

Chapter 16

Onboard and Vessel Layout Modifications



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Abstract The purpose of this chapter is to discuss challenges that the EU Landing Obligation presents to the onboard handling of unwanted catches and how vessel layout modifications can be applied to meet these challenges. The key challenge the industry is facing is having to bring ashore catches of little or no value, which requires significant effort to handle and takes up valuable space that is, in many cases, not available. Considering that 85% of EU fishing vessels are under 12 metres long and 97% are under 24 metres, it is evident that the majority of the EU fleet has limited options when it comes to handling and stowage of catches that would have been discarded prior to the implementation of the Landing Obligation. The Landing Obligation only applies to species subject to catch limits, which means that the current set-up on vessels can, for the most part, accommodate the fish of legal size that needs to be landed. The main challenge is catches of undersized fish that are not permitted to be used for direct human consumption. For those catches, the simplest approach is to handle them as targeted catch, which will allow them to be used for higher-value products such as pet food, pharmaceuticals, food supplements, etc. This is, however, not applicable for the majority of the fleet, due to a lack of space and the labour effort required. Solutions such as bulk storage and simple silage preservation are alternatives that are being explored for smaller vessels. The larger vessels have more options, such as full silage production, fish protein hydrolysate and fish meal production.

Keywords Automated classification · Bulk landing · Fish protein · Fish silage · Hydrolysate · MCRS · Onboard handling · Vessel modifications

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16.1 Introduction

Discards have been a part of fishing practices in most fisheries around the world since fisheries began. Fishers have selected what fish to keep and what to release or throw back into the sea long before quotas and catch limits were invented. The introduction of catch limits has, however, created new incentives for discarding, as fishers try to maximise the value of their catches under quota regimes. Unwanted catches (UWC), such as low-value bycatches, undersized fish, catches exceeding quotas and catches of target species that are unlikely to attain premium prices are thrown back, and much of these catches are dead or dying. This has been the practice in European fisheries under the Common Fisheries Policy (CFP) of the European Union (EU). European fishers have annually discarded more than 1.5 million tons of fish in order to maximise the value of their catch and to meet with regulations (EC 2011). This practice has been the subject of increasing levels of debate (Borges and Penas Lado, [this volume](#)). As a result, the European Commission has introduced a Landing Obligation as a part of the 2013 reform of the CFP (EC 2013). This means that all catches of species subject to catch limits, i.e. where total allowable catches (TAC) have been set and in the Mediterranean catches of species subject to minimum sizes, will have to be landed and will be counted against quotas. The obligation is gradually implemented. The first fisheries were subject to this Landing Obligation in the beginning of 2015, and by 2019, all EU fisheries are required to land the entire catch of all species subject to catch limits.

The Landing Obligation presents a number of challenges for the European seafood sector. Fishing strategies of individual fishers will have to be enhanced; selectivity of fishing gear will need to be improved; onboard handling, sorting, storing and monitoring of compliance will need to be reconsidered; land-based processing will have to adjust to different supplies; and markets will be affected. The purpose of this chapter is to discuss challenges that the Landing Obligation presents to the onboard handling of unwanted catches and how vessel layout modifications can be applied to meet with these challenges.

16.2 Challenges

In recent years, the main focus of the EU authorities, researchers and the seafood industry working on the implementation of the Landing Obligation has been on how to avoid unwanted catches (see Reid et al., [this volume](#); O'Neill et al., [this volume](#)) and how to facilitate efficient monitoring, control and surveillance (MCS) of unavoidable unwanted catches (see also James et al., [this volume](#); Nuevo et al., [this volume](#)). There has, however, been much less attention given to what to do with the unwanted catches which, prior to the implementation of the Landing Obligation, would have been discarded after being caught. Exceptions to the Landing Obligation

and limits on permitted uses of the unwanted catches do have to be taken carefully into consideration when contemplating onboard handling and stowage. Species not covered bycatch limits, species where high survivability can be demonstrated and catches falling under the de minimis exceptions can still be discarded under the Landing Obligation; but everything else will need to be landed. In addition, catches under minimum conservation reference size (MCRS) need to be landed but cannot be used for direct human consumption. With all this in mind, it is clear that space for classification, proper handling and stowage will become an issue for much of the EU fishing fleet when the Landing Obligation is fully implemented. The available alternatives for addressing that challenge are scarce and are generally only applicable for larger vessels – but 85% of the EU fleet are under 12 metres long and 97% are under 24 metres (EU 2016), which severely reduces available solutions.

Catches falling under the Landing Obligation can be broken into two basic groups, i.e. catches under MCRS that cannot be used for direct human consumption and catches above MCRS that can be used for human consumption. Bycatch of species not subject to catch limits (or minimum size in the Mediterranean) can still be discarded as before. The main challenges for onboard handling are connected to catches under MCRS, as the larger fish destined for human consumption can, for the most part, simply be diverted to the traditional onboard handling processes that are already available. However, stowage of low-value species with catch limits can have an effect on the duration of fishing trips, as stowage space is limited. The MCRS catches have to be recorded and stowed separately from the catches intended for human consumption (EU 2015/812), and vessels greater than 12 metres in length overall also have to place their catches in boxes, compartments or containers separately for each stock, just as with any other catches (EC 1224/2009). This basically means that any mixing of species during stowage onboard is prohibited. Vessels will therefore need to have two separated compartments for stowage, i.e. one for < MCRS catches and another for human consumption catches; vessels greater than 12 metres in length will need to sort everything into boxes, tubs or other such compartments. It is therefore evident that significantly more space will be required for onboard classification, handling and stowage, in addition to added labour.

There are, however, a number of available alternatives for adapting onboard handling to the Landing Obligation, and some of them require modifications of the vessels and their equipment. These are highly dependent on each fleet type. The main challenges and available alternatives for each fleet type are discussed below.

16.2.1 Small Coastal Vessels

About 85% of the EU fishing fleet consists of vessels that are under 12 metres in length (EU 2016). Unlike larger vessels, they do not have the necessary space onboard to handle and stow their catch (Viðarsson et al. 2016). The catches of these vessels are however generally quite limited, as they are most often counted in

kilogrammes or hundreds of kilogrammes per fishing trip. These catches are almost solely landed on the day of capture, which is why the lack of proper bleeding, cleaning, chilling, sorting and storing is often not of major concern. These vessels are allowed to stow their catches without sorting each species into boxes or other such compartments, which makes it much easier to fit everything onboard (EC 1224/2009). They are, however, required to record and stow < MCRS catches separately from other catches (EU 2015/812). The Landing Obligation as such should therefore not create major challenges for this fleet sector in regard to onboard handling, as all < MCRS can simply be stored in bulk in boxes or larger containers. The problem is that the < MCRS catches being landed after each fishing trip are so small that they do not create enough incentives for buyers to source them (Viðarsson et al., 2017). Special solutions will therefore have to be implemented to aggregate these catches so that they become large enough to attract the attention of potential buyers. This is a subject discussed in another chapter of this book (Iñarra et al., [this volume](#)).

16.2.2 Small- and Intermediate-Sized Vessels

About 12% of the EU fleet are vessels between 12 and 24 metres in length (EU 2016). This is a highly diverse fleet targeting most commercial species in European waters, such as crustaceans, molluscs, groundfish and pelagics. They use a range of fishing gears, including dredges, bottom trawls, pots, gill nets, longline, handline, Danish seine and purse seine. The space onboard these vessels is limited when it comes to onboard handling of unwanted catches (Viðarsson et al. 2016). As these vessels are generally at sea for several days, it is important that all catches are properly handled, i.e. bled, gutted, cleaned, chilled, sorted and stowed, in accordance to the need of each species. These vessels are required to sort catches according to species into boxes and to stow catches < MCRS separately from catches intended for human consumption. The challenge for these vessels is therefore twofold, i.e. to ensure proper onboard handling of all catches, including sorting by species and intended utilisation (< MCRS or human consumption), and to appropriately stow all species. Due to the limited space onboard vessels of this size, both on the processing deck and in the hold, this can present major challenges. It is therefore likely that in some cases, the Landing Obligation will result in the need for investment in new equipment on the processing deck, e.g. storage boxes for separating between species and sizes, increased throughput capabilities of bleeding and cleaning tanks and increased numbers of stowage boxes, which should preferably be of different colours depending on intended usage (< MCRS or human consumption). Separation panels in the hold so that storage of < MCRS catches are clearly separated from other catches are also advised. Such separation panels could be adjustable so that the space required for each type of catches would not have to be fixed. Finally, it is likely that the Landing Obligation will require increased numbers of crew or longer working time because of the additional handling requirements and that the fishing trips will be shortened due to the lack of stowage space.

There are limited alternatives for small vessels to handle unwanted catches beyond what has been described above (Viðarsson et al. 2017). There are, however, options available which may need special permission from authorities to implement, or even changes in regulations. One such option is bulk storage of < MCRS catches, i.e. to store all catches below MCRS mixed in large boxes or compartments. The sorting would then have to be done after landing. These options are already being explored, for example, AZTI Tecnalia in Spain has been working on the development of an automatic system for the quantification and classification of catches landed in bulk (Melado et al. 2018), and the life iSEAS project has been looking into similar solutions (iSEAS 2018). Such systems, if approved by the authorities, would allow for bulk landing of < MCRS catches, or even entire catches. This solution could be a major contributor to solving the main challenges associated with a lack of space and human capital onboard this sector of the fleet. It may also reduce the cost that the fishers have to pay for renting boxes. It is however not permitted at the moment according to current EU regulations (EC 1224/2009).

Another option is to produce silage from < MCRS catches onboard the vessels (Viðarsson et al. 2017). Simple and relatively compact equipment can be fitted onboard vessels of this size that produces basic silage. What is needed is a powerful mincer, acid dispenser and a tank for storage. The fish are minced and mixed with organic acid in a storage tank. Around 2–3% of 85% formic acid is most commonly used, i.e. 20–30 kg of acid per ton of raw material. The acid lowers the pH of the silage, which gives it an extremely long shelf-life. Silage of this type is, however, not very valuable. But in any case, this option currently contradicts EU legislation that requires catches to be placed in boxes, compartments or containers separately for each stock (EC 1224/2009). It may also prove difficult to validate what is actually in the silage, as fishermen may claim that catches not subjected to the Landing Obligation have been used as raw material for the silage. For similar reasons, it may also contradict the EU regulation that requires < MCRS catches to be stowed separately from other catches (EU 2015/812).

There are, however, examples where onboard silage production has been permitted within CFP fisheries. For example, some Danish fishing vessels have been fitted with silage equipment, and the Danish authorities have given them an exemption from the regulations, with the condition that what goes into the silage is recorded via camera (FiskerForum 2008; Fiskeritidende 2016; FiskerForum 2017).

In 2016, the Danish fishing trawler Juli-Ane RI-568, from the fishing port of Hvide Sande, was renovated and extended to 23.95 metres overall length (Fiskeritidende 2016; FiskerForum 2017). In connection with the renovation, it was decided to install a silage system with grinder, automatic dosing of formic acid and storage tanks with the capacity of 16 tons – all done in acid proof steel. CCTV was installed to monitor and document the catch, according to specifications from the authorities. The system has been tested but has never reached the level of continuous day-to-day use, mainly because of management problems, and the hardware has been exposed to more strain than expected (Larsen 2018).

Previous to the trials onboard Juli-Ane RI-568, the 40 metre Danish fishing trawler Tobis HG-306, from the harbour of Hanstholm, ran similar experiments in 2008. The vessel was equipped with a silage system and 20 ton storage tanks, which was supposed to be a practical full load for a lorry (FiskerForum 2008). The system was tested in the Baltic and North Sea, but the results were not as positive as hoped for, especially because the quality of the silage was poorer than expected and the transportation cost was higher than anticipated. As a result, the system was uneconomic and was therefore taken out of use.

The figure below shows upper and lower deck of a Danish fishing boat that is around 25 metres in length and has been fitted with a basic silage system. The handling on the upper deck ensures proper bleeding and cleaning, as well as sorting what goes in to silage preservation. On the lower deck is the target catch sorted and iced into boxes. There is also an option to stow unwanted catches in bulk storage in differently coloured tubs.

The steel tank on the lower deck is an ice slurry machine that produces slurry to use during cleaning on the upper deck and can also be used in the boxes on the lower deck. The machine next to it produces flake ice that is used on the target catches stowed in boxes. The different coloured tubs are intended for bulk storage of unwanted catches, and the intermediate bulk container (IBC) stores the silage. It is then simple to replace tubs with IBC, or vice versa, if necessary.

The silage tanks used in the experiments onboard Juli-Ane and Tobis were able to carry 16 and 20 tons of silage and only had to be emptied or replaced when they had been filled, which could take several fishing trips. The tanks were fitted on the upper deck of the vessels, and the weight therefore had an effect on the stability of the vessels, in addition to taking up considerable space. Silage tanks of that size can be fitted below deck where they have less impact on stability, e.g. instead of oil or water tanks, but they must then be made of stainless steel and be easily emptied and cleaned. In the figure above (Fig. 16.1), the silage is stored in 1000 litre IBC in the hold of the vessel, which can be easily replaced after each fishing trip. The official discard rates of the Danish bottom trawl fleet operating in the North Sea prior to the implementation of the Landing Obligation was 0.9% (STECF 2015) which indicates that one IBC tank should easily be enough to stow the silage produced in a single fishing trip. The average discard rates in Skagerrak and Kattegat are, however, much higher, which is primarily explained by high discard rates in the Nephrops fishery.

The Danish silage trials have shown that the quality of the silage is the dominant factor that determines if this solution is economically viable or not.

The experiences from these two trials have not been very promising. The solutions have met with opposition from crew members for taking up too much space, and the value of the silage has not been as expected. The conclusion of one of the skippers on these trial vessels was that modification of an older fishing vessel to accommodate silage production is a significant challenge and that a vessel that is purpose-built for silage production from the start would be more likely to be successful (FiskerForum 2017).

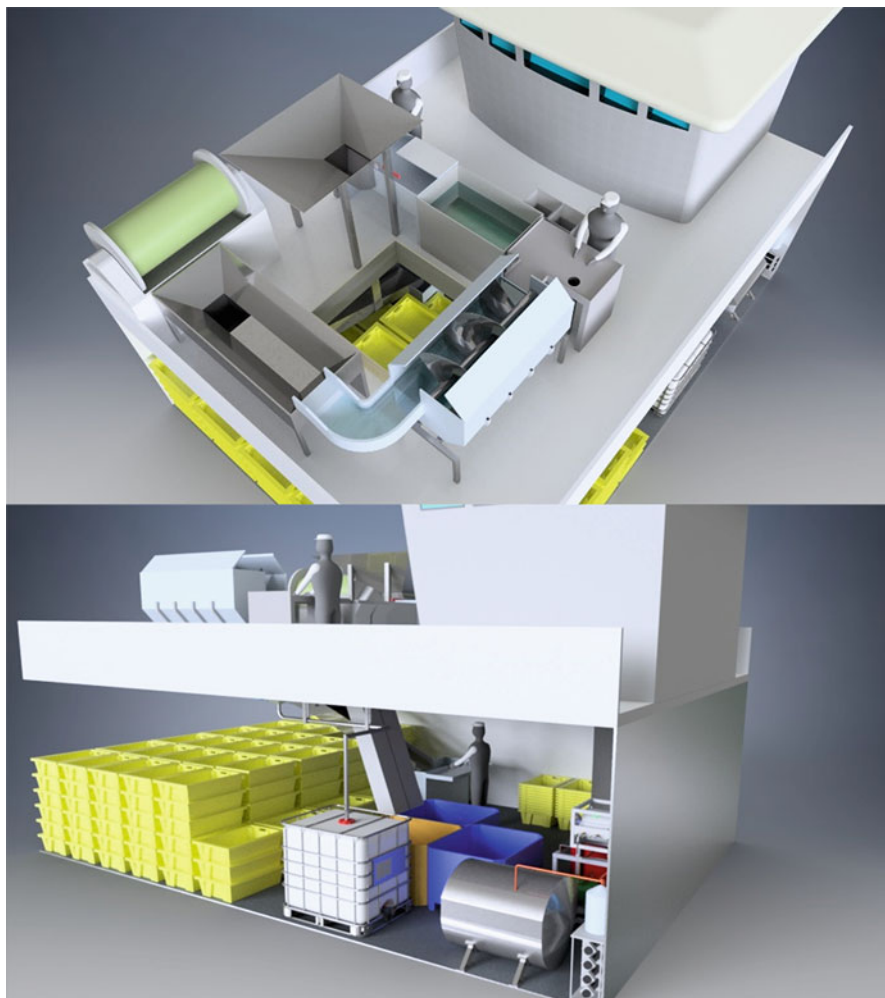


Fig. 16.1 Upper and lower deck of a medium-sized Danish seiner. The handling on the upper deck ensures proper bleeding and cleaning, as well as sorting what goes into silage preservation. On the lower deck is the target catch sorted and iced into boxes. There is also an option to stow unwanted catches in bulk storage in differently coloured tubs

The main potential buyers of fish silage are either the fishmeal and fish oil sector or feed producers, e.g. mink feed or pig feed (Iñarra et al., [this volume](#)). The fishmeal and fish oil producers do not have a positive view of silage because their equipment is, in most cases, not made from acid proof steel. They need to add a base to the silage to bring the pH to 7.0. This is an additional cost in the production both in manpower and chemicals. Feed producers for mink and pig farms prefer fresh or frozen fish over silage, especially when the silage is of the variable quality shown in the Danish trials.

16.2.3 *Larger Fresh Fish and Factory Vessels*

Options for onboard handling of unwanted catches increase with increasing size of the vessels (Viðarsson et al. 2016). The bleeding, gutting, cleaning, chilling, sorting and stowing of unwanted catches require significant space and labour effort if it is to be done properly; and the same applies if additional onboard handling is applied such as silage or fishmeal production. Investment in onboard solutions and the ability to add crewmembers also become more applicable as space and throughput increase. Solutions that increase automation also usually require significant throughput in order to be economically sensible. Larger vessels with high throughput can be equipped with automatic species and size grading equipment (Skaginn 3X 2018a). These solutions are already on the market and use computer vision for identifying species and sizes. Flowline graders are also used for size grading onboard some fishing vessels (Marel 2018). Using such equipment can obviously increase throughput, reduce labour costs and make grading more accurate. This is already being done on bottom trawlers in Iceland (Skaginn 3X 2018b).

One option for larger vessels is to equip them with silage production units (Viðarsson et al. 2017). These units in their simplest form consist of a mincer, acid dispenser, two primary silage tanks and secondary silage tanks. The mincer shreds the material apart, which is then pumped into the primary silage tanks. In these tanks, commonly referred to as day tanks, formic acid is mixed in proportions with the raw material and heated up to 25–30 °C to speed up the digestion and to create a more uniform product. Each tank has a pump for constant circulation of the material to prevent settling of bones and other particles. When the material has been kept under these conditions for approximately 24 hours, it is pumped into secondary storage tank (s), which can be located at any place where space can be found onboard the vessel, as long as they can be easily emptied and cleaned. This type of silage has a high water content, which requires considerable space, and the value per cubic metre is rather low. By modifying the equipment, it is possible to separate the oil from the rest of the silage and then remove some (and in some cases most) of the water by evaporation, reducing the need for storage space and increasing the value of the final product(s). An example of such a mechanism on a 40 m bottom trawler is shown in Fig. 16.2.

Silage tanks full of silage are heavy and will therefore have an effect on the stability of the vessel. Locating the storage tanks as far below deck as possible will help in reducing those effects, but it is very important that safety issues concerning stability are taken into consideration when developing silage units for fishing vessels.

Production of fish protein hydrolysis (FPH) is another option, where hydrolysis is used to separate the bones from the rest of the fish (Viðarsson et al. 2017). The bones are then filtered out and what's left is a "soup" to which enzymes are added. The addition of those enzymes allows oils, proteins and amino acids to be extracted, which can be of high value as ingredients to animal feed or human food supplements. However, this requires complicated and expensive machinery, and it is therefore unlikely it will be a suitable solution for many vessels. The Norwegian freezer trawler Molnes M-69-G was recently equipped with such FPH system. This was

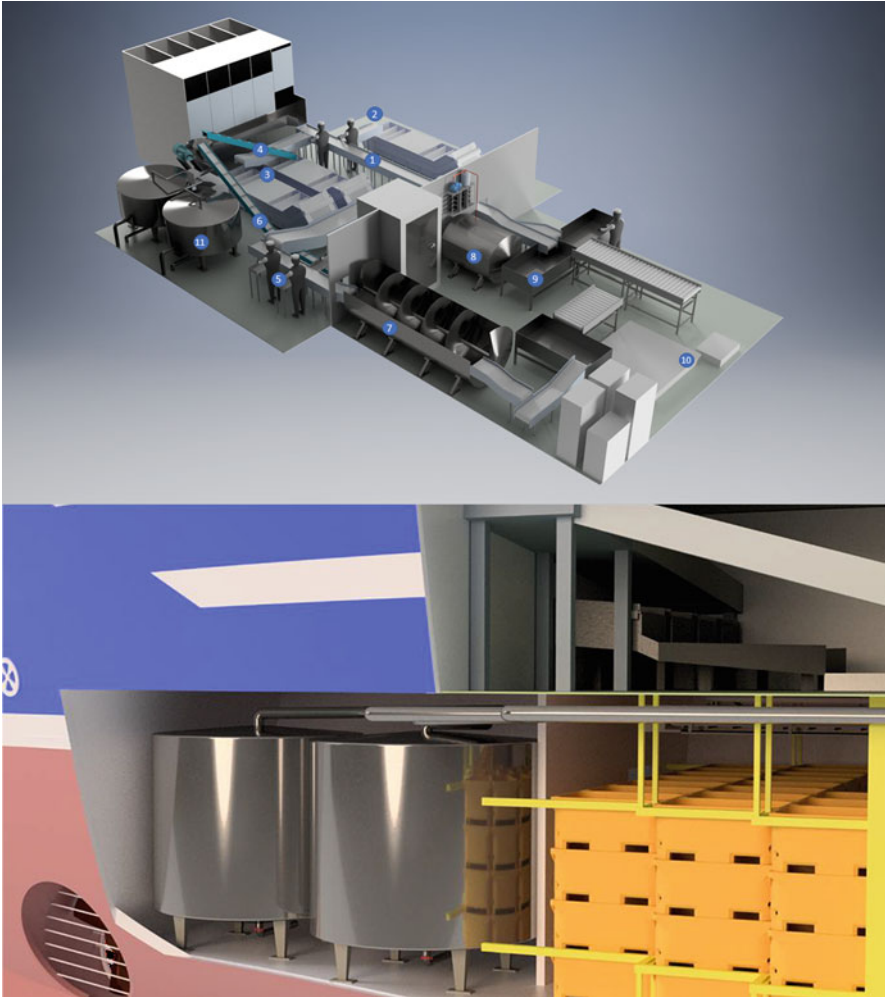


Fig. 16.2 Overview of a concept prospecting deck of a 40 metre bottom trawler with silage production. No.1 – Target catch (only bled) / not bled. No.2 – Target catch (bled in seawater / not to be gutted). No.3 – Target catch (bled in seawater / to be gutted). No.4 – Path for UWC/MCRS. No.5 – Gutting. No.6 – Path for viscera. No.7 – Rotary cooling / cleaning tank. No.8 – Slurry ice buffer tank. No.9 – Fish buffer tank with slurry ice. No.10 – Elevator down to hold. No.11 – Silage unit. The primary (day tanks) are located on the processing deck, but the evaporators and the storage tanks can be located elsewhere

part of a major renovation that was done on this 66-metre-long and 14-metre-wide bottom trawler. The results on the long-term economic viability of the investment for Molnes are still unknown.

The largest fishing vessels, particularly factory vessels, can be equipped with compact onboard fishmeal or fish protein plants (Amof-fjell 2018; Haarslev 2018; Héðinn 2018; Viðarsson et al. 2017). This is a solution that has been used onboard factory vessels for decades and has been proven to be a practical and cost-efficient alternative. The plants that are available today are relatively compact and require little manpower. The products do, however, require significant storage space, and the investment cost can be substantial. With regard to the Landing Obligation, the issue of documenting what is in the fishmeal might also be an issue, as with silage production.

16.3 Discussion

Very little progress has been achieved with regard to vessel modifications to meet the requirements of the Landing Obligation. The available solutions are generally not applicable for the EU fleet, the potential products are low value and require significant manpower, and the space onboard vessels to accommodate these low-value catches is scarce or not available. Vessel owners are reluctant to invest in technology that is unlikely to be economically viable, and enforcement by authorities has been undertaken in such a manner that places little pressure on the vessel owners to react.

At the moment, it seems that the most applicable short-term solution for most vessels is to either get permission to land unwanted catches in bulk, where the classification will then take place at official weighing stations on land; for larger vessels, and where there is an economic benefit, silage systems or fishmeal plants may be appropriate. More complicated solutions need to be investigated in the long term, including FPH systems (Iñarra et al., [this volume](#)).

Many consider the production of pet food, cosmetics, food supplements and even pharmaceuticals, when discussing potential products derived from unwanted catches. And there are, in fact, opportunities in such products, but they depend on the landed catch being of the highest quality and with the fish being processed onshore. The raw materials used for such products are generally specific parts of the fish, and not the whole fish. For such products, the only onboard modifications necessary are therefore to make sure that all catches are properly handled, i.e. bled, cleaned, chilled, sorted and stored. This has been the process in other countries with long experiences of discard bans, such as Iceland, Norway and the Faroe Islands, where the emphasis has been on landing all catches at sufficient quality so that the land-based processing can make as much value from them as possible (Karp et al., [this volume](#)). To begin with, the economic returns for the fishermen were insignificant, but as the volume increased, processes improved and markets established, the returns to the fishermen have grown.

By the end of 2017, around EUR 30 million of the European Maritime and Fisheries Fund (EMFF) had been committed to projects related to the Landing Obligation across ten member states (EC 2018). Most of the funding had been

allocated to projects focusing on gear selectivity and MCS, as well as investment in ports and processing. Very little had been allocated to fleet investment, but countries such as Denmark, Spain, the Netherlands and Italy have allocated some funds to such projects for 2018 and onwards. In the coming years, it is therefore likely that more focus will be on onboard handling and vessel modifications to meet the requirements of the Landing Obligation.

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