“Piloting of eco-innovative fishery supply–chains to market added–value Adriatic fish products”
Priority Axis: Blue innovation
1.1 - Enhance the framework conditions for innovation in the relevant sectors of the blue economy within the cooperation area

D4.2.3. Courses and training, with mini-piloting, on developed innovative production solutions

WP4 -INNOVATING TOOLS AND PROCESSES FOR ADDED-VALUE ADRIATIC FISHERY PRODUCTS/ A 4.2. DESIGN, DEVELOPMENT FEASIBILITY OF SPECIALIZED POLYVALENT-MULTIUSE PROCESSING PACKAGING SOLUTIONS

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Document description

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The Prizefish project envisions the responsible fishery actions taken by the 3 private producer organizations assigned to partnership (FC Omega 3 (PO status), FC Istra (PO status) and P.O. Bivalvia), in sense of applying the innovative technology methods in catching/harvesting and processing of target sea species, with the final emphasis of creating innovative value-added products. To achieve goals related to less catch, with better prices, while affecting positively microeconomic ratios in the fishery sector, three P.O.'s have conducted different piloting actions. Thus, ensuring the increased quality of the catch and social aspects of each fisherman, as well as welfare of caught species in the future.

This document contains detail description on 3 separate piloting of innovative technology cases;

Piloting of the “sea pumps” for improved catching & handling of small pelagic blue fish - FC “Omega 3”

For the piloting of innovative on-board technology, the FC “Omega 3” has selected the external company MARIBU Ltd to conduct the tests by using the services from French Faivre Group. The main issue was to change transfer and manipulation of fish on board by pumping them to the bins instead of handling them manually. Additionally, manufacturer made adjustments to the existing aquaculture pump systems after technical evaluation on site. After the modifications, the pump was installed on the first purse seiner boat – “GALO”, owned by official PO member Mr. Damir Mišlov. Once the flock is surrounded with the net, and pulled gently to the side of the boat, the suction process begins. The central part is placed on the main deck next to the winch where it does not interfere with the preparation of the input cable, while water separation unit is placed on the cabin deck above the pump. All segments are always connected by flexible pipes. The thrust from the pump to the water separation unit must be sufficient to overcome a difference of at least three meters or more, as well as the primary suction. After separating the seawater, the fish is brought into the thermal insulation bins by the free fall. By piloted innovative technology, significant progress has been made in the management of responsible fishing, which is visible in the positive economic, social and environmental indicators. Economic indicators relate to raising the quality of raw materials: reducing damage when transferring fish to thermal insulation bins and avoiding the crushing of fish when attracting the net next to the ship. Faster transfer of the catch is enabled by releasing larger amount of the sea through the sea separation unit, allowing to quickly shock the live fish. Such action reduces the accumulation of lactic acid in the meat and deep tissue damage, which directly affects the preservation of the Ph level of the meat and prolongs the shelf life of the raw material. The presence of a smaller number of fishermen on board who are operating with the pump in relation to traditional catching method on the purse seiner ensures a reduction in operating costs.

By achieving better quality, fishermen benefit with a higher purchase price, while with the reduction in operating costs support higher earnings. Positive social effects are visible through greater safety on board, especially during bad weather conditions. Because of the effective operations on a vessel, fishermen also spend less time at the sea, and more with their families. Special emphasis is placed on the ecological aspect in terms of preserving the population of sardines and anchovies in the Adriatic Sea, because the piloted technology allows further progress in terms of the possibility of separating juveniles from mature populations, through the direct return of a live fish to the sea.

Piloting of innovative processing technology for shrimp de-pealing

Before it´s establishment in 2004, the Fisherman´s Cooperative Istra struggled with the uncertain placement of their goods on the fish market caused by the (seasonality of fish catching) seasonal nature of the fish catch, where a large number of fish would be caught in a short period of time and caused a reduction in the market price. This situation favored creation of the first fishermen association in Poreč. In order to reduce the falling prices and loss of money due to such outcomes, FC Istra decided to build a fish and maritime organisms processing factory in Labinci, where the fish surplus was processed, frozen and sold in the summer season when restaurants, hotels and fish markets are working at full capacity. Fisherman´s Cooperative Istra decided to make a step forward in production using new innovative technology. In order to start the piloting innovative technology in processing, Istra cooperated with external experts, Dalmatia Developers company - which developed guidelines with a technical description of the innovative production process. The innovative production process aimed to repurpose an already existing fish boning machine (German model Bader 601), which is the machine separation of shrimp shell and head from body separation. The technical operating principle of the machine is based on creating pressure with a flexible PVC tape on the perforated drum. For the separation of the Adriatic shrimp the 2 mm perforation is used. The machine is producing highest quality products thanks to the gentle, so-called ˝soft processing˝. It achieves a compact performance in high-quality stainless-steel machine parts, allows easy handling, cleaning and maintenance of the machine (saves time, reduces labor costs), and ensures the highest world-class hygiene standard. The machine is CE/ETL certified and USDA approved. Additionally, using new technology, FC decided to create a new innovative product – fish burger, made from fresh shrimp meat and minced mullet fillet, as an example of possible business diversification, which will add new market value to its product, reduce the load on resources, reduce labor costs and increase business profitability.

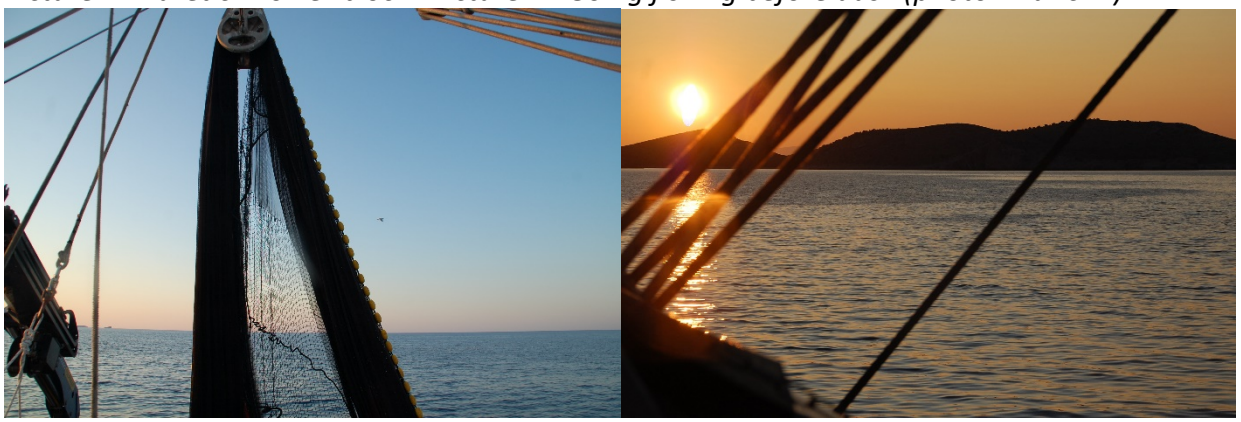
Piloting of the innovative clam harvesting tool and improving the cold chain process

The piloting activity of innovative technology of OP Bivalvia involved adopting different modified clam dredges. The main objective of the innovation process is to reduce the physiological stress of the caught clams that are otherwise subject to high water pressure jets and vibrations throughout the fishing process. Three different alternative configurations of clam dredges were installed on board of three fishing vessels and compared to a standard clam dredge used today. Different configurations of the gear involved modifying the cutting water jets, their shape and location, and also the configuration of the sieving screen, either horizontal or perpendicular. The test was conducted in the same fishing area and monitored by the experts. The goal was to evaluate the selectivity of the dredges, the impact on the environment, and to take clam samples to analyze the biological responses through microbiological tests. The results show that one of the tested fishing gears has consistently contributed to reduction of physiological stress of the clams, observed by lower values of weight loss and clams less subjective to microbiological proliferation than compared to clams from the standard fishing gear. Moreover, this fishing gear also reduces the impact on the environment by visibly decreasing the time of settlement of the sand cloud caused by the fishing activity. The reduction of physiological stress will benefit the fresh product allowing a possibility to extend the shelf life of the product and reduce the quantity of sand that the clams "ingest" during fishing. The undersized clams returned to the sea will also reduce physiological stress by increasing their survivability and therefore improving the conservation of the clam population and increasing the future ecological and economical sustainability of this fishing activity.

1. FC “OMEGA 3” CASE

The history of the development of fishing, fishing boats, fishing tools and fishing techniques is largely related to the development of fishing equipment that enabled easier manipulation, support in achieving catches and maintaining quality and facilitated the overall work of many supporting categories present in fishing. When we talk about purse seine "surrounding nets " and a significant improvement in fishing, the most significant achievement is the use of Puretić pulley "power block" patent-invention of fisherman Mario Puretić in San Pedro, who fundamentally changed the efficiency of fishing in the early fifties.

Picture 1. Puretić “Power block” Picture 2 . Going fishing before dusk (photo Andrić V.)



Significant inventions of fish detection in the sea through echo detection, the use of sounders and sonar, and the use of ice and cold water to preserve the freshness of the fish on board followed with fleet modernization. Part of the innovation on the equipment was dedicated to the facilitated transfer of fish to the ship using vacuum pumps, mainly on ocean-offshore fishing boats with direct transfer to ship's cold storage.

Today, the basic goal of improving technical operations comes down to generating a better position in the market through the achieved quality.

The market for small pelagic fishery products in the Republic of Croatia and Republic of Italy is specific due to the history of development and growth of the sector, due to new circumstances in the catch and due to the current situation on the domestic and world markets. The market for small pelagic fish catches consists of:

- The traditional canning processing market which mainly includes sardines
- Renewed salting processing market, which mostly includes anchovies, and a smaller part of the market is looking for sardines
- Newer market for anchovy processing by marinating
- Freezing processing market
- Fresh produce market
- Market of fresh product intended for animal nutrition (tuna farming)

Some buyers in the market have the opportunity to process the fish in several ways, as well as ship it to tuna farms. For this reason, it is not possible, according to customers, to clearly distinguish the purpose of the purchased fish, or to determine the market of the caught product according to the final product.

The basis of the piloting program through the PRIZE FISH project is to develop significant innovation or apply new adaptive techniques and technologies in preserving the quality of catches of small pelagic blue fish whose experiences would be shared among fishermen in the Adriatic basin and which would enable greater participation in the fresh market. Previous studies have shown that it is more significant to raise the quality, but a number of other frameworks for catching small pelagic fish can be raised by using pumps in fishing instead of the traditional method of fishing with a fishing net with the help of a crane.

Although the use of pumps in fishing to transfer fish from sea is not a recent technological operation on a global scale, but it is an absolute novelty and innovation in the Adriatic basin, but also in the Mediterranean in catching the largest fishing resources of sardines and anchovies. Fishing with pumps in ocean fishing is applied on large vessels where the fish is pumped into built-in ship cold tanks where it is frozen. Today, two types of pumps and suction are known in fishing. One is a submersible propeller pump, while the other is a vacuum pump. Both pumps are used in industrial fishing however both have part of the limitation which is why we decided to test the pump used in aquaculture.

Namely, in addition to the issue of safety at sea at different weather conditions, as well as the dimensions or volume of fitting the equipment in the general plan of the ship, the issue of damage to fish using other pumps is also raised. Pumps in aquaculture are used to transfer live fish from a few grams to several kilograms. The proposal of this project was to follow the technologies applicable in aquaculture and adapt all units for use on a fishing boat, assuming a significant increase in fish quality.

Guidelines and assumptions for the development of the application of innovative techniques and technologies in this case were primarily related to:

-Raising quality (reducing damage, avoiding crushing, preserving muscle pH, prolonged shelf life, histamine avoidance, (etc.)

-Adjustment to operations with smaller dimensions of equipment -volume and weight on deck (does not affect the workflow of operations on deck and does not affect the stability of the ship)

-Continuous operation without process interruption or obstacles or bottle neck

-Possibility of discharging a larger amount of sea (separation of the sea before entering the thermal bins)

- Significantly increased operational safety

-Less load and fewer fishermen in the operation

After the development and processing of the market, it was realized that such standard units are not in use within the Adriatic Fleet and the Mediterranean Basin and that it is necessary to make significant changes in terms of defining the new system and especially the efficiency of pumping and discharge of excess seawater. Taking into account all the settings, it is defined that the prototype must fit into the existing technical technological processes on board with the implementation of pilot testing of the manufacturer closest to the desired technical solutions. In that direction, the equipment manufacturer Faivre Srl was contacted and offered the option of participating in a pilot project with the desire to monitor and adapt the system to a functional sense.
Based on all previous experience, it can be assumed that the company is able to follow the construction of a pilot unit selected for the purpose of manipulating the catch, which has the characteristics of innovation and is ready to apply it in a pilot experiment without requiring additional funds. He also confirmed this with a letter of intent like the fishing boat Galo where the implementation will be done.

1.1. Basic management settings of the FC “OMEGA 3”

By building its own processing plant for the FC “Omega 3”, the market of the first sale for most of the catch was precisely determined, while the remaining part was estimated on the basis of the dominant activities of the customers. The next step was, on the basis of sufficient economic activity, to obtain the conditions for recognizing the status of a producer organization. This chapter will present the basic settings for the functioning of the cooperative as a producer organization excluded from their development plans.
To promote sustainable FC “Omega 3” fisheries, the producer organization initially planned to reduce catches per boat. Due to the demanding quality of the products and the un-equipment of the fishing vessels themselves, lower catches per product are required, thus creating the Premium quality category in accordance with raising the level of quality of fish preparation on board.
The strategic determinant was the creation, but also the raising of the share of PREMIUM quality products. The same was recognized in the SWOT analysis as an opportunity to establish better quality "Premium" and prices for fishermen. It is necessary to define the possible branding, licensing and promotion of fishery products today and tomorrow, but due to a large number of public and private standards, it largely depends on the market in terms of choosing the method and type of certification. It is exclusively a market category that is related to consumer perception and customer requirements in a particular market which can be very different.

Fishermen's Cooperative Omega 3 - producer organization planned to start making its own or funded marketing analysis to select the right direction of certification for their own catch products and products placed on the market. The certificates that the plant has are: ISO 9001 and ISO 22 000, but it has its own standard implementations that need to be confirmed and renewed every year (recertification). For possible new certificates, it is necessary to create a basis for recognizing the necessary standards in relation to the markets, and then move in that direction of the selected certificates.

Premium products are harvested in smaller quantities, but achieve a higher market price on average 25-30% more. Of course, such a strategy is correlated with sustainable fisheries and the level of management, so we can say that the FC “Omega 3” - producer organization with this determinant gives its contribution to sustainable fisheries in the Republic of Croatia. When catching and delivering premium fish from catch to plant, more effort is needed (more ice, faster transport, higher costs) which are returned with a better price, and the need for logistical structures can be seen from unloading, transport, acceptance and processing to plant and shipment to end consumers or distribution channels.

In order to achieve premium quality, more effort is needed, especially on board, and therefore there is a need to equip ships that are not yet equipped with ice machines, cold water and a crane (faster transport of fish) as soon as possible. Today, most ships are very well covered in this field.

There is a need for education and fishermen’s self-education in terms of technical and technological settings for the application and use of new equipment. It is necessary for fishermen to change their mentality from "as much catch as possible" to "as high-quality catch as possible - PREMIUM" through organized education, with a constant increase in quality.

It is also a strategic determinant of the capacity of the plant in Šopot (Benkovac) and the expansion of the capacity of the IQF for freezing as well as the storage capacity of frozen fish. The FC “Omega 3” is a stable business unit with highly organized fishermen involved, good market and business management, built its own plant for receiving, freezing and storing fish. In line with good European practice, it represents a very good start in terms of starting to set up producer organizations where the Fisheries Administration and the competent authorities can be an outstanding partner in measures and implementation of biological resource management rules. The same is recognized as strength - sustainability and joint and contractual management - partnership with the state - recognizing the importance of cooperatives and producer organizations.

When we speak about management, given the long-standing trends so far, no problems are expected in the sustainability of sardine livestock in the future, and by organizing fishermen there is an increasing share of fishermen in marketing their catches, which contributes to the category of resource management through marketing and catch control. Unlike sardines, anchovies are located in the red zone and there is a need to raise management levels in anchovy fishing. FC “Omega 3”, regardless of the stability of the sardine state, will continue to apply all mechanisms that benefit the further preservation of biological stocks. In its strength and power, FC “Omega 3” will implement all measures adopted at the level of the Fisheries Administration - Ministry of Agriculture.

FC “Omega 3” has introduced and continues to introduce premium quality for which fishermen receive a higher price, provided that the catches do not exceed 75% of the maximum daily catch capacity for an individual boat because only then the fish can be preserved in the "premium" class, or increase boat performance in terms of catches by introducing new technologies. This approach to establishing and increasing the share of the Premium class can significantly contribute to establishing market stability and preservation of the natural resources. The goal is to constantly increase the share of catches and fish preparations in the premium class to approximately 65%, by expanding the production facility and increasing the catch acceptance at a level greater than 50%, the overall effect can be reflected in reducing sardine catches. Increasing the capacity of the plant opens the possibility of introducing a premium class for anchovies. In addition, there will be coordination of dialogue and cooperation with relevant scientific organizations in fisheries and cooperation in terms of developing scientific advice to support management decisions related to fishery resources (Institute of Oceanography and Fisheries and other relevant institutes and scientific bodies, Ministry of Agriculture, projects …)

Special categories of action - extracted from the FC „Omega 3“program:

Avoiding and reducing unwanted catches

• avoiding and reducing, as far as possible, unwanted catches of commercial stocks and, where appropriate, exploiting such catches, without creating a market for those below the minimum conservation reference size, in accordance with Article 15 of Regulation (EU) No 182/2011. 1380/2013;

Catch discards are a rare category. All members of the organization are fishermen with extensive experience, aware of the harmfulness of hunting juveniles and "bycatch". Knowing the situation on the market and biological livestock, they try to avoid any type of illegal catch as much as possible. In case of the need to dispose of part of the unwanted catch, there is a readiness to take it to the nearest unit for receiving and processing fish into other categories. Currently, the legislative framework provides for a minimum net “eye” size of 14 mm. It is planned to gradually animate the members for a minimum net “eye” size of 16 mm and thus avoid completely catching juvenile anchovies and sardines. Some members are already using a larger size.

Contributes to the traceability of fishery products and access to complete information for consumers

• contributing to the traceability of fishery products and access to clear and comprehensible information for consumers;

The contribution of traceability and food safety and information to consumers is carried out through our own plant, respecting all standards of food handling and labeling the product in the prescribed manner. The production facility is registered by the competent authorities.

Education on traceability, consumer safety and labeling is carried out with all new members of the producer organization, but there is also control over its members and assistance in implementation. The part of the fish that goes through the drive is easier to monitor, and the rest is subject to regular checks through periodic inspections.

Branding as a category with regard to the type of fish is a very demanding category and at the same time a category that must be approached by knowing the marketing and sales framework where fish ends with regard to the specifics of each market. The same needs to be linked to certification and the proper selection of public and private certification bodies as these categories are market determined.

Contribution to the elimination of "IUU" fishing practices

• contributing to the elimination of illegal, unreported and unregulated fishing

In accordance with the previous, the fish is inspected on landing by the competent authorities and all traffic is documented.

1.2. Framework for application of technological solutions in FC “Omega 3”

The catch of FC “Omega 3” members is mostly small pelagic fish. The dominant, caught and marketed species is the sardine. Anchovies come in second place in terms of quantity, and the category of mixed fish is in third place. The catch of fishermen members has a significant share in the entire Croatian fishery, and especially in fishing with purse seiner catching the sardines, where it participates with over 20% in the total national catch of small pelagic fish. Categories of mixed fish also appear in the catch, which mainly characterizes mixed catches of sardines and anchovies. Given the high share of sardines and anchovies in previous catches, no significant change in the structure of catches by sardine purse seiner is expected. Members of the fishing cooperative put their catch on the market in bulk through the collection and distribution center in Šopot or, due to the lack of cold storage capacity, market their catch directly in compliance with the rules of the Producer Organization. The main port for all members is Kali and Zadar.

- Presentation of the SWOT analysis of the entire sector of catches of small pelagic fish with the connection on the OP action

STRENGHTS	OPORTUNITIES
1. Significant populations of small pelagic fish in the natural environment - good fishing areas 2. Accepted management plan for the surrounding network of sardine purse seiners 3. Implementation of GFCM measures 4. Strong tradition and tourism development 5. Limited fleet 6. Sustainability, joint and contractual management - partnership with the state - recognizing the importance of cooperatives and producer organizations - responsibility 7. Several market-oriented cooperatives 8. Selective fishing methods 9. Development of monitoring systems and programs 10. Ownership of benefits 11. Organization of the sector through fisheries associations 12. High quality of fishery products due to favorable environmental conditions, 13. Natura 2000 marine, which enables the preservation of habitats that contribute to the renewal of fish stocks.	1. Strengthening effective fisheries market cooperatives and associations 2. Raising the price of fish with a market-oriented approach 3. Demanding market niches (product quality, product price and continuity of demand) for frozen fish 4. The need for a greater degree of processing and processing of frozen fish 5. Needs to increase the capacity of the plant to receive fresh fish 6. Changes in fishing management to meet the needs and requirements of the market, continuity of supply, quality and price. Integrated management 7. Sustainability due to limited number of permits 8. Possibility of progress in education, manipulation of catch on board, establishment of a cold chain 9. Better quality "Premium" and price, branding, certification, reduction of complaints 10. Possibility of direct sales to esteemed and targeted markets 11. Constant reporting on the economic size and importance of the industry 12. Development of a regional management plan 14. The possibility of using the EMFF fund in raising the objectives of the Common Fisheries Policy 15. Direct participation in MEDAC

WEAKNNESES	THREATS
1. Lack of logistical strength of cooperatives 2. Large market oscillations, low purchase price of catches and uncontrolled fishing. 3. Insufficient education, insufficient equipment of vessels and facilities for the cold chain, lack of storage refrigeration capacity 4. Lack of marketing and economic studies and analysis 5. Lack of administrative staff to assist in bookkeeping and administrative legal new monitoring and reporting needs 6. Insufficient cooperation and lack of reasoned discussions within industry and industry at the regional level of cities, municipalities and counties in terms of industry needs 7. Lack of industry scale in terms of transport - logistical problem of reaching distant markets with a better price 8. Insufficiently researched markets - new ones are currently missing 9. Impossibility to attract younger generations in fishing from the catch itself to the management structures due to lower incomes 10. Lack of fish waste management - by-catches, discard. 11. Distance from fishing landing places, especially in the summer months, and lack of thermo bins, sea ice equipment, the crane reduces the quality of the catch 12. Insufficient fishing infrastructure and superstructure - port facilities for receiving logistics 13. Lack of complete product traceability 14. Lack of perceptions of importance on food safety 15. Unfavorable composition of catches in purse seiner catches leading to increased fishing effort on insufficiently equipped vessels.	1. Reduction of resources due to the impact of global climate change, pollution, urban pressure 2. Competition in the same product - low prices 3. Lack of economic perspective and perception in decisions in resource management 4. Lack of funding for science 5. Strengthen fishing restrictions 6. Unargued discussions on the environment / economy / resource balance 7. Management of fishing for other species independently of small pelagic fish

The entire SWOT analysis was made according to the model of analysis of the fisheries sector, but with special reference and connection to the possible activities of fishing cooperatives and producer organizations in the conceptual definitions and environment. In a very large part of the processing, given the direction of the analysis, there is a detailed link between the same and the more widely processed SWOT analysis in the category of sea fishing.

The presentation of the SWOT analysis shows that a good part of the possible opportunities, but also a part of the weaknesses is in direct correlation with the quality of the fish. The catch so far has been left to large market fluctuations, low purchase price and partly uncontrolled fishing, which can be red from the weaknesses in the SWOT analysis conducted in the table.

With the establishment of the fishing cooperative, its gradual strengthening, the construction of a collection and distribution center, the market position, there was a strong change in the perception and participation of fishermen in marketing and management of fishing effort and the above moments in terms of joint and agreed management and producer organization - the responsibility of several market-oriented cooperatives is a strength that is recognized in the SWOT analysis. The presentation of catches in the past few years shows the stability of the FC “Omega 3”. It has started to make production plans while achieving a significant impact on the stability of the market and income for members of the cooperative and beyond. Such an approach to production management, along with the development of marketing plans, are possible tools for resource management with constant work on quality.

1.3. Raising the quality of catches on board

The production plan for FC is almost always based on the strategic determinant of production of the "Premium" sardine class, which includes the maximum daily catch per vessel. Premium quality is defined by a special protocol and recognition of the input and output quality of the fish, for which a better price can be obtained. This means that the fish is properly shocked already on board as part of a small catch, delivered to the facility without signs of gill bleeding and has the characteristic recognizable properties prescribed by the protocols. By limiting catches and increasing quality, sustainability is being pursued and preparations are being made for expected catch restrictions. Despite this catch-restrictive measure which should reduce catches per vessel, this plan expects an increase in the market value of sardine catches, which is based on the expected price increase.

This is especially seen through the following elements:
- Increase in catch revenue in the first sale market
- Adding value to products from own catch
- Contribution to market stabilization
- Contribution to rural development

Adding value to the own catch, in the new FC plant, is achieved on two levels. The first level is the composition and quality of the fish caught, and the second level is the processing into a frozen product. The composition of the catch implies the purity of the catch by the presence of the dominant species as well as by the uniformity of sizes within one species in the catch. Mixed catches of sardines and anchovies have a lower price on first sale due to the need for additional sorting work. Such catches enter the plant and sorting is done in the plant itself. The sorted fish is then entered in the records as a catch by individual species and such goes to freeze. The quality of the fish caught includes preparation, acceptance of the fish on the vessel and maintenance of the cold chain until freezing. At this stage, the emphasis is on sardines for which a "premium" class has been introduced. Premium quality can only be achieved when the catch is limited to the receiving capacity of the vessel to preserve the required qualities that are assessed upon arrival at the facility itself.

In this way, the sustainability of fishing is encouraged because the income of fishermen is sought to be improved by increasing the quality of products instead of increasing the catch itself. On the contrary, it stimulates the fisherman to target a smaller catch that will ensure a better price. At the first sale (in this phase of investing in the plant where part of the income after processing goes to settling debts for the investment) premium class fishermen achieve a price on average 22% higher than the price that would be realized in the available market outside the plant. Freezing and premium class contributed to the increase in revenue on first sale through its own plant. The overall effect of the increase in value through production activities in the plant in the investment phase is related to the state of market prices, and bearing in mind that the fall in market prices requires a disproportionate provision of plant revenues for servicing labor costs and loan repayments.
With regard to fishing activity, the first-sale market relating to in-house processing or to canning and salting processing has the following characteristics:

• The price of the first sale depends on the seal and the quality of preparation and maintenance of the cold chain
• Purchase options are limited by the processing capacity of the processor
• Selectivity in catch contributes to market price
• Fishing costs are rising with catch targeting for a market with better prices

A relatively small part of the catch is placed on the fresh market, which offers the best prices, but is the costliest and logistically demanding for fishermen.
At the moment, the structure of catches, costs and opportunities to accept catches on the market are such that it is not possible to quickly and significantly change market positioning. However, it is necessary and possible to gradually change the basis for turning to markets that allow to increase the sustainability of sardine fishing. For this it is necessary to work on longer preservation of freshness and quality of fish. Anchovy is an important species in fishing with purse seiner because its share in the catch is inversely proportional to the fishing pressure on the sardine resource. This is due to the price of anchovies on the first sale which is 2-3 times higher than sardines. The missing catch of anchovies thus lacks the income that must be compensated by multiple catches of sardines.

The first sale for anchovies is simpler than sardines, because anchovies are placed in three market niches. The main niche markets for anchovies are the salting and marinating processing market, the fresh anchovy market and the freezing processing market, which is partly related to the preparation for long forms of processing. FC will continue to work on the preparation and monitoring of scientific and technical education aimed at reducing operating costs, raising quality and developing services to members of the producer organization.
One of the found innovations is the possible use of pumps for transferring fish, and the project will determine the possibility of implementing a pump system as new equipment to improve the quality of fishing, fisherman safety and easier work on a fishing boat.

The main goals of this project are:
• Examine the possibility of using an aquaculture pump for fishing while adapting to the technical and technological framework of the catch and accommodation operation within the general plan of the vessel
• Testing in the direction of raising the quality, efficiency and welfare of fish
• Testing that new fishing practices can replace those currently in use,
• Examination of the possibility of pumps in vertical and horizontal transmission of fish with simultaneous replacement of existing fishing methods,
• Conduct a comparative study of the pump system for fishing on board with classical methods and replacement cost

1.4. Selection of an initial prototype for the implementation of a pilot fish pumping program

Most of the available operational options have been reviewed and it is concluded that emphasis is placed on the innovative application of pumps used in aquaculture and ensure adaptation to the fisheries sector by compiling a new technical-technological operational flow. Previous analyzes have been carried out, with strict adherence to previous fish handling recommendations, the implementation of newer methods of loading and transporting catches involving the use of loading pumps, sea separation units and isothermal transport bins on all vessels where conditions allow, as that the combination of these methods, with strict adherence to standard recommendations for fish handling, ensures maximum uplift and preservation of catch quality.

Pictures 5. and 6. Fish treatment in industrial fishing,
Source https://www.youtube.com/watch?v=V2Prpr4GF_I

The implementation of the pumps, the assumed speed and efficiency allow to act directly and indirectly on other critical points as well as the possibility of collecting without excessive squeezing of fish and possible separation of sardines from anchovies, which is also a new moment of the assumed operation.

The following priorities are important when fishing and catching:
• Achieve maximum quality of catch or landed raw fish with minimizing damage
• Improve working conditions by eliminating all jobs that cause physical exertion and fatigue of fishermen,
• Raise the safety of fishermen when conducting new operations
• Improve fish welfare conditions through faster operations

To achieve these goals, it is necessary to introduce the use of equipment and procedures that will, in addition to quality assurance, eliminate difficult lifting, uncomfortable body positions of workers and rough handling of fish. This speeds up catch processing and reduces the time required to cool the fish (Olsen, 1992). (source: (Olsen, KB, K. Whittle, N. Strachan, FA Veenstra, F. Storbeck, and P. van Leeuwen (1993). Integrated Quality Assurance of Chilled Food Fish at Sea. Technological Laboratory, Technical University, Lyngby, Denmark. 58-60.). It is also necessary to reduce anoxic phenomena in fish and shorten the killing time.

Pictures 7. and 8. Influence of new catch and freezing methods on histamine levels and shelf life (freshness), Source: https://www.youtube.com/watch?v=V2Prpr4GF_I

Pelagic trawlers and purse seine catching small pelagic fish, lift the entire catch using cranes to the deck by various methods. The total weight to be lifted can be up to 4 tons in the surrounding net, which poses a high risk for cracking of the net, loss of catch, damage to equipment and injuries to workers, especially in case of bad weather conditions. There are several methods to make it easier to transfer the catch to the boat. The simplest is to use **brailer (scoop net)**, followed by conveyor belts with bulkheads or spoons that grab the fish and transfer it from the net to the deck, but always with the use of cranes. The basis of transferring within the Adriatic basin is the use of brailers and cranes. With this fully used method of transfer, there is a significant compression of the fish in the net as well as the crushing of the fish in the brailer where up to 400 kg of fish can be concentrated. The process is extremely active, requires maximum attention and the work of at least 5 people on the operation. Since the full brailer must be dropped during bad weather, it is very easy for fishermen to be injured if they are not maximally concentrated as well as skilled.

Pictures 9. and 10. Classic fishing using brailer and a crane
https://www.youtube.com/watch?v=0420KRojNhs

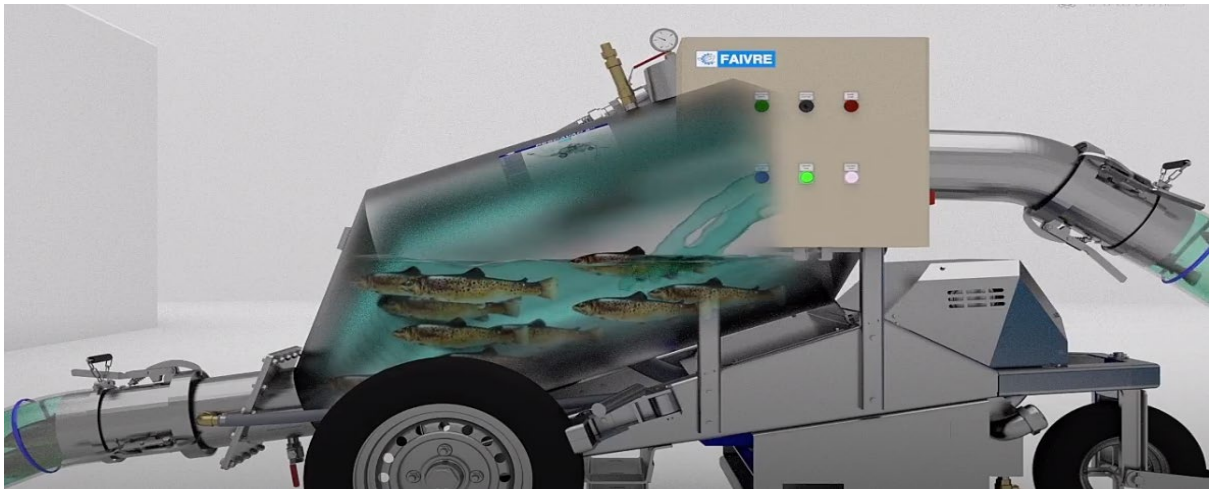
In addition to the manual method, dry and wet pumps are used. Wet pumps do much less damage to the fish as they carry a mixture of fish and seawater that protects the fish from shocks.
Submersible pumps are known in industrial fishing, but they are of considerable size, require exceptional insulation of moving parts, and their main disadvantage is to immerse themselves completely in a compressed flock of fish where there is significant depletion of fish and mechanical damage caused by hitting fish on metal structures, but also by pulling the fish itself. At the same time immersing the suction device in the net can lead to damage to the net, too much thrashing during bad weather so that the use of these catch systems is abandoned.

Pictures 11. and 12. Submersible drainage pump type
Source https://www.youtube.com/watch?v=V2Prpr4GF_I

Another form is vacuum pumps that do not have a constant flow, but the capture and ejection of fish occurs alternately using vacuum and pressure P / V pump (eng. - pressure / vacuum). Usually these pumps have significantly larger dimensions and it is difficult to place them in an adequate place - they must be fixed.

Picture 13. Appearance of fish when fishing with classic industrial submersible pumps
Source https://www.youtube.com/watch?v=V2Prpr4GF_I

Picture 14. Vacuum pump - display of water concentration (web-Faivre)



The principle of operation of the vacuum units of the pump consists in the fact that a vacuum and increased pressure are alternately created in the storage tank by means of the pump and non-return valves. The fish is sucked together with the water through the pipe and valve to the tank. When the tank is full, the direction of pumping is changed from vacuum to pressure and the fish is transferred through another tube to the strainer. P / V pumps do not damage the fish too much, but work relatively slowly due to the change in pumping direction and pressure. This can be avoided by installing two P / V tanks that work alternately and use a common pump.

Such use of pumps in aquaculture has been replaced by suction propeller pumps with non-return valve, semicircular turbine and blades and creating vacuum in the pump itself, using double pumps, where the need for large tanks is lost and the fish goes continuously without touching dangerous parts of the pump. When used in aquaculture after the fish is sucked out of the water, it is usually necessary to sort it by size or species and possibly count and create uniform cages by number and size of fish.

Picture 15. Demonstration of fish transfer in aquaculture
https://www.youtube.com/watch?v=hqzUduFMGlk

1.5. Description of the selected production solution

It has been established that operations in the traditional catch of small pelagic fish in our country, but also in industrial fishing, carry the risks of damage and quality decline. The development of fish conservation from catch to plant and to the final consumer of small pelagic fish has made significant strides throughout history. The preservation of fish as well as the growth of quality is directly related to the application of modern technical and technological achievements and application on the ship, ie the quality of fish can be preserved in the initial phase immediately after catching. What is missing in this process is the further handling of the catch because it is subject to damage, kneading and biochemical spoilage processes.

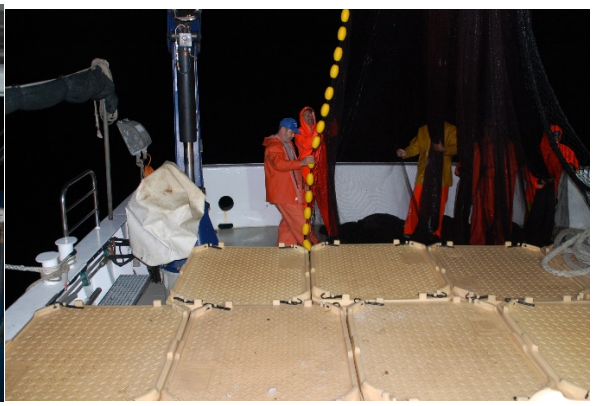
A more significant solution to the problem of damage and efficiency, as stated in the previous study, could be solved by the use of pumps for loading fish, which enable much higher speed of grabbing fish and suction and shortening the time the fish spends inside the net. In addition, according to fishermen's experience, pumping does not require as high a flock density as the brailer loading method, reducing the impact of stress, mortality and the possibility of physical damage to the fish, as well as improving the quality of the meat. Also, the fish is lifted to the deck in the jet by means of a pump, which eliminates the possibility of damage due to crushing and additionally contributes to the quality of the fish since it is possible to transfer live fish directly from the net to the cooling tanks.

The basic input parameters for the selection of pumps or systems of fishing equipment were based on the following assumptions:

-Dimensions of equipment and volumes adapted to ships and the lack of cooling chambers in the hull- the use of thermo bins on deck
-Installation of pumps of smaller dimensions, portable, easy to install and operate, high suction capabilities, variable suction power
-According to the total weight of the equipment on deck- lighter units
-Achieved better quality of fish with reduction of crushing and physical damage - use for the market of fresh fish and fresh frozen fish- damage minimized
- Efficient model of pump and discharge unit so not to impair the need for rapid cooling of fish in thermo bins
-Adapt the system so that it can be installed on a ship that has movement, and it is necessary to make suction and discharge of the sea before entering the thermal insulation bins.

The pump operating system used in aquaculture, the so-called propeller or impeller pump, was chosen as the most optimal production solution. By studying the fishing industry in the world as well as studying the possibilities of implementation, it decided to make innovative solutions by using existing solutions from the aquaculture industry. Namely, the aquaculture industry has been developing pumps for years, which transfer live fish from the minimum size of a few grams of weight to several kilograms of individual weight. This transfer system knows the transfer of live fish from one pool to another as well as selection, but always in the presence of the sea and in selection and counting. However, the clash between the fishing industry and the breeding industry in this segment has not yet occurred. Such an assumption has become a hypothesis in terms of making a complete unit.

Pictures 16. and 17. View of the arrangement of insulation bins and stern part of the ship for stacking the purse seiner's net / lack of space as one of the limiting factors (photo Andrić V.)



1.6. Implementations in the current technical and technological framework or production process

The need for small transmission units with high suction efficiency, variable power and a unique pre-pump frame was taken through the Faivre pesca pump category 6. By studying the capacity and capabilities of existing pumps on the market, the primary aim was to avoid vacuum systems with a tank that require more space and are difficult to implement on existing ships as well as submersible pump systems.

Picture 18. and 19. Smaller pump for transferring live fish in aquaculture (Source: Faivre web)

Classic equipment on board, which in addition to the usual discarded parts of the engine room has classic winches and a significant part of fishing equipment and tanks takes up considerable space, so it is planned to place the pump on deck where fish would be dragged to the pump by at least one and several meters of altitude difference and after the pump ascended to the sea separation unit which would be located on the ship's cabin. The basic characteristics of the pesca 6 pump are its very light weight of 190 kg (419 lbs), as well as its small volume and the possibility of transport on a wheel. The propeller is directly driven by the so-called motor. "Direct drive" unlike previous pulleys. No maintenance required. Filling to the pump goes through the primary pump "prime pump" very fast filling to the main pump and then automatic shutdown when the flow of the sea and the flow of circulation has been established. The pump has a potentiometer with which it can regulate the speed of the sea flow, and the speed is also adjusted in relation to the size of the fish. The pump can also be controlled remotely.

Pictures 20. and 21. Inspection of equipment when going fishing and selected pieces of equipment on deck (photo Andrić V.)

By using this very small pump, the required deck space is significantly reduced, while ensuring that the thrust from the pump to the dewatering unit is sufficient to overcome a difference of at least three or more meters from the suction point to the pump, where the fish with sea is pushed to the dewatering unit, and later by free fall of the pipes is transferred to the thermal insulation bins. The whole system requires a more significant level of combinations to obtain a unique implementation solution on multiple ship types. By reviewing the dimensions as well as making technical sketches and experimental units, it was determined that it is possible to assemble a system that will not interfere with most operational processes and passage, providing a very much needed and wanted effect.

1.7. Technical schemes for the implementation of the pilot project

This chapter will present the basic technical schemes that have been used and modified for assembly before the investigative categories of mechanical components should be installed on a ship, taking into account dimensions, positioning, pumping height differences and assumed pumping efficiency. Given the completely new experiences in this segment of all participants, two options were considered regarding the suction power and the required speed of fish extraction, so that in the primary development, two pump options of 5.5 and 11 kw were considered, respectively larger or smaller pump. Considering the possible evaluation and the speed of pumping and raising the sea, a lower variant of the Pescamotion 6 pump was selected for pilot testing. Inlet size 150 mm. The elaboration of the possibility of accommodating the pumping system has been done on several ships in order to see a possible unique model of installation or optimum installation.

As the deck of fishing boats is occupied with external mechanical equipment, deck equipment, engine room covers, superstructure, it is most ideal to place the pump itself in the central part of the vessel towards the stern of the cabin. Namely, the entire stern part is connected to the reserved place for the purse seiner net, and as many rows of thermal insulation bins as possible where the catch is stored should be placed from the stern towards the central part of the ship. It is strictly necessary to take care that the iso-thermal bins are blocked in one part or secured and that there is no movement in case of bad weather during transport after the end of fishing.

Pictures 22.,23.,24. and 25. Overview of the measures for a classic purse seiner (photo Brnčić V)

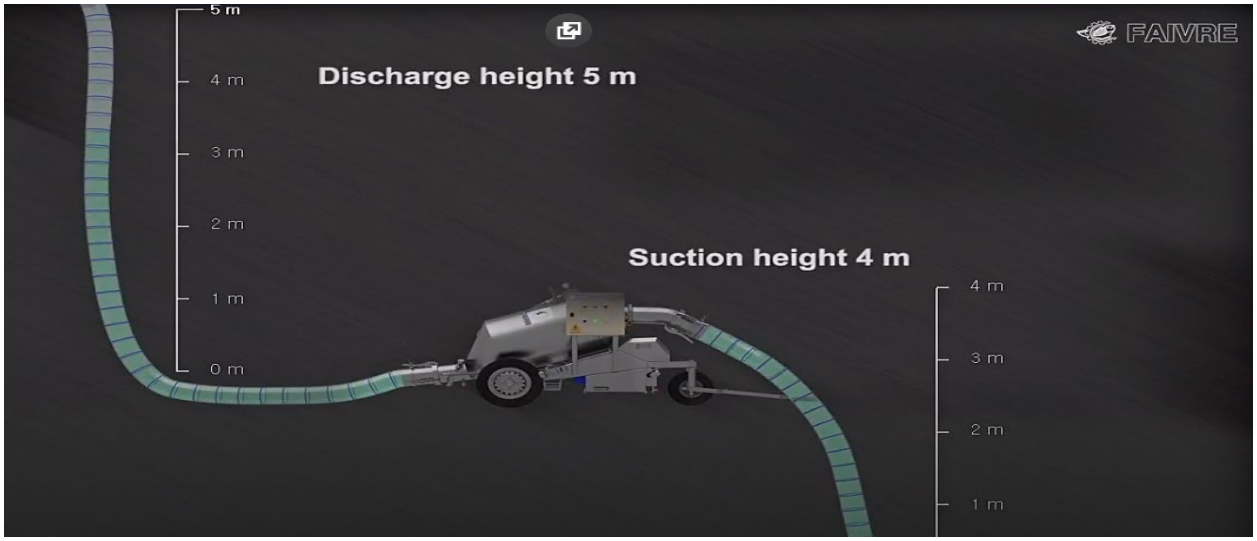
The pictures above show the classic look and occupancy of the deck of a boat fishing for small pelagic fish. From the center of the ship to the stern there is no place to implement a pump because the same surface is used to accommodate bins. At the same time, in order to fill the bins and to achieve the discharge rate as well as the separation of the sea before discharge into the bins, it is necessary to place the dewatering unit on the roof of the cabin, preferably just above the pump. It follows that the pump is best placed in the passage to the winch so that the pipes connecting to the separation unit must be as close as possible, but again far enough away to allow the system to work properly.

Namely, the shortness of the pipe can cause excessive concentrations of sucked fish, which is not good and can significantly affect the quality of the fish.

Picture 26. Vinch placement next to the cabin (photo Brnčić V.)

The placement of the pump usually occurs near the winch, at the stern of the cabin. It is this position of the passage to the winch that could be ideal for connecting to the sea separation unit which should be located above the pump on the cabin. Namely, the fish that is sucked into the pump together with the sea, must be transferred to the dewatering unit and then using the free fall the fish must be significantly separated from the sea and released into bins. It is also important to drain the sea from the fish very fast to transport them into the cooled bins, where they are shocked. It is also important for the suction speed to have as little intervention in the sea as possible, ie to enable the shortest pipe path per deck. The depth of suction can be greater so as to avoid excessive squeezing of the fish.

Picture 27. Display of pumping direction and overcoming height differences
https://www.youtube.com/watch?v=wI1-X45x3tw

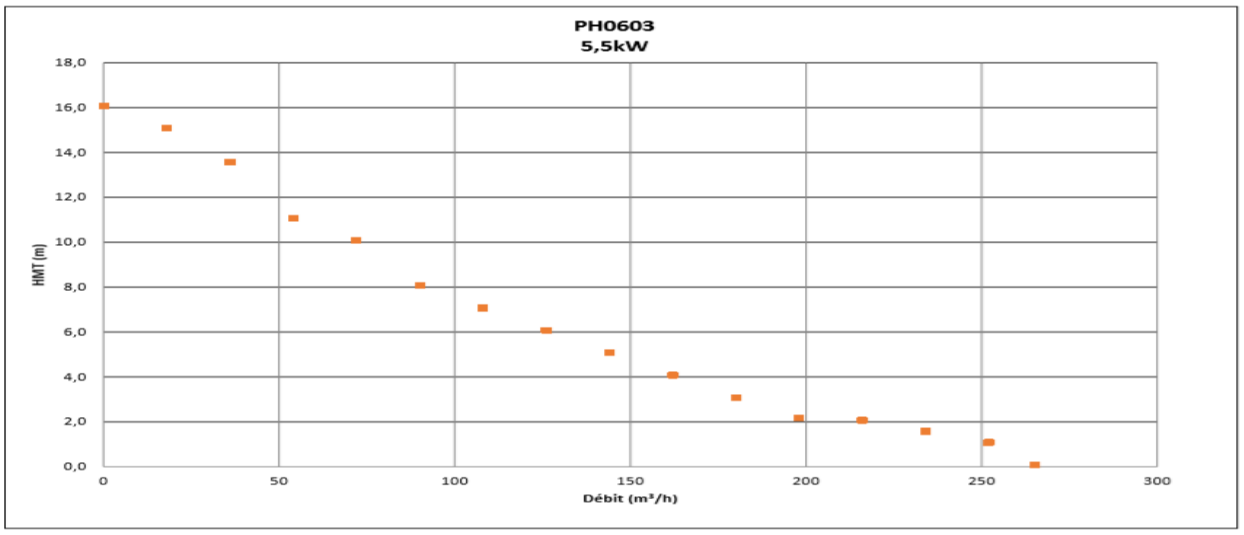


It can be seen from the above that there is very little horizontal transmission of sea and fish while the basic emphasis is on overcoming height differences. Working with the vacuum pump shown in the figure would slow down the whole process due to the vacuum pump operation settings (suction-push-stop) so it is necessary to take a pump unit with a continuous flow that can be accelerated or reduced depending on the number of fish. The ideal pump for such interventions is the impeller pump.

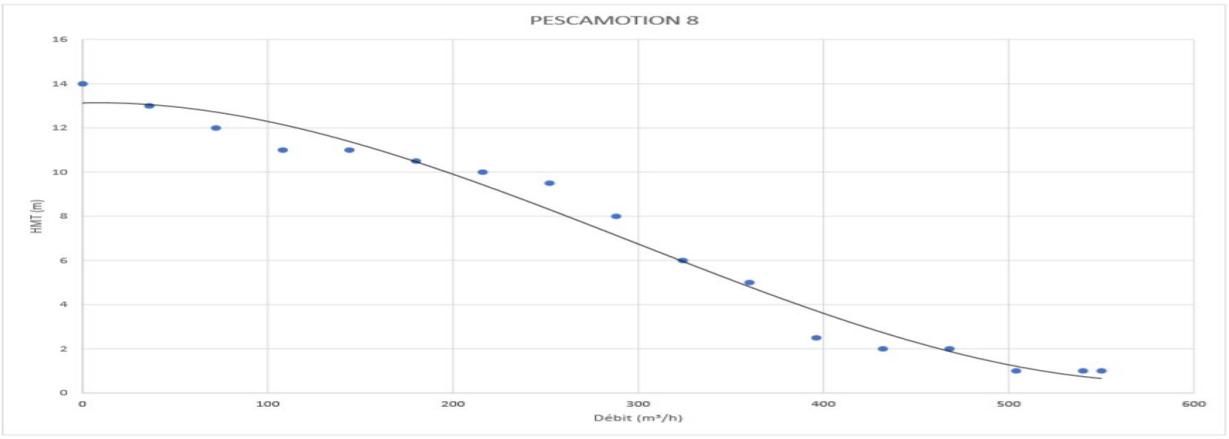
Technical documentation of equipment to be adapted to the pilot project

When selecting the pumps as well as the suction assumptions, care was taken to ensure that the suction was strong enough to overcome the height difference of about 3 to 4 meters at the start to a pipe size of 6 inches (152 mm). After that, it can transfer the fish vertically to the dewatering unit for the next 4-7 m. Of course, the depth of the intervention as well as the assessment of fish damage is related to the amount of sea that can be raised, and the selection of this pump was chosen as optimal for testing with an indication of the possibility of testing a larger unit.

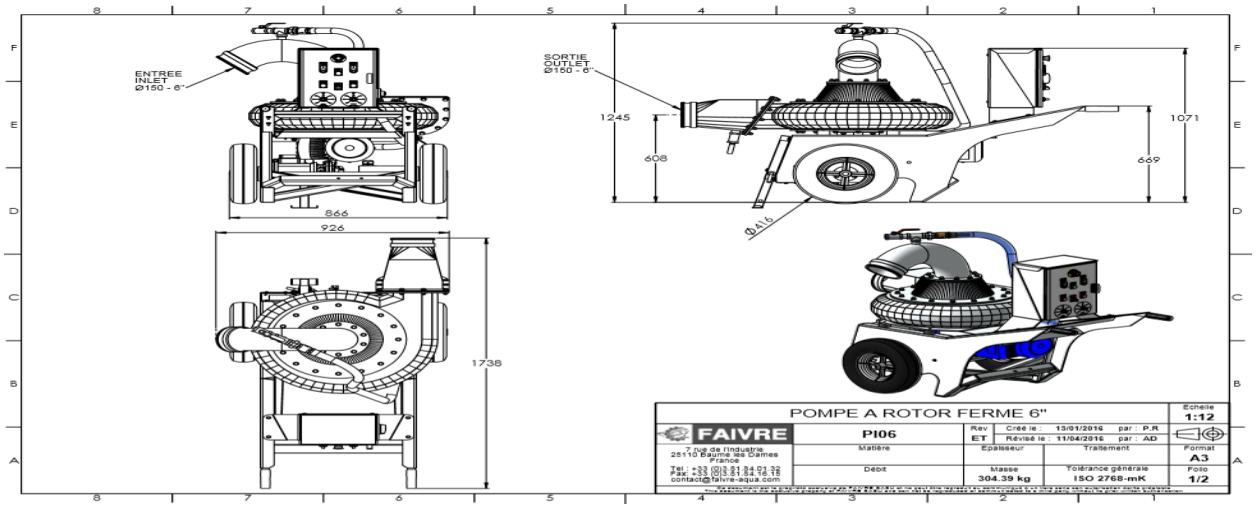
Picture 28. Pump power display - pesca motion 6 (Source: Faivre documentation)



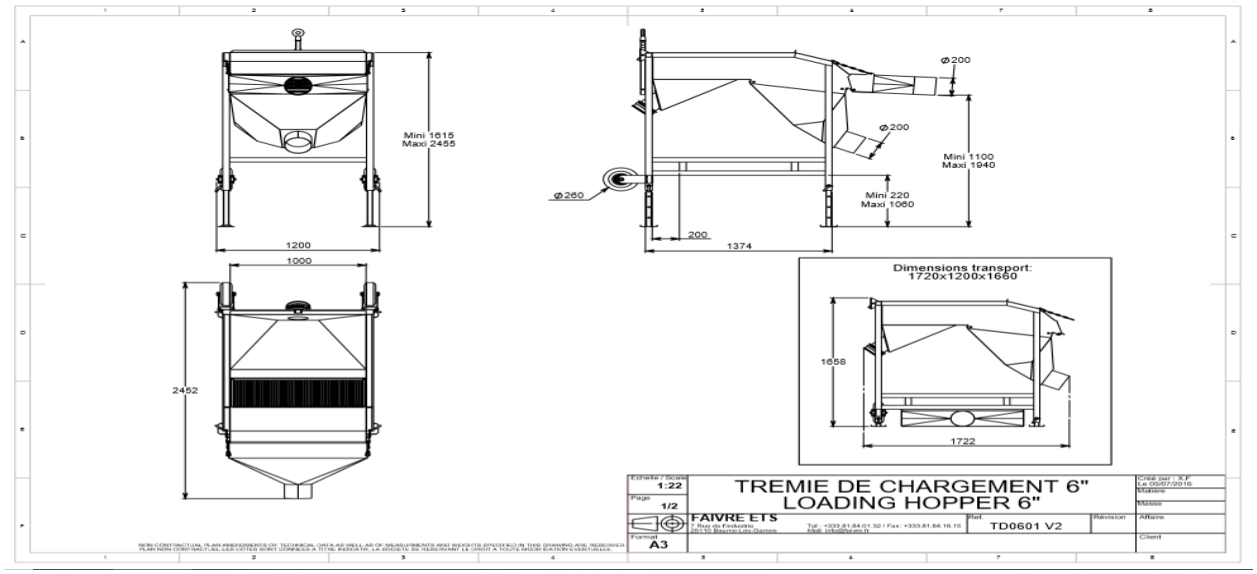
Picture 29. Pump power display - pesca motion 8 (Source: Faivre documentation)



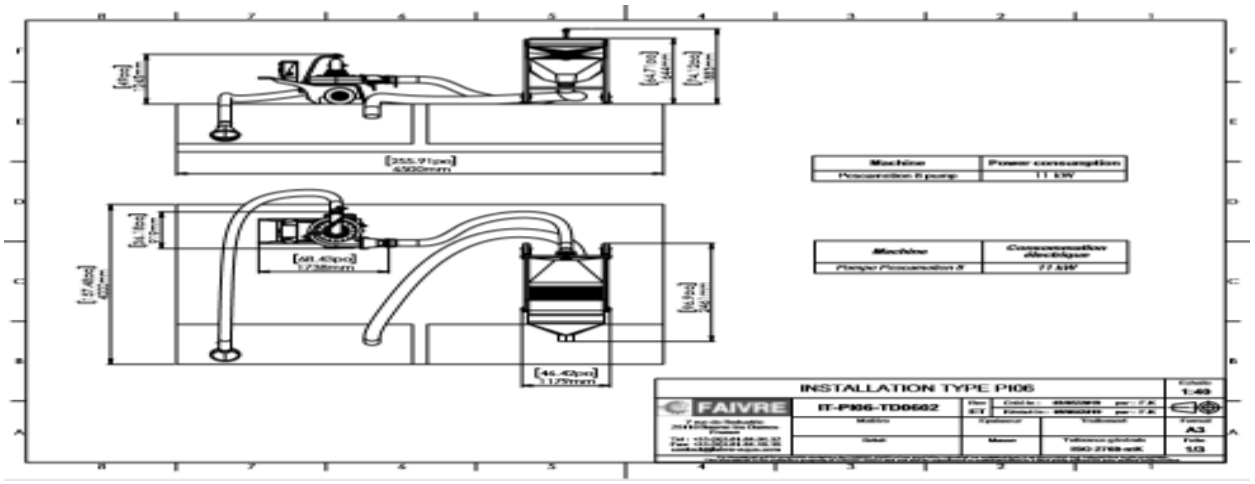
Picture 30. Pump size 6 inches- 150 mm pescamotion 6 (Source: Faivre documentation)



Picture 31. Dewatering unit (Source: Faivre documentation)



Picture 32. Display of connections for which height differences need to be managed (Source: Faivre documentation)



Selected fishing system equipment such as the pump, dewatering unit, pipes and fittings were supplied by Faivre Srl and taken on board to the Galo ship where the primary assembly frame is set which is assumed to function as well as monitor efficiency at catch rate and fish quality. Analysis will be performed on site and later on fresh and frozen products.

1.8. Basic technical settings of the prototype and selection of the implementation carrier

Through this chapter we will provide the basic technical schemes that were used and modified for assembly before the investigative categories of mechanical components to be installed on the ship taking into account the dimensions, positioning, height differences for pumping and the assumed pumping efficiency according to the dewatering unit. Given the completely new experiences in this segment of all process participants, two options were considered regarding the suction power and the required speed of fish extraction, so that in the primary development, two pump options of 5.5 and 11 kw were considered, respectively larger or smaller pump. Considering the possible evaluation and the speed of pumping and lifting, a lower variant of the Pescamotion 6 pump was selected for pilot testing with the inlet size 150 mm.

The technical name of the product is pump Pescamotion 6 (Ø150 mm)

Main features :

- The flow must be up to 232 m3 / h with a maximum hydraulic transmission height: 12 meters, very light weight of 202 kg, portable and easy to handle. Automatic shutdown of the primary pump when flow is established. Direct maintenance-free operation.
- Power supply 50Hz: 3x400V (320-415V)
- Power supply 60Hz: 3x460V (345-480V)

IP67 Remote control for Pescamotion 6 "(range 200 m). Supplied with charging stand and rectifier. Basic functions are start and speed adjustment.

The technical name of the product is pump Pescamotion 8 (Ø200 mm)
Main features:
- The flow must be up to 470 m3 / h for a height of 2 m. The flow must be 100 m3 / h for a height of 11 m. Maximum hydraulic transmission height: 12 meters, (4 m maximum suction height and 8 m discharge)
- Maximum transmission length: 1000 m, very light weight of 600 kg, portable and easy to handle. Automatic shutdown of the primary pump when flow is established. Direct maintenance-free operation.
- Main pump motor 11kW. IP67 Remote control for Pescamotion 6 "(range 200 m). Supplied with charging cradle and rectifier. Basic functions are start and speed adjustment.
- Power supply 50Hz: 3x400V (320-415V)
All installation is poured into one socket and it is necessary to prepare a sufficient length and strength of the cable for connection.

Pictures: 33. and 34. Control cabinets and remote control
https://www.youtube.com/watch?v=P7CcAVikLtU

These pumps prove to be ideal for flowing large amounts of fluid over relatively short distances, which generate large flows at ultra-low power levels, designed to maximize system efficiency. These pumps are specially designed and custom made for such applications. The use of these pumps processes a large amount of fluid in which it is constantly circulating. In the new application, their use becomes an innovative application. Within the ship, the systems can be installed quickly and economically due to their low weight, mobility and small dimensions. By placing the two basic elements of the pump and the sea discharge unit (dewatering unit) in the correct places on the ship, later comes only the connection with flexible pipes that can be permanently connected, but also, if necessary, quickly separated. Controlled increase of power, continuous flow, low hydraulic losses in the system and optimal pumping operating points result in the best economical solution. The pump is designed for applications that require a very large opening through the ultra-low head. The pumps are extremely compact, using multi-pole motors instead of a mechanical gear. Removing the gear box saves mechanical wear, improving reliability. The reduction of spare parts has also been improved.

Socket adjustment, combined into a single, rigid plug-in unit, protects the motor from intrusion by sea. Direct drive also means fewer moving parts for greater reliability. The propeller is made for maximum efficiency and optimum operating point. The electric motor has thermal overload protection and is practically for very difficult working conditions. ASTM 316L stainless steel provides excellent corrosion resistance.
Implementation carrier - the first implementation on the Galo ship owned by Ribarski obrt Mišlov - Captain Damir Mišlov

Picture 35. Motor boat GALO (IMO: 8657122) is a fishing boat built in 2008. and is part of the Croatian fishing fleet.

Source https://www.vesselfinder.com/vessels/GALO-IMO-8657122-MMSI-0
Ship characteristics:
Total Gross Tonnage: 106 tons, length 25 m.
The fishing boat Galo was chosen because of the exceptionally good results in the category of conservation and quality of fish, as well as the technique of catching fish.

1.9. Use of workshop drawings and operational preparation of the unit on board

After the decision on the definition of a pilot pump, it was assembled and tested in the factory of Faivre Srl. With the delivery of the unit, the assembly on the ship Galo, which was in the port of Kali, began. After unpacking the equipment, the pump unit was first positioned on the central deck near the stern part of the cabin and the winch where there is the most room for passage and manipulation. The pump is placed below the protective barrier so that it can also be secured to prevent movement in the event of adverse weather conditions.

This was followed by assembling all the units on board and putting them into trial operation before going to sea - that is, a closed-circuit test.

Pictures 36. and 37. Location of the pump in front of the stern of the cabin and fastening (photo Lovrinov M.)

The positioning of the pump was followed by the placement of the dewatering unit, which was located in the part of the cabin above the pump. The need for such a position is to reduce the required thrust height, but also to have easier access to the unit. This unit is also attached to a fence to prevent any movement.

Pictures 38. ,39., 40. ,41., 42. and 43. Placement of the fish discharge unit on the cabin (photo Lovrinov M.)

At the end of the connection, the suction pipe had to be prepared and connected to the pump. The suction pipe has a conical funnel at its inlet, which allows fish catching as well as possible and prevents damage.

Pictures 44. and 45. Tube with funnel for catching fish (photo Lovrinov M.)

After all the elements were connected, and the wiring was previously prepared, the pump has started. The control panel is very understandable and clearly shows the steps that need to be followed to make a referral. After starting the primary pump (prime pump) which is used to bring sea water to the pump and solve the primary sulci (filling the complete pipe with water), after filling the sound signal appears, after which we start the main pump and the flow is established. In case of intervention, it is necessary to start the number of revolutions with the potentiometer in case of a possibly larger height difference for overcoming. When the main pump is switched on, the primary pump stops automatically. Establishment of a full circle with verification of all elements, and the highest one which is the dewatering unit indicated that technically all operations from suction to pump, thrust to the dewatering unit, and the separation of the sea from fish work.

Pictures 46., 47. and 48. Test release in Kali (photo Lovrinov M.)

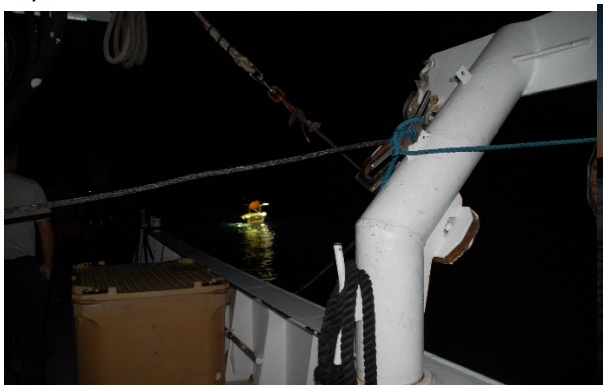
Picture 49. The ship Galo prepared for the first test hunt (photo Lovrinov M.)

1.10. Conducting the first test catches by pumping

After all the equipment was installed and all the elements were checked, with the beginning of the darkness, the first fishing trips started. The fishing area was the offshore islands of central Dalmatia. After collecting the fish, they started to store or throw the net and close it and pull it out. The fishing technique is explained in the previous program section.

Picture 50. Monitoring fish movements and netting decisions (photo Andrić V.)

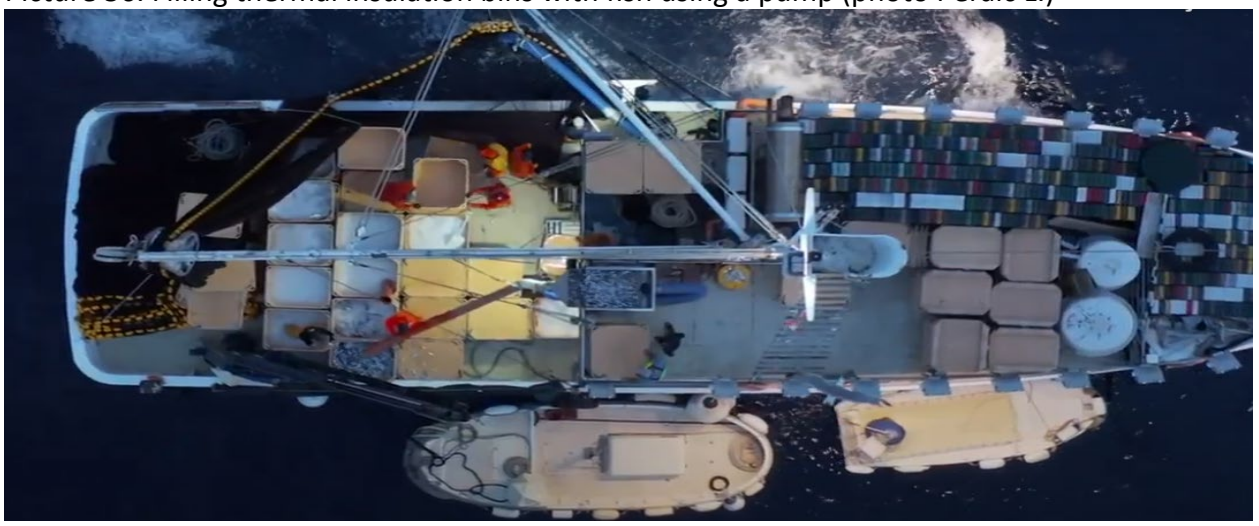
Pictures 51., 52., 53. and 54. Attracting fish to the light, stocking and pulling the net (photo Andrić V.)



After throwing and rounding the fish, its withdrawal to the boat begins, while closing the bottom. When the net is sufficiently gathered next to the boat, the pumping or catching of fish from the net begins. For the purpose of better presentation of the operation as well as the dimensions occupied by the equipment, a drone camera was used to obtain a high-quality aerial image.

Picture 55. View of the boat in the fishing operation - the net is raised and the catch begins - suction and transfer (photo Peraić L.)

Picture 56. Filling thermal insulation bins with fish using a pump (photo Peraić L.)

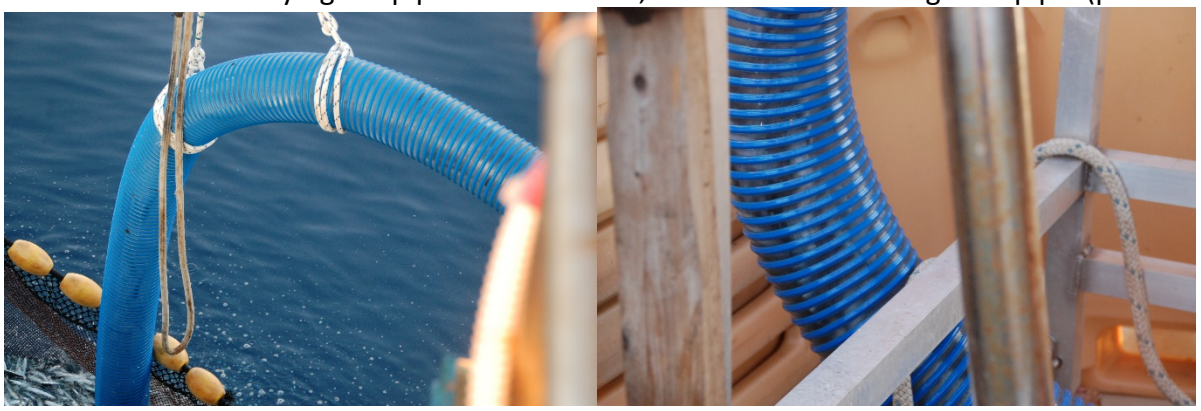


From the picture above, which was made using a drone, an aerial shot clearly shows the pipe that collects the catch and transfers it between the cabin and the winch to the pump. The pump is located on the deck below the dewatering unit, which is located on the cabin. After separating the sea, the fish is filled into thermal insulation bins by pipes. The picture clearly shows the schedule of operations as well as the small dimensions when looking at the whole ship. The same indicates the possibility of installing a larger 8-inch pump as well as a larger dewatering unit in case of need.

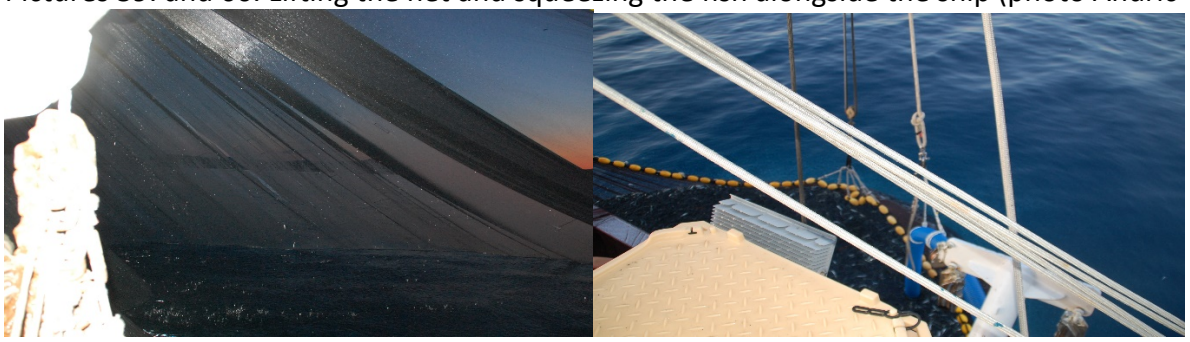
System adjustments in operation and first output parameters

The first operation went without any problems in terms of starting the pump and starting the suction. Given the completely different practice of pulling the catch on deck, it was necessary to change the course of work of fishermen in operations where they had to control only the filling of thermal insulation bins after pulling the net and the start of suction. During suction, it was noticed that individual pipes should be adjusted to the pressure in order not to create pockets or depressions. Namely, a part of the flexible pipes does not have sufficient strength, so it bends and prevents the normal flow of the fish. The same was solved by tying the part of the pipe where the dents occur and later changing it into stiffer pipes that do not allow bending.

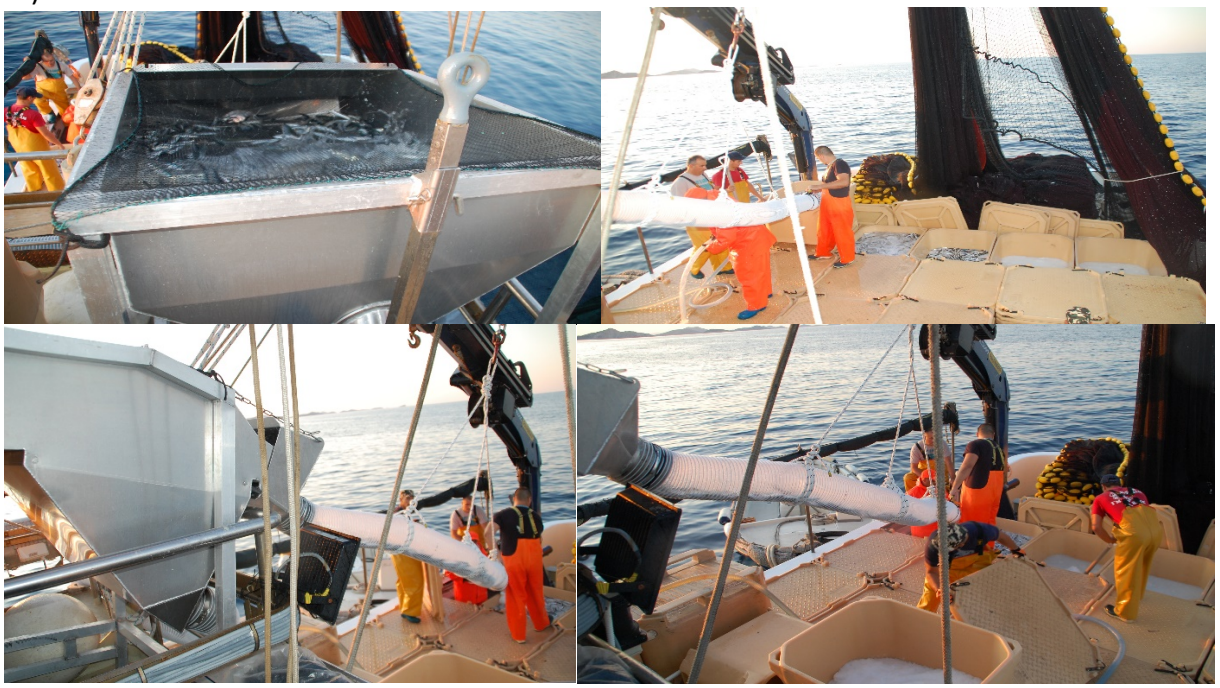
Pictures 57. and 58. Tying the pipe to avoid dents, the flow of fish through the pipe. (photo Andrić V.)



Pictures 59. and 60. Lifting the net and squeezing the fish alongside the ship (photo Andrić V.)



Pictures 61., 62., 63. and 64. Passage through the dewatering unit and filling into bins (photo Andrić V.)



1.11. Determining technical and technological advantages and disadvantages

The first catch of fish proved very promising with slightly observed problems related to pipe twisting. The main problem occurred only on the differences in the quality of flexible pipes as mentioned earlier. Namely, the flexible pipe must have its displacements, but the stronger it is, the harder it is to manipulate. The correct that, the ratio must be found between the strength of the pipe and its bending and the problem of notching at the bends.

Pictures 65. and 66. Connections for quick connection of elements and pipes (photo Andrić V.)

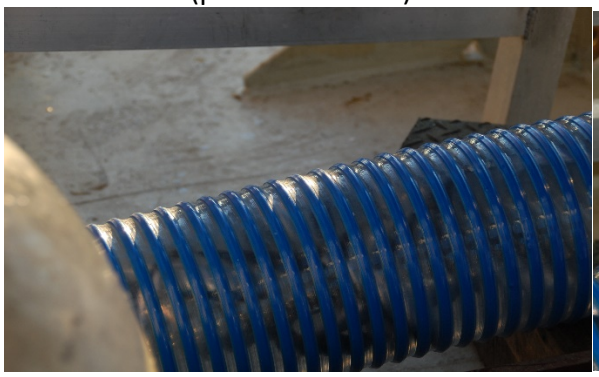

The connection joints are very well made, which enable quick connection and separation of individual system elements.

Pictures 67. and 68. Pipe damage at bends (photo Andrić V.)


Pictures 69. and 70. quality differences in connecting pipes (photo Andrić V.)


When purchasing the pipes, it is necessary to take care that they are transparent - so that the flow of fish can be seen through them.

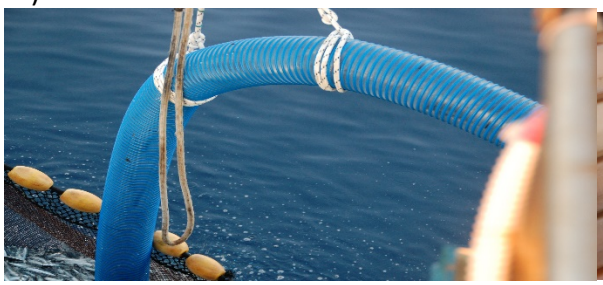
Pictures 70. and 71. The transparency of the pipe allows you to see the flow rate as well as the number of fish sucked (photo Andrić V.)




The transparency of the tube allows you to see the flow rate as well as the number of fish sucked.

It is recommended not to squeeze the fishing net to the end and to suck 2/3 of the sea and 1/3 of the fish even less so as not to crush the fish in case of pulling a larger number of fish without the sea. The main goal is to harvest practically undamaged fish, reach the dewatering unit and be transferred by free fall to a bin with chilled water. In this way, in addition to raising the quality, we also work on the welfare of fish in terms of their faster and painless killing.

Pictures 72. and 73. Demonstration of pipe filling and protection against pipe bending (photo Andrić V.)




1.12. Preparation for later evaluation of the final product

This chapter defines the possibility of technical implementation of the system for pumping fish on board. The categories sought were related to quality, worker safety, facilitated handling, speed of operation, and fish welfare.

Pictures 74. and 75. Drawing near and preparation for pumping (photo Andrić V.)


Examination of samples for analysis of visible damage and subsequent assessment of the final product will be defined in the processing plant.

PREMIUM PROTOCOL

The protocol for fish production in the plant in Šopot, as well as the protocol for achieving "Premium" quality contains a number of technical parameters as well as systematization by technologists that FC “Omega 3” implements to meet the better quality of fish.

FC adheres to the food safety system HACCP, ISO 9001 and ISO 22000, which it implements in the given forms. From these systems that we apply, the final characteristic of the fish is clear, which is where we emphasize the responsibility of the technologist to accurately mark the fish based on the given protocol parameters of production (HACCP, ISO 9001, ISO 22000) and visual appearance where it records its assessment in prescribed forms.

Finally, the system of organizing HACCP, ISO standards and the work of employees is all defined with special emphasis on the technologist who is responsible for assessing the premium quality of fish and who gives the final assessment.

Fish quality assessment

The quality of the samples was assessed according to the quality assessment system applied within the FC, which assigns points to the samples in the range of 1 - 10 based on external appearance, ie the presence of yellow and red shades (blood) on the gill covers and abdomen after freezing. Samples with a rating in the range 1 - 2 are considered the third category and are used for feeding tuna in farms. Samples with a rating of 3 - 5 are considered the second category, which is primarily intended for processing into canned fish, while samples with a rating of 6 - 10 are considered the first category, ie fish of the highest quality. The presence of damage to the abdomen (belly burst) automatically classifies samples into the third category and such samples are awarded 1 point, regardless of other parameters that are evaluated. The presence of other physical damage was determined by visual inspection.

The basic primary monitoring parameters were taken from part of the experiment conducted by WWF-Adria on determining fish quality by comparing catches from several vessels by traditional catching methods. Vessel A is a vessel with a pilot pump category done on Galo boat, through this piloting experiment.

Picture 76. Appearance of fish after pump extraction (photo Peraić L)

Efficiency of loading fish from the net by different methods

The efficiency of loading fish onto the vessel using different methods (pump, turkey-catch bag) in combination with different transport methods was assessed based on the measured duration of loading fish and the total weight of the catch after weighing in the processing plant.

Comparison of the quality and efficiency of using a fishing pump in relation to traditional ways of catching small pelagic fish

Temperature profile from the moment of catch to processing

A review of the results of temperature measurements from the moment of catch to the beginning of processing showed that cooling with a mixture of sea water and ice effectively lowers the temperature of the fish in the short term. Immediately after immersion of the fish in the cooling bins, a sharp drop in the temperature of the samples was observed, which in the period of 15 - 17 min from the initial temperature in the range of 17 - 18 ° C reached a temperature in the range of -2 to 2 ° C in ships A and B and 1 , 5 - 7.5 ° C for ships C and D. The differences in the achieved cooling temperature are due to the different ratio of water, ice and fish in the cooling tank, which in ships A and B was 1: 1: 2, while on ships C and D were 1: 1: 2.8. Significant differences were observed in the temperature profile during transport and storage until processing, where in the samples from ships A and B (transport in isothermal bins) the sample temperatures were almost constant, in the range of -2 to 2 ° C and gradually approached 0 ° C. During the transport of fish in cassettes (boats C and D), a sudden jump in temperature was observed after packing the fish in cassettes, which was also contributed to by the fact that no ice was added to the cassettes due to the relatively large amount of catch. During transport to the unloading point, with the air temperature in the range of 15 - 18 ° C, the temperature of the samples increased to 7 - 10 ° C (ship C) and 10 - 14 ° C (ship D).

With the addition of ice when unloading the cassettes into the truck and transporting them in a refrigerated cargo space, the temperature of the samples decreased to 1 - 2 ° C (ship C) and 2 - 6 ° C (ship D).

The described temperature oscillations can have a significant impact on the quality of fish, which was confirmed by the assessment of the quality of fish in the plant, which was carried out immediately before the start of processing. In vessels A and B the fish was of the highest quality and was classified in category 1, while in vessels C and D the fish was classified in category 2 although the total time from catch to processing was shorter (about 7 h) than in the case of vessels A and B (about 9 h). Since the temperatures of the sea (17 - 18 ° C) and air (15 - 18 ° C) were almost the same during all 4 experiments, these differences can be attributed to differences in the method of cooling and maintaining the cold chain during transport and storage. It should be noted that the temperatures during the experiments were relatively mild and that during the summer months the sea and air temperatures can be more than 25 ° C, which is why a much greater impact on fish quality can be expected during the summer months.

Influence of time elapsed from death to onset of cooling

An experiment in which the standing of compacted fish in the net during boarding was simulated showed a marked influence of the time spent in the net on the quality of the fish. The average fish quality assessment shows a constant decline during the standing of the fish in the sea, immediately from the moment of catch. During the first 60 minutes, the decline in the average quality score is very slight (average score in the range of 9 - 10), after which there is a faster decrease in the average score, ie loss of quality. The limit score (6 points) for the transition to the second quality category was achieved by the samples at about 140 minutes in the case of ship C and about 170 minutes in the case of ship D. 1 point was awarded and they were automatically classified in category 3. The first abdominal injuries (10 - 20% of the examined samples) appeared in samples that stood in the sea for a period of 100 - 120 min, after which the number of such samples increased rapidly. with further standing in the sea and in the period of 140 - 180 min the share of damaged samples ranges from 40 to 47% of the examined samples.

As the samples in these experiments were transported separately from the rest of the catch after cooling, in an insulated bin with a large amount of ice, larger changes in quality due to manipulation and temperature fluctuations during transport can be expected for samples undergoing the usual transport procedure. In addition to the above, the fact that the samples were kept at a temperature of 17 - 18 ° C during the experiment and that a significant and much faster loss of quality can be expected in the summer months due to the higher sea temperature should also be taken into account. From the above, it can be concluded that fast boarding from the net to the vessel is crucial for the quality of the fish in order to minimize the time from catch to cooling the catch.

Physical damage

Although during the assessment of the current fish handling practice no physical damage was observed due to inadequate fish handling, i.e., the influence of human factors, it can be expected that the method of loading and transporting fish has a certain impact on the possibility of physical damage. The fact that the damage is not visible to the eye does not exclude the possibility of internal damage due to shocks, crushing and vibration during transport, which expose the tissue to enzymes and microorganisms and accelerate the process of quality loss.

The highest probability of such damage occurs during the removal of fish from the net using a brailer, since a full net can hold and transfer about 100-400 kg of fish and can crush the fish at the bottom. In the case of pumping fish, there is less possibility of crushing since live fish is continuously transported in a water jet and there is no possibility of accumulating a large mass of fish in one place. There is a certain possibility of damage to the fish due to shocks or scraping during the transfer of fish into cassettes and transport in cassettes, since the fish is transported without the presence of water, which can mitigate vibrations and shocks. This is not the case with the transport of fish in isothermal bins, since after placing the fish in bins with a mixture of water and ice and constant mixing, there is no further manipulation until the moment of processing. In addition, the fish is immersed in water with a small amount of ice during transport and the likelihood of damage due to vibration is minimal.

Efficiency of loading fish from the net by different methods

The efficiency, i.e., the capacity of each method of boarding the catch is determined on the basis of the total amount of catch and the time required for it to be loaded on the vessel. The obtained results show that the pump loading method has a much higher capacity (almost twice as much), i.e., it enables the loading of the same amount of catch in a much shorter time compared to the brailer loading method. Boarding capacity on ship A where the pump was used, approximate value of boarding capacity was about 195 kg / min, while in the case of boarding on ships B, C and D the values are around 77, 89 and 91 kg / min. The relatively low boarding capacity on board B is due to the relatively small total catch. Namely, after filling the first row of isothermal bins, a break of about 15 minutes was made in order to prepare the bins in the second row for receiving fish, and after the break, the remaining quantity of fish was loaded, which was not as large as in the case of ships C and D. In case the total amount of catch is equal, it can be expected that the boarding capacity is slightly higher in vessel B than in vessels C and D due to a slightly shorter break, but the expected value is in the range of 90-95 kg / min.

High capacity when loading fish with a pump is primarily due to the capacity of the pump itself, but it is also significantly contributed by the fact that pumping requires 1 crew member (boarding requires the engagement of 4 members) and other crew members can prepare the second row of bins for boarding fish. Therefore, when loading by pump, it is not necessary to suspend boarding after filling the first row of bins.

Critical points and recommendations in the definition of catch management

Based on the conducted experiments, critical points in the process from catch to processing were identified that have a significant impact on the quality of fish. It is generally known that fish must be cooled as soon as possible after catching and the cold chain maintained until the moment of consumption or processing. Although recommendations for proper handling of fish after catch are available in several places, these recommendations in practice are not always easy to implement during fishing due to various factors such as weather conditions, limited working space on vessels, in case of very large catches and the like. Even if the general recommendations for avoiding physical damage, using adequate amounts of ice and respecting the ratio of water, ice and fish during refrigeration and transport are followed, newer technologies offer room for further improvements and improvements in catch quality.

The first identified critical point is the loading of fish from the net into the vessel, during which there are significant quality losses if the boarding lasts a long time, ie the fish stays in the net for a longer period of time. As previously described, the loss of quality during the standing of the fish in the net is constant, but during the first 60 minutes it is extremely mild, after which it accelerates and can result in significant losses. For this reason, it is recommended that the total catch be loaded on the vessel and started cooling within 60 minutes of the fish being compacted within the net. This is very difficult to achieve in the case when large quantities of catch need to be loaded by the traditional method using brailer. In this case, the use of pumps provides multiple advantages, primarily in the form of high loading capacity due to the capacity of the pump and the fact that pumping requires the involvement of 1 crew member while other crew members can simultaneously prepare bins to receive fish and avoid interruptions. In addition, practical experience shows that pumping requires a lower density of fish inside the net compared to loading with a brailer, which is why fish inside the net die more slowly and, as a rule, the complete catch is loaded on deck alive, thus reducing quality losses. Also, during boarding with a pump, the fish is lifted onto the deck in a jet of water, during which there is less possibility of physical damage due to crushing and impact, compared to boarding with a brailer.

The next critical point is the cooling of the catch, which should be carried out in such a way as to enable the fish temperature to reach around 0 ° C as quickly as possible. This is achieved by following the recommendations in terms of using an adequate ratio of chilled seawater, ice and fish, which is 1: 1: 2. Also, during cooling, it is necessary to periodically mix the contents of the cooling bin to avoid the formation of layers of different temperatures inside the bin. The cooling process should be carried out until a satisfactorily low temperature is reached in the center of the fish (0 - 2 ° C).

The last critical point is to maintain the cold chain, i.e., the temperature of the fish as close as possible to the temperature of 0 ° C, from the moment of cooling to the moment of processing. As mentioned earlier, during this step, the method of transporting fish in isothermal bins with a mixture of water and ice showed a great advantage over the traditional way of transporting fish in cassettes. This method ensures minimal temperature fluctuations during transport and reduces the possibility of physical damage due to manipulation and vibrations and shocks during fish transport.

Following all the above, it is recommended, in strict compliance with previous recommendations for fish handling, the implementation of newer methods of loading and transporting catches that include the use of loading pumps and isothermal bins for transport on all vessels where conditions allow, since the combination of these methods' adherence to standard recommendations for fish handling, ensures maximum preservation of catch quality.

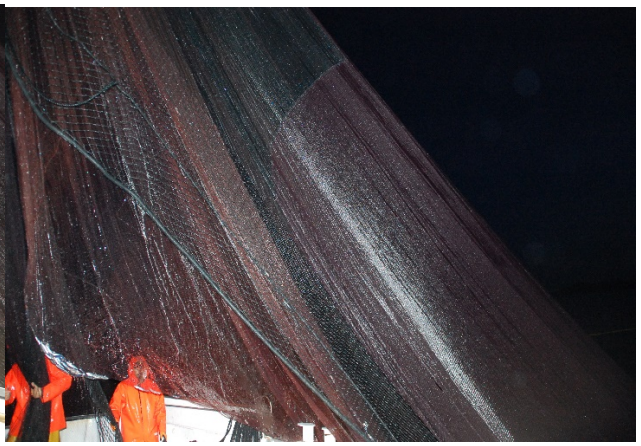
Pictures 77.,78.,79.,80. and 81. Differences in fishing methods and fish compression *(photo Andrić V.) (web)*

Pictures 82.,83.,84. and 85. Thermal bin filling - display of the optimal amount of filling *(photo Andrić V.)*

1.13. Recommendations for further system development, implementation and dissemination

Technical implementation of aquaculture pumps for use in fishing for small pelagic fish is possible. Currently, no boat in the Adriatic that catches small pelagic fish uses the system of using pumps. There have been attempts to implement it in history, but the systems have not proven to be as efficient in terms of quality as they have been in terms of volume. The pilot implementation of aquaculture pumps and their adaptation to the fishing vessel showed that significant improvements are possible in raising the quality, speeding up the process as well as the safety of fishermen and facilitated and less strenuous work.

Pictures 86. and 87. Pulling the purse seine net out of the sea and stacking at the stern of the ship (photo Andrić V.)

Pictures 88. and 89. View to the stern and from the stern of the fishing boat and occupation of space (photo Andrić V.)


Installation of larger system units is possible on standard size boats of 20 m or more however both pumps and smaller suction sizes of 6 inches or 150 mm and 8 inches or 200 mm meet their considerable advantage over traditional fishing methods.

A larger unit than the pesca 6 model with 150 mm is the 200 mm pesca 8 pump system. Note that it affects more seas and more fish in almost the same flow. It is important to note that it is necessary to take care that there is no need to over-squeeze the fish in the net because the suction of the fish must be kept in the proportion of 2/3 of the sea 1/3 of the fish. Excessive squeezing of the fish through the suction tube is not good, so care should be taken not to cause bleeding caused by squeezing. The pump 8 occupies slightly larger dimensions than the 6 and the same is shown in the technical drawing. At the same time, due to the larger amount of sea and fish sucked in, it is necessary to dimension a larger dewatering unit.

1.14. Occupational safety - special regulations governing the use of machinery and equipment on fishing vessels

Use of pumps in fish transfer-general and special safety aspects

There are two basic categories of sea fishing in the Republic of Croatia - commercial and non-economic (sport and recreational). Within commercial fishing, there is a distinction between commercial fishing in the narrower sense and small-scale coastal commercial fishing, limited by tools and conditions.

4039 vessels have entered in the Register of the Fishing Fleet of the Republic of Croatia. The largest percentage of the fleet (over 80%) are vessels smaller than 12 meters in length, which also make up the largest share of fleet power (about 50 kW). The most significant part of the total tonnage of the Croatian fishing fleet is made up of purse seine boats, and the most significant part of the total power is multi-purpose vessels. The total power of the fleet is just over 310,000 kW and the tonnage is just over 40,000 GT.

The largest number of vessels are registered as multi-purpose vessels (over 45%). These vessels are presenting typical Mediterranean form of fishing, in which there are usually no target species and in which fishermen often change their gear throughout the year. Purse seiners make up about 5% of the fleet and these vessels make the largest amount of catch, while trawlers make up about 14% of the fishing fleet of the Republic of Croatia.

Surrounding fishing gear (purse seine nets) makes by far the largest amount of catch (89%). Retractable fishing gear accounts for about 8% of the catch, while standing nets make up just over 1% of the total catch. Percentages of other fishing gears are represented individually with less than 1% of the total catch. The largest part of the catch - over 80% - is small pelagic fish (sardines and anchovies). Of the total catch, the share of catches of white and blue fish is about 96%, cephalopods about 2%, crabs and shellfish about 2%.

(https://ribarstvo.mps.hr/default.aspx?id=13)

Definition of a fishing boat

Law on Amendments to the Maritime Code (NN17/19) Article 5 of the Maritime Code was amended (in force since 1.1.2020) and the term fishing vessel is defined under point 42 -„ fishing vessel is a vessel with a mechanical propulsion intended and equipped to catch fish and other living beings from the sea or on the sea bottom, the length of which is greater than 15 meters “.

Article 90 of the Maritime Code prescribes that the calibration of ships is performed according to the Technical Rules, and paragraph 2 of the same article prescribes the calibration of a fishing vessel. –„ Calibration of a fishing vessel and a boat used for fishing activities, whether for personal use or economic activity, shall be carried out in accordance with Regulation (EU) 2017/1130 of the European Parliament and of the Council of 14 June 2017 defining the characteristics of fishing vessels (SL L 169, 30.6.2017) “

Regulation (EU) 2017/1130 of the European Parliament and of the Council defining the characteristics of fishing vessels of 14.6.2017, within the Common Fisheries Policy, refers to the characteristics of fishing vessels, such as length, width, tonnage, date of commissioning and engine power.

Safety systems for fishing boats

Directive 97/70 / EC from 11 December 1997 establishing a harmonized safety system for fishing vessels of 24 meters in length and over concerns the safety requirements for fishing vessels of 24 meters in length and over, which are fully transposed by Annex I. Rules for statutory certification fishing boats.

Directive 93/103/EC from 23 November 1993 on safety and health requirements for work on board fishing vessels on minimum safety and health requirements for work on board fishing vessels (thirteenth individual Directive within the meaning of Article 16 (1) of Directive 89/391 / EEC), which are fully transposed by Annex III. Rules for statutory certification of fishing vessels.

By the decision on the rules for the statutory certification of fishing vessels (NN 66/12), the same rules entered into force on 1 July 2012.

The rules for the statutory certification of fishing vessels include the requirements of the following regulations:

- Council Directive 97/70 / EC laying down safety requirements for fishing vessels of 24 m in length and over as amended by European Commission Directives 1999/19 / EC and 2002/35 / EC and Directive 2002/84 / EC of the European Parliament and of the Council
- Directive 93/103 / EC as regards minimum safety and health requirements for work on board fishing vessels
- Torremolinos Protocol 1993 relating to the International Convention for the Safety of Fishing Vessels, Torremolinos 1977.
- Partial requirements of Commission Regulation no. 1381/87 and 1382/87 of 20 May 1987.

RULES FOR STATUTORY CERTIFICATION OF FISHING VESSELS are technical regulations that prescribe requirements for the purpose of determining the navigability of fishing vessels intended for navigation by sea and waters accessible from the sea, in connection with the basic technical and statutory requirements.

Rules for the statutory certification of fishing vessels are available at the link - https://mmpi.gov.hr/UserDocsImages/arhiva/Pravila%20za%20statutarnu%20certifikaciju%20ribarskih%20brodova,%202012.pdf)

The world's population is expected to increase by two billion over the next 30 years. Global demand for food is growing rapidly and the answer lies in the oceans, and for this reason it is necessary to use ocean resources in a sustainable way.

Fishery equipment manufacturers are increasingly developing innovative solutions to increase fish welfare, thus contributing to changes in the fishing industry by increasing sustainability and protecting the environment.

It invests in the development of state-of-the-art technology that improves fish safety, its quality with increased profitability and system solutions within fish handling, processing and cooling.

Improving fish welfare increases both quality and profit. This is crucial in aquaculture, where fish health is important for the ability to reduce stress, bacteria, viruses and parasites.

Gentle handling of fish is of the utmost importance for maintaining optimal fish health, reducing stress and fighting disease. Fishery equipment manufacturers develop systemic solutions for fish management in a sustainable and gentle way and work to promote good fish health, maintain fish welfare and preserve the environment when developing products and solutions for handling and transporting live fish.

The transport and transfer of fish will always involve a certain amount of risk. Factors such as water quality, temperature and cleaning, combined with fish density and pump distance, are crucial to fish welfare.
The process of fish handling includes pumping-transfer, grading / grading, cooling and storage. Ensuring the welfare of the fish is crucial for the quality of the catch. Gentle handling of the fish, appropriate temperature and a good monitoring system ensure the safety and quality of the catch.
Fish-friendly pumps - screw rotors are used to reload caught fish into ship's warehouses to reduce catch damage and ensure the quality of the final product.
Vacuum pumps are specially designed for transporting fish in refrigerated medium - sea, and the type of pump is determined depending on the capacity, available storage space and type of fish.
Installation of pumps / fish transfer systems
Unauthorized modifications of the structure, machinery, equipment and devices related to the general plan of the ship **are not allowed on the ships**. Although this pump system is a very light and mobile fishing equipment, it is recommended to contact the Croatian Register of Shipping regarding the further installation procedure or in this case of equipment. **The same applies to the volume of the specified equipment, ie the capacity of the equipment, technical characteristics and their placement on the ship.**
Depending on the above, the Croatian Register of Shipping can give consent without additional requirements or may request the preparation of project documentation from an authorized designer, and after project approval can be installed equipment through an authorized company, all under the supervision of HRB staff. Since this is not an installation but an accommodation, it will be necessary to temporarily fasten the same equipment with simple methods that allow quick installation.
The Croatian Register of Shipping is authorized to work on behalf of the Maritime Administration of the Republic of Croatia regarding statutory certification in accordance with national regulations and international maritime conventions SOLAS, MARPOL, ILL, etc., as well as the relevant Codes.
On the link http://www.crs.hr/hr-hr/data/tipnaodobrenja/odobreniproizvodi.aspx on the website of the Croatian Register of Shipping there are lists of **Type Approved Products, Approved Manufacturers and Service Companies.**
The basic inspection is a mandatory inspection of the items to which the existing ship is subject, regardless of its size or area of navigation, before the start of service when the relevant documents are issued for the first time.
The certificate of seaworthiness of the ship contains a List of data certified by the Croatian Register of Shipping, in which all changes on the ship and equipment must be entered from the last date of its compilation.

Every ship must have an inspection and surveillance book. It records the inspections performed on the ship. In the book of inspections and supervisions, the data are entered by the authorized bodies that perform the inspections, which are: the Croatian Register of Shipping and the Harbor Master's Office within the inspection supervision. When entering the data, it will be stated what shortcomings have been noticed and what needs to be done to eliminate them. The inspection and control book contains information on: ship's documents and books, equipment and hull of the ship, mechanical and electrical devices, radio devices, fire protection equipment, means of preventing pollution and more.

Therefore, retrofitted pumps and associated fish transfer equipment should be added to the Data List in the Vessel's Certificate of Fitness as well as in the Inspection and Supervision Book.

In order to be able to do the same, it is necessary that the said equipment be placed on the ship or installed on the ship in accordance with the procedure described above.

RULEBOOK ON BOATS, BOATS AND YACHTS (NN 13/20 from 31.1.2020.) regulates, among other things, technical requirements for the purpose of determining the ability of a fishing boat to navigate in relation to safety at work and safety of cargo handling devices.

In the case of significant repairs or modifications to an existing ship, regardless of its purpose, type of propulsion and navigation area, which affect or may affect the structural integrity of the hull, stability, navigability, propulsion systems, permitted number of persons, carrying capacity or navigation area owner must immediately notify the competent port authority or branch office before the start of work.

EXAMPLES:

Directive 93/103 / EC - Council Directive 93/103 / EC on the minimum safety and health requirements for work on board fishing vessels (thirteenth individual Directive within the meaning of Article 16 (1) of Directive 89/391 / EEC).

4.12 Modification - modification of an existing fishing vessel which:

.1 significantly alter the dimensions or capacities of the ship; or

.2 changing the purpose of the vessel or the method of fishing;

or

.3 increase the fishing effort of the vessel; or

.4 work on the ship is of such scope that it is intended to significantly extend the life of the ship; or

.5 work on the ship is such that it is considered justified to apply the requirements as for a new ship; or

.6 changes the area of navigation of the ship.

Repairs and replacement of elements (components) of the ship with the same elements are not considered a modification (components).

It is not entirely clear from the above whether the installation of transfer equipment would be considered a modification, but from the safety aspect of its operation and handling, as well as due to mandatory regular inspections of these devices, it is necessary to contact the Croatian Register of Shipping.

Directive 97/70 / EC

Chapter IV - Machinery and electrical appliances and occasionally unattended machinery spaces

1.4.4 All new and existing fishing vessels of 24 meters in length and over in relation to machinery, in addition to the requirements specified in 1.1.1, shall meet the following:

1. Appendix II. of these Rules - Torremolinos Protocol 1993, Chapter IV. - Machinery, electrical appliances and occasionally unattended machinery spaces,

Part A - General:

a) Rule 2 - Definitions.

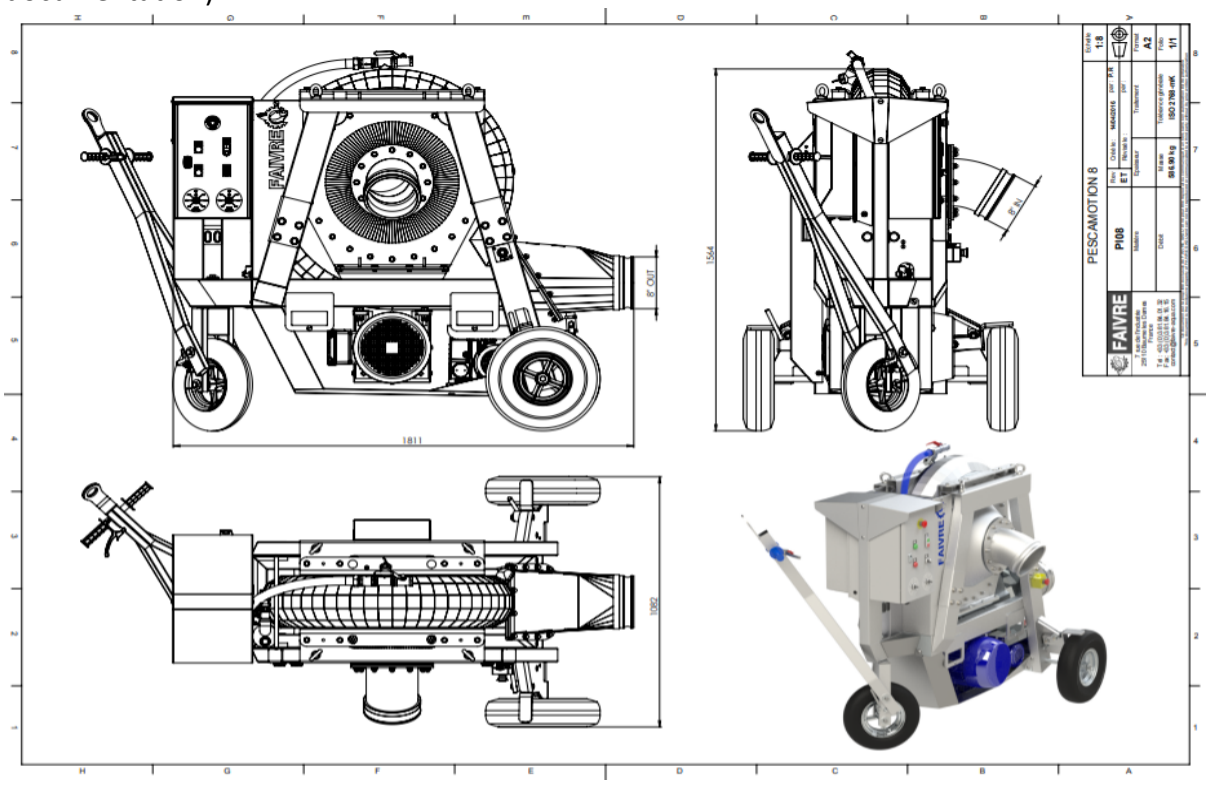
b) Regulation 3 - General - Machinery:

Main propulsion system, monitoring system, steam, fuel, compressed air piping system, electrical and refrigeration systems; auxiliary machinery, boilers and other pressure vessels; pipelines and pumps; steering equipment and devices, axles and clutches for power transmission must be designed, constructed, tested and installed and serviced in accordance with the regulations of a recognized organization. These machinery and equipment, as well as lifting devices, winches, fish handling and fish processing equipment, must be protected to minimize any danger to persons on board.

Special attention should be paid to moving parts, hot surfaces and other hazards.

Fishing boats and fishing boats over the past twenty years have undergone changes in the adaptation of technologies for operations and catch maintenance, and the same were related to the installation of cranes, placement of a large number of thermal insulation tanks where we can count this transmission system pump. Therefore, it is certainly necessary to contact the Croatian Register of Vessels to include it in the list of portable fishing equipment.

Picture 90. Technical specification of the sand pump 8 weighing approx. 600 kg (Faivre documentation)



Pictures 91. ,92.,93. and 94. Equipment on the deck of a fishing boat (photo Andrić V.)

Picture 95.- fishing boats in the port of Gaženica-Zadar (photo Lovrinov M.)

1.15. Literature

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2. FC ISTRA CASE

Abstract

The study, with a piloting and technical description of the processing operational protocols, sublimate the basic innovative application of existent machinery to promote new commercial and technological preferences in assortment of existent cooperative Istra plant. Main point focus is on the processing of shrimp and fileting mullets as a species with major seasonal catch in Adriatic with interest for both country Italy and Croatia. The analysis cover production with existing machinery, analyses the current state of the processing, trends in using machinery and packaging, quality and safety assessment, innovative process solutions as well as management recommendations. The operational flow is defined from transporting to dispatch of the new product. Emphasis is given to finding and identifying those parts of the operating procedure where the introduction of innovative application of operational procedures, changes in techniques and technology that could make new product definition.

Through the focusing on two species with a major concern, an attempt was made to identify the level of operation what can be changed in existent processing. Considering that the use of machinery as a novel way of preparing shrimp and mullets would be an innovation that has not yet been applied in the Adriatic it would be an important and comprehensive sound of innovation. Current operational procedures allow the integration and implementation of a new application in processing whose adaptation will be a pilot action to verify the efficiency of their use, in terms of raising quality and efficiency. This provides a complete operational point of process where quality product can easily withstand for further processing and packaging operations. The FC business is primarily based on the fishing activity of demersal fish and other marine organisms, creating biggest catch on mullet (por. Mugilidae, muscy ostopus- Elodone moschata), shrimp (Parapenaeus longirostris) on some occasions

PROJECT BENEFITS- As an already written the project made structure in order to create possibilities for sustainable development and increased economic benefits in the Croatian/Italian fishery sector. A main task is to identify and recognize which “bottle necks” exist within organization structure, technology innovation, investment, and ensuring quality aspects in primary processing in case of Istra cooperative.

The piloting is divided into several specific tasks, which all together bring efficiency through:

- Knowledge transfer
- Education
- Know-how
- Evaluation of opportunities and threats
- New organizational, technical and technological solutions in processing

New possibilities

The main aim of the project is to develop more sustainable fishery sector value chains, based on technical/technological innovations. The specific aims were Introduction of innovation techniques and technologies in on board quality handling and improved models in processing of shrimp and fish for the value-added products. The main difficulties in Istra were found in big seasonal catches with no ability to place on market with better price. Also lack of quick processing of the catches for making added value and possibility to store and sell after period of season and trough whole year. Major problem was disorganization of product supply and marketing, price instability, strong competition for the supply of export and national markets, lack of processing machinery, Improvements can be done through development of more efficient operational management system in processing. Achieving good practices, it will be a step towards sustainable, responsible and efficient use of fisheries with the emphasis on growth, innovation, adding value, etc. Primarily to implement the technological innovation on existent machinery to make production better by quality issue and creation pf popular industrial product with significant cost reduction. This project recognized two possible solutions for increased cost efficiency and seasonal catch handling for added value implementation. Those are separation of shrimp meat as a preparation model for burger production and high size range fileting machine for mullet. Both of the process can rapidly speed up the process of handling a seasonal catch and giving a huge opportunity to added value implementation benefits.

2.1. Introduction

FC Istra is founded in 2004, and in 2018 it was recognized as a producer organization. A few years ago, it opened its own fish processing plant intended for processing its own catch and raising the added value of fishery products. The Fishermen's Cooperative operates as a functional unit, and according to the fish turnover of its members, it presents itself as a respectable business entity in the local and regional fish market. The Cooperative Istra has been operating in the area of the Fish Wholesale Market in Poreč since the beginning of 2009, which it manages as well, and the facility has an export number. The facility was working on the establishment of the wholesale market on the principle of "auction commercialization" of catches, which implies the gradual introduction of the system, but the same has not narrowed due to traditional markets. Given the need to diversify activities and dispose of mainly seasonal catches, there was a need to build a new facility with the space for processing. For this purpose, the FC bought a construction land in the business zone "Labinci" in 2008. which created the basis for the design and construction of the current production plant.

For this purpose, the basic idea was to build a business facility, a facility that will primarily serve to dispose of market surpluses from the fish wholesale market in Poreč, and secondarily to create added value through the improvement of fishery products - catches of fishermen members of the fishing cooperative. Through the hall with a gross volume of approximately 400 m2, the purpose of processing, finishing, canning and storage of fish and marine organisms has been defined. The most important annual catches of the Istrian region are musky octopuses, sardines, mullets and sole as the main species and especially oysters, but there are also significant catches of cuttlefish. Most vessels operate all year round and catch more species. Catches in the winter months predominate as significant seasonal catches when a lot of fish and other marine organisms are caught, with a significant drop in prices in a shorter period of time. This is an additional reason for processing, ie the disposal of market surpluses in periods of unfavorable prices.

From above mentioned, the idea of offering products to the HORECA sector was imposed, and the offer was supplemented with products from aquaculture and imports, as well as processed products from processing plants and frozen products. In this way, the constant availability of fish products for caterers is ensured. It has also been offered the possibility of cleaning and preparing fillets for their needs. This is especially well received in the kitchens of hotel chains. Processing, freezing and storage of fishery products is important because of the seasonality of catches for achieving a continuous supply. Today, in addition to the classic processing, the cooperative is trying to make production technological steps in order to be more competitive for the placement of new products. The initial lower price of raw materials burdened by the high cost of manual cleaning and lack of labor due to the needs in tourism, indicating that the need for work on the production characteristics of machines and the application of machines and automation in primary fish processing is necessary to significantly reduce costs and achieve competitiveness.

As can be seen from the above, the project should introduce a range of new products combined to meet demand when looking for a complete fish meal that will not spend preparation time, and will retain all the properties of originality and high-quality seasonal catches. Through its assortment, the Fishermen's Cooperative wants to offer a range of products ready for serving in restaurants and hotels, as well as the possibility of selling in wholesale chains. The focus of the research was mostly on the production of shrimp and mullet burger mixes as seasonal and species of common interest for Italy and Croatia. The production of shrimp and mullet burgers begins with the primary processing required for the production of the final product and refers to the basic technological units and steps in the primary processing and partial processing. It also relates to receiving, storage, washing, deboning, filleting, freezing and shipping. Guidelines and assumptions for the development of the application of innovative techniques and technologies in this case were primarily related to:

- *Finding new ways of processing certain seasonal catch species*
- *Adaptation of existing machines in innovative operations*
- *Improved utilization of input raw materials and high efficiency*
- *Lowering the product cost*
- *Less workload*

After processing the market and reviewing the possibilities of machine operation, it was realized that it is possible to adapt part of the machines to another purpose and create a basis for the production of new products.

2.2. Basic management settings of the producer organization FC ISTRA

With the construction of its own processing plant for the FC Istra, the market of the first sale for a part of the catch was precisely determined, while the remaining part is planned for the processing of larger seasonal catches. The framework for the application of technical and technological solutions in FC ISTRA is reflected in several types that can enter the categories of value-added products. The main customers are domestic and foreign wholesalers. However, when supplying restaurants and small retailers, there is a need to have some more quality fish species, but also to create lines that would satisfy hotel consumption. The biggest problem in placement seems to be the "excessive flood effect" in the market (low prices as a result of huge supply compared to lower demand) and it is necessary to find a solution that would raise the price level through value added products.

Table 1. Review of SWOT analysis of the entire sector of catching demersal resources and business with the connection of activities on the OP in Istria

STRENGHTS	**OPORTUNITIES**
1. Significant population of seasonal catch species in the natural environment - good fishing areas 2. Polyvalent fleet and fishing tools 3. Implementation of management measures 4. Strong tradition and tourism development 5. Sustainability - joint and agreed management 6. Selective fishing methods 7. Development of monitoring systems and programs 8. Ownership of benefits 9. Sector organization through fisheries associations 10. High quality of fishery products due to favorable environmental conditions, 11. Natura 2000, which enables the preservation of habitats that contribute to the renewal of fish stocks.	1. Strengthening production units 2. Raising the price of fish with a market-oriented approach 3. Demanding market niches (product quality, product price and continuity of demand) for frozen fish and prepared products 4. The need for a greater degree of finishing and processing 5. Needs to increase the capacity of the plant to receive fresh fish 6. Changes in fisheries management to meet the needs and requirements of the market, continuity of supply, quality and price. Integrated management 7. Sustainability due to limited number of permits 8. Possibility of progress in education, manipulation of catch on board, establishment of a cold chain 9. Better quality and price, branding, certification, reduction of complaints 10. Possibility of direct sales to esteemed and targeted markets 11. Constant reporting on the economic size and importance of the industry 12. Development of a regional management plan 13. Possibility to use funds

WEAKNNESES	THREATS
1. Large market oscillations, low purchase price of catches and uncontrolled fishing. 2.Insufficient education, insufficient equipment of vessels and facilities for the cold chain, lack of storage refrigeration capacity 3. Lack of marketing and economic studies and analyzes 4. Lack of management staff 5. Lack of administrative staff to assist in bookkeeping and administrative new legal rules - monitoring and reporting needs 6. Insufficient cooperation and lack of reasoned discussions within industry and industry at the regional level of cities, municipalities and counties in terms of industry needs 7. Lack of industry scale in terms of transport - logistical problem of reaching distant markets with a better price 8. Insufficiently researched markets - new ones are currently missing 9. Impossibility to attract younger generations in fishing from the catch itself to the management structures due to lower incomes 10. Lack of fish waste management - by-catches, discard. 11. Distance from fishing landing places, especially in the summer months and lack of thermo bin equipment, ice on the sea. The crane reduces the catch quality. 12. Insufficient fishing infrastructure - port facilities for catch landing - logistics 13. Lack of complete product traceability 14. Lack of perceptions of importance on food safety	1. Reduction of resources due to the impact of global climate change, pollution, urban pressure 2.Competition in the same product lines - low prices 3. Lack of economic perspective and perception in decisions - resource management 4. Lack of funding for science 5. Strengthen fishing restrictions 6. Unargued discussions on the environment / economy / resource balance 7. Management of fishing for demersal species

The entire SWOT analysis has been made according to the model of analysis of the fishing sector in Istria County, but with special reference and connection to the possible activities of fishing cooperatives and producer organizations in the conceptual definitions and environment. In a very large part of the processing, given the direction of the analysis, there is a detailed link between the same and the more widely processed SWOT analysis in the category of sea fishing. The presentation of the SWOT analysis shows that there is a good part of the possible opportunities, but also a part of the weaknesses in the direct correlation of price and seasonal catches. Raising quality and processing capabilities are imperative for better market positioning. FC Istra will continue to work on the preparation and monitoring of scientific and technical education aimed at reducing operating costs, raising development solutions and quality.

One of the innovations found is the possible use of a fish de-boning machine in the possibility of separating the meat-pulp of shrimp for which there is no definition. Shrimp make a significant catch in the Adriatic basin, especially on the Italian side, and their release on the market today is related to the placement of whole and cleaned shrimp.

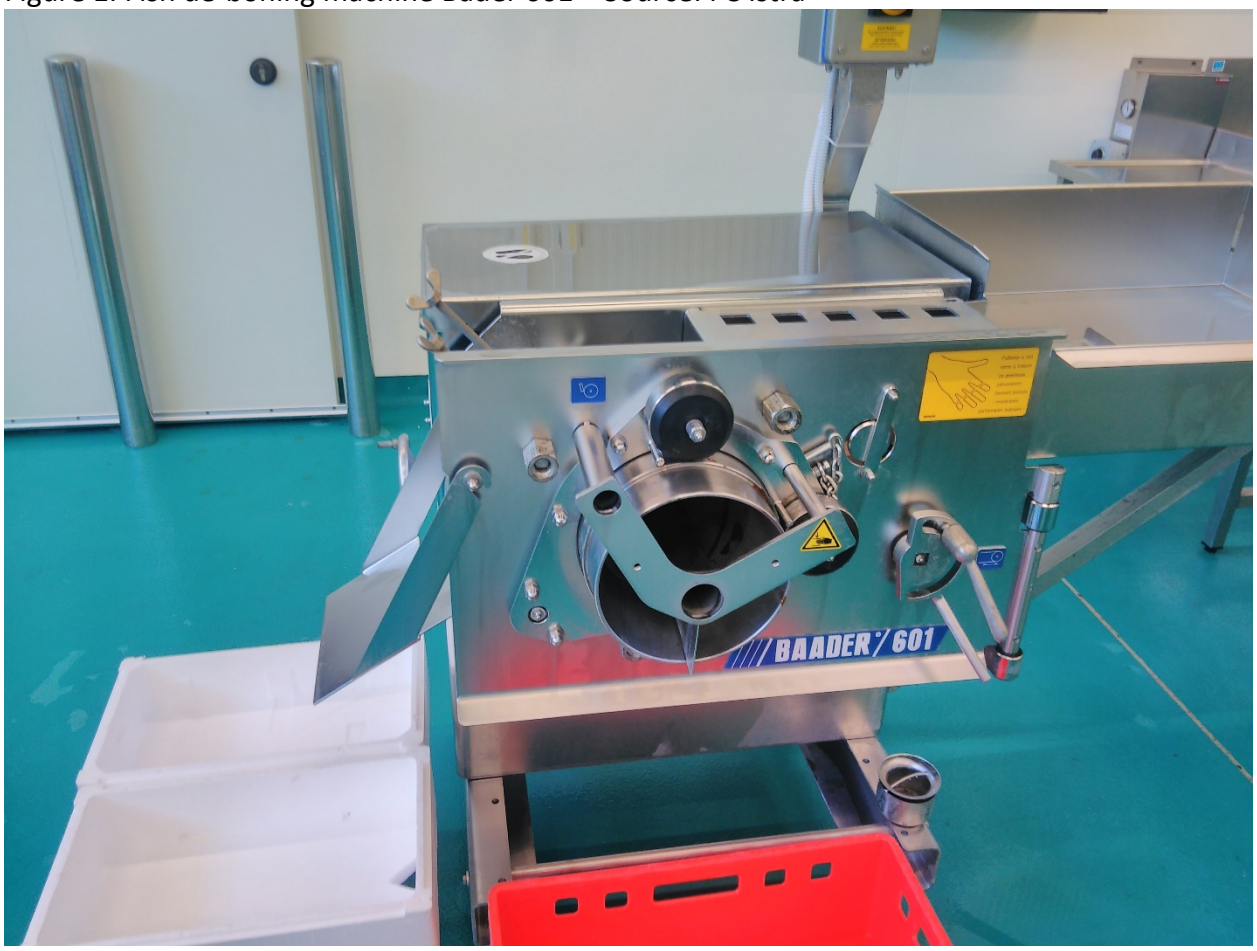
The main goals of this project are:
- Examine the possibility of applying existing machines to other species
- Testing of new machines in the direction of raising the quality and efficiency of work
- The possibility of using someone else's catch in the processing to ensure sufficient market quantities
- Find a way to transform seasonal catches into the possibility of continuous supply for the market
- Testing the new practice in order to replace the currently in use,
- Testing the capabilities of machines for conversion

2.3. Selection of the initial machine for the implementation of the pilot program

Most of the available operational possibilities in the processing plant, which is and can be worked on most types, have been reviewed. The conclusion has been made with emphasis on the innovative application of the fish de-boning machine, as mentioned above. The same makes it possible to significantly solve the problem of catching shrimp and creating a basis for a new semi-finished product or mixture for making burgers from shrimp and mixed fish. The operating system for cleaning, ie the fish deboning machine, was finally chosen as the most optimal production solution for the innovative application. In separation techniques, the company Bader has created a unique and worldwide proven method for separating soft and hard fish components for a wide range of applications. De-boning as a category has taken the industry a step forward in terms of exploiting meat residues in production, and FC Istra has acquired a stand for the needs of deboning fillet residues as well as small fish. However, through the implementation of this project and the study of the possibilities of the machine there was an experiment and application on shrimp in terms of possible shell separation, which proved to be excellent in terms of usability and creating a basis for industrial production of burgers.

For the needs of the pilot project, a Bader 601 deboning machine was taken for testing, from the already mentioned German manufacturer of process equipment (Bader). The machine is made of the highest quality stainless steel aisi 316 and is designed for use in the food industry. It is compact, robust and can be used in both the meat and fish processing industries. It is used primarily for the separation of meat remains from bones. What is important to emphasize in the manufacturer's recommendations we cannot find that it is used to separate the meat of shrimp and shrimp are still cleaned by hand in most industries. The framework of the end use of the product in this sense of cleaning refers to the preparation of the mixture and the base for making burgers. Such a purpose makes the use of this machine the perfect choice for lowering the cost of production.

Figure 1. Fish de-boning machine Bader 601 – Source: FC Istra



The technical principle of operation is simple and is based on creating pressure with a movable flexible PVC tape on the perforated drum. The perforation can be 1.3 mm, 2 mm, 3 mm, 4 mm or 5 mm depending on the needs of the user. As standard, the machine is equipped with a 3 mm perforation drum, but a 2 mm perforation will be tested for the separation of Adriatic shrimp. The same perforation can be used to process fish waste after filleting or the whole fish.

The machine is served by 1 person and the processing capacity depends mainly on the raw material used. It is higher if the raw material is as adapted as possible to the opening where the raw material is inserted. The capacity for shrimp is estimated at up to 300 kg per hour.

The machine is characterized by the following:

- The highest quality of processed products due to the gentle process of processing the so-called "soft processing"
- Compact versions in high quality stainless steel
- Easy manipulation - reduced labor costs
- Easy cleaning and maintenance of the machine - time saving
- The highest world-class hygiene standard
- Minimal depletion of machine spare parts
- CE / ETL certificate and USDA approval
- "Heavy duty" control handles for easier machine control

The assumption of using the machine goes in the direction of squeezing the meat from shrimp and the definition of usability as well as usability from filleting residues which will be implemented in the pilot project and give the framework of an innovative technological operation. As an accompanying support for pilot testing of machines, it was decided to test filleting and for this purpose a fish filleting machine Movinox model FM 90 has been selected. The reason for choosing is that filleting of different size categories can sometimes be a huge challenge in adapting the machine and there are few solutions on the market related to filleting of different size categories without the need for adjustment. Therefore, for categories that are caught in different sizes and without the need for prior selection, it is necessary to have machines that can fillet a larger range of size categories of fish as is the case with mullet, which is one of the main catch seasonal species in FC Istra. As an example of the possibility of filleting several size categories, a filleting machine from the Italian process equipment manufacturer (Movinox) was taken as a test. This semi-automatic machine is made of quality stainless steel aisi 316 for food purposes and is designed exclusively for use in the fish processing industry. It is compact and easy to use, and for its operation, in addition to the electricity connection, a connection to the water supply network is also required. The technical principle of operation is simple and is based on two technological procedures. The first procedure involves cutting the head and tail fin of the fish and the second procedure is the filleting process. The cutting of the head and tail is done with a circular saw that rotates constantly and which is located on the front right side of the machine with a stand (cutting pad).

The second process is the filleting process that takes place inside the machine in such a way that after inserting the decapitated fish through the opening for receiving raw materials into the receiving transport mechanism consisting of PVC stoppers and rubber bands the fish is transported between the stoppers. The fish is carried through a center created by two rotating circular knives, which rotate on an axis. It is easy to adjust their spacing and cutting angle depending on the type and size of the fish. After the cutting process, the fillets fall through the opening on the lower right side of the machine into the tank and the spine with the entrails falls out through a funnel-shaped extension at the rear of the machine into the set tank. All technological procedures are accompanied by rinsing with water through nozzles provided for that purpose. The machine is operated by one person and the processing capacity (fillets / hour) depends mainly on the engagement of the server. For mullet, the estimated capacity is up to 500 fillets per hour.

2.4. Description of the selected production solution

The following priorities are important when fishing and handling or later processing: 1. Achieve maximum quality of catch or landed raw fish and other marine organisms with minimizing damage and 2. Improve storage and processing conditions with faster operations.

Characteristics of technological and technical equipment

The equipment and the equipping of the FC Istra facility in Labinci is specific. Namely, the production plant itself consists of individual process equipment. There are no in-line machines, so the requirement is that the process to be introduced must be functionally connected to existing machines, which guarantees efficiency. The equipment comes individually and is listed as such. For the purposes of the new redefinition of the drive and the start of the cycle, it is necessary to complete the following units of equipment, which are shown as stated, namely line equipment in a row and individual equipment; Autoclave-Cooker, fish defrosting and preparation line (continuous defrosting container and perforated sheet baskets), musky octopus cleaning machine, confection-packaging line, packer - vacuum cleaner with one or two work surfaces, a machine for washing and softening cephalopods, eviscerator for shellfish and crabs, fish eviscerator, complete refrigerator -25 C, complete refrigerator 0 C, ice machine, freezing tunnel, sterilizer, brine and marinade equipment, smoking chamber, de-boning machine. Additional equipment: electronic scale 3000 kg, electronic scale 20 kg, labeling machine, work space – tables Other: refrigerator vehicle, smaller delivery vehicle, electric forklift, gas forklift, hand pallet trucks, engine room equipment and generators, boiler room equipment, laboratory equipment, equipping the office, informatics and sanitary solutions.

Figure 2. Overview of part of the classic equipment of FC Istra, Source: FC Istra photos

2.5. Implementation of the machine in a new technical and technological framework or production process

Given the current catching practices, the quantities of fishes and other marine organisms in seasonal catches that vary considerably, and in processing there is a need for small transmission units of high processing efficiency or multifunctionality. Through the use of a de-boning machine, or in this case the separation of shrimp meat from the shell, it is possible to create a semi-product as an excellent basis for the industrial production of burgers. This production enables high machine efficiency and a very simple processing and storage process. The production process in FC Istra is being developed in the following production lines: frozen sardines, cleaned cephalopods and depth species, cleaned shells, salads, spreads, stockings, marinades and smoked fish, separation - deboning of meat for possible production of fish balls. A new possible process is the use of a deboning machine in a shrimp de-pealing machine. The calculations made so far speak in favor of the possibility of placing the product at very competitive and acceptable prices on the market because of the utilization degree from 80-85% of separated meat and body fluids when shrimp is passed through the machine. Prices from the market as well as the offered products analysis in processed and unprocessed form can be found in statistical journals and publications (ISMEA, FISHSITE, MERCATI ITTICI, CBI and others), while the prices of individual processed products are experientially directly on the market. The price of the product is analyzed in the previous chapter.

Figure 3. Minced shrimp meat and mullet fillets prepared for the laboratory - for the formation of burgers, Source: FC Istra photos

With the first conversations and open discussions during the implementation of this pilot project, the management of the cooperative tried to define the base of the raw material in terms of unquestionable availability, then the calculation of production and sales prices and design of products that would be acceptable in the market in terms of prices and demand for this type of product, and profitable to start the production process. Through the accompanying analyzes, product categories were determined that meet all the necessary parameters and the range was made within FC Istra for shrimp and mullet, while the use of musky octopus in terms of added value for the needs of this pilot was omitted.

Based on the innovative adaptation of machines, there are bases that can define more new products made in machining and form the following units:
1. Extracting meat from crab shells
- Separation of meat by machine
- Separate substrate for further production
2. Evisceration and filleting of white fish of a wide size range - mullet
- cleaning and processing of fish of several size categories up to fillets - manually and by machine
- fillet finishing
- disposal of fish remains after filleting
- basis for further production
3. Line processing into final ready main dishes and appetizers
4. Line for making “fish / shrimp” burgers, fish and shrimp burgers and / or outsourcing
5. Freeze-thaw
As already mentioned, the mullet can be filleted manually or mechanically, and both methods require prior de-shelling. The shell is removed with a knife, a special serrated tool or a special device with a rotating drum.

Filleting can start after the fish skin has been removed. The rest of the fish after filleting (head and spine) has a certain amount of meat on it, which can be collected using a separator that is planned to be used in the innovative separation of shrimp meat and this mixture will also provide an additional basis for meat content. The deboning machine itself has a movable strap that presses the fish onto a rotating perforated drum. The meat is pushed through the holes in the drum, while the bones and skin remain on the outside of the drum. If whole fish is used, it must be de-gutted, headless, split on half and without a part of the spine above the abdominal cavity that can spoil the quality of the minced meat. Therefore, before using the machine, it is necessary to strictly take care of cleaning the fish. By using deboning machine, it is necessary to obtain quality minced meat from shrimp and mullet for further preparation. The classes should be taken into account, because minced fish meat differs by classes. The highest class is meat prepared from fresh raw material and it is light in color with only a few darker parts or pieces of the abdominal cavity. The lowest class of minced meat is obtained by deboning the residue after filleting and results in a darker color of the meat. There are strict hygiene requirements for the production of minced meat that must be adhered to. Raw materials must be well cleaned and fresh, and the deboning machine should be cleaned every 2 hours to avoid contamination with bacterial films.

Immediately after processing, the meat should be packaged, frozen or processed into a product that will be frozen or stabilized by some other method. Due to the high price of raw shrimp, but also the very intense taste, the production of shrimp burgers requires the addition of white fish meat. Hake fillet can be used, as well as mullet meat, which is of high quality and has significant catch resources, and the rest of the meat produced by filleting can be used for additives. The technological process of production begins, if necessary, with thawing, washing and cleaning of raw materials if they have not been purchased as already cleaned (e.g., hake fillet as an additive). If raw materials are used in the plant, then it is necessary to store the raw materials, preferably by freezing, or cleaning and then freezing in order to collect a sufficient amount to start the technological process of making burgers and dumplings. It is necessary to plan the production flow from the raw materials intake, their cleaning and processing in terms of the best utilization of the plant and labor and the most optimal cost. The greatest emphasis was placed in terms of cleaning and preparation with the highest efficiency using innovative machine technologies.

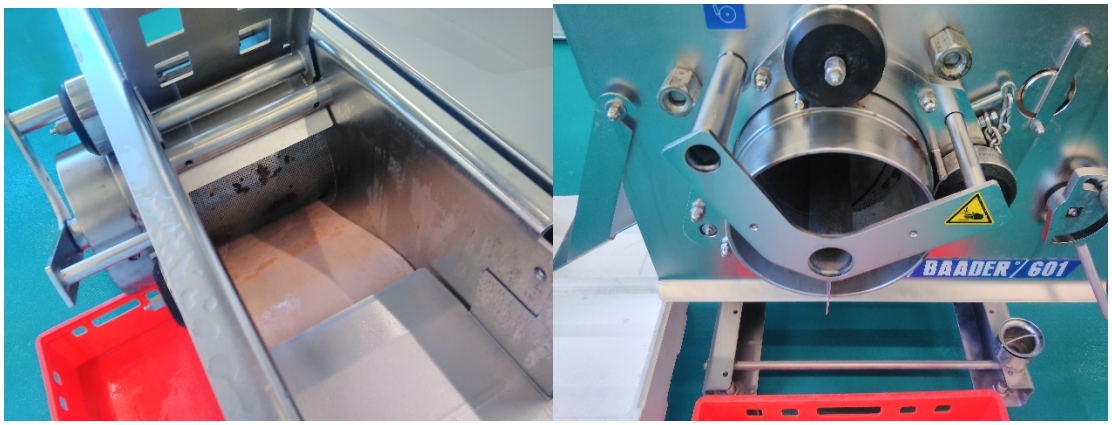
2.6. Technical schemes of the separation process for the implementation of the pilot project

The basic technical schemes related to the implementation of this project relate to the technical schemes for adjusting the production flow in the existing processing plant. The basis is the addition of a new shrimp de-peeling process to the specification via a known machine that will be used for the purpose of de-peeling shrimps. The basic characteristics of the processes and products that were planned to be obtained were related to:

- Full possibility of separating shrimp shell from meat
- Maximum efficiency of separation
- Texture for packaging and freezing

The operation of the machine, as said, is based on the creation of mechanical pressure and the separation of solid residues and the extrusion of meat pulp from the shrimp shell. In doing so, it is distinguished between complete separation of solid particles as well as greater efficiency.

Figure 4. A look inside the separation machine, Source: FC Istra photos



The first preliminary attempts to peel off the shrimp started with the use of a 3 mm drum, but it did not prove to be adequate because there was a leakage of solid residues from the shrimp shell. As such, the product was unusable for further use. After a negative experience, a 2 mm measure was taken on the drum and it proved to be ideal in cleaning shrimp without any category of shell residues. The pressure from the drum along the belt rubber can be weaker and stronger while the machine has the ability to tighten the belt. By tightening the belt, itself, a higher efficiency is obtained, however, excessive tightening can lead to the presence of small shells in the final mixture, so it is necessary to stop the tightening at a certain limit depending on the size of the shrimp. The separation of soft and hard components can be used for a wide range of applications. The process itself begins with the insertion of raw materials into the primary collector and further leads to the belt located in the protected part of the machine. The squeezing belt further brings the product into the perforated drum and presses the soft parts through the holes of the drum. Solid components remain outside the drum. The ratio of yield and quality can be influenced by adjusting the pressure roller as already mentioned.

Figure 5. Pressure adjustment valve, Source: FC Istra photos

The range of soft separators itself is available in five models, each with different options suitable for different applications and capacities. The permeability values vary greatly depending on the size of the hole in the perforated drum, the type of input, the product and its pre-treatment (eg pre-treatment stage), the supply temperature, the selected pressure, etc. The values for each application must be determined individually. For the 2 mm drum the shrimp does not need to be pre-treated.
With regard to the implementation of the new process, it is necessary to adjust the production schemes or production diagram as well as to check the implementation of the HACCP plan.

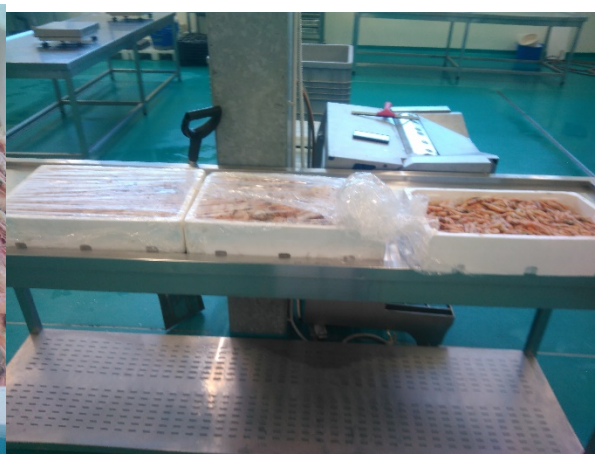
Shrimp meat separation flow diagram

Given the adherence to the cold chain from catch to plant, the plant must take care to transport the caught shrimp to the separation machine, separation and storage before delivery to the market or in further processing with freezing if the product is not shipped immediately after separation. The quality of fresh shrimp, which would otherwise be intended for the market or classic processing by cleaning shrimp tails in processing separation, is significantly affected by the speed of separation and packaging and storage of separated meat until its delivery or further processing. In the case of pealed products or minced shrimp meat, those are placed under the category of semi-finished products. The time of the separation process must be as short as possible and the operating temperatures as low as possible.

Transport of caught shrimp from catch to production plant

After the shrimp is caught and loaded into the cassettes, it is covered with a layer of ice, after which the other rows of cassettes are stacked and each is frozen. During transport in the summer months, if necessary, additional ice is added in case of melting.

Figure 6. Shrimp prepared for meat separation, Source: FC Istra photos

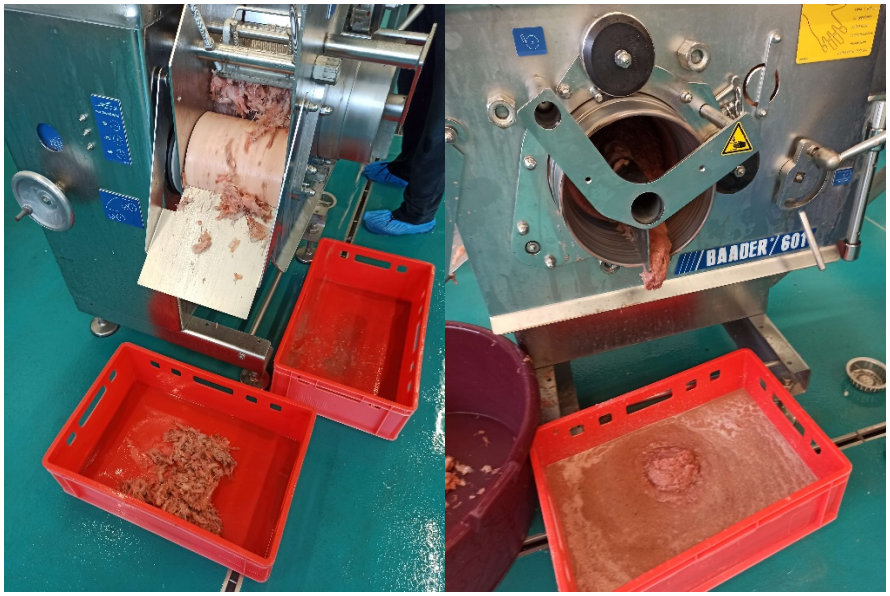


Meat separation

After transporting the frozen shrimp from the ship to the facility, the shrimp is placed on a draining table and rinsed with water. In the future, it is necessary to consider the use of purified water without chlorate. The drained shrimps are then transferred from the draining table to the inlet of the separator from which it is mechanically pushed onto the drum. Pealed shrimps are separated into one container and the shells are moved into another. Examination of the shells determines whether a sufficient degree of efficiency has been achieved or whether the mechanical pressure needs to be increased. If the degree of usability is not sufficient the mass of the shells can be returned to the process to squeeze out the remaining meat.

Figure 7. The beginning of the separation of shrimp meat - insertion into the receiving chamber – Source: FC Istra photos

Figure 8. Separation of flesh – shrimp pulp and shell, Source: FC Istra photos



The pulp is stacked in trays - depending on customer requirements as well as the future process, weighed, vacuumed and taken to the freezer or chamber to keep fresh seafood refrigerated. Labels with the product declaration are glued on the trays and then placed on plastic pallets for further transport (in the refrigerator or directly to wholesalers).

Figure 9. Minced shrimp meat in trays, Source: FC Istra photos

Store fish in the refrigerator before delivery

Pallets on which shrimp trays are stacked are stored in a refrigerator at + 2 ° C or they freeze. The refrigerator must be washed and disinfected before storage. The temperature is measured continuously with an instrument.

Boarding fish in personal vehicles, or customer vehicles

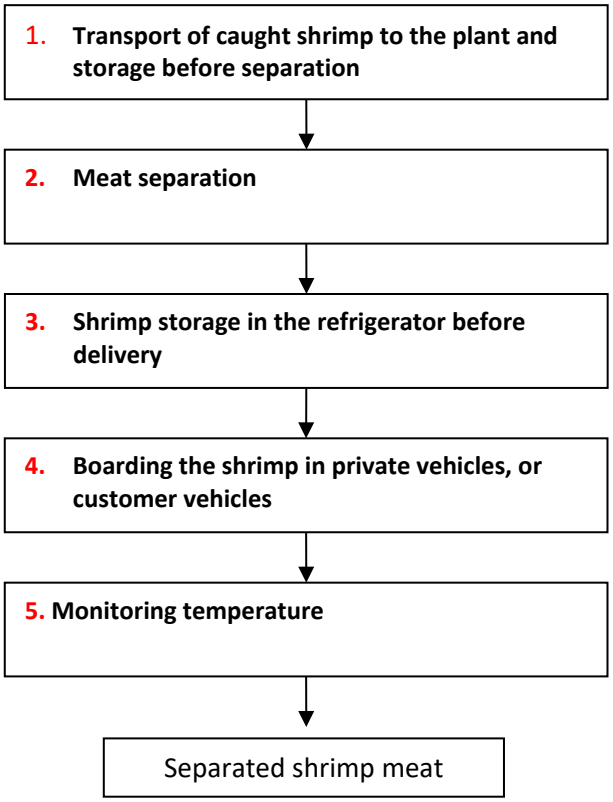
Shrimp cassettes can only be loaded on clean vehicles (washed and disinfected). Vehicles must also have cooling devices during transport. The temperature in the vehicles should be monitored continuously.

POSSIBLE RISK FACTORS IN THE PROCESS OF SHRIMP MINCED MEAT PRODUCTION

BIOLOGICAL – Possible growth of bacteria if the prescribed technological procedures are not performed correctly. It is also possible to enter pathogenic bacteria in the process of filleting fish in case the prescribed SSOP is not applied (the same should be done). Of the biological factors, bacteriological as well as accelerated enzymatic degradation of tissues during storage of fish in the refrigerator is possible if the prescribed temperature regime is not observed.

CHEMICAL – Excessive moisture of the product if the prescribed technological procedures are not followed during grinding (correct ratio of the fillet weight, separated meat and the amount of water content).
PHYSICAL – Residues of shells in the filleting process due to carelessness (use of magnifiers with light during filleting).

Diagram 1. The process of transporting caught fish and preparing it for sale or processing



Hazard analysis and risk assessment

Table 2. Hazard analysis and risk assessment

No.	Process step		Hazard	Description/Source	Severity	Probability	Importance / risk	Control measure
1.	Transport of caught shrimp to the plant and storage	Bio	*Salmonella spp., Listeria monocytogenes, Enterobacteriaceae,*	Fresh shrimp / spoilage processes due to elevated temperature	3	2	6	The shrimp is inserted into the cassettes, covered with a layer of ice. During transport in the summer months, if necessary, additional ice is added to the cassettes. Temperature check.
2.	Meat separation	Bio	*Salmonella spp., Listeria monocytogenes, Enterobacteriaceae*	Occurrence of darkening - appearance of mucus, possible substrate for the growth of microorganisms, / Product - Staff	3	1	3	Shrimp rinsing with water, Prerequisite programs (personal hygiene, wearing protective clothing and footwear).
3.	Shrimp storage in the refrigerator before delivery	Bio	*Salmonella spp., Listeria monocytogenes, Enterobacteriaceae,*	Growth of microorganisms due to increased temperature / Unwashed cassettes Shrimp / Staff	3	3	9	Shrimp storage until delivery in refrigerators at + 2C, Implementation of prerequisite programs (maintenance of the functionality of the refrigerator according to the equipment maintenance plan, cleaning of the refrigerator)
4.	Boarding the shrimp in private vehicles, or customer vehicles	Bio	*Salmonella spp., Listeria monocytogenes, Enterobacteriaceae,*	Growth of microorganisms due to increased temperature / Unwashed Shrimp cassettes / Staff	3	2	6	Transport of shrimp in refrigerated vehicles, Implementation of prerequisite programs. (Maintenance of vehicle functionality according to the equipment maintenance plan, vehicle cleaning)

STEP	CONTROL MEASURES	DECISSION TREE				Control measures category (CP – CCP)
		P1	P2	P3	P4	
		Are there preventive measures in this step of the process?	Is the process step specifically designed to eliminate or reduce to an acceptable limit the possible occurrence of hazards?	Does contamination with identified hazards occur within acceptable limits or can it increase to unacceptable levels?	Does the next step of the process eliminate or reduce to an acceptable level the possibility of hazards?	
Transport of caught shrimp to the plant and storage	The shrimp is inserted into the cassettes, covered with a layer of ice. During transport in the summer months, if necessary, additional ice is added to the cassettes. Temperature check.	YES	YES	NO	-	CP1
Meat separation	Shrimp rinsing with water, Prerequisite programs (personal hygiene, wearing protective clothing and footwear).	YES	NO	NO	-	PP
Shrimp storage in the refrigerator before delivery	Shrimp storage until delivery in refrigerators at + 2C, Implementation of prerequisite programs (maintenance of the functionality of the refrigerator according to the equipment maintenance plan, cleaning of the refrigerator)	YES	YES	NO	YES	CCP1
Shrimp transport with private vehicles	Transport of shrimp in refrigerated vehicles, Implementation of prerequisite programs. (maintenance of vehicle functionality according to the equipment maintenance plan, vehicle cleaning)	YES	YES	NO	-	CP2

Table 3. Categorization of control measures and determination of CCP

Critical points plan

Table. Critical points plan Table 5. Critical control point

	CP 1	**CP2**
Process step	Transport of caught shrimp to the plant and storage	Shrimp transport with private vehicles
Food safety hazard	B - Salmonella *spp., Listeria monocytogenes, Enterobacteriaceae*	B - *Salmonella spp., Listeria monocytogenes, Enterobacteriaceae,*
Control measure	Monitoring water temperature	Shrimp transport with refrigerated vehicles
Limit	T = +2 ºC do + 2ºC	T vehicle < 2ºC
Activities	Monitoring water temperature / recording	Monitoring and recording vehicle temperature
Supervision record	OB – Monitoring water temperature	OB – vehicle temperature record
Supervision responsibility	Technologist	Driver
Device used	Thermometer	Vehicle thermometer
Device calibration interval	1 year	1 year
Corrections and corrective actions	If the water temperature is> +2 ºC it is necessary to add ice to reduce it to +2 ºC	Measuring the temperature of shrimp, if the temperature of the middle of the shrimp is> 6 ºC, it is necessary to make a decision on removal
		Eliminating the cause of the malfunction on the vehicle refrigerator
Liability (for corrections and corrective actions)	HACCP team lead	HACC team lead
Control measure verification		Finished product analysis
Verification responsibility	HACCP team lead	HACCP team lead

	CCP 2	
Process step	Shrimp storage in the refrigerator before delivery	
Food safety hazard	B - S*almonella spp., Listeria monocytogenes, Enterobacteriaceae*	
Control measure	Storage of shrimp at temperatures where the development of microorganisms is prevented / Monitoring of storage temperature	
Critical limit	T= 0 ºC - 2ºC (±1ºC)	
Activities	Continuous measurement and recording of refrigerator temperature, monitoring measurements every 4 hours within working hours	
Supervision record	Thermographic record of temperature monitoring in the refrigerator OB- Monitoring refrigerator temperature	
Supervision responsibility	Warehouse worker	
Device used	Refrigerator thermometer	
Device calibration interval	1 Year	
Corrections and corrective actions	Freezing, moving the shrimp to the valid refrigerators, Define shelf life RU-create work instructions	
	Elimination of the cause of the malfunction on the refrigerator	
Liability (for corrections and corrective actions)	HACCP team lead	
Control measure verification	Analyzes of the authorized laboratory for health safety / 4 times a year according to the plan of sampling and testing of health safety or as needed	
Verification responsibility	HACCP team lead and technologist	
Control measure verification		Finished product analysis
Verification responsibility	HACCP team lead	HACCP team lead

Process:	Shrimp transport to the plant and storage
Validation date:	
Validation team:	Responsible person:

Process step	Control measure	Evidence	YES/NO
Shrimp storage in the refrigerator before delivery	Keeping shrimps at 0 – 2 ºC		
Validation mark:			YES/NO
The list of potential hazards and hazard assessments is based on scientific and technological knowledge - all potential hazards are included.			YES
Control measures appropriately control the hazard, i.e., they serve preventively to eliminate the hazard, eliminate the hazard or reduce it to an acceptable level.			YES
Fluctuation of parameters within the permissible limits will not affect the health safety of the product.			YES
The selected control measures enable the achievement of the envisaged control of food safety hazards			YES
Control measures are effective and able in combination to ensure control of identified food safety hazards			YES

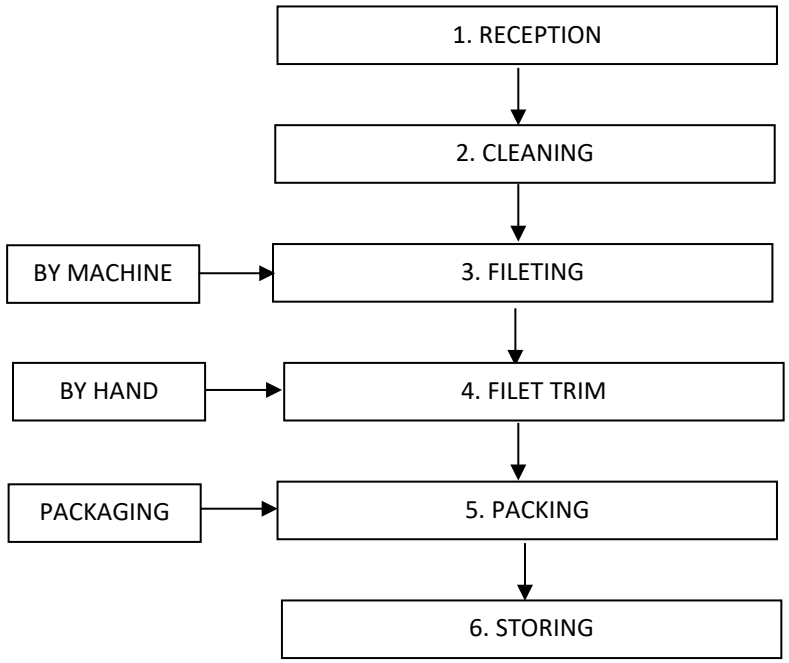
Validation Table 5. Validation

Evaluation (re-validation) of control measures due to the following changes:	YES/NO
Product description change	
Changing norms and raw materials used for production	
Product purpose change	
Change of product storage terms	
New approved supplier	
Changing production diagrams	
Change of equipment used in the process	
Change of personnel trained to manage corrections and corrective actions	
Change of staff trained to supervise CCPs	
Evaluation (re-validation) of control measures due to the following changes:	
Large deviations in the control of HACCP plans	
Product recall	
New product hazards	
Customer complaints about product safety	

Fresh fish come from their own catch or purchase, and are received undercooked from the cold store where it is stored after the catch. Fresh fish is under constant control during transport as well as during storage.

Fish skin removal and filleting takes place in a fish cleaning room where the cleaned fillets are rinsed. After filleting, the fillets are inspected for possible bone debris, cleaned (deboned) and left for packaging.

Fillet making diagram Diagram 2. Filet production process



3. OP BIVALVIA CASE

The P.O. Bivalvia Veneto, in synergy with the Consortium for the Management of Bivalve Molluscs of Venice, conducted a series of activities for testing new models of fishing gears and sorting sieves within the research and development framework of new fishing technologies aiming to improve the selectivity of stripped venus (*Chamelea gallina*). The activities focus on improving the sustainability of the resources and safeguarding the environment during the fishing of stripped venus with the hydraulic dredge and testing new designs to reduce the catch of under-sized clam specimens and the discard of macrobenthic fauna.

The obtained results are integrated in the Discard Management Plan with other activities (real-time geo-localized fishing vessels monitoring system, landing points, restocking areas) and the information provided to the management authority for evaluating the discards and the minimum conservation reference size (currently 22 mm). This document reports the piloting actions of testing the innovative fishing gears and the sieving system.

3.1. Past, current and future strategies MSC

The Producer Organization operates an artisanal fleet in the maritime compartments of Venice and Chioggia whose fishing fleet is certified as a sustainable by the Marine Stewardship Council (MSC). The fishing vessels are between 11 and 15 meters of length overall and accommodate between 2 and 5 fishermen, operating 4 days a week and respecting a maximum daily catch limit of 400 kg per vessel. Although the minimum requirement is 2 months of interruption of fishing activities, the Consortium of Venice and Chioggia adopts a 5-month interruption aiming to reduce the stress on the stock during the reproductive period and leaving the population to grow (called among fishermen “reproductive biological rest”).

The stripped venus (*Chamelea gallina*) is a marine bivalve mollusk that lives in sandy bottoms of the Adriatic Sea up to 12 meters deep. The clam is rich in omega-3 fat acids, vitamin B, iron and proteins and is a very popular food resource in Italy and a key ingredient in traditional culinary fish recipes known around the world such as pasta with sea clams.

The fishing of the stripped venus in the northern Adriatic Sea started about 60 years ago. Today it is mainly fished using hydraulic dredges. The annual commercial landings in Veneto are around 4.000 tons (average 2016-2017), or 26% of the national production. Currently the national consumption of the product is 95% fresh and 5% is frozen.
The certification of P.O. Bivalvia Veneto, in collaboration with the Consortium of Venice and Chioggia, does not imply that all Italian fisheries using hydraulic dredges are in line with the requirements of the MSC sustainability standards, which consider the state of the stock, minimization of impact on the marine ecosystem and effective management measures. The activity of P.O. Bivalvia complies with the MSC environmental sustainability standards following an analysis of data relating to the specific context in which the fishing activity takes place.

P.O. Bivalvia Veneto uses hydraulic dredges on an area equal to 35% of the area populated by the stripped venus, and a rotation plan of fishing areas is systematically implemented to allow the full recovery of the exploited or depleted populations. Moreover, periodical restocking activities are carried to reseed the juvenile clams in less productive or depleted areas. Subsequently, the same areas are closed for fishing, creating biological-reproductive nurseries and letting the specie grow. Regular scientific monitoring in collaboration with the Agri.Te.Co company is carried periodically both in the fishing and recovering or closed areas to ensure that fishing is in accordance with the management objectives. Finally, the fishing vessels are subject to real-time control by a satellite system to verify the compliance of the activity with the management plan; in addition to the regular control by the authorities in charge, an internal sanctioning system is in place in case of infringements.

Framework of technological solutions in P.O. Bivlalvia

The conditions highlighted by the independent certifier have the objective of ensuring sustainable management of fisheries in the medium and long term, so P.O. Bivalvia Veneto has been asked to prove according to scientific parameters that the stock is managed at maximum sustainable yield (MSY) levels or better. In addition, regular scientific monitoring program of the catches (seasonal quantities, spatial distribution, discards) is foreseen in order to monitor and minimize the impact of fishing on species not directly targeted by the activity.

Improving the fishing gears and production procedures

The protection and management of the stripped venus resources aims to ensure responsible fishing and a balance between fishing effort, the actual productivity of the stock at sea and at safeguarding the marine environment. The current tools for sorting procedures on board fishing vessels (vibrating sieves) separate the clam specimens according to their diameter and have a high selection capacity, but are unable to guarantee flawless (100 %) separation between commercial and undersized specimens. O.P. Bivalvia Veneto has set itself the goal of testing technological solutions for increasing the selectivity of current sorting equipment and testing new types of hydraulic dredges to limit the collection of by-catch organisms as much as possible. The main objectives are:

- Testing the selectivity of innovative hydraulic dredge to improve or replace those currently in use.
- Testing the selectivity of improved sorting machines.

Past experiences in improving fishing gears and available technologies

In Italy, striped venus clam fishing has always been regulated by appropriate decrees and the fishing vessels had to use a fishing gear and equipment with prescribed exact technical characteristics. For Italy these indications are given in Annex “D” to the MIPAAF DECREE of 22 December 2000 – Amendments to the Ministerial Decree of 21 July 1998 concerning the regulation of fishing for bivalve mollusks – Gazzetta Ufficiale n. 102 of 04.05.2001. Therefore, in the past there was less freedom of choosing different types of fishing gears than those allowed in the regulation so there were very few studies and tests of other solutions.

Description of selected fishing gears and their prototyping

Four fishing vessels were involved in this piloting action, all part of the Clam Management Consortium (Co.Ge.Vo.) of Venice, on which was tested the fishing gear and the sorting sieves. Table: List of involved fishing vessels and used fishing gears and sorting sieves in the piloting action.

Table: List of involved fishing vessels and used fishing gears and sorting sieves in the piloting action. Source: web

Name	Identification number	Fishing gear type	Sorting sieve type
Nani Gata	3VE946	Standard	Standard
Nicoletta	3VE780	Experimental	Experimental
Giove	3VE777	Experimental	Experimental
Freccia Azzurra III	3VE955	Experimental	Experimental

Figures: The fishing vessel Nani Gata (top) and detail of the standard fishing gear (bottom). Source OP Bivalvia photos

Three new fishing gears were designed, manufactured and installed on board different fishing vessels in this piloting action.

The first fishing gear is installed and tested on board the fishing vessel Nicoletta (3VE780). It has a simple design with horizontal steel rods (perpendicular to the towing direction) spaced between them 11mm and overall sizes measuring 2,50 m x 1,50 m x 0,35 m. The gear has a modified collector with two rows of cylindrical nozzles, not high-pressure ones and similar to ones used in the gear in the Marche region, with an additional sieve placed vertically.

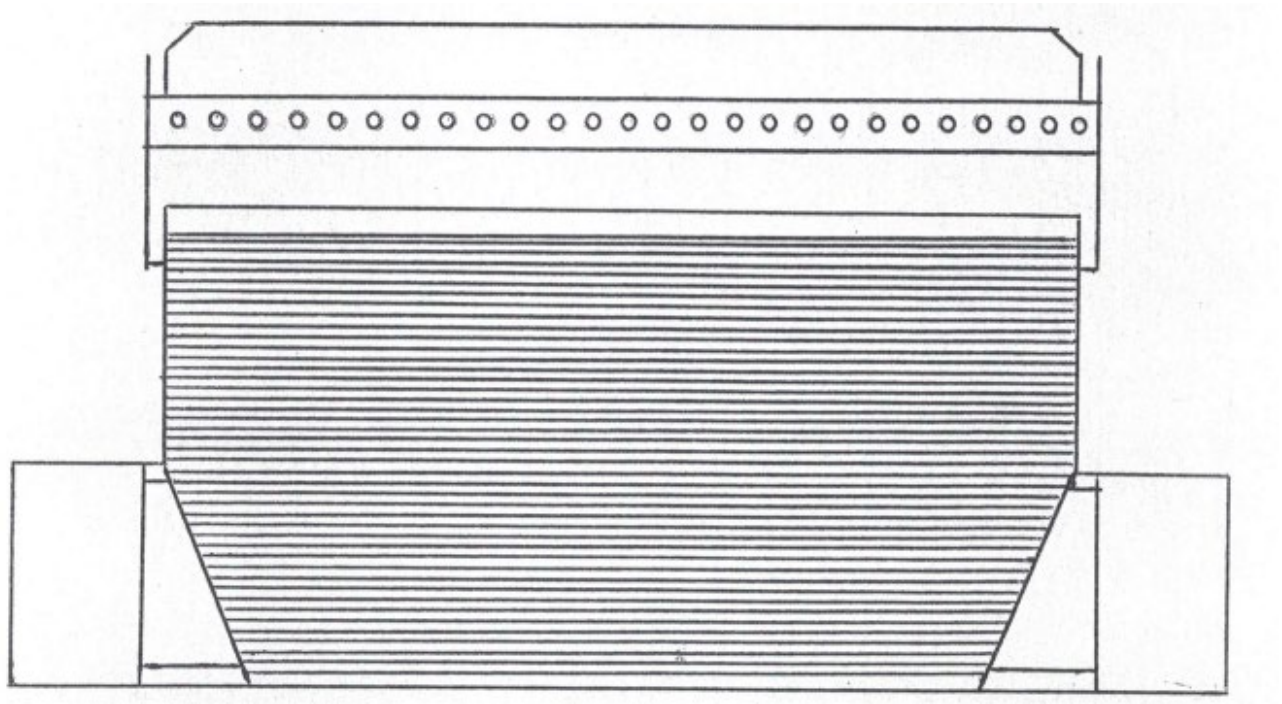


Figure: Fishing gear N. 1 on fishing vessel Nicoletta, Source: web

Figures: The fishing vessel Nicoletta during fishing operations (top) and detail of the new fishing gear (bottom). Source: Web

The second fishing gear is installed on board the fishing vessels Giove (3VE777). This gear measures 2,50 m x 1,50 m x 0,35 m and uses steel rods spaced 11 mm. This gear has an alternating configuration of steel rods, both horizontally and vertically, where the vertical sections should improve the escapement of undersized specimen. Moreover, the row of nozzles is put at angle towards inside to reduce the pressure of water jets on the benthic macrofauna.

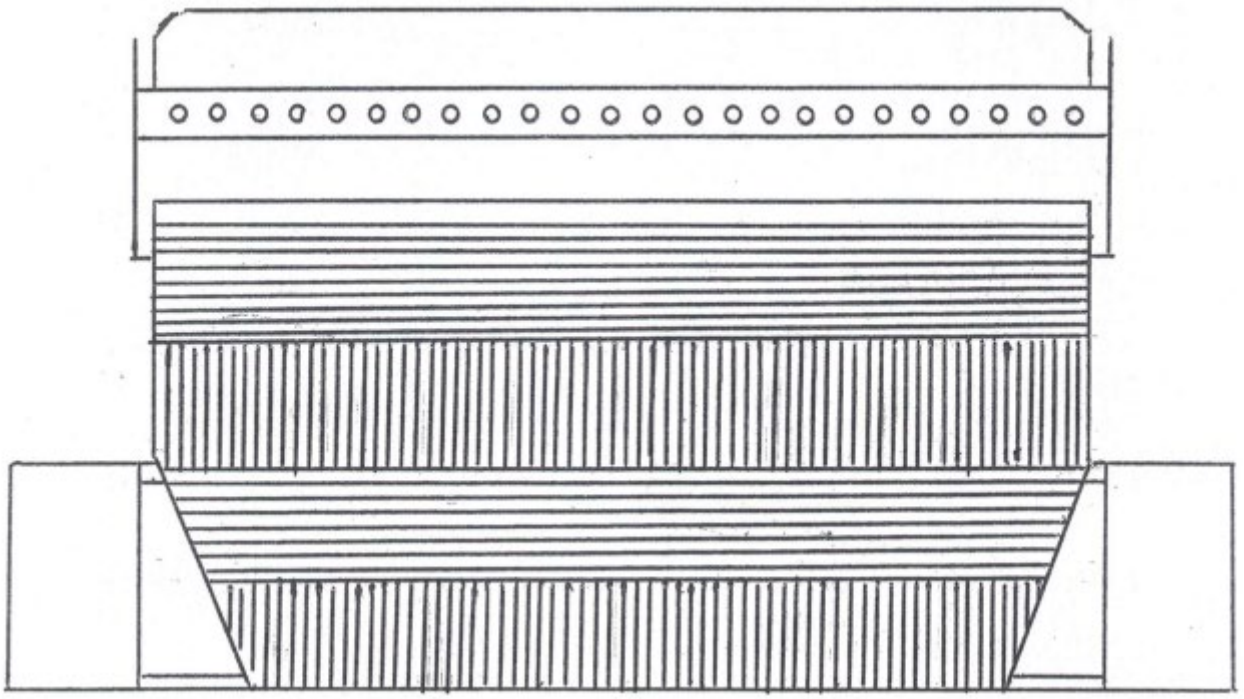


Figure: Fishing gear N. 2 on fishing vessel Giove, Source: Web

Figures: The fishing vessel Giove equipped with the fishing gear N. 2 (top) and detail of the new fishing gear (bottom). Source: Web

The third fishing gear was installed on board the fishing vessel Freccia Azzurra III (3VE955). The fishing gear measures 2,50 m x 1,50 m x 0,35 m and the design is a sieve consisting of horizontal bars spaced 11 mm gives the basic design. The innovation consists in water jet nozzles placed in multiple rows and different angles.

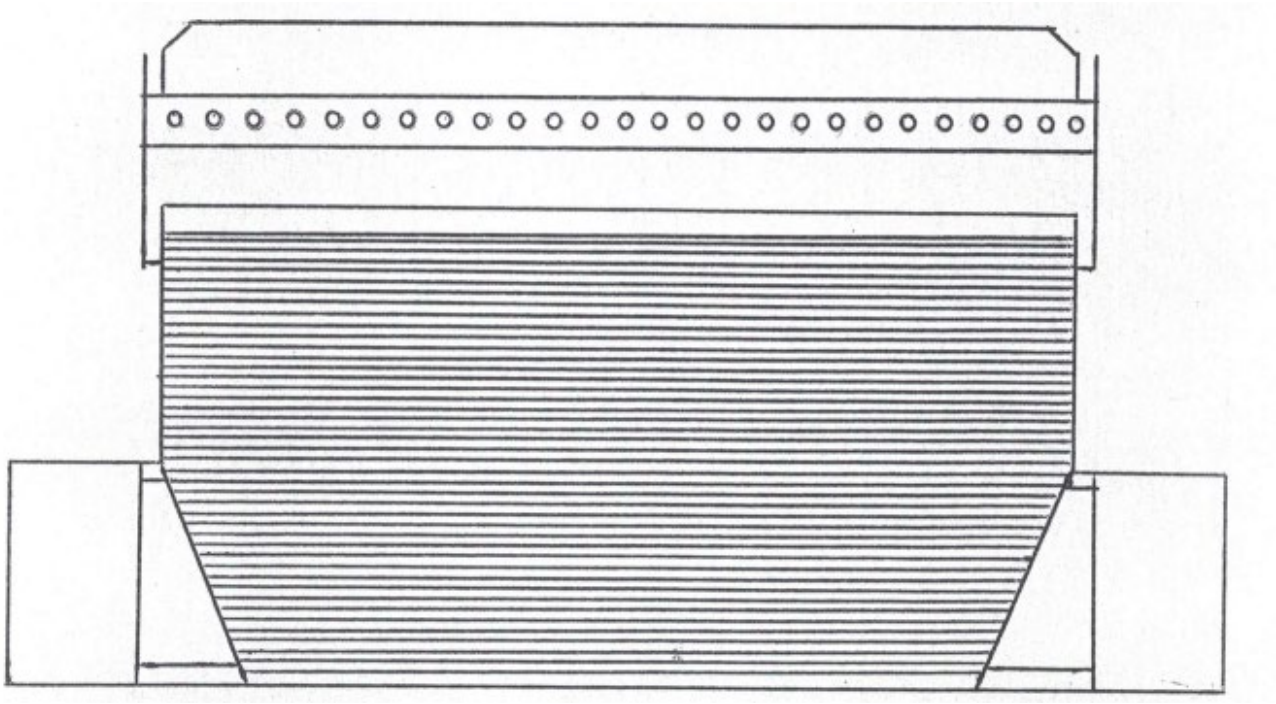
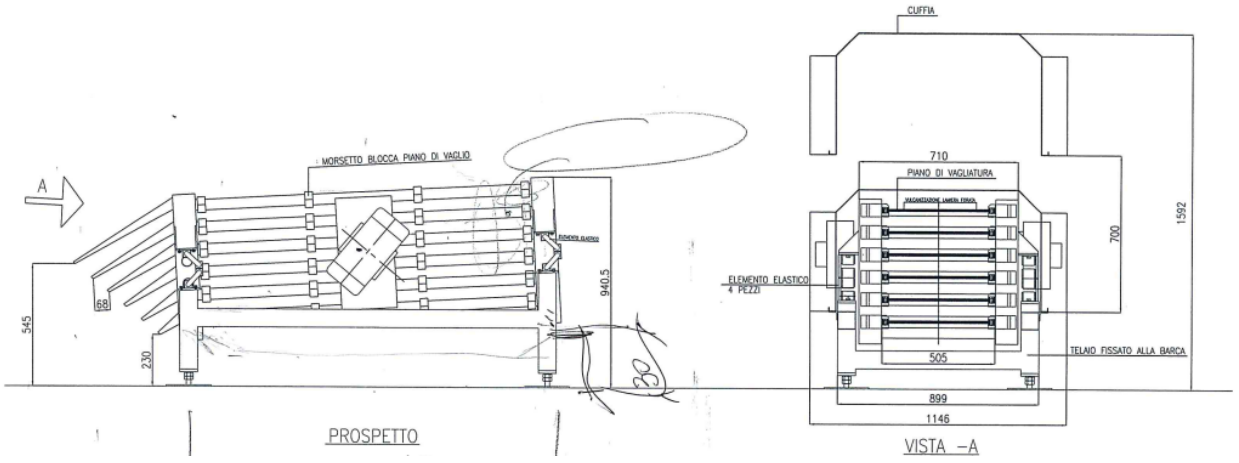


Figure: Fishing gear N. 3 on fishing vessel Freccia Azzura III., Source: Web



Figures: The fishing vessel Freccia Azzura III fishing with the gear N. 3 (top) and detail of the new fishing gear (bottom). Source: Web

Moreover, two experimental vibrating sieves were constructed, one with 6 sieving levels and the other with 4. Each of them is equipped with different sieving screens who's designed as parallel bars, round wholes and plain sections. The parallel bars screens tested were either made of inox steel bars or inox steel bars coated in a plastic material, to reduce the mechanical impact on the shells of the clams.

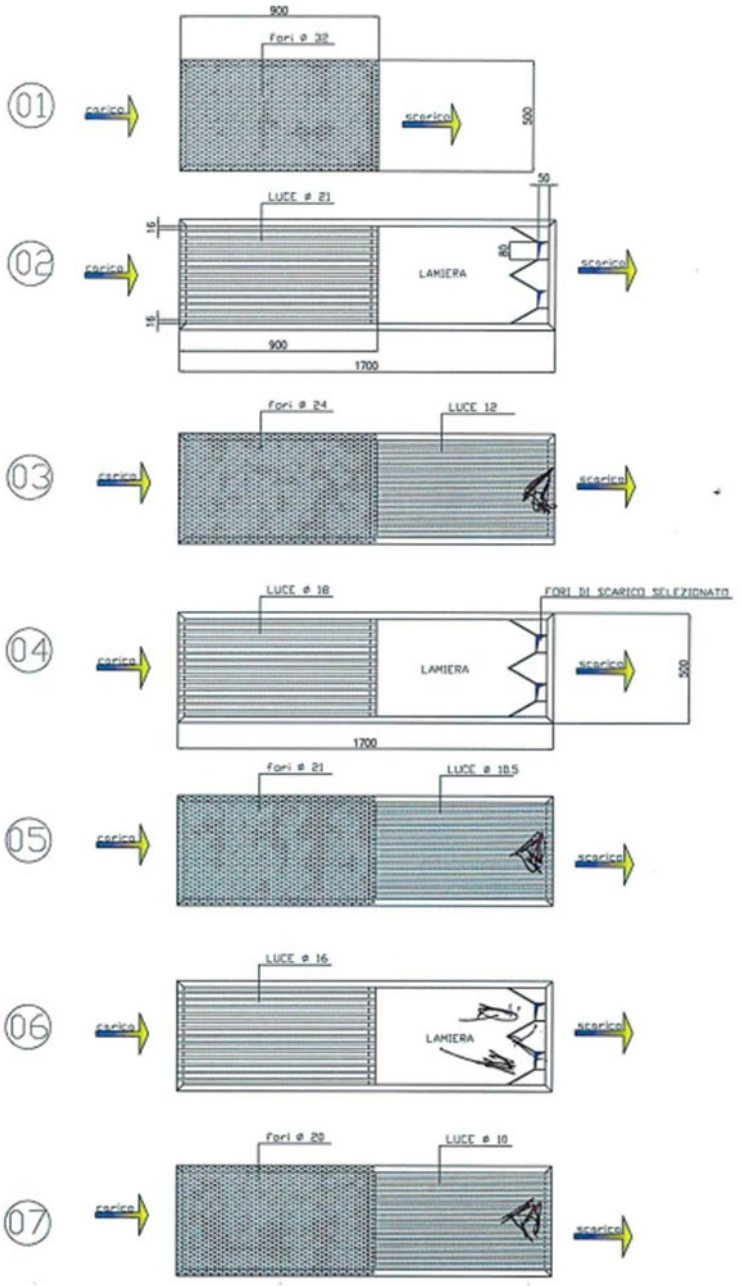


Figure: Design of the sorting sieve with 6 levels (top) and details of different sorting screens (bottom). Source: Web

3.2. Piloting and testing on sea

The piloting of the fishing gears was conducted within the marine compartment of Venice, on natural populations of stipped venus in front of Caorle and Cavallino-Treporti within the 2 nautical miles from the coast.

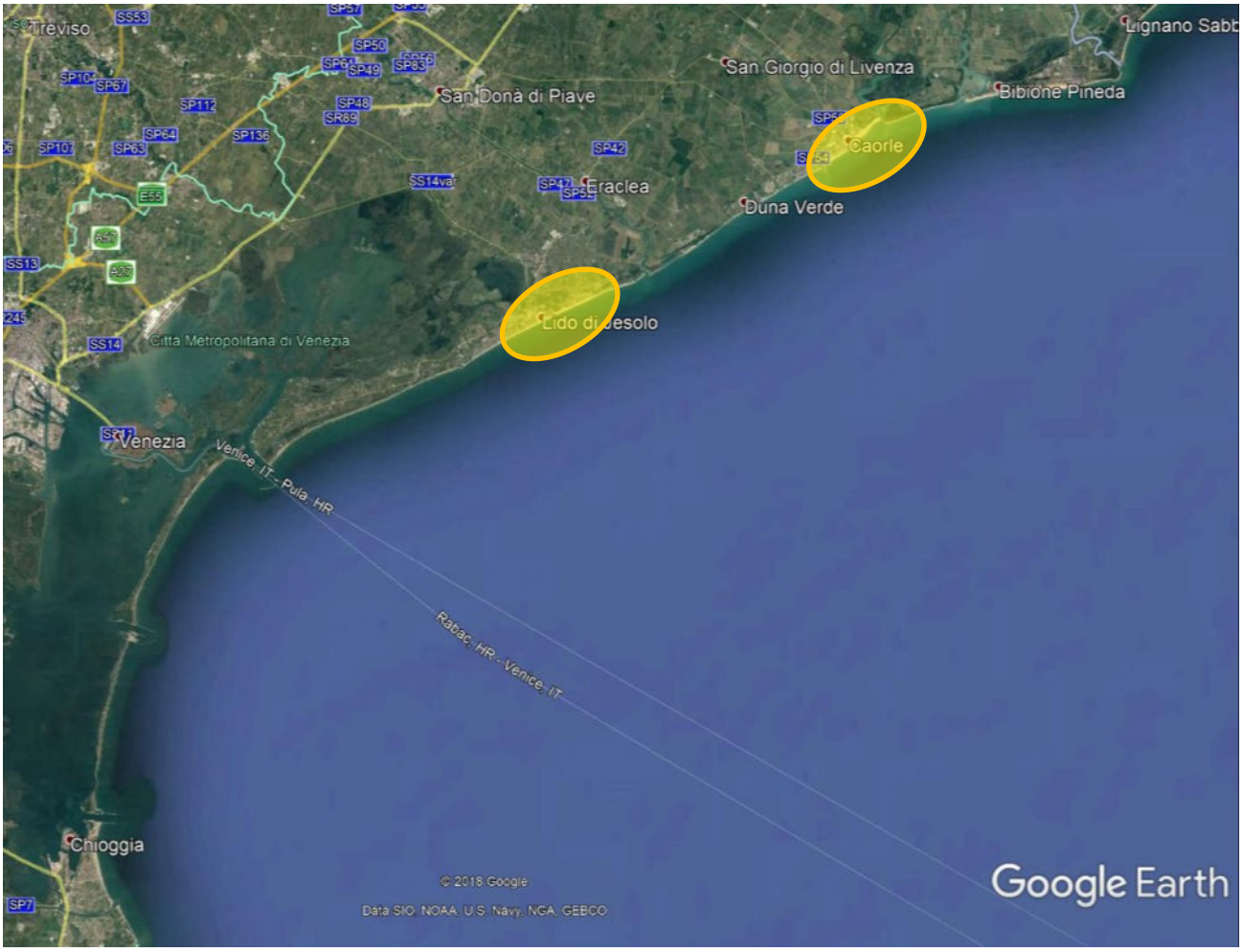


Figure: Testing areas in front of Caorle and Cavallino-Treporti. Source: web

The study area was the same for the duration of the piloting action. The commercial catches are a crucial parameter during the study for evaluating the capability of the innovative fishing gears for catching the stripped venus. The analysis of the length frequency distribution of the stripped venus allows to evaluate the structure of the population and to evaluate the selectivity of the fishing gear by comparing the contribution of the number of specimens below and above the minimum conservation reference seize of 22 mm (MCRS).

Finally, the qualitative and quantitative characterization of the by-catch allowed evaluating the impact on the macro benthonic community.
The impact of the hydraulic dredging with the new fishing gears on the benthic environment was evaluated visually using a mini underwater remotely operated vehicle (ROV; FIFISH V6 by QYSEA) and the physical-chemical properties using an oceanographic multi-parameter probe (Hydrolab HL7; temperature, salinity, Ph, dissolved O2, chlorophyll-a and turbidity). In particular, the impact of the resuspended sediments on the environment, created by fishing gear due to the high-pressure water jets evaluated by measuring the turbidity. The physical-chemical properties of the water column were measured before any activity, as a control situation. The turbidity was measured before, during and after the fishing operations, at sampling intervals between 30 seconds and 5 minutes.


Figure: Measurement of water column properties with the multi-parameter probe.
Source: Bivalvia photos

Figure: The Mini ROV used in the piloting and its properties. Source: web

Sampling activities were conducted in during several days during summer and autumn, on 24-25 June, 30 July and 19 October 2020.

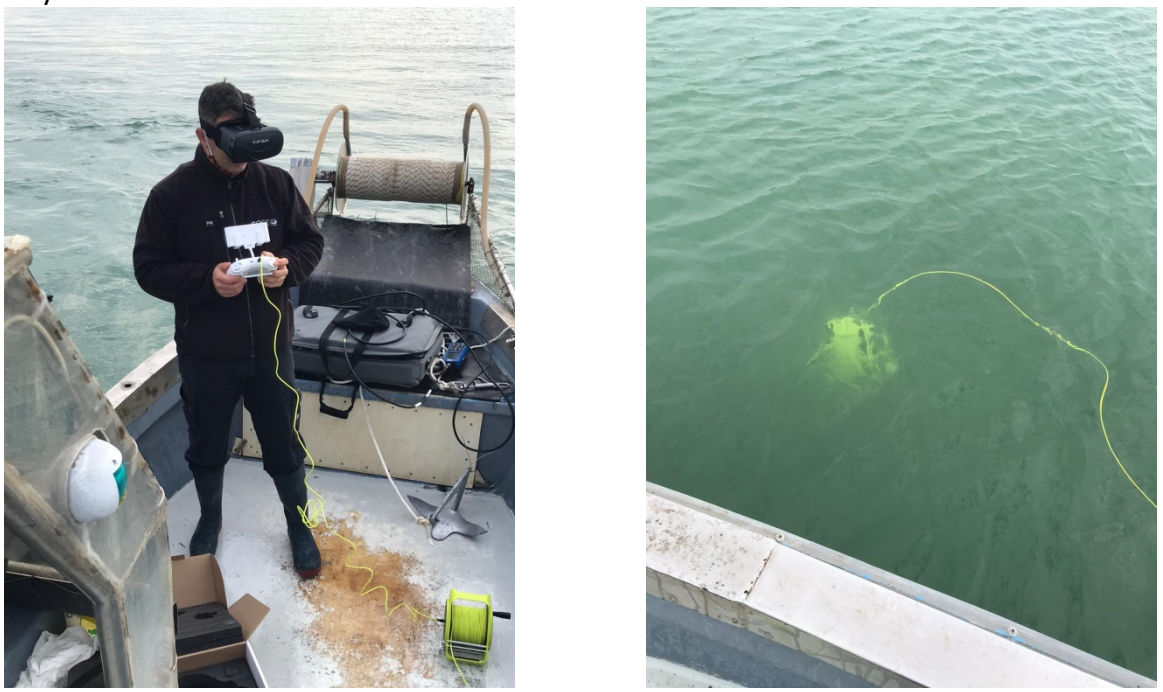


Figure: Use of the ROV for underwater monitoring. Source: Bivalvia photos

3.3. Observations gathered during piloting

The testing of fishing gears for harvesting clams allowed the operators to design these new innovative experimental dredges based solely on the ideas proposed by the fishermen translated into physical solutions, without any interference from technical-professional figures. Therefore, the fishermen had a chance during this piloting action of validating their suggestions for designing a fishing gear based on intuitions and their accumulated experience. The purely engineering aspects only concerned how to make these new types of gear in compliance with the regulations to make it suitable for professional fishing. The fishing activities did not undergo any major changes compared to what fishermen already did, however adjusting the fishing operations was needed for using the new fishing gears. The fishermen needed a period of training to learn how to best configure the vessel's setup to ensure the best yield per fishing action. During the present monitoring activities, there was not enough time to setup correctly the fishing gear for optimal fishing efficiency. A longer tuning period is needed to setup the fine adjustments of different properties of the fishing gear, such as the blade, the weights, the length of the bridles (the towing line), the towing speed and the optimal water pressure. Therefore, the boats selected for piloting were asked to maintain during commercial fishing operations the same experimental gear in order to refine its setting.

An interview with the fishermen involved in the piloting allowed to obtain qualitative feedback on handling of the new gears and catch impressions during fishing operations. Fishermen feedback highlighted positive aspects during the trials, reporting the gears being handy, achieving a good yield and a clean catch. Additionally, it could be summarized in the willingness to keep the innovative fishing gears as a future fishing gear even at the end of the trial as it also complies with the current regulations.

A particular interest was toward reducing the sand content within the clams by setting a method for achieving a closure of clams' valves before reaching the section of the dredge with high pressure jets. A set of low-pressure nozzles at the beginning of the dredge disturbs gently the clams but without creating high turbulent water flows with a lot of resuspended sediments and seems to help "warning" them and giving some time for valve closure. Interest was expressed also towards larger opening nozzles that work well, but they need more testing and adjusting the water pressure for a correct use. Interest and positive feedback are reported also for the single continuous nozzle blade, which seems to work well but needs further testing to refine its performance.