

blue ventures

nd conservation

THE MANGROVE CRAB INDUSTRY

in Madagascar

GOOD PRACTICE GUIDE

Can you earn more without catching more?



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GOOD PRACTICE GUIDE

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1. INTRODUCTION

Until recently, Madagascar's fishers, collectors and fisheries authorities have considered the country's crab fishery to be of lower importance than its shrimp and fish industries. However, over the last five years, this situation has changed entirely. Following a rise in demand for live crab from Asia, the value of crab exports tripled between 2012 and 2017. This spectacular leap in export values was largely due to the higher prices commanded by live compared with frozen crab, and to a lesser extent because of increased production and a reduction in post-harvest losses.

This situation has significantly improved the income of actors in the crab industry. According to a survey carried out by SmartFish in 2015, the average sale price fishers received for crabs went from 0.30 USD/kg in 2011 to 1.00 USD/kg in 2015. As a result, almost all fishers working in the mangroves now fish for crab for at least part of the year, including specialist shrimp fishers. Job and income opportunities have stimulated migration to the mangrove areas.

Positive changes such as increased foreign revenue, increased income for actors in the crab industry, and more jobs, may lead to negative medium- and longterm impacts on the industry caused by overexploitation of wild crab populations and degradation of their mangrove habitat. Madagascar's fishery authority, the Ministry of Aquatic Resources and Fisheries (MRHP), is aware of this risk, having learned lessons from inefficient management of the shrimp industry, which has been marked by overexploitation of shrimp populations and a drop in production.

Despite the lack of complete biostatistical studies, the MRHP prepared various management measures in late 2014 to ensure harmonious and sustainable development of the crab industry, and implemented them from January 2015. However, even relatively comprehensive legislation does not guarantee results on the ground without practical measures for application, combining economic incentives and a monitoring system.

As the NGO Blue Ventures is established in Madagascar's key mangrove regions (Atsimo Andrefana, Menabe, Melaky, Diana, Boeny and Sofia), it is well placed to help apply the current management measures on the ground. It is already doing so in its intervention areas, through public information and awareness raising campaigns and by supporting community-based monitoring. Blue Ventures also carries out studies on crab spawning periods, size at first maturity, sex ratios, biological seasonality of fishing, and mangrove coverage and productivity. These studies are mainly carried out in certain bays in the regions of Menabe, Diana and soon Boeny. These studies are sufficiently detailed to put together national measures and translate them for application at a regional level or even across the

main large deltas and bays (for example regarding distribution of catch quotas or setting the closure period). The results may enable the MRHP to change regulations on fishery closure periods, fishing quotas, minimum authorised size, or bans on cutting down mangroves.

Blue Ventures aims to promote the protection and sustainable use of coastal areas and their natural resources by and for coastal communities. In designing collaborative marine management initiatives, it is vital to find economically viable measures to ensure fishers and other operators engage with the initiatives. While these measures certainly include finding alternatives to fishing, in the short term they also involve optimising the value chains. In this case it is necessary to increase revenue for each operator along the full length of the supply chain, by reducing post-harvest losses and improving the physical condition of the crabs destined for live export (they must be high meat-yield, vigorous and well hydrated).

The fishers that adopt the best practices can supply collectors and exporters with a live product that is ready to withstand the journey to the captital city Antananarivo, and on to the importing countries. The average price for crabs bought by these operators is two times higher than the price for crabs destined for the local market.

This guide follows on from several reports published by SmartFish between 2012¹ and 2014², and adds to the action proposals presented by the SmartFish Technical Manual no. 35, "Meilleure valorisation des crabes de mangrove à travers la réduction des pertes après captures" (Improved use of mangrove crabs through reduction of post-harvest losses)³. This guide contains innovative solutions to keep crabs alive and strengthen them. It was produced as part of a competition launched by SmartFish in 2015. In December 2017 and January 2018, the Blue Ventures consultant and field staff visited 35 competition participants to see how their proposed innovations work. Certain proposals had been abandoned since 2015, but most were still being applied, and some had even been improved. Finally, 16 innovations were found to be interesting and worth publishing in this guide.

This guide is aimed at trainers and, perhaps more importantly, at operators in the crab sector. It includes many diagrams, drawings and photos, so even people who have difficulty reading will find it easy to understand how to manufacture and use the technical solutions proposed. Versions are available in French, English, and Malagasy (Sakalava and Vezo dialects).

¹ Une Analyse Globale de la Chaîne D'approvisionnement de la Pêcherie du Crabe de Mangrove (*Scylla serrata*) à Madagasar (http://www.fao.org/3/a-az394f.pdf)

² Handling of Mud Crab (http://commissionoceanindien.org/fileadmin/projets/smartfish/ FAO/Handling_of_Mud_Crab.pdf)

³ Technical manual no. 35 (http://www.fao.org/3/a-az050f.pdf)

TO BE AVOIDED: PRACTICES THAT INCREASE MORTALITY RATES



Inappropriate storage of fishing gear



Outdoor storage of crab



Transportation in unprotected rice sacks



Transportation in lorries without shelves



Carrying sacks or baskets of crab on the head



Overloading crab transportation baskets



Transportion in boats without shelves



Placing crabs on the ground for sale

2. EXPLOITATION OF CRAB RESOURCES AND OPPORTUNITIES FOR MAXIMISING VALUE

2.1 MANGROVE CRAB PRODUCTION POTENTIAL

According to various estimates carried out in the 1970s, 1990s and the 2010s, Madagascar has 3,250 km² of mangroves. These mangrove forests cover about 0.5% of the area of the country, and also represent 20% of the mangroves in Africa and 2% of the mangroves in the world. Almost all the mangroves in Madagascar are located on the west coast; only 2% are on the eastern side of the country.

The mangrove crab *Scylla serrata* (Forskal, 1755), also known as mud crab, is the largest and most sought after species in the Portunidae family. The MRHP sets a Maximum Sustainable Yield (MSY) for the *Scylla serrata* crab of 7,500 tonnes/year. This figure was first estimated 30 years ago on the basis of an annual production of 2.5 tonnes/km² with an estimated 3,000 km² of mangroves.

Another study carried out 12 years later in the province of Mahajanga, for an area of 831 km² of mangroves, estimated production of 3.8 tonnes/km²/year. It should be noted that at this time the mangroves were still relatively well preserved, which explains this relatively high production rate. The MRHP continues to use a conservative reference yield of 2.5 tonnes/km²/year, and keeps the annual MSY at 7,500 tonnes. The caution of the state of Madagascar can be explained by various factors:

- The current overexploitation of the crab fishing areas located near towns and villages: 20 years ago fishing was still very limited and mud crab populations were largely untouched;
- The degradation of some mangrove areas due to the rapid increase in local population and their need for wood and charcoal;
- Other countries with long-established mangrove crab fisheries (such as South Africa and Thailand) had estimated MSYs of 2.0–2.5 tonnes/ $\rm km^2/year$ as early as the 1980s.



2.2 CHANGES IN CRAB PRODUCTION AND DESTINATION

We should recall that crab harvests have increased significantly over the last five years. Table 1 shows the change in harvests and their distribution between 2012 and 2017.

Description	2012	2017
Total harvests	4,052	6,018
Distribution		
- post-harvest losses	970	1,050
- exports	2,454	3,008
- local consumption	628	1,964

Table 1: Crab harvests and distribution in 2012 and 2017 (in tonnes)

Some general observations can be made on the basis of the data in Table 1:

1. Crab production increased by about 50%;

2. Despite increased harvests, post-harvest losses remained at about the same level as in 2012 thanks to a reduction in the mortality rate;

3. Exports, shown in physical tonnes (converted into live weight), "only" increased by 23%, but they increased 3.1 times in value (from 2.9 million USD to 9.1 million USD between 2012 and 2017). This spectacular growth was due to the increase in exports of live crabs, which command a price three times higher than frozen produce.

4. There was a strong increase in the quantity of crabs destined for sale on local markets and for consumption by fishers themselves: from 628 tonnes to 1,964 tonnes. This is partly explained by the growth in harvests, but it is principally because the collectors/exporters reject a significant quantity of live crabs that are weak, injured, thin, or do not meet the legal size requirements. On average, 40–45% of the crabs supplied to these operators are rejected and sold immediately to local vendors, and to a lesser extent to frozen crab exporters.

2.3 CRAB RESOURCE MANAGEMENT MEASURES

The creation of a management system for the crab fishery began in 2006 with a ban on catching, collecting, transporting, processing and sale/export of crabs with a shell width under 10 cm (measured at the broadest point, in the gaps between the spines, see below). The harvesting of soft-shell crabs and female crabs with eggs was also banned.

It was only nine years later that the MRHP managed to achieve a sufficiently broad legal framework to ensure the prudent development of this fishery (Decree no. 32 101/14). Despite the lack of comprehensive biostatistical studies, the MRHP prepared various management measures from late 2014, and implemented them from 1st January 2015:

- annual fishing quota (5,000 tonnes);
- export quota, in live weight (4,250 tonnes);
- minimum authorised size (11 cm);
- closure period for the fishery;
- protection of females with eggs and soft-shell crabs;
- the ban on cutting and sale of mangrove wood to protect crab habitat.



Measurement of the shell width (SW) of the crab

However, this legislation is often not applied or enforced on the ground, so action must be taken to ensure that the legislation is more widely respected. This will require engaging with and informing village groups, enabling and supporting community monitoring, and also setting and implementing penalties and fines for offending operators, or even revoking professional credentials and fishing licences.

Based on the results of recent studies, we recommend that workshops should be organised every two years, to present, explain, discuss and adopt any changes or additions to the provisions of the existing crab industry management system.



2.4 OPPORTUNITIES TO INCREASE THE VALUE OF CRAB HARVESTS

Stabilising or increasing crab production are not the only ways to maintain or improve income for fishers, wholesalers and sub-collectors. In fact, it is highly probable that their financial situation will worsen over time, due to ferocious competition and overexploitation of resources. Furthermore, the legislation governing the functioning of the crab industry may have a negative impact on their revenues in the short term, due to the obligation to throw back undersized crabs, soft-shell crabs, and females with eggs, and to stop fishing during the closure period. Although these restrictions are necessary to ensure renewal of the crab stocks in the medium- and long-term interests of the sector, this does not sufficiently address the short-term needs of operators. These operators must all be

persuaded that it is possible to make up for this shortfall by increasing the value of what is produced, particularly by:

• reducing the mortality rate, so they have more crabs to sell;

• supplying collectors/exporters directly or via sub-collectors with high meat-yield, vigorous, well-hydrated crabs. This external market sometimes enables a sale price that is double the price obtained for sale to dealers on the local market.

This new guide contains 16 fact sheets presenting the innovations implemented by some of the operators that participated in the competition launched in 2015. In the short term, and for a modest investment, these innovations make it possible to harvest better quality crabs, reduce their post-harvest mortality, while improving their physical condition to enable them to withstand the long journey to the importing countries.

The fact sheets in the guide are classified according to their position in the crab value chain:

- Harvest and storage in villages: 5 fact sheets
- Storage at collection points: 4 fact sheets
- Transportation to collectors and exporters: 6 fact sheets
- Local sale: 1 fact sheet

Each fact sheet shows the aims and benefits of the innovation, as well as results achieved by the operators (reduction in mortality rates, additional income, and amortisation periods), and the types, costs and potential service life of materials required to make each solution. The photos and illustrations present a general view of the innovation and give advice for use.

The information and figures presented on the fact sheet come from the people who created the solutions. The "results achieved" were verified as described below:

Reduction in mortality

The percentage was calculated by asking the author to state the quantity of dead crabs found, in the past and currently, in a basket ("sobika") containing 40 kg of crabs. For example, if the response was 2.0 kg and 0.5 kg, the percentages would be calculated as 5% and 1%.

Additional income

In the case of fishers, additional weekly income is linked to the increase in fishing yield.

For wholesalers and sub-collectors, their additional income ultimately depends on the reduction in mortality rate, and thus on the additional quantity of crabs sold.

For collectors supplying crabs to exporters of live produce, the additional income is also based on the improvement in the rate of crabs sold for live export. These crabs command a higher price than those that are rejected and marketed locally.

Amortisation period

This period is calculated by dividing the investment costs by the additional income.

To maintain consistency between this guide and the 2014 SmartFish manual, these fact sheets and results achieved are presented in a similar way. One difference between the two publications is the increased focus on actions to improve the quality of live crabs supplied to collectors/exporters.

High quality crabs (high meat-yield, vigorous, well hydrated and resilient) command a much higher price. Using these good practices means operators in the sector can increase their revenue without increasing production (perhaps even producing less), and therefore without placing any additional pressure on the mangrove resources.

So in answer to the question on the front cover, yes it is indeed possible to earn more without catching more. The following chapters of the guide provides some examples of how to achieve this goal.



3. TECHNICAL INNOVATIONS AND GOOD PRACTICES TO DISSEMINATE

Storrett"

Carlos

F1. IMPROVED CRAB HOOP NET

Action to take	Fishing is more selective, more productive, and less tiring.
Point /actors in value chain	Fishing; fishers.
Objectives	Increase income for fishers; Save time during bait gathering and crab fishing.
Justification	Saving on bait; the same piece of bait can be used several times; Increase in harvest yield with 2–3 pieces of bait fixed to a single hoop net; Labour saving; you only raise the hoop net when the float moves (indicating the presence of a crab).
Results achieved	Increase of around 30% in crabs harvested; For one fisher, using 10 crab hoop nets, each with 2–3 bags containing bait, the additional income is 53 USD per month; Amortisation period: 2 days of harvesting.
Observations	Previously it was necessary to raise the hoop net 20 times to find 1–2 crabs; with the improvement, you find 1–3 crabs every time you raise the hoop net; Practical innovation from 2013 by 58 fishers in the village of Antaririky Nord and fishers in 9 villages in the district of Antsohihy; Low cost: about 6 USD to improve 10–15 crab hoop nets.



The bag is fixed to the hoop net



Attaching bait to the hoop net



Materials	Costs	Service life
Bait bag made of nylon thread no. 2 (3 m required), sewn by fishers or their family members.	0.20 USD per unit 5 USD per hoop	3 to 4 months

F2. DOUBLE CRAB HOOP NET

Action to take	Fishing is more selective, more productive and less tiring.
Point /actors in value chain	Fishing; fishers
Objectives	Increase or stabilise (in overexploited fishing areas) the income of fishers and reduce the physical effort of fishing.
Justification	8 points are used for attaching bait to a single hoop net, increasing the fishing yield; Each hoop net is rotated/immersed 2 (or max. 3) times during each fishing trip; Makes use of the deepest waters during the spring tide, which are populated by large crabs.
Results achieved	Fishing yield increased or maintained, with a significant proportion of large specimens: 1.5–3 kg per hoop net for two immersions (15–30 kg for 10 hoop nets in a day); Harvesting only carried out 15 days a month, during period of abundant high meat-yield crabs; Rate of sale to collectors/exporters nearly 90% (with a sale price 3 times higher than for the local market).
Observations	The manufacture cost is 3 times higher than for the simple hoop net, so it is vital to maintain it well (it must be cleaned, dried in the open air, and stored in a place sheltered from the sun and rain); The double hoop net can also be used to catch fish during the dead tide / low tide (relatively low but not negligible production). Technical solution implemented by various fishers in the village of Antsatrana (Ambilobe district).

Double hoop net, laid flat, with float



Top view hoop diameter d = 60 cm



Side view height between hoops h = 40 cm



Organising harvest, storage and sale of crabs direct to collectors / exporters in the town

(Crab circuit without intermediaries such as wholesalers and sub-collectors)

1. Bait preparation

2. Fishing trip



3. Storage

Crabs stored in a live-crab cage or hut for up to 3 days



Baskets of crabs are covered and watered





Materials	Costs	Service life
2 round iron bars with diameter 5–6 mm and length 2 m (each), to manufacture 2 hoops.	5.0 USD	2–3 years, if well
1 reel of line no. 1 or no. 2 (100 m), to weave a net.	1.2 USD	maintained
1 line no. 3 or no. 4 (10 m), for the main line.	1.2 USD	
1 float made of polyester (reused material) or light wood (raffia).	0.6 USD	
Manufacture time for one (1) double hoop net in the village: $\frac{1}{2}$ day.	Total 8.0 USD	

Fishing

F3. CRAB HARVESTING WITH GILLNETS

Action to take	Fish in deeper areas, during spring tides.
Point /actors in value chain	Fishing; fishers
Objectives	Increase income for fishers during the crab fishing season, as the crabs caught with a have a higher meat yield, so they can be exported and they command a higher price than crabs that are hooked.
Justification	No additional expenses for fishers who already have a gillnet for fish; These fishers can remain active all year round by targeting a different catch (fish or crabs) on the basis of what is biologically in season and available market opportunities; They can also use the net to catch fish during part of the day and target crabs later; Using the net at a depth of 8 m makes it possible to catch crabs during high tide and spring tides, and achieve a higher rate of high meat-yield crabs.
Results achieved	Additional income of 91 USD/month for average catch of 75 kg by a team of two fishers (using the net for a single immersion per day, targeting crabs).
Observations	The main activity of the net owner is still catching fish. However, during the crab season, it is general practice to do a single immersion per fishing trip targeting crabs (before or after targeting fish); Fishing technique used since 2015 by more than 20 fishers in the village of Ampangatana (Ambilobe district).

Checking the gillnet



Placing the gillnet in the water

Collecting crabs



Organising net fishing

Maximum of 15 days of fishing per month (Only during the spring tide period)

1. Immersion of net with bait



3. Transportation

Crabs transported to collectors/exporters in the town in baskets, on a motorboat with shelves and a protective isolating partition.



Materials	Costs	Service life
Gillnet 100 m x 8 m Required materials: net with a mesh size of 30 mm, and ropes, floats and ballasts. Manufacture time: 2–3 days	60 USD	3 years, if well maintained

F4. TRIANGULAR WOODEN LIVE-CRAB CAGE

Action to take	Construct a storage cage from local materials.
Point / actors in value chain	Storage in village or camp; Fishers, wholesalers.
Objectives	Reduce mortality during storage, and strengthen crabs destined for collection / export.
Justification	Crabs are stored in their natural environment (water and mangrove habitat), where they survive longer; Protection against sun and wind (cage is installed among the mangroves); Fattening thin crabs (with little flesh).
Results achieved	Reduction in mortality from 20% to 7.5% during 1 week of storage; Rejection rate for crabs supplied to collectors/exporters: 0–25%; Additional income: 60 USD/month (for 200 kg stored); Amortisation period: 2 days of activity.
Observations	Sort crabs well, before and during storage; collectors/exporters are supplied with vigorous and high meat-yield crabs; Protect the cage with a plastic canvas in case of heavy rain; Practical solution applied since at least 2015 in the village of Ankotika, Ambanja district (3 people); and in Maromandia, Analalava district (more than 50 people).

General view (from the side). Choose a place sheltered by mangroves and covered by the tide

General view (opposite). 40-50 kg of crabs are stored per m² of floor space



Materials	Costs	Service life
Triangular cage – material used: wood and line. Smallest version: 1 m x 1 m x 1 m; Medium-sized version: 3 m x 1 m x 1 m; Manufacture time: 2 days (finding wood and manufacture)	3–4.5 USD	At least 2 years, depending on maintenance.
Reused plastic canvas (2 m x 2 m)	3 USD	2 years

Manufacture

1. Dig out the mud

2. Make a floor of closely spaced pieces of wood (to prevent crabs escaping)

3. Cover the floor with at least 15 cm of mud

4. Insert the cage support into the ground (rod) above the floor

5. Position the pieces wood alternately along the rod to form two slanted sides

6. Insert the pieces of wood along the edge vertically and tie them to the slanted sides <image>

Floor made of closely spaced pieces of wood, which are then covered in mud

Use

The crabs must not be tied





Feed the crabs with dried fish and mangrove leaves: once every 2 days, depending on the availability of dried fish.

F5. STORAGE IN HUTS

Action to take	Improve storage conditions and security.
Point / actors in value chain	Storage in the village; Fishers, wholesalers and sub-collectors
Objectives	Reduce mortality and supply collectors with crabs in good physical condition; Reduce risk of theft.
Justification	Crabs are protected from the sun, rain, wind and dry currents of air, so they can stay moist and avoid dessication; Protection against theft: the hut is attached to a dwelling. Relatively low construction cost in comparison to an independent storage hangar.
Results achieved	Reduction in mortality rate from 7% to 4% compared to storage at home or on the terrace; Additional income for 200 kg of crabs stored and dispatched per month: 9 USD; Amortisation period: 2 months.
Observations	Less effective solution than the live-crab cage, but lower risk of theft; if possible, use in combination with basket soaking method (Fact sheet 6). More effective solution than storage in the home or on the terrace, which are still common practices among operators. Easily constructed by the operator themselves using local materials, for a low cost; Solution has been implemented since at least 2015 by various operators in the districts of Ananalava, Namakia and Soalala.

General view of hut



1. Types of hut

The hut must be attached to the north side of the house.



North







Long and narrow hut

Wide and short hut

2. Storage procedure



Sort the crabs at least every 2 days during storage, add fresh mud (not more than 10% of the weight of the crabs) and check they are properly tied.











Materials Costs Service life Locally available materials: raffia and bamboo stems, 13.60-15 1-2 years depending on USD maintenance and weather reeds and palm fronds. Construction time: 3-6 days conditions

F6. STORAGE IN PERFORATED PLASTIC BASKETS

Action to take	Alternative to the live-crab cage; simplest solution to apply.	
Point / actors in value chain	Storage in the fishing or collecting village; Fishers, wholesalers, sub-collectors	
Objectives	Reduce mortality of crabs during storage and improve their physical condition, to meet the requirements of collectors/ exporters;	
Justification	The perforated plastic basket is light, and easy to move for soaking the crabs at high tide; Baskets are stored in the hangar near the operator's home at night, to prevent theft; Mortality rate is low during transportation and handling. Improves on live-crab cage for areas where theft is a problem, as moving crabs from the live-crab cage to the hangar every evening (to prevent theft) and putting them back in the live- crab cage the following morning increases mortality due to increased handling of individual crabs.	
Results achieved	Reduction of mortality from 5% to 1% compared to storage in the hangar without prolonged soaking in mangrove water. Supplementary income for an operator that handles 250 kg of crabs per month: 24 USD. Amortisation period: 3 weeks	
Observations	Simple solution preventing theft overnight. Perforated plastic baskets can be substituted with robust bamboo baskets; Plastic basket is covered with sack made of jute or other absorbant material (to maintain humidity during storage); Solution implemented since 2015 by a sub-collector in the village of Ampisaraha-Lavalahaliba (Ambanja district).	

Immersing the plastic basket at high tide





1. Sort and prepare crabs for storage in the basket



2. Daily soaking

The plastic basket is soaked in sea/mangrove water at high tide every day.

The basket should be placed on a firm base (add boards if necessary)



3. Storage in hangars

Storage on shelves in hangars

hours



Maximum storage period: 1 week before dispatch



Materials	Costs	Service life
Perforated plastic basket:	12 USD	1 year
30–40 kg of crabs)		
Jute/cloth sac.	1.2 USD	6 months

F7. STORAGE IN BASKETS PLACED IN A POOL

Action to take	Store crabs in a protected, clean and secure place.
Point / actors in value chain	Storage at the collection point (sub-collector and collector)
Objectives	Reduce mortality during storage and transportation; supply exporters with crabs in good physical condition (vigorous and well hydrated).
Justification	Improved hydration of crabs, protection against the sun and the rain, protection against wind and dry air currents (maintaining humidity). Concrete pool is easy to clean (fewer bacteria). Protection against theft (stored close to dwelling).
Results achieved	Reduction in mortality from 5% to 1% during 2 days of storage; Improved proportion of crabs sold live for export, from 60% to 80%; Additional income: 574 USD/month (for 1,200 kg collected); Amortisation period: 2–3 weeks of activity.
Observations	The sale of live crabs for export enables a significant increase in income; Innovation implemented since 2014 in Antafiampanba (Antsohihy district) by ten collectors.

Short-term storage in dry, interlocked baskets



Cement storage pool 0.5 m 1.5 m Interlocked baskets 60 cm x 70 cm

MaterialsCostsService lifeBasket, 70 cm in diameter and 60 cm in height0.6–0.9 USD each1–2 weeksHangar made from local materials45–60 USD2 yearsCement pool: 5 m x 1.5 m x 0.5 m
Construction time: 5–6 days120 USDSeveral years

FACT SHEET 7. Storage in baskets placed in a pool

1. Sort and tie crabs



F8. IMPROVED STORAGE HANGAR

Action to take	Store and handle crabs in a clay hangar with a receiving/ dispatch compartment.
Point / actors in value chain	Storage at the collection point (sub-collectors and collectors).
Objectives	Reduce post-harvest mortality both in Madagascar and during export of live crabs (more vigorous and well-hydrated crabs).
Justification	Protection against the sun, rain and wind; Humidity and lower temperature maintained inside the hangar (due to the clay walls); Limits crushing of crabs: shelving allows more storage space; Protection against theft (stored close to dwelling).
Results achieved	Reduction in mortality from 15% to 3% during 3 days of storage; Improved proportion of crabs sold live for export, from 60% to 75%; Additional income: 59 USD/month (for 240 kg collected); Amortisation period: 2 months.
Observations	Storage time limited to 2–3 days; No longer using mud: the tied crabs are soaked twice a day in a basin filled with seawater; The covered basket is wet to ensure the humidity and lower the temperature during storage; Innovation practised since 2015 in Ankitsiky (Analalava district).



Materials	Costs	Service life
Basket, 50 cm in diameter and 60 cm in height	0.76 USD each	2 weeks
Hangar made from local materials (construction time: 15 days)	120 USD	At least 3 years

1. Sort and tie crabs



F9. STORAGE / TRANSPORT IN BAMBOO BASKETS

Action to take	Used instead of palm baskets or rice sacks.
Point / actors in value chain	Storage in the village and at the collection point; transportation by dirt road and sea to collectors and exporters; storage at vendors/local traders. Fishers, wholesalers, sub- collectors and vendors.
Objectives	Reduce mortality during storage and transportation; supply crabs in good physical condition (vigorous and well hydrated).
Justification	Bamboo baskets make it possible to store crabs near the home, in a hut or hangar. They can replace live-crab cages (lower cost, less risk of theft), but the losses are higher. Lower rate of loss during transportation compared with palm baskets or rice sacks.
Results achieved	Reduction of losses from 20% to 10–15% (compared with losses of just 1–5% in live-crab cages). Additional income, for 200 kg of crabs stored and dispatched per month: 3.6 USD Amortisation period: 1 week.
Observations	Solution appropriate for small operators who store crabs for a maximum of 3 to 5 days. The bamboo basket, lined with a jute bag, is good packaging for transportation in areas where there are not many cardboard boxes. Note: using rice sacks instead of jute bags can increase the mortality rate. Solution implemented since 2015 in Ankotapike, Morombe district, and in the districts of Ambanja and Maintirano.

Morombe-type basket Small model: h 33 cm, d 36 cm < 18 kg of crabs.



Morombe-type basket Large model: h 25 cm, d 50 cm < 25 kg of crabs.



Ambanja-type basket h 40 cm, d 65 cm < 40 kg of crabs.







Moisten once a day with seawater and change the mud every 2 days

Stored on shelves in clean, ventilated hangar NEVER stack the baskets during storage or transportation (this crushes crabs)

Materials	Costs	Service life
Basket: thin and supple bamboo, split in two and evenly braided. - Morombe type (small model) - Morombe type (large model) - Ambanja type Manufacture time: 1 hour.	0.5 USD 0.9 USD 2 USD	2 weeks 2 weeks 1 year if used for storage
Jute bag: each bag is cut lengthwise into 2 sheets; 3 sheets are used for one basket.	1.8 USD	6 months

F10. TRANSPORTING CRABS BY BICYCLE

Action to take	Transport crabs in a wooden box on a bicycle.
Point / actors in value chain	Fishers, wholesalers: transportation from the village to the collection point.
Objectives	Reduce crab mortality and injuries and supply vigorous, well- hydrated crabs.
Justification	Wooden boxes are better than baskets at protecting crabs from the rain, sun, wind and crushing; Boxes also ensure that humidity and low temperatures are maintained around the crabs; Bicycles loaded with boxes are more stable than with baskets; Appropriate for quick transportation over short distances.
Results achieved	Reduction in mortality from 8% (transportation in baskets) to 2% (transportation in boxes) for a 5–10 km dirt road; Additional income for wholesalers: 26 USD/month (for 250 kg collected); Amortisation period: about 1 week.
Observations	If the crabs are first sorted then transported in boxes, and if transportation lasts less than one hour, rejection rates for crabs at the collector are very low $(2-3\%)$; Innovation implemented since 2014 by 1 person, adopted since 2015 by 4 other inhabitants of Ankitsiky and neighbouring villages (Analalava district).



Materials	Costs	Service life
Large box (length 40 cm, width 80 cm, height 30 cm, board thickness 1.5–2.0 cm)	6 USD	3 years
Small box (length 50 cm, width 40 cm, height 30 cm, board thickness 1.5–2.0 cm)	6 USD	3 years

1. Sort and tie crabs



F11. TRANSPORTATION BY MOTORBIKE

Action to take	Collect and transport crabs in baskets appropriate for motorbikes.
Point / actors in value chain	Collection in fishing villages; transportation by dirt road to the collection/storage point (wholesalers and sub-collectors).
Objectives	Reduce mortality during collection, storage and transportation. Supply crabs in good physical condition (vigorous and well hydrated).
Justification	Bamboo baskets are better than palm baskets at protecting the crabs from crushing (caused by the rope attaching it to the luggage rack). The weight and production costs are lower than for wooden boxes. Appropriate for quick transportation over short distances on dirt roads.
Results achieved	The mortality rate went from 20% to 6–7% for collection and transportation along 10 to 15 km by dirt road and storage for 2 days in a hangar. Thanks to this circuit for quick collection by motorbike, and a shorter storage period before transportation (2 days), 90% of the crabs that are then delivered by bush taxi (> 100km journey) are bought by the collectors/exporters. The monthly additional income for 450kg sold is estimated at 145 USD.
Observations	In view of the reduction in crab production in the nearest and most accessible villages, and in view of the increasingly fierce competition, it is necessary to use motorbikes for fast collection from new sites that are further away. Collection has been organised in this way for 2-3 years by three people in Mahitsihazo and Maropapango (Analalava district).

Long bamboo basket



Long basket with crabs protected by rice sack



1. Collect and sort crabs in the villages



Materials	Costs	Service life
Basket made of thin and supple bamboo, split in two and evenly braided. Dimensions: length 75 cm, width 40 cm, and height 30 cm.	2 USD (purchase price at the market)	About 1 year

F12. TRANSPORTATION IN WOODEN BOXES

Action to take	Replace the palm baskets or sacks with wooden boxes.
Point / actors in value chain	Transportation by dirt road or sea to the collectors and exporters; sub-collectors, collectors, exporters and transporters.
Objectives	Reduce mortality during transportation and supply vigorous, well-hydrated crabs.
Justification	Reduction in the number of crushed, injured and dead crabs (compared to transportation in baskets and sacks); Keeps the crabs fresh and humid, thanks to: 1) the natural properties of wood and 2) the wet jute bag, which lines the inside of the box.
Results achieved	For a distance of 300–350 km on difficult dirt roads, mortality dropped from 30% to 5–10% (higher in the rainy season); Additional income, for 1,000 kg of crabs transported: 333 USD/trip; The crabs arrive in better physical condition, ready to withstand transportation to destination (e.g. Antananarivo) and export.
Observations	Transport crab boxes in canvas-covered, well-ventilated lorries; Clean the boxes well and store them in the shade after use, to avoid bacteria; wash well and dry the jute bags to avoid bacterial contamination; Practical solution since 2015 in Ankotapike and Morombe (Morombe district).

Closed wooden box

Jute-lined box filled with crabs





Materials	Costs	Service life
Pine box lined with jute bag. Dimensions: length 61 cm, width 43 cm, height 36 cm, board thickness 3 cm. Manufacture time: 3 days for 15 boxes.	9 USD per box and 1.2 USD per jute bag	2 years per box, with small daily repairs.

1. Sort and tie crabs





Too small < 11 cm

Healthy and large enough > 11 cm



Tied

2. Remove the mud





The remaining mud should not exceed 10% of the weight of crabs



The crabs are (re)tied

3. Separate males and females





To distinguish the males and females, look at the crabs' abdomens



F13. CART WITH REMOVABLE SHELF

Action to take	Adapt the cart to transport crabs in baskets.	
Point / actors in value chain	Transportation by dirt road, from the fishing village to the collection point; Fishers, wholesalers and sub-collectors.	
Objectives	Limit the mortality and injury of crabs; supply collectors/ exporters with crabs in good physical condition, ready to withstand transportation to destination (e.g. Antananarivo) then export.	
Justification	Fewer crushed crabs thanks to the shelf, the smaller size of the baskets, and the thick bedding on the boards; The cart (covered with canvas, palm matting or cloth) provides protection against the sun, rain and wind, and maintains humidity and low temperatures within the baskets.	
Results achieved	For a 10 km dirt road journey (45 min) with 100 kg of crabs, the mortality rate went from 10% to 3–6% (highest mortality during the hot season); Additional income: 13.6 USD per trip for 100 kg of crabs. Amortisation period: 5 weeks	
Observations	The shelf is removable; The crabs are transported in palm baskets containing 10–15 kg of crabs; The cart transports a maximum of 12 baskets; The baskets of crabs are placed on a 5–10 cm bedding of straw / leaves collected from the forest; Solution applied for 5 years by three fishers/wholesalers in the village of Andranolava Belily (Morombe district), and for 3 years by the 2 sub-collectors in the municipality of Andranoboka (Mahajanga II district).	

Traditional cart with tyred wheels.



Removable shelf/luggage carrier



FACT SHEET 13. Cart with removable shelf

1. Prepare the baskets



roads

F14. FAST TRANSPORTATION VAN

Action to take	Fit three shelves in a fast vehicle.
Point /actors in value chain	Collectors, collector-exporters, and transporters
Objectives	Reduce mortality during transportation to port/airport (e.g. Antananarivo) and supply crabs in good physical condition, ready to withstand long air journey to the importing countries.
Justification	Reduces the transportation time in Madagascar. Crabs are well protected against the sun, rain and wind Ventilation and reduced risk of crushing due to the removable shelves.
Results achieved	Over a distance of 700 km, the mortality rate in a fast van is 4–5%, compared to 10% for transportation by canvas-covered lorry or by bush taxi (2013).
Observations	On average, a Mercedes Sprinter van can hold 2,000 kg of crabs and reach Antananarivo in 12 hours overnight. The boards can easily be removed for the return journey if necessary; Practical adaptation applied since 2015 by a collector in Ambalobe/Antsohihy and by some other operators; It is advisable to travel by night for journeys lasting <15 hours.

Van fitted with light metal support and removable wooden boards





Materials	Costs	Service life
Basket, 70 cm in diameter and 60 cm in height	0.6-0.9 USD	1 to 2 weeks
Metal support and hardwood boards: 20–30 cm wide and 3–4 cm thick. Manufacturing time: 2 days	151 USD	Several years, depending on the tonnage transported and maintenance.

Preparing and carrying out a dispatch

1. Wash and soak just before dispatch

The crabs are washed and cleared of mud



2. Place in baskets

The interior is covered with cardboard (to preserve humidity)



3. Loading

About 2 tonnes of crabs are loaded for one trip

hours.





The basket is covered with an unperforated rice sack







40–45 baskets each containing

(tied crabs, without mud)



F15. ENGINE COOLING AND ANTI-TOXICITY

Action to take	Adapt a boat / pirogue with an in-board diesel engine for transporting live crabs.
Point in value chain	Sub-collectors, collectors and transporters; Transportation by sea to collectors and exporters of live crabs.
Objectives	Reduce mortality during sea transportation and supply crabs in good physical condition, ready to withstand the journey to the port/airport (e.g. Antananarivo) and export.
Explanation	Reduces the risk of crabs being poisoned by engine leaks (fuel, lubricant and hot water), thanks to an protective isolating partition and a waste tank. Reduced risk of overheating and engine breakdown thanks to the closed-circuit cooling system.
Results achieved	Reduction in mortality from 30% to 5% for a sea journey of 100–150 km (the transport vessel should also be equipped with removable shelves in the hold, to prevent crushing of crabs).
Observations	Motorisation reduces the transport time, and therefore post- harvest mortality; however, it is advisable to keep the option of sail power (for economic and safety reasons); In-board diesel engines with vertical shafts are widely used in sea transport in Madagascar. This system for engine cooling and anti-toxicity has been applied since 2005 by a mechanic in Maromandia (more than 50 installations carried out so far).

Motorised transport boat

Motorised collection pirogue





1. Motorise the transport pirogue (10-12 m)



3. Engine-cooling system



Hold

(crab transportation)

Engine

compartment

Materials	Costs	Service life
 <u>Anti-toxicity</u>: Wood or fibre-glass partitions, metal tank (l 120 cm, w 80 cm, h 30cm). Cooling system: Piping made of copper, brass or radiator hose (resistant to heat and a good thermal conductor); joints made of heat-resistant rubber. Labour (5–7 days for manufacture and fitting) 	272–302 USD	1–2 years, depending on maintenance
A 10–12 m pirogue is motorised: Chinese 10–18 HP diesel engine, vertical shaft, 3 belts, other fastening materials and labour.	1,813–2,116 USD	2 years, depending on maintenance

F16. COVERED MARKETS FOR LIVE CRABS

Action to take	Renovate areas where live crabs are sold.	
Point / actors in value chain	Sale on the local market; Vendors.	
Objectives	Improve the value of crabs sold locally and the conditions of sale for vendors.	
Justification	Reduces mortality of crabs at the market, due to protection against the wind, sun and rain, and improved hygiene with concrete sale stalls, easily washable walls, and discharge channels for waste water; Improves the quality of crabs sold, and therefore their sale price; Improves public hygiene in the market.	
Results achieved	The mortality rate is 6% for the three regional markets that were renovated in 2014 (Morondava, Antsohihy, Ambanja).	
Observations	Following the growth in exports of live crabs, the local market has been provisioned largely by the weak and injured crabs rejected by the collectors/exporters. This is the main factor explaining the relatively high mortality rate. The other factors causing mortality are: i) overloaded baskets and sacks for transport, ii) insufficient soaking, iii) use of too much mud during storage and transport, iv) heat and rain. The points in the crab value chain with the highest mortality rates are "sale at bazaars / local markets" and "storage at collection points, with transportation to towns". Construction costs vary between 2,116 USD and 6,650 USD depending on the initial state of the market and its size.	

Ambanja, crab market before renovation (2014)



Ambanja, crab market now (2018)



Key points of the live crab market



Arrangement of sale stalls. Customer and vendor spaces well separated.



Sale stall - customer side.



Protection against the sun and rain. Protective vertical sheets and canvases.



Sale stall - vendor side.



Discharge channels for waste water, covered.



Waste bin for small waste.



Hangar gate (protects against animals such as dogs, rats, chickens etc.)



Information sign for customers (showing the minimum size of crabs authorised for sale).

4. MATERIALS AND DISSEMINATION APPROACH

Experiences in Madagascar, and indeed across the world, show that even innovations that provide clear financial benefits may take a long time to be adopted. In many cases, new technical solutions are not adopted on a wider scale beyond the direct beneficiaries of a particular field programme. We propose two complementary stages to encourage wider uptake of the innovation.

Stage 1

Produce a guide to present new technical and organisational solutions in a simple way; in the case of the crab sector this allows people to increase the value of production. This publication, translated into local dialects, will be widely distributed among staff at various projects, NGOs, and groups that are active in mangrove areas, the fisheries and environment authorities, researchers, and crab sub-collectors, collectors and exporters.

Fishers are far more numerous than other operators, so a different solution will be used: double-sided, laminated sheets showing some technical innovations in the guide. These teaching materials are a practical, simple, low-cost solution. For example, there could be a sheet showing all innovations regarding i) crab fishing, ii) storage materials in the village, or iii) dirt-road transportation options (for wholesalers and sub-collectors).

Stage 2

Carry out a broad-scale awareness-raising and training programme using:

- workshops organised in coastal villages and large crab-collection centres;
- training and demonstration sessions in fishing villages and rural municipalities, organised by NGOs, government authorities or other actors working in the field, or via a mobile unit for awareness-raising, dissemination and demonstration;
- exchange visits to villages that have been using good practices for several years;
- radio broadcasts.

Appropriate materials will be needed for each activity.

Regional workshops will be largely based on the content in the guide. It is vital that meetings in villages are accompanied by demonstration sessions covering the manufacture and use of specific technical innovations. The trainers giving these demonstrations should also be practitioners, ideally assisted by videos of the innovation being manufactured and implemented by the people who came up with the original idea.

These awareness-raising activities could be carried out by a mobile demonstration unit that would also have materials for manufacture/construction and the necessary tools for on-site manufacture: for example, the enhanced crab hoop net, the storage cage, and the storage/transportation baskets.

Radio broadcasts are a good way of communicating with the operators (the fishers, wholesalers and sub-collectors) who are not in direct contact with the trainers/disseminators working for the authorities or NGOs. Radio broadcasts are inexpensive, they can draw attention to the issues, and they can provide details about how to obtain further information and training on the technical solutions.



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- Mr Daoudao TOLIFA, Ampangatana, Ambilobe district (Fact sheet no. 3)
- Mr ABDALAH, Ankotika, Ambanja district (Fact sheet no. 4)
- Mr Christophe TIANDRAZANA, Sakoany, Mahajanga district (Fact sheet no. 5)
- Mr Réné JEAN, Ampisaraha, Ambanja district (Fact sheet no. 6)
- Mrs Anastasie MAHATSARA, Antafiampanaba, Antsohihy district (Fact sheet no. 7)
- Mrs LAMINJARA Delphine, Ankitsika, Analalava district (Fact sheet no. 8)
- Mr Jean MATHIEU, Ankotapika, Morombe district (Fact sheet no. 9)
- Mr RODIN, Ankitsika, Analalava district (Fact sheet no. 10)
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- Mr Benjisthy RAKOTOARINORO, Maromandia, Analalava district (Fact sheet no. 15)
- Mr Socrate RABODOSON, Ambanja, Ambanja district (Fact sheet no. 16)



NOTES

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The crab industry has become one of the most lucrative in Madagascar's fishing sector over the last five years. The eagerly awaited opportunity provided by the recent live crab boom also poses a threat to an industry that is still new and largely unstructured. Fishing methods are often not very selective, and they sometimes damage the mangrove habitats. The methods used for collection, storage and transportation sometimes cause significant ecological and economical post-harvest losses.

This guide, which is aimed at fishers and other operators in the industry, describes the best innovative solutions applied in Madagascar to make better use of mangrove crabs and maximise the value of the catch. It is available in French, English, and Malagasy (Sakalava and Vezo dialects).

These good practices provide economic benefits, enabling fishers and other operators within the industry to comply with current rules for a more sustainable fishery, thus reducing the pressure on wild crab populations. The fisheries authorities, seafood collectors, and civil society organisations all have an important role in promoting these good practices.

Blue Ventures was founded 15 years ago in Madagascar, and is now active in eight other countries. Blue Ventures is a marine conservation organisation that works with local communities to rebuild tropical fisheries. We work in places where the ocean is vital to the regional culture and economy, and are committed to advancing the rights of small-scale fishers throughout the coastal tropics. A particular focus of Blue Ventures' work is to uncouple income (and well-being) from increased exploitation of resources, by working with fishing communities to develop innovative models to enhance value chains.

MIHARI (Mitantana HArena an-dRanomasina avy eny ifotony) is a national network created in 2012 to respond to the isolation faced by fishing communities in Madagascar by exchanging good practices and sharing experience amongst them. The Network's mission is to represent the voices of small-scale fishers at the national and international level. MIHARI also strengthens fishers' capacity to improve and sustain management of marine areas in Madagascar. MIHARI is a civil society movement currently made up of 23 member organisations and more than 150 community associations managing over 70 Locally Managed Marine Areas.

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