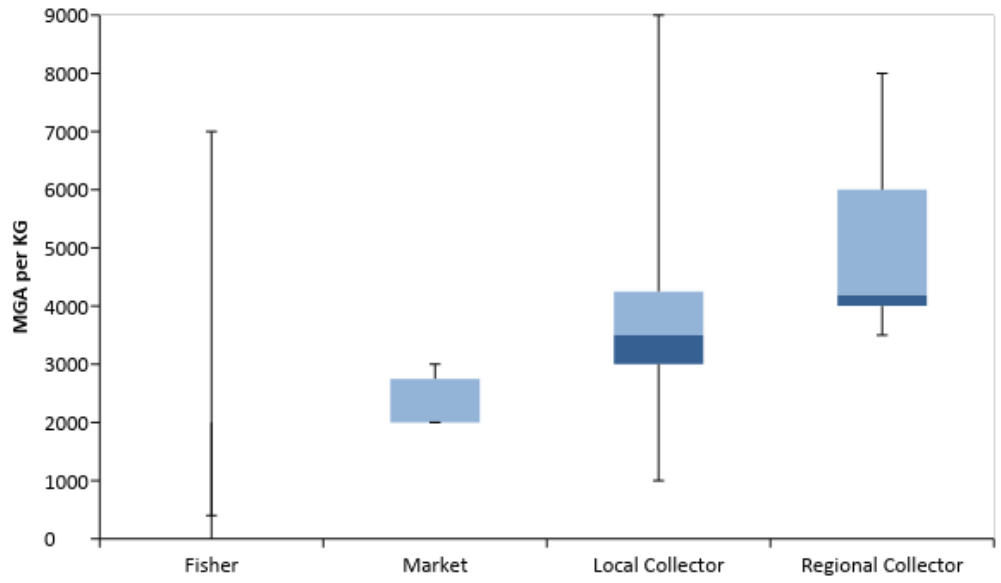


Figure 11: Crab sale price in MGA per kg for the different stakeholder groups included within the VCA. The dark blue lower box represents the second quartile of the data, i.e. 25% of the data is below this. The meeting of the dark and light blue boxes is the median and the light blue box is the third quartile (i.e. 25% of the data was higher than this). The whiskers (lines and bars) show the total spread of the data, i.e. the highest data points within the first (bottom whisker) and the fourth (top whisker) quartiles.

Local collectors purchase crabs from fishers at an average of 1950 MGA per kg for mixed crab. These are graded and then sold in three distinct grades: "mixed light" at 2000 MGA per kg, "mixed" at 3280 MGA per kg and "whole full" at 7600 MGA per kg. By separating crabs into these grades, local collectors more than double their profit for every kilogram of "whole full" sold. This is accompanied by a greater spread in profit per kilogram with higher value grades, with "whole full" selling for an average of 2.3 times that of lower value grades, such as "mixed". Figure 12 shows the increased spread of profit per kilogram seen by local collectors that often grade crabs as compared to fishers that rarely practice grading.

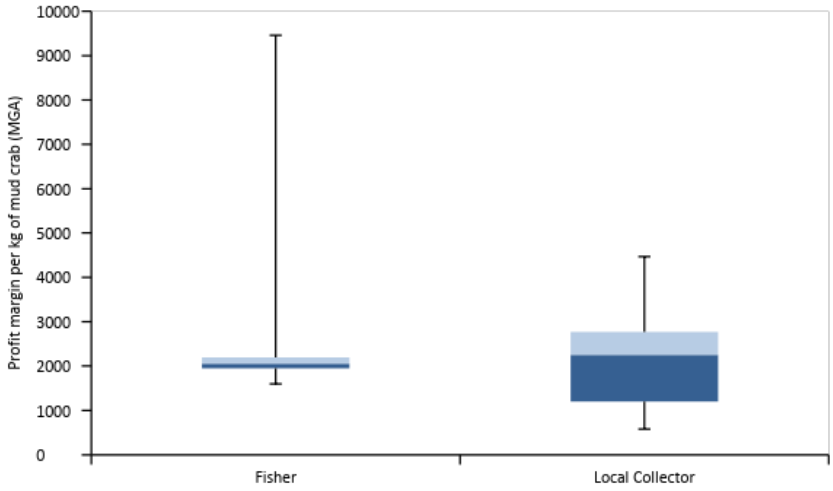


Figure 12 The profit margins on mud crab (per kg) made by fishers and local collectors.

3.6 Value loss

Value loss was found to have a much larger effect on the value chain than activities that added value to mud crabs. Value lost in the value chain occurred principally in two ways: damage and/or mortality, or expenses.

3.6.1 Mortality and damage

Post-harvest there are two principle paths for crab within the local value chain (Figure 2): from fishers to local and then regional collectors, or from fishers to the informal market for resale. Crabs passed along these chains have different levels of associated value and loss. Typically, crabs sent to the informal markets have lower levels of loss (Figure 13) but also a lower resale value (Figure 11). Based on our field experience and interviews with market vendors, we find crabs that are rejected or damaged throughout the value chain are sold to markets to help mitigate loss by realising some value through a quick sale at a depressed price.

Case Study

A fisher from Antsatsabo relies on crab fishing for his entire income. He sells exclusively to local collectors, but, unlike most other fishers he sells some of his crabs in the highly prized "whole/full" grade, for which he receives 3.7 times the average sale price. This shows clearly that there is an appetite amongst collectors for value added, graded crabs if the right connections can be made, and barriers to market removed.

Mud crab mortality rates were found to increase at each stage in the supply chain. Fishers suffered around 1% recorded losses and median losses went up to 5% for market vendors, 12% for local collectors and 20% for regional collectors respectively (Figure 13). This suggests that, while storage and transport time seemed to have no obvious effect on loss, the further

along the value chain and thus longer out of the mangrove, the weaker, more stressed and therefore more susceptible to mortality crabs become.

Once crabs pass through the hands of both local and regional collectors they have, on average, suffered losses through mortality of around 28% (Table 3). This represents a huge sink in the value chain and a major barrier, but also an opportunity for stakeholders in the fishery to realise higher profits and returns on their effort. The opportunity cost of mortality and damage for local collectors was calculated at 138,261,707 MGA annually, between the 14 local collectors surveyed. Reducing this loss to zero would increase the group's combined income by 77%.

Mortality and damage were reported at a higher rate by the five license-holding local collectors when compared to those without a license. It is not currently known what is causing this. One license-holding local collector reported such a high rate of mortality and damage, around 70%, that his business was found to be losing tens of millions of MGA a year.

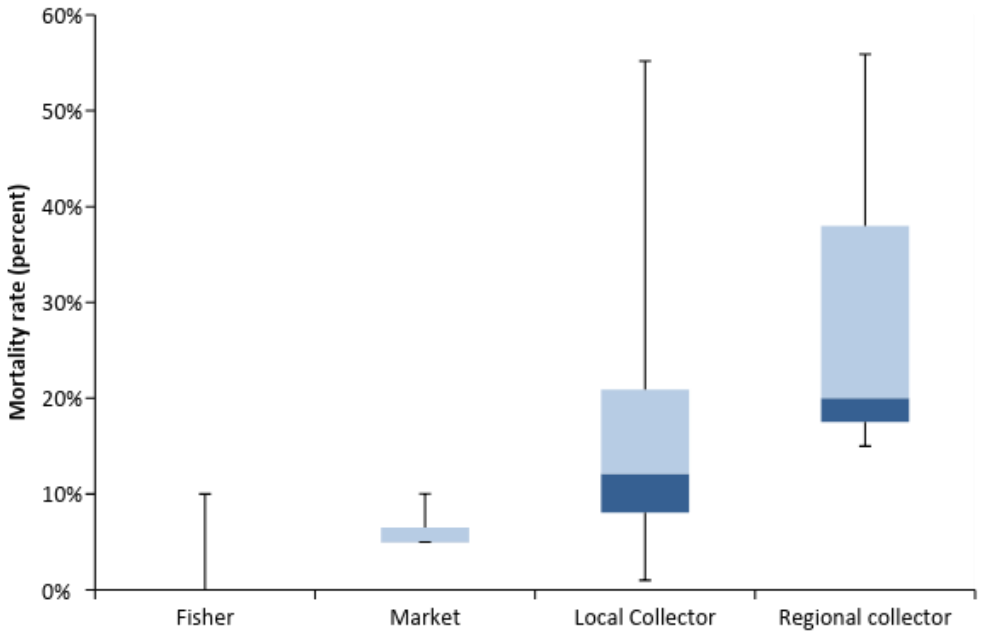


Figure 13. Shows the crabs lost, as a percentage of the total held, by various stakeholders in the value chain.

Table 3. Crab loss through the supply chain from fishers to local and then regional collectors.

Stakeholder	Stage where loss occurs	Loss
Fisher	Transport	1%
Local collectors	Storage	7%
	Transport	4%
Regional collectors	Storage	4%
	Transport	15%
Remaining		72%
Cumulative Loss		28%

Table 4. Crab loss through the supply chain for fishers to markets

Stakeholder	Stage where loss occurs	Loss
Fisher to	Transport	1%
Market	Storage	6%
Remaining		93%
Loss		7%

3.6.2 Expenses

The most costly overall, and most widely reported, expense for fishers was their boat, accounting for 43% of all reported expenses at an average cost of 61,923 MGA per fisher. However, for the 31 fishers that reported fishing lures as an expense, this was their largest overhead at 91,897 MGA a year on average. This expense is directly linked to the fishing method they use. Overall, expenses do not appear to have a large effect on fishers, acting as a value sink of around 2% (in total) of the revenue generated by crab fishing.

For local collectors, transport was by far the highest reported expense, at an average of ~1 million MGA per year. This represents a value sink of around 8% of the average annual revenue of a local collector. Figure 14 shows the modes of transport used by local collectors to get their mud crabs to the buyers.

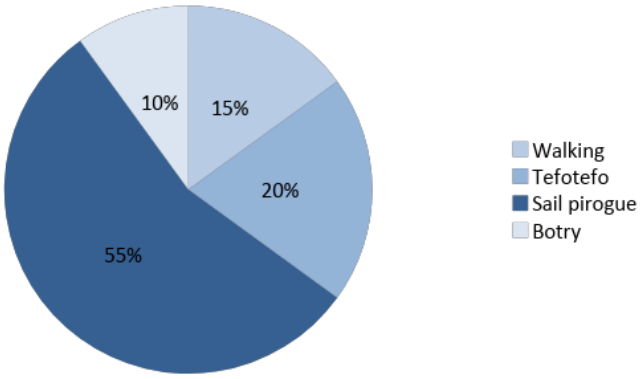


Figure 14. The transport methods used by local collectors to get their crabs to buyers. Tefotefo is a schooner boat with an old engine on it and a Botry is a sailing schooner

3.7 Stakeholder perceptions

By a majority of around two thirds, regional and local collectors both perceived the demand for mud crab is currently greater than supply (Figures 15 and 16, respectively). This represents a clear opportunity to increase the value flow along the supply chain, but meeting this demand in a sustainable way will require careful negotiation.

When asked how mud crab abundance and size has changed over time, over 90% of fishers reported a decreasing trend in both metrics (Figure 17). This echoes empirical evidence of a reduction in Catch Per Unit Effort (CPUE) of mud crabs in the Menabe region since at least 2015[18], clear signs that the mud crab stock is suffering from over-fishing. Any attempt to meet the high demand for mud crabs by increasing harvesting pressure is likely to exacerbate the effects of overfishing, leading to a greater drop in abundance and CPUE over time. If left unchecked, this could potentially lead to complete collapse of the mud crab stock, fishery and the value chain that has grown around it.

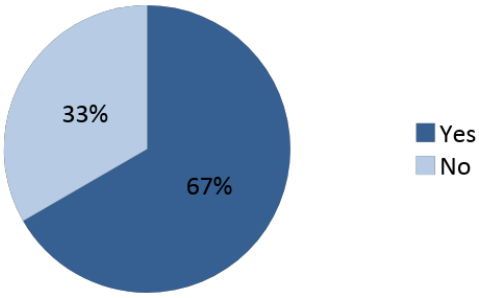


Figure 15. Regional collectors perceptions of the demand for mud crabs.

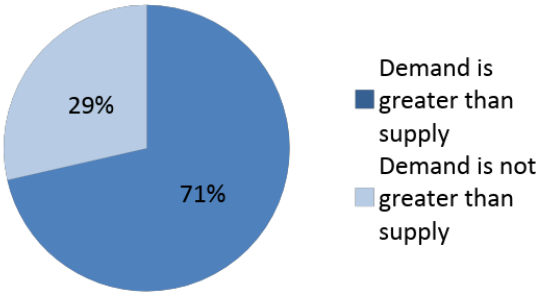


Figure 16. Local collectors perceptions of the demand for mud crabs.

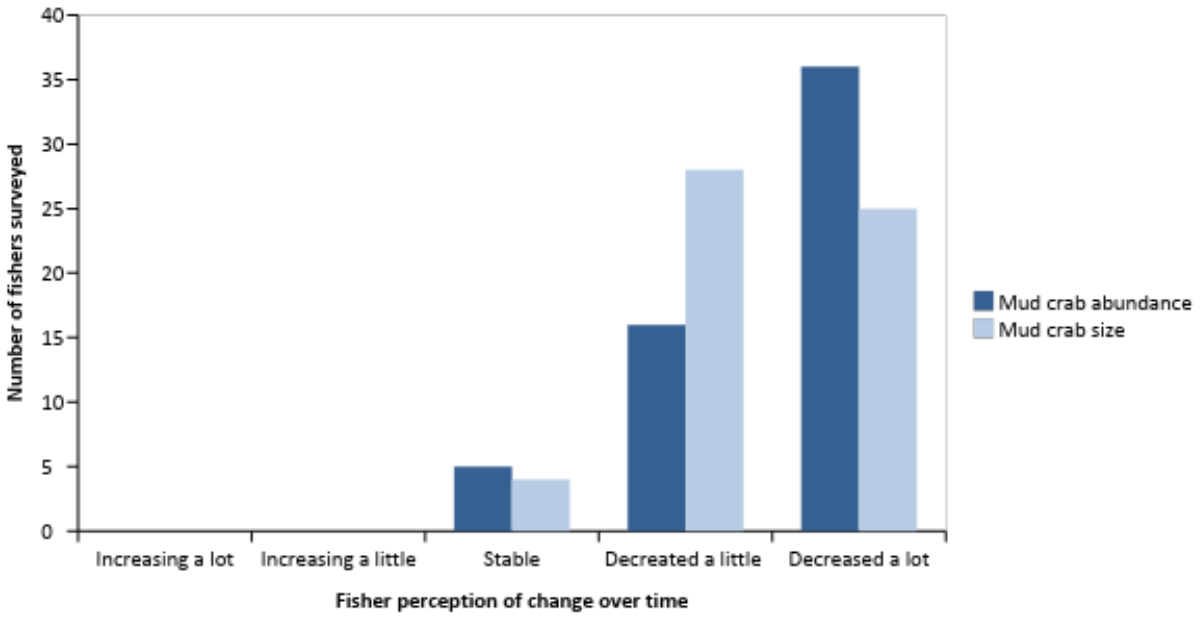


Figure 17. Fisher perceptions of the change in mud crab abundance and size over time.

3.8 Gender roles

Understanding how value flows through the community is an important part of a progressive value chain analysis and helps to identify ways to improve income security and development of an ethical, equitable market. Assessing gender roles within the value chain can help build this understanding and guide subsequent work.

Of the 59 fishers interviewed, only 7% were women. This does not reflect a fishery that, according to the latest census data, has a gender balanced composition (Table 5). This finding, therefore, is likely to reflect sampling bias during the survey. Although this requires further examination to determine the cause(s), field experience suggests it could be linked to entrenched gender roles within the community. Women, for example, often do not participate in community or fishers' meetings, so were not present when crab fisher interviews were taking place, and fishers were self or community identified for this study.

Table 5. The gender divide between workers in each stakeholder group within the local value chain for mud crabs.

Role	Male	Female	Total sample VCA
Fishers[19] (According to the latest census)	48%	52%	-
Fishers (interviewed for the value chain analysis)	93%	7%	57
Market vendors	0%	100%	11
Hotel representatives	58%	42%	13
Local collectors	50%	50%	14
Regional collectors	100%	0%	3

The even distribution of employment between men and women across several levels within the value chain (Table 5) suggests that the mud crab fishery, and the value chain it supports, could be a useful tool for driving women's empowerment and gender equality. This is supported by the fact that income was not linked to gender in any stakeholder group containing both men and women. There were, however, two stakeholder groups found to have an extreme gender bias. Market vendors, for example, were the only exclusively female group in the value chain, while regional collectors were all male. Although the sample sizes in this study were small, the apparent lack of women working in the highest levels in the value chain, as regional collectors and exporters, suggests a glass ceiling within the value chain and merits further research.

4. Conclusions

The mud crab fishery in the south of Madagascar's Menabe region is a high value but largely unmanaged fishery that has been showing increasing signs of over-exploitation. Fishers collect mud crabs from local mangroves, and are sometimes consumed by the family, but more often stored in mud and sold to local collectors, or – to a lesser extent – directly to a range of customers including hotels. The fishery and resulting industries are fairly evenly split between men and women. The exceptions are that women dominate the low-value market sales while men appear to dominate the higher value regional collector roles.

Stakeholders across the value chain are highly dependent on mud crab for their income, but it is the fishers that hold the lowest market power. One possible factor contributing to this is the cycles of lending and debt between local collectors, offering advanced payments that fishers accept in order to keep their families solvent during seasonal dips in crab abundance. The result of this disparity in market power is that prices are set by buyers and fishers currently have very little ability to affect this.

As crabs move from one stakeholder in the supply chain to another, they increase in value. Grading is currently the only mechanism for adding value used by any stakeholder assessed in this study. It is clear, however, that there are other ways in which value can be added. For example, activities such as mud crab ranching or freezing, would allow fishers to catch crabs and sell during the low season when prices are high. These should be assessed for their potential to add value within the chain and give fishers greater market power.

It is much more common for crabs to lose value than have value added. Mortality and damage represent the largest sink in the value chain with an opportunity cost (for fishers and local collectors) equal to around 21% of their combined profits. Although it was not possible to calculate the opportunity cost for regional collectors, mortality and damage increase in frequency with every stage in the supply chain, so it is likely the cost is even greater than that observed for local collectors. Damage is the most important factor determining whether crabs were sold (if healthy and mainly unbroken) or consumed by the family (if damaged). Consumption as a result of damage may have social and community benefits; however, it still represents a clear loss in monetary value.

Demand represents the greatest opportunity to increase the value within, but is also the greatest threat to, the value chain. This is currently higher than supply, meaning that there is an unmet need for a higher volume of crabs, and possibly value-added products. However, current trends in CPUE and fisher perceptions show signs of over-exploitation and therefore the industry will have to be careful how this demand is met. Higher levels of exploitation, an obvious path to meet demand, are likely to exacerbate

the situation, resulting in medium- to long-term reduced crab availability and even stock collapse. Demand could, instead, be met by ranching and/or reducing mortality and damage, realising the value in this currently wasted portion of the catch.

Finally, geographical location appears to play an important role in fisher earnings, with proximity to the main commercial hub of Morondava affecting prices, expenses, transport time and overall annual income. The precise mechanisms for this are not clear, so additional research is necessary to understand what the drivers are.

5. Recommendations

Based on the value chain analysis of the Menabe mud crab fishery, a number of recommendations have been listed below that could be used to help improve the value flow within the industry. Other ideas are already being explored by Blue Ventures, including governance strategies, size limits and other catch restrictions, and addressing mangrove and ecosystem health. These will not be discussed in this report but will continue to be considered in future phases of this work.

5.1 Diversify markets

We recommend diversifying markets in the following three ways:

A. Encouraging fishers to practice grading and to sell directly to regional collectors

Explore the avenues available to connect fishers directly to a wider range of buyers. Examine the tactics used by some fishers already identified as successfully selling crabs above the average sale price, and by high value grades. This may offer a path for other fishers to charge higher prices for their crabs.

B. Frozen crab meat

Freezing crabs, or shelling for meat and then freezing when crabs are broken or too weak to survive transport, could be a way to mitigate the losses associated with damage and mortality. One risk to this process is that undersized crabs could also be taken for frozen crabs, having a negative impact on the fishery.

C. Hotels

Hotels represent a local market with a demand for healthy premium crabs and crab meat. Fishers, especially those near the hotels of Belo sur Mer or Morondava, could sell directly to these buyers.

5.2 Ranching and fattening

We show in section 3.4 that seasonality has a twofold impact on crab fishers:

A. During periods of high abundance of crabs their value decreases
B. Fishers accept advances from collectors in periods of low crab abundance to maintain family income, creating cycles of debt

Seasonality can alternatively present an opportunity for increasing the value of mud crabs sold by fishers. Some of the most effectively managed and most profitable fisheries worldwide are also highly seasonal, such as the bluefin tuna fishery in the Mediterranean. This fishery, and others like it, avoid flooding the market with their produce during the high season by ranching. Ranching involves catching wild fish during the high season and then containing them within ranches for several months before they are slaughtered or sold to order. For the crab fishery, this practice could have multiple benefits, providing time for crabs to grow in size so that they obtain a higher price when they are eventually sold, and it would allow crabs to be fed into the market slowly, keeping their price high. This would increase the market power held by fishers, who would be able to have an influence on how prices are set.

Ranching could have the added benefit of reducing levels of dependency seen between fishers and local collectors. One explanation given for the reliance fishers have on advances from local collectors was that they keep families solvent during the low season when crabs (and therefore income) are scarce. Ranching could help artificially smooth seasonal peaks and troughs in supply and price, allowing fishers a constant source of income without reliance on advances during the low season.

This being said, although ranching has the potential to provide clear benefits to fishers, the practice is currently illegal in Madagascar, and we are not able to recommend it as a feasible option. Fattening, on the other hand, is legal and easier to put in place, with low-yield crabs kept for a couple of weeks only, in order to be fed until they reach full-yield. Given the current legal context in Madagascar, we recommend exploring fattening as way to increase crab value at the village level.

5.3 Mortality and damage

In section 3.6.1 we show that rates of crab mortality and damage are extremely high within the fishery and associated value chain. There is a huge opportunity cost associated with this that could be reduced within the value chain if a method for decreasing mortality and damage can be found. Work should be carried out with local fishers, collectors and possibly academic institutions, to explore opportunities for addressing this issue.

5.4 Mortality for license holding local collectors

Crab mortality and damage were reported at greater rates by local collectors who own a license when compared to those that do not. It is important to know if the observed relationship reflects reality, or in fact represents bias as some point in the survey.

5.5 Reduce indebtedness

We recommend promoting a culture of money management and saving amongst fishers to reduce indebtedness, fishers' vulnerability and their dependency on collectors. This will empower fishers within the market, creating the opportunity for fishers to set crab prices. Loan and savings groups among crab fishermen have been identified as a potentially efficient way to reach this objective.

Appendix A

Belo-sur-Mer Crab VCA ODK form

Basics - Introduce the survey, explain to the fisher and ask for their consent to take part.

Question	Answer
Name	Name
Gender	Male
	Female
Fish for other fish	Yes
	No
Alternative income to fishing	Yes
	No
Which gives the most income?	Fishing
	Other
Proportion income crabs represent?	Percent income
Number days fishing crab per week	Days
Number crabs caught per day	Integer
Number crabs caught on good day	
Number crabs caught on bad day	
Destination of mud crabs once caught	Eaten by household
	Sold at market
	Sold to collector
	Sold to hotels or restaurants
	Other (specify)
Primary destination	Where most crabs end up (pick answer from previous questions list)

Destination market

Question	Answer
Who sells your crabs?	Myself
	Family
	Other
How often do your crabs get sold?	Every trip
	More than once per week
	Once per week
	Three times a month
	Twice a month
	Once a month
	Less than once a month
How much crabs sold?	Volume

Then repeat questions on crab info, see page 37

Destination collector

Question	Answer
Number regular collectors crab sold to	Integer
Number opportunistic collectors crab sold to	
Number/ weight crabs sold in a week	Integer/ weight
When is high season for collectors?	Month(s)
When is low season for collectors?	
Collector name	Text (name)
Collector location	Text (location)
Collector phone	Telephone number
Collector type	Regular
	Opportunistic
	Yes

Does collector live in this village?	No
If no, how do you sell crabs to them?	Collector visits village
	You go to collector's village
How often does collector come?	Every trip
	More than once per week
	Once per week
	Three times a month
	Twice a month
	Once a month
	Less than once a month
Where do you deliver crabs?	Village(s)
How often do you deliver the crabs?	Every trip
	More than once per week
	Once per week
	Three times a month
	Twice a month
	Once a month
	Less than once a month
How are the crabs transported?	Sailing pirogue
	Rowing pirogue
	Motor pirogue
	Botry
	Tuftuf
	Motor boat
	Car
	Zebu
	Walking
	Other (specify)
	Rice bag

What are the crabs transported in?	Sobika
	Basket
	Box
	Mangrove
	Cuvette
	Other (specify)
How long does the transport take?	Integer
Proportion crabs spoiled in transport	Percentage

Then repeat questions on crab info, see page 37

Destination hotels and restaurants

Question	Answer
Number hotels & restaurants crabs sold to	Integer
Hotel name	Text (name)
Location	Text (location)
Hotel phone number	Telephone number
Hotel type	Regular
	Opportunistic

Then repeat questions on crab info, see page 37

Destination of crabs rejected by hotel	None
	Another hotel
	Collector
	Market
	Village
	Home
	Reject

Crab info for all destinations

Type of crabs sold	Crab type
Quality of crabs sold (complete)	Whole
	Part
	Mixed
Quality of crabs sold (weight)	Full
	Light
	Mixed
Minimum size sold	Size
Maximum size sold	
Sex of crab	Male
	Female
	Non preference
	Cannot identify
*Payment received for crabs	Integer
*Who determines the price received?	Buyer
	Negotiated
Last time price renegotiated	Date
Time of year payment received highest	Month(s)
Time of year payment received lowest	
Price received during highest times	Integer
Price received during lowest times	
Opinion of fairest price	
Reason for price changes at high/ low times	Text (thoughts)
Ideas to improve prices	Text (ideas)

*Does not apply to destination market

Costs for all destinations

Question	Answer
Are there costs involved in catching crabs?	Text (note costs)
What are the costs?	Pirogue
	Fuel
	Fishing gear
	Renovation material
	Beat
	Torch
	Batteries
	Storage depot
	Employees
	Storage material
	Transport
	Transport Morondava
	Doker
	Posy
	Taxi
	Soliciting
	Other (specify)
How much is the cost?	Integer
How frequent are the costs?	More than weekly
	Weekly
	More than monthly
	Monthly
	More than yearly
	Yearly
	Less than yearly

Proportion crabs spoil so can't be sold	Percentage
Has number of crabs changed over time? Has the size of crabs changed over time?	Increased a lot
	Increased a little
	Stable
	Decreased a little
	Decreased a lot
What are the biggest threats to crab fisheries?	Text (detail threats)
Have you had any education on crabs?	BV
	NGO
	MIHARI
	Community
	Association
	Data collectors
Time of year most crab caught	Month(s)
Time of year least crab caught	
Time of year largest crabs caught	
Time of year smallest crabs caught	
Do you have official work permit?	Yes (please show)
	No (other type?)

Collector Survey

Question	Answer
Name	Text (name)
Gender	Male
	Female
How long have you been trading in crabs?	Text (note years and months)
Is crab collection your only activity?	Yes
	No
What proportion of your activities is seafood trade?	Percent
What proportion of your seafood purchases is crabs?	
Which villages do you collect crab?	Text (village)
Do you travel to collect crabs yourself?	Yes
	No
How are the crabs transported?	Sailing pirogue
	Rowing pirogue
	Motor pirogue
	Botry
	Tuftuf
	Motor boat
	Car
	Zebu
	Walking
	Other (specify)
What are the crabs transported in?	Rice bag
	Sobika
	Basket
	Box
	Mangrove

	Cuvette
	Other (specify)
How long does this transport take?	Integer
Proportion crabs spoiled in transport?	Percentage
Do you have business arrangements with the people you buy crabs from?	No
	Advances
	Credit
	Preferred buyer
	Fixed price
	Fixed quantity
	Other
Type of crab bought	Text (note)

Then repeat questions on crab info, see page 37

Question	Answer
Rank the destinations with 1 being the place you send the most crab	Individual customers
	Regional collectors
	Seafood retailers
	Restaurants/ hotels/ resorts
	Exporters
	Other (specify)

Buyers

Question	Answer
Destination type	Text (type)
Destination name	Text (name)
Destination location	Text (location)
Destination phone number	Telephone number
Type of crabs sold	Text

Then repeat questions on crab info, see page 37

At what price do you sell crabs?	Integer
How much crab do you sell to this destination?	
What sorting method does this buyer use?	Eye
	Scales
	Hand
	Pressing
	Other (specify)

Do you employ anyone to help you purchase/ source crabs?	Yes
	No
How many people do you employ?	Integer
What job do they do?	Text
How much do you pay them?	Integer
Do you have any quality issues or spoilage?	Yes
	No
What proportion of crabs do you need to discard due to quality issues?	Percentage
	No
	Advances

Do you have any pre-arrangement with your buyers?	Credit
	Preferred buyer
	Fixed price
	Fixed quantity
	Other (specify)
What do you do with crabs refused by sellers?	Eat
	Sell in village
	Reject
	Market
	Hotel
	Buyer
	Other (specify)
Are you always able to buy enough crabs to meet your sales demands?	Yes (detail)
	No (detail)
Does demand change through the year?	Yes
	No
When is demand highest?	Month(s)
When is demand lowest?	
Last time you sell crabs how many did you sell?	Integer
How much was this total?	
What do you think is a fair price to sell crab?	
Do you have ideas to improve prices?	Text (ideas)
Do you store crabs?	Yes
	No
How long do you store crabs?	Integer
Where do you store crabs?	House
	Building
	Shelter
	Mangrove

	Fridge
	Kitchen
	Other
In what do you store the crabs?	Rice bag
	Sobika
	Basket
	Box
	Mangrove
	Cuvette
	Other (specify)
Do you store the crabs with mud?	Yes
	No
Proportion crabs spoiled during storage?	Percentage
Do you deliver crabs to buyers?	Yes
	No
Where do you deliver crabs?	Text (villages)
How are the crabs transported?	Sailing pirogue
	Rowing pirogue
	Motor pirogue
	Botry
	Tuftuf
	Motor boat
	Car
	Zebu
	Walking
	Other (specify)
	Rice bag
	Sobika
	Basket

What are the crabs transported in?	Box
	Mangrove
	Cuvette
	Other (specify)
How long does the transport take?	Integer
Proportion crabs spoiled in transport	Percentage
Have you received training on crab handling?	Yes
	No
Who trained you?	BV
	NGO
	MIHARI
	Community
	Association
	Data collectors
	Other (specify)
How do you think you could expand your crab business/ sales in future?	Text
Do you have an official work permit?	Yes (please show)
	No (other?)
Do you know there is a law about crabs you buy?	Yes
	No
How large is the minimum carapace? size of crab that you're allowed to buy?	Text (7 cm-15 cm)
	None
	Don't know
Is the crab resource threatened?	Yes
	No
Would you spend more on a crab fished sustainably?	Yes
	No
How much would you be prepared to pay?	Integer

Hotel survey

Question	Answer
Hotel name	Text (name)
Hotel location	Text (location)
Hotel interviewee	Name of interviewee
Role/ job of interviewee	Role/ job of interviewee
Do you propose a menu or do you work like a 'table d'hote'?	Menu
	Table d'hote
How many crab dishes do you prepare?	Integer
How many dishes require... ...parts of crab. ...shelled crab ...whole crab	Integer
List dishes that require... ...parts of crab ...shelled crab ...whole crab	Text (list dishes)
What type of crab do you need for this dish?	Text (specify)
Do you need more male or female?	Male
	Female
What is the minimum size needed for this dish?	Integer
What is the maximum size needed for this dish?	
What is the mean number of crabs you use for this dish?	Decimal
How much is the average price of these types of meals?	Integer
For dishes that require shelled crabs what type of crabs do you need?	Text (specify)
What is the minimum size needed for this dish?	Integer
What is the maximum size needed for this dish?	
What is the mean number of crabs you use for this dish?	Decimal
How much is the average price of these types of meals?	Integer
	Male

Do you need more male or female?	Female
Who do you buy crabs from?	Text (specify)
What type?	
Supplier name	Text (name)
Supplier location	Text (location)
Supplier society	Text (society)
Supplier telephone	Telephone number
Do you have any pre-arrangement with your buyers?	No
	Advances
	Credit
	Preferred buyer
	Fixed price
	Fixed quantity
	Other (specify)

Then repeat questions on crab info, see page 37

Do you know where the crabs you buy come from?	Yes
	No
Proportion from North of Morondava/ South of Morondava	Percentage/ percentage
Do you prefer crab from the north or south?	North
	South
Why?	Text (detail)
Does the demand for mud crabs vary at different times of year?	Yes
	No
When is demand highest?	Month(s)
When is demand lowest?	
How many mud crabs do you sell in a normal week?	Integer
How many days in a week do you sell crabs?	

Are all the crabs you buy eaten by clients?	Yes
	No
What happens to the other crabs?	Text (detail)
Do you store crabs?	Yes (how long and where)
	No
In what do you store the crabs?	Rice bag
	Sobika
	Basket
	Box
	Mangrove
	Cuvette
	Other (specify)
Do you store the crabs with mud?	Yes
	No
Proportion crabs spoiled during storage	Percentage
When is the best time of year for crab quality and quantity?	Month(s)
Do you know there is a law about crabs you buy?	Yes
	No
How large is the minimum carapace? size of crab that you're allowed to buy?	Text (7 cm-15 cm with each cm individually being an answer e.g.10 cm)
	None
	Don't know
Is the crab resource threatened?	Yes
	No
Would you spend more on a crab fished sustainably?	Yes
	No
How much would you be prepared to pay?	Integer

References

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[5]Blue Ventures 2018 unpublished data.

[6]Ibid.

[7] Signa, D; Yvergniaux, Y; Kasprzyk, Z. FAO Aquaculture Newsletter; Rome Iss. 52, (2014): 24-26.

[8]Blue Ventures 2018 unpublished data.

[9]Global wild capture production peaked at about 44,670 tonnes in 2011 and then decreased to about 38,652 tonnes in 2014. Wild capture fishing also supports an enormous aquaculture industry, where wild caught juveniles are fattened to adult size, producing 183,852 tonnes in 2014. https://public.tableau.com/profile/abigail.leadbeater#!/vizhome/crab_workshop_export/StatistiquesNationales?publish=yes

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[12]Kaplinsky R, Morris M (2000) A handbook for value chain research. Report for IDRC. 113 pp.

[13] Ibid

[14]Brown EO, Perez ML, Garces LR, Ragaza RJ, Bassig RA, Zaragoza EC (2010) Value chain analysis for sea cucumber in the Philippines. Studies & Reviews 2120. The WorldFishCenter, Penang Malaysia, 44 pp.

[15] One of the regional collectors interviewed had recently switched to a local collector license. He was, however, interviewed from his perspective as a regional collector, in which position he had more years of experience than the other two regional collectors combined.

[16] Blue Ventures, Unpublished data.

[17] Direction Régionale des Ressources Halieutiques et de la Peche (DRRHP), Menabe, 2017. Statistique Recap, Tableau Recapitulatif des Statistiques Annee 2016 (Morondava et Belo) (data shared internally).

[18]Blue Ventures, 2018 unpublished data.

[19]Blue Ventures 2018 unpublished data