"Piloting of eco-innovative fishery supply-chains to market added-value Adriatic fish product"

D4.1.1. Report of present production status of target species and their relevant processing industry

WP4 -Innovating tools and processes for added-value Adriatic fishery products/ A4.1. The state of art of technological and process innovation

PP1- Zadar County, July 2019.
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Contents

1. Introduction

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First projecting period in WP 4 was dedicated to follow up ***Activity 1. THE STATE OF ART OF TECHNOLOGICAL AND PROCESS INNOVATION where the main goal and activity was to evaluate*** the status and the growth potential of the seafood industry for production analyses, market price comparison for the production- cooperative group involved. Those separate production groups represent wider fisherman organizations and area of organizations. Main issue is tackling gaps and needs in technological and process innovations, identifying new solutions and opportunities (D 4.1.1). This preliminary report already gives some indications in sense of production targets species which are for PP8 – FC Omega 3 for purse seine gear (sardine and anchovy), PP9 - FC Istra for bottom trawlers, Rapido trawl and set nets targeting demersal species (bluefish, oyster, musky octopus, cuttlefish, red mullets, mullets, rays, queen scallop) with little distance from previous species showing higher marketing potential and PP10 – OP Bivalvia for dredges for harvesting clams. It's also important to adjust those species with the valuation of both countries' preferred fishes but the main issue is to find a species with existent small value and high processing possibility.

For the FC Omega 3 main finding in technological and process innovation according to main fresh market dedication to work on quality on board processing and preservation to reach extra premium fish quality. Today Omega 3 has a protocol for obtaining premium fish and there is still space to move more in the sense of extra premium quality with innovative techniques. According to a survey done and market analysis it was concluded that change of production – handling method and technique can also influence the quality of fish preserved on board. Traditional way of harvesting fish was conducted by hand net when the fish is stretched near the boat. This practice is common for the whole Adriatic basin and the procedure is long and requires more time to harvest quantity which impacts negative physiological processes. New industrial technology and innovations lead to work for handling a fish with pumps while harvesting. Survey analysis shows that there are several and three main solutions for harvesting by pumping a fish and as a quality is a main goal to achieve the decision was to adopt aquaculture pumps as innovations to harvest the fish. Also, to invite other solutions of different methods for possible test and training in the next programming period Main producers of equipment are observed and techniques are presented on how to adopt pumps on board. In the next programming period – second half of

the year intensive training will be done and will open a possibility to make new protocols for harvesting advanced quality. Also, other processing and packaging methods will be developed.

Based on FC Istra approach in innovative solutions for demersal resources, crystalize that main target for them will be processing and packaging solutions for specific target species like is bluefish, oyster, musky octopus, cuttlefish, red mullets, mullets, rays, queen scallop. Today processing and packaging solutions are not defined and there is a gap between market demand and products offered and way of presentation. There is a need for more initiative in the sense of presentation and promotion of new products and also knowing different versions of production and processing technology. Initially present technology was evaluated, production steps and species evaluated for the next programming period.

In the next project period focus will be on designing and adopting existing and new equipment, adjusting technology to follow up market demand for customized handling, processing and packaging solutions on board and in a plant. The work will be performed by the PO's internal and external experts, while other PPs will assist the implementation of the equipment, PP1-Zadar will provide specific training to internal PO personnel (D4.1.2).

During the first 6 months of the project, PP8-PP9-PP10 staff participated in the main project meetings. Project is presented to several different companies which can be involved in the innovation process in fishery handling and processing equipment. Preliminary reports are done by support of external expertise, and some novel products are designed in processing. WP4 programming staff worked in close cooperation with other WP leaders in order to customize a list of products which can develop in a marketing sense.

2. Fisherman's Cooperative "Omega 3" case study

Source: Web

2.1. Description of the company

Co-operative: Omega 3
Location: Kali
County: Zadar
Number of members; 16,
Number of boats: 21
Target species: sardine (Sardina pilchardus) and anchovy (Engraulis encrasicolus)

The FC "Omega 3" was established in 2008 in the town of Kali on the Island of Ugljan. Kali is a home of the most famous fishermen on the Adriatic who proved their maritime talents even in international waters.

The primary occupation of the FC "Omega 3" is fishing for small pelagic fishes (sardines and anchovies). The catches of the fishermen members of the FC "Omega 3" have a significant share in total Croatian catches, and especially with purse seine nets, where they participate with over 20 % of the total national catch of small pelagic fishes. It gathers 16 associates and owns a fleet of 21 vessels (21 purse seine vessels).

In 2015., the FC "Omega 3 was acknowledged by the Ministry of Agriculture – Directorate of Fisheries, as the first organization of producers in the Republic of Croatia under the name "Fisherman's Cooperative Omega 3 – organization of producers", abbreviated as O3OP.

In June 2017, "Omega 3" signed a Memorandum of Understanding for the "Adriatic small pelagic fishery improvement project" – (GSA 17 and 18) fisheries improvement project (FIP).

2.2. Description of the fishing fleet and target species

When started its operations on 1st January 2009. FC „ Omega 3"had 23 vessels:

Bottom trawlers	> 15 meters	3 pcs
Bottom trawlers	> 10 meters	
Purse seiners	> 20 meters	12 pcs
Purse seiners	< 20 meters	8 pcs

The vessels are based at the following ports;

ZADAR	5 vessels
KALI	18 vessels

FC “Omega 3” is focused on purse seiners and today there are 21 of them. Their fleet is moving along the whole Croatian coast. The fleet represents more than 20 % of the Zadar County fleet. Sardines are the main product of Omega 3; landed are sardines and anchovy but not all quantities are landed in Zadar County. Nevertheless FC “Omega 3” represents approx. 20 % of the county landings and on national level approx. 10 % of national sardine and approx. 6 % of national anchovy quantity landings.

The purse seine vessels are fishing from 12 - 36 hours and land on various landing sites within 20 - 85 kilometers of Zadar in most of the months but sometimes the fleet move to distant areas.

The vessels are fishing all year round and the average number of days at sea was 150.

2.3. Description of the catches and the seasonality of the catch quantities

Sardines and anchovies as a small pelagic fish are the major species caught by the FC “OMEGA 3”. The larger purse seiners rely on the pelagic fish for the majority of their income with the heaviest landings anchovies occurring in April, May, June, July and August and Sardines from January to April and September to November.

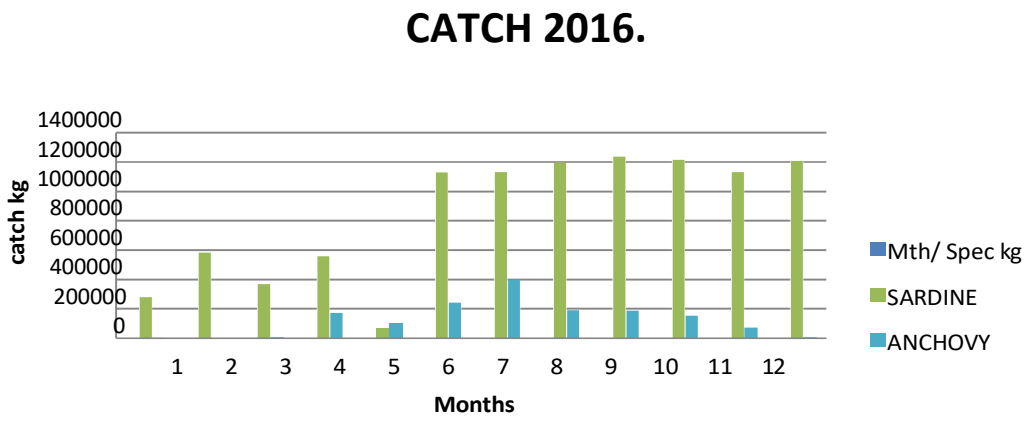

Figure 2.1. Catch of sardine and anchovy in 2016.

From the catch in 2016. it can be seen that the sardines were mostly caught in the second part of the year, and anchovy in the summer.

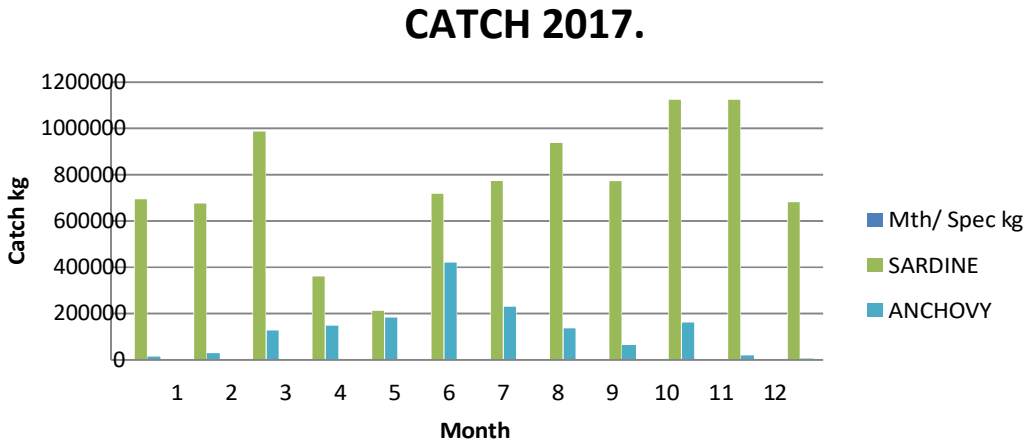

Figure 2.2. Catch of sardine and anchovy in 2017.

From the catches in 2017. it can be seen that the most sardines were caught in the autumn and the anchovy in the summer months.

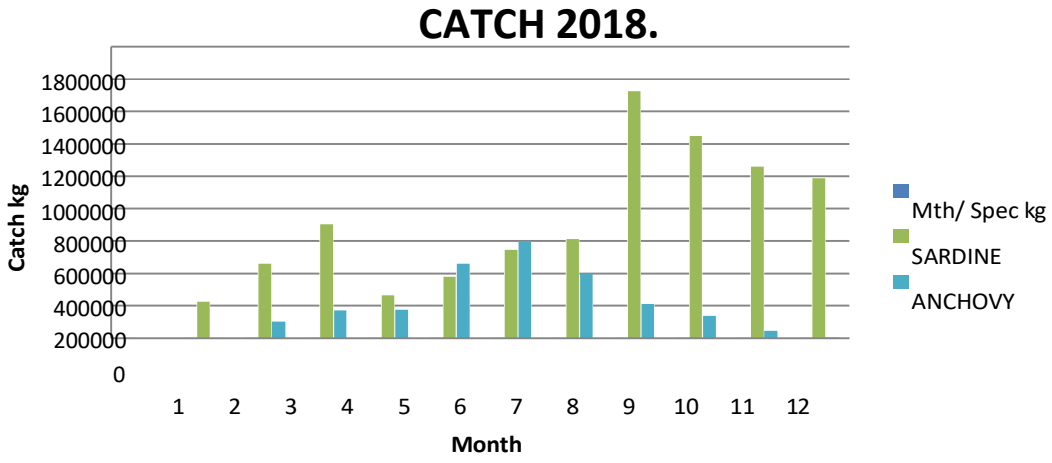

Figure 2.3. Catch of sardine and anchovy in 2018.

In 2018, the highest number of sardines was caught in the autumn and winter and anchovy in the summer.

2.4. Description of the fishing and production process

In June 2012. in the industrial zone Šopot, the "Omega 3" Fishing Association built its logistics base which includes a production facility which allows processing of fresh fish into a frozen product with the modern technology of individual freezing (IQF) and the freezer warehouse. With its own trucks, it transports the fresh fish from the vessels to the production facility in the Šopot industrial zone.

Present products offered on market are:

IQF FROZEN SARDINE WHOLE
IQF FROZEN SARDINE WITHOUT HEAD
IQF FROZEN SARDINE FILET
IQF FROZEN ANCHOVIES
IQF FROZEN MACKEREL
IQF FROZEN HORSE MACKEREL
FRESH SARDINES
FRESH ANCHOVIES

Figure 2.4. Process of unloading and processing plant, Source: Web

FC "Omega 3" previously caught sardines and anchovy fish to the existing processing industry, tuna farmers and clients abroad. Strategic plan was to start up quality freezing of the catch and open a new channel in the value chain. At the beginning cooperative trade was only fresh fish and it was very hard to follow the market without processing lines and storage. Processors are mainly in Croatia related to the caning and marinating industry. Regularly the catch was too high for the clients to absorb; some ships do not have ice machines; fish was landed in poor quality. Strong points are: centralized landing place in Zadar. Processing industry is also close to Zadar.

After a few years "Omega 3" builds and starts up with a new facility, equipped with the newest IQF (individually quick frozen) technology with a capacity of 5 tons per hour, this way, the product is frozen individually, achieving a temperature of -18 degrees °C along the fish bone.

Figure 2.5. Preparation and freezing a fish in IQF, Source: Web

After freezing, the product obtains a thin layer of glaze. The mentioned glaze serves to protect the product from drying. Unlike classic tunnels, this system of freezing does not dry the fish by freezing in cold air, but rather keeps all of its natural characteristics. The entire process of freezing, from the entrance of the raw material into the line, up to packaging, lasts a maximum of 15 minutes. The short process of freezing is exceptionally important in order to avoid the creation of ice crystals within the product, which in turn greatly affect its quality.

Today, the Cooperative shortened the supply chain; opening new markets in central and Eastern Europe was a target initially. Now sardines and anchovy fish produced in Omega 3 are mainly consumed in Spain and Italy. The cooperation among fishermen gave possibilities to strengthen the quality management, marketing etc.; FC developed an important opportunity through modern landing facilities.

2.5. Description of existing management over the resources (self-management) and availability and consistency of the resources.

"Omega 3"representatives are mostly active in small pelagic fisheries. Recognition as a Producer Organization gives the fisherman's more special attention for the development of sustainable fish resource management in Croatia. In addition, cooperatives make rules related to lower catch and increased quality for premium fish- adjusting capacity management. Main points which are taken from the cooperative to consider in future are:

Main points which are taken from cooperative to consider in future are:

- How to decrease the fishing capacity for better price; and to avoid pressure on fish resources. This is a process of many years where the private sector and government have to work together. One of the instruments applied in other EU countries will have to be introduced in Croatia: Fish capacity management (fishing days, restrictions for periods and zones etc.) need to be analyzed; the best would be that the FC's would take responsibility to describe their policy and find agreement among their members.
- How to get a better price for the fish. For example, in the beginning the use of sardines for fish feed is an inferior use of this catch; the fishermen should find a better market for this catch. Main problem is not the catch but the marketing of the fish. A new generation of Croatian fish traders/salesmen has to stand up. There is sufficient potential and market exists in the countries around Croatia.
- Work towards a sustainable fishery sector together with science, professional organizations, and the government. It is a group process; many stakeholder meetings need to take place,

concerning the development of concepts in which every stakeholder has a position which is recognized and accepted. Omega 3 needs to lead in those processes.

2.6. Short market analyses, landing prices, existent market flow for target species

"Omega 3" cooperative is trying to assess market options and formulate a strategy for 5 or even 10 years on following major markets:

1. Italy, France
2. Western Balkan (including Croatia)
3. Middle Europe (Austria, Switzerland, Bavaria, Hungary, Czech Republic and Slovakia)
4. Other markets; Japan, Russia etc.

With different options to organize the marketing: Via the Italian trades, supply to processing industry, establish marketing company in the region; other options.

Figure 2.6. Warehouse and prepared product, Source: Web

2016. Specie	**Quantity**	**Income**	**Average price**
Sardine	10,101,590.00	29,159,598.00	2.89
Anchovy	1,548,969.00	9,226,344.00	5.96
2017. Specie	**Quantity**	**Income**	**Average price**
Sardine	9,003,213.00	31,601,279.00	3.51
Anchovy	1,536,550.00	14,750,877.00	9.60
2018. Specie	**Quantity**	**Income**	**Average price**
Sardine	8,005,509.00	23,859,445.96	2.98
Anchovy	2,302,551.96	13,883,554.48	6.03

Table 2.1. Total catch and value in HRK (Croatian kuna) for 2016., 2017. and 2018. (for FC "Omega 3" - without segmentation)

The concentration of small pelagic in the summer months causes natural fluctuations in the market. The FC plans to introduce a system of intervention if the quayside price falls below 1.00 - 1,20 €/kg for sardine on fresh market, for industrial purposes 0,50 - 0,60 €/kg and for Anchovies 1,5 - 2,00 €/kg for fresh market, for industrial purposes 0,60 - 0,70 €/kg.

The FC "OMEGA 3" actively encourages its members to fish in the fresh market and to increase demand by seeking alternative outlets for its products. All landed fish carry a label denoting membership of the FC "OMEGA 3" and wherever possible the name of the boat. Identification with an individual boat and traceability are seen as key parts of the FC "OMEGA 3" marketing strategy.

2.7. Strengths and weaknesses of the production status

Clients: caning producers of anchovy and sardines (canning and marinating) and mixed fish for tuna farms, all in Croatia. Fresh market domestic and foreign
Needs: more demand than can be delivered
Satisfy: fresh fish (freezing facility at the moment- goal- frozen quality is fresh)
Objective: increase freezing capacity, increase quality with on-board handling with catch, new processing and packaging solutions.

Strengths	Weaknesses
Limited number of licenses	Trust of fishermen to hand over fishery management (catch plans)
Concentration of supply (20% in two ports)	Continuity of supply (weather conditions)
Present tuna farms in the region	Lack of freezing capacity (carry over)
Processing industry is nearby	Geographical position (distance to markets)
Processing plant- freezing and packaging	Quality management (poor quality conditions on some boats, lack of ice)
	Getting loans for investments
Opportunities	**Threats**
Adding value	Tuna predation on small pelagic
Low supply (poor stock)	Small market for seasonality (Italy and Spain)
Consumption of fish (fatty acids)	Competition from Spanish fishermen (Bay of Biscay).
Ministry is more supporting development of co-operatives/PO's	Harbor facilities (lack of space and number of ports for landing)
	No added value
	Stocks are decreasing

Central Problem: To increase a share of selling fresh (frozen) product

2.8. Conclusion with areas where to apply development and innovations from catch to processing and packaging

Presentation and discussion of technical subjects relevant for improvement of sustainable fishing, quality of produce, increase of income of fishermen: Which are the options for usage in Croatia?

Developments in fishing gear and on-board processing

- Fish handling on board of vessel: Catching, sorting, weighing, registration
- Reduction of fuel consumption
- Limit the by-catch and discards
- Improvement of quality of fish during catch, handling on board, transport, cleaning
- New developments in passive fishing techniques
- Functioning of the fishery co-operative
- Processing and packaging possibility

CATCH METHODS AND TECHNOLOGIES IN PURSE SEINER FLEET

Present situation in the Croatian purse seine fleet is characterized by insufficient structured conservation and quality measures for on-board handling. Croatian commercial fisheries are characterized by a relatively old- medium fishing fleet, which are limited in terms of vessel length, engine size and equipment. The principal target fisheries are pelagic species (tuna, sardine, anchovy, sprat), in 2016. the reported total annual catch of small pelagic fish was approx. 65.000 t. A number of fishery management measures are in force (closed areas, restrictions in the use of fishing gears and minimum landing sizes). All vessels are licensed and the licenses specify the types of gear that may be used. Monitoring of catch distribution in Croatia is based on recorded fishery logbooks and catch reports for vessels. There are no quotas except for ICCAT catch restrictions set for tuna. Possibilities for improvement are recognizable in the introduction of efficient methods for preservation of sea bed, “friendly” gears, reporting/monitoring system and energy economizing. Croatia has a long knowledge/experience in effective data-based management, as well-developed system for observation of fishing vessel profitability. Experience on technical measure/gear adjustment

also, can lead to better profitability by reducing cost of operation as well to have a lower impact on fish by-catch and reduced discards.

The overall objective is to suggest catch methods for quality improvements based on knowledge, experience and practice.

Figure 2.7. Sardine chilled in slurry ice and in short chain frozen in IQF, Source: web

ONBOARD CATCH HANDLING

Due to situations where fishermen lack better organized landing places, there is a need to improve conditions for on-board catch handling in order to preserve fish quality. The main difficulties are: (a) On board catch handling or processing, (b) On board quality measures (c) On board preservation of catch (d) Equipment improvement.

Improvements can be made through introduction of new/different technical/technological solutions and by establishing a laboratory for monitoring the quality. Some quality issues and on-board fish handling operations are necessary to be connected. A pilot program for on board catch handling can be one of the models for transfer of available knowledge/expertise and experience from other industries in fish handling on board.

The overall objective is to improve on board handling of the catch by knowledge transfer, improvement in equipment/ technologies and quality issues.

Catch handling on board is a crucial point for quality preservation, involving both gear/vessel technology equipment as well as delivery and landing conditions.

3. Fisherman's Cooperative ISTRA case study

Source: Web

3.1. Description of the company

Co-operative: Istra
Location: Poreč and Kaštelir
County: Istria
Number of members: 43
Number of boats: 50
Target species: mullet (*Mugilidae*), musky octopus (*Eledone moschata*), queen scallop (*Aequipecten opercularis*), bluefish (*Pomatomus saltatrix*)

The fishing vessels remain on the sea 12 - 36 hours and land to various landing sites within 20 km of Poreč. The vessels fish all year round and the average number of days at sea is 135.

Sardine (*Sardina pilchardus*), anchovy (*Engraulis encrasicolus*) in the early beginning of cooperative where the main landing species while now major landings are musky octopus but there are also significant landings of red mullet (*Mullus barbatus*) and sole (*Solea solea*).

The smaller vessels operate all year round and are multi species catchers. The predominant landings in the winter months are sole and musky octopus.

The Fisherman's Cooperative "Istra" was established in 2004. and today is the leading fishermen cooperative in the Istria region. It has in lease the object of the wholesale fish market in Poreč and in 2017. they built its own processing plant in the business zone of Kaštelir – Labinci. In 2018. a mobile fish shop, situated in Poreč near a big shopping center, was put into operation.

It gathers 43 small fishing companies with over 50 fishing vessels that mostly fish with bottom otter trawls, boat dredges, gill nets and trammel nets. FC also takes fish from a few subcontractors that are not members but sell their catch to the FC. Fishing methods deliver a varied catch of demersal species, fish, cephalopods, crustaceans and bivalves. The catch changes on a monthly basis and shows perennial cycles.

In 2017., the FC Istra was recognized as a producer organization (PO ISTRA) for sole and oyster. Recognition is done by the Ministry of Agriculture – Directorate of Fisheries, as the second fishery producer organization in the Republic of Croatia.

FC Istra continues a centuries-old fishing tradition of closing a local bay Tarska vala with a large beach seine net for catching mullet in the winter months for a scientific purpose. For many years FC Istra had a concession for fishing in ˝Tarska vala˝, a special aquatic habitat near the

river Mirna delta, where traditional fishing was performed for 1.000 years. Under EU regulations, these kinds of fishing need special derogation, so all activities are focused on getting scientific data to fulfill the derogation request. The catch is made in winter and the main species caught is mullet, although in the last couple of years there have been significant amounts of invasive bluefish (Pomatomus saltatrix).

FC Istra has a Supervisory Board with 9 members and a General Assembly composed of all members of the Cooperative. There are 19 employees: 1 manager, 3 employees in administration and bookkeeping, 7 in the fresh market, 1 in the purification and dispatch center of live bivalve molluscs, 2 in the retail and 5 in the fish processing plant.

As a producer organization FC Istra plans to build an oyster farm and start aquaculture activities and also to recommend no take zones for reproduction of European flat oyster (Ostrea edulis). FC Istra conducts activities of the Association of Fisheries Cooperatives in Croatia in order to strengthen the cooperative sector in fisheries. Since 2016. it is also an active member of FLAG ˝Istarski švoj˝, a local action-group specialized in fisheries and is recently involved in the construction of the Santa Marina fishing port.

3.2. Description of the fishing fleet and target species

Structure of the fishing vessels and gear

TYPE OF GEAR USED AND VESSEL LENGTH	NUMBER OF SIGNIFICANT VESSELS
Purse seiners 12-<18 m	1
Boat dredges 6-<12 m	4
Boat dredges 12-<18 m	6
Bottom otter trawls 6-<12 m	7
Bottom otter trawls 12-<18 m	5
Vessels with gill nets <6 m	2
Vessels with gill nets 6-<12 m	17
Traps 6-<12 m	1
Vessels with active and passive gear <6 m	2
Vessels with other active gear 6-<12 m	2

The vessels are based at the following ports: Pula, Rovinj, Vrsar, Funtana, Poreč, Tar and Novigrad. Most vessels are between 6 and 12 meters long, and there are 11 vessels longer than 12 meters. These vessels have towed gear. Higher numbers of the vessels are operating all year round and they are multi species catchers.

The predominant landings in the winter months are musky octopus, mullet and sole and in the summer months musky octopus and sardines. Based on specific gear species in the catch of the bottom trawlers are musky octopus (*E. moschata*) and red mullet (*M. barbatus*), in dredges there is a significant catch of oysters (*O. edulis*), Mediterranean scallop (*Pecten jacobaeus*) and queen scallop (*A. opercularis*).

In general, bluefish (*P. saltatrix)* and other species caught in minor or significant quantities are cuttlefish (*Sepia officinalis*), squid (*Loligo vulgaris*), sole (*Solea solea*), mullet and whiting

(*Merlangius merlangus*), and a mixture of other demersal fish species. Some of them are species of interest to be processed for added value products.

Target species	Caught in 2018 by FC Istra (kg)	Total value (€)	Average price (€/kg)
Mullet	6,730	5.765,99	0,86
Musky octopus	95,273	329.856,63	3,46
Cuttlefish	11,125	52.279,88	4,70
Bluefish	595	1.781,38	2,99
Queen scallop	16,231	16.322,58	1,01

Table 3.1. Catch and average prices for target species

Fishing vessels with different gear land their catch at different times of day. Trawlers and dredges usually work all day and land in the evening, while small scale fishers with gill and trammel nets land the catch early in the morning. This requires for the cold storage to be open early in the morning and again late in the evening, and also during weekends. Such operation time demands more employees that will work within storage and loading the fish from or in the trucks. There is one owner of a purse seiner who is a member of the FC, however the sardines caught with this vessel are not sold through the FC and although the quantities of this small pelagic fish are large by comparison, they do not have a significant value for the FC Istra.

3.3. Description of the catches and the seasonality of the catch quantities

The picture is very similar for most of the coastal part of the Istria region. Major difference is that Istria catches more second grade (white) curled octopus (*Elodone cirrhosa*) year-round and there is a lack of market orientation for added value products. Red mullet, also high quantity catch, is caught for 2 - 3 months during autumn and winter. During this period the market is full of fish and it is the low tourist season. Formulation of market objectives is not easy because of high level seasonality. One option was to start up processing and cold storage capacity in Poreč with diversification of products. Aiming at reduction of costs it is important to increase the co-operation between co-operatives and fishermen in the Istria area. The enlargement of the fishing

season up to 12 months could be done by starting up the fishing in a wider range of coastal zones. Strengths include the availability of the daily sales and cold storage facilities. Italian buyers do not take any fish during the weekend; landings on Friday will be accepted only on Monday being three days old. The strategy is aiming at the development of new products. A problem is caused by the large number of small-scale fishermen; they supply local retail and restaurants.

The three species that are most important in value for the FC Istra are musky octopus, oyster and sole, and they each have an average yearly value of over 1 million HRK, around 130.000 €). Catches of oysters are significantly dropping in the last two years.

Species	Landings in 2018 (kg)	Total value (EUR)
Musky octopus	95,273	329.856,63
Oyster	17.594	74.905,08
Sole	35.538	347.379,12

Table 3.2. Catch and value of main products

FC Istra regularly made a couple of tons of mostly mullet and invasive bluefish (*P. saltatrix*) which is increasing in market value and becoming recognized by the consumers.

Target species	J	F	M	A	M	J	J	A	S	O	N	D
Mullet												
Musky octopus												
Cuttlefish												
Bluefish												
Mediterranean scallop												
Queen scallop												

Table 3.3. Months in which the target species is mainly caught, Source: FC Istra data's

Most of the target species are caught in the winter, except for Mediterranean scallops which are available throughout the year. This requires additional processing, storage and market strategy to ensure products can be delivered to the customers when needed.

3.4. Description of the fishing and production process

In 2017., FC Istra finished the construction of a fish processing plant in the Industrial zone of Kaštelir-Labinci (850 m^2) and in 2018. the plant started to process fishermen´s catches in a sense of diversification of seasonal and cheap species catch. FC Istra has in lease the wholesale fish market in Poreč in which it has a cold storage facility and a purification center for bivalves. The catch is usually brought to this facility in Poreč with trucks or refrigerator vans and is then sorted and repackaged to suit market needs. Most of the catch is exported to Italy and a part of it is sold directly to restaurants and hotels - HORECA segment, and a part also to final consumers through small fish shops in Poreč. Some species like queen scallop, mullets and bluefish are brought to the processing plant. FC Istra also buys raw material for processing, especially shrimp which is caught mainly in the central and south Adriatic.

Present products of the processing plant offered on market or explore are:

- frozen queen scallop meat
- frozen shrimp meat
- fish fillets (red mullet, sea bass)
- preparation and packaging for HORECA segment

Figure 3.1. Processing plant, Source: FC Istra

Figure 3.2. Mobile fish shop, Source: Web

The project idea to build a processing plant was initiated in early 2010. by the Istrian County, with the aim of creating added value for species, as well as enabling higher prices and easier placement of semi-finished or finished products on the market. The equipment of the plant is selected for processing the specific catch of FC fishermen and enables production with a variety

of finalization from simple evisceration and decapitation through salting and marinating to smoking, baking and cooking. The main species that was planned for processing was primarily musky octopus (*E. moschata*).

Since then, the structure of the catch changed due to biological changes in the ecosystem, stock changes and new EU regulations that banned certain fishing grounds for some gear (trawlers under 3 miles from the shore, beach seine in Tar Bay). The fishing pressure increased on other grounds due to these new regulations and many fishermen stopped using trawls and started using dredges for catching oysters. Due to this the catch of oysters reached a maximum in 2016, and has since declined.

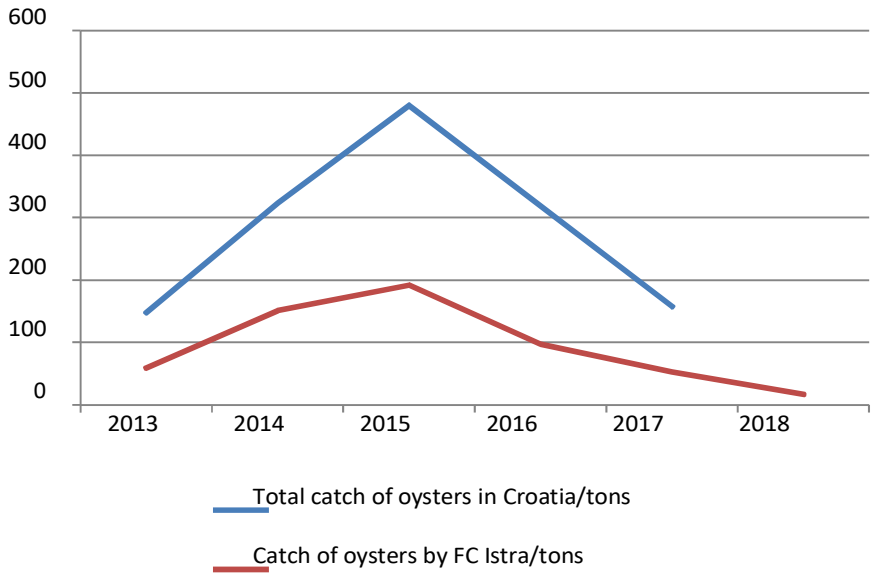

Figure 3.3. Catch of oysters in Croatia form 2013. – 2018., Source: Web

After all of those disturbances, second species chosen for diversification were mullet, planned to be fileted and smoked and finally queen scallop and bluefish.

3.5. Description of existing management over the resources (self-management) and availability and consistency of the resources.

The EU regulation prohibits the use of towed gears within 3 nautical miles of the coast or within the 50 m isobaths where that depth is reached at a shorter distance from the coast. The use of dredges can be authorized by derogation within 3 nautical miles irrespective of the depth provided that the catch of species other than shellfish does not exceed 10 % of the total live weight of the catch. Croatian law prohibits the use of dredges except in the fishing zones H and I and part of zone A. Therefore, fishing areas are managed on the EU and national level, so there is room for co-management.

Given the current regulations and possibilities for extending / limiting fishing areas, expected problems of fish and bivalve stock and resource management need to be assessed. Through the producer's organization of fishermen, it is possible to act on the minimum landing size, fishing effort (number of days a week at sea) and minimum mesh size. For example, negotiation for a minimum size of 7 cm for commercialization of oysters and limitation of fishing effort to five days a week are opening access to resource management through marketing and control of catches.

The big problem with managing variable catches of demersal species is that these species have different migration patterns. Some species are completely sedentary, like oysters, and are suitable for sea ranching. Other species, like sole, migrate throughout the territory of three EU states (Italy, Slovenia and Croatia), and are subject to joint management. For such species, it is questionable to what extent the FC Istra can influence improvement of the stock. In addition, a major risk factor is the uncontrolled and unknown size of the dolphin population, which may have fatal consequences for the survival of small coastal fishing.

It is therefore necessary to conduct impact studies for the purpose of applying new management measures and effective participation in various appropriate fisheries management bodies at national, regional, European and international level.

Regardless, FC Istra will continue to apply all the mechanisms that will benefit further conservation of biological stocks and will implement all measures determined by the Directorate of Fisheries by the Ministry of Agriculture.

At present, because of the scarcity of oysters on the market, an agreement is to be made with other producers to merge the quantities caught, which would make it possible to reduce transport costs and thus, by offering a sufficient quantity, to achieve a better price through bidding.

The FC Istra will submit a proposal for a study on increasing the mesh size on trammel nets from 80 mm to 84 mm or 88 mm, which should in 2 - 3 years lead to an increase in the average size of the sole and to reduce the catch of small specimens. There are no unwanted catches in the catch of sole, when very selective tools are used in fishing, such as 80 mm eye-catching network, as well as a 76 mm-sized eye-catching “rampon” which does not wear any individuals below a minimum permissible size of 20 cm.

This would raise the structure of the catch and those measures to be effective must be underlined for Italy and Croatia. The purpose is to avoid a catch of large amounts of immature sole.

At present, because of the scarcity of oysters on the market, the only point of contact with other producers is an agreement on the merger of the quantities caught, which would make it possible to reduce transport costs and thus, by offering a sufficient quantity, to achieve a better price through bidding.

Oyster is an ideal species for management (sea farming / ranching) because it does not migrate and it is easy to track the state of larvae and populations at the seabed. In such a way forming a no-take zone can provide a stock of large reproductive potential for the purpose of repopulating a larger aquarium. In this "no take" zone can be deposited large oysters of high reproductive potential, and less commercial values that will produce a large number of larvae and juveniles. The juvenile can be collected in parallel with the laying of native reproductive fats in the same zones. After a certain period, the "no take" zone opens again for fishing with certain agreed catch rules, while other waters are converted into a "no take" zone. This ensures long-term sustainable fishing of oysters and continuous recruitment.

This can also lead to construction of small farms (procurement of construction materials and necessary equipment, establishment of farms, recruitment of production staff - technologists and auxiliary workers).

Additionally, the FC Istra will work on identifying and promoting fisheries practices that help avoid and reduce unwanted catches (timely notifies of fishermen on unwanted catches) as well as determine the best way to exploit such catches.

3.6. Short market analysis, landing prices, existing market flow for target species

Previously concentration of small pelagic in the summer months caused natural fluctuations in the market. The PO plans to introduce a system of intervention if the quayside price falls below €1.00 for sardine and anchovy. It can freeze a maximum of 5 tons per day and has a storage capacity of 50 tons. The intervention plan for a maximum of 2 tons per day and storage of 10 tons at any one time. If these measures do not prevent prices falling below the agreed prices the boats will be required to reduce their landings or their time at sea.

A similar position may arise with musky octopus in October and November. The end of the tourist season in September sees a drop in local demand and in most years a continuation of heavy landings. Prices for musky octopus will be allowed to fall to € 1.00 before the FC "Istra" intervenes.

The FC actively encourages its members to fish to the market and to increase demand by seeking alternative outlets for its products. All landed fish carry a label denoting membership of the FC "Istra" and wherever possible the name of the boat. Identification with an individual boat and traceability are seen as key parts of the FC marketing strategy. According to medium landing prices it has achieved prices for some target species (species for product diversification) in 2018.

Target species	Average price for FC Istra (€ / kg)
	2018.
mullet	0.86
musky octopus	3.46
cuttlefish	4.70
bluefish	2.99
queen scallop	1.01

Table 3.4. Target species, landing and prices for Istra cooperative

It can be recognized easily that mullet, bluefish, queen scallops are caught in the highest quantity and that there is a strong need to process those products for added value. Also, while comparing some species in front of land price it is important beside quantity to also look at subspecies of sale because there is a difference in musky octopus and queen scallop sub variety and price in different regions.

Target species	Average price in Croatia, given by Directorate of fisheries (€ / kg)					
	2012.	2013.	2014.	2015.	2016.	2017.
Mullet	1.45	1.32	1.97	1.82	1.44	1.56
Musky octopus	2.86	2.82	2.43	2.44	2.71	2.81
Cuttlefish	3.50	3.97	4.41	4.71	4.85	4.96
Bluefish	-	-	-	4.03	3.74	0.95
Queen scallop	3.24	2.92	2.96	2.07	2.22	2.68

Table 3.5. Landing prices for target species in Croatia, Source: Directorate of fisheries, Croatia

Target species	2012.	2013.	2014.	2015.	2016.	2017.
Oyster	3.19	2.35	2.21	2.71	3.00	2.57

Table 3.6. Average price of oyster (€ / kg) (*Ostrea edulis*) in Croatia, given by Directorate of fisheries

The fishing activity and the first sales for **oyster** in sense of balanced resources have the following characteristics:

- First sale price that is realistic and constant
- Great purchasing opportunities due to constant demand
- Fishing size selectivity that is important for the market and price
- Fishing costs that are moderate (the fishing area is near so the fuel costs are lower, the cost of labor is lower due to one-day fishing)

Target species	2012.	2013.	2014.	2015.	2016.	2017.
sole	7.69	7.74	8.12	8.62	8.91	7.99

Table 3.7. Average price of sole (EUR/kg) (*Solea solea*) in Croatia, given by Directorate of fisheries

The fishing activity and the first sales for **sole** have the following characteristics:

- The price of first sale in the ascendancy, because it depends on the size of the fish, quality and the maintenance of the cold chain (in 2017 there is a significant price drop, probably due to size reduction of sole)
- In winter period there are large quantities of sole caught, while there is a demand for bigger sizes during summer and touristic season
- Catch selectivity would contribute to higher market prices. There would at first be a growing fishing cost, until the stock recovery and higher prices that would compensate for this.

At this point, the structure of catches, costs and opportunities for marketing are such that it is not possible to quickly and significantly change positioning on the market. However, it is also necessary to gradually turn to those markets that will enable the sustainability of fishing.

3.7. Strengths and weaknesses of the production status

Catch: Fresh musky octopus (60 – 70 %), a lot of seasonal species of low market value such as mullets, queen scallops, bluefish etc.

Objectives:

1. Efficient utilization of processing plant
2. Diversification and added value on low market value fish
3. Continues supply of clients
4. Less costs
5. Find new markets for process products
6. Increase cold store stock
7. More members in region

Strengths	**Weaknesses**
Own facilities (wholesale market plus processing plant)	Transport cost for fish from the Islands when fleet migrate- dislocated members or catch season
Location to fishing grounds (2-3 months they fish south)	Transport to Italy
Specialists in catching musky octopus	Seasonal supply (sole, red mullet, sole, squid) in winter, in the tourist season there is no fish for local clients (restaurants)
Near markets in Italy	Italian clients only take fish during the week (Monday – Wednesday).
	Dependent on weather (small vessels)
Opportunities	**Threats**
EU membership open markets	Higher prices for Italian musky octopus (better organized, fresher product)
Italian consumer wants product diversification	Fresh market is not growing, Italians wants cheaper French octopus
	Black landings (restaurants)

Central problem: small landing prices due to market environment needs for diversification and processing of low value seasonal species. Fishery policy needs to create more efficient economic models and without use of resource recovery mechanisms while respecting fisherman profitability.

3.8. Conclusion with areas where to apply development and innovations from catch to processing and packaging

Fishermen of the FC Istra catch and sell around 150 - 200 tons of fish and cephalopods plus the variable number of oysters (over 150 tons in 2015.). In 2018. chosen target species, i.e., mullet (*Muglidae*), musky octopus (*E. moschata*), queen scallop (*A. opercularis*), bluefish (*P. saltatrix*), make around 130 tons. The average prices for these species range from less than 1 to 4 € / kg, so they can be considered low value species.

Therefore, the primary development and innovation should be to add value to this type of catch.

Increasing the prices / value of the catch for 25 % would create additional profit of around 100.000 euros per year. A significant share of this profit can go back to fishermen.

Catch handling on board is a crucial point for quality preservation, AND CAN BE IMPROVED ON ALL VESSELS AND TARGETED SPECIES.

Development and innovations - mullet (Muglidae)

- **catch** – more focus on direct catch. It should be analyzed how many fishermen use “ciplara” net and what are the quantities caught. In the past this species was bycatch in purse seines during night, however, it is forbidden under new regulations. Maybe there should be some pilot studies or support for fishermen to start using these nets again to increase the quantities of mullet catch.
- **processing** – to develop -mullet can be fileted, but also marinated on the finest premium product. Relationships with chefs-culinary experts and new recipes can ensure better marketing.
- **packaging** – to develop frozen, vacuumed, in MAP packaging

Development and innovations - musky octopus (*E. moschata*)

- **catch -** to evaluate appropriate fishing methods
- **processing** – cleaning and freezing would make it available for restaurants and tourist season, increasing the price
- **packaging** - frozen, vacuumed, prepared for salad's…

Development and innovations – cuttlefish (*S. officinalis*)

- **catch -** There are some pilot projects on collecting cuttlefish eggs and letting them hatch in protected environments and then releasing immature individuals back to the sea.
- **processing** – cleaning and freezing, same as musky octopus. Preparing ready to eat salads or cooked dishes that can be frozen only to add rice at home (risotto, brodetto)
- **packaging** – frozen, vacuumed

Development and innovations – bluefish (*P. saltatrix*)

- **catch** – to develop catching methods, since it seems that this species resides in the area for a significant part of the year. This is an invasive and predatory species so it should be caught in larger quantities. There should be some pilot studies to make innovative purse seine nets with stronger mesh for catching this species, since it can tear up all nets with its sharp teeth.
- **processing** – fileting, freezing. Due to large size and significant offal, heads can be used to make various products.
- **packaging –** frozen, vacuumed

Development and innovations – queen scallop (*A. opercularis*)

- **catch** – it is by-catch in trawls, so no development is needed
- **processing** – cleaning meat and freezing, raw or cooked, preparing ready to cook sauces (just add rice or pasta)
- **packaging –** frozen, vacuumed….

In general, to develop the income some priority should be addressed to:

1. Better price & new products
2. Size of the fish
3. Cost reduction in processing

4. Sustainable fishing
5. Balancing of the profit
6. Protection of small fishermen's communications

By prescribing the standards for the catch and storing & processing and packaging of fish and providing the fisherman the best service (port, storage) cooperative will go towards branding the catch which will increase the value of the fish, and thus be recognized for its quality and will be more effectively promoted. Perhaps one could investigate the need for a quality specialist to help facilitate this process.

Equipping a facility for the processing of certain fish species needs to have constant progress (smoking, fileting, canning) and use of polyvalent machines. The intention is to process the species that are currently very little or not at all processed and that have a low price as a fresh product. Processing will add value to the fish that will then be able to be successfully placed in the domestic and foreign market. What is the potential of this? Maybe a short-term goal is to investigate this.

4. OP BIVALVIA case study

Source: web

4.1. Description of the company

Co-operative: Bivalvia
Location: Caorle
Region: Veneto

PO Bivalvia Veneto (Producer Organization) is an Italian fishermen cooperative society, whose headquarters is situated in the city of Caorle. It collaborates closely with Co.Ge.Vo. (Consortium for the Management and Protection of Fishing of Bivalve Molluscs) for eco-friendly fishing management and the marketing of the venus clams (*Chamelea gallina*) (Figure 4.1).

The Co.Ge.Vo. of Venice and the Co.Ge.Vo. of Chioggia are two consortia of companies authorized to fish bivalve molluscs, with boats equipped with hydraulic dredges, located throughout the Veneto Region. They have been established, based on the provisions of the “Ministerial Decree of 12 January 1995., No. 44”. Both the Consortia have the task of managing, improving and protecting the fishing of bivalve molluscs, with competence in the respective maritime compartments. The mission of the consortia, based on the "D.M. 21/07/1998 and later modifications" is to determine the quotas, the minimum catch size, to carry the activity of control and compliance with the rules, establish the time of departure from the port and the beginning of the fishing activities and establishing periods for temporary interruption of fishing activities. They bring together a total of 163 companies to represent the totality of the Venetian vessels dedicated to this type of fishing. There are 43 vessels that catch the smooth clam (*Callista chione*) and are associated with the PO Fasolari. The other 120 vessels catch the venus clam (*Chamelea gallina*). 75 % of these vessels (around 100) are associated with PO Bivalvia.

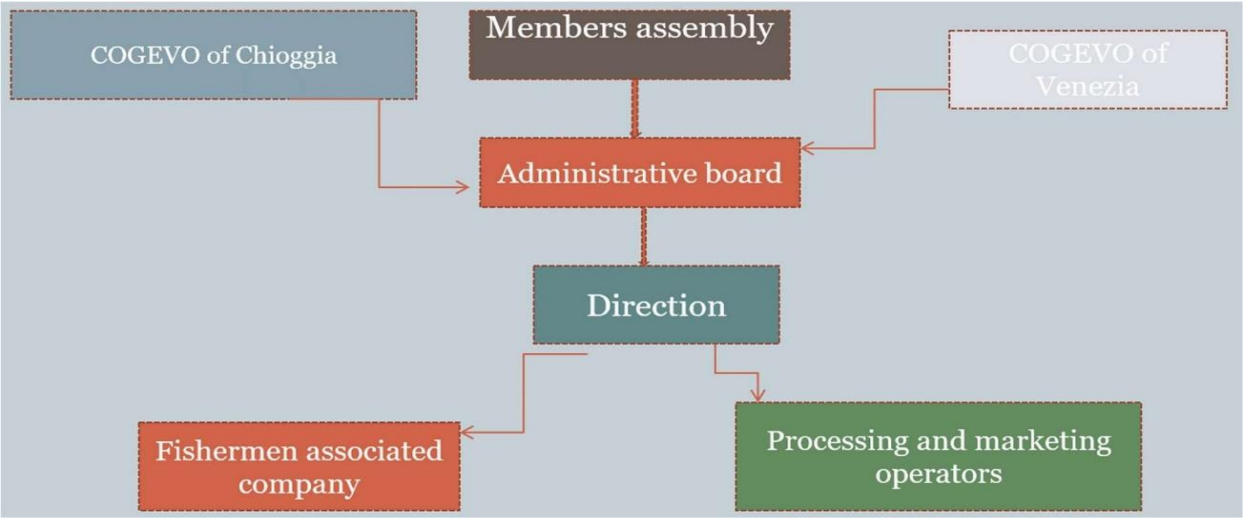

Figure 4.1. Organogram of PO Bivalvia, Source: OP Bivalvia

4.2. Description of the fishing fleet and target species

The fishing fleet consists of around 100 vessels associated with PO Bivalvia and another 60 vessels associated only with Co.Ge.Vo consortium, both use the hydraulic dredge (HMD) as their fishing gear. Most of the vessels have a length overall (LOA) between 14 and 18 meters, engine power around 200 horsepower and all of them are equipped with the automatic identification systems (AIS). Vessels of PO Bivalvia target the venus clam (*C. gallina*) in inshore shallow waters and bars along the coast of the Veneto region, while the vessels of Co.Ge.Vo. target the smooth clams (*C. chione*) situated further off the coast in deeper waters on coarse sand bottoms (Figure 4.2). The boats are equipped with a metal frame on the bow, where the dredge is located, and a big anchor and its towing winch on the back. The cage is pulled backwards using the propeller thrust in case of the venus clam (*C. gallina*), while the anchor and the retrieval of the anchor line is used in case of the smooth clam (*C. chione*), also due to deeper waters where this specie lives (Figure 4.3).

Figure 4.2. The venus clam *Chamelea gallina* (left) and smooth clam *Callista chione* (right). Source: Web

The hydraulic dredges consist of a metal cage with a front cutting blade aided by high pressure water jets, and metal skids attached on the side of the cage to prevent further sinking into the sea bottom. The width of the dredge may be between 1.8 and 2.5 meters, usually scaled to the size of the vessel. The dredge targeting the venus clam (*C. gallina*) digs around 10 cm into the sea bottom and the screen has narrow grills, while the dredge for the smooth clam (*C. chione*) digs around 15 cm into the seabed and has a wider grill since the later specie has a larger size.

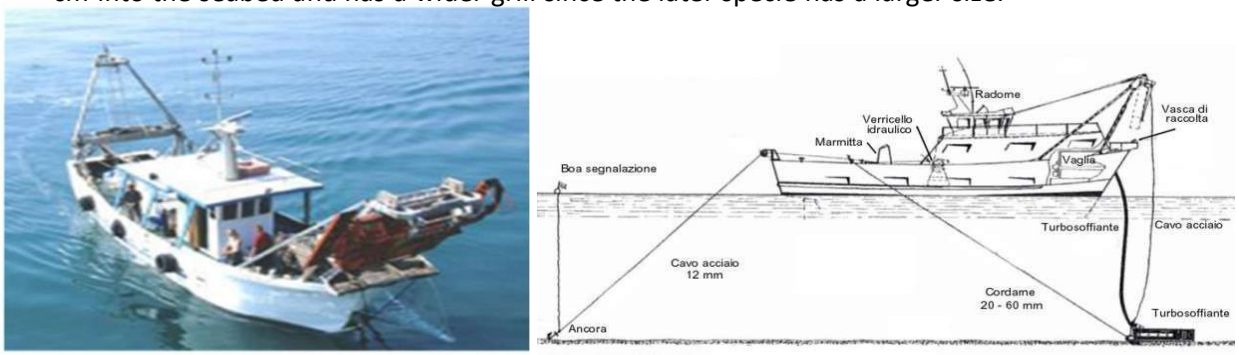

Figure 4.3. The hydraulic dredge vessel. The vessel from above (left) and illustration of the equipment for fishing in its working position (right). Source: Web

4.3. Description of the catches and the seasonality of the catch quantities

The average yearly landings of the venus clam in the between 2014. and 2018. are around 4 thousand tons, and approximately 840 tons for the smooth clam (Table 4.1). In particular, an increasing trend in landings for the clam is observed from 2014. to 2017. (4.970 tons), and later the landings decreased to 4.027 tons in 2018. Instead, a constant decreasing trend of landings is observed for the smooth clam (Table 4.1). Additionally, the total number of cumulative days at sea for venus clam fishery has a same trend as its landings, and the number of vessels has an increasing trend from 97 vessels in 2014. to 119 vessels in 2018. Moreover, daily quotas for the venus clam are the highest in 2015 and 2016, further; the quotas are decreasing to the lowest values in 2018. On the other hand, in case of the smooth clam the total cumulative fishing days at sea have its peak in 2017. and then reduce to its lowest values in 2018. Further, both the number of fishing vessels and the daily quotas show a constant decreasing trend from 2014. to 2018.

	venus clam (*C. gallina*)				**smooth clam (*C. chione*)**			
	Landings (t)	Fishing days at sea	Number of vessels	Daily quota (kg)	Landings (t)	Fishing days at sea	Number of vessels	Daily quota (kg)
2014.	2938	7629	97	385	987	2832	52	348
2015.	3521	8378	98	420	890	2856	46	312
2016.	4237	10133	106	418	840	2949	41	285
2017.	4970	13418	113	371	821	3043	39	270
2018.	4027	11331	119	355	679	2427	35	280

Table 4.1. Yearly trend of landings (t), total fishing days at sea, number of vessels and quotas for the venus clam (*C. gallina*) and the smooth clam (*C. chione*) from 2014. to 2018. Source: Web

The commercial landings of the venus clam do not have a real seasonality because they are based on market orders received on daily bases; therefore, the catches have daily adjustments. Generally, higher market orders are observed in the summer period and in December, since in those periods there are the tourist season and other holidays. The PO Bivalvia warns the customers of the imminent interruption of fishing activities and therefore the buyers order a larger amount of product to address the lack of product for the next months.

PO Bivalvia processes the product, froze it and stores it for further use. This strategy allows us to rationally use and preserve the resources (Figure 4.4). However, the daily catch quotas are kept relatively stable even if the orders vary and therefore the fishing days at sea are adjusted. However, even if the landings varied in time there is an increasing trend of the number of vessels involved.

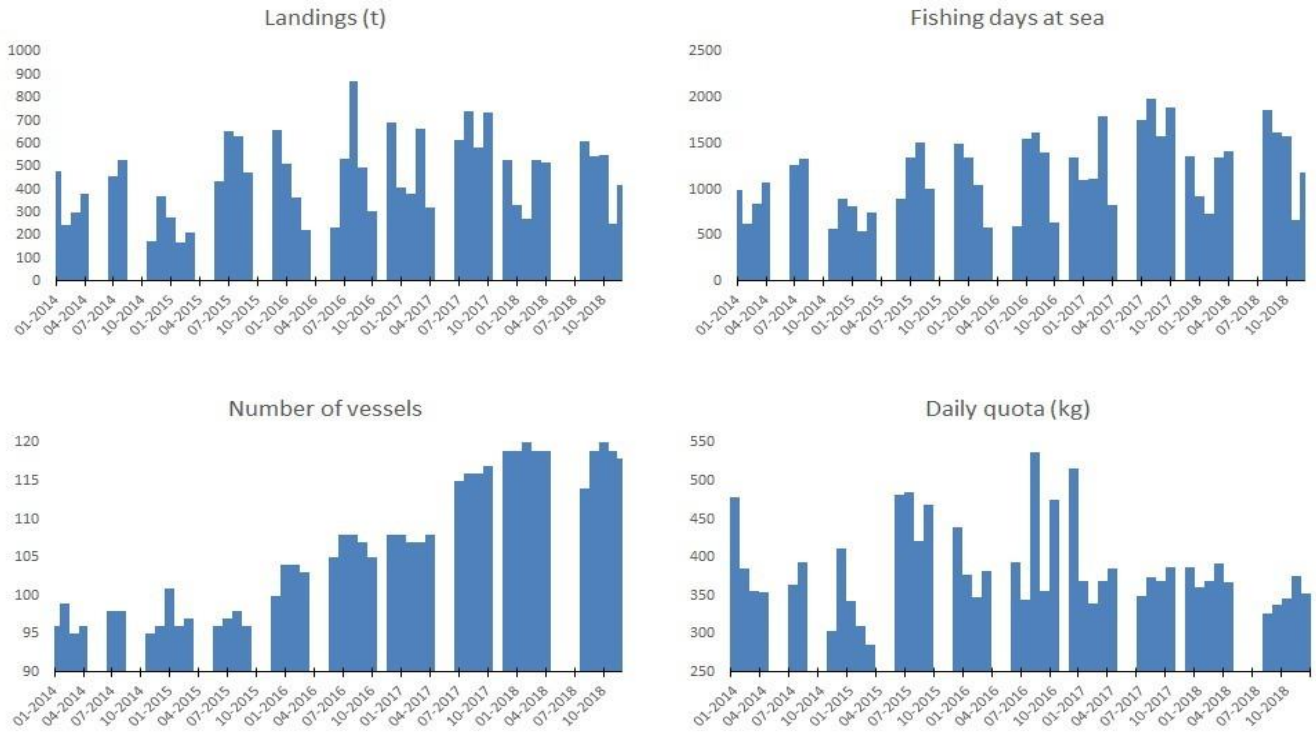

Figure 4.4. Observed trends in venus clam (*Chamelea gallina*) fishery. The trend of landings (up left), total cumulative fishing days at sea (top right), the number of vessels involved (bottom left) and daily quotas (bottom right). The trend is interrupted by temporary interruption of the fishing activities. Source: Web

On the other hand, the commercial landings of the smooth clam (*C. chione*) show a clear seasonality, where the highest landings are in the summer period and in December for the holidays (Figure 4.5). Accordingly, the fishing days at sea follow the same trend as the

commercial landings. There is also a decreasing trend of the number of fishing vessels, and the daily quotas have the same decreasing trend in combination with oscillations of the landings.

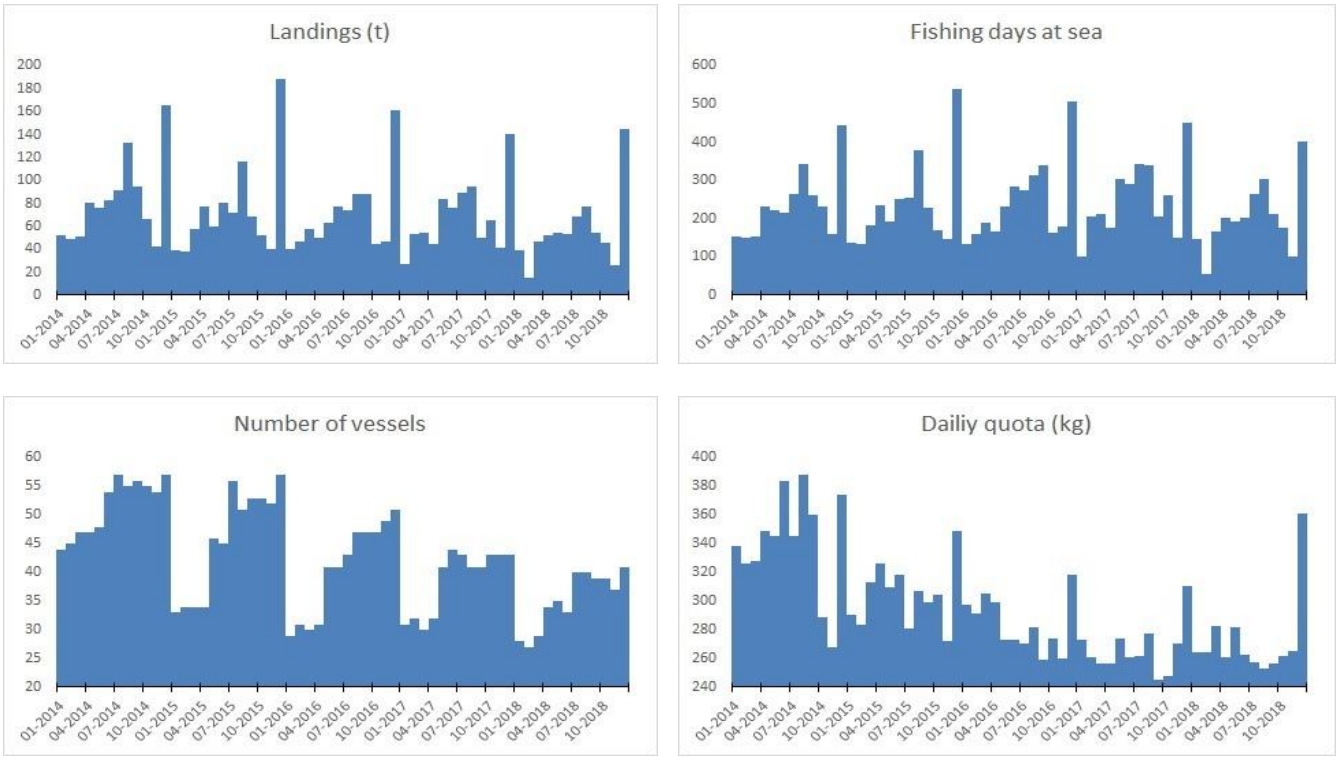

Figure 4.5. Observed trends in smooth clam (*Callista chione*) fishery. The trend of landings (up left), total cumulative fishing days at sea (top right), the number of vessels involved (bottom left) and daily quotas (bottom right). Source: Web

4.4. Description of the fishing and production process

The fishing activity for the venus clam (*C. gallina*) is conducted on a daily basis in inshore shallow waters along the Veneto coast, usually early in the morning and lasts 3-4 hours. The fishing activity for the smooth clam (*C. chione*) is conducted also on daily bases but takes more time because the sites are more distant from the ports and additional navigation time is required. The procedure for both species is similar; the appropriate hydraulic dredge with an appropriate grill size for the target species is towed backwards and the catch lifted on-board. The catch goes to a further selection process through a rotating sieve and a vibrating grill mesh. On board all clams are sorted, weighed and labeled with non-removable tags indicating the: i) name of the vessel, ii) specie, iii) method of capture, iv) fishing area, v) date of capture, vi) FAO zone (Figure 4.6) vii) country of origin, viii) unique lot number, ix) weight (usually 10 kg) and x) FAO code (SVE for venus clam *C. gallina*, KMK for the smooth clam *C. chione*). The remaining bycatch species are thrown back to the sea, while the undersized clams are released into designated areas for further growth. No additional processing is done on board the fishing vessels.

Figure 4.6. A map of the Mediterranean Sea (FAO 37) subareas. PO Bivalvia operates on the FAO zone 37.2.1. Source: Web

Further, the fishing vessels unload the bags of clams to processing facilities of OP Bivalvia located in Caorle (VE) or Chioggia (VE). There the processing starts by unloading the bags into a hopper, after which the clams go through a sieve and are measured and carefully selected. The first phase is carried by a machine, while the second selection procedure is conducted manually by an employee. Next, the clams are placed into large containers with a flowing salty water for purification and de-gritting. Finally, the purified clams are slightly seared and frozen, ready to be packed into PVC boxes.

4.5. Description of existing management over the resources (self-management) and availability and consistency of the resources

All the mentioned fishing vessels are part of two co-management consortia (the Co.Ge.Vo. of Venice and Chioggia) designated by the Ministry in 1995. to manage the resources ant catches of bivalve species like the venus clam and the hard clam.

Each vessel is equipped with GPS navigation and AIS and allows monitoring in real time of the fishing activity, and ensuring that they do not operate in protected or closed areas.

The venus clam (*C. gallina*) has a minimum conservation reference size (MCRS), set at 25 mm by the EU Common Fishery Policy (CFP) Mediterranean regulation (EU Reg. 1967/2006). Further, in 2016. the EU the European Commission adopted a three-year derogation (2017.-2019.) for Italy, setting the MCRS at 22 mm (EU Reg. 2016/2376). PO Bivalvia has additional conservation measures for catches of undersized clams, which should be released into designated or closed (nursery) areas for further growth and reaching the MCRS. By doing so, PO Bivalvia catches only the required quantities of clams above MCRS and preserves the remaining resources. Additionally, according to Italian regulation (DM 22nd December 2000.) there should be a two months interruption of fishing activities (temporary closure) each year, with the freedom left to the co-management consortium (Co.Ge.Vo.) to choose which months it should be. The temporary closure period may coincide with the reproduction period of the venus clam (*C. gallina*) from April until June.

From 2009. until 2011., the local venus clam (*C. gallina*) stock biomass had a significant decreasing trend in the maritime districts of Venice and Chioggia. However, later the stock has gradually recovered. The National Management Plan for hydraulic dredgers from 2014. (Reg. CE n.1967/2006) imposes the minimum biomass density to 5 g/m². The management plan for the period 2019. - 2021. proposes an objective to increase the biomass density to 10 g/m² by implementing a more efficient fishing management strategy. Local research institutes conduct the yearly monitoring surveys as a support for an appropriate management of the fishing activity and a long-term sustainable exploitation of resources. Additional support to Co.Ge.Vo. is provided by the research institutes, local health authorities and veterinary services who monitor the status of the resources, its biomass, growth rates, diseases and the status of the surrounding environment.

In particular, PO Bivalvia, cooperating with Co.Ge.Vo., adopted several initiatives for a sustainable exploitation of the clams, such as: i) seeding in nursery areas, ii) restocking, iii) catch control, iv) rotation of exploitation areas, v) temporary closure of specific areas for reproduction, nursery or recovery purposes.

The Co.Ge.Vo. also tries to manage the balance between long-term economic profitability and the sustainability of the resources. In particular, it adopts catch management rules with lower daily quotas (maximum 400 kg) than the actual market needs in order to maintain a high value of the product by avoiding over-flooding the market with excess of the product. Furthermore, fishing activity is limited to four days per week.

OP Bivalvia has also a resource management plan for the venus clam (*C. gallina*). The venus clam reproduces in the late spring/summer period, usually July - August, although there are year-by-year variations due to the reproduction cycle being influenced by environmental and site-specific conditions. Accordingly, the fishing activities are interrupted during its reproduction period. According to the regulation (DM 22nd December 2000.) each year there is 2 months obligatory interruption of fishing activities during the reproductive period. However, PO Bivalvia voluntarily adopts even more strict practices to preserve its resources, extending up to 5 months per year an unpaid interruption of fishing activities. For example, in 2018. the fishing activities for the venus clam were interrupted from April until the end of June, and then suspended again from October until November. Additionally, PO Bivalvia manages the spatial distribution of the resources to improve the stock biomasses. When necessary and in cases of

significant stock densities differences between different banks or areas, juvenile clams are redistributed from high-density areas to low-density areas to balance the natural stocks. When needed, the PO Bivalvia collects and re-seeds clams to nursery areas closed to fishing activities. For example, during 2018., PO Bivalvia re-seeded approximately 500 million venus clams.

The management of the smooth clam (*C. chione*) is carried only by the Co.Ge.Vo. consortium, who adopt the same practices as for the venus clam (*C. gallina*). The major difference is the adoption of the rotation of the fishing areas, where the vessels stop alternately for about two months. This way, the catches are continuous during the year and allow the resources to reproduce and grow in closed areas.

4.6. Short market analyses, landing prices, existent market flow for target species

PO Bivalvia sells exclusively fresh and frozen venus clams (*C. gallina*), while PO Fasolari in collaboration with Co.Ge.Vo. sell also the smooth clams (*C. chione*).

Both species are an important part of local traditional seafood cuisine, but also wider throughout the Italian coast, like spaghetti with clams and many others.

To achieve a whole year presence in the market, during the fishing period and also during the biological rest, we offer both frozen and fresh products. The fresh products are sold to local wholesalers packed in nets of 2, 5, or 10 kilograms.

On request, selected larger clams are sold as a premium product. The clients for the frozen product are the GDO/Retail sector and the Ho.Re.Ca. These products are sold under two different brands and two different packages, 450 and 1.000 grams. The standard brand used for the venus clam (*C. gallina*) is “I PescaOri” (Figure 4.7), while a brand certified for MSC and BIO is “La Venexiana” (Figure 4.7).

Figure 4.7. The brands used by PO Bivalvia for marketing the venus clam, "I PescaOri" on the left and "La Venexiana" on the right. Source: Web

The venus clam price is constantly changing due to the climatic conditions, if it is frozen or fresh, how many orders we received and even the price of our competitors.

OP Bivalvia has a 25 % of the fresh product market share, and although this is its strength, there is a constant need to adapt to other competitors and the demand-supply of the market. The price is always changing and it usually stays in a range between 2.80 and 5.90 €/kg.

On the other side, there are very few competitors for the frozen product, and therefore PO Bivalvia has a better control of the market quotes. The frozen clams have standard processing and packaging costs that can assure a stable price from 6.00 to 8.00 €/kg. The volume of the order is the main factor determining the price, lower processes are available for larger orders. The smooth clam (*C. chione*) is a resource present only in the north Adriatic Sea and the vessels associated with PO Fasolari are the only one fishing it, without other competition. The market demands for smooth clams are lower than the ones for the venus clam. Smooth clams are mainly sold in southern Italy for a price around 5.00 €/kg.

4.7. Strengths and weaknesses of the production status

At the base of PO's strength in the production process is the resources management plan, conducted in collaboration with Co.Ge.Vo. Restocking activities and an extended fishing interruption period and closure of areas are the key for maintaining sustainable resources, stable catches and constant and long-term presence on the market. The adoption of a short market chain allows containing and reducing the costs and offering high quality products. The production process is fast and efficient; the product is processed shortly after the delivery from the fishing vessels.

Although the production process is efficient, a significant point of weakness is the susceptibility of the resources, in particular the venus clam, to environmental parameters. In case of the venus clam, there can be significant events of natural mortality of the stocks due to changes of environmental parameters outside tolerated ranges for life. For example, sudden decrease of salinity due to extensive inputs of river runoff's fresh water can cause a high and significant natural mortality. In case of extensive mortalities in a certain area a restocking practice is required to help rebuild the stock.

Moreover, the current selection process implementing the vibrating screen allows a good selection for individuals of a certain minimum size. However, the selection process is 100 % efficient due to the variable ratio between the thickness of the clam and its length. This is an issue because the minimum conservation reference size is based on the length of the clam, while the selection process is based on the thickness of the clam.

4.8. Conclusion with areas where to apply development and innovations from catch to processing and packaging

A possible innovation in the production process may be to tackle the issue of undersized specimens to reduce the by-catches by increasing the selectivity of the catching (dredge) and sorting equipment (on board). Small variations in the diameter of the sieve holes lead to significant changes in selectivity (Froglia and Gramitto, 1981.).

Also, given the importance the environment has on the clams, a possible improvement in the production could be to develop dredges and fishing methods that would reduce the stress on the sea bottom and the organisms of infauna (Figure 4.8) and undersized specimens that could continue to grow in the same environment.

Figure 4.8. An example of the species caught by the hydraulic dredge during the fishing activities of venus clam (*C. gallina*). There are represented both species living in the seabed (infauna) and living above the seabed (epifauna). It can be noticed the difference in the abundance of large specimens of the venus clam (on the right) and the smaller ones just on the left of the larger specimens. Source: Web

The qualitative and quantitative structure of the associated in-faunal and epifaunal community can be used as an indicator of the environmental stress. In addition, the composition of the associated community can be used as a proxy to evaluate the influence of the pressure of the dredge on that environment and to evaluate its impact.

Finally, OP thinks it should be mandatory to find a proper option for the plastic net used for on-board packaging. A net made of biodegradable natural fibers could be a solution that would help respecting and safeguarding our environment and the sea from the threat of micro plastic.