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Science, Technology and Society Initiative to Minimize Unwanted Catches in European Fisheries

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1 Summary

Discarding fish represents a waste of marine resources that could be used productively, when economically feasible and with due regard to the overall ecological goal to minimize discards in European fisheries (Art. 15 of EU Reg. 1380/2013). For instance, unwanted catches can be brought to land and processed as fish meal, fish oil or other types of "traditional" uses. Other types of utilization for "niche" markets are possible although little researched for south European fisheries, and could help to add value to the catches of these fisheries. On the other hand, in the absence of clear market outlets for former discards, the fishing industry should lead to practice more selective fisheries in order to maximize the use of productive factors (particularly, labour). However, even very highly selective fishing methods produce some unwanted by-catch (here termed "unwanted catches": UWC), that can be rationally utilized and brought productively into the economy. The processing sector offers a great variety of products and possibilities for the utilization of landed UWC, possibly combined with leftovers, offal and cut-offs from intermediate processing, for non-human consumption or indirect human consumption. A rational strategy of processing fisheries UWC in southern European waters needs to take into account the specificities of the area, where most fish is landed fresh for human consumption. This predominant traditional mode of fish consumption coupled with a low volume of fish production has led historically to low entrepreneurship in fish processing plants. However, making use of available start-up funding for small scale processing plants, currently under development in other research projects and preferably economically integrated with the fishing industry, could be a solution for the full utilization of UWC, because otherwise former discards for which no legal commercial outlet can be found have to be handled separately and destroyed at the producer's cost.

This deliverable summarizes desktop and field research carried out during the MINOUW project. Because the landing obligation enters fully into force only in January 2019, very few successful experiences with bringing to land former discards could be documented. However, the project has made an important effort to identify the problematics of utilization of former discards from the perspective of both, the fishing industry and the processing industry. The first three sections (Sections 2, 3 and 4) review the problem of discards production in fisheries, possibilities of industrial utilization and fish processing. Section 4 includes also the results of a field trip to a cooperative that exemplifies the full use of catches. Sections 5, 6 and 7 shows the results of field research with stakeholders interviews and examples on the practice of handling unwanted catches for utilization. This document includes also an appendix with estimates of unwanted catches falling under the remit of Art. 15 and total quantities that could be brought to land for industrial utilization for Mediterranean EU geographical subareas, based on the fisheries data collection (DCF) for the years 2012-2014.

The overall conclusion is that, although economically viable, the utilization of former discards for industrial purposes from Mediterranean fisheries needs to overcome important barriers related to a perceived lack of incentives to the fishing industry, lack of sufficient infrastructure for utilization, and legal issues related to the handling or disposal of animal by-products.

2 Introduction

The Common Fisheries Policy reform of 2013 (EU Reg. 1380/2013) includes in its Art. 15 the gradual introduction of a discards ban or Landing Obligation (LO) for regulated species for fishing fleets operating in European waters, as well as certain fleets in other waters. The objective of this landings obligation is to reduce the fishing mortality of stocks and progress towards the full utilization of catches, as measures contributing to the sustainable use of marine resources in Europe.
Art. 15 establishes the obligation of landing all regulated species in commercial fisheries, i.e. species subject to TAC or regulated by Minimum Conservation Reference Size. To facilitate the adaptation of the fishing industry to the new policy, the obligation is being gradually introduced between 2015 and 2019. The details of its implementation are specified in the regional multiannual plans or in specific discards plans prepared by the member states. These plans should specify the regulated species, provisions for the full documentation of catches, MCRS and the conditions for exemption.
The production of unwanted catches (UWC) and discarding in EU fisheries is highly heterogeneous among regions, fishing gear, vessel size and fishery. The amounts of UWC, spatio-temporal variation and composition are determined by the interaction of fish harvesting process with the marine ecosystem, as well as economic and social considerations, that make it very difficult to estimate the volume of UWC that will be subject to landing obligation and industrial valorization.
There exist generic estimates of the total volume discards. For instance, a rough Mediterranean-wide estimate of discards around 230,000 t or 18.6% (13.3–26.8%) of the catch was obtained by Tsagarakis et al. (2014), but this includes: a) the fraction of fish species not covered by the LO, and b) a non-negligible fraction of hard-shelled invertebrates that cannot --in general-- be brought under utilization with current fish-processing technologies[1].
Discarding is a decision taken on board, related to economic motives and limited by legal and technical reasons (Rochet and Trenkel, 2005). Discard quantities are affected by several factors such as species and size composition of the catch, environmental conditions, fishing strategies, and cultural characteristics. These factors often act synergistically and it is not always easy to determine which are more relevant, especially in multispecies fisheries, such as mixed bottom trawl fisheries on continental shelves. High regional, seasonal, and inter-annual fluctuations are observed even within the same fishing gear (Tsagarakis et al., 2014), hence only approximate volumes of UWC for utilization can be provided and the processing industry must be aware of the fluctuations in quality and quantities, and must plan their operations accordingly.
In the specific case of fishers' attitude in south European waters towards discarding practices, it must be taken into account that due to historically low compliance with fisheries regulations, all catch with economic value was routinely marketed, regardless of size, at prices normally higher than can be expected to fetch for industrial utilization, hence the risk often mentioned in stakeholders'

[1] but new developments could rapidly bring the possibilities of using even this fraction. Consider for example research project *n-chitopack* (http://cordis.europa.eu/result/rcn/163251_en.html) investigating the use of chitins in the shells of lobster, crab or shrimp for candy wrappers (project coordinator Prof. Pierfrancesco Morganti, R&D director at MAVI).

forums of exacerbating the problem of black markets for undersize fish (Damalas, 2015). On the other hand, fishing units are relatively small (the majority of vessels being < 24 m LOA), with limited storage capacity. The sorting capacity of the crew can be also a limiting factor in certain cases. The combination of limits to storage and time for sorting led in the past to discarding practices of low-value fish, like in small pelagic fisheries (Anon., 2001; Santojanni et al., 2005).

A general overview of the possible fate of the different catch fractions is given in Fig. 2.1. The fraction of unwanted catches (UWC) that cannot be distributed to traditional fish markets for human consumption and that can or must be brought to land for industrial utilization is split in the following fractions:

1. UWC under the remit of the LO,
2. UWC that are exempted but could be utilised: bitten or damaged fish,
3. UWC that do not fall under the LO but could be utilized: non quota species and/or no MCRS.

The minimum volume for utilization is [1], but could be complemented with [2] and [3] to a maximum volume for utilization.

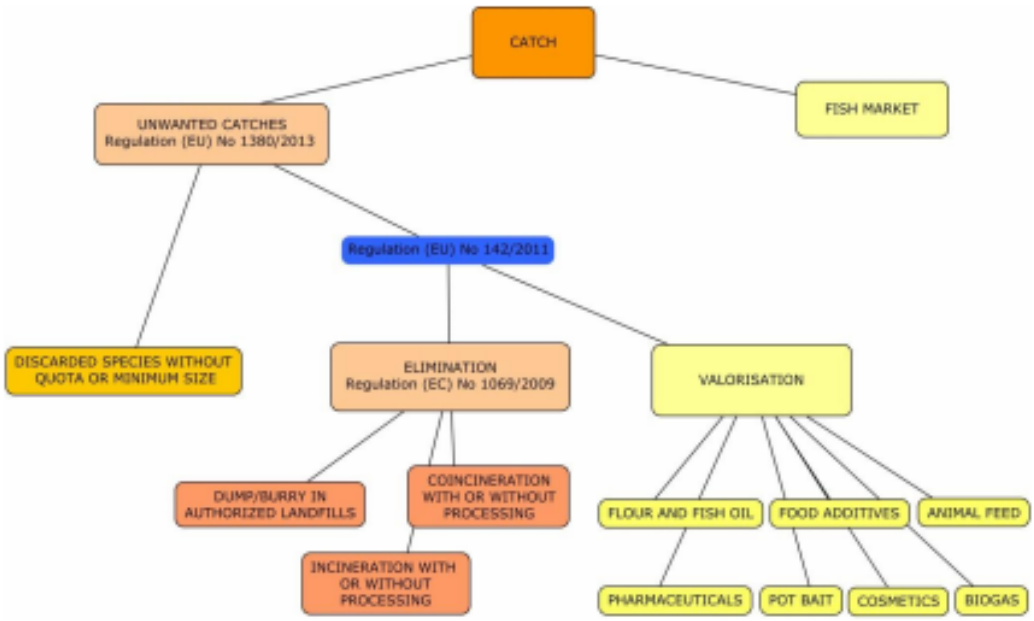


Fig. 2.1. Fate of portions of fisheries catches according to current EU regulations.

When no possible industrial outlet can be found, UWC of regulated species must be destroyed, according EC Reg. 1069/2009 because they are considered as animal waste (animal by-products or ABPs).

3 Industrial utilization of UWC

The European Union (EU) is an importer of marine fish and other seafood products, mainly for direct human consumption. All in all, the trade deficit in marine fishery-related products in the EU reached 17.8 billion € in 2015. Non-food uses represented imports of 841,400 tonnes in 2015, mainly referring to fishmeal, oil and fish waste, which are the main utilization options, both in terms of weight and value (EUMOFA, 2016, p. 46). In comparison, the European meat sector imports four times less than the fish sector (EUMOFA, 2016, p. 35 et seq.), showing the low self-sufficiency of the EU in the sector of marine fishery-related products. The full utilization of former discards can be a step towards minimizing Europe's dependence on foreign imports, as well as improving the economic efficiency of utilizing marine resources.

Estimates for Mediterranean European GSAs produced in the MINOUW project from DCF data for the period 2012-2014 show that UWC covered by the LO could amount to 9% of the catches (at minimum), while total utilizable catches are of the order of 16% (Appendix 1). These figures represent from 54 to 96 000 t annually of biomass available for utilization in Mediterranean European GSAs, based on a rough estimate of 600 000 t fisheries catches annually (450 000 t landings, FAO FISHSTAT data 2013, plus 1/3 of unwanted catches).

However, unwanted catches for utilization have a high spatial and temporal variability, inherent to numerous uncertainties in volume or composition and will remain difficult to estimate accurately (Borges, 2015, p. 538). Knowing that 4.46 million tonnes of live weight catches were landed in Europe in 2014 (EU, 2016a, p. 20, excluding non-EU waters) and assuming that 5-10% of European fisheries catches are brought to land under the discards ban after full implementation in 2019 an amount of 223,000 to 446,000 tonnes of landed *ex-discards* could be expected from European marine fisheries[2], which is the within the range of the annual fisheries catches of France, the fourth biggest fishing country in Europe, and comparable to ca. 230,000 tonnes of discards annually estimated for Nordic countries in the North Atlantic (Laksá et al. 2016).

Basically, there are two main possibilities of valorization of UWC brought to land: for ***niche*** (or high added value) markets or for ***reduction*** to fish meal / fish oil destined to animal-feed markets. The latter is the main and classical outlet; the former is relatively new, requiring advanced processing technology and needs less amount of product. In some cases, markets already exist for niche products, like collagen as food supplement for humans or minerals / essential nutrients for animal feeds, but in many cases new markets will need to be developed. A third possibility (Charity) is not considered here because in theory UWC cannot be used for direct human consumption (although charity does not involve the creation of markets for UWC, as expressly noted in Art. 15).

[2] Not considering changes in quota or gear selectivity and composition of non-regulated species in these catches.

4 Fish processing

According to official figures 3,500 companies work on fish processing in Europe with a turnover of € 28 billion and over € 6 billion GVA (Döring & Borrello, 2014). More than half of these companies, however, have less than ten employees and only one percent have more than 250 employees. This is an indicator supporting the assumption that most fish processing takes place locally or regionally in small enterprises. In 2012 approximately 120,000 workers were employed in the fish processing sector (Döring and Borrello, 2014).[3]

The fish processing sector depends heavily on world markets because it relies on imports of raw materials, which is one of the main cost drivers (compared to other costs) (Döring & Borrello, 2014). In a scenario of lower amounts of fish in the future due to lower quotas and overexploited fish stocks, the access to raw material could worsen and/or the prices of this commodity might rise (Delgado et al., 2003; Merino et al., 2012). With vertical integration of fish processing (Döring and Borrello, 2014; Vigfússon, 2016) and full utilization of discards the position could alleviate. However, since the discards ban seek to minimize UWC in the future and the volume available is very difficult to estimate, companies are exposed to the risk of unreliable delivery, which makes depending on a single source of production difficult.

Producers organizations and fishery associations are groups of fishers working together, from associations in small harbors which support and coordinate commercial fishing to large-scale fisheries organization, such as the Pelagic Freezer-Trawler Association (http://www.pelagicfish.eu/). Their interests might be very similar to individual operators, but associations manage, among other, the administrative expenses and, notably, have direct information about new policies and are in a better position to implement handling, storage and transport at landing sites. Local pilot processing plants for UWC, developed in the projects LIFE 'iSEAS' (www.lifeiseas.eu) and H2020 'DiscardLess' (www.discardless.eu) rely to a crucial extent on the logistics afforded by Fishers' Associations.

In all cases, for the utilization of UWC of formerly discarded species, the fishing and processing industries need to address the following issues:

- handling on board
- storage at sea
- storage on land
- transport to processing plant
- utilization opportunity (i.e. product to be made and potential market for it)

Naturally, along the distribution chain, from catching to industrial utilization, the UWC must follow the requirements of traceability, full documentation and hygiene.

4.1 Handling at sea

The sorting process is one of the limiting factors for fisheries. The process should be fast, clean and precise to guarantee a high quality product that can generate profit. The more species get caught in one haul the longer sorting time is needed to separate in valuable, regulated and discardable species. Mixed-fisheries in the Mediterranean for example have up to 100 species in one haul which, ca. 30 are

[3] Even though this is 20 percent less employment than in fishing fleets, the remuneration to workers is 60 percent higher than the average remuneration in the fishing sector (Döring & Borrello, 2014).

subject to MCRS and will fall under the L.O. (Tsagarakis et al., 2014, p. 1220). The crew members' salary often has a high proportion of bonus based on fishing success. Everybody on board tries to do the best job in shortest possible time. Thus, sorting discards additionally has a direct impact on the fisher's economic feasibility because less time is available to handle valuable fish and maybe additional crew is needed which, in fisheries where salaries are paid on share basis, lowers the individual share. Large vessels (i.e. Atlantic pelagic fisheries) with trips about 40 days have standardized procedures comprising processing facilities like freezing, canning, mincing or filleting on board which makes handling of discards easier. Whole fish schools can be caught in one haul with low discard rates but the total volume is much higher.

Further handling of the discards demands complying with EU law for animal by-products and derived products not intended for human consumption (EU, 2011). Discards belong to Category 3, material with low risk, or Category 2 with medium risk when, for example, by-products from Category 3 are processed. The law intensifies the storage problem on the vessel and locally on the landing site because fish for human consumption cannot be stored, handled or transported with Category 2 or 3 material. Whereas fishers in Spain are allowed to carry discards to the port in the same storage room like the commercial fish in clearly separated boxes, the German fishers are not allowed to have mixed categorized products in the same room. Thus, they need to store non-refrigerated items on deck. So, this is another undefined grey area which hinders a clear European regulation and equal treatment of products. This also makes handling complicated and more expensive.

An important barrier to appropriate sorting of UWC at sea is the lack of incentive to the sorting crew. Normally, crew members in many fisheries, such as south European fisheries, are paid on a share basis (Guillén et al. 2017), i.e., their wage is proportional to the landed income. Considering the low price that can realistically be obtained from UWC in the short to mid-term, the extra work of carefully sorting the catch to account for UWC under the Landing Obligation will practically remain unremunerated.

4.2 Storage and transport on fishing vessels

The storage of UWC on board, and their transport to land storing / processing facilities, is an important challenge for the relatively small south European fishing vessels. Although the volume of UWC is relatively small, it might pose logistic problems for vessels working long fishing trips at sea (e.g. Portuguese trawlers; Italian trawlers, particularly the Sicilian fleet) in terms of hold capacity and refrigeration. For Spanish Mediterranean vessels with daily obligatory return to port, the problem is less severe. Our interviews with fishers in WP1 (MINOUW Deliverable D1.5) highlighted the practical problems of storage and transport, as well as the fact that the costs of bringing UWC ashore will likely exceed any economic benefits, given the current low price of raw materials for the fishmeal/fish oil processing industry. Note that improper handling and storage on board can lead to poorer quality of the raw material and hence even lower prices (Archer 2001), in addition to any legal consequences that may derive from the regulation on ABPs.

Note that total or partial processing on board, to reduce the volume of product, by means of ensilage, grinding, mincing or other physical or chemical process is possible, but will complicate the proper documentation of catches.

4.3 Storage on land

If no storage on the landing site is possible, it needs to be ensured that the material can be transported to other storage facilities or directly to processing companies in order to prevent spoiling and hygienic concerns. For little amounts collection and transport costs can be very high but reducible through economies of scale. Due to the lack of facilities and suitable infrastructure challenges are intensified in small harbors. When no suitable storage is available or no collecting transport system is in place to bring the discard to processing companies, former discards brought to land must be picked up by incineration companies, paid by the fisher.
The operator landing the UWC is responsible for its handling and storage until the product is sold for industrial processing. UWC for indirect human consumption markets must continue to be handled according to food hygiene rules at sea, as well as onshore, while UWC for non-human consumption markets must be handled according to Animal By-Product rules (ABP, see below). These rules apply from the moment the owner of UWC decides on its ultimate market (indirect human consumption vs. non-human consumption), but ABP rules do not apply on board fishing vessels. When UWC are destined to animal feed, they are considered raw materials and not ABPs, regulated by specific provisions.

4.4 Transport to processing plants

If no ABP-registered storage facility is available, the ABP must be placed directly and immediately into an ABP-registered transport. This is likely to be the case at landing points with limited infrastructure. Fish destined for human consumption and fish ABPs can be transported in the same vehicle as long as they are handled and stored separately.

4.5 Utilization possibilities

Compared to the meat industry where even by-products with no value on European markets are sold to countries in Africa and create a profit to the manufactures (Jayathilakan et al., 2012), the degree of usage of fish is low. Depending on the species, the fillet-yield is between 30 and 65 percent (FAO & OECD, 2014, p. 195). By-products and wastes are mainly given inferior uses as fishmeal or otherwise dumped. Processing of fish often takes place close to relevant harbors or are transported to other factories. Therefore, utilizing discards is not something completely new to the industry. Using discards means in this case processing the discards in any form, like fileting or cutting, boiling, drying, ensiling to make a product for further uses or for end users. Some studies are already available on the topic of using discards or other fish raw materials (e.g. Condie et al., 2013; Laksá et al., 2016; Stewart, 2014; Tsagarakis et al., 2014; Villasante et al., 2016). Limited attempts to introduce discards in existing manufacture process as supplementary raw material are also known.
In the different possibilities of utilization, it is important to consider the legal aspects of bycatch classification. In the European Union there are two main regulations: Regulation (CE) num. 1069/2009 and the regulation (EU) num.

142/2011. The applicable legislation to bycatch fish products varies depending on whether it is ultimately destined to human consumption (indirect human consumption) or not. Animal by-products not intended for human consumption (ABPs) are defined as the whole body or parts of animals, products of animal origin or other products obtained from animals that are not intended for human consumption, either for public health reasons or due to a commercial decision of the operator.
The fish ABPs that could be used for indirect human consumption are:
- Fish or fish parts considered suitable for the human consumption, according EC regulations, but not designated to that end because of commercial reasons. In this category, we find typically the situation when a high production of low value fish could flood the market and bring down ex-vessel fish sale price and the operator decides not to bring the product into the human-consumption market.
- Fish or fish parts rejected for human consumption, that do not present any sign of illness transmittable to human beings or animals, and that come from channels allowed for the human consumption in conformity with the community regulations. As example, fish damaged during the sorting operation or bitten (frequent in static gear fisheries) are typically excluded from fish fresh markets in the Mediterranean sea.
- ABPs derived from the elaboration of products destined for human consumption (typically by-products of fish processing such as filleting, consisting of heads, bones and tail).
- Old food of fishery origin or that contains products of fishery origin, excluding cooking waste, or that are no longer designated for the human consumption because of commercial reasons or fabrication packing flaws or other nature, but do not mean any risk for humans or animals.
- Fishes and other marine animals, except for marine mammals, captured in open seas in reduction fisheries
- Fresh ABPs coming from industrial installations that manufacture products destined to human consumption using fish.

In generally, ABPs not destined to indirect human consumption have two possible destinations: disposal or recovery. Whether a particular ABP is disposed of or recovered depends firstly on the provisions of Art. 12, 13 and 14 of the Regulation (EC) 1069/2009 and, secondly, on the operator's decision. ABPs for non-human consumption are broadly categorized in:
- Category 1 material: only disposal is permitted (with some exceptions).
- Category 2 material: certain technical uses are permitted, but generally its use in animal feed is not permitted (with some exceptions).
- Category 3 material: it may be used as raw material for the production of animal feed, provided they are subjected to the appropriate treatment, bearing in mind certain important exceptions such as: i) "cannibalism", that is, the ban on feeding animals with products deriving from the same species, and ii) the ban on the use of catering waste.

The options for utilization or elimination of any ABPs in Categories 1 -3 above are:
- Incineration
- Co-incineration
- Collection in controlled deposits
- Composting and storage in a silo
- Biogas production
- Manure production
- Petrochemical industry
- Pharmaceutical industry
- Other uses
- Animal feed

Under no circumstances may these ABPs re-enter the human food chain. According to Commission regulation (EU) No 142/2011, products derived from the processing of Category 2 or Category 3 material shall be:
1. Disposed of as provided for in point 1 (a) (i) or (ii), with or without prior processing as provided for in Article 12(a) and (b) of Regulation (EC) No 1069/2009:
    (i) disposed of in accordance with Article 12 (a) or (b) of Regulation (EC) No 1069/2009.
    (ii) disposed of by burial in an authorised landfill.
2. Further processed into fat derivatives for uses other than feeding.
3. Used as an organic fertiliser or soil improver.
4. Composted or transformed into biogas.

In Europe, the final destinations of the unwanted catches mainly include at present: processing into fish meal and fish oil, additive food ingredients, biogas, pet food, pharmaceuticals, cosmetics and bait in fisheries using pots or longlines.
Of these uses, fishmeal and fish oil appear to show the highest commercial potential (Catchpole et al., 2015). This utilization route is already developed or in the process of development and can include any finfish species, particularly in Germany, Spain (Atlantic seaboard), the UK, Norway and Sweden. Niche utilization opportunities currently implemented include pet food, food ingredients or additives, and food for minks (fur industry) in processing plants in Germany, Sweden, Iceland, Norway and Denmark. Some utilization opportunities such as biogas are partially developed or under development in the UK and Germany, while others such as pharmaceuticals and cosmetics show strong potential for development. In practice the potential for business development will vary from sector to sector, and locality to locality (Catchpole et al., 2015). At present, the value of fishery products in Europe for uses other than human consumption is only 3% of the total value of fishery products (although the volume processed is 16%, EUMOFA 2016, p. 80 et seq.)
There are already some market opportunities for non-human consumption catches, but it is clear that new markets will need to be developed if the supply of UWC is to be fully utilized. This presents some market opportunities and some market challenges (Mangi and Catchpole 2014).
Several attempts have also been made to develop and demonstrate processing techniques and technologies that can yield valuable products of other types, such as essential nutrients (vitamin A, iodine, zinc, iron), compounds (including omega-

3 lipids, enzymes, proteins) that can be used in chemical or pharmaceutical products or industrial products (Adler, 2014; European Fisheries Technology Platform, 2012). Note however, that the development of niche products from fish UWC may normally take years or decades to reach commercial production (Laksá et al. 2016, p. 52).

A non-exhaustive, but representative, list of potential uses of fisheries by-products (ABPs) is presented in the Fig. 4.1 and Table 4.1, including such uses as molecular components in proteins and oils, uses of macromolecules such as collagen and hyaluronic acid, as well as other traditional or potential uses.

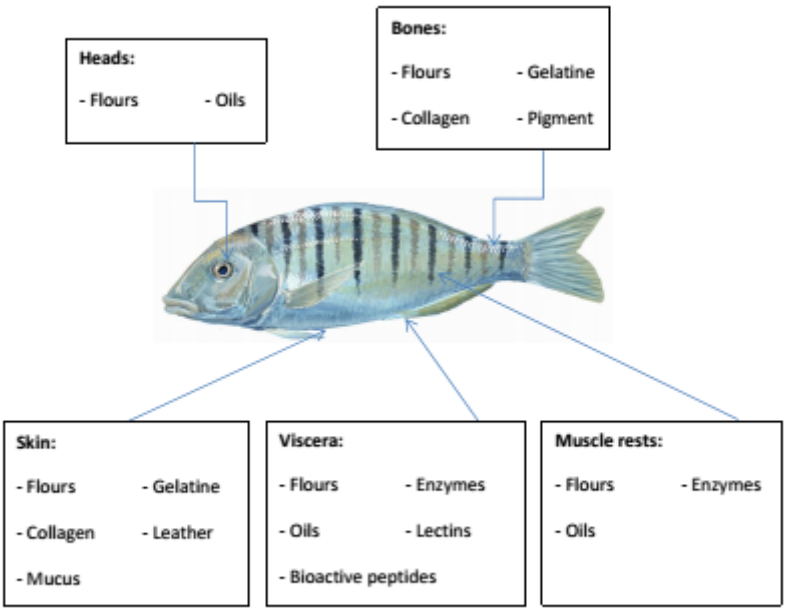


Figure 4.1. Possible uses of fish by products or unwanted catches (indicative only).

Table 4.1. Indicative list of products that can be obtained from fish by-products or unwanted catches, with examples.

Product group	Product	Product information
Indirect Human Consumption	**Fish sauce & flavours**	**About 0.4 million tons of fish sauce are produced yearly (Archer, 2001, p. 29; Kim & Venkatesan, 2014, p. 2). Unpopular species or fish parts can be processes as ingredients for fish soup[4] for human consumption or to make fish-flavoured salt.**
Animal feed	**Bait**	**There are studies like Tryggvadóttir et al. (2002) which show utilizations of fish waste. Not all parts can be used and not all species, the needed amount is limited**

[4] Example of fish soup produced locally in Roses harbor (North Mediterranean Spain) by the Fishers' Association: https://www.pescadorsderoses.com/ca/productes/productes-elaborats/sopa-de-peix/

		and fisher mostly use already their own catches as bait.
Animal feed	**Pet food**	**Pet food based on fish meal, minced and fresh fish is available for dogs and cats[5]. Pet owners pay a comparatively high price for canned products. In the paper Archer (2001, p. 36) it states that the pet food factories pay more for fish waste than fish meal factories.**
Animal feed	**Fishmeal**	**Fishmeal can be used as feed additive for fatlings, feed pellets for aquaculture and suit as basis for other products. The production process can manufacture high and low quality primary material of mixed and single-origin sources. It is delivered by reducing fisheries or filleting enterprises (Archer, 2001, p. 23; FAO, 1986, chap. 2.1 et seq.). For fish wastes this is the most common use (Archer, 2001, p. 4) because whole fishes can be used. It plays an important role in the European non-food industry (EUMOFA, 2016, p. 46).**
Animal feed	**Fish oil**	**Fish oil can be gained in the fishmeal process. The ratio is about 20-80 kg of fish oil per tonne of fish. It is usable as feed, for leather tanning, lubricants, elastic and long polymers, supportive materials for food industry waste (Archer, 2001, p. 53) .**
Animal feed	**Ensilage**	**Fish silage can be produced with a variety of fishes and can be used as pig feed (liquid and powder). In terms of space, this is a good option because only tanks are needed on board (Archer, 2001, p. 39; Laksá et al., 2016, p. 53).**
Industrial uses	**Chitin and Chitosan**	**Chitosan can be a great replacement oil-based plastic since it is the most important natural polymer. It is universally applicable for implants, fertilizer, scalpel blade, tools and even for car parts and used in the waste water treatment industry, paper industry, feed additive pharmaceuticals (Arvanitoyannis & Kassaveti, 2008, p. 728; Busse, n.d. , p. 1; Kim & Venkatesan, 2014, p. 6). The source are mainly crustaceans.**

[5] Example of high-end pet food manufactured in Galicia (West Atlantic Spain) http://www.jealsa.com/es/nuestro-mercado/pet-food/

Industrial uses	**Pharma products**	**Omega-3 fish oil capsules, vitamins and gelatine find pharmaceutical purposes (Archer, 2001, pp. 4,35). Not all species are conceivable and should have a high quality.**
Industrial uses	**Gelatine and Collagen**	**Fish gelatine can form gels and can be used in food, coating applications etc. Usable are skin, bones, fins etc. Gel structure will not be destroyed in high temperatures (cf. Jayathilakan et al., 2012, Table 7).**
Energy productio n	**Fuel**	**Fish oil can be used as biodiesel. It can be processed for small amounts and as mass product but to implement this fuel wide spread, the amount will be probably too high to be covered by bycatches (Jayathilakan et al., 2012).**
Energy productio n	**Energy productio n**	**Renewable energy can be produced with fish waste or bycatches in biogas plants, like the multi-fuel power plant manufactured by Wärtsilä.**
Compost	**Compost**	**Composting as a technology is adaptable and suitable for treating wastes in a variety of locations (Wallström, 2000, p. 8). The process of composting can be adapted to the substances properties for example to produce an organic fertilizer (cf. López-Mosquera et al., 2011, p. 114).**
Compost	**Fertilizer**	**In regard to composting, creating a fertilizer for agriculture use is conceivable because fish is high in nitrogen which supports plants growth and health (cf. Archer, 2001, p. 37; Ovissipou, 2015). Through anaerobic digestion of fish waste methane and sludge can be produced, these can be processes to generate electricity (Arvanitoyannis & Kassaveti, 2008, p. 729)**
Incinerati on	**Incinerati on**	**Incineration is burning wastes, it does not add any value but can be (and is) a last-resort solution.**
Dump	**Dump**	**Waste disposal sides are distributed all over Europe, particularly for farm-waste disposal. All wastes are deposited for long-term and find no further uses.**

Reduction of UWC of formerly discarded species to fishmeal / fish oil is naturally the more versatile option and the option that can absorb higher quantities UWC. Established processing plants have access to other raw materials and the fluctuation in the availability of UWC brought to land can be absorbed. Additionally, former discards would be only a minor part of the raw material and

because their price is low, it is not expected that the demand would create "a market for discards", expressly vetoed by Art. 15 of the reformed CFP. The price paid for raw material by the fish meal / fish oil producers ranges from 0.10 to 0.20 €/kg (EUMOFA 2015), but is expected to rise in the next years (Delgado, 2003; World Bank, 2016), following the increasing trends observed in the processed products destined to animal feed in the growing aquaculture industry.
Iceland is well advanced towards the full utilization of marine products. For instance, Smáradótttir et al. (2014) mention that 72% of cod is utilized, primarily for human consumption (fillets, cod liver oil, roe, etc.), but also for niche products in the pharmaceutical, medical and cosmetic industries (collagen, enzymes, omega-3, etc.). The key to the success of the Icelandic full utilization model lies in the vertical integration of the production chain (Vigfússon, 2016), which also incentivizes fishers to bring all catches ashore. This model of utilization is difficult to export to southern European countries as most fish is consumed fresh and there is generally no processing after capture. Fishers in south Europe lose control of fish after it has been auctioned and have no business interests in the fish production value chain. Nevertheless, timid steps in the direction of increasing the degree of utilization of by catch and integrating fishers in the fish production value chain can be mentioned, such as the example of the fish processing plant in the harbor of Roses (North Mediterranean Spain), owned and operated by the local Fishers' Association (http://www.pescadorsderoses.com/ca/productes/productes-elaborats/)

4.6 Full utilization of UWC: economic and technical feasibility

A company or a fishers' association interested in the utilization of UWC brought to land must consider the following aspects in a study of technical and economic viability:

1. Characterization of the product(s)
    a. volume of UWC, along with its likely temporal variability
    b. physical and chemical characterization of UWC
    c. location of landing points
2. Assessment
    a. market analysis: cost of production against value added
    b. existing and potential demand
    c. similar and competing products
    d. required investments
    e. existence of external infrastructure
    f. legal, environmental, social aspects

4.7 The Kutterfisch cooperative example

The example Kutterfisch[6] cooperative in Cuxhaven (Germany, North Sea) was investigated in detail during the MINOUW project, including a visit to its facilities and interview with its CEO by a German-speaking collaborator to the MINOUW project. Kutterfisch was chosen because the amount of catches of this fishers' cooperative targeting demersal resources (40 000 t/yr) is roughly equivalent to the catches of one GSA in the Mediterranean (viz. fisheries catches in GSA06

[6] http://www.kutterfisch.de

amount approximately to 46 000 t annually, of which 32 000 t are landed for human consumption, fresh, and the rest are discarded) and because the cooperative is directly or indirectly involved in all steps from fish capture to full utilization of catches, including the processing of UWC for indirect human consumption (single origin fish protein; fish oils) or non-human consumption (fish meal and fish oil for animal feed), in partnership with the companies Bioceval[7] and Lipromar[8]. The process is summarized in the schematic:

[7] http://www.bioceval.de/vfc/sonderseiten/home/
[8] http://www.lipromar.de/lip/unternehmen/

Case Study - Kutterfisch and Bioceval

Kutterfisch

- Producer organisation
- Located in Cuxhaven, Germany
- 60 Fisher + 50 employees on land
- Using bigger mesh sizes to avoid bycatches
- Pelagic and bottom trawlers
- 10 vessels

- Landings in Germany and Denmark

- Fileting and packaging in Cuxhaven

- Fileting by-products and future landed discards to Bioceval; distance 1,1 km

Direct cooperations with supermarkets

BIOCEVAL SARIAGroup

- Bioceval collects other by-products from fish processing inter alia in France, Netherlands, Denmark, Poland, Germany
- Landed discards and spoiled fish collected from small habors, also in small amounts

LIPROMAR

High-quality, **single-origin fish proteins and fish oil** for food industry

Indirect human consumption

Non human consumption

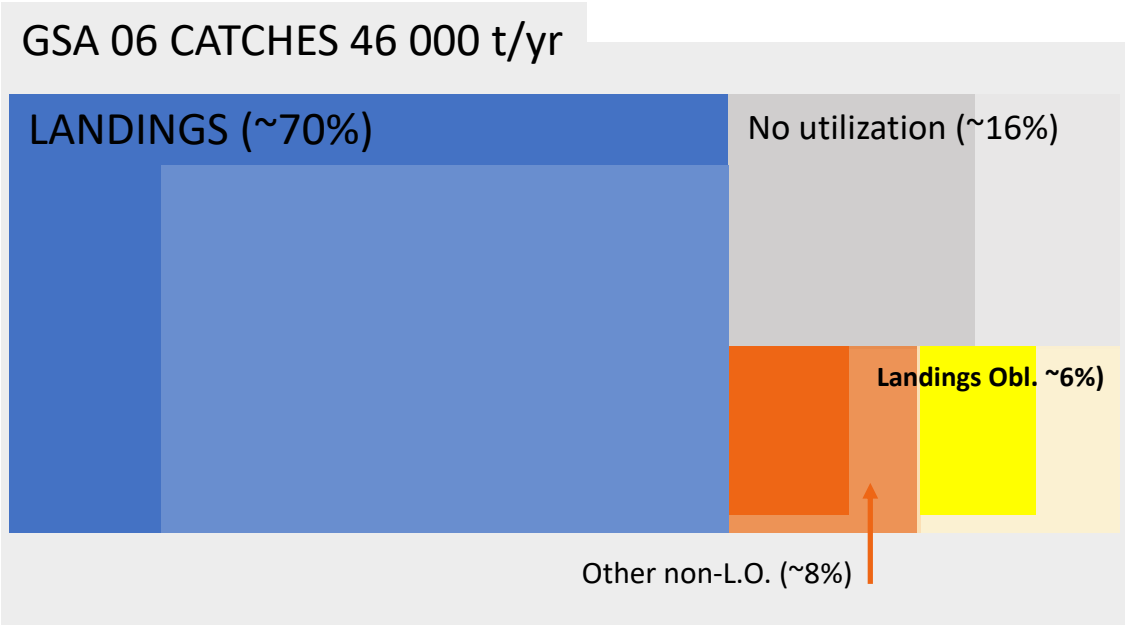
Fish oil and fish meal varieties for animal feed and pet food (beyond human food chain) production , organic and MSC certificated products

Quota 2016:
7.000 tons Pollack
7.700 tons Herring
12.900 tons Sprat
3.350 tons Cod "Dorsch"
1.900 tons Cod "Kabeljau"
700 tons Plaice
100 tons Prawn " Kaisergranat"
unlimited Flatfish

There are several important differences between the Kutterfisch model and the fishing operations in the Mediterranean Sea that may pose barriers to the full utilization of UWC:

- The German cooperative processes most of the catches for packaged consumption, generating by-products that add to any UWC from over quota catches or MCRS. Because Mediterranean fisheries target the fresh consumption market, the amount of by-products from fish processing is low to non-existent.
- The German cooperative works with 10 large vessels, while in the Mediterranean GSA06 the trawl fleet comprises ca. 600 units.
- The ca. 40 000 t of fish caught by the Kutterfisch fleet are usually landed at a single point (Cuxhaven), hence the logistics of transport to the fish processing plants can be simplified. In GSA06 there are at least 20 fish landings points along an 800-km long coastline.

In spite of the atomization of the production of UWC for industrial utilization, the quantities produced in a Mediterranean GSA such as GSA06 are non-negligible, amounting to approximately to 8-15 t / week per landing point. The lower estimate (8 t / week / landing point) includes only UWC covered by the LO, while the higher estimate includes other, non-regulated UWC of similar quality (bony and cartilaginous fish), based on official fisheries catches reported in the DCF for 2014. Note than one two- or three-axle truck has a maximum gross weight of 18 t in most EU countries (Directive 96/53/EC).



5 Stakeholders perceptions of discards utilization

[the material in this section is taken from the manuscript Kraus, G. and Maynou, F. (under review) Challenges to the implementation of the Landing Obligation based on the analysis of stakeholders' perceptions of discards utilization. Ecological Economics, submitted Jan. 2018].

We investigated the perception of stakeholders regarding the implementation of the landing obligation, to evaluate emerging economic consequences of the policy, possibilities for the utilization of UWC, as well as whether significant differences in perceptions can be detected across geographical areas or stakeholder types in Europe.

5.1 Data

Following standard methods of data collection in Social Sciences, semi-structured expert interviews were carried out to obtain the perception of different types of fisheries stakeholders (Atteslander and Cromm 2010). A questionnaire containing 22 questions, plus 9 additional qualitative questions, investigating the stakeholders' perception of the landing obligation, focusing on utilization of former discards, was designed. The first block with 9 questions asked about the interviewee's opinion on practical aspects of utilization under the LO, while the second block with the remaining 13 questions asked about the likelihood that different types of utilization will take place in the near future. The questionnaire was addressed to selected experts from different types of stakeholders in European fisheries with knowledge about the issue, covering all interest groups (Mayring 2010). In fisheries, there are several stakeholder groups involved who might act as providers, purchasers, consumers, manager or supervisors. A stakeholder mapping exercise was made to establish a list of stakeholder types in EU fisheries (geographically restricted to the North Sea, Western Waters and Mediterranean sea). Obviously, fishers are one of the key stakeholder group, comprising individual fishers (owner-operated), representatives of the fishing industry and producers' organizations. Additionally, the local, national and European fisheries management and governmental agencies play an important role. Fisheries scientists as well as related non-governmental organizations are considered to provide industry-independent viewpoints. With regard to the utilization of landed discards, companies related to that industry, i.e. the processing industry, are included to investigate with them the economic possibilities of utilizing former discards. The 6 stakeholder groups defined *a priori* represent the main actors involved in the implementation of the landing obligation. As fisheries management moves away from prescriptive, top-down management by technical agencies, it is essential to incorporate the views of all actors involved for effective fisheries governance (de Vos et al. 2016).

The 27 experts that completed the entire interviews were allocated to their respective stakeholder groups and geographical areas, to assess the possible effect of stakeholder type and area on their perceptions. The study includes all relevant key experts and is considered as a representative and balanced sample, in the

sense that each expert has an important role in the implementation of the policy and no stakeholder group is more represented than another. The 6 stakeholder groups were: 1) Fishers' associations or cooperatives [Assoc]; 2) Processing companies [Comp]; 3) Individual fishers (Owner-operators) [Fisher]; 4) Government fisheries management agencies [Govern]; 5) Non-Governmental Organizations [NGO]; and 6) Fisheries Scientists [Science]. Likewise, the geographical areas were defined as: 1) Mediterranean Sea [Medi]; 2) North Sea [North]; 3) Over all European seas [Over]; and 4) Western Waters [West].
The interviews were carried out in person at the interviewee's premises, by telephone or through Skype in summer 2016, having pre-arranged the meeting with the expert in question by e-mail. The interview started with a short verbal description of the objectives of the Horizon 2020 project MINOUW, recalling the material used in the first contact e-mail (a project's brochure in different languages is available at http://minouw-project.eu). All interviews were carried out in English or German, except the interviews with Mediterranean fishers. Those interviews were carried out in the local language with the assistance of a fisheries scientist acting as translator. In the majority of cases, the conversations were recorded, after securing consent from the interviewed expert. The recorded interviews were transcribed, in anonymized form, with the program ***f4*** (https://www.audiotranskription.de/f4.htm). Minutes of the interviews of the 11 experts that refused recording were conducted.
The flexible interview guideline consists of questions suitable for qualitative and quantitative observations. All questions analysed for statistical analysis (Table 5.1) were closed questions, asking the level of agreement of the interviewee with the question on a 4-point Likert scale, from very low to very high. "Don't know" was allowed. Subsidiary open questions give additional insights about the targeted topic.

Table 5.1. Questions on perceptions of the Landing Obligation and possible utilization. Responses were on a 4-point Likert scale (from very low to very high). "Don't know" was acceptable. *UWC: UnWanted Catches.*

	Question
Q1	**The general knowledge about the Landing Obligation in the fishery sector is …**
Q2	**The clarity about utilization of discards regarding Landing obligation in the policy is…**
Q3	**The knowhow for utilization and processing in the sector is …**
Q4	**The willingness of companies to invest in the sector and processing is …**
Q5	**The innovation strength in the sector is …**
Q6	**The availability of suitable technology for processing is…**

Q7	**The demand on the market for UWCs products will be…**
Q8	**The possibility that quantity of supplied UWCs will be sufficient is…**
Q9	**The delivery reliability of UWCs for processing companies is…**
Q10	**The likelihood that former discards can be utilized as pet food is…**
Q11	**" as animal (cattle) feed is…**
Q12	**" as Fish meal/ oil is…**
Q13 [a]	**" as raw material for ensilage is…**
Q15	**" as Bait is…**
Q16	**" as Energy/ Fuel is…**
Q17	**" as Fertilizer is…**
Q18	**" as Food additive/ Indirect Human consumption is…**
Q19	**" as Industrial additives or materials is…**
Q20	**" as Pharma/ Healthcare/ Cosmetics is…**
Q21	**" as Charity is…**
Q22	**" as waste for incineration/ dump is…**
Q23	**The need of support from the state (or government agencies) to adapt processes for the full utilization of discards is…**

[a] Q14 asked about the possibility of using fish skin as leather but the majority of respondents did not provide a meaningful answer and this question is not analysed here.

5.2 Statistical analyses

The ordered multinomial responses to the questions (scores 1 to 4 plus "don't know") were subjected to a chi-square test to examine whether the percentage of responses in the 5-point scale were statistically different from the expected 20 percent in each category. Additionally, the ordered multinomial responses were analysed with ordered probit regression (Adkins and Hill 2011) to examine the influence of the explanatory stakeholder type ("group") or area against the hypothesis of no difference of perception for a given question according to group or area. Statistical significance was tested at the 10 percent level, as often used in the social sciences. All statistical analyses were performed with STATA 12.0. Additional to the quantitatively analysed questions, the interview guideline contained questions suitable for qualitative analysis (Table 5.2). The anonymous analysis took place on the basis of Mayring (2010) content analysis. This analysis is divided in several interpretation steps which ensure intersubjective transparency and material reduction (Mayring 2010).

Table 5.2. Questions on perceptions of the Landing Obligation for qualitative analysis

	Question
Q24	**How does the Landing Obligation influence the European Fisheries and their competitiveness?**
Q25	**How would you describe the status quo of the utilization of landed Discards in Europa?**
Q26	**What do we need to create a processing industry for UWC products?**
Q27	**What is the best form to land and store Discards?**
Q28	**Which infrastructure for storage, freezing and processing the landed Discards are available near the landing sides?**
Q29	**What kind of risks and uncertainties are the companies exposed to who use Discards in their production in short and long term?**
Q30	**Which advantages arise for companies using Discards in their production?**
Q31	**What changes do you expect and which are needed to support sound utilization of landed Discards in the fishery sector in Europe?**
Q32	**Which supports for the industry are conceivable to support the needed adaptations?**

5.3 Results

5.3.1 Quantitative analysis

The number of respondents by question, geographical area and stakeholder type is given in Table 5.3.

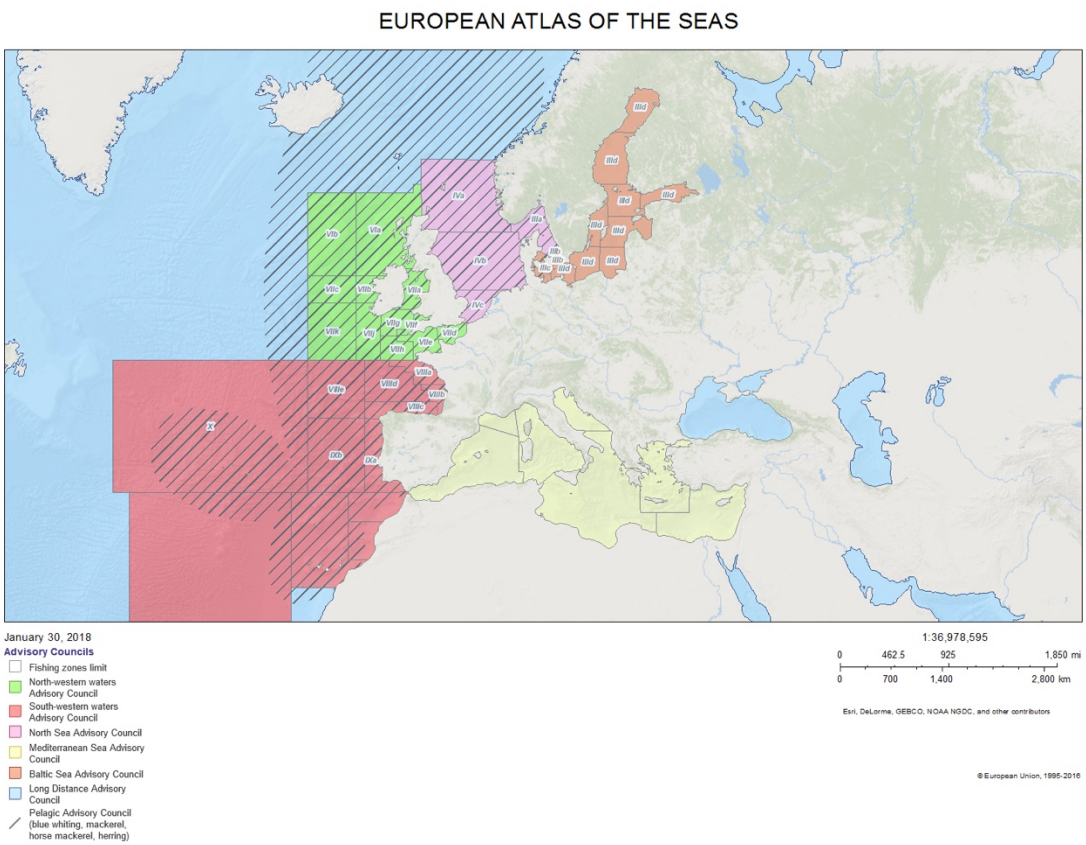


Table 5.3. Number of valid interviews per geographical area and stakeholder type

	Association	Company	Fisher	Govern	NGO	Science	Total
Mediterranean Sea	1		4	3		1	9
North Sea	3	2		2		2	9
Overall				2	2		4
Western Waters	1	1		2		1	5
Total	5	3	4	9	2	4	27

In all cases, the ordered multinomial responses to the questions (scores 1 to 4, plus "don't know") were statistically different from the expected 20 percent in each category. The scores produced are shown in Fig. 3 and 4, for block 1 and block 2 questions, respectively.

The responses to questions Q1-Q10 were:

Question 1: The knowledge of the LO within the fishery sector is perceived to be relatively high (mean 2.83, the highest value in the first block of questions, Q1-Q9), combining all responses, although stakeholders of type 6 (scientists) gave statistically lower scores to this question (p=0.088).

Question 2: The clarity about possible utilization options in the LO was perceived to be low (mean 1.96) and stakeholders of type 6 (scientists) gave again statistically lower scores to this question (p=0.084).
Question 3: The knowhow in the processing sector on the utilization of former discards was relatively high (mean 2.39) but the opinion diverged among stakeholders, with stakeholders in areas 2 (North) and 3 (Over) providing significantly higher values than Mediterranean stakeholders (p=0.004 and p=0.096, respectively). Scientists gave statistically lower scores to this question (p=0.03).
Question 4: The willingness of companies to invest in processing was estimated to be low (mean 1.82), with no significant differences among stakeholders or geographical areas.
Question 5: The innovation strength of the fish processing sector was perceived to be high (mean 2.23), with the significant exception of fishers, who tended to give lower scores to this question (p=0.045).
Question 6: The availability of suitable technology for processing was perceived as being high (mean 2.77; together with Q1, the highest value in the first block of questions, Q1-Q9), with stakeholders from areas 2 (North) and 4 (West) providing statistically higher scores (p=0.056 and p=0.012, respectively).
Question 7: The demand for products from unwanted catches (UWC) is anticipated to be high (mean 2.35) and no differences between stakeholders or geographical areas were detected.
Question 8: Respondents tended to agree that the quantity of UWC supplied for processing will be sufficient in the near future (mean 2.35), with no statistically significant differences.
Question 9: However, the reliability of supply was perceived relatively low (mean 2.05), again with no significant differences among stakeholders or areas.

Figure 5.1. Spider plot with the results of answers to questions Q1-Q9 on a four point scale, color-coded by stakeholder type

The responses to questions Q10-Q23 are summarized in Table 5.4 and in Figs 5.1-5.3. Regarding possible utilization options, all possible utilization options were ranked higher than 2 (except Q16 “energy/fuel”; Q17 “fertilizer”; Q21 “charity”, likely because special permit is needed for direct human consumption which is expressly forbidden by Art. 15 and fishers are not willing to give the fish for free, and Q22 “incineration/dump”). The highest ranking was received by the utilization types fish meal / oil (Q12 with mean score of 3.56), pet food (Q10 with a mean score of 2.87) and food additives (Q18 with mean score of 2.81). Q23, asking whether the processing industry will need support from government agencies, produced also high scores (mean 3.14). Regarding geographical differences in scoring block 2 questions, only questions Q11, Q21 and Q23 revealed geographical significant differences. In Q11 and Q23 respondents from Western Waters tended to give higher scores than average, while in Q21 and Q23 respondents from the North sea tended to provide higher scores. I.e. under question Q23, respondents of Western Waters and North sea feel that the support of administrations is necessary for the correct transition to the full utilization of discards.

Figure 5.2. Level of agreement of interviewees with questions Q10 to Q23 with average score, by stakeholder type. The traditional types of products (e.g. materials for animal feed or indirect human consumption) are favoured, while destructive outlets (e.g. energy, fertilizer, incineration/dump) received lower scores. Score 1: very low, score 2: low, score 3. high, score 4: very high.

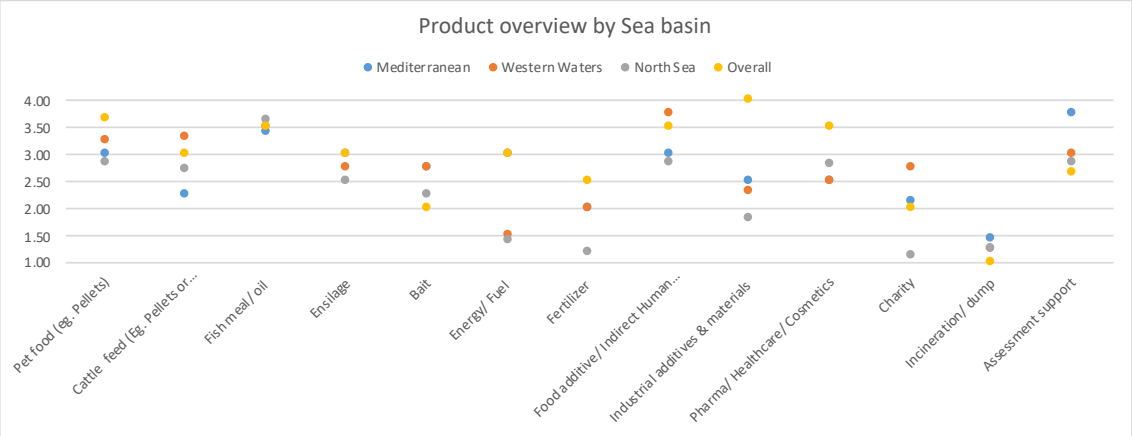


Figure 5.3. Level of agreement of interviewees with questions Q10 to Q23 with average score, by sea basin. No significant differences can be revealed overall. Score 1: very low, score 2: low, score 3. high, score 4: very high.

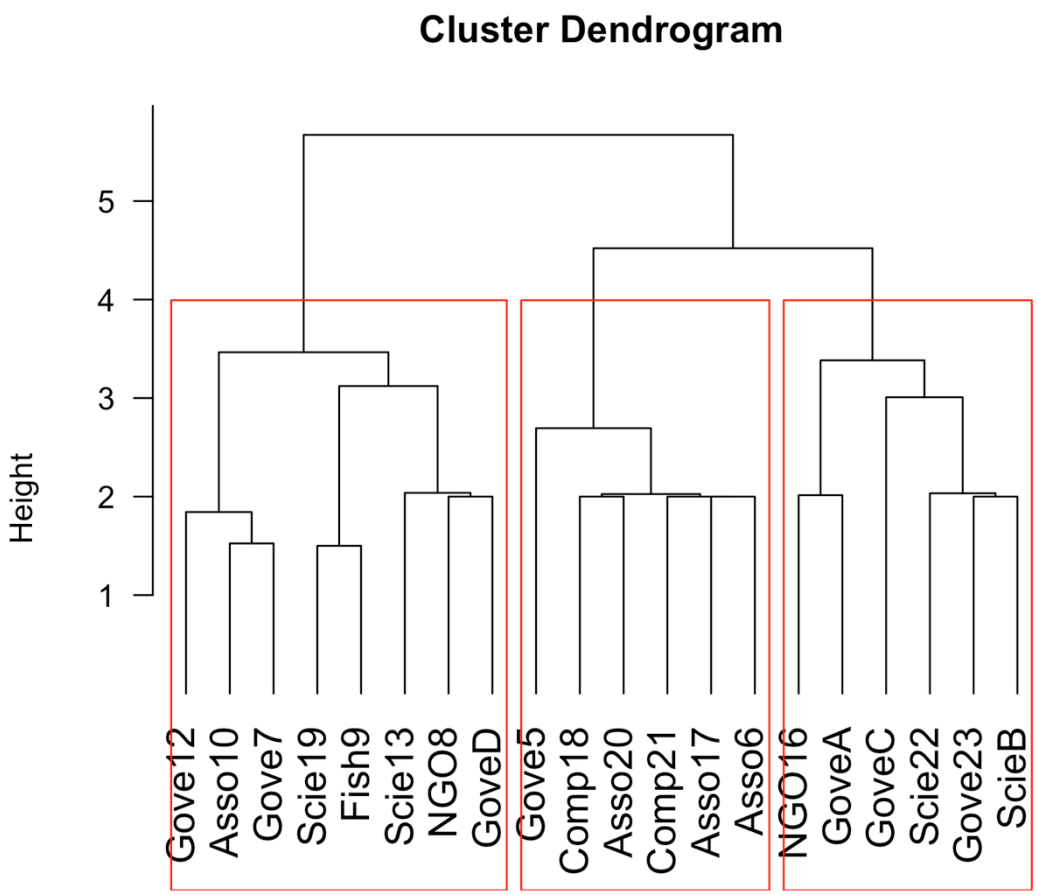


Fig. 5.4. Classification of the stakeholders types by their responses to Q10 to Q23. No overall significant differences by stakeholder type or sea basin could be revealed.

Table 5.4. Results of the ordered probit analysis estimating the effect of stakeholder type or geographical area on the responses to questions on possible utilization.

	Stakeholder effect	**geographical effect**	**Goodness of fit statistics**[9]	
			AIC	**BIC**
Q1	**scientists scored lower than average (p. 0.088)**	**no difference**	**85.51**	**99.65**
Q2	**scientists scored lower than average (p. 0.084)**	**no difference**	**74.94**	**87.9**

[9] AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion

Q3	**scientists scored lower than average (p. 0.03)**	**North Sea and overall stakeholders scored higher than average (p=0.004 and 0.096, respectively)**	**70.03**	**83.87**
Q4	**no difference**	**no difference**	**42.35**	**52.17**
Q5	**fishers scored lower than average (p. 0.045)**	**no difference**	**45.09**	**58.93**
Q6	**no difference**	**North Sea and Western Waters stakeholders scored higher than average (p=0.056 and 0.012, respectively)**	**53.62**	**65.63**
Q7	**no difference**	**no difference**	**56.17**	**64.5**
Q8	**no difference**	**no difference**	**46.66**	**55.83**
Q9	**no difference**	**no difference**	**47.18**	**56.62**
Q10	**fishers and scientists scored lower than average (p= 0.016 and p=0.06, respectively)**	**no difference**	**68.49**	**80.98**
Q11	**no difference**	**Western Waters stakeholders scored higher than average (p=0.028)**	**50.64**	**60.08**
Q12	**no difference**	**no difference**	**67.04**	**80.45**
Q13	**no difference**	**no difference**	**51.71**	**58.1**
Q15	**no difference**	**no difference**	**69.74**	**82.23**
Q16	**no difference**	**no difference**	**53.08**	**64.57**

Q17	**no difference**	**no difference**	**42.43**	**50.77**
Q18	**no difference**	**no difference**	**52.31**	**62.75**
Q19	**no difference**	**no difference**	**38.16**	**45.24**
Q20	**no difference**	**no difference**	**59.03**	**68.48**
Q21	**no difference**	**North Sea stakeholders scored higher than average (p=0.027)**	**61.77**	**74.73**
Q22	**no difference**	**no difference**	**40.44**	**51.79**
Q23	**no difference**	**North Sea and Western Waters stakeholders scored higher than average (p=0.049 and p=0.087, respectively**	**49.68**	**61.17**

5.3.2 Qualitative analysis

In general, the qualitative view shows a split picture of the stakeholder's perception about the LO. Some stakeholders react with clear rejection, some accept the policy decision whereas others welcome the radical reform. With regard to the utilization discards, four main issues with influence on use could be identified:
Firstly, a lack of legal security and detailed guidelines for stakeholders make long-term planning difficult and hinder justification of investments. Hereby, unclarities with regard to the policy and its implementation turned out to be problematic. For example, stakeholders expect that the policy will be adjusted to regional specifications (related to multiannual and discard plans). Ambiguities lead to grey zones regarding the interpretation of the regulation, unsettling the stakeholders because not all details are clarified yet. Stakeholders worry about changes in the near future and prefer to wait for further clarifications before starting the processes of adaptation, particularly in the case of stakeholders from processing companies which need to calculate their production in long-term. Estimates by the stakeholders are therefore heterogeneous.
Secondly, since the obligation is not fully in place and the prescribed exemptions enable the fisher to stick with discarding practices, the quantity of discards landed is expected to be, depending on the area, too low to arouse interest by processing

companies. Due to many influencing factors, composition and quantity of the catches now and in future are unpredictable causing risks for the companies' supply chains. Transport costs to collect the raw material from small and big harbours are high because there is no centralized market in place which is linked to a lack of infrastructure.

Thirdly, the infrastructure for (refrigerated) storage and European wide transport was identified as a relevant issue. Equipment to handle, store and transport the discards are missing, mainly in small harbours where small-scale fisheries sell their catches primarily on local markets for human consumption at the same day. Big harbours and big fishing vessels are in advantage because there is the possibility to freeze the material on board and store it in big storage facility.

The last identified concerns are related to discards ashore; suitable handling to support demanded quality of raw material can be challenging and costly for the fisher but this is not reflected in the market price. The price is expected to be low because high priced products for direct human consumption are prohibited and thus, there is no incentive to provide high-quality products for potential customers. Because of this the landed discards might not be suitable for complex applications with specific requirements. The most flexible and suitable product seems to be therefore fishmeal and oil. This is evidenced by the fact that this product received the highest ranking in the survey.

With regard to the stakeholder groups, the small-scale fisheries receive the highest pressure through the LO because it is elaborate and costly to adjust sorting processes on board, hire additional crew or finding a market for relatively small amounts of landed discards. Here, local fishery associations play an important role to find organizational solutions for the regional specific necessities. Another relevant task for associations is the information and coordination of potential buyers to provide an easy accessible market platform. Furthermore, this coordination could help to extend the planning horizon of fisher and companies. However, if nothing appears to change and develop, these difficulties combined with expected low prices for the fisher and low quality of landed discards, could, in the worst case, introduce the problem of centralization of fishing harbours or not compliance. If infrastructure only needs to be implemented in big harbours, high costs and effort could be avoided. Compared to this, small harbours have to cope with little quantities of discards on shore without infrastructure connected to big industries which means without positive economy of scale effects.

Furthermore, to estimate the impact on the competitiveness of the sector, it needs to be clarified how further implementation shall take place and how the details are defined otherwise the consequence are not clearly predictable rather based on suppositions. However, the stakeholders agree on the assumption that the industry is able to cope with the expected material and find economic suitable solutions by supplementing existing production lines with discards. Setting up a new production line seems unlikely to the processing companies due to the unpredictable composition and amount of discards.

Besides the fundamental discussion whether discards should be utilized or not, it was stated that fish meal will be the most suitable solution. During the interviews fish meal and oil production appeared to be a well-known and welcomed solution in short- and mid-term. This is because of several reasons: First of all, within the fish meal and oil production basically all qualities of raw material can be used. Key characteristics of the end product are hereby the protein and omega-3 content which is expected to be higher with discards as raw material compared to by-products and leftovers because of a lower ash proportion. Secondly, the product finds versatile applications in different sectors (Archer 2001). Mainly it is used as feed in aquaculture where the demand is expected to rise (FAO and OECD 2014). Thirdly, to protect fish stocks, it is essential that prey in sufficient amount is available for predators. That is why the supplied raw material by reducing fisheries is expected to decline (FAO and OECD 2014) due to stricter regulations which could partly be supplemented by discards. Fourthly, the EU imported 2015 fish meal worth EUR 60 million from Peru (EUMOFA, 2016). The European processing sector is depending on the world market because they rely on imports of raw material which is one of the main cost drivers (Döring & Borrello, 2014). The price for fish meal experienced a sharp increase in 2016 of 17 percent on the German and 40 percent on the Danish market (EUMOFA, 2016; cf. World Bank Group, 2016). Increasing the production within the EU can increase therefore the economic independency. Also, basic infrastructure for fish meal factories is in place to collect the product from different harbours or filleting factories. To extend the existing structures based on local needs, short-term funding is welcomed, e.g. through the European Maritime Fisheries Fund (EMFF). More important, however, is the support of close vertical and horizontal cooperation in the sector to ensure long-term success (cf. Döring & Borrello, 2014). It is essential to provide a basis for further activities by clarifying details of the policy, distributing transparent information (e.g. online), creating a transnational platform for experience exchange and promoting research on recognized issues and chances. It is the turn of the market operators to make use out of these assistances.

5.4 Discussion

Our results show a high degree of agreement in the scoring of the majority of questions, although scientists tended to give statistically significant lower scores to some questions (Q1, Q2, Q3, Q10) (Table 4). To a lesser extent, fishers disagreed from the general pattern in some questions (Q5, Q10) (Table 4). In geographic terms, there was difference of perception between Atlantic (North Sea; Western Waters) and Mediterranean stakeholders in some questions (Q3, Q5, Q22, Q23) (Table 5.4).

Examining the suitability of a variety of end-products promoting the full utilization of former discards through stakeholders' interviews, the estimates preferred outcomes turned out to be sea basin independent. The utilization in fish meal or fish oil production is the preferred outcome. It appears as an uncomplicated and

flexible solution, able to cope with different compositions and quantities of discards. Fish meal or fish oil production has the advantage that it can cope with emerging uncertainties like fluctuations in composition and quality. Fish meal is the traditional type of utilization and realistically it will be the first choice to economically utilize discards in Europe, as Europe is relatively disadvantaged in this aspect. Non-food uses of fisheries products represented imports of 841,400 tonnes in 2015, mainly referring to fish meal, oil and fish waste in volume and value (EUMOFA, 2016). In comparison, the European meat sector imports four times less than the fish sector (EUMOFA, 2016), showing that the self-sufficiency in non-food uses of fisheries products in Europe is low. Managing the renewable resource more sustainable by making use of all catches can bring manifold economic advantages for the sector.

The production of fish discards falling under the remit of the LO have high inherent variability due to numerous uncertainties in volume or composition and are difficult to estimate (Borges, 2015) but we can assume that a minimum of 5 to 10% of all catches of commercial fish will be landed after the full implementation of the LO in 2019, considering a total amount of discards in European waters of 1 million tonnes (Holmyard, 2015), i.e. 1/6 of the total catch and around half of this amount under the remit of the LO. In 2014, 5.4 million tonnes of live weight catches were landed in Europe (Eurostat, 2015), excluding non-EU waters; while based on 2013 data, 4.46 million tonnes were landed (EU, 2016). Without considering changes in quota or gear selectivity and composition of non-regulated species in these catches, an amount of 223,000 to 446,000 tonnes of landed former discards could be expected under the full implementation of the LO, which is comparable to the total annual catch of France, the fourth biggest fishing country in Europe. The comparison shows that the amount is appreciable with possible significant effects on the processing sector.

However, regarding the problem of the LO from the perspective of the fisher, or producer, some shortcomings are apparent. The fisher has to cope with economic challenges regarding sorting, storing and selling where the expected price will be much lower than for high quality fish for human consumption. The incentive to bring discards ashore, needs to be assured through enforcement and incentives if the market is not able to solve the problems of handling, storage and transport through attractive prices (Laksá et al., 2016). The difficulty in incentivising compliance on the part of fishing industry, together with other weaknesses in the discard ban as currently formulated (e.g. high cost of enforcement), suggests that the risk of failure of the LO is high (Sigurðardóttir et al., 2015). As the study showed, there is still a lack of knowledge and awareness about the LO among stakeholders which has to be solved to ensure functionality and legitimacy (cf. Kraus, 2016). The risk of failure could be mitigated by accompanying measures to constrain fishing mortality and rebuild stocks (Condie et al., 2014), but there still is a significant source of uncertainty for the processing industry, explaining the concerns about reliability of supply, and need for state help in financing new

investments in the processing industry (questions Q8-9 and Q23, respectively). Moreover, discard rates might decrease in the future due to more selectivity which makes internal investment in the processing sector even less attractive. Additionally, lack of legal security and detailed guidelines may pose additional difficulties on long-term planning investments by the processing industry.
In any case, without a demand on the market and sufficient supplies, utilizing discards economically will be challenging. Former discards can be supplementary material for the fish processing industry, complementing cut-offs and remains from traditional capture or aquaculture sources, but likely not the main source of cheap raw material. The full utilization of former discards offers new business opportunities for product diversification and new markets, but these opportunities depend on price and quality that cannot be controlled by purchasers beforehand. With full utilization of fisheries catches, discards become part of the capitalist market process as a private good and the external costs for the society can be lowered because no loss is incurred in terms of not wasting the whole material (recall that the fish capture process produces in general almost 100 percent mortality rates, hence the interest in using productively all fish that is caught).

6 Handling unwanted catches: the Italian case and experience

The actual implementation of the LO for the Italian fleets is regulated by the Mediterranean pelagic and demersal discard plans[10]. These plans define two different types of possible exemptions: species and fisheries can be exempted based on evidence of high survival rates for discarded fish; further, up to 5% of the total catch of a species may be discarded if it is shown that selectivity increases are difficult to achieve or that handling of unwanted catches is overly costly (*de minimis* exemptions).

Discards plans and related exemptions to the LO, with the example of regulations applied to Italian fisheries (the regulations applicable to other western Mediterranean countries, Spain and France, are very similar)

Adopted Mediterranean pelagic and demersal discard plans:

- Commission Delegated Regulation (EU) No 1392/2014 (pelagics)
- Commission Delegated Regulation (EU) No 2016/2376 (molluscs)
- Commission Delegated Regulation (EU) 2017/86 (Hake, red mullets, common sole, deep water rose shrimp)

High Survival exemptions:

- Common sole caught with "rapido" (valid for 2017 only)
- Clams, valid for 2017-2019

De minimis exemptions:

- Small pelagics (between 3 and 7% of total annual catches in purse seine and mid-water trawl fisheries)
- Hake, red mullets, sole & rose shrimp on the basis of disproportionate costs of handling unwanted catches

Several issues actually affected the implementation of the LO through the discard plans.
In particular, the discard plan on small pelagics implies a real time monitoring of the "*de minimis* exemption", while the discard plan for demersal species was based on the determination by the Member States concerned of the list of vessels subject to the landing obligation for each particular fishery. In the cases of Hake, Red Mullet, Common Sole and Rose Shrimp, 25% of a vessel's catch in 2014 and 2015 must have been made up of the respective species in order for them to be subject to the LO for that species. This list of vessels subject to LO has not been prepared by national administration and therefore LO on demersal species for the transitional period (until the end of 2018) was not implemented.
On the basis of these considerations, it is evident that in the transition period 2015-2018, very limited catches of species under the LO have been landed in Italian ports and therefore the utilization of unwanted catches is very rare. However, a preliminary assessment of eventual new market destinations for the organisms subjected to landing obligation for purposes other than the direct human consumption has been carried out. This assessment is in any case useful to provide technical advice and management options considering that the landing obligation, as established under Reg. 1380/2013, will entry into force in January 2019.

- Commission Delegated Regulation (EU) No 1392/2014 (pelagics)
- Commission Delegated Regulation (EU) No 2016/2376 (molluscs)
- Commission Delegated Regulation (EU) 2017/86 (Hake, red mullets, common sole, deep water rose shrimp)

The analysis in this section includes the following points, complementing the general aspects established in Sections 3 to 5:

- an assessment of possible market destinations for the organisms subjected to landing obligation for purposes other than the direct human consumption,
- a preliminary estimate of potential costs related to the disposal of discards as special waste,
- an analysis of logistic issues for local handling of discards,
- an overview of the actions taken in Italy to manage this issue if present.

As in Section 5, representatives of companies working in the processing of fish material and representatives of public bodies involved in management of discards were contacted and interviewed as a basis for investigating the problems and alternative solutions.

6.1 Handling unwanted catches

The methodology was based on interviews with various stakeholders who were deemed to have a role and an active participation in the management of "discards" caught during commercial fishing operations. The evaluation of the market possibilities identified the following main outlet markets:

- feed production for both aquaculture and, in general, for the animal sector (both large-scale and pet animals)
- production of bait for rec recreational and sport fishing in sea and brackish water;
- chemical production (cosmetic and pharmaceutical) and technological innovations (polymers);
- energy sector - biomassification.

The analysis made it possible to identify a list of macro-groups that, potentially, would have been interested in absorbing the volumes of UWC, which will be available in the near future under the LO. These macro-groups are:

- companies in the feed sector, both for the production of feed for aquaculture and for the production of pet food;
- companies and small businesses that produce bait destined for the sport fishing market;
- scientific stakeholders engaged in research for the use of fish waste for the production of polymers;
- stakeholders in the industrial and technological sectors, particularly in the field of biotechnologies, such as waste-to-energy and industrial plants designed to reduce the bacterial load of a highly perishable fresh product.

6.2 Handling unwanted catches – fish oil and fish meal

The feed and food sector for pet products has always been identified as a potential channel in which products deriving from commercial fishing that cannot be marketed for human use could converge. This situation is strengthened in Italy by the fact that the feed sector from 2007 to today has recorded a growing trend, especially as far as exports are concerned. The growth of the market, which took

place between 2011[11] and part of 2013, has more affected the domestic market and, to a lesser extent, exports.
The national register of companies available at the Chambers of Commerce records all legal entities and partnerships that are classified under the ATECO NACE Rev. 2 activity code: 1091 - Production of feed for the feeding of farm animals. The feed sector identified by the activity code 1091, in the first half of 2015, included 251 companies, all joint-stock companies and which, as a whole, have a permanent workforce of over 9,800 people.
Approaching and considering the feed segment is a motivated also considering the impact that fish-based flours have on the growth curves of the species most bred in the Mediterranean area, such as trout, bass/sea bass and sea bream. These fish species are carnivorous, and therefore have rather high protein and energy needs, although it must be said that fish are very efficient in using these nutrients compared to other species. In fact, the conversion efficiencies of proteins and energy in fish are more than 30% higher than the values of terrestrial animals. The feeds marketed today in Italy for the breeding of fish species have on average a fairly high level of protein (between 40% and 50%) and thus also fat (between 10% and 30%).
The raw materials used include ingredients of marine origin (flours and fish oils), terrestrial animals (of avian origin or swine) and vegetable (protein flours and oils) (Table 6.1). A peculiar aspect of the feeding of fish species concerns the relationship between resources used in the production of feed (flour and oils deriving from fishes, especially pelagics) and fish produced.

Table 6.1 - Raw materials most used to produce feed for the zootechnical sector (both land and marine)

	2014	2015	Var.2015/2014	
			Euro/t.	%
Wheat	196.61	188.92	-7.69	-3.91
Corn	180.94	161.71	-19.23	-10.63
Soy flour	451.25	395.04	-56.21	-12.46
Bran	136.17	128.38	-7.79	-5.72
Corn germ	210.51	219.76	9.25	4.39
Glutinous flour	186.31	167.01	-19.3	-10.36
Sunflower	225.19	229.85	4.66	2.07
Alfalfa flour	221.11	202.45	-18.66	-8.44
Beetroot pulp	221.89	168.54	-53.35	-24.04
Fish flour	**1,543.58**	**1,766.36**	**222.78**	**14.43**
Vegetable oils	682.03	732.3	50.27	7.37
Barley	201.94	190.72	-11.22	-5.56

Source: Elaboration on weekly quotations of the Bologna and Milan stock exchanges

Feed companies tend to reduce the use of products of marine origin also because of the high cost of raw materials. Fishmeal costs on average 1.72 Euro / kg, compared

[11] IL Sole24Ore, 2013 Cfr .: "The feed industry is growing: positive trend for production and turnover". The feed industry goes against the trend of the crisis affecting the agro-food sector. In 2011, in fact, both production increased (+ 1.8% compared to the previous twelve months), which reached 14.5 million tons, and turnover (+ 13.5%) passed from 6.65 billion 2010 to 7.55 billion in 2011.

to bran (0.12 € / kg) or vegetable oils (0.72 € / kg) that could be used to supplement recipes and doses to obtain vegetable flours.
The high cost of raw materials of fish origin, combined with the need to achieve a 1:1 ratio between farmed produce and fish used to produce feed and, therefore to nourish/breed it, has supported the choice to investigate the segment in question. The study revealed that companies have no interest in absorbing volumes of fresh fish, as they have no economic incentive in using this raw material. The main reason for not offering opportunities for UWC was to manage the problem of the high perishability of the potentially available product. In addition to this issue, the aspect linked to the need for a certainty and stability of the volumes to be absorbed is also to be considered. This is an important constraint that could compromise the efficiency of the industrial production line, because the companies fear that it is not possible to plan and to manage the quantities of fishing discards to be transformed.
Indeed, these constraints - high perishability and stability of the volumes - could be exceeded, if:

- products already stabilized (at least frozen just landed) are guaranteed to companies;
- withdrawals are managed through a fixed calendar (number of times a month) to be agreed with the vessel and with the public authorities (harbor office, fish market, Municipality, etc.) that will authorize the withdrawal.

As part of the study, the price that a company is willing to pay to operators who choose to give their own discards was also estimated. This aspect was important, as it allowed to exclude the possibility of generating a parallel market for discards. On the basis of what was declared by representatives of some companies eventually available to make the withdrawal, the prices per ton of UWC vary from € 50/ton up to € 150/ ton (from 0.05 € / kg to 0.15 €/kg).
It is evident that it is a price substantially symbolic, compared to the indirect costs that the correct application of the rule will generate (increase in labour costs, costs for management and traceability of discards, etc.). If, instead, we consider the cost that is generated if the discards were classified as waste, the prospect may undergo an important turn.
At the moment there are no tariff references for the conferment of this waste to the incinerator, but, by assonance, the tariffs applied both to aquaculture companies, which dispose of non-marketable fish product, and to companies that must dispose of waste from slaughter were considered. In both cases the costs for collection and conferral range from 0.45 €/kg up to 0.65 €/kg.
These direct costs, that vary according to the volumes to be disposed, must be added to the fixed costs for the maintenance of the waste loading/unloading registers, the cost for the annual waste declaration as well as the cost of obligatory and periodic analysis of waste for their correct classification according to the national legislation. Against a very small economic recovery, equal at maximum to € 150/ton, a vessel could register a minimum cost of € 450/ton, where the same product is conferred to an incinerator and/or authorized disposal company.

6.3 Quantification of the yield in fish flour and oil of UWC

A project funded by the Italian Ministry (Production of food feeds using professional fishing waste, EuroAcque, 2017)[12] tried to quantify the yield in fish flour and oil to appreciate the commercial value of the small pelagics below the minimum reference size.
The project involved for the experimentation phase a leading company in the processing of by-products of the food industry and a fishing cooperative among the most representative for the quantities landed in small pelagics with midwater pair trawlers.
The experimentation envisaged the positioning of a refrigerated container in the quay area of the port of Chioggia, under the control of the local Fish Market.

Figure 6.2 – the experimentation phase of the "EuroAqua project"

The collection period was relatively short due to delays and administrative obstacles that emerged from time to time. Several bureaucratic issues were raised (where should the container be located, veterinary authorization) and solved before the project could start. The small weight conferred in the container at the end of the experimentation has made it impossible to obtain a significant result from the company in charge of transforming the waste into flour. However, the project allowed to make a rough estimate of yields:

- flour content: about 18%
- oil content: about 4-5%

The economic value of fishmeal is directly linked to the protein content, that was not possible to measure due to the scarce quantity of material available for the experimentation.
The strength of the project was to provide indications on the optimal operating conditions in the management of UWC, both on board and on shore. Furthermore, the project allowed to identify the procedure that is more compliant with current legislation regarding the traceability and final destination of the product.
The project confirmed that, from the point of view of the fishing companies, the conferment of unwanted catches for a centralized treatment represents a significant reduction in management costs but it is also a valid alternative to inappropriate or incorrect behaviour such as uncontrolled discharge.

[12] EuroAcque, Produzione di mangimi alimentari mediante l'utilizzo degli scarti della pesca professionale, progetto del Mipaaf, progetto approvato con D.M. n. 38 del 23.12. 2014

6.4 Handling unwanted catches – Bait for recreational fishing

Further developments and future investment markets are represented by the highly specialized segment of the artisanal production of bait for recreational fishing. The volumes are closely linked to the seasonality of recreational and sport fishing. Surely the sector is valid to be investigated, although the volumes that can be absorbed fresh, quality and well preserved, are marginal. Over 90% of the companies present on the web sells bait obtained from industrial processes where often fish flours or fish oils represent very low doses in the recipes published. In this context, local producers of bait would be interested in buying from the landing sites where the semi-processed/processed products of local origin are present. Although the segment has not been a simple investigation, it is clear that the small companies have an interest in purchasing fishing waste because they consider the product to be valid, in terms of species / quality, and are aware that they could certainly get cheap supplies. But the volumes that could be purchased on average per month do not exceed 50/100 kilograms of product. These volumes are completely variable and seasonal, depending on the opening periods of sport fishing. In general, the bait segment was more open and free than the feed companies, as the processing to obtain bait is very artisanal, based on certain species and the volumes processed are very small, never exceeding 50-100 kilograms of raw material (considering only the fish ingredient) processed per month.

However, there are important critical issues, mainly related to the possibility of knowing in advance the species that, periodically, could be available, because not all species are adequate for producing baits. The greatest interest was towards the purchase price per kilo of product. Not of secondary importance, the producers should have clear indication on the points of disembarkation where to buy the fish, or, even better, any possibility of being able to receive directly in their own laboratories the product.

In conclusion, on the basis of this analysis, the possibilities of the use in the bait sector seem very limited.

6.5 Handling unwanted catches – Chemical sector

The exploitation of UWC as a source of bioactive substances should lead to the development of innovative health products aimed at ensuring the technological advancement and competitiveness of companies in the agro-food, nutraceutical, pharmaceutical and dermocosmetic sectors. The residue of the extractions could be used as fillers in combination with polymeric and biopolymer materials for the improvement of chemical and / or mechanical characteristics.

In Italy the National Research Council[13] is developing research activities to extract polymers and pellets for the feeding of aquatic species from UWC. These researches are subject to patent filing. In particular, technological research is developing patents for the use of bioactive molecules of phenolic nature (eg, deriving from scraps of fish) that allow to obtain functional pellets for use as feed in aquaculture plants and other types of applications such as bioactive peptides, antioxidant, antimicrobial molecules for use in the cosmetic sector.

However, it is important to underline the scarce availability of fish species destined to be used to obtain functional pellets. This criticality becomes even more

[13] Istituto Per i Polimeri, Compositi e Biomateriali (IPCB) e Istituto di Scienze dell'alimentazione (ISA)

significant when the productions will be large-scale as marketable. Further criticism regards the lack of infrastructures at the ports that can guarantee the quality of the biomasses destined to transformations of high qualitative value, as that of functional pellets. Finally, but perhaps the first reason for strategic importance, there is not yet an organic framework from a legislative point of view that can accompany and outline the process of change taking place.

6.6 Handling unwanted catches – Biogas

Anaerobic digestion of biomass is a commonly used process utilizing troublesome waste and producing biogas. Biogas plants treat various types of organic residues including sewage sludge, food industry residues and fish wastes.
The anaerobic digestion of fish waste and by-catch have been proposed in several studies. It could not only reduce the pollution by discard of fish waste and bycatch, but also reproduce valuable substances such as CH_4 used as alternative energy or fuels for vehicles, and the rest digested substrates and liquid used as fertilizer. Those products could be obtained by digested a large number of organic compounds in the oxygen free condition (Shi, 2012).
In this context, the possibility to use unwanted catches under the LO to produce BioGas has been considered and investigated. The production in m^3/t from different material is reported in table 6.3.

Table 6.3 - Biomasses suitable and their yield in Biogas (m^3 per ton of solid volatiles)

Materal (Substratum)	Production m^3/t
Potato pulp (91% humidity)	32
Fats	1300
Recovered fats (fat pulp)	250
Slaughter waste (blood only, non-expelled manure, soft tissue)	300
Rhizomatous plants	100
Technical glycerine	500
Fish material	300
Source: Cocozza - University of Bari	

In Italy, there are about 1500 plants producing BIOGAS, mostly located in the countryside of Northern Italy. However, the analysis of the possible use of UWC for BioGas production led to a negative assessment because of the following reasons:

- the biogas plants need to receive important quantities of materials to be treated in order to be economically efficient, for instance the slaughter waste used to produce biogas is equal to 1 million tons per year (source Centro Ricerche Produzioni Animal - C.R.P.A.);
- disproportionate cost of transport between widely separated small ports of small quantities of discards. The landing ports are scattered along the cost and unwanted catches need to be collected and transported to biogas plants.

6.7 Handling unwanted catches – special waste

If the unwanted catches are landed and no alternative used is foreseen, they should be considered as special waste.

The costs for disposal of catches as a waste range from 0.45 € / kg up to 0.65 € / kg. The costs include all the fixed costs for the maintenance of the waste registers, the cost for the annual declaration on waste, as well as the cost of obligatory and periodic analysis of waste for their correct classification according to national rules.
Taking into account an "average" trawl vessel (producing around 40 kg/day of discard of species Annex III and working around 140 days/year), the cost due to the discard disposal should be around 3000 euro per year (after 1st January 2019). This amount is about the 7.5% of the gross profit of an "average" vessel. This estimation, although it can change according to the characteristics of the different fleets, may inform on the incidence of such costs on the economic performance of the vessels.
However, even the treatment of UWC as special waste is not well regulated and actually there are no rules and procedures to manage the UWC on shore. Operators (fishermen) are responsible to track the landed product but correct control procedures on shore are still not available. On the other hand, there is no clarity regarding who is responsible of drafting and disseminating the correct procedures: technical tables and discussions between the representatives of the fishermen, managers of the Port Authorities, representatives of the fish markets and municipal authorities are still ongoing.

6.8 Handling unwanted catches – infrastructures/logistics

Not all fishing ports currently have identified ecological areas that can guarantee the correct supply of waste. In addition, there is not yet an organic framework, both from a legislative and management point of view, that can accompany and outline the implementation of the LO.
There is a general lack of infrastructures to handle discards in ports. A fish processing industry for discards doesn't exist and, in many areas, even cold storage facilities are lacking.
In order to facilitate compliance with the obligation to land all catches in accordance with Article 15 of Regulation (EU) No 1380/2013 and Article 8(2)(b) of Regulation (EU) No 1379/2013, as well as to add value to under-used components of the catch, the EMFF may support investments in fishing ports, auction halls, landing sites and shelters. Investment in infrastructure would be needed however may be difficult to justify as the objective of the LO is to reduce quantities of discards over time.
One of the most critical aspects in handling UWC is linked to the storage and transport of the discards to be transformed for other uses, taking also into account that the product, before to be transformed, should preferable be pre-treated, otherwise discards would have to be treated as "waste" with a negative impact on the environment together with a cost of disposal.
A process of primary transformation and stabilization of the product at the landing site would highly facilitate the entire process. Indeed, with the appropriate technology, the UWC could have a second life cycle, becoming a *secondary* raw material that could have good chances of integration of income by the subjects that would withdraw the product (as for instance companies in the feed sector).

A project funded by the Italian Ministry (NISEA, 2016)[14] investigated a possible investment to set up a plant to stabilize discards at landing sites before subsequent withdrawal by processing companies.
The plant to be implemented should be able to process about 100 kg of material per day and provide formulations for various types of animal feed. Table 6.4 shows an estimate of the investment costs for the construction of a pilot plant for the production of *pellets* that could work from 100 to 300 kg / day of product.

Table 6.4 - Sizing of a pilot plant: cost in € of the three main components in the production of fish feed pellets.

GRINDER SYSTEM	EXTRUDER MIXER	DRYING OVEN
25.000,00	**35.000,00**	**30.000,00**
TOTAL INVESTMENT	***90.000,00***	

The Mipaaf Project (NISEA, 2016) proposed, as an example, the estimate for discards in GSA 10 (South Thyrrenian Sea) that, as reported in the National Data Collection Program, may vary from 10 tons in 2014 in the port of Procida (Napoli), to over 23 tons in the port of Acciaroli (Salerno). Given the price that a company would be ready to pay to the producer of fish not marketable for human consumption, equal to about 0.05 €/kg, and instead considered the average price of fish meal (about 1.72 €/kg), we can estimate, using an average price between the two above mentioned and considering the maximum amount of discard that the prototype plant will be able to work on, that the above investment can generate positive revenues already after the first two years of operation.
It is technically possible to realize only the plant for the dehydration of the under-sieve, which is then stabilized, for a subsequent phase of production of the pellets with an estimate of the investment of the plant for stabilization only of 55,000 €.
Within the EMFF Operational Program, it should be possible to finance the implementation of the proposed technology that could be considered an added value for the adaptation of the landing points with facilities allowing compliance with the LO regulations.

6.9 Conclusions

Considering that the fishing vessles in Italy are dispersed over more than 8000 km of coast in hundreds of landing points and the variability of the volume of discard that can be produced daily, it seems very complex to establish a system able to guarantee the withdrawal and storage of the discards on the territory.
A critical issue is related to the costs and to the difficulty to implement a system able to manage the discard. At present, there is an overall lack of infrastructures and logistic support to manage the discards; at the same time, specific guidelines and administrative supports are lacking.
The main constraints in the correct and efficient handling and management of UWC are:

[14] Nisea, Indagine conoscitiva sullo scarto della pesca alle specie demersali nei mari italiani, progetto Mipaaf, 2016

- lack of storage facilities in landing ports;
- variability of the minimum volumes needed to guarantee the efficiency of production cycles;
- poor guarantee of quality conservation of the UWC landed;
- lack of control over health procedures and poor ability to guarantee the cold chain; risk that the product may lose the characteristics to be transformed into pasture / feed / pet-food;
- poor knowledge of species to be supplied with regards to seasonality, landing areas and fishing systems by the companies;
- lack of ground infrastructures that can stabilize UWC to supply raw materials for the pharmaceutical and cosmetic industries.

An appropriate governance process to handle UWC is needed to avoid possible risks related to:

- classification of UWC as waste; in this case the UWC shall be disposed as a special waste; this could generate costs, of about 0.50 €/kg, for the fishermen or the bodies in charge for the management of discards;
- increase of the volume of discards landed, in the case of selling of discards to be destined to a transformation process. In the case, prices ranging from 0.05 €/kg to 0.15 €/kg have been estimated.

The investigation with representatives of different companies revealed that the animal feed and the pet-food sectors were the more promising destinations for the UWC coming from the landing obligation; the possibilities of the use in the bait and pharmaceutical-cosmetic sectors seem very limited or null.
However, the feed and pet-food sector in general showed a low propensity towards the supply of products coming from UWC. The feed companies will be interested in withdrawing the product as it is, if it will be possible to dialogue with the institutional bodies in charge of the landing areas (in some cases the Municipalities, in others the Port Authorities or even the fish markets), so as to share the costs to manage a storage area, but also for coordination, relating to the administrative procedure that guarantees the traceability of volumes.
A more positive response from the feed sector could come if the waste product underwent a first treatment on shore that could break down the bacterial load, stabilize and transform it.
Communication between players at various levels and institutional responsiveness are critical factors in implementation success and in stimulating creative solutions. In the future management of the aspect linked to the involvement of the feed companies, the authorities that are responsible and holders of the landing points should necessarily play an active role, as well as the trade unions associations.

7 An investigation on the management of discards in the Northern Adriatic

The Northern Adriatic region (GSA 17) represents the main fishing area of Italy in terms of volume of production. In this area three main fleets operate: the dredge fleet targeting clams, the pelagic trawlers fleet mainly targeting anchovies and the beam trawl fleet, targeting sole and scallops. In addition to these fleets there are significant industrial bottom trawl and small-scale fleets. Chioggia represents the main fishing port of the region in terms of gross tonnage, production and, moreover, it has a fleet that covers all the different fishing systems that operate in the area. In the Chioggia area there is also one of the main concentration of companies specialized in seafood marketing and processing and some of the biggest at national level, organized in "districts". A district represents a cluster of interconnected companies operating in a small geographical area with the objective of participating in a common activity, but the ownership of each company remains separate.
Chioggia therefore represents a unique case for the investigation of discards as it involves one of the main fishing fleets of Italy that covers all the main fishing systems and has a cluster of industries specialized in seafood processing. Through a set of structured interviews the study aims to investigate the discard management followed by the fishers and the seafood industries, trying to identify the constraints and the underlining reasons and potential success cases in discard management with a model that can be used in other areas or fishing systems.

7.1 Methodology

Data was collected by means of direct interviews supported by a specifically designed questionnaire. For this reason, a specific questionnaire was designed for the two categories under investigation: the fishing vessels and the seafood industries.
The activity was divided into three stages: planning; data collection and entry; analysis.

7.1.1 Stage 1: Planning

The fishing vessels were segmented according to the European Union Data Collection Framework (DCF) fleet segmentation. This was the natural criterion as it is the same utilised for the national data collection programme. The industries were segmented according to the number of employees as the number of employees is a good proxy for the overall turnover of the activity.
As detailed information was not available on the existing discard production per fishing fleet, a set of meetings were organised. These meetings were organized in order to make an appraisal of the discards production and related factors and to collect the necessary information to organize a more structured survey. This would allow for a better assessment of the status of the discards as well as the main constraints faced by the fishers. After the meetings draft questionnaires were devised and then tested, refined and finalized. Finally, a sampling scheme was devised (Tables 7.1, 7.2) for the data collection. This phase of questionnaire preparation and discard appraisal was carried out by consultants during the first half of April 2018.

Table 7.1. Fishing fleet.

Category	Fishing system	Length overall class (LOA)	No. of interviews
DTS_1218	Trawlers	=>12 <18	2
DTS_1824	Trawlers	=>18 <24	2
TBB_1824	Beam trawlers	=>18 <24	2
TM_1240	Pelagic trawlers	=>18 <24	3
DRB_1218	Dredgers	=>12 <18	3
PGP_0018	Small-scale	< 18	2
Total	Total		14

Table 7.2. Seafood industries

Category Fisheries	Nr of employees	No. of interviews
A	<10	1
B	10-20	1
C	20-50	1
D	>50	1
Total		4

7.1.2 Stage 2: Data collection and data entry

The data collection was conducted through the questionnaire using face-to-face interviews. The data collection was organized for each of the groups as described in the following table (Table 7.3). The bulk of the interviews was carried out in the period from the second half of April to the first half of May 2018.

Table 7.3. Sample.

Group	Data collection period	Number of data collectors	Number of completed questionnaires
Fishers	April-May 2018	1	14
Seafood industries	May 2018	1	4

7.1.2.1 Data entry

The data entry was conducted through a two-step process. In the first phase, all data from the questionnaires was entered onto a data entry spreadsheet. These data entry spreadsheets were prepared and organised along with the questionnaires. The two-step process, questionnaire-based interviews and data entry, allowed for more thorough data quality checks as the data collectors had to interact with the data twice. Moreover, it was suggested that the data entry be done the same day that the interview was carried out, as this allowed for a better and more precise values. The data entry phase allowed for a cross-checking of the data if any missing or anomalous values were spotted the data collector could try to find a way to correct it.

7.1.3 Stage 3: Data analysis

Following the data entry, all of the questionnaires were collated into a single spreadsheet by group of respondents. During this final stage, the data were analysed in order to generate the results presented in this report. The first step of the analysis was to correctly categorize the questionnaires into the most appropriate category and then the spreadsheets were edited and standardized to follow the same template. As a matter of routine, the data also needed to be edited as a result of typing errors.
This project was able to meet the objectives of the 'semi-qualitative' analysis by providing a mapping of the complexity of the discard management and highlights critical factors of the discard management. It was reported a very good cooperation for the respondents as they were interested in highlighting the problems encountered with the management of fishing discards.

7.1.4 The fishing fleet

The fishing fleet of Chioggia was composed by 215 vessels (Table 7.4). It covered all the main fishing fleets typical of Mediterranean fisheries, such as trawlers – bottom trawlers, beam trawlers and pelagic trawlers – dredgers and small-scale vessels. The most important fleet segment in terms of number of vessels was the dredgers, composed by 70 vessels with an average LOA of 13.2 metres and an engine of 110 KW, targeting clams or smooth clams. The second largest fleet segment was composed by bottom trawlers, in total 57 vessels of which 28 with a LOA below 18 metres and 29 with a LOA between 18 and 24 metres. While the small-scale vessels accounted 51 vessels with a LOA of 8.3 metres.

Table 7.2. The fishing fleet of Chioggia (2017 data).

Fleet segment	Fishing system	Length overall class (LOA)	No. of vessels	Average LOA	Average KW
DTS_1218	Bottom trawlers	=>12 <18	28	13.3	127.3
DTS_1824	Bottom trawlers	=>18 <24	29	23.2	389.2
TBB_1824	Beam trawlers	=>18 <24	25	22.6	446.8
TM_1240	Pelagic trawlers	=>18 <24	12	23.5	451.7
DRB_1218	Dredgers	=>12 <18	70	13.2	109.8
PGP_0018	Small-scale	< 18	51	8.3	42.6
Total	Total		215	15.1	192.1

7.1.5 Fisheries production

The total production sold through the fish market of Chioggia in 2016 was 11.390 tonnes worth 39.84 million Euro (Table 7.5). Most of the production (81%) was composed by local production, while the import represented about 10% of the total volume. Small pelagics were the main group of species, representing about 50% of

the total volume (Table 7.6). However, the main group of species in value was represented by ground fish, which alone represented 20% of total value (Table 7.7).

Table 7.3. Total production of Chioggia fish market.

Fish Market	2016 - Volume of production (Tonnes)	2006 - Volume of production (Tonnes)	Difference (2016/2006)	2016 - Value of production (Million Euro)	2006 - Value of production (Million Euro)	Difference (2016/2006)
Chioggia						
Local product	**9267**	**8828**	**5.0%**	**25.11**	**23.72**	**5.9%**
Italian product	**928**	**1904**	**-51.3%**	**6.79**	**11.14**	**-39.1%**
Imported product	**1194**	**1492**	**-20.0%**	**7.94**	**9.31**	**-14.7%**
Total Chioggia	**11390**	**12224**	**-6.8%**	**39.84**	**44.17**	**-9.8%**
Total Veneto region	**20149**	**20963**	**-3.9%**	**54.76**	**56.43**	**-3.0%**

Source: elaborazioni Osservatorio Socio Economico della Pesca e dell'Acquacoltura su dati dei Mercati Ittici

Table 7.4. Total volume of production of Veneto (2016 and 2006).

Fish Market	Small pelagic	Bottom fish	Molluscs	Crustacean	Total
Chioggia	**5883**	**1686**	**1428**	**270**	**9267**
Total Veneto region	**11998**	**3361**	**4152**	**638**	**20149**

Source: elaborazioni Osservatorio Socio Economico della Pesca e dell'Acquacoltura su dati dei Mercati Ittici

Table 7.5. Total value of production of Veneto (2016 and 2006) (million Euro)

Fish Market	Small pelagic	Bottom fish	Molluscs	Crustacean	Total
Chioggia	**5.15**	**9.75**	**7.82**	**2.38**	**25.11**
Total Veneto region	**12.66**	**16.49**	**20.64**	**4.97**	**54.76**

Source: elaborazioni Osservatorio Socio Economico della Pesca e dell'Acquacoltura su dati dei Mercati Ittici

7.1.6 The Consorzi di Gestione Vongole

The Veneto region is one of the main area for the fishery of bivalves, in particular clams (*Chamelea gallina*) and smooth clams (*Challista chione*), both fished by means of hydraulic dredges. There are two Clam Management Consortiums (Co.Ge.Vo.) operating in the Veneto, one in Chioggia and another in Venice. Co.Ge.VO have the important function of managing the resource in a rational way, coordinating the fishing activity.

In the region, the fleet of hydraulic dredges is composed of about 163 units, of which 77 operating in the Maritime division of Chioggia and the other 86 are active in the Maritime division of Venice. These vessels are highly specialized targeting exclusively bivalve molluscs. The fleet is divided into two categories, depending on their target, with 102 vessels targeting clams and 61 targeting smooth clams.

The vessels targeting smooth clams are managed by the Producers Organization 'O.P. I Fasolari', which defines the daily landing quota, with the aim of stabilizing the price and protecting the resources. The 'O.P. I Fasolari' groups 100% of the vessels, and the ex-vessel price is stable at € 4.50 / kg.

The total production of clams and smooth clams in 2016 was 4,850 tonnes, with a decrease of -19.6% compared to the production in 2006 (Table 8).

Table 7.6. Total production in volume of bivalves in Veneto

Fish Market	Chioggia	Venezia	Total
Fasolari	**374**	**465**	**840**
Vongole	**1820**	**2190**	**4010**
Total	**2195**	**2655**	**4850**

Source: elaborazioni Osservatorio Socio Economico della Pesca e dell'Acquacoltura su dati dei Co.Ge.Vo.

7.1.7 The legal framework on minimum sizes and discards

EU Regulation 1380/2013, in its article 15 states that in the Mediterranean all catches of species subjected to minimum sizes as defined in Annex III of Regulation (EC) No. 1967/2006, must be retained on board the fishing vessels, registered and landed. This landing obligation began the 1st January 2015 for small pelagics, such as anchovy (*Engraulis encrasicolus*), sardine (*Sardina pilchardus*), Mackerel (*Scomber spp.*), Horse mackerel (*Trachurus spp.*), which already have a minimum

landing size according to Reg.1967/06. No later than 1st January 2019 for all other species which have a minimum size in Reg.1967/06, namely:

• Demersal species: European seabass (*Dicentrarchus labrax*), Annular seabream (*Diplodus annularis*), Sharpsnout bream (*Diplodus puntazzo*), White seabream (*Diplodus sargus*), Common seabream (*Diplodus vulgaris*), White grouper (*Epinephelus* spp.), Sand steenbras (*Lithognathus mormyrus*), hake (*Merluccius merluccius*), Mullet (*Mullus* spp.), Axillary seabream (*Pagellus acarne*), Blackspot seabream (*Pagellus bogaraveo*), Wreckfish (*Polyprion americanus*), Common sole (*Solea vulgaris*), Gilthead seabream (*Sparus aurata*), unless scientific evidence demonstrates high survival rates, taking into account the characteristics of the gear, fishing practices and the ecosystem (Art. 15, par. 4, letter b)

• Crustaceans: Norway lobster (*Nephrops norvegicus*), Common lobster (*Homarus gammarus*), Spiny lobster (Palinuridae), Deep-water Rose Shrimp (*Parapenaeus longirostris*), unless scientific evidence demonstrates high survival rates, taking into account the characteristics of fishing gear, practices and the ecosystem (Art. 15 , par. 4 , letter b)

• Bivalve molluscs: Great scallop (*Pecten jacobaeus*), Carpet shell clam (*Venerupis spp.*), Clam (*Venus spp.*), unless scientific evidence demonstrates high survival rates, taking into account the characteristics of the gear, fishing practices and ecosystem (Art. 15, par. 4, letter b)

In this regard it should be noted that, while the shellfish and the sole will require a specific written certification of scientific research that confirms the high rate of survival after discard at sea, for bivalve molluscs it appears to be undisputed that they are alive at the time of discarding (see Reg.853/2004) as this product must be alive when marketed. It does not therefore seem necessary to provide written evidence of research.

7.2 Results

The results are presented with the combined categories under the fisheries and seafood companies that were detailed in Table 7.1. All of the data, including those presented in the tables, refers to 2017, unless otherwise specified.

7.2.1 Fishing Vessels

7.2.1.1 Characteristics of the respondents

Three categories were created with according to the fleet segmentation followed by the Data Collection Framework of the EU[15]. The bigger vessels were under the category of beam trawlers (TBB_1824), while the smaller were small-scale vessels (PGP_0018) (Table 7.9). The small-scale vessels interviewed utilised the fixed nets as main gear and the traps as second gear (Table 7.10).

[15] European Union (EU) Data Collection Framework (DCF). 2017. Regulation (EU) 2017/1004 of the European Parliament and of the Council on the establishment of a Union framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the common fisheries policy and repealing Council Regulation (EC) No. 199/2008.

Table 7.7. Average dimensions of respondents

Category	Length overall (metres)	Gross tonnage (GT)	Horse power (KW)
DTS_1218	15.9	52.0	263.0
DTS_1824	23.1	97.0	607.0
TBB_1824	24.5	104.4	658.0
TM_1240	22.9	106.7	388.3
DRB_1218	14.4	12.0	144.4
PGP_0018	12.0	15.0	225.0

Table 7.8. Main gear utilized (No. of respondents)

Category	Bottom trawlers	Pelagic trawlers	Beam trawlers	Fixed nets	Dredge	Traps	Other
DTS_1218	2	0	0	0	0	0	0
DTS_1824	2	0	0	0	0	0	0
TBB_1824	0	0	2	0	0	0	0
TM_1240	0	3	0	0	0	0	0
DRB_1218	0	0	0	0	3	0	0
PGP_0018	0	0	0	2	0	0	0

Table 7.9. Second gear utilized (No. of respondents)

Category	Bottom trawlers	Pelagic trawlers	Beam trawlers	Fixed nets	Dredge	Traps	Other
DTS_1218	0	0	1	0	0	0	0
DTS_1824	0	0	1	0	0	0	0
TBB_1824	2	0	0	1	0	0	0
TM_1240	1	0	2	0	0	0	0
DRB_1218	0	0	0	3	1	1	0
PGP_0018	0	0	0	0	0	2	0

7.2.1.2 Activity and discard production

The engaged crew per vessel ranged between 3 and 7, with the highest number engaged in the pelagic trawlers (TM_1240). The average duration of the fishing trips ranged between 6 h of the dredgers and 31 h of the big trawlers (DTS_1824), while

the number of working days per year ranged between 83 of the dredgers and 183 of the pelagic trawlers (Table 7.12). As shown in Table 7.12, the number of hauls per day was quite stable during the year with the beam trawl that carried out the highest number of hauls per day, 12-16, and the pelagic trawls the lowest number, 2-3.

Table 7.10. Fishing operations in 2017 (average value per category).

Category	Engaged crew per vessel (including owner)	Average duration of a fishing trip (hours)	Number of fishing trips per year	Days at sea per year	If trawlers or beam trawlers: average number of hauls per day - spring	If trawlers or beam trawlers: average number of hauls per day - summer	If trawlers or beam trawlers: average number of hauls per day - autumn	If trawlers or beam trawlers: average number of hauls per day - winter
DTS_1218	3	13	135	135	8	9	9	9
DTS_1824	4	31	115	155	9	9	9	9
TBB_1824	6	26	120	148	12	12	13	16
TM_1240	7	10	183	183	3	2	3	3
DRB_1218	3	6	83	83	0	0	0	0
PGP_0018	3	29	105	130	0	0	0	0

The lowest quantity of daily landings was produced by the small trawlers, with a value ranging between 90 and 110 Kg/day, while the highest was produced by pelagic trawlers and ranged between 1.9 and 3.4 tonne per day (Table 7.13).

Table 7.11. Average daily landings per season (2017).

Category	Spring (Kg)	Summer (Kg)	Autumn (Kg)	Winter (Kg)
DTS_1218	90	100	110	90
DTS_1824	385	385	435	335
TBB_1824	165	160	220	225
TM_1240	2247	3433	3200	1910
DRB_1218	288	211	211	288
PGP_0018	40	50	50	40

Table 7.14 describes the main group of species targeted per season. It shows as dredgers are the only fleet segment targeting only one category, the bivalves, and specifically clams and smooth clams (*Callista chione*). The pelagic trawlers target mainly small pelagics, mainly anchovies and sardine and the European sprat (*Clupea sprattus)* and sand smelt (*Atherina boyeri*). The beam trawl target sole, cuttlefish and scallops. The small scale fleets targets mainly sole, ray and cuttlefish, while the trawlers target red mullet, hake, sole, cuttlefish and Norway Lobster, depending on the season.

Table 7.12. Landing composition per main group of species.

Category	Small pelagics	Bottom fish	Molluscs	Bivalves	Crustacean	Other
DTS_1218	0	70	18	0	12	0
DTS_1824	0	83	10	0	7	0
TBB_1824	0	60	30	0	10	0
TM_1240	80	1	0	0	0	20
DRB_1218	0	0	0	100	0	0
PGP_0018	0	65	30	0	5	0

Table 7.15 shows that discard composition changes according to the fleet segment and the season and, in general, are aligned with the target species.

Table 7.13. Discards composition.

Category	Spring		Summer		Autumn		Winter	
	Main discarded species	Second discarded species	Main discarded species	Second discarded species	Main discarded species	Second discarded species	Main discarded species	Second discarded species
DTS_1218	Sole	Hake; Seabream	Sole	Hake; Seabream	Sole; red mullet	Hake; Seabream	Sole	Hake; Seabream
DTS_1824	Sole	Hake	Sole	Hake	Red mullet	Sole	Sole	Hake
TBB_1824	Sole	Scallop	Sole	Scallop	Sole	Scallop	Sole	Scallop
TM_1240	Anchovy	Sardine	Sardine; Anchovy	Anchovy; Sardine	Sardine; Anchovy	Anchovy; Sardine	Anchovy	Sardine
DRB_1218	Clam		Clam		Clam		Clam	
PGP_0018	Seabream; Sole	Sole; Horse mackerel	Sole	Seabream	Sole	Seabream; striped seabream	Sole	Seabream

According to the respondent's answers, reported in Table 7.16, the main quantity of discards in absolute terms were produced by the trawlers and the beam trawlers. While the pelagic trawlers generated a relatively low volume of discards per day. Low quantity of discards is landed by the dredgers, and this was the segment that produced the lowest quantity, both in absolute terms and relative to the landings.
As shown in table 7.17, all the interviewed fishers declared that they did not land the discards but rather threw them directly back into the sea during the fishing operation (Table 7.18). The only exception was represented by the dredgers which do a first sift of the product onboard, throwing into the sea the undersized specimens. A second sifting is done on-shore, with the undersized specimens re-introduced in specific areas, according to a specific management plan.
Most respondents do not think that the landing obligation was a correct regulation. The exception was represented by the large trawlers and the dredgers, where between half and one third of respondents believe that the landing obligation of discards was a good regulation.

Table 7.14. Average discard production per vessel per day.

Category	Spring		Summer		Autumn		Winter	
	Daily discard production (species in the Annex III of EU regulation16) kg	Daily discard production (other species) kg	Daily discard production (species in the Annex III of EU regulation)kg	Daily discard production (other species)kg	Daily discard production (species in the Annex III of EU regulation)kg	Daily discard production (other species)kg	Daily discard production (species in the Annex III of EU regulation)kg	Daily discard production (other species)kg
DTS_1218	50	110	70	150	130	275	75	160
DTS_1824	30	50	40	60	100	200	50	60
TBB_1824	50	200	60	250	80	250	50	200
TM_1240	80	8	47	13	65	13	70	10
DRB_1218	10	30	5	40	5	50	15	40
PGP_0018	25	35	30	40	35	50	10	25

Table 7.15. Do you land the discards?

Category	YES	NO
DTS_1218	0%	100%
DTS_1824	0%	100%
TBB_1824	0%	100%
TM_1240	0%	100%
DRB_1218	Partially	Partially
PGP_0018	0%	100%

[16] COUNCIL REGULATION (EC) No 1967/2006

Table 7.16. How do you manage on-board the discards?

Category	
DTS_1218	Thrown into the sea
DTS_1824	Thrown into the sea
TBB_1824	Thrown into the sea
TM_1240	Thrown into the sea
DRB_1218	Partially thrown into the sea and partially landed
PGP_0018	Thrown into the sea

Table 7.17. Do you think that the landing obligation of discards was a correct regulation?

Category	YES	NO
DTS_1218	0%	100%
DTS_1824	50%	50%
TBB_1824	0%	100%
TM_1240	0%	100%
DRB_1218	33%	66%
PGP_0018	0%	100%

The respondents did not seem to be fully aware about the reasons why the landing obligation was established (Table 7.21). Interestingly, one of the respondents though that it was established in order to provide an easy and cheap way to feed the tuna raised in Croatian plants, as, in some cases, this is how the discards are redirected.

Table 7.18. Why do you think established the LO was established?

Category	
DTS_1218	To allow us to work better
DTS_1824	No response
TBB_1824	To monitor us
TM_1240	To provide food for feeding the tuna cages of Croatia
DRB_1218	To avoid to sell under sized marine organism
PGP_0018	To monitor us

Table 7.22 lists the main reasons provided by the fishers to explain why fishing activity produces discards. The main reason, provided by small trawlers, beam trawlers and small-scale fishers, was low market quality due to damaged specimens. On the other hand, the presence of undersized species was reported by large trawlers and pelagic trawlers. Trawlers also reported one of the reason to be the fishing area, while both trawlers and dredgers reported that the mesh size is a factor affecting the discard production.

Table 7.19. Which of the following reasons cause discards production?

Category	Limited mesh size	Presence of undersized species	Overexploitation	Fishing habits (for example fishing in specific grounds)	Low marked demand	Gear selectivity	Damaged fish (low market quality)	Other
DTS_1218	X			X			X	X
DTS_1824		X	X	X				
TBB_1824								X
TM_1240		X			X		X	
DRB_1218	X							
PGP_0018						X	X	X

When the respondents were specifically asked about the best way to reduce discards (Table 7.20), no significant answers were provided. The dredgers seem to be satisfied about the current system, and the trawlers declare that a certain amount of discards is normal and an increase of mesh size could further reduce the discards. The small scale vessels proposed a change in gear, probably moving toward more selective gears.

While, when specifically queried about specific measures that could reduce discards, such as change of gear characteristics (Table 7.23), fishing grounds (Table 7.24) and time of fishing (Table 7.25), the majority of the respondents reported a positive response to the possibility to reduce discards by changing gear characteristics and fishing areas, while a negative response was provided to the question about the

fishing time, which evidently do not seem to affect discard production at all. In particular, all the large trawlers, the beam trawlers and the pelagic trawlers, reported that the change in gear characteristics and fishing grounds could cause a reduction of discards.

Table 7.20. Do you think that there is a better way to reduce discards?

Category	
DTS_1218	A certain amount of discards is normal
DTS_1824	Increasing the mesh size
TBB_1824	No
TM_1240	No
DRB_1218	The system in place is the better
PGP_0018	Change gear

Table 7.21. Do you think that it could be possible to reduce the discard production by changing gear characteristics?

Category	YES	NO
DTS_1218	50%	50%
DTS_1824	100%	
TBB_1824	100%	
TM_1240		100%
DRB_1218	50%	50%
PGP_0018	50%	50%

Table 7.22. Do you think that it could be possible to reduce the discard production by changing fishing grounds?

Category	YES	NO
DTS_1218	100%	
DTS_1824	100%	
TBB_1824	100%	
TM_1240		100%
DRB_1218	50%	50%
PGP_0018	50%	50%

Table 7.23 Do you think that it could be possible to reduce the discard production by changing the time that the fishing is conducted?

Category	YES	NO
DTS_1218		100%
DTS_1824		100%
TBB_1824		100%
TM_1240		100%
DRB_1218		100%
PGP_0018		100%

Most respondents did not deploy any strategy to reduce discards (Table 7.26), but interestingly pelagic trawls and dredgers, the minor producers of discards, have installed on board new machineries that further reduce the discards. In particular, dredgers installed a grid in order to detect undersized specimens and pelagic trawls an automatic machine for sorting the product according to the size and the species. In this way both have an immediate idea on the presence of discards in that area and can instantly change fishing strategy.
In all cases, the attempts that have been trialled to reduce discards have produced some results (Table 7.27).

Table 7.24. Which strategy did you deploy in order to reduce discards?

Category	Change gear characteristics	Change fishing grounds	Change technical characteristics of the gear	Change time of fishing	Installation of new on-board machineries	Other	Nothing
DTS_1218							X
DTS_1824			X				X
TBB_1824						X	X
TM_1240		X			X		
DRB_1218					X		X
PGP_0018							X

Table 7.25. What was the effect of these changes?

Category	
DTS_1218	None
DTS_1824	Discard reduction
TBB_1824	Discard reduction
TM_1240	Discard reduction
DRB_1218	Discard reduction
PGP_0018	None

Although it was not easy to quantify the economic impact, the respondents provided an estimate of the daily costs and the working hours related to discards (Table 7.28). The main costs were declared by large trawlers, about 300 Euro per day, corresponding to about 40-50 thousand Euro per year. The cost quantified by the small-sale vessels was also surprisingly high – 200 Euros and this corresponded to 5 working hours per day.

Table 7.26. Estimation of the economic impact of discards

Category	Average cost per fishing trip produced by discards (Euro)	Average working hours per fisher due to discards
DTS_1218	100	
DTS_1824	300	5
TBB_1824		1
TM_1240	50	3
DRB_1218		0
PGP_0018	200	5

All the respondents declared that there are no areas equipped for landing the discards, with the exception of the dredgers (Table 7.29).
The majority of them declared to not be contacted by any company operating with discards, with the exceptions of dredgers and pelagic trawlers.
The survey identified only one case of success that was represented by the management of discards of Consorzio di Gestione vongole (Co.Ge.vo.), which deployed specific strategies in order to manage the discards largely represented by undersized specimens.

Table 7.27. Are there areas where is it possible to land the discards?

Category	YES	NO
DTS_1218		100%
DTS_1824		100%
TBB_1824		100%
TM_1240		100%
DRB_1218	100%	
PGP_0018		100%

Table 7.28. Have you ever been contacted by any company interested in discards?

Category	YES	NO
DTS_1218		100%
DTS_1824		100%
TBB_1824		100%
TM_1240	100%	
DRB_1218	100%	
PGP_0018		100%

Table 7.29 Do you know any case of success in the discard management?

Category	
DTS_1218	No
DTS_1824	Consorzio di gestione vongole (Co.Ge.vo.)
TBB_1824	No
TM_1240	No
DRB_1218	Consorzio di gestione vongole (Co.Ge.vo.)
PGP_0018	No

7.2.2 Seafood companies

7.2.2.1 Characteristics of the respondents

The interviews covered four categories of companies, segmented by number of employees. The four categories were: <10, 10-20, 20-50, >50 employees. These categories are the most representative of the companies of the local district. Bivalves are a significant component of the product sold by the two largest companies, accounting for about half of their total volume, while small pelagic species represented respectively 45% and 30% of the product sold by the two intermediate companies. Molluscs were mainly represented by cuttlefish and Horned octopus (*Eledone moschata*), while crustacean were mainly Norway lobster and caramote prawn (*Penaeus kerathurus*) and the imported *Homarus gammarus*. Cuttlefish were mainly cleaned, while the other species were sold whole. Bivalves were mainly constituted by clams (*Chamelea gallina* and *Tapes philippinarum*), smooth clams and scallops (*Aequipecten opercularis* and *Pecten jacobaeus*). Only scallops *Aequipecten opercularis* were cleaned and sold without shells, while *Pecten jacobaeus* was sold whole. Clams and smooth clams were sold whole, although purified and sorted.

Table 7.30. Characterizations of the interviews

			Group of species sold (as % to the total)				
Category	**Nr of employees**	**Volume of product per year**	**Small-pelagic species**	**Fish**	**Molluscs**	**Bivalves**	**Crustacean**
A	**70**	**10000**	**5**	**30**		**50**	**15**
B	**22**	**3000**	**30**	**15**	**15**	**40**	
C	**15**	**1200**	**45**	**30**	**10**	**10**	**5**
D	**8**	**700**		**70**	**20**		**10**

7.2.2.2 Origin of the product

Table 7.33 shows that the small pelagics, molluscs and bivalves were all locally produced, while ground fish and crustaceans were both imported and locally produced. In general, frozen fish were imported from non-EU countries while fresh fish was local or imported from EU countries, mainly Croatia. Crustaceans were mainly lobsters imported from the USA and Norway lobsters locally produced.

Table 7.31. Small-pelagic

Category	Small pelagic			Fish			Molluscs			Bivalves			Crustacean		
	Local	Imported EU	Imported non-EU	Local	Imported EU	Imported non-EU	Local	Imported EU	Imported non-EU	Local	Imported EU	Imported non-EU	Local	Imported EU	Imported non-EU
A	**100**			**20**	**80**					**100**					**100**
B	**100**			**30**	**70**		**100**			**100**					
C	**100**			**100**			**100**			**100**			**100**		
D				**50**	**50**		**100**						**100**		

7.2.2.3 Discards production and management

As shown in Table 7.34 the main quantity of discards were produced by mollusc and bivalves processors. The discards from molluscs were mainly represented by entrails and bones of cuttlefish, while for bivalve discards represented by shells and dead specimens. Fish, small pelagic and crustacean were sold whole and almost did not produce any discard, with the exception of damaged specimens. In the past, it was reported that the clam shells were used both for creating street surfaces as well as making concrete. The current destination of the clam shells is not known, however there are many potential uses for the clam shells – particularly in the local lagoon environment.

Table 7.32. Percentage of discards produced per volume of product

Category	Small pelagic	Bottom fish	Molluscs	Bivalves	Crustacean
A				**10**	**5**
B			**30**	**18**	
C	**5**	**5**	**5**	**10**	
D		**0**	**30**		**0**

In all cases, discards were collected by a specialized company at a cost of about €130/t. Interestingly the same company was utilized by the different companies and it was a generalist company that processed all kind of discarded organic items, not only seafood (Table 7.35). The respondents of category A reported that they also pay for the disposal of water resulting from processing. They also made investments on machineries, mainly for sorting the product.

Table 7.33. Percentage of discards produced per volume of product

Category	Are discards internally processed?	Are discards collected by specialised companies?	Cost per tonne
A	No	Yes	130
B	No	Yes	130
C	No	Yes	130
D	No	Yes	

7.2.2.4 Main problems related to discards

Respondents reported that the main problem related to discards was the cost of disposal, which represented a significant amount considering the total volume of products and their overall turnover (Table 7.36). They also complained that, in their opinion, the law was not always applied with the same level of detail to all companies, and this created a distortion to the market.

One of the reasons it was difficult to comply with the law, as reported by the respondents was that the regulation was too complex and not fully understood (Table 7.37). Moreover, it was highlighted that the bureaucracy burdens and problems related to the strict requirements on permitted range of difference between the buying and selling weight of the product. They suggested that in order to improve discards disposal it would be useful to simplify the regulation (Table 7.38).

No specific issues were raised about the presence of undersized species.

Table 7.34. Main problems related to discards.

Category	Main
A	Inequality: the law is not applied the same ways to all the companies and everywhere in Italy
B	Cost of disposal
C	Cost of disposal
D	Legal framework too complex

Table 7.37. Reasons why it is too complicate to comply with the law.

Category	Main	Second
A	**Regulations and bureaucracy too complex**	
B	**Regulations and bureaucracy too complex**	**The inspectors did not acknowledge the difference in weight that resulted from the physiological decrease in weight**
C	**Regulations and bureaucracy too complex**	
D	**Regulations were not fully explained nor understood**	

Table 7.38. Is it possible to improve the disposal of discards?

Category	Main
A	**Applying the regulation to all the companies in the same way**
B	
C	
D	**Simplifying regulations**

7.3 Highlights

The key highlights are presented grouped by the fishing vessels and the companies. Following these summaries the main success case that was identified is described.

7.3.1 Fishing vessels

Pelagic trawlers generated a relatively low volume of discards per day. This was the result of the application of better techniques and technology (fish finders and sonar, as well as the use of a grid to sort the catch once it is on-board the vessel). This allows for the immediate identification of the presence of undersized specimens. Once the school of fish is identified the skippers conduct a small trial haul that allows them to assess the size of the fish in the school. If the school of fish contains undersized individuals the skippers move to target another school and, in this way, they avoid large hauls with undersized fish. They have strong market disincentives for catching small and undersized species. Further, the higher the catch rates of undersized specimens the higher the work-load for the crew on the vessel (without increases in profit). Good skippers are recognized as such when they are able to avoid catching specimens.

Low quantities of discards are landed by the dredgers, and this was the segment that produced the lowest quantity, both in absolute terms and relative to the landings. The grid used by the dredgers already reduces the capture of under-sized

specimens. A second sorting is conducted on-board the vessels with undersized specimens being thrown back directly into the sea, still alive.
Of note, all of the interviewed fishers, apart from the dredgers, declared that they do not in practice follow the landing obligations as they throw discards directly into the sea. A lack of knowledge about the motivation for the landing obligations; knowledge about managing discards; a lack of training on meeting the landing obligations; and a lack of on-shore facilities for landing discards all resulted in the fishers not following the discard requirements.
Moreover, the quantity of undersized specimens, particularly for the small pelagic fisheries, are not high enough for the required scales of economy needed to make landing the discards profitable. Interestingly, anecdotal information suggests that in neighbouring Croatia the landing of discards for small pelagics is conducted more regularly as an informal market with tuna fattening operations has been developed.
Only trawlers and dredgers reported using a mesh size as factor affecting the discard production. Beam trawlers and pelagic trawlers use mesh size well above the minimum legal requirement. They use the larger mesh sizes in an attempt to avoid the presence of undersized specimens as this produces an increase in the cost along with a decrease of efficiency while not producing any relevant economic benefit. The species they target do not have a market value if undersized, unlike some of the target species of trawlers, in particular the molluscs. Further, the beam trawlers positively viewed the closure of fishing within three nautical miles as they are convinced the closure produced an increase in flat fish yield.
All the large trawlers, the beam trawlers and the pelagic trawlers, reported that a change in gear characteristics and fishing ground could result in a reduction of discards.
Pelagic trawlers and dredgers are the lower discard producers and, on the contrary, the small-scale segment produces the highest relative level of discards. Discards are caused mainly by undersize specimens in the case of mobile gears (trawlers, beam trawlers and pelagic trawlers), while most discards from passive gears are the result of damaged specimens.
The majority of fishers have not been contacted by companies that specialize in handling discards, with the exception of dredgers and pelagic trawlers that are also the lower discard producers and already deployed strategies to reduce discards. The most appealing discards, in terms of market interest, is the small pelagic category.

7.3.2 Seafood companies

The main quantity of discards were produced from mollusc and bivalves processing. The discards from molluscs were mainly represented by the entrails and bones of cuttlefish, while for bivalves they are represented by shells and dead specimens. The small pelagic, molluscs and bivalves were all locals, while fish and crustacea were both imported and locally produced. Only one company collected the discards in Chioggia, at a rate of 130 Euro/t, and this company was the same for the different companies as it is a generalist company that processed all kind of organic waste items. Following this, respondents reported that the main problem related to discards was the cost of disposal and this was up to 80 000 Euro annually for the largest company that was interviewed.
Again for this category, a lack of knowledge and understanding about the complexity of the laws were reported. The issue of undersized specimens does not arise at this

stage of the product cycle as the issue has already been dealt with by the fishers and so no specific issues were raised about the presence of undersized species.

7.3.3 A success case on discard management: the bivalve management

A single success case was identified by both fishers and the managers of the processing companies, and this case is summarized below.
A rigid management obligation was put in place with compliance parameters that were extremely difficult to meet. The particular requirement was that, according to Annex III of Reg. 1967/06, the minimum landing size for the vongola di mare clam (*Chamelea gallina*) is 25 mm with zero tolerance for landings of even a single individual below this size. However, the legal gear dimension did not guarantee that the minimum landing size was consistently met. The difficulty in aligning the three elements – the zero tolerance with the landing obligations, the utilization of the legal gear that was not adequate for the landing requirements to be met and the high volumes of landings (composed by many individuals) – all led to the need for a collaborative approach to solve the issue. The bivalve fisheries were already completely managed under a consortium, Co.Ge.Vo, which facilitated the collective management approach.
An official request was made by Italy17 and a national management plan was prepared by The Mediterranean Advisory Council (MEDAC). A management plan, 'Piano di gestione nazionale rigetti, per la risorsa vongole (*Chamelea gallina*)' along with a national implementation of the law, 'Piano sperimentale di gestione dei rigetti per la risorsa vongole (*Chamelea gallina*)'. Through these actions the minimum mesh size of the grid as well as the minimum landing size of the clams were adapted within the parameters of the European legal framework. Following the sorting done on board the vessel a provision has been made for a sorting to be conducted on land with the undersized specimens returned to designated restocking areas. Within this measure, a second level of control is implemented with shore-based landing samplings following a sampling plan where once per month each landing site has 20% of the landings monitored for 30% of the vessels that are landing. The consortium is both responsible and accountable for the monitoring of the landing obligations.

[17] lettera Prot. 10041 del 14 maggio 2015 della Direzione Generale della pesca e dell'acquacoltura –MIPAAF

7.4 Main recommendations for actions

Based on the findings of the study combined with the feedback from the respondents the main recommendations for actions have been compiled.

Table 7.39. Recommendations arising from the investigation for improving discard management.

Recommendations	Priority
Continuing encouraging co-management approaches to addressing discards in fisheries beyond the dredgers	High
Devise management plans per fishery that includes discard management	High
Conduct capacity development to increase fishers' awareness and understanding of the discard regulations	Medium
Incentivize the landings of undersized species through the creation of shore-based facilities	Medium
Identify areas with the fishers to close areas that have higher incidences of catch of undersized specimens	Medium
Direct waste products (e.g. clam shells) to novel or re-introduce traditional uses such as a component in making concrete or using for shoreline retention structures	High
Provide support to industries supporting the utilization of landed discards	Medium

8 Incentives towards full utilization

The analyses in the previous sections show that there are numerous barriers to the full utilization of UWC in south European countries. Several actions can be taken by the authorities to incentivize the full utilization of unwanted catches at the level of the fishing industry:

- "branding" marketing strategies facilitating to the consumer information on how catches are fully utilized in the local economy
- financing new equipment or structural modifications to fishing vessels to adopt systems to facilitate storage and transport, such as storing as silage, processing into fish meal / oil on board or separate freezing compartments. Note however that due to the small size of fishing units these options may not be viable.
- financial premiums (subsidies or tax exemptions) to fishing units that demonstrate compliance with the landing obligation, including full documentation of catches and taking former discards ashore. The ensuing benefits would need to be distributed across the vessel working force, naturally.

Actions will be required at the level of the processing industry, particularly:

- facilitate transport of UWC from multiple landing places to processing plants
- facilitate access to funds to invest in new developments related to the utilization of UWC (new products, new markets)
- encourage integration of R&D research in biotechnology with processing industry, following the example of companies such as Matís (Iceland) or Nofima (Norway), which collaborate in creating value from underutilized marine biological resources.
- fund flagship projects with strong involvement of fishers and local entrepreneurship, such as the demonstration processing plant developed by LIFE project iSEAS in Galicia (NW Spain)[18].

Additionally, it is recommended integrating both levels, the fishing industry and the processing industry, to capitalize on value added along the production chain.

[18] http://lifeiseas.eu/valorization-of-fish-discards-pilot-plant-port-of-marin/

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10 APPENDIX – Estimating the volume of unwanted catches in Mediterranean EU fisheries

The objective of this study is to quantify the amount of discards of commercial species for European Mediterranean fisheries. Other authors have estimated the total amount of discards in Mediterranean fisheries (see for example Tsagarakis et al. 2014), including non-commercial invertebrates as well as commercial organisms. Here we attempt to estimate the quantities of commercial species that were discarded for different reasons "unwanted catches", including those that would fall under the remit of the Landing Obligation in the reform Common Fisheries Policy (CFP) (Art. 15, EU Reg. 1380/2013). A fraction of these unwanted catches will be subject to the regulation from 1st January 2019 (i.e. must be brought to land for uses other than human consumption), while another fraction can continue to be discarded. In this second fraction, we are interested in estimating the quantity that, although not obligatory, could be brought to land for industrial uses (either for reduction to fishmeal and similar, or for processing for indirect human consumption) to estimate a total quantity of biomass available for industrial processing.
In summary, the four types of fractions in which the commercial catches can be divided are:

a. Commercial catch

b. Unwanted catch under LO (in the Mediterranean sea, those species regulated by minimum catch size, listed in Annex 3 of the Mediterranean regulation EU Reg. 1967/2006)

c. Other unwanted catch that could be used for industrial purposes with present technologies and markets

d. Other unwanted catch unlikely to be used for industrial purposes with present technologies and markets (e.g. hard shelled invertebrates)

For the purposes of this study, we assume that all fishes (bony fish as well as cartilaginous fish) can be processed with the same technology and for simplification we will assume that the main market for unwanted catches b+c is reduction to fishmeal and similar. Given the nature of the data used (see below) the quantities estimated are necessarily minimum quantities.

10.1 Data used

The data used correspond to tables `discards_length.csv`, `catches_length.csv`, `landings_length.csv` and `effort.csv` of the official Data Collection Framework data call 2015 (DCF 2015) facilitated to the project MINOUW by the EC Joint Research Centre. The most recent year in the data is 2014, immediately before the entry into force of the first phase of the Landing Obligation (discards ban on small pelagics: 1st Jan. 2015).

10.2 Data consistency

The period with information on discards is 2009-2014, but the information is not consistently represented for all fisheries, gear, GSA or countries. When reported,

information on discards is available for bottom trawl (OTB) and purse seine (PS) fisheries, and in some GSA for nets also (GND, GNS or GTR). The fisheries-gear / GSA combinations for which information on discards is available produce ca. 80% of the total European catches in the Mediterranean.
Regarding the time coverage of discards information, the quantities reported in the period 2009-2011 were considerably lower than the quantities reported in 2012-2014 hence only the latter period is used here. Furthermore, data for 2012 was unreliable or not available for France and Greece. Other cases of inconsistency in the data arise when cross-checking the total amount of discards reported in table `catches_length.csv` with table `discards_length.csv`, and even in the value of landings per fishery-gear / GSA combination in a few cases. These inconsistencies have been analysed case-by-case and solved whenever possible by choosing a likely value.

10.3 Fisheries

European Mediterranean fishing fleets operate in 8 countries (Spain ESP, France FRA, Italy ITA, Malta MLT, Slovenia SVN, Croatia HRV, Greece GRC and Cyprus CYP) and 18 GSAs (namely 1, 2, 5, 6, 7, 8, 9, 10, 11, 15, 16, 17, 18, 19, 20, 22, 23, 25), with 11 "target assemblages"[19] (e.g. DEMF: demersal fishes, DEMPS: demersal species, etc., Level 5 of the DCF) and 21 types of fishing gear (e.g. DRB: dredges, LLS: surface longlines, etc., Level 4 of the DCF). From the large amount of possible combinations, we selected those target assemblages – gear – GSA – country combinations with at least 50 t of landings per year in the period 2012-2014. This resulted in 125 fisheries. Estimates (of varying accuracy) of unwanted catches could be made for 65 fisheries.
Each combination or *fishery* was characterized individually by the main target species, summary effort statistics, total catches, total landings and total discards, as well as the catches, landings and discards per species, when possible. The definition of the target species followed the same methodology of the STECF EWG 15-19 report, where the main European Mediterranean demersal fisheries were characterized by those species contributing to 75% or more of the landings (here we extend the analysis to all other fisheries) (STECF 2015) [20]. The table below reports annual averages for the period 2012-2014 (except, where indicated, 2013-2014):

- Area, target assemblage, fishing gear and country, when relevant.
- Catches and the total quantity (and percentage) of species under the Landing Obligation, as well as total quantity of species (and percentage) that could be subject to industrial processing (utilizable).

Note however the following:

- in some cases, catches that should have been discarded according to legislation previous to the adoption of the LO were being landed. For

[19] the target assemblage (Level 5) is reported as "fishery" in the DCF tables; however in this document fishery refers to the combination target assemblage-gear-GSA-country
[20] STECF 2015. Landing Obligation – Part 6 (Fisheries targeting demersal species in the Mediterranean sea) (STECF 15-19). This EWG used the same data sources (DCF 2015), but note that only years 2013-2014 were used.

instance, undersize catches of certain species that appear in the landings_length table.

- the data set does not provide discards information for some species that appear in Annex III of the Med. regulation, viz. seabreams (ANN, *Diplodus annularis* and CTB, *Diplodus vulgaris*), groupers (GPX, *Epinephelus* spp.), jack mackerel (JAA, *Trachurus picturatus*), wreckfish (WRF, *Polyprion americanus*), lobster (LBE, *Homarus gammarus*), spiny lobsters (PSL, Palinuridae), carpet clams (VEN, *Venerupis* spp., currently in *Tapes*), scallop (SJA, *Pecten jacobaeus*). Catches (and unwanted catches) of these species are generally low in the Mediterranean.
- catches and discards are not always well reported for some species which are caught abundantly and discarded frequently, such as the blue whiting (WHB, *Micromesistius poutassou*) or the bogue (BOO, *Boops boops*).
- discards volume or size frequency are not reported for some fisheries.

From these considerations it is clear that the DCF will provide only a minimum estimate of UWC that could be subject to utilization. The estimates of catches (and %) under the remit of the L.O. and additional catches with possible industrial utilization are given in the Table A1 for 65 of the 125 fisheries where these quantities could be calculated. Note that the information produced is of heterogeneous quality.

Table A1. Fisheries in Mediterranean EU countries with > 50 t of annual catches (average 2012-2014, except for FRA and FRC, 2013-2014), with estimates of catches under the remit of the Landing Obligation, with total utilization volume when considering non-regulated unwanted catches. The 65 fisheries for which information could be retrieved are ca. half of the 125 fisheries identified.

country	fishery	Catches (t)	*Annex III percentage*	*Annex III catches*	*Utilization percentage*	*Utilization catches*
ESP	**GSA01-DEMSP-GTR**	**412**	**0.70%**	**3**	**2%**	**7**
ESP	**GSA01-DEMSP-OTB**	**5013**	**11.42%**	**573**	**19%**	**974**
ESP	**GSA01-DWSP-OTB**	**271**	**0.00%**	**0**	**20%**	**55**
ESP	**GSA02-DWSP-OTB**	**114**	**0.00%**	**0**	**53%**	**60**
ESP	**GSA05-DEMSP-GTR**	**123**	**1.24%**	**2**	**2%**	**2**
ESP	**GSA05-DEMSP-OTB**	**1045**	**3.32%**	**35**	**16%**	**169**
ESP	**GSA05-DWSP-OTB**	**212**	**0.19%**	**0**	**6%**	**13**
ESP	**GSA05-MDDWSP-OTB**	**350**	**1.91%**	**7**	**18%**	**64**
ESP	**GSA06-DEMF-LLS**	**290**	**5.59%**	**16**	**6%**	**17**

ESP	GSA06-DEMSP-GNS	596	0.20%	1	0%	1
ESP	GSA06-DEMSP-GTR	1236	0.00%	0	1%	7
ESP	GSA06-DEMSP-OTB	17305	13.86%	2398	25%	4253
ESP	GSA06-DWSP-OTB	1053	0.39%	4	11%	117
ESP	GSA07-DEMSP-OTB	992	2.66%	26	22%	217
FRA	GSA07-DEMSP-OTB	2284	2.13%	49	3%	75
ESP	GSA07-DWSP-OTB	83	0.21%	0	20%	16
FRA	GSA07-SPF-OTM	2567	6.22%	160	6%	160
FRA	GSA08-DEMF-GTR	75	0.79%	1	7%	5
FRA	GSA08-DEMSP-OTB	57	0.00%	0	0%	0
ITA	GSA09-DEMSP-GNS	543	8.48%	46	8%	46
ITA	GSA09-DEMSP-OTB	8279	8.90%	737	39%	3244
ITA	GSA09-MDDWSP-OTB	671	1.83%	12	6%	41
ITA	GSA10-DEMSP-GTR	864	0.00%	0	0%	0
ITA	GSA10-DEMSP-OTB	1071	6.92%	74	7%	74
ITA	GSA10-MDDWSP-OTB	517	0.69%	4	1%	4
ITA	GSA10-SPF-PS	5338	0.62%	33	1%	33
ITA	GSA11-DEMSP-GTR	181	0.00%	0	33%	60
ITA	GSA11-DEMSP-OTB	1545	6.74%	104	35%	536
MLT	GSA15-DEMSP-OTB	55	0.03%	0	0%	0
ITA	GSA16-DEMSP-GTR	245	10.24%	25	10%	25
ITA	GSA16-DEMSP-OTB	8193	21.27%	1742	21%	1742
ITA	GSA16-DWSP-OTB	1549	1.21%	19	1%	19
ITA	GSA16-MDDWSP-OTB	2372	27.02%	641	27%	641
HRV	GSA17-DEMF-GNS	51	90.24%	46	90%	46
HRV	GSA17-DEMF-GTR	291	70.54%	205	71%	205
HRV	GSA17-DEMF-LLS	779	92.13%	718	92%	718
HRV	GSA17-DEMF-OTB	*5513*	9.59%	529	10%	529

HRV	GSA17-DEMSP-OTB	3461	22.69%	785	23%	785
ITA	GSA17-DEMSP-OTB	12799	21.90%	2802	73%	9364
SVN	GSA17-DEMSP-OTB	122	2.67%	3	3%	4
ITA	GSA17-DEMSP-TBB	1756	0.00%	0	0%	2
SVN	GSA17-SPF-PS	99	4.53%	4	5%	5
ITA	GSA17-SPF-PTM	37445	0.00%	0	4%	1634
ITA	GSA18-DEMF-LLS	491	0.00%	0	0%	0
ITA	GSA18-DEMSP-OTB	7575	7.54%	571	8%	580
ITA	GSA18-MDDWSP-OTB	337	4.59%	15	5%	16
ITA	GSA18-not spec.-OTB	4709	26.71%	1258	44%	2059
ITA	GSA19-DEMSP-OTB	277	2.86%	8	3%	8
ITA	GSA19-DWSP-OTB	462	0.08%	0	0%	0
ITA	GSA19-MDDWSP-OTB	879	1.93%	17	2%	17
ITA	GSA19-not spec.-OTB	1928	34.98%	674	51%	992
ITA	GSA19-SPF-GND	225	8.93%	20	9%	20
ITA	GSA19-SPF-PS	637	6.98%	44	7%	44
GRE	GSA20-DEMSP-GNS	360	7.56%	27	9%	33
GRE	GSA20-DEMSP-GTR	608	0.64%	4	2%	13
GRE	GSA20-DEMSP-LLS	128	0.31%	0	0%	0
GRE	GSA20-DEMSP-OTB	896	10.56%	95	21%	189
GRE	GSA22-DEMSP-GNS	2134	2.55%	54	6%	124
GRE	GSA22-DEMSP-GTR	2047	2.14%	44	3%	67
GRE	GSA22-DEMSP-LLS	581	0.79%	5	1%	5
GRE	GSA22-DEMSP-OTB	5180	13.81%	715	18%	931
GRE	GSA22-SPF-PS	8198	0.02%	2	0%	3
GRE	GSA23-DEMSP-OTB	323	5.59%	18	22%	71
CYP	GSA25-DEMSP-OTB	80	0.40%	0	2%	2

The MINOUW Consortium

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Beneficiaries:

Linked parties: