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ASSESSMENT OF THE COMMERCIAL CHAIN OF BIVALVES IN EGYPT

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ASSESSMENT OF THE COMMERCIAL CHAIN OF BIVALVES IN EGYPT

by

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PREPARATION OF THIS DOCUMENT

In recent years, the FAO regional project EastMed (Scientific and Institutional Cooperation to Support Responsible Fisheries in the Eastern Mediterranean) has supported a number of activities to investigate the feasibility of exploiting clams off the Mediterranean coast of Egypt. A preliminary survey conducted in 2013 showed that unexploited clam resources (including *Chamelea gallina*) exist in shallow coastal waters and that these resources could support a potential small fishery based on the conversion of small trawlers. The idea of converting trawlers to fish for clams was particularly welcomed by Egypt because of the overcapacity of the trawl fleet and the overfished status of demersal fish resources. Upon the demonstration of the potential for the development of a new fishery, the present market chain study was launched to better understand the current situation of the bivalve fisheries in Egypt and the potential to successfully introduce new products to the local markets. The study was funded and executed by EastMed (GCP/INT/318/EC –041/ITA/TD-00) in close collaboration with the General Authority for Fish Resources Development of Egypt (GAFRD).

ABSTRACT

Fisheries represent an important source of employment and income for Egypt, especially in coastal communities. Seafood has traditionally been an important component of the Egyptian diet and is the main source of cheap animal protein for a growing population.

The country has a strong need to diversify the activity of its fishing fleet in order to alleviate the pressure exerted by trawling on demersal resources, while maintaining the current employment rates and average salary per fisher. As a result, there has been strong political pressure to find alternative fishing opportunities. A more structured exploitation of bivalve species in the Mediterranean has been identified as one potential alternative to bottom trawling. However, there was a significant dearth of knowledge about the bivalve fisheries and the related market dynamics in Egypt. This study provided a first assessment of the bivalve fisheries value chain and the number of fishers, fishing techniques, production, employment, income and all the related commercial activities.

Based on the results of this study, the estimated number of fishers involved in the activity, both on a part-time and full-time basis, ranged between 2 600 and 7 300. It was estimated that the total production ranges between a minimum of 3 000 tonnes and a maximum of 21 000 tonnes per year and the revenue generated was estimated to be between USD 4.3 million and USD 18.5 million. This guaranteed an average yearly remuneration per fisher that ranged between about USD 100 and USD 4 000, depending on the area and the type of activity. In total, about 75 wholesalers and 24 auctioneers/wholesalers were identified who dealt partially or mainly with bivalves. About 10 to 15 of them were highly specialized in bivalves. The study also identified that bivalves are commonly present in fish markets, with several bivalve species already well-known to consumers, and that the market conditions are ripe for new bivalves species. Several issues were identified as requiring management attention in order to optimize the use of bivalve resources in Egypt, including the need for appropriate regulatory systems, improvements in harvesting techniques and post-harvesting processes to improve the quality and value of the products.

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ABBREVIATIONS AND ACRONYMS

CLAR Central Laboratory for Aquaculture Research

EGP Egyptian Pound

EU European Union

FAO Food and Agriculture Organization of the United Nations

FTE Full-time equivalent (jobs)

GAFRD General Authority for Fish Resources Development

GAMI General Authority for Maritime Inspection

GAVS General Authority for Veterinary Services

GDP Gross domestic product

NIOF National Institute of Oceanography and Fisheries

PPP Purchasing Power Parity

USD United States Dollar

The conversion factor utilised in the analysis refers to 2015 and was the following:

1 USD = EGP 7.83

All dollar amounts are United States dollars, unless otherwise indicated.

All the monetary figures are without taxes, unless otherwise specified.

EXECUTIVE SUMMARY

Fisheries represent an important source of employment and income for Egypt, especially in coastal communities. Seafood has traditionally been an important component of the Egyptian diet and is the main source of cheap animal protein for a growing population. The domestic demand for seafood is high, with imports exceeding exports. The trawl fishery represents the backbone of the sector in terms of both economic value of production and employment, and the Egyptian trawl fleet is the second largest trawl fleet in the Mediterranean. This fleet, however, is reported to be in a condition of overcapacity, with profits declining – especially for the smaller vessels. At the same time, demersal resources are considered to be overexploited.

In this context, the country has a strong need to diversify the activity of its fishing fleet in order to alleviate the pressure exerted by trawling on demersal resources, while maintaining the current employment rates and average salary per fisher. As a result, there has been strong political pressure to find alternative fishing opportunities. A more structured exploitation of bivalve species in the Mediterranean has been identified as one potential alternative to bottom trawling. However, there was a significant dearth of knowledge about the bivalve fisheries and the related market dynamics in Egypt. For instance, little was known about the main fishing areas, number of fishers, fishing techniques, production, employment, income and all the related commercial activities. Addressing this shortage of knowledge was one of the main aims of this study. Furthermore, this study provided a first assessment of the bivalve fisheries value chain.

Based on the results of this study, the estimated number of fishers involved in the activity, both on a part-time and full-time basis, ranged between 2 600 and 7 300. The estimated total production ranged between a minimum of 3 000 tonnes and a maximum of 21 000 tonnes per year and the revenue generated was estimated to be between USD 4.3 million and USD 18.5 million. This guaranteed an average yearly remuneration per fisher that ranged between about USD 100 and USD 4 000, depending on the area and the type of activity. In total, about 75 wholesalers and 24 auctioneers/wholesalers were identified who dealt partially or mainly with bivalves, and about 10 to 15 of them were highly specialized in bivalves.

The study identified the following three macro-areas characterized by similar fishing patterns, species landed, selling behaviours and economic performance:

a) Alexandria, in the west part of the Delta Region, where most of the production was made up of the grooved carpet shell (*Ruditapes decussatus*) and the date mussel (*Lithophaga lithophaga*) which fetched the highest prices. This in turn resulted in the best remuneration per fisher.

b) Edku to Port Said, in the central region of the Nile Delta, which was the area of production of the bivalve wedge clam (*Donax trunculus*). Here the fishery is based on hand-raking and the costs of production are extremely low. This area recorded the lowest value of production and revenue per fisher.

c) Suez Canal, between the Mediterranean and Red seas, that is characterized by production of the carpet clam (*Paphia textile*) and grooved carpet shell (*Ruditapes decussatus*), which were fished using all fishing techniques. This is the area with the largest production, accounting for about 40 to 60 percent of the total bivalve production in Egypt. In general, this area was the most specialized in the fishing of bivalves and the one with the best commercial organization.

The study and fieldwork made it possible to identifiy the following key features:

- Bivalves are commonly present in fish markets, with several bivalve species already well-known to consumers;
- Products from the Mediterranean region fetch high retail prices and are considered to be of better quality and tastier than seafood products from other areas. Relative to the cost of living, and with respect to the value of landings, in general the average price per kilogram of production was found to be relatively high when compared to bivalve fisheries in European countries;

- The market conditions are ideal for the introduction of a new bivalve species and the market can easily absorb more production. There is good potential to increase the production of bivalves as there are species which are found in deeper waters that are currently not exploited.

The following main issues were identified as requiring management attention in order to optimize the use of bivalve resources in Egypt:

- The bivalve fishing sector needs to be regulated by a licensing system in line with what already exists for all other fishing sectors in Egypt;
- There is no monitoring and management of the bivalve sector, and a management plan with specific regulations should be developed in order to plan for the monitoring and for ensuring the sustainable management of the sector;
- The fishing techniques which are currently in use are rudimentary and there is great potential and room for improvement. This could lead to an improvement in equipment, quality of the products, better conservation of resources, etc.
- Some specific problems relate to the deterioration/spoilage of products and the keeping of bivalves in unhygienic conditions, along with a lack of labelling and the consequent lack of traceability of the products. Training for fishers working in the sector may be particularly necessary to address these issues and this should be paired with an improvement of facilities.
- The post-harvest purification and processing of the product would increase its value and allow for the introduction of bivalves to new markets and customers.
- The added value could also be enhanced through the development of a “manual of best practices” that sets out the recommended treatment of the product, from the fishing operation to the first sale.

In conclusion, through this study many elements were identified that allowed for an improved understanding of the bivalve sector, while highlighting the significant potential for enhancing and optimizing the use of bivalve resources in Egypt.

1. INTRODUCTION AND BACKGROUND

1.1 Objectives

The goal of this study was to make a preliminary assessment of the fisheries targeting bivalves and the structure of the market for bivalves in Egypt. The objective was to provide a qualitative and quantitative description of the production, employment, activity, fisheries products, major participants in the markets and market dynamics. This study represents the second step of an activity undertaken within the framework of the EastMed project, with the purpose of investigating the potential exploitation of bivalves in the Delta region of Egypt.

The exploitation of bivalves may be one way to diversify the fishing activity of the trawl fleet, since the Egyptian trawl fisheries are in decline and making only a marginal profit. Furthermore, there is overcapacity in the trawl feet and overexploitation of the demersal resources. This is especially relevant for the trawlers smaller than 18 m in length which fish mostly inshore at less than 3 nautical miles from the coast. As a result, there has been strong political pressure to find alternative fishing opportunities. Fishing for clams could be one of these solutions, since the small trawlers could be easily adapted to fish for clams.

The study was conducted by a team of local fisheries experts from the General Authority for Fish Resources Development (GAFRD), supported by two experts in fisheries economics and biology from the Food and Agriculture Organization of the United Nations (FAO). It aimed to provide information to assist GAFRD to make informed decisions about the future of the clam fisheries. Consequently, an initial discussion of the objectives and needs of the study was undertaken to clarify its different purposes.

The areas investigated were those where the production and marketing of bivalves is established and included the Delta region, the Ismailia district and, partially, the Cairo Al-Obour central market. The reference year was 2015.

Key elements of the study include:

- Assess the bivalve fisheries in terms of number of fishers, landings and gears utilised;
- Identify the main areas and patterns of production;
- Provide a qualitative and general description of the market for bivalves in Egypt;
- Provide an insight into the existing commercial chain for the production of bivalves;
- Understand the costs and earnings profiles;
- Identify principle routes from raw material to consumer for each of the areas identified;
- Price analysis throughout the commercial chain;
- Understand the key constraints and problems impacting different actors in the commercial chain;
- Identify potential solutions to the problems identified.

1.2 Introduction to value chain analysis

Value chains are the main structure in the core of diversified and specialized economic activities linking natural resources, production and distribution systems to market needs (Porter, 1985; Macfadyen *et al*., 2011). The traditional definition of a value chain is a "complex set of interrelated activities required to produce a good or service and distribute it to consumers" (Hayter and Patchell, 2011). Furthermore, a value chain exists when all the actors in the chain operate in a way that maximizes the generation of value through the chain (M4P, 2008).

The value chain approach is flexible and is mainly a descriptive tool to look at the interactions between different economic agents. Value chain analysis allows for different entry points, depending upon the objective of the analysis (M4P, 2008). As a descriptive tool it has various advantages in so far as it forces the analyst to consider both the micro and macro aspects involved in the production and exchange activities. At the heart of the analysis is the mapping of actors and key linkages. By systematically understanding these linkages

within a network, one can better prescribe policy recommendations and, moreover, further understand their reverberations throughout the chain (Rosales *et al*., 2017).

Many authors have stated that there is no "correct" way to conduct a value chain analysis: rather, the approach taken fundamentally rests upon the research question that is being answered (Kaplinsky and Morris, 2001).

At its most basic level, a value chain analysis systematically maps the economic agents participating in the production, distribution, marketing and sale of a product (or products) (Macfadyen *et al*., 2011).

Value chain analysis can play a key role in identifying the distribution of benefits amongst economic agents in the chain. Each firm in the chain may be categorized within one out of a set of strategic groups, each of which follows the same strategies and is exposed to similar competition with respect to limited production factors and customers (Porter, 1985).

1.3 Overview of the national context

1.3.1 National macroeconomic context

With a population of 95.6 million in 2016, Egypt has the fifteenth largest population in the world, the largest population in the Arab region, and the third largest population in Africa (World Bank, 2019). Population has been growing in recent years at a constant rate of about 1.48 million per year (FAO, 2014a).

National figures for gross domestic product (GDP), and for GDP per capita, show a constant increase over the past ten years. However, with annual per capita incomes of USD 3 500 in 2016 (World Bank, 2019), Egypt remains a developing country. Official unemployment figures have hovered around 10 percent for the past ten years, with unemployment numbers particularly high for the 20 to 30 year-old age group (FAO, 2014a). Around 75 percent of the labour force are men (Macfadyen, Nasr-Allah and Dickson, 2012).

The great majority of Egypt's population lives near the banks of the Nile River, an area of about 40 000 km^2, where the only arable land is found. The large regions of the Sahara Desert, which constitutes most of Egypt's territory, are sparsely inhabited. About half of Egypt's residents live in urban areas, with most spread across the densely populated centres of greater Cairo, Alexandria and other major cities in the Nile Delta (FAO, 2014a).

Table 1 Major macroeconomic indicators

Characteristics	
Total population (2016)	95.6 million
Income level	Lower-middle income
GDP per capita (current, 2016)	USD 3 515
GDP per capita, PPP (current USD) (2012)	USD 10 248
Official minimum wage per month (2012)	USD 118
Wage in the aquaculture sector (2011)	USD 130–150
Population below poverty line (2008)	22%
Unemployment total (% of total labour force) (2012)	12.7%

Source: World Bank, 2016

The contribution of fishing to GDP was calculated in terms of gross value added by the FAO EastMed project, utilising only the fisheries production from the Mediterranean Sea. In particular, it was calculated as value of landings minus all expenses except salaries (revenues – [energy costs + maintenance costs + operational costs + commercial costs + fixed costs]) (FAO, 2016).

Table 2. Economic contribution of agriculture and fisheries

Characteristics	2012
Agriculture, value-added (% of GDP)	14.5%
Fisheries, value-added (% of GDP)	0.04%*
Agriculture value-added per worker	USD 2 384
Fisheries value-added per worker (FTE)	USD 5 061
Employment in agriculture (% of total employment)	27%
Employment in fisheries (% of agriculture)	0.004%*

Source: World Bank, 2016; FAO, 2016

*Only production from the Mediterranean Sea

The contribution of agriculture to the economy of Egypt is significant, amounting to 14.5 percent of GDP and 27 percent of employment (Table 2). In comparison, the contribution of Mediterranean fisheries is limited, especially when considered at national level. However, in terms of value-added per worker, which is considered as an indicator of the productivity of a sector, fisheries provides more than double the value of agriculture (Table 2).

In terms of employment, the contribution of agriculture is considerable, with about one quarter of the total labour force employed in agriculture, compared to less than 1 percent in fisheries. However, in the coastal communities of the region, fisheries represent an important source of employment, income and a highly valuable source of animal protein.

1.3.2 Institutional and legal context

The main fisheries legislation in Egypt is Act No. 124 of 1983 on Fishing, Aquatic Life and Aquaculture. The legislation deals with administrative issues in its first section, water pollution and obstructions to fishing operations in its second section, and aquatic resources and the regulation of fish farms in its third section.

The main provisions related to capture fisheries of the Act No. 124 of 1983 include:

- Every vessel designated for fishing shall be marked on its sides by GAFRD with a serial number and with a sign indicating the class of vessel and the area in which it may be used for fishing (art. 2).
- Fishing vessels must operate in the licensed area and by the authorized methods and shall not carry nets or apparatus other than those with which it is licensed to operate (arts. 8 and 9).
- Catching, sale and possession of fish or other aquatic life must be performed in accordance with the regulations on length and size established by the Minister of Agriculture (art. 10).
- The use of noxious, poisonous, stupefying, explosive substances is prohibited, as well as fishing with the use of bamboo traps, fish traps, etc. (art. 13).
- Fish fry may not be collected, removed or obtained from the sea, lakes, or other expanses of water without first obtaining a permit from the aforementioned Authority (art. 19).
- Draining any area of a lake unless for fishery exploitation is prohibited (art. 20).
- Licences shall be valid until 31 December of each year and shall be renewed annually within 90 days (art. 27).
- Concessions relating to the exploitation of aquatic resources and terms shall be issued by a decree of the Minister of Agriculture where the term of the concession shall not exceed five years (art. 47).

1.3.3 Fisheries administration

The GAFRD is responsible for the development and management of fishery resources, including aquaculture, as designated by Act No. 124 of 1983. It is responsible for issuing fishing licences, supervising fisheries cooperatives and producing statistical information on fish production, consumption and trade, among others.

The GAFRD is also the authority for licensing, production control, extension services and strategy development. Furthermore, it takes all the necessary measures for the sustainable management of the sector. Three central offices – for the western coastal provinces, Dumyat region and Delta provinces – are part of the GAFRD headquarter complex in Cairo, with another general office for the eastern provinces and three local offices for the Nile provinces, the Aswan region and the Red Sea province. These local offices are responsible for issuing fishing licenses, collecting catch statistics data, controlling aquaculture activities, managing and developing the inland water bodies, and applying the fisheries law with the support of the coast guard, for marine fisheries, and the water bodies' police for inland fisheries. The GAFRD headquarters is responsible for development projects, applied research, national and international agreements and maintenance activities.

The GAFRD also includes seven central departments located in the areas of production and geographically spread all over Egypt:

- Central administration of the Central Delta;
- Central administration for Damietta area;
- Central administration of the Western region;
- Suez and Red Sea region;
- Ismailia region;
- Nile Valley region; and
- Aswan region.

Each central department includes several specialized departments, such as the departments of fish farms management, hatcheries, fisheries management, research, nutrition, legal affairs, international affairs, administration and finance, training, cooperation, planning and projects, engineering and construction.

The GAFRD cooperates with many other national institutions involved in fisheries management. These agencies belong to other ministries and include: the General Authority for Maritime Inspection (GAMI); the Central Laboratory for Aquaculture Research (CLAR); the Police of Environment and Water Bodies; the National Institute of Oceanography and Fisheries (NIOF); the institutes and colleges specializing in fisheries and aquaculture studies in the Egyptian Universities; and the General Authority for Veterinary Services (GAVS).

The private sector, which includes fishers, vessel owners and fish producers, is thoroughly represented by the Egyptian Cooperative Union for Fisheries Resources that participates with government institutions in all decision-making processes for the adoption of fisheries management measures.

1.3.4 Egyptian fisheries in the Mediterranean

The total number of Egyptian registered fishing vessels operating in the Mediterranean and Red Sea is 6 480; 4 089 of these vessels are equipped with inboard engines, with between 50 hp and 1 000 hp, and use a variety of fishing gears such as trawl, purse-seine, longlines, trammel and gill nets. In 2008 in the Mediterranean, the fleet comprised 4 509 fishing boats, including 1 379 sail boats and 2 900 vessels equipped with inboard engines of between 10 hp and 500 hp. The Mediterranean fleet makes use of the full range of fishing gears named above and in 2008 there were 1 095 trawlers, 238 purse seiners, 1 267 pelagic longliners (targeting tuna and swordfish) and 529 trammel nets. While the number of trawlers and purse seiners was stable in the past five years, the number of longliners has doubled.

The most important fishing gear types in the Mediterranean Egyptian fisheries are bottom trawl, purse seine, longline and fixed nets. The bottom trawls probably represent the backbone of the sector in terms of both economic value and employment.

The main sources of fish production in Egypt include marine fisheries; inland fisheries in lakes, lagoons, the Nile River, irrigation and drainage canals; and aquaculture. Total production levels increased by more than 50 percent over the period 2000 to 2009, from 724 300 tonnes in 2000 to 1.1 million tonnes in 2009. The rise in production was primarily obtained from the significant increase in aquaculture production, while wild capture fisheries production remained almost constant (389 398 tonnes in 2009). By 2009, the share of total production provided by aquaculture had risen to 65 percent (up from 47 percent in 2000). The Mediterranean fisheries account for about 20 percent of the total capture production.

Fish has traditionally been an important component of the Egyptian diet and is the main source of cheap animal protein for a growing population (Feidi, 2010). The FAO Food Balance Sheet for Egypt estimates that the average annual fish per capita consumption in 2013 was 22.1 kg and that fish supplies consumers with 40 calories, 6.3 g of animal protein and 1.4 g of fat per day (FAO, 2017). In the Egyptian fisheries economy, only small quantities are exported, while imports are very much higher than exports due to the high domestic demand for fish. In 2009, the trade economy value of marine fisheries shows that imports were very much higher than exports, confirming the increase from the previous years. In fact, for export of fish products the value was USD 3.5 million, whereas for imports it was USD 167.7 million; that means a grand total of USD 171 million for international trade of fish products.

There are about 90 fishery and aquaculture cooperatives, seven of which are aquaculture cooperatives with about 1 550 members. All existing fishing cooperatives in Egypt must belong to the Federation of Fishing Cooperatives, run under the auspices of the GAFRD. Membership of almost all these cooperatives is restricted to boat owners, the most influential of whom are elected to administer the cooperatives.

1.3.5 Bivalve fisheries in Egypt

In Egypt several bivalve species (Farag, Dekinesh and El-Odessy, 1999) are well-known to consumers (Plates 1, 2, 3, 4). These include:

- the oysters *Pinctata radiata* (Al-Seridia) and *Pinctata margaritifera* (Al-Sadaf) (Farag, Dekinesh and El-Odessy, 1999);
- the clams *Tridacana* spp. (Al-Boshr);
- the mussels *Mytilus* spp. and *Modiulus* spp. (Balah Al Bahr);
- the cockles *Cardium glaucum* (Al-bakalaweez) (Farag, Dekinesh and El-Odessy, 1999);
- different species of the family Veneridae, such as *Ruditapes decussatus* (Al-Gandofly), *Venerupis pullastra* (Gabr and Gab-Alla, 2008), and *Paphia textile* (pers. observ.);
- different species of the family Donacidae such as *Donax trunculus* (Om El-Kholool) (Farag, Dekinesh and El-Odessy, 1999) and the ark clam *Anadara* spp. (Farag, Dekinesh and El-Odessy, 1999).

Plate 1. A vendor of bivalves in the market of Port Said, Egypt. *Ruditapes decussatus* can be seen in the right and lower right corner, submerged in water, while unsubmerged *Donax trunculus* can be seen in the upper left corner.

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Plate 2. Left and centre, *Paphia textile* being sold at the central fish market in Cairo. The species on the right is pullet carpet shell, *Venerupis pullastra*.

The most important commercial species by far is the clam *Ruditapes decussatus* which is widely distributed in high densities in the shallow inshore waters of Lake Timsah within the Suez canal (Gabr and Gab-Alla, 2008; Kandeel, 2016; Kandeel, 2006). In Egypt, these clams are greatly appreciated by seafood consumers and in the last decade, the importance of *Ruditapes decussatus* has increased in terms of landing volumes, economic value and relative importance among other marine resources. The first sale (ex-vessel) price for this species in 2013 was 60 EGP/kg (pers. observ.). At that price, this species is extremely expensive for the regular Egyptian consumer but has a high value for the upper class and tourists. One aquaculture facility exists for *Ruditapes decussatus*. It is located at the Damietta side of the mouth of Lake Manzala on the Mediterranean coast (Plate 3). The seeds for the aquaculture facility are fished from Lake Timsah in the Suez canal.

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Plate 3. A clam aquaculture farm (left) and a freshly caught sample of *Ruditapes decussatus* (right).

The second most important species seems to be the bean clam *Donax trunculus* which is commonly found in the market with a first sale price of about 15 EGP/kg (pers. observ.).

A very common but not so commercially important species is *Anadara polii* with a first sale price of about 8 EGP/kg (pers. observ; Plate 4).

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Plate 4. *Anadara polii* are sold along the highway from Rasheed to Alexandria.

Most of the species mentioned are caught in waters shallower than 1.5 m, mostly picked by hand, as well as with a rake which is pulled by the fishers in a rocking motion (Plate 5) and the clams end up in a collection basket at the end of the clam rake. Species which are fished in deeper waters, such as the clam *Venus verrucosa*, are caught by diving. Some large specimens of scallops are also occasionally caught by bottom trawlers fishing for shrimps (pers. observ).

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Plate 5. A fisher fishing for *Donax trunculus* in the bay between Port Said and Damietta (left) and a typical hand-rake used for fishing clams (right).

Clams which are found in waters deeper than two meters, such as the venus clam *Chamelea gallina*, the smooth clam *Callista chione* and the razor clams, *Ensis* spp. are not fished by a specific fishery. However, it is thought that these clams may be present in Egyptian waters in commercial quantities. In other countries in the Mediterranean, clam banks are usually exploited through the use of a hydraulic dredge, by fishing vessels with an average gross tonnage of about 9 to 13 t, 50 to 150 hp and 14 to 16 m length overall (Froglia, 1989).

In 2011 and 2012, an attempt was made by a local fisher to fish with a hydraulic dredge and commercialize the clam *Chamelea gallina* (pers. comm.). Although he managed to find commercial quantities, the clam could not be commercialized because it was not well-known in the local markets (pers. comm.).

1.4 Description of the products

1.4.1 Donax trunculus

Donax trunculus (wedge-shell) is a species of bivalve mollusc (family Donacidae) that can be found along the coasts of Western Europe and West Africa to Senegal, as well as in the Mediterranean, the Aegean, the Black and the Red seas (Encyclopedia of life, 2019). *Donax trunculus*' presence in the Red Sea means that it has colonized the area in spite of the invasive species that have been entering the Mediterranean through the Suez Canal (Mooney and Cleland, 2001). It usually inhabits the shallowest waters of the coastline, occurring near the shore as well as between 0 and 2 m below the surface (Neuberger-Cywiak, Achituv and Mizrahi, 1989). *Donax trunculus* is a suspension feeder and prefers to live in high-energy environments with suspended particles and wave action (Ramon, Abello and Richardson, 1999).

The shell of *Donax trunculus* is a wedge-shaped equivalve, no longer than 150 mm, with the posterior longer than the anterior. The shell can be found in colours ranging from olive, through chestnut, to yellow-white and is over 25 mm broad. The sexual dimorphism of *Donax trunculus* is largely gonadal and both sexes are equally represented in populations. *Donax trunculus* has an observed maximum lifespan of six years, but four years is more typical (Deval, 2009).

It is commercially harvested for food. In the Mediterranean it is locally known as *tellin, tellina* or *telline*. In French it is called "*tenille*", in Spanish it is *tellina* or *coquina*, and in Portuguese it is *conquilha* or *cadelinha*. *Donax trunculus* is consumed as a food in these countries. Due to its large natural populations, it is able to withstand the impacts of fishing (Ramon, Abello and Richardson, 1999). There is virtually no risk of *Donax trunculus* becoming an endangered or protected species in the near future. However, a natural threat to the species that could possibly destablilize populations is the trematode *Bacciger bacciger*. This parasite embeds itself in the gonadal tissue of *Donax trunculus* and eventually leads to castration and lack of physical sexual differentiation (Ramon, Abello and Richardson, 1999).

Donax trunculus accumulates trace amounts of metals such as copper, cadmium, iron, magnesium and zinc, and is useful as a bioindicator for these materials. This ability may be useful in detecting and preventing water contamination or pollution (Romeo, Sidoumou and Gnassia-Barelli, 2000).

1.4.2 Ruditapes decussatus

The grooved carpet shell, *Ruditapes decussatus*, is a clam in the family Veneridae. It is distributed worldwide, ranging from the North Sea and the United Kingdom of Great Britain and Northern Ireland southward to the Mediterranean Sea and North Africa. It is found buried in soft substrates – sand, muddy sand, gravel or clay – on the lower shore and at depths down to a few metres in the intertidal zone.

The shell of *Ruditapes decussatus* is robust and can grow to a length of 75 mm. The shell is broadly oval or square in shape and is cream, yellowish, or light brown in colour, often with darker markings. The structure of the shell is made up of of concentric grooves and bold radiating ridges. There are quite distinct criss-cross (decussate) markings present posteriorly. When the valves are closed, below the beak there is a shallow, not particularly distinct, heart-

shaped depression with light and dark brown fine radiating ridges. The animal itself is pale grey or cream coloured with the mantle fringed with white. The two siphons are separate for all their length, they are quite characteristic and have brownish tips where they reach the surface. This species tends to bury itself in sand, muddy gravel, or clay and is found on the lower shore and shallow sublittoral zone.

The chequered carpet shell is superficially similar in shape and size to the Manila clam *Tapes philippinarum* and to *Venerupis senegalensis*. The chequered carpet shell is distinguishable from the Manila clam by its very distinct radiating lines which are present on the shell and white foot. *Tapes philippinarum* is distinguishable by the distinctive black and white markings and orange foot. *Venerupis senegalensis* often has zigzag markings on the shell.

This species is one of the most popular and commercially profitable molluscs of lagoonal and coastal sites in the Mediterranean, where it has been collected as food for a long time. It is consumed fresh and canned. *Ruditapes decussatus* is cultured on the Atlantic coast of France, Spain and Portugal and in the Mediterranean basin. It is often grown with other bivalves (*Venerupis pullastra, Venerupis rhomboideus, Venerupis aurea, Dosinia exoleta* and *Tellina incarnate*).

The species' main predators are shore crabs (*Carcinus maenas*); starfish (*Asterias rubens* and *Marthasterias glaciais*); gastropods (*Natica* spp.); and birds (*Larus* spp.). An individual *Carcinus maenas* (6.5 cm width) can consume five or six clams per day.

Ruditapes decussatus is an important species for both capture fisheries and marine aquaculture. Most production is from Portugal, France, Italy, Spain and Turkey. Global production seems to be declining. In recent years it has been replaced by *Tapes philippinarum* in marine aquaculture since this species grows faster and produces a better yield.

1.4.3 Paphia textile

Paphia textile is a species of saltwater clam in the family Veneridae, the Venus clams. It is commonly called the carpet clam and is an edible clam found in the Indo-West Pacific oceans from the Mediterranean, Eastern Africa to Papua New Guinea; north to the South China Sea and south to Indonesia. It was first recorded in the Mediterranean in Palestine (Haas, 1948), where it was introduced through the Suez Canal. These bivalves live on sandy bottoms or attached to rocks, at depths of up to 4 m. It is fished for human consumption and the shells are also sold as decorative items.

The shell of *Paphia textile* can reach a length of 3 to 4 cm, with a maximum length of 8 cm; width: 1.8 cm to 2.6 cm and height: 1.6 mm to 2 mm. These shells are elongate, elliptical-ovate and moderately inflated, with rounded margins. The outer shell surface is smooth, glossy, pale yellowish-white, with pale purplish grey inverted V-shaped markings. The hinge is narrow, with three radiating cardinal teeth but without lateral teeth.

It is preyed upon by benthic fish species such as *Repomucenus richardsonii* and *Cynoglossus arel*.

1.4.4 Venerupis pullastra

Venerupis pullastra, the pullet carpet shell, is a species of bivalve mollusc in the family Veneridae. It is found buried in the sediment on the seabed in shallow parts of the Eastern Atlantic Ocean and the Mediterranean Sea. The clam's range extends from the coasts of Norway, south to West Africa. It lives in a shallow burrow just under the surface in sand, mud or gravel. It occurs in the intertidal zone down to about 40 m.

The shells are more or less rectangular in shape with a far off-centred hinge, with obvious growth rings. Fossil specimens are darker and often date back to around 100 000 years. The pullet carpet shell has a pair of hinged, oblong valves that grow to about 5 cm in length. The umbone or beak is about one third of the way along the shell. The anterior part of the hinge forms an angle with the posterior part and there are three cardinal teeth on each valve. The shell is sculptured on the outside with fine radial ribs running from the umbone to the margin and with fine concentric striations. The colour is cream, grey or pale brown, sometimes with irregular streaks or rays of darker colour. The inside of the shell is glossy white, sometimes with purple markings near the umbone. The adductor muscle scars and the pallial line are

clearly visible and there is a large, rounded pallial sinus. The siphons are joined for their full length, a fact that distinguishes this species from the otherwise similar *Ruditapes decussatus*.

The pullet carpet shell is harvested for human consumption in Spain and other parts of Western Europe and in the Mediterranean. It is cultivated in Spain, Portugal, France and Italy for human consumption. The clam fishing industry in Spain grew rapidly in 1926 and 1927 with clams of all sizes being dug out of the sands indiscriminately. In time, over-harvesting caused a drop in natural populations.

1.4.5 Chamelea gallina

Chamelea gallina is a species of small saltwater clam, a marine bivalve in the family Veneridae, the venus clams, that grows up to 4 cm and can live for up to ten or 11 years. *Chamelea gallina* occurs on the Eastern Atlantic coasts, from Norway and the United Kingdom of Great Britain and Northern Ireland to Portugal, Morocco, Madeira and the Canary Islands. It is also found in the Mediterranean Sea and the Black Sea and is abundant in the Adriatic Sea.

Chamelea gallina lives under the surface of clean and muddy sand at a depth of between 5 m and 20 m. It is a filter feeder, taking in a variety of microalgae, bacteria and small particles of detritus. The shells are triangular in shape with a conspicuous curl at the top and a serrated edge. They sometimes have pretty, colourful patterns. The shell is off-white or cream in colour and often tinted pale yellow. There may be numerous, very fine chestnut or pinkish streaks. There are typically three broad bands of deep chestnut or reddish-brown radiating from the umbones. The dark lines running over the shell form blocks or V-shapes. Old striped Venus shells are often dark brown or black, but are still recognizable because of their shape.

In Southern Europe and the Mediterranean these shellfish are highly appreciated as food and are found in all kinds of dishes. In 2013 the total recorded catch in the Mediterranean was 43 000 t, the largest landing of any bivalve mollusc in the Mediterranean. The largest catches were taken by Italy and Turkey. The shells are mostly caught with dredges and some aquaculture takes place in Italy.

1.4.6 Litophaga litophaga

Lithophaga lithophaga, also known as date shells or date mussels, is a species of bivalve, belonging to the family Mytilidae. Fossils of *Lithophaga lithophaga* are found in marine strata from the Miocene until the Quaternary (from 20 million years ago). They can be found in the Northeast Atlantic Ocean, the Mediterranean Sea and the Red Sea.

These bivalves live mainly in the area that is battered by waves, but they can reach depths of 125 m to 200 m. They bore into marine rocks, producing a boring called *Gastrochaenolites*. Shells of *Lithophaga lithophaga* can reach a length of about 8.5 cm. Their growth is very slow, and to reach 5 cm in length, they require 15 to 35 years. They are yellowish or brownish, almost cylindrical, rounded at both ends. The interior is whitish, iridescent purple with a pink tinge. These shells are relatively thin. The surface is nearly smooth, covered with growth lines, which sometimes can be quite rough. They feed on plankton, algae and debris by filtering them from the water. They reach sexual maturity after about two years. The number of eggs that are released in a season is about 120 000 to about 4.5 million. Fertilization takes place in the open water.

Historically these bivalves were considered a delicacy, cooked and served in a broth of white wine, garlic and parsley. Several governments have restricted the collection of these shells or even made it wholly illegal, in order to protect the rocks on which they are found. The extraction of the shells from the rocks leads to desertification of the coast. These countries include the European Union and many Non-European countries in the Mediterranean, including participants in the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

2. STUDY METHODOLOGY AND APPROACH

2.1 Preparation for the survey

In order to prepare for the survey a team was set up within the GAFRD. The study was planned for key areas in which seafood consumption is important. The goal of the commercial chain analysis was to better understand the existing market for bivalves in Egypt. The main objectives of the survey team were to:

- Provide a qualitative and general description of the market for bivalves in Egypt, together with a snapshot of the general market for marine fisheries products.
- Provide a close look at the value chain for the existing production of bivalves, i.e. to describe the main stakeholders and the flow of product through the value chain.
- Understand the costs and earnings profile of the different subsectors of the value chain.
- Identify principal routes, from raw material to consumers, for each of the species.
- Analyse the price of selected products throughout the value chain.
- Benchmark the products by comparing the value chain with other regions in the Mediterranean and identify where there is a need for improvement.
- Understand the key constraints and problems impacting the different actors in the value chain.
- Identify potential solutions to the problems identified.

Importantly, the main focus of the survey team was to map the flow of bivalves through the different stages of the value chain, from the producers to the consumers. This would serve to develop strategies that would allow for the marketing of the new bivalve species *Chamelea gallina*. In this respect the existing market for bivalves; the production areas; the quantity and value of production; the number of fishers involved and their remuneration; the production and selling areas; and the main market dynamics had to be investigated.

Collection of data and other information from the target population, which consisted of fishers, wholesalers, auctioneers, fishmongers and traders, was carried out by the team from GAFRD with several direct interviews conducted during two field missions. The sample was selected by the interviewers, based on representivity and their judgement and therefore it was a non-probabilistic sample survey. Estimates of the total value proved to be difficult and in many cases have been substituted with range values.

2.2 Approach

The study was carried out in the following stages:

Introductory meeting

- Presentation and discussion of the objectives of the study, the strategy to follow to collect the information and an introduction on the bivalve market and its value chain analysis.

Project design

- Segmentation of the sampling area into sub-zones and identification of categories to be interviewed, namely fishers and traders (wholesalers, auctioneers and fishmongers). This segmentation was also used to produce the final estimates.
- Setting up of the questionnaires for data collection, differentiated for fishers and traders. The questionnaires were discussed by the study team and various changes were applied. The questionnaires were then tested on some fishers and traders in Alexandria and Cairo. This testing resulted in some additional amendments after which the questions were finalized and prepared for the field work. The questionnaires are presented in Appendix 2 and Appendix 3.

Training course

- A small course was conducted for the data collectors in order to describe the questionnaire and the variables and define the interviewees and interview methodologies.

Data collection

- This was conducted in two separate phases:
  i.) First the total target population was estimated by category and then most of the data using the predefined questionnaire was collected.
  ii.) Second the collected data was entered into an Excel database, after which it was checked for quality and consistency and revised by filling some gaps and completing the data collection by contacting some of the interviewees again to discuss additions and/or clarification.
- A special effort was made in Ismailia, as this was identified as one of the most important areas in terms of production and number of fishers.

Analysis

- The raw data was utilised to obtain the mean value for each area and this was then raised to the total estimated population.
- The final estimates were cross-checked and analysed by the study team.

2.3 Limitations

Several limits in the implementation of the methodology were encountered and these are summarized as follows:

The estimation of the population under investigation presented many difficulties. First, no previous studies were available, nor are there official registers that record the exact number of fishers, traders or wholesalers specialized in bivalves. Consequently it was not possible to distinguish the exact numbers of traders specialized in bivalves and for this reason the first phase of the study mainly focused on the identification of the target population, its characteristics and the areas where production is concentrated.

For all these reasons, the estimation of the population is qualitative, reflecting the opinion of the interviewees and the judgement of the study team. This, combined with non-randomly selected samples, severely affects the statistical quality and probably also the level of representivity of the final estimates.

Some traders did not answer at all or did not answer some questions and we assume that this might have biased the level of representivity as well as the final estimates.

2.4 Collection of the data

A preliminary mission was arranged to undertake an appraisal of the sector and thus delineate the area where production and first sale takes place, gain a general idea on the commercial dynamics and a rough estimate of the number of players involved. This also helped in devising the data collection strategy. During the mission, two study questionnaires were also drafted, one for fishers, and one to cover the post-harvest subsector i.e. traders/wholesalers and retailers. The questionnaires were tested with a group of fishers at the Alexandria fisher's cooperative and at Cairo Al-Obour central market with three traders/auctioneers specialized in bivalves. The questionnaires are presented (in English) in Appendix 2 and Appendix 3.

Two missions in the field were conducted in the autumn of 2015 and at the beginning of 2016. The interview team consisted of two officers from GAFRD. The general approach taken by the interviewing team was to use local contacts of GAFRD in each area to arrange meetings with the stakeholders. Both missions covered the coastal area of the Delta, from Alexandria to Port Said and Ismailia. All the main production ports of the area were visited and the most relevant stakeholders were interviewed.

The first mission was mainly focused on estimating the population, namely the fishers and traders. Fishers were categorized by the fishing technique utilised and activity costs, and production data were collected. Following this mission it was possible to segment the area of production into six zones according to their characteristics for type of product and fishing methods, as shown in Figure 1.

Figure 1. The main zones of production for the bivalves: (1) Alexandria; (2) Edku; (3) Rashid; (4) Baltim/ Ras El-Bar, called Damietta; (5) Port Said; (6) Ismailia.

The Ismailia area is outside the Mediterranean. The fishers here operate in salt lakes crossed by the Suez Canal. It is one of the principal areas for the fishing of bivalves, both in terms of number of fishers and volume of production. For this reason, the area was divided into two areas: “Ismailia” and “Ismailia Fayed”.

A detailed description of interviews conducted is presented in Table 3.

Table 3. Detailed description of the sampling frame (first stage)

	Fishers		Traders		
Area	**No. of interviews**	**Fishing as main income generator**	**Wholesaler (no. of interviews)**	**Fishmonger (no. of interviews)**	**Auctioneer/ Wholesaler (no. of interviews)**
Alexandria	5	80%	1	1	1
Edku	6	50%			3
Rashid	4	100%			2
Port Said	6	86%			
Ismailia	4	100%	2		
Ismailia Fayed	5	100%	1	1	
Total	**30**		**4**	**2**	**6**

In the second stage, another mission was conducted in order to follow up on the preliminary results obtained. A second set of interviews was conducted to refine and cross-check the information already collected, particularly that relating to the value chain. For this reason, the questionnaire utilised was simplified and contained a lower number of variables than the first one. The interviewees were mostly a subsample of the same operators that had already been interviewed in the first stage, except in Damietta that was excluded in the first stage and where a new wholesaler was interviewed so as to gain a better estimate of the number of buyers of bivalves in the area. In fact, in Damietta bivalves are not produced but only sold, with the product supplied from the area of Ismailia. The total number of interviews conducted was lower than in the first phase but the number of traders interviewed was higher (Table 4).

Table 4. General description of the sampling frame (first and second stages)

	First stage		Second stage	
Area	**Fishers**	**Traders**	**Fishers**	**Traders**
Alexandria	5	3	2	2
Edku	6	3	3	3
Rashid	4	2	2	2
Port Said	6		3	3
Ismailia	4	2		
Ismailia Fayed	5	2	2	2
Damietta				1
Total	**30**	**12**	**12**	**13**

3. RESULTS

3.1 General description of the fisheries

It is likely that when estimating the number of fishers per area, some overlap between areas may have occurred. This is due to the lack of official registers and might have led to an overestimation of the number of fishers. It was particularly relevant in the areas where no vessels are utilised for the fishing activity, where many different landing and selling points exist and where fishers move from one area to another, thus possibly being double-counted. For example, this was the case of Rashid and Edku, in which some of the range values obtained from the interviews were reduced. In general however, in order to reduce this risk, the lower value of the range obtained through the interviews was utilised in the calculations, as can be seen for example in the second and third columns of Table 7.

Since in many areas the activity was conducted without a vessel, the term “fishing unit” rather than “fishing vessel” was utilised. It should be emphasized that in the area of Ismailia, the activity is conducted both by vessel and on foot (pers. observ; Plate 6). In fact, in many cases the vessels operate by directly towing a boat-rake or by carrying the fishers to the fishing areas where they operate on foot with a hand-rake. In the Ismailia area, a specific rake towed by a vessel is also used.

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Plate 6. A typical fishing unit in Ismailia.

In general, *Ruditapes decussatus* was collected by hand, through diving operations, while all the other bivalves where collected by a rake – hand- or vessel-operated.

In the area of Damietta, between Baltim and Ras El-Bar, no fishers were encountered. For this reason, the area, although originally defined, was excluded from the analysis and the resulting tables.

3.1.1 Estimation of the fishers involved in the activity

The estimates of the total number of fishers involved in the activity, both on a part-time and full-time basis, ranged between 2 600 and 7 300 (Table 5). The main area where the fishers operate was identified as Ismailia, where between 1 000 and 4 400 fishers were operating. The area was also characterized by fishing units crewed by a minimum of two fishers, and up to eight fishers. As already described, in many cases the crew members operated individually, utilising a vessel for their transfer from the port to the fishing area. The estimates were derived by multiplying respectively the minimum and maximum number of fishing units by the minimum and maximum average number of fishers per unit, thus providing a range of values based on the responses received. The estimate of the average number of fishers per fishing unit did not present any difficulties, while the estimation of the fishing units presented many difficulties and it was necessary to refine the first estimate during the second stage of the survey. For example, in the areas of Edku (area 2) and Rashid (area 3), the first estimates were reduced by 20 percent and 30 percent respectively. This was required because the fishers customarily move between the two areas, which made the interviewee's estimation difficult and it is likely that in many cases the same fisher was counted twice, once per area.

In general, when compared to the 22 000 fishers directly involved in the commercial fishing fleet of the area (FAO, 2014a), the number of fishers involved in the bivalve fishery (when one considers both the lowest and the highest estimates) was relatively high and probably represented the main fishing activity in the Suez Canal area. It is likely that the bivalve fishery

was also a supplementary or part-time activity for some of the fishers operating in the marine fleet and therefore, again, it is possible that some fishers were counted twice.

Table 5. Estimation of the fishers involved in the activity

Area	Number of fishing units		Average number of fishers per fishing unit (full-time + part-time)		Number of fishers (full-time + part-time)	
	Min	Max	Min	Max	Min	Max
Alexandria	300	400	1	2	300	800
Edku	500	1 000	1	1	500	1 000
Rashid	500	1 000	1	1	500	1 000
Port Said	300	500	1	1	300	500
Ismailia	200	200	2	8	400	1 600
Ismailia Fayed	300	400	2	7	600	2 800
Total	**2 100**	**3 500**			**2 600**	**7 300**

3.1.2 Estimation of the activity

The activity was conducted by hand- or boat-rake or diving. Fishing is directly conducted by vessel only in the case of the boat-rake, where the rake is towed by the vessel. This fishing method was only conducted in Ismailia. In the same area, vessels were also utilised for transporting the fishers to the fishing grounds and for carrying the product, but the gear was operated manually by the fishers (Plate 6). Diving was the most common fishing method in Alexandria and in part of the Ismailia area. In both cases the product was collected by hand with the support of a vessel. The hand-rake was the most common method in the central and eastern areas of the coastal zone of the Delta. In general, the Ismailia area was the only one where all three fishing methods were utilised, while in the other areas fishing activities were conducted mainly by means of one method only (Table 6).

Table 6. Description of the gear or type of fishing activity

Area	Gear/activity
Alexandria	Dive harvesting
Edku	Hand-raking
Rashid	Hand-raking
Port Said	Hand-raking
Ismailia	Hand-raking/dive harvesting
Ismailia Fayed	Vessel/hand-raking and dive harvesting

The average working days carried out per year by each fishing unit ranged between a minimum of 84 and a maximum of 200. The daily working hours were between 3 and 12 hours, which should be added to 1 to 3 hours of post-harvest work.

The area with the highest activity level was Ismailia, where the fishing units operated on average between 150 and 200 days per year, working between 4 and 15 hours per day, including the hours spent on shore for the post-harvesting activities. On the other hand, Port Said was the area with the lowest activity level, where the fishing days per year ranged between 84 and 112 and the working hours per day between 4 and 8 (Table 7). In general, in the coastal areas the peak of the fishing season was between spring and summer. Vessels are generally utilised in the Ismailia and Alexandria areas but not in the Edku–Port Said area.

Table 7. Average activity level per fishing unit

Area	Working days at sea/ year		Working hours/day – fishing		Working hours/day – post harvest	
	Min	Max	Min	Max	Min	Max
Alexandria	144	176	3	4	1	2
Edku	110	200	3	5	2	3
Rashid	150	200	3	5	1	2
Port Said	84	112	3	6	1	2
Ismailia	150	200	3	6	1	3
Ismailia Fayed	150	200	4	12	2	3

3.1.3 Estimation of the production

The estimation of total production was undertaken by considering the range of landings per day and per year for each fishing unit (Table 8), whereas the value of fishing units and of fishing days utilised for the calculations in Table 9 were the minimum values of the ranges of estimation.

The highest value of landings per day was reached in Ismailia Fayed, were the range was between 20 kg and 180 kg per day, while the lowest value range was registered in Alexandria and was between 8.5 kg and 10 kg. The fishing activity in the Ismailia area was more productive as it was conducted by a combination of hand- and boat-rake and each fishing unit engaged about two to eight fishers. In the Alexandria area, on the other hand, the fishing activity was conducted by one or two fishers diving and collecting the product by hand. These values were raised to the total working days per year and generated an annual volume of production per fishing unit ranging between 1.2 tonnes and 1.4 tonnes in Alexandria and from 3 tonnes to 27 tonnes in Ismailia Fayed (Table 8).

Raising these values to the total fishing units and to the total activity for the year, the total volume of production for 2015 was estimated between a minimum of 3 000 tonnes and a maximum of 21 000 tonnes per year. This estimated range may be considered conservative, its true value might be higher. The resulting value of production was estimated by considering the average weighted price per species (Table 9).

Table 8. Production per fishing unit

Area	Landings per day (kg) per fishing unit		Landings per year (kg) per fishing unit		Revenue per year per fishing unit (USD)		Revenue per year per fishing unit (EGP)	
	Min	Max	Min	Max	Min	Max	Min	Max
Alexandria	8.5	10	1 224	1 440	7 099	8 352	55 591	65 403
Edku	10	50	1 100	5 500	1 100	5 500	8 614	43 070
Rashid	2	50	300	7 500	90	2 250	705	17 619
Port Said	30	50	2 520	4 200	1 512	2 520	11 840	19 734
Ismailia	12	150	1 800	22 500	1 620	20 250	12 686	158 575
Ismailia Fayed	20	180	3 000	27 000	2 700	24 300	21 143	190 290

Table 9. Total production (2015)

Area	Number of fishing units (Min)	Working days at sea/year (Min)	Total landings per year (tonnes)		Total revenue per year (USD 1000)		Total revenue per year (1 000 EGP)	
			Min	Max	Min	Max	Min	Max
Alexandria	300	144	367	432	2 130	2 506	16 669	19 621
Edku	500	110	550	2 750	550	2 750	4 307	21 535
Rashid	500	150	150	3 750	45	1 125	352	8 810
Port Said	300	84	756	1 260	454	756	3 552	5 920
Ismailia	200	150	360	4 500	324	4 050	2 537	31 715
Ismailia Fayed	300	150	900	8 100	810	7 290	6 343	57 087
Total	**2 100**	**788**	**3 083**	**20 792**	**4 312**	**18 477**	**33 760**	**144 688**

The catch composition presented markedly different patterns, with *Ruditapes decussatus* representing the main target species in the western part of the Delta, *Donax trunculus* representing the only target species in the central part of the Delta, from Edku to Port Said, and *Paphia textile* the main target species in the Ismailia area (Table 10).

Table 10. Catch composition (%)

Area	*Donax trunculus*	*Ruditapes decussatus*	*Paphia textile*	*Venerupis pullastra*	*Chamelea gallina*	Other bivalves	Total
Alexandria		80				20	100
Edku	100						100
Rashid	100						100
Port Said	100						100
Ismailia		10	90				100
Ismailia Fayed		40	60				100

In terms of production, *Paphia textile* and *Donax trunculus* represented the two main species of bivalves landed. The only production area for *Paphia textile* was Ismailia, where *Paphia textile* and *Ruditapes decussatus* represented the two species produced, while the coastal area from Edku to Port Said represented the only area in terms of production of *Donax trunculus*, which was this area's only landed species. Despite the fact that the highest proportion of production of *Ruditapes decussatus* out of total area of production was found in the Alexandria area (80 percent), the largest total production was in the Ismailia Fayed area (3 240 tonnes) (Table 11).

Table 11. Breakdown of production per species, year and area (tonnes)

Area	*Donax trunculus* (tonnes)		*Ruditapes decussatus* (tonnes)		*Paphia textile* (tonnes)		Other bivalves (tonnes)	
	Min	Max	Min	Max	Min	Max	Min	Max
Alexandria			294	346			73	86
Edku	550	2 750						
Rashid	150	3 750						
Port Said	756	1 260						
Ismailia			36	450	324	4 050		
Ismailia Fayed			360	3 240	540	4 860		
Total	**1 456**	**7 760**	**690**	**4 036**	**864**	**8 910**	**73**	**86**

In the following table, we show the breakdown of prices by species, commercial category and area. In terms of average first sale price per species and excluding other bivalves, *Ruditapes decussatus* fetched the highest average price of EGP 36.0/kg, and prices ranged between EGP 29.8/kg and EGP 75.2/kg, with the highest general average price registered in Alexandria. *Paphia textile* on the other hand, reached the lowest average price of EGP 7.0 kg, ranging between EGP 6.3/kg in the Ismailia area and EGP 25.1/kg in Alexandria. *Donax trunculus* reached an average price of EGP 7.8/kg and ranged between EGP 1.6/kg for second grade and EGP 14.9/kg for first grade product in Edku. The latter two species, which are very similar in terms of dimension, shape and colour, fetched a similar first sale price. The difference was partly due to a different supply and demand equilibrium in the two areas and the different organization of value chains. The group of other bivalves, mainly constituted by *Litophaga litophaga*, reached the highest average price, ranging between EGP 80/kg and EGP 150/kg (Table 12).

Table 12. Average first sale price per species (EGP/kg)

	USD			EGP		
Area	**Min**	**Max**	**Average (weighted value)**	**Min**	**Max**	**Average (weighted value)**
Donax trunculus	0.2	1.9	1.0	1.6	14.9	7.8
Ruditapes decussatus	3.8	9.6	4.6	29.8	75.2	36.0
Paphia textile	0.8	3.2	0,9	6.3	25.1	7.0
Other bivalves	10.2	19.2	10.8	79.9	150.4	84.6

The analysis of the breakdown of first sale prices per commercial category and area showed that Alexandria was in general the area with the highest first sale prices. Here *Ruditapes decussatus* fetched prices about 30 percent higher compared to Rashid and Ismailia, while for *Paphia textile* the price was almost double compared to the Ismailia area (Table 13). This was probably due to the traditional consumption of bivalves and to an unbalanced demand and supply equilibrium.

Table 13. Average first sale price (EGP/kg) detailed per species, commercial category and area

Species	**Commercial category**	**Alexandria**		**Edku**		**Rashid**		**Port Said**		**Ismailia**		**Ismailia Fayed**	
		Min	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Donax trunculus	First grade			11.7	14.9								
	Second grade			1.6	4.7	1.6	2.3	4.7	4.7				
Ruditapes decussatus	First grade	69.7	75.2			44.6	50.1			53.2	53.2		
	Second grade	29.8	39.9										
Paphia textile	First grade	20.4	25.1							10.2	12.5	10.2	12.5
	Second grade									6.3	10.2	6.3	10.2
Other bivalves		79.9	150.4										

3.1.4 Costs and economic performance

The operational costs related to the activity consisted of fuel, transportation, food, commissions and other residual costs. Remuneration was excluded from this list because in most cases the fishers were also owners of the activity and in the case of employed fishers, the crew-share system was applied, with the remuneration being a proportion of the revenue. The most expensive fishing activity was the one conducted in Alexandria, by means

of a fishing vessel and diving, where the total operational costs were about EGP 17 000 per year. The main cost item was fuel, accounting for about 70 percent of total costs. This was largely due to the relatively distant fishing grounds and the frequent movements of the vessel to locate the resource. In Ismailia Fayed the annual operational costs per fishing unit were EGP 11 000. Two thirds of this amount were transportation expenses, related to the transporting of the product to the selling point, while the remaining costs were food expenses for the crew members. In Ismailia, the annual operational costs were EGP 6 700, made up of two thirds for transportation expenses and one third for food. In the other areas along the Delta coast, the operational costs were lower – between EGP 2 800 and EGP 5 400, with transportation and food accounting for about one third each (Table 14).

The total value of investments required for the activity was estimated to be EGP 23 493 for buying a fishing vessel (which as mentioned before is only utilised in Alexandria and Ismailia); EGP 3 915 for equipment when harvesting is by means of diving; and EGP 783 for hand-raking. For this reason, in Alexandria the investments consisted of a vessel and diving equipment; in the area between Edku and Port Said the investments included only the hand-rake; in Ismailia they included a vessel and diving equipment; while in Ismailia Fayed investments consisted of a vessel, diving equipment and hand-rake. The estimate of the value of the vessel was made according to the market value of the vessels included in the 2011 official data for the category of small-scale vessels < 6 m (FAO, 2014a), converted into 2015 Egyptian Pound value. In the case of hand-raking, the value of the investments was largely figurative and based on theoretical considerations, as the fishers generally make the gears themselves, without any cash expenditure.

Table 14. Yearly operational costs per fishing unit (USD)

	Total operational costs* (USD)	Total operational costs* (EGP)	Operational costs (%)				
			Fuel	Transportation	Food	Commissions	Other*
Alexandria	2 248	17 600	0.71	0.09	0.10	0.04	0.06
Edku	574	4 496	0.00	0.35	0.37	0.18	0.11
Rashid	696	5 450	0.00	0.30	0.33	0.11	0.27
Port Said	365	2 857	0.00	0.32	0.35	0.14	0.19
Ismailia	857	6 713	0.00	0.67	0.33	0.00	0.00
Ismailia Fayed	1 405	11 000	0.00	0.67	0.33	0.00	0.00

*Excluding remuneration

The socio-economic performance of the activities per area was estimated by calculating the average range of annual gross cash flow per fishing unit and the remuneration per fisher. The calculations considered a range of gross turnover and the average operational costs per fishing unit. The investments were also considered, although these did not affect either the economic performance or the remuneration.

The remuneration was estimated through the crew-share formula the fishers applied in the area (Pinello, Gee and Polymeros, 2017). It consisted of 50 percent of the revenue after discounting the activity costs (mainly fuel and food). This allowed for the estimation of remuneration for all the fishers involved, regardless of whether they were owners of the business or employees. The same method was followed in the analysis of the economic performance of the fisheries sector and thus the comparison is meaningful.

The highest gross cash flow per fishing unit was reported in the Ismailia area, and this was in line with the highest revenue. However, the best range of remuneration per fisher, per year was registered in Alexandria, with values ranging between EGP 25 000 and EGP 32 000, equal to USD 3 200 and USD 4 000. In the Ismailia area, despite the high revenues, the remuneration values were similar to the other coastal areas such as Port Said and Edku. The Rashid area showed the lowest range of remuneration values (Table 15).

Considering data per day of activity, the gross cash flow showed the highest value in Ismailia Fayed, ranging between EGP 70 and EGP 1 198, equal to USD 9 and USD 153. The lowest range of value was estimated in Rashid where, according to the revenue and the operational costs utilised, it ranged from zero to EGP 78, equal to USD 10. In fact, according to the range value utilised for the estimation, in this case the estimated operational costs exceeded the lowest value of the range of daily revenue (Table 16).

Table 15. Estimation of the main economic indicators per year (EGP)

Area	Revenue (EGP)		Operat-ional costs (EGP)	Gross cash flow (EGP)		Invest-ments (EGP)	Crew (No. of fishers)	Remuneration per fisher (EGP)	
	Min	Max		Min	Max			Min	Max
Alexandria	55 591	65 403	17 604	37 987	47 800	27 408	1.5	25 325	31 864
Edku	8 614	43 070	4 495	4 119	38 575	783	1.0	4 119	38 575
Rashid	705	17 619	5 450	-	12 169	783	1.0	-	12 169
Port Said	11 840	19 734	2 858	8982	16 875	783	1.0	8 982	16 875
Ismailia	12 686	158 575	6 711	5 975	151 864	27 408	4.0	744	18 982
Ismailia Fayed	21 143	190 290	11 002	10 141	179 287	28 191	3.5	1 449	25 615

Table 16. Estimation of the main economic indicators per day (EGP)

Area	Working days at sea/year (minimum)	Daily revenue (EGP)		Operat-ional costs	Gross cash flow		Remuneration per fisher	
		Min	Max		Min	Max	Min	Max
Alexandria	144	384	454	125	266	329	172	219
Edku	110	78	392	39	39	352	39	352
Rashid	150	8	117	39	-	78	-	78
Port Said	84	141	235	31	110	204	110	204
Ismailia	150	86	1 057	47	39	1 010	8	125
Ismailia Fayed	150	141	1 269	70	70	1 198	8	172

3.1.5 Marketing

The preferred channel for selling the product was through a wholesaler, except in Edku where it was the auction market. However, in most cases, a hybrid category was found, represented by auctioneers who also act as wholesalers. This is generally considered to be a service that the market provides. Therefore, where an auction market exists, the auctioneer also operates as a wholesaler. These two categories largely dominate the marketing of the production of the fishery. They are found, for example, in Alexandria and the Al-Obour market in Cairo. Two other significant marketing channels were found in Port Said, where about 40 percent of the production was sold either directly to the fishmongers or to the restaurants. In Alexandria, one-fifth of the fishers sell their product directly to the restaurants and this was the same in Port Said, especially with respect to first grade products and the most valuable species. Selling directly to the final consumer was most common of all in Ismailia, because of the domestic consumption of bivalves in this region, however this represented a small proportion of total sales, even there (Table 17).

The interviews also queried the seasonality of consumption of bivalves. No differences were highlighted, with the only exception being an increase in demand during the summer months from restaurants in Alexandria, while in Cairo an increase in connection with religious holidays was registered.

Table 17. Market channels (%)

Area	Wholesaler	Fishmonger	Directly to the customer	Fish market – auction	Restaurant	Self-consumption
Alexandria	77	-	-	-	21	02
Edku	20	-	01	75	01	03
Rashid	98	01	01	-	-	-
Port Said	58	20	-	-	19	04
Ismailia	86	-	12	-	-	02
Ismailia Fayed	90	-	06	-	-	04
Total	**68**	**05**	**03**	**14**	**08**	**03**

For all those cases where it was necessary to borrow money to cover the necessary investments, the fishers relied mainly on the buyers or on their own finances, while formal channels, such as banks, were not utilised at all (Table 18).

Table 18. Main source of finance for conducting the activity (%)

Area	Own finance	Wholesalers/ traders	Formal bank	Other
Alexandria	0	100	0	0
Edku	30	70	0	0
Rashid	70	30	0	0
Port Said	90	0	0	0
Ismailia	0	100	0	0
Ismailia Fayed	40	60	0	0
Total	**40**	**60**	**0**	**0**

Also interrogated was the question of whether the activity of the fishers was coordinated by someone in terms of working days, fishing area and marketing of the product. The results showed that the activity was well-coordinated in Port Said and Rashid and partially in Edku and Ismailia Fayed, while it was not coordinated in Alexandria and Ismailia. In this respect hand-raking was the most coordinated activity while harvesting by diving was not coordinated at all (Table 19).

Table 19. Coordination of the activity

	Is the bivalves marketing managed/coordinated by someone in the area?	
Area	**Yes**	**No**
Alexandria	0	100
Edku	30	70
Rashid	80	20
Port Said	100	0
Ismailia	0	100
Ismailia Fayed	40	60
Total	**40**	**60**

3.2 Description of the different areas identified

Based on the results, three main macro-areas were identified, characterized by similar fishing patterns, species landed, selling behaviours and economic performance. The three areas are illustrated in Figure 2.

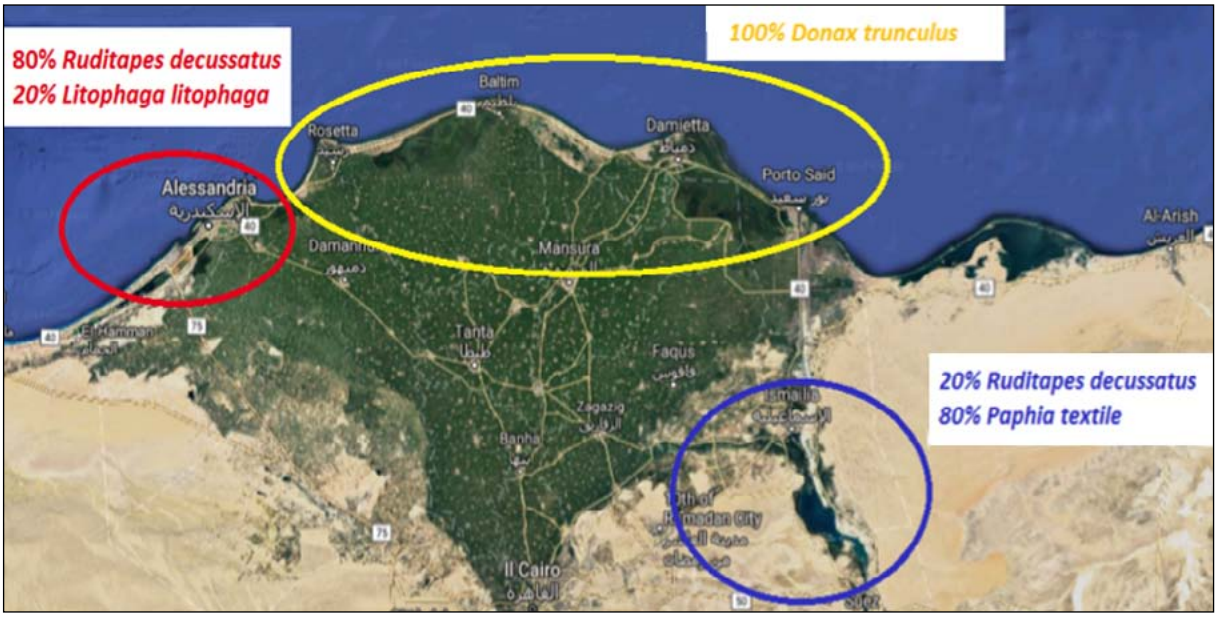

Figure 2. The three macro-areas identified: Area 1 (red circle) called “Alexandria”; Area 2 (yellow circle) called “Edku-Port Said”; and Area 3 (blue circle) called “Ismailia”.

3.2.1 Area 1: Alexandria

In Alexandria about 300 to 800 fishers operate and produce about 400 tonnes. The activity is conducted by diving and the product is selectively harvested from the sea floor by hand. The fishers use a support boat and there are normally two or three fishers to assist the diver. The daily production of each fishing unit amounted to approximately 8 to 10 kg/day consisting of high-value species, such as *Ruditapes decussatus*, locally named “Balady”, and *Litophaga litophaga*, named “Balaam”. The average first sale price for *Ruditapes decussatus* was approximately EGP 70/kg and EGP 35/kg for first and second grade product, respectively, while the retail price achieved on the local market was about EGP 120/kg for first grade and EGP 60/kg for second grade product. The low-grade category is named “Englize”, and it is likely that this name is also used for small specimens of *Paphia texile* and *Donax trunculus*.

The fishing season starts in April and ends when the production drops to levels that are not economically viable, usually towards the end of September. At the same time, in this period market demand decreases and the weather conditions constrain the fishing activity. For this reason also, the estimated total working days per year ranged between 144 and 176. This area also reported the highest operational costs out of all the areas studied, amounting to EGP 17 600 (USD 2 248) per fishing unit per year, mainly due to high fuel costs which account for 71 percent of costs. This was reported as being due to the fishing grounds being located at some distance from the shore and the need to frequently move between fishing grounds.

In this area 80 percent of the production was composed of *Ruditapes decussatus* and this was the only area to report production of other bivalves. However, other species only accounted for between 2 percent and 12 percent of the total production. Whereas this area accounted for the lowest share of production among the three areas, it offered the highest mean remuneration rates for fishers, at a minimum of EGP 25 325 per fisher, per year to a maximum of EGP 31 864.

In the Alexandria area, approximately 19 traders operated, most of them also acting as auctioneers in the local market and four of them were specialized in bivalves and bought the majority of the production of the area. Each collected the production of about 70 fishers. Typically, the wholesaler buys the whole production of the fisher at a fixed price and provides

the money to cover all the operating costs and the necessary investments, such as equipment or the repair of the engine or vessel. No specific problems in selling the product resulted. Supply and demand of bivalves is unbalanced in the area, with demand far exceeding supply.

3.2.2 Area 2: Edku to Port Said

In the coastal area from Edku to Port Said, part of which is beyond the Suez Canal, about 1 300 to 2 500 fishers were operating, landing between 1 500 to 7 700 tonnes of product. They operated exclusively by hand-raking, without the use of a vessel, generating a daily production per fishing unit of between 2 kg and 50 kg. They targeted exclusively the *Donax trunculus*, locally named "Mulculula" and sold to the wholesaler at an average price of about EGP 13 for first grade and EGP 3 for second grade products. This area was the only one to produce this variety of bivalve, with a total production of between 1 456 tonnes and 7 760 tonnes per year produced exclusively in this area and a total annual revenue for the fishers of between EGP 8 211 and EGP 36 265 (i.e. USD 1 049 to USD 4 631). The fishing activity usually lasts the entire year, depending on weather conditions, with a peak during summer. The fishers in the area usually carry out between 84 and 200 fishing days per year and in the Edku subarea they enjoy the highest maximum remuneration rates in the area and all the subareas studied. Remuneration amounts to a maximum of EGP 38 575 per fisher per year, although the minimum is much lower, at EGP 4 119 per fisher per year. There is a very high degree of variation between the minimum and maximum fisher remunerations in this subarea and this is also higher than in any other area or subarea.

This area also reported the lowest operating costs and investment costs among the three areas studied, mainly due to the area being characterized by a single, low cost production technique, i.e. hand-raking. Investment is only in one gear type and not in vessels. Operating costs were also more evenly spread between items of cost than in the other two areas.

The auction market is the most common channel in Edku, while in Rashid and Port Said most of the production is channeled through the wholesalers. In Port Said it is also common to sell directly to the fishmongers or the restaurants.

3.2.3 Area 3: Ismailia

The area of Ismailia includes Timsah Lake (Ismailia) and the Great Bitter Lake (Ismailia Fayed). It represented the main area of production for bivalves in Egypt, with the highest number of fishers involved in the bivalve fisheries – in the range of 1 000 to 4 400 fishers. Overall production was estimated between 1 300 and 12 600 tonnes, that is about 50 percent of the total production of the three areas combined. This area thus also produces the largest revenue from bivalves out of the three areas. Revenues range between EGP 8 880 000 and EGP 88 802 000 per year (that is USD 1 134 000 to USD 11 340 000). Yet, as seen above, fisher remuneration is not particularly high in this area and in fact is in the middle to low range of fisher remuneration, compared to the other two areas.

The daily production of a typical fishing unit was about 12 to 180 kg. The fishing units are constituted by sailing vessels and engaged the largest average number of crew, ranging from two to eight people. The gear utilised is the boat-rake and the crew members also individually used hand-rakes and/or dived for bivalves. Thus, this area is the only one to utilise all three production techniques: hand-rake, boat-rake and diving. On average, each fishing unit carried out between 150 and 200 fishing days per year. The main species produced are *Paphia textile*, with an annual production of this variety standing at between 864 tonnes and 8 910 tonnes per year. This area was the only producer of *Paphia textile* and was also the main producer of *Ruditapes decussatus* among the study areas, although the latter species was also produced in Alexandria. Investment costs overall were the highest in this area out of the three areas studied as all three production techniques were utilised and thus investments in all three gears, including vessels, are made. Operational costs were second highest after the Alexandria area, standing at EGP 17 713 (USD 2 262) per fishing unit, per year with most of the costs accounted for by transportation costs (67 percent).

4. TRADE

4.1 Description of the business context

In the Alexandria and Edku/Port Said areas, it is common for an auctioneer to also act as a wholesaler. In some cases, buying the unsold product at a fixed price was considered an additional service to the fisher.

In total, about 75 wholesalers and 24 auctioneers/wholesalers were identified who deal partially or mainly with bivalves. For most of them, bivalves constituted a small part of their business. In total, about 10 to 15 traders were highly specialized in bivalves, half of them located in the Ismailia area which is most specialized in bivalve production (Table 20).

Table 20. Description of the business context

Area	Wholesaler	Auctioneer/Wholesaler	Total
Alexandria	4	15	19
Edku		4	4
Rashid		5	5
Damietta	15		15
Port Said	7		7
Ismailia	33		33
Ismailia Fayed	15		15
Total	**75**	**24**	**98**

When questioned about the factors that their buyers considered to be important drivers, the wholesalers highlighted the colour of the product first, then the type of packaging and the quantity and regularity of supply (Table 21). These can be areas for future improvement, e.g. identifying the right size and type of packaging or sorting the product according to its colour. It is likely that different colour shades might be appreciated in different areas, according to different customers' preferences.

Table 21. Factors that the customers considered important on a scale of 1 to 5 (5 = the most important of all and 1 = not important)

Area	Quality of product (cleanliness, smell)	Colour of the product	Quantity of supply	Market category (market size)	How the product is presented (i.e. in the water)	Type of packaging
Alexandria	2	4	4	2	3	4
Edku	1	3	3	1	4	3
Rashid	2	4	3	2	3	3
Ismailia	1	1	2	2		1
Ismailia Fayed	2	3		2		2
Total	**8**	**15**	**12**	**9**	**10**	**13**

As expected, the demand for the species per area was in general linked to the area of production, where the customers are already familiar with a specific product. *Ruditapes decussatus* was highly appreciated in Alexandria and *Donax trunculus* in the Edku area. It is worth noting that *Paphia texile* seems to be appreciated across geographic areas. Moreover, it was the main species present in Al-Obour market and it was likely to be the most consumed species in the Cairo area (Table 22).

Table 22. Most demanded species per area (high, medium, low)

Area	*Paphia textile*	*Ruditapes decussatus*	*Donax trunculus*
Alexandria	medium	high	low
Edku			high
Rashid			medium
Ismailia	medium	medium	
Ismailia Fayed	medium	low	low

The wholesalers preferred to sell the product to the fishmongers, except in Ismailia. Only in Alexandria and Ismailia, around half of the production was sold directly to the restaurants (Table 23). In the Ismailia area however, the answers were biased by the presence of wholesalers that also operate as fishmongers. No cases were found of wholesalers selling directly to final consumers.

When the product was not sold, it was mainly because of: no market demand and deterioration of the product in Alexandria; too small a size of the product and deterioration in Ismailia; and small size of the product in Edku. No market demand was a secondary reason for not being able to sell the product in the Edku and Rashid areas (Table 24).

Table 23. If a wholesaler, you sell the product to:

Area	Fishmonger	Restaurant	Final consumer
Alexandria	60	40	
Edku	100		
Rashid	100		
Ismailia	50	50	
Ismailia Fayed	100		

Table 24. Reasons for not being able to sell the product (high, medium, high)

Area	No market demand	Small product size	Deterioration
Alexandria	high		high
Edku	medium	high	
Rashid	medium		
Ismailia		high	high
Ismailia Fayed			

5. DESCRIPTIVE VALUE CHAIN PER AREA

Alexandria

In Alexandria, the value chain is quite straightforward, due to the limited quantity of product landed and the high local demand. The wholesalers buy around 77 percent of the product from the local fishers and re-sell it to the local fishmongers and restaurants, with an average mark-up of 6 percent. The results of the study showed that there was no product sent to Al-Obour market in Cairo. The local demand is very high and this is probably an area of Egypt with one of the highest levels of bivalve consumption. The production is thus almost entirely consumed locally. The restaurants are particularly active during summer, when people eat seafood more often. Both the restaurants and the fishmongers customarily have an average mark-up of 90 percent when re-selling the product to the final customer.

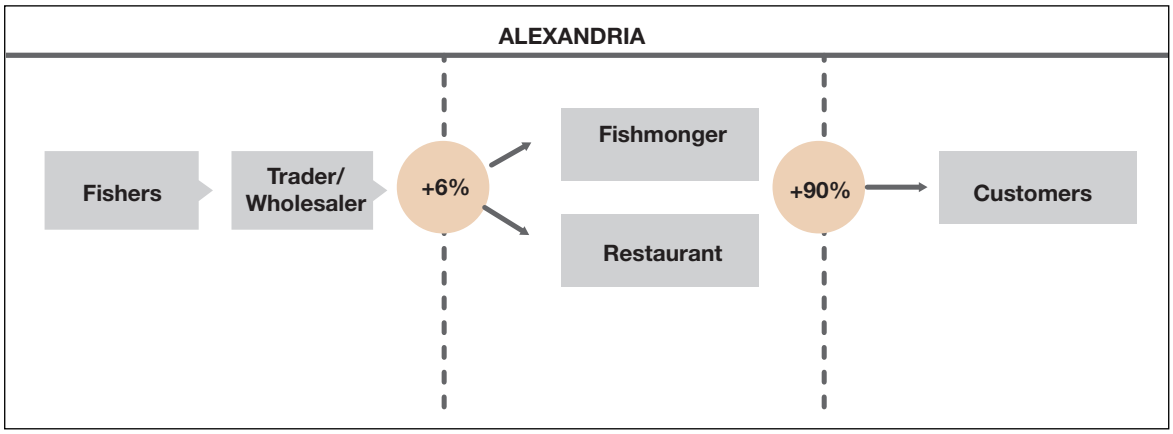

Figure 3. Alexandria value chain structure.

Ismailia

The Ismailia area constitutes the main area of production in general, and is the main supplier of *Paphia texile* and *Ruditapes decussatus*. Its production supplies the cities along the Mediterranean coast and Al-Obour market in Cairo, which is about 50 kilometers from Ismailia and well connected by highway. The local consumption is consequently high and there is strong demand for bivalves. Ismailia is considered "the city of bivalves", but due to its limited population, only a portion of total production is locally consumed. Most of it was transported to Al-Obour market.

In the area, nearly 50 wholesalers operated, four or five of which are big, probably the biggest in Egypt. They bought nearly the whole local production and, for most of them, bivalves constituted their main product. The production was partly sold locally but mostly to Al-Obour market. When selling to the local customers (fishmongers and secondary wholesalers) the mark-up was about 25 percent. The fishmongers then applied a further mark-up of 50 percent so that the price paid by the final customers was +75 percent more than the price paid to the fishers. In Al-Obour market the wholesalers paid a commission of 6 percent to the auctioneers.

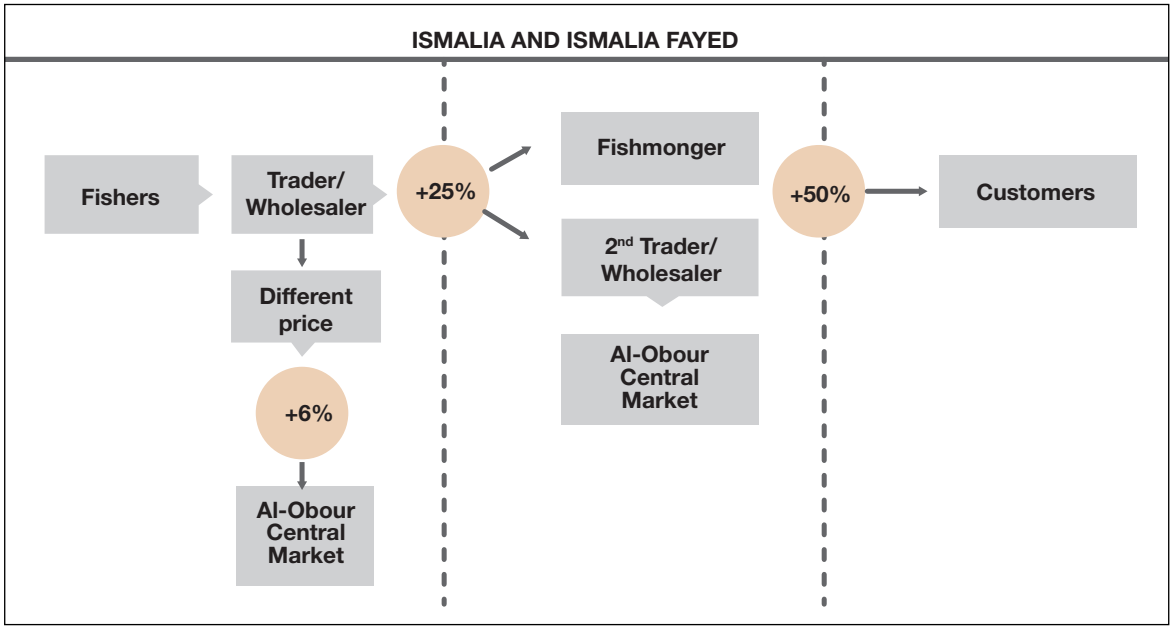

Figure 4. Descriptive value chain in Ismailia area.

Edku-Port Said

In the area from Edku to Port Said, about 30 wholesalers were operating, 50 percent of whom operated in Damietta. Most of them were not specialized in bivalves.

The general picture in the Edku area is the following: the wholesalers buy the product from the fishers and re-sell to the fishmongers or to secondary wholesalers, with a mark-up of 10 percent (or 25 percent in Port Said); the fishmongers then sell to the final consumer with a further mark-up of 50 percent. Auctioneers at the Al-Obour central market place a commission of 6 percent on sales.

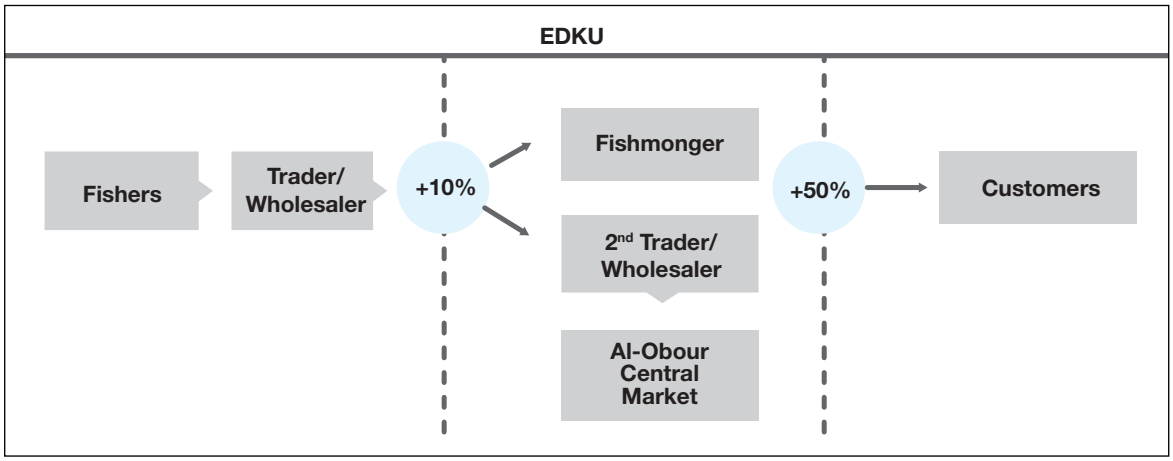

Figure 5. Edku value chain structure.

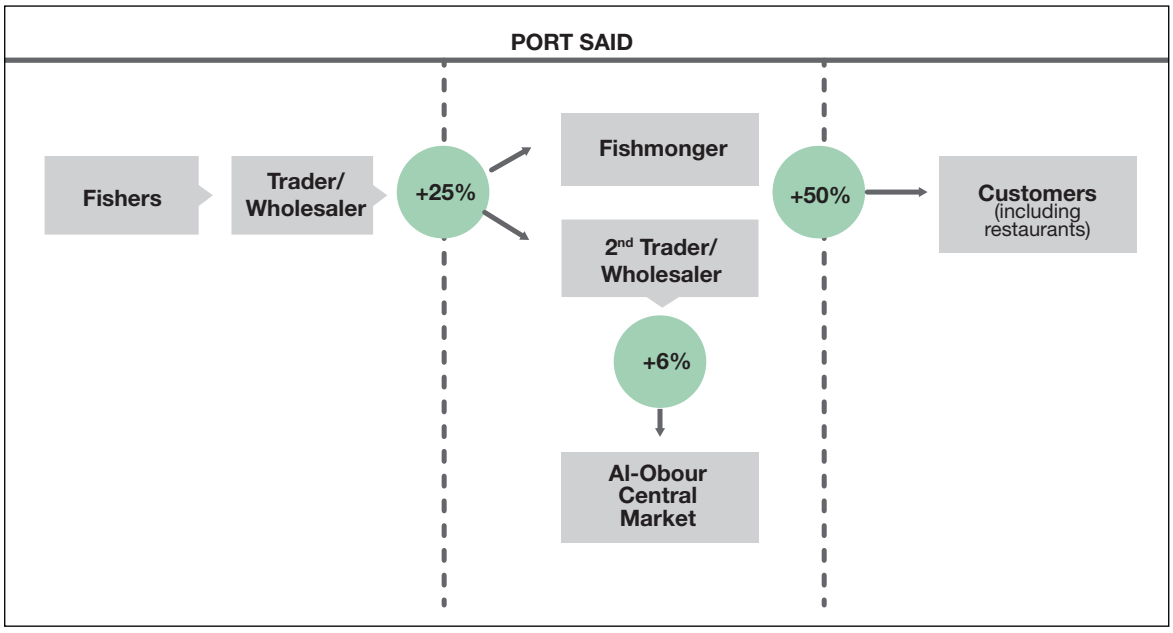

Figure 6. Port Said value chain structure.

Al-Obour central market, Cairo

In the market, five big auctioneers and about 100 wholesalers and fishmongers operate. The auctioneers also act as wholesalers and many wholesalers also act as fishmongers inside the market. Indeed, it is common for restaurant owners, fishmongers and final customers to all go to the market in the morning and buy their product directly. In general, about 80 percent of the product is bought by fishmongers/wholesalers, and 20 percent by restaurants.

In general, most of the seafood products in the market comprised freshwater species, such as tilapia, Nile perch, grey mullet, carp and eels. About one third of products were marine species, mainly from the Red Sea. Mediterranean species represented less than 5 percent of the overall annual product sold in the market. Mediterranean products are considered to be better quality, highly tasty, and fetch higher prices than the Red Sea production. The average prices are highest when the fishing season for Red Sea trawlers is closed (from May to September) and during the Christian Lent.

There was only one wholesaler highly specialized in bivalves. Almost all the other traders operating in the market sold bivalves, although in small quantities. In general, bivalves are almost always present on the sales counters of the traders and generally the market demands low priced species. The most commonly sold species is *Paphia texile*, while *Ruditapes decussatus* is only rarely marketed in Al-Obour market. The bivalves are usually sold inside a net containing 1 kg or 5 kg of product each (Plate 7). No information was found on the *Chamelea gallina* and the interviewed wholesalers did not know of the species.

The product followed the scheme shown in Figure 7, with the auctioneer applying a commission of 6 percent to all the transactions, while the mark-up between each step of the chain inside the market was about 10 percent to 50 percent.

An average, wholesalers marketed about 500 kg of bivalves per month. The majority of bivalves sold in Al-Obour go mainly to the Red Sea tourist resorts, in particular Sharm el Sheik. The restaurants of Cairo buy only a small amount of product, in quantities generally less than 5 kg and 10 kg, individually on each occasion.

The average prices paid for *Paphia texile* were EGP 10/kg to 30/kg for second grade products and EGP 20/kg to EGP 40/kg for first grade products.

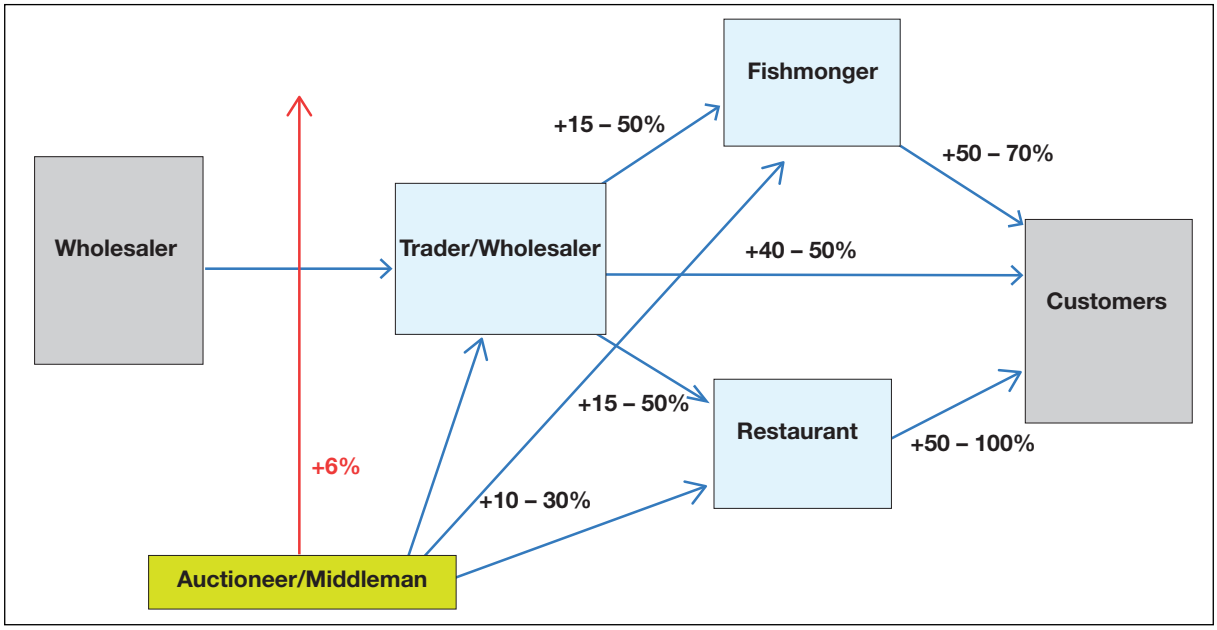

Figure 7. General description of the value chain analysis in the Al-Obour central market.

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Plate 7. Bivalves in Al-Obour market.

Examples of flow chart of bivalve's value chain

Example 1: Typical flow chart and selling prices of *Paphia texile* – first grade, produced in Ismailia and sold in Al-Obour:

Fisher (EGP 12.5/kg)⟶Wholesaler (EGP 20/kg)⟶Fishmonger (EGP 31.8/kg)

↓

Auctioneer (1.2LL/kg)

Mark-up

- Wholesaler: EGP 7.5/kg
- Auctioneer: EGP 1.2/kg
- Fishmonger: EGP 10.6/kg

Example 2: Typical flow chart and selling prices of *Donax trunculus* – first grade produced in Edku and sold in Alexandria:

Fisher (EGP 12/kg)⟶Middleman/wholesaler (EGP 13.2/kg)⟶Fishmonger (EGP 20/kg

Mark-up

- Wholesaler: EGP 1.2/kg
- Fishmonger: EGP 6.8/kg

6. CONCLUSIONS AND RECOMMENDATIONS

Prior to this study, there was a huge lack of knowledge about the bivalve fisheries in Egypt. For instance, little was known about the main fishing areas, landing sites, number of fishers, fishing vessels, production, employment and all the related commercial activities. Furthermore, this was the first time that the capture fisheries value chain was investigated in Egypt, with a special focus on bivalves. This study has provided the first insight into these aspects, but it was impossible to determine exactly the number of fishing vessels and fishers involved, since neither are registered by the fisheries administration. Nor are the different categories of traders, such as wholesalers and street vendors, registered.

In spite of these constraints, good information was obtained on the areas which produce different types of products, the species themselves and their commercialization.

In Alexandria, most of the production was harvested from April to September and was made up of the grooved carpet shell (*Ruditapes decussatus*) and the date mussel (*Lithophaga lithophaga*) which fetched the highest prices. The fishery in this area was based on diving and collection of bivalves by hand, using a small vessel as support for the fishing activity. This was

also the area that registered the highest demand – much more than the production – and hence the area of Alexandria imported a considerable volume of bivalves, especially from Ismailia. This was an indication of the traditional culture of a coastal area consuming bivalve molluscs and means the area is one of the end consumers of bivales in Egypt, so much so that according to our initial result, all of the production remained in the city, with no export to Cairo. This was also shown by the high mark-up value of the first sale, where the consumer was willing to pay relatively high prices for bivalves. This in turn resulted in the best remuneration per fisher.

In this respect any commercialization of new bivalve products should be attempted in Alexandria.

On the other hand the bivalve wedge clam (*Donax trunculus*) was exclusively produced in the central region of the Nile Delta, from Edku to Port Said. The fishery is based on hand-raking at a maximum of 1 m to 1.5 m depth, with no fishing vessels used. In this respect the costs of production are extremely low, and although the activity is labour intensive, the lowest value of production and revenue per fisher were recorded in this area, out of the three areas studied. However the quantity of production is higher in this area than it is in Alexandria. This region is mostly characterized by low consumption and by being a production centre – most of the production is transported to and sold in Alexandria and Cairo.

The third area included in the study was in the Suez Canal, between the Mediterranean and Red seas. This area is characterized by production of the carpet clam (*Paphia textile*) and *Ruditapes decussatus*, which were fished using all the fishing techniques, including hand-raking, diving and boat-raking (a large rake being towed by a small vessel). *Paphia textile* was only produced from this area. This bivalve is present in the Mediterranean Sea (FAO, 2014) but it is not exploited. This is the area with the largest production, two to four times greater than the other areas, and accounting for about 40 to 60 percent of the total bivalve production in Egypt. Most of the production from this area is transported to Cairo from where it may be distributed to other areas, such as Alexandria and the Red Sea.

The fishing units in this area are larger than in other areas and are made up of fishing vessels with up to eight crew members each.

The commercial chain in this area is the most complex because there are more players than in other areas, including different types of traders, such as wholesalers that sell in Cairo, while at the same time selling to other traders in the area. In general the area is more specialized in the fishing of bivalves and it is better organized because of the relatively high productivity.

Factors, challenges and opportunities

1) Regulation and licencing of the clam fishing sector

This part of the fishing sector needs to be regulated by a licensing system. Such a system already exists for all the other fishing sectors in Egypt, such as the trawl fleet, purse seine fleet and the small-scale fleet. In this respect what could be done is to start registering both the vessels and the fishers (diving and hand-raking) within the existing system of registering and licencing fishers and fishing vessels in Egypt.

Since there is no monitoring and management of the clam sector, a management plan should be developed in order to plan for the monitoring and management of the sector. Regulations could be introduced with the purpose of exploiting clam stocks more sustainably. Monitoring could be undertaken within the existing structure of the government regulator and the data collection system for stocks exploited by other fishing fleets, such as trawlers and purse seiners, could be extended to cover the clam fishery. Furthermore, within the context of a management plan, management measures could be drafted, for example: number of licences, fishing seasons and fishing gears. Such measures could improve the exploitation of the clam species. Added to these measures, the sector could be developed to exploit new species such as the clam *Chamelea gallina*, which is found in deeper waters (3 m to 10 m), using small-scale vessels, and hence modernization and diversification of the fleet (FAO, 2014) could take place.

2) Improvement in production related to the high prices

Relative to the cost of living in Egypt, and with respect to the value of landings, in general the average price per kilogram of production was found to be relatively high compared to bivalves in European countries. For example, the first sale price of *Ruditapes decussatus* adjusted to the World Bank Purchasing Power Parity (PPP) conversion factor results in ca. USD 6/kg in Italy and USD 26/kg in Egypt. The adjustment to the cost of living in the different countries was conducted using the World Bank official exchange rates and PPP conversion factors. The mark-up is usually simpler in the coastal areas (60 to 96 percent), so usually higher in the Cairo Al- Obour central fish market due to the transportation of the product to the final consumer. Consequently, the mark-up can be extremely high from the producer to the final consumer, about 160 percent.

With respect to the production of bivalves, this could be improved as there are species which are found in deeper waters which are currently not exploited (FAO, 2014b). This could include several species of bivalves, and further research and exploratory surveys need to be conducted in order to determine an estimate of the type of species and quantities that could be harvested. Based on some preliminary investigations (FAO, 2014b), the potential to increase the production of bivalves in Egypt seems to be high. This adds to the rationale for further exploration.

Chamelea gallina, which is similar to *Paphia textile*, can easily be entered into the market because it is a species with similar market characteristics. The species should be safe for human use.

The main constraint in developing this fishery will be the market because at present it is not traded on the Egyptian market and so a market analysis and marketing strategy should be carried out in order to understand the best way to introduce the product to the local market.

The prices are exceedingly high and therefore the market conditions are ideal to introduce a new product. The market can easily absorb more production. Presently, an increase in production can only be achieved by the harvesting of new species, or harvesting in deeper waters, and/or through the aquaculture of species such as *Ruditapes decussatum*. However aquaculture can be limited by a lack of hatchery facilities and sites for the culture of this species.

3) Employment

This study has provided new information on employment in the Egyptian bivalve fishery. The figures obtained show that the sector is important, with numbers of employees ranging from 2 600 to 7 300 people. The total number of fishers on the Mediterranean coast of Egypt was 22 000 (FAO, 2014a), so the number of fishers working in the clam sector is significant.

Further investigations would be required to determine how many fishers work full-time, part-time or conduct bivalve fishing activity in addition to other work. Furthermore one needs to investigate in detail the number of fishers involved and the activities related to the sector, such as transportation, selling, etc. No information on livelihoods exists, including social security, etc.

No women were encountered working in the sector but if the industry is developed, especially in the marine sectors, women could be involved in the post harvesting and processing of clams.

4) Equipment and labour skill

The fishing techniques which are currently in use are rudimentary and there is great potential and room for improvement. This could lead to an improvement in equipment, quality of the products, better conservation of resources, among other factors. Training for fishers working in the sector may be especially necessary to address issues of handling, hygiene and an improvement of facilities. It is therefore recommended that relevant stakeholders, such as the government ministries and the private sector, work to jointly address the various capacity development needs.

5) Hygenic conditions and food safety

Some specific problems relating to the deterioration/spoilage of products and the keeping of bivalves in unhygenic conditions, such as in water, were reported. Another problem was a

lack of labeling and the consequent lack of traceability of the products. These problems are exacerbated by the high temperatures in Egypt which hastens the deterioration of products and exposes the consumers to higher risks with respect to food safety. The deterioration of products was mentioned by some of the sellers as one of the problems influencing the ability to sell some products.

One of the problems specific to clams is the presence of sand in the animal. In order to remove the sand, clams are usually purged in a flow tank. This 48-hour process provides the sweetest clam meat, free of sand and grit. The purification process also helps to eliminate any bacteria and viruses which may be present in the clams. The presence of bacteria and viruses is dependent on the condition of local waters.

Several studies have been conducted on the pollution levels of clams in Egypt and all of the studies show that the pollution levels in the clam *Ruditapes decussatus* are high (FAO, 2014b). Although harvesting and purging evidently reduced heavy metal levels, these still exceeded the maximum permissible levels laid down by the World Health Organisation (FAO, 2014b).

The post harvest purification and processing of the product would increase its value and allow for the introduction of the bivalves to new markets and customers. The added value could also be achieved for example by a “manual of best practices” that sets out the recommended treatment of the product, from the fishing operation to the first sale.

Furthermore, storage facilities at the markets and vendor behaviours could be improved, but this would require infrastructure for the whole fisheries sector in order to improve the hygiene practices in general.

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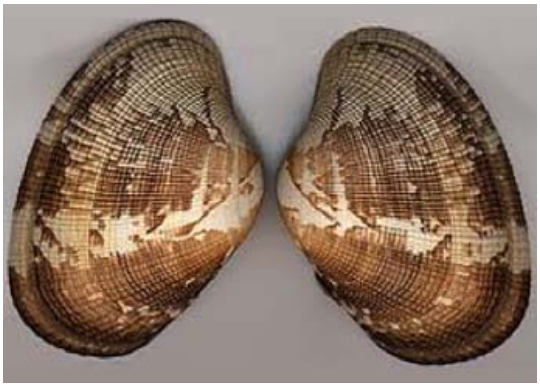
APPENDIX 1: Description of the commercial bivalves species present in Egypt

Donax trunculus

Ruditapes decussatus



Paphia textile

Venerupis pullastra

Chamelea gallina

Litophaga litophaga

Mytilus galloprovincialis

Species unknown 1

Species unknown 2

Appendix 2: Study questionnaire

FISHER

Questionnaire number ☐

General information

1. Date of interview

……

2. Location

……

3. Is fishing your main income generator? Yes ☐ No ☐
4. If no, what other sources of income in addition to fishing

……

5. What proportion of your total yearly revenue comes from fishing (%)? ☐

6. How many other fishers are in the area? No. ☐

Activity

7. Type of activity (only for the bivalves fishery):

with vessel ☐ diving ☐ raking on foot ☐

	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
Days (no.)												
Avg. working hours per day – fishing												
Avg. working hours per day – post-harvest												

Employment

	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
No. of full-time (including the interviewee)												
No. of part-time (including the interviewee)												

Marketing

8. What proportion of the total volume of bivalves produced did you sell through the following market channels

Market channel	Winter (%)	Spring (%)	Summer (%)	Autumn (%)
Wholesaler				
Fishmonger				
Directly to costumer				
Fish market - auction				
Restaurant				
Self-consumption				
Other (specify)				
Total	100%	100%	100%	100%

9. How long do you usually have/store the product after you have caught it until you sell it (in days)? (tick boxes)

	Winter	Spring	Summer	Autumn
The same day				
+1				
+2				
> 3				

10. What proportion (%) of the total amount of bivalves that you harvest are you typically unable to sell because of

	Winter	Spring	Summer	Autumn
No market demand				
Small market size				
Deterioration				
Other (specify)				

11. The main operating costs of 2014

Operating costs	**Total cost per year (LE)**	**How is cost changing over the years (up, down, static)?**
Fuel (at sea)		
Commercial (transportation, facility, etc.)		
Commissions (wholesaler, fishmarket, etc.) (%)	%	
Salaries		
Social security, social costs and pension contributions		
Purchasing food		
Repair and maintenance (vessel + gear)		
Other (specify)		
Other (specify)		
Total		

12. What are the main sources of finance used in your business (tick)

☐ Own finance

☐ Wholesalers/traders or other links in the value chain

☐ Formal bank sources

☐ Other

13. Is the bivalves marketing managed/coordinated by someone in the area?

Yes ☐ No ☐

What services does it provides you?

……

……

14. What is the most demanded species of bivalves in the market? And which market category?

……

……

15. Critical factors

Problem experienced	Why does this problem occur?	What do you think could be done to solve the problem and/or what are you doing to try to solve the problem?

16. % of bivalves production (in volume)?

		%
Bivalves	• *Donax trunculus*	
	• *Ruditapes decussatus*	
	• *Paphia textile*	
	• *Venerupis pullastra*	
	• *Chamelea gallina*	
	• Other bivalves (specify)	
Total		**100%**

17. Average production of an average fishing day: volume (kg) ☐ value (LE) ☐
Prices (first-sale)

		Price (LE/kg)
Total bivalves	• *Donax trunculus*	
	• *Ruditapes decussatus*	
	• *Paphia textile*	
	• *Venerupis pullastra*	
	• *Chamelea gallina*	
	• Other bivalves (specify)	

18. Do you have any other comments you would like to make about your activities, or how you think your livelihood and profits could be improved?

……...

……...

19. Interviewee name

……..

20. Interviewee contact phone number and/or email

……..

WHOLESALER OR FISHMONGER

Questionnaire number ☐

General information

1. Date of interview

……

2. Location

……

3. Activity (tick the options)

Wholesaler ☐

Fishmonger ☐

Auctioner/wholesaler ☐

4. Other sources of income in addition to seafood sales

……

5. How many other (answer No.3) are in the area? No. ☐

6. No. of people employed full-time (including the interviewee) ☐

7. No. of people employed part-time ☐

8. How important do you think the following issues are to your customers on a scale of 1–5 (5 = not important and 1 = the most important at all)

	Interviewee perception of importance of issue to their buyers/markets (1–5)
Price	
Quality of product (cleanliness, smell)	
Color of the product	
Quantity of supply	
Maket category (market size)	
How the product is presented (i.e. in the water)	
Type of packaging	
Other (specify)	
Other (specify)	
Other (specify)	

9. What is the most demanded species of bivalves in the market? And which market category (market size)?

……

10. What proportion (%) of your total product (bivalves) come directly from

Fisher ☐

Wholesaler ☐

Fish market auctioner ☐

11. If wholesaler/trader, what proportion (%) of your total product (bivalves) you sell to

Fishmonger ☐

Restaurant ☐

Final consumer ☐

Fish market auctioner ☐

12. Where do you buy the product (bivalves)?

……

13. Is any part of your product imported? Yes ☐ No ☐

If yes which percentage of your product is imported? % ☐

And which product is imported? Local and/or scientific name ……

14. How long do you usually have/store the product after you have bought it until you sell it (in days)? (tick boxes)

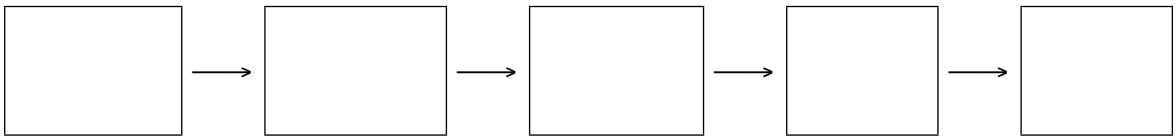
	Season			
	Winter	**Spring**	**Summer**	**Autumn**
The same day				
+1				
+2				
>3				

15. What proportion (%) of the total amount of bivalves that you buy are you typically unable to sell because of

	Season			
	Winter	**Spring**	**Summer**	**Autumn**
No market demand				
Deterioration				
Pollution				
Other (specify)				

16. Can you shortly describes the value chain of you products (% of increase):

Fisher ....



17. How much did you sell last year in terms of volume and value, and for what average price?

	Volume (kg)	**Value (LE)**	**Avg price (LE/kg)**
Total seafood from the Mediterranean			
Total seafood from the Red Sea			
Total seafood from aquaculture			
Total seafood imported			
Total bivalves			
• *Donax trunculus*			
• *Ruditapes decussatus*			
• *Paphia textile*			
• *Venerupis pullastra*			
• *Chamelea gallina*			
• Other bivalves (specify)			

18. Could you please explain how seafood prices change over the course of the year, and what are the main reasons for any fluctuations?

……

……

……

CRITICAL FACTORS

Issues	Problem experienced	Why does this problem occur?	What do you think could be done to solve the problem and/or what are you doing to try to solve the problem?

19. Definition of the market category and prices

Species	Maket category	No. of specimens/ kg	Price (LE/kg)
Bivalvia			
Donax trunculus	1° grade		
	2° grade		
	General		
Ruditapes decussatus	1° grade		
	2° grade		
	General		
Paphia textile	1° grade		
	2° grade		
	General		

Venerupis pullastra	1° grade		
	2° grade		
	General		
Chamelea gallina	1° grade		
	2° grade		
	General		
Other bivalves (specify)	1° grade		
	2° grade		
	General		

20. Do you have any other comments you would like to make about your activities, or how you think your livelihood and profits could be improved?

……...

……...

21. Interviewee name and position

……..

22. Company name

……..

23. Interviewee contact phone number and/or email

……..

Appendix 3: Second-stage study questionnaire

FISHER

Description of the area (ONLY FOR BIVALVES)

No. of fishers operating in the area:

1_____
2_____
3_____
4_____
5_____
6_____

No. of wholesalers that buy the product:

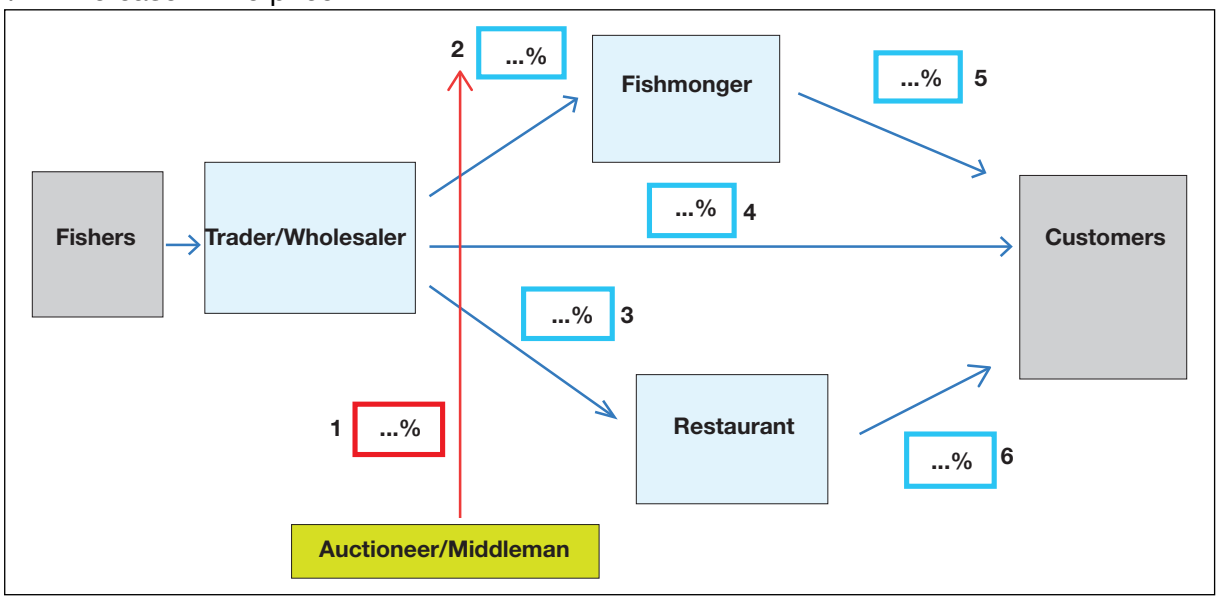
1_____
2_____
3_____
4_____
5_____
6_____

Production	***Donax trunculus***	***Ruditapes decussatus***	***Paphia textile***	***Venerupis pullastra***	***Chamelea gallina***	***Litophaga litophaga***
Local name	Mulculula	Balady				Balaam
Kg/day						
Days per year						

	Average price (LE/kg)
Donax trunculus - 1° grade	
Donax trunculus - 2° grade	
Ruditapes decussatus - 1° grade	
Ruditapes decussatus - 2° grade	
Paphia textile - 1° grade	
Paphia textile - 2° grade	
Venerupis pullastra - 1° grade	
Venerupis pullastra - 2° grade	
Litophaga litophaga	

TRADER / WHOLESALER / FISHMONGER

Descriptive value chain of the bivalves production in _____
% = increase in the price



Description of the area (ONLY FOR BIVALVES)

- No. of fishers operating in the area:
- No. of wholesalers that buy the product:
- Each of them collecting the production of about _____ fishers:

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