This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633680

Deliverable No. 2.2

DiscardLess

Strategies for the gradual elimination of discards in European fisheries

Grant agreement No: **633680**
Project co-funded by the European Commission within the
Horizon 2020 Programme

Start date of project: **1st March 2015**
Duration: **48 months**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633680

Deliverable No. 2.2

Appropriate economic and social criteria to evaluate the Discard Mitigation Strategies and the defined management scenarios

(Month 6)

Due date of deliverable:	1st September 2015
Actual submission date:	17th September 2015

Dissemination Level: PU[1]

Main Authors: Katia Frangoudes and Jordi Guillen

Université de Bretagne Occidentale (UBO, Beneficiary 7)

WP Leader: Peder Andersen

IFRO-University of Copenhagen (IFRO, Beneficiary 6)

[1] PU: Public, PP: Restricted to other programme participants (including the Commission Services), RE: Restricted to a group specified by the consortium (including the Commission Services), CO: Confidential, only for members of the consortium (including the Commission Services)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633680

Revision Control

Role	Name	Organisation	Date
Main Authors	Katia Frangoudes & Jordi Guillen	UBO	01/09/2015, 09/09/2015, 16/09/2015
Task Leader	Katia Frangoudes	UBO	09/09/2015
WP leader	Peder Andersen	IFRO	09/09/2015
Coordinator	Clara Ulrich	DTU Aqua	02/09/2015, 10/09/2015, 16/09/2015
Advisory Board	Dan Holland	NOAA	12/09/2015
Administrative Coordinator	Ole Henrik Haslund	DTU Aqua	17/09/2015

With report contributions from 13 co-authors from DiscardLess Project Participants

Name	Contribution to section(s)	Institution	DiscardLess beneficiary nr
Katia Frangoudes, Jordi Guillen	all	UBO	7
Ayoe Hoff	all	IFRO	6
Mike Fitzpatrick	all	MNRG	27
George Triantaphyllidis, Ionna Argyrou	all	NAYS	15
Javier Gonzàles, Antoni Quetglas	all	IEO	3
Telmo Fernandez Morato Gomes	all	IMAR-UAz	17
Lewis Cowie	all	SEAFISH	8
Raúl Prellezo	all	AZTI	23
Géraldine Brazier	all	AQUIMER	16
Norman Graham	all	MI	14

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633680

Executive Summary

In biological terms, a discard ban will be beneficial if total removals are reduced. From an economic perspective it is important that this reduction in total removals is done in a cost-effective way.

For a landing obligation to help to reduce or avoid discards, either a high level of surveillance or proper economic incentives to land the catch are needed. If a landing obligation is established but there are no incentives to avoid undersized fish, the exploitation pattern would remain unchanged and landings would include undersized individuals that would be otherwise discarded. In this case, the effort (or fishing mortality) that maximizes landings in weight (including undersized fish) will be higher than the effort (fishing mortality) that maximizes landings without the landing obligation (that did not include undersized fish). This happens because in the long-term higher fishing effort and fishing mortality level lead to lower average size of the individuals. If quotas are set accordingly to landing maximisation, this could lead to a lower biomass at sea and larger landings but a reduction of their average size.

For some fisheries a landing obligation could provide by itself (i.e., with no need of more measures) an incentive to improve selectivity, either because the storage capacity on board is constrained or because sorting time is too large. If fish that was previously discarded could be avoided, then compared to the current situation (with the same effort or quota level), landings above Minimum Landing Size (MLS) would increase together with the average weight of landings and the biomass at sea.

Hence, we identify the economic and social criteria to evaluate discard mitigation strategies. These criteria can be divided in three groups: changes in the economic performance, changes in employment, and changes in production. A series of parameters are provided, that need to be taken into account in order to measure the economic and social impacts of each Discard Mitigation Strategies (DMS) or of any other defined management scenario.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633680

Contents

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633680

1 Introduction

The establishment of landings obligation (discard ban) is one of the main aspects in the new EU Common Fisheries Policy (CFP), which aims for a gradual elimination of discards of commercially exploited stocks on a case-by-case basis (EU, 2013).

In fact, the extended practice of discarding has been identified as one of the reasons for the failure of the past CFP. Discarding has prevented several fish stock from recovering, despite of the low quotas (EC, 2009). Moreover, the obligation to land all catches and a better use of marine resources are in line with the EU's Europe 2020 Strategy objective of a more resource efficient economy (EC, 2010).

Discards, or discarded catch, is that portion of the total organic material of animal origin in the catch, which is thrown away, or dumped at sea for whatever reason (FAO, 1996). Discarding has indeed been identified as a major issue even if discard rates' estimations suffer from data availability and data quality. Alverson et al. (1994) give a first estimation of world-wide discards ranging from 17.9 million to 39.5 million tonnes. Alverson (1998) and FAO (1999) estimated more precisely total discards at about 20 million tonnes, which was about a quarter of the total catches. The update of the FAO study on discards in the world's marine fisheries pointed out some differences with the previous estimations (Kelleher, 2005). Kelleher (2005), based on a more exhaustive set of records in the discard database, revised global discards estimations to be 7.3 million tonnes for a total recorded landings of 78.4 million tonnes, an is 9 percent discard rate. In a different study, Nellemann *et al.* (2009) reported worldwide discards to be about 30 million tonnes, accounting for 23% of the world-wide catches.

Discards are highly variable depending on fisheries and fishing gears (Rochet and Trenkel, 2005). Indeed, discards can reach 80% in some fisheries.

Discards occur because of legal and economic reasons. Regulations often define the catch that can be legally targeted or landed. Fishes that exceed the quota, are below the minimum landing size (MLS) or do not meet catch composition regulations cannot be retained on board and must be discarded (i.e., European Commission, 2002). For economic reasons, catch of target species could also be discarded if it is of small size or poor quality (e.g., damaged or not so fresh) because of highgrading (especially when quota or storage room is limited) or low market value that do not compensate sorting costs; or catch of non-commercial species because of low demand resulting in low market value (Pascoe, 1997; Catchpole, Frid and Gray 2005; See also DiscardLess Deliverables D1.1 and D2.1 for reviews on discarding processes).

Discards are often not documented, which leads to undocumented catch and so mortality (Davis, 2002). This leads to further uncertainty in stock assessments and subsequently in determining the optimal fishing mortality (Davis, 2002; MRAG, 2007). The impact of discards in a fishery depends however on the survival rate that is linked to the species and the fishing gear (Davis, 2002). The survival rate of discards is generally low for fishes and can reach 0% of the discards for some of them (Hill and Wassenberg, 1990; Davis, 2002; STECF, 2013). The expected survival

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633680

rate is potentially higher for crustacean and skates/rays (STECF 2013; ICES, 2015; see also DiscardLess Deliverable D1.1), and for example, a survival value of 25% (from Wileman et al., 1999) is currently used by ICES in the stock assessment of *Nephrops* stocks.

Improving selectivity, in particular reducing discards of the smallest individuals, results in medium to long term higher yields per unit of fishing effort and in greater catch values (Broadhurst *et al.*, 1996; Fonseca *et al.*, 2005a; Fonseca *et al.*, 2005b; Raveau *et al.*, 2012). The implications of selectivity on MSY estimations have been explored in several papers. MSY indeed depends mainly on the exploitation pattern, thus on gear selectivity, but also on the fishing effort distribution by fleet and on the spatial distribution of the resource and the fishing mortality (i.e., Beverton and Holt, 1957; Goodyear, 1996; Macher *et al.*, 2010; ICES, 2010; Scott and Sampson, 2011; Cardinale and Hjelm, 2012; Guillen *et al.*, 2013). Guillen *et al.* (2014) show that in a fishery where discards take place, MSY considered as maximum landings may be different with the presence of a discard ban (which may be equal to maximize catches). Therefore, success and outcomes of a landing obligation will largely depend on the extent fishers will avoid undersized fish that otherwise would be discarded.

Discards take place because fishermen expect to obtain more profits with this practise or are obliged due to legal issues. If a discard ban removes the legal obstacles, discards may still occur because of economic reasons (see also DiscardLess deliverables D1.1 and D2.1). In fact, a discard ban to result in a real reduction of discards needs a high level of surveillance or economic incentives to land more of the catch (Condie, Grant, & Catchpole, 2014). Typically fisheries control and enforcement is quite costly (Arnason *et al.*, 2008); consequently a high level of surveillance to ensure the full implementation of a EU discard ban could be very costly considering the size of the EU fleet (Condie, Grant, & Catchpole, 2014). Therefore, incentives to land the catch need to be higher than the incentives to discard it. Even if legal obstacles are removed, incentives to discard even target species may remain. These incentives to discard part of the catch are mainly related to the limited physical storage on board and high sorting costs compared to expected revenues. Moreover, the extent of the discards will also depend on the selectivity of the gear and the fishing strategy (e.g., the ability and willingness of the skipper to avoid nursery areas), which will depend on the expected revenues and costs.

A discard ban will be beneficial (at least from a biological perspective) if total removals are reduced (Condie, Grant, & Catchpole, 2014) or if at the same amount of removals, these are obtained from a fishing pattern closer to the optimal exploitation pattern. Such a reduction of removals can take place without reducing landings, by avoiding undersized fish, non-commercial or overquota catch. Experience shows that discard bans in order to have a positive effect require additional management measures to improve selectivity and consequently to reduce fishing mortality (Bellido *et al.*, 2011; Condie, Grant, & Catchpole, 2014).

2 Economic impacts of discard bans

DiscardLess will place a strong emphasis on associating economic impacts with each Discard Mitigation Strategies (DMS). The analysis will be done through simplified scenario modelling, modifying between three types of parameters: changes in catch profiles, changes in fish price profiles and/or changes in operational cost profiles.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633680

Though business economic data have historically been lacking or imprecise in many cases, the quality of economic data routinely collected is continuously improving in Europe thanks to the Data Collection Framework. However, current data collected seems to be insufficient to analyse all economic impacts (cf. Deliverable 2.1)

The following effects can create negative economic impacts if discarding is banned:

2.1 Changes in catch profiles

(1) Ending fishing when quotas for the most restrictive choke species are exhausted: potential decrease in total landings, and consequently revenues. But this will depend on the fishermen's capacity to avoid catching the most restrictive species, and of quota-swap mechanisms.

(2) Quicker filling of storage rooms implying shorter and more numerous trips: may lead to lower landings.

(3) Changes in selectivity and the fishing strategy/behaviour (e.g., the ability and willingness of the skipper to avoid nursery areas): missing catches, even if would have not been previously discarded.

(4) Decrease of scavenger species (e.g., shrimps, *Nephrops*, octopuses). Due to the decrease in food availability for meso-pelagic scavengers or benthic fish and invertebrates (e.g., Catchpole *et al.*, 2006), although these processes are less well understood (ICES, 2014). A direct consequence of banning discards is the creation of a food shortage for scavenging species, but the effect of this shortage will depend on their ability to switch to other preys, potentially causing cascading effects on other species through increased predation or competition. Bioenergetic and ecosystem models have shown that discards may have strong direct and indirect impacts across the whole food-web, which may have positive or negative impacts on populations, or even alteration or simplification of trophic webs (Fulton *et al.*, 2005, Catchpole *et al.*, 2006; Kaiser and Hiddink, 2007, Heath *et al.*, 2014).

(5) Potential increase in the abundance of small sized fish through changes in fishing strategies, with potential effects on the whole food-web and so on species biomass.

(6) Potential changes in the quota estimations/calculations. MSY considered as maximum landings might be different with the presence of a landing obligation (which may be equal to maximize catches, including undersized fish), and consequently "optimal" effort and quotas may be higher (Guillen *et al.*, 2014). Thus, there is the need to know what criteria are going to be followed when estimating quotas.

(7) Future recovery of stocks: it is expected that in the future fish stocks will recover, and consequently catches will increase, in part thanks to the landing obligation regulation.

2.2 Changes in fish price profiles

(8) Quicker filling of storage rooms implying shorter and more numerous trips: Prices may increase as products are fresher.

(9) There might be changes in product forms and new products

(10) No highgrading may lead to a price decrease because of smaller size/quality of individuals, which could be compensated by a price increase due to a reduction in the quotas (as previously discarded fish would now be counted in the quotas).

(11) Average size of landings may increase in the long term, leading to higher prices. Guillen *et al.*, (2014) show that if discards could be reduced or avoided (i.e., with selectivity

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633680

improvements), then landings above MLS would increase together with the average weight of landings and the biomass at sea.

2.3 Changes in operational cost profiles

(12) Quicker filling of storage rooms implying shorter and more numerous trips may lead to fuel cost increases. Moreover, some fishers may invest in newer vessels with larger storage room or even some processing onboard.

(13) Changes in selectivity and the fishing strategy/behaviour (e.g., the ability and willingness of the skipper to avoid nursery areas): This can lead to changes in the gears used (increasing costs) and potential fuel costs changes.

(14) Future recovery of stocks: higher biomass at sea should lead to a higher Catch per Unit of Effort (CPUE), and consequently fishing costs may partly decrease.

(15) More handling/sorting on-board: This could lead to labour cost increases. The need of more work to be done on-board, and even the potential need to hire more crew, may lead to labour cost increases (or not) depending on the (shared) remuneration system and the fixity of the share rate (Guillen *et al.*, 2015).

2.4 Changes in fisheries control and monitoring

(16) Need to increase fisheries control and enforcement to guarantee compliance may easily lead to higher control and enforcement costs.

2.5 Other impacts

(17) A great portion of discards are consumed by seabirds, potentially leading to either positive or negative effects on seabirds' populations (e.g., Bicknell *et al.*, 2013; Votier *et al.*, 2013).

3 Methodology: Economic and social criteria to evaluate discard mitigation strategies

Discard mitigation strategies can be evaluated following different economic and social criteria. The main economic and social criteria to evaluate DMS are:

- Changes in the economic performance of the fleets/vessels involved. These changes can come mainly due to a reduction in the landings value and/or an increase in the costs. In addition, it could also be considered changes in the economic performance of fish processing plants, other activities in land (e.g., fishing guilds, marketing), and of the public administrations (especially if further control and enforcement needs to be put in place).
- Changes in employment: number of fishers, average wage, average working hours. In addition, it should also be considered employment in land (e.g., fish processing plants).
- Changes in production: quantity (and value) of landings by species, available fish for the processing industry (human and non-human production).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633680

4 Methodology: Economic and social variables to be collected in order to evaluate discard mitigation strategies

There are different variables that need to be collected in order to estimate the economic and social impacts for each Discard Mitigation Strategy. The parameters that need to be collected are classified in three groups: fleet economic quantitative data, fleet social qualitative data, and processing industry economic quantitative data. The fleet economic quantitative data will be used in the bio-economic models to directly evaluate the different discard mitigation strategies (cf also D2.1). Fleet social qualitative data will inform about the fishers' views towards the landings obligation regulation and its implementation, providing insights of the regulation impacts and the fishers' adaptation strategies. While processing industry economic quantitative data, even if cannot be used in bio-economic models, provide information of the inland impact of the landings obligation. The parameters required to estimate these economic impacts have to be collected before, during and after the landings obligation is implemented.

4.1 Quantitative data: Fleet variables guidelines

The fleet economic quantitative data will provide the main input to evaluate discard mitigation strategies. Specifically, with the help of bio-economic models, the changes in the fleets' economic performance, employment and production will be investigated. The required variables in each case study will largely depend on the bio-economic models used. However, there are some common parameters to be collected in most bio-economic models in order to evaluate discard mitigation strategies. These common parameters to be collected are also in line with the parameters collected under the EU's Data Collection Framework. Common parameters to be collected:

1. Quantity and value of fish by species (if possible by age, weight or length) landed and caught. This will provide information on the fleet's revenues and importance of each species caught. Before the landings obligation takes place, quantities caught and landed may be different to the existence of discards. Information on discards it is of great importance as it will provide insights of the fishers' capacity to avoid undesired fish. Other sources of income (e.g., subsidies, selling fishing rights) should be also collected if they represent a significant share in the totals income.
2. The number of vessels, average (or total) Kw, and average (or total) GT will provide information of the evolution of the fishing fleet overtime, and if the landings obligation has impacted it.
3. Days at sea and/or fishing days show the effort devoted in a fishery, and consequently will show how the landings obligation has impacted effort. Together with the quantities caught may provide an estimate of the evolution of the catch per unit of effort (CPUE). Similarly, information on the number of fishing trips and average time per fishing trip will reflect changes in the fishing patterns.
4. Number of fishers and working hours, which allows estimating the full time equivalent - FTE, will show the evolution of employment (and employment per vessel) due to the landing obligation. Information of unpaid labour should be provided if it exists.
5. Average wage and how are fishers remunerated (e.g., fixed or shared remuneration systems) will help to estimate labour costs, and how they change over time.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633680

6. Fuel costs and fuel consumption (e.g., in litres), repair and maintenance costs, other variable costs (e.g., oil, ice, bait, commercialization costs), other non variable costs (e.g., mooring costs, insurance, permits).
7. Value of assets (includes vessel, gears, and quotas attached to the vessel) to estimate capital and depreciation costs. Also value of investments done, which should especially include changes/adaptations of new gears, and storage rooms.

In addition to these economic parameters, bio-economic models will also require some biological parameters in order to evaluate discard mitigation strategies. Required biological parameters to model the fishery will depend on the bio-economic model used. Most commonly required biological parameters are: biomass at sea (by age-class), fishing mortality, selectivity, etc.

4.2 Qualitative data: Social Indicators guidelines

Qualitative data is mainly related to social and governance issues. Such qualitative data should be collected through the annual meetings organized at Case Studies (CS) level and at European level during the annual meeting of the project. In a case that is possible and human capacity is available, within local teams, short surveys or interviews to collect fishers' opinion as complementary sources of information can be realized.

The objective is to gather fishers' opinions towards the landings obligation regulation and its implementation, impacts and strategies of adaptation, relations between fishers and sciences, etc.

The following qualitative indicators should be checked annually because they will allow identifying the evolutions of fishers' visions/opinions. The results and the analysis of these indicators will contribute to achieve the others WP (e.g., WP3, 4, 7, 8). During the annual meetings at CS level (focus groups or larger, based on questions and answers, potentially supplemented with individual interviews), the discussion needs to be structured in a way to provide the necessary information to fill the required variables. In all cases it needs to take notes or register and then type and send gather material to the partner in charge of this is task for analysis.

Stakeholders participating to the annual meetings should be boat owners and when possible also crew members because the implementation of the landings obligation regulation will impact considerably this group of actors as it will modify their work and working conditions (e.g., handling and sorting, but also the experimentation and introduction of new selective gears).

In cases studies, where environmental NGO's or others civil society organizations are present it is possible to held some complementary meetings with them and at the end of the project bring all actors together for a wider discussion. In case of meetings with civil society (not fisheries industries) only some of the variables need to be filled. The European meeting will regroup civil society's organizations, representatives of fisheries administrations and fisheries managers working for fishers' organizations and others actors such processing industry, etc.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633680

Qualitative data to be collected:

1. Fishers' opinions towards the regulation. Obtain the opinion of fisher's about the regulation is important at the first period of the project. Gather these data will help to understand how the regulation is perceived by the major actors of the system (fishers) and how it is accepted by them. This kind of information is necessary to be gathered during the first year of the project. Another variable will be added aiming to understand fishers' opinions toward the landings obligation implementation process (see the following variable).
2. Fishers' opinions related to the implementation process. The aim here is to understand if fisher thinks that national administration collect and bring their ideas and position at the transnational negotiation process. In some countries national authorities or regional created working groups bringing together fisheries industry and administration to discuss the landings obligation regulation and its impact on the fleet and fisheries enterprises. In this case do fishers believe that their voice reached the negotiation process or not.
3. Fishers' opinions related to the observations on board related to discards. This variable will provide information not only about the relations between science and fishers but also how fishers perceive the observation and the results. The different arguments given by fishers can contribute to understand if they consider the sampling programs appropriate and the results representative (acceptation and legitimization of the observations).
4. Fishers' opinions related to the causes of discards. This variable will provide qualitative data explaining from their point of view the reasons to discards. Gathering these data can contribute to the formulation of the scenarios to be tested by the model and also complement the quantitative data provided by observations on board programs.
5. Fishers' opinions related to the strategies of adaptation. This variable should be gathered every year because it will contribute to understand the evolution of their opinion towards the landings obligation regulation. More particularly after the realization of the different selective gears trials. Gathering these data can also contribute to the formulation of scenarios for the models.
6. Fishers' opinions related to the use of discards. This variable will help first understand whether fishers accept the use of fish for other purposes than human consumption and second it will give elements responding to the point 1 above related to their opinion of whose needs is the landings obligation regulation responding to. For example, fishers may believe that the implementation of the landings obligation is satisfying the needs of the aquaculture sector, and for that reason it may not be socially acceptable.
7. Fisher's needs to get support from scientists to adapt to the landings obligation regulation. Variable helping to evaluate fishers' needs in matters of scientific support and financial one. It helps first to understand if *DiscardLess* or other research projects can respond to fishers' needs and second if is possible to satisfy fishers' needs. This variable is useful for WP3, WP4, etc.
8. Fisher's opinion towards enforcement and compliance related to landings obligation especially in countries where this rule is already implemented. In countries where the regulation is underway the number of exemptions formulated by Member States can be significant at this stage.
9. Fishers' opinions related to the impacts of the implementation. Variable gathered every year which also contributes to observe if fishers' opinion evolves with time. During the life of the project, the opinion of fishers' about this impact will be modified and evolve. The main issue

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633680

here is the modification of working conditions on board and safety of the boat (mainly for the small boats). The different trials realized on board of the boats will probably bring more detailed information:

- Working conditions of the crew (which tasks will increase in terms of work);
- Health impact: more accident at sea could take place due to the working conditions;
- Economic impact: economic quantitative data will show this impact but in some cases ideas of fishers can help to take in account others variables that these data don't provide. For example, increase of fuel, ice, boxes, auctions taxes, etc., but also new investments (e.g., new selective gears, or new storage room);
- Legal impact: modification of current laws or regulations linked to discards including quotas system;
- Impact on the ecosystem: the aim is to understand which changes on the ecosystem will be produced, including birds following fisher's opinion. This variable will point out the question of survival rate of some species as sole, plaice, langoustine or shellfish.

4.3 Quantitative data: Processing Industry and processing of unwanted fishes guidelines

Variables related to the processing industry cannot be used by the models, but they are important for the implementation of the landings obligation, and consequently for our project. Landing unwanted fishes means that they should be used for others purposes, either for eco-products (for human consumption or for biotech) or for animals or fish consumption. For this to happen, some prerequisites are necessary, such as the presence of processing industry near to the landing points and a regular quantity of unwanted catches to be processed. At a case study level, the following variables are necessary to be collected:

1. Number of businesses (companies and processing plants if possible) and employment;
2. Is it possible to use all fish and discards by the processing industry local or not)?;
3. Number of biotech business having capacity to innovate and fish uses;
4. Or presence of a public body or research laboratories ready to participate in this type of innovation;
5. Weight and value of fish used by the fish processing industry, part of local fish and not local, divided by used for human consumption and non human (e.g., fishmeal and fish oil) if is possible;
6. Value of the final production by use;
7. Added value of the different processing sectors;
8. Turnover and volume from other segments (e.g., marketing and aquaculture).

4.4 Control and enforcement costs for the administration

Higher levels of control and enforcement in order to ensure compliance with the landing obligation regulation may be required so that the landing obligation works properly (i.e., helps to reduce or avoid discards). Thus, a discard ban may result in further control and enforcement costs for the administration.

So, to fully evaluate the desirability of different DMS (or of the landings obligation ban in general), there would be the need to consider if these different strategies have also different

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633680

control and enforcement costs for the administration (and the increase in control and enforcement costs for the administration) and may lead to different levels of compliance (e.g. percentage of undersized fish discarded or commercialised).

The following data (before and after the discard ban is in place) may be required to estimate control & enforcement costs and compliance of the establishment of the discard ban in a particular fishery:

- Good description of how control and enforcement work in a country and in the fishery in particular. What are the changes needed for the landing obligation regulation?,
- Fisheries control and enforcement costs (of the administration) per year,
- Some estimate of the control capacity (e.g. number of inspections, number of flying hours, observers on board, etc.) per year,
- Identify what resources (or their %) of the control administration go to the discard ban control per year,
- Some estimate of the compliance (number of detected infractions, percentage of undersized fish discarded or that goes to the market) per year,

However, data needs to estimate control and enforcement costs and compliance levels are too difficult and costly to obtain. In addition, most of the current bio-economic models do not model control and enforcement costs and compliance.

5 Conclusion

In biological terms, a discard ban will be beneficial if total removals are reduced (Condie, Grant, & Catchpole, 2014). From an economic perspective it is important that this reduction in total removals is done in a cost-effective way.

For a landing obligation to help to reduce or avoid discards a high level of surveillance or economic incentives to land the catch are needed (Condie, Grant, & Catchpole, 2014). If a landings obligation is established but there are no incentives to avoid undersized fish, the exploitation pattern would remain unchanged and landings would include undersized individuals that would be otherwise discarded. In this case, the effort (or fishing mortality) that maximizes landings in weight (including undersized fish) will be higher than the effort (fishing mortality) that maximizes landings without the landings obligation (that did not include undersized fish). If quotas are set accordingly, this could lead to a lower biomass at sea and larger landings but a reduction of their average size.

For some fisheries a landing obligation could provide by itself (i.e., with no need of more measures) an incentive to improve selectivity, either because the storage capacity on board is constrained or because sorting time is too large. If fish that was previously discarded could be avoided, then compared to the current situation (with the same effort or quota level), landings above MLS would increase together with the average weight of landings and the biomass at sea.

Hence, we have identified the economic and social criteria to evaluate DMS. Criteria to evaluate DMS have been divided in three big groups: changes in the economic performance, changes in

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633680

employment, and changes in production. A series of parameters have been provided, that need to be taken into account in order to measure the economic and social impacts of each DMS.

6 References

Alverson, D.L. 1998. Discarding practices and unobserved fishing mortalities in marine fisheries: an update. Washington Sea Grant Program, 98-06. Seattle, Washington.

Alverson, D.L., Freeberg, M.H., Murawski, S.A., and Pope, J.G. 1994. A global assessement of fisheries bycatch and dicards. FAO Fisheries Technical Paper, 339, FAO, Rome: 233 p.

Arnason R, Kelleher K, Willmann R. (2008). The Sunken Billions: The Economic Justification for Fisheries Reform. Joint publication of the World Bank and the FAO. ISBN 978-0-8213-7790-1.

Bellido J, Santos M, Pennino M, Valeiras X, Prierce G. 2011. Fishery 'discards and bycatch:solutions for an ecosystem approach to fisheries management? Hydrobiologia 670: 317–33.

Beverton, R.J.H., and Holt, S.J. 1957. On the dynamics of exploited fish populations. United Kingdom Ministry of Agriculture and Fisheries, Fishery Investigations, Series II, Volume XIX. London.

Broadhurst, M.K., Kennelly, S.J., and Isaksen, B. 1996. Assessments of modified codends that reduce the by-catch of fish in two estuarine prawn-trawl fisheries in New South Wales, Australia. Fisheries Research, 27(1–3): 89–111.

Cardinale, M., and Hjelm, J. 2012. Size matters: Short term loss and long term gain in a size-selective fishery. Marine Policy, 36: 903-906.

Catchpole TL, Frid CLJ, Gray TS. 2005. Discards in North Sea fisheries: causes, consequences and solutions. Marine Policy; 29: 421–30.

Catchpole, T.L., Frid, C.L.J., Gray, T.S. 2006. Importance of discards from the English Nephrops norvegicus fishery in the North Sea to marine scavengers. Mar Ecol Prog Ser 313: 215–226.

Commission of the European Communities (EC). 2009. Green Paper on the Reform of the Common Fisheries Policy. Brussels, 22.4.2009, COM(2009) 163 final.

Condie, H. M., Grant, A., & Catchpole, T. L. 2014. Incentivising selective fishing under a policy to ban discards; lessons from European and global fisheries. Marine Policy, 45, 287-292.

Davis M.W. 2002. Key principles for understanding fish bycatch discard mortality. Canadian Journal of Fisheries and Aquatic Sciences, 59(11): 1834-1843.

Delaney, A., 2009. Social Impact Assessment and Community Profile, Uncover Project, EC n° 022717, IFM-Aalborg University Research Center.

European Commission. 2002. Communication from the Commission to the Council and the European Parliament: on a Community Action Plan to Reduce Discards of Fish. COM (2002) 656 Final, Brussels; p. 22.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633680

European Commission. 2010. COM 2020/2010. COMMUNICATION FROM THE COMMISSION EUROPE 2020. A strategy for smart, sustainable and inclusive growth. Brussels, Belgium.

EU. 2013. Regulation (EU) No 1380/2013 of the European parliament and of the council of 11 December 2013 on the Common Fisheries Policy, amending Council Regulations (EC) No 1954/2003 and (EC) No 1224/2009 and repealing Council Regulations (EC) No 2371/2002, (EC) No 639/2004 and Council Decision (EC) No 2004/585/EC.

FAO. 1996. Report of the Technical Consultation on Reduction of Wastage in Fisheries. Tokyo, Japan, 28 October - 1 November 1996. FAO Fisheries Report. No.547. Rome, FAO. 27p.

FAO. 1999. The state of world fisheries and aquaculture. FAO Fisheries and Aquaculture Department, Rome, Italy.

Fonseca, P., Campos, A., Larsen, R.B., Borges, T.C., and Erzini, K. 2005a. Using a modified Nordmøre grid for by-catch reduction in the Portuguese crustacean-trawl fishery. Fisheries Research, 71(2): 223–39.

Fonseca, P., Campos, A., Mendes, B., and Larsen, R.B. 2005b. Potential use of a Nordmøre grid for by-catch reduction in a Portuguese bottom-trawl multispecies fishery. Fisheries Research, 73(1-2): 49–66.

Frangoudes, K., 2012, L'identification des indicateurs sociaux pour le secteur de la pêche dans l'Union Européenne, rapport réalisé pour la DG MARE, Commitment S12.615631.

Fulton, E. A., Smith, A. D. M., and Punt, A. E. 2005. Which ecological indicators can robustly detect effects of fishing? ICES Journal of Marine Science, 62: 540-551.

Goodyear, G.P. 1996. Variability of fishing mortality by age: consequences for maximum sustainable yield. North American Journal of Fisheries Management, 16, 8-13.

Guillen, J., Macher, C., Merzéréaud, M., Fifas, S., and Guyader, O. 2014. The effect of discards and survival rate when choosing between landings or catches as yield in the Maximum Sustainable Yield estimation: Application to the nephrops fishery in the Bay of Biscay. Marine Policy, 50: 207-214.

Guillen, J., Macher, C., Merzéréaud, M., Bertignac, M., Fifas, S., and Guyader, O. 2013. Estimating MSY and MEY in multi-species and multi-fleet fisheries: The Bay of Biscay mixed fishery. Marine Policy, 40: 64-74.

Guillen, J., Macher, C., Boncoeur, J., Merzéréaud, M., and Guyader, O. 2015. Effects of the share remuneration system on fisheries management targets and rent distribution. Marine Resource Economics, 30(2): 123-138.

Heath, M. R., Cook, R.M, Cameron, A.I., Morris, D.J., Speirs, D.C., 2014. Cascading ecological effects of eliminating fishery discards. Nat. Commun. 5:3893 doi: 10.1038/ncomms4893.

Hill, BJ. and Wassenberg, TJ. 1990. Fate of discards from prawn trawlers in Torres Strait. Marine and Freshwater Research, 41(1):53-64.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633680

ICES. 2010. Report of the Workshop on Implementing the ICES Fmsy framework, 22-26 March 2010, Copenhagen, Denmark. ICES CM 2010/ACOM:54. 83 pp.

ICES, 2014. Report of the Working Group on the Ecosystem Effects of Fishing Activities (WGECO), 8-15 April 2014, Copenhagen, Denmark.

ICES, 2015. Report of the Workshop on Methods for Estimating Discard Survival 3. (WKMEDS 3), 20-24 April 2015, London, UK. ICES CM 2015\ACOM:39. 47pp.

Kaiser, M.J., Hiddink, J.G., 2007. Food subsidies from fisheries to continental shelf benthic scavengers. Mar. Ecol. Prog. Ser. 350, 267-276.

Kelleher, K., 2005. Discards in the world's Marine Fisheries. An Update . FAO Fisheries Technical Paper. N° 470, Rome, FAO, 131p.

Macher C., Guyader O., Talidec C., and Bertignac, M. 2008. A cost-benefit analysis of improving trawl selectivity in the case of discards: The Nephrops norvegicus fishery in the Bay of Biscay. Fisheries Research, 92: 76-89.

Macher, C., and Boncoeur, J. 2010. Optimal Selectivity and Effort Cost A Simple Bioeconomic Model with an Application to the Bay of Biscay Nephrops Fishery. Marine Resource Economics, 25(2): 213-232.

MRAG. 2007. Impact assessment of discard policy for specific fisheries. European Commission Studies and Pilot Projects for Carrying out the Common Fisheries Policy. No. FISH/2006/17 – Lot 1, Brussels; p.289. Available at: http://ec.europa.eu/ fisheries/documentation/studies/impact_assessment_discard_policy_2007_en.pdf.

Nellemann, C., Mac Devette, M., Manders, T., Eickhout, B., Svihus, B., Prins, A.G., and Kaltenborn, B.P. (Editors). 2009. The environmental food crisis - the environment's role in averting future food crises. A UNEP rapid response assessment. United Nations Environment Programme; GRID-Arendal www.grida.no.

Pascoe, S. 1997. Bycatch management and the economics of discarding. FAO Fisheries Technical Paper. No 370. Rome, FAO. 137 pp.

Raveau, A., Macher, C., Méhault, S., Merzéréaud, M., Le Grand, C., Guyader, O., Bertignac, M., et al. 2012. A bio-economic analysis of experimental selective devices in the Norway lobster (Nephrops norvegicus) fishery in the Bay of Biscay. Aquatic Living Resources, 25: 215-229.

Rochet, M.-J. and Trenkel V.M. 2005. Factors for the variability of discards: assumptions and field evidence. Canadian Journal of Fisheries and Aquatic Sciences, 62(1): 224-235.

Scientific, Technical and Economic Committee for Fisheries (STECF) – Landing obligation in EU fisheries (STECF-13-23). 2013. Publications Office of the European Union, Luxembourg, EUR 26330 EN, JRC 86112, 115 pp.

Scott R., Sampson, D. 2011. The sensitivity of long-term yield targets to changes in fishery age-selectivity. Marine Policy, 35: 79-84.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633680

Wileman, D. A., Sangster, G. I., Breen, M., Ulmestrand, M., Soldal, A. V., & Harris, R. R. (1999). Roundfish and Nephrops survival after escape from commercial fishing gear. EC Contract No: FAIR-CT95-0753. Final Report.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633680

7 Appendixes: Brief overview of a subset of national or EU projects linked to Landings Obligation in some DiscardLess Case studies

A rapid survey to identify some ongoing studies or research on Landings Obligation in countries involved in DiscardLess project has been initiated by Beneficiary 7. The main goal of the survey is to identify the aspects studied by these studies and more particular the economics and social ones. The following appendixes show the first results of the survey in the following order: at first the projects and second the studies aspects. The survey will be expended over time, and the final results will be linked to the Atlas and DMS toolbox (WP8).

Case 1: AZTI

Ongoing study on Trawlers mixed demersal fishery in the Bay of Biscay.

Two approaches:

- Trip analysis (including choke problems, crew conditions, income and costs.
- Mid long term analysis using a BEM (FLBEIA) in where (still prototype) the exemptions to the LO established by the CFP are being assessed. It includes, de minimis, Quota Swaps,…

Case 2: NAYS (Mediterranean)

DCF and DCR data collections.

Case 3: IEO (Mediterranean)

Report: The Obligation to land all catches: consequences for the Mediterranean (http://www.europarl.europa.eu/RegData/etudes/note/join/2014/529055/IPOL-PECH_NT%282014%29529055_EN.pdf).

Case 4: IEO (Mediterranean)

Project: IBISES "Impacts of fisheries on Biodiversity and evidences for sustainable management in the Spanish Mediterranean" – Project funded by the Spanish National Program (http://imedea.uib-csic.es/proyecto.php?id=10202). Period: 2014-2014; Coordinator: Daniel Oró (CSIC-IMEDEA).

Case 5: IEO (Mediterranean)

Project: MINOUW "Science, Technology, and Society Initiative to minimize Unwanted Catches in European Fisheries"; (H2020, ref. 634495); Period: 2015-2019; Coordinator: Francesc Maynou (ICM-Barcelona).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633680

Case 6: IEO (Mediterranean)

Project: DISCATCH "Pilot Project on catch and discard composition including solutions for limitation and possible elimination of unwanted by-catches in trawl net fisheries in the Mediterranean (DISCATCH)"; DG MARE European Commission (Contract Nº MARE/2012/24 Lot 2); Period: 2014-2015; Coordinator: Antonello Sala (CNR)

Case 7: SEAFISH (North Sea/West of Scotland)

North Sea cod catch quota trials. August 2014 – Marine Management Organisation

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/342449/North_Sea_Cod_Catch_Quota_Trials_Final_Report_2013.pdf

Case 8: SEAFISH (North Sea/West of Scotland)

A case study review of the potential economic implications of the proposed CFP landing obligation. December 2013 – Poseidon/Seafish.

http://www.seafish.org/media/publications/Poseidon_Landings_Obligation_Economic_Impact_JAN_2014_FINAL.pdf

Case 9: SEAFISH (North Sea/West of Scotland)

Catch comparison trials of the flip flap netting grid trawl. August 2012 – Marine Scotland.

http://www.gov.scot/Resource/0039/00391333.pdf

Case 10: SEAFISH (South coast of England)

Use of discards in bait. August 2014 – Seafish.

http://www.seafish.org/media/Publications/SR668_use_of_discards_in_bait.pdf

Case 11: SEAFISH (North Sea/West of Scotland)

Landing obligation economic impact analysis final interim report one: choke analysis. March 2015 (work ongoing) – Seafish.

http://www.seafish.org/media/Publications/Seafish_LOEIA_Interim_Report_1_-_Final_260315.pdf

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633680

Case 12: SEAFISH (England)

The English Discard Ban Trial. October 2014 – Cefas/Defra https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/361564/Discard_Ban_Trial_Report_v11.pdf

Case 13: SEAFISH (SW England)

Catch quota trials for western haddock. September 2014 – Marine Management Organisation.

https://www.gov.uk/government/publications/catch-quota-trial-final-report-2013-western-haddock

Case 14: SEAFISH (SW England)

Self-sampling in the inshore sector. October 2014 – Defra.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/361558/SESAMI_final_report_Final.pdf

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633680

Case Study	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Aspects covered by existing reports or on-going studies	AZTI	NAYS	IEO Report	IEO Project IBISES	IEO Project MINOUW	IEO Project DISCATCH	SEAFISH North Sea Cod	SEAFISH Economic Imp. of the CFP	SEAFISH Flip-flap trawl trials	SEAFISH Discards in bait	SEAFISH LO choke analysis	SEAFISH English discard ban trial	SEAFISH Catch quota trials (haddock)	SEAFISH Self-sampling in inshore	Case-study of Boulogne sur Mer	Case Study Celtic Sea/ Bretagne Nord
On-board monitoring of discards	No	YES	Yes	No	Yes	Yes	Yes, CCTV	Yes	Yes			Yes	Yes	Yes. Assesses willingness of fisher's to self-sample and report catches and discards (tangle & trammel nets and handlines).	YES, Obsmer program	Yes, Obsmer program

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633680

Use of selective gears	Not yet	--	No	No	Yes				Yes. At sea trials of a more selective Nephrops trawl. Reduced unwanted catches of cod, haddock and whiting by 73, 67 and 82% respectively			Brief discussion of options and fishermen's opinions.	Yes. Trialed the use of large headline mesh to reduce unwanted haddock catches.		Trials of discards made by EODE program run by the Regional fisheries committee of Nord Pas de Calais	Start the use of selective gears program run by the PO Combrenord
Labour organization on board	Yes	?	No	No	No	?	Yes								Yes with Eode program	No
Working conditions for crew (safety,…)	Yes	No	No	No	No	?						Yes. Problems with storing catch on deck, increased working hours for crew etc.			Yes with Eode program	No
Impact on costs and income	Yes	No	No	No	Yes	?		Yes, models costs for 2011-12 as if landing obligation had already been in place		Yes	Yes	Yes, inc. changing costs of leasing quota.			No	No

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633680

Handling of not for human consumption fish after landing	Starting with this	No	Yes (pages 31-32)	Yes	Yes	?				Yes. Explores the potential of using fish that would otherwise have been discarded as pot bait in static gear fisheries.		Yes. Discusses options for sending unwanted fish to processors (fish meal).			Eode program experiment the use of discard with local processing industry	No
Boat owner perception	No	No	Yes (pages 35-36)	No	Yes	?				Yes	Yes. Provides feedback from Producer's Organisations.	Yes		Yes. Presents fishers perceptions of the self-sampling trial and potential for increased self-sampling in the inshore fleet.	Yes through CarRejet (CNPM) and EODE programs	Yes through CarRejet(CNPM) project
Crew perception	Not yet	No	Yes (pages 35-36)	No	No	?									No	No
Individual adaptation strategies	Not yet	No	Yes (pages 27-29)	Yes (Seabirds populations)	Yes	?				Yes		Yes			Yes through EODE program	No
Collective adaptation strategies	Not yet	No	Yes (pages 27-29)	Yes (Ecosystems effects)	Yes	?									Yes through CarRejet	Yes