

# Fishers' perceptions of the European Union discards ban: perspective from south European fisheries.

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## Highlights

- The implementation of the discards ban in South European fisheries is perceived by fishers as difficult
- Accompanying measures to the European discards ban should provide incentives for compliance
- The European discards ban is not perceived by fishers as conducive to future sustainable fisheries
- The fishing industry in South European fisheries do not consider that commercial utilization of former discards will offset costs of landing former discards

## Abstract

The estimated impact of the EU Landing Obligation was investigated, which bans discards of regulated species, in South European fisheries through stakeholders' perceptions with the intention to identify implementation shortcomings and practicalities that might lead to obstacles to enforcement. Structured interviews were conducted with 173 fishers in 4 countries practicing 4 generic fisheries (as typified by the dominant fishing gear) asking a total of 26 questions. Results show that fishers estimate that the full implementation of the discards ban will result in longer sorting times. Added to the limited space on board, especially in the more productive trawl and purse seine vessels, this may lead to practical difficulties in relation to compliance. Most of the respondents estimate that there are no realistic possibilities of utilizing the formerly discarded fish in the short term, because of the lack of adequate infrastructure on land. Furthermore, the possible utilization types foreseen in the regulation will not help offset the costs of bringing former discards to land. The outcomes of this study have confirmed the implementation difficulties of the landing obligation, especially when the fishing industry cannot expect any medium to long-term benefits.

*Keywords:* Common Fisheries Policy, Discards Ban, Perceptions, Incentives, questionnaire surveys

## 1. Introduction

The European Union recently modified its Common Fisheries Policy and brought into force the prohibition of discarding catches of regulated species (European Commission 2013). A Landing Obligation (LO) was included in this reform (Article 15 of EU Reg. 1380/2013) affecting all commercial species subject to catch limits or minimum landing sizes. These catches shall be hauled and retained on board the fishing vessels, recorded and landed at ports, and may enter the productive economy, but only for uses other than direct human consumption. The EU expects that forcing fishers

to land former discards of regulated species will be a significant step towards more selective fisheries, while the products eventually landed could be of some use and might be commercialized (Sardà et al. 2013). The LO entered into force in 2014, but is being applied progressively across different stocks and fisheries (started with small pelagics on January 1<sup>st</sup>, 2015) and it is expected to be fully enforced by Jan 1<sup>st</sup>, 2019 (European Commission 2013). The motivation behind this regulation was the perception that high amounts of discards represent a structural deficiency of European fisheries (European Commission 2012). Discards generated by the European fleets can be more than 60% of the biomass captured in demersal fisheries (Kelleher, 2005). In discarding fisheries, resources that could be used productively, for instance processed as fish meal, are wasted. Therefore, the discard ban aims at rationalizing the fishing process, through selective gears and sustainable practices (Gullestad et al., 2015). Additionally, by adding an extra burden to fishers, this management measure should incentivise more selective fishing practices. In the long term, Art. 15 of EU Reg. 1380/2013 should contribute to a decrease of fishing mortality and an improvement of the exploitation of European marine resources. However, the successful implementation of the LO will rely heavily on the provision of effective technical solutions and finding appropriate incentives that will encourage fishers to adopt more selective harvesting methods (Bellido Millán et al. 2014; Villasante et al. 2016).

In southern European fisheries the amount of discards is perceived by scientists and policy makers to be high, but with important variation across fleet segments and fishing gears (Uhlmann et al. 2014). For example, Tsagarakis et al. (2014) estimate values generally between 13 and 27% in the different Mediterranean fisheries, with extreme values of 0 and 90% in certain cases. In Portuguese purse seine fisheries discards estimates in the range between 3-51% in weight are reported (Borges et al. 2001; Gonçalves et al. 2008; Monteiro et al. 2001), while the range is between 13-15% for the Spanish purse seiners (Kelleher 2005). Although small scale fisheries using fixed gear are generally perceived as fisheries with lower discards rates, Shester and Micheli (2011) question the broad generalization that small scale fisheries are inherently more sustainable than industrial fisheries. Specific studies in small scale fisheries in southern European fisheries report a range of 13-22% in Portuguese trammel nets (Batista et al. 2009) and a sizeable 40% in lobster trammel net fisheries of the Balearic islands (Quetglas et al. 2004). A recent study (Sartor et al., 2016) analysing Italian official data (EU Data Collection Framework, DCF) from 2009 to 2014 regarding the species characterising the otter bottom trawl fisheries (for which the LO provisions are in force since Jan. 1<sup>st</sup>, 2017), show that the discards of European hake varied from 5% to 20% of the total catch, depending on the marine region, while for the red mullet and, more evidently for the deep water pink shrimp, discards were scarce. For species that do not characterise the trawl fisheries (for which the LO will enter in force on Jan. 1<sup>st</sup>, 2019), the same authors report negligible values of discard for Norway lobster and red shrimps, but high values, up to 75%, for mid pelagic fishes, such as horse mackerels. Finally, Sartor et al. (2016) report that the discards of the species characterising the set net fisheries, such as the striped red mullet and the

common sole, are low, less than the 2% of the total catch in weight. The amount of discards per fleet segment is generally known with low precision (Uhlmann et al. 2014), reflecting both the relatively low intensity of discard studies and the high variability in the amounts of fish discarded, even within a single fishery (Martinet et al. 2007).

Discarding of commercial fish caught in bottom trawls in many south European countries has risen over the last 70 years based on information gathered by interviews, while changes in the species composition of the discarded part were evident, attributed mainly to changes in market demand, and recent legal and regulatory restrictions (Damalas et al., 2015). Reasons for discarding vary and depend on many factors and different local parameters which define landings. The economic development of fishing communities across the Mediterranean is a possible indicator of fisheries exploitation pattern, with wealthier communities being the most selective ones in comparison to poorer ones that land and consume a wider spectrum of species and sizes (Tsagarakis et al., 2014). The role that fishers play in determining the landed portion is critical and a series of decisions onboard and in land define the harvested biomass finally landed (Eliassen et al., 2014).

For the successful implementation of sensitive fisheries policies, such as the implementation of the LO, knowing the perceptions of the agents involved is of paramount importance (Garza-Gil et al. 2015). Understanding the perception of the fishing industry on the LO should help increase the legitimacy and favourable reception of the regulation and diminish the potential of conflicts in its application (Mikalsen and Jentoft 2008; Pita et al. 2010), as well as reduce the risk of unintended consequences (Fitzpatrick et al. 2017). However, in south European fisheries, low levels of compliance with regulations (Damalas and Vassilopoulou 2013), and particularly in the Mediterranean Sea, the institutional setting of fisheries management (based on effort control, Damalas 2015) may further jeopardize the implementation of the LO due to resistance on the part of industry. Fishers' adaptive capacity and ability to alter their fishing techniques, by i.e. using more selective devices or maximizing the operating profits with optimal routes, will eventually define the impact of the landing obligation (Condie et al., 2014a).

The objective of this work is to investigate the perception of the fishing industry in South European waters (Portugal and Mediterranean EU countries) with regards to the implementation of the EU Landing Obligation and whether significant differences in perceptions can be detected across countries, fleet types, length of vessels or fishers. The perceived outcomes of the landing obligation and the potential incentives for compliance are also discussed. It is important to carefully examine fishers' strategies and take into account fishers' perceptions based on their socioeconomic profile (Christou et al., 2017), since management tailored to local peculiarities may facilitate the design of effective management and may help to achieve a smooth transition towards the landing obligation.

## 2. Material and Methods

### 2.1 Data source: The interviews

A questionnaire containing 26 questions investigating the fishers' perception of the Landing Obligation was designed, organized in 6 blocks of questions (Appendix A):

1. Current discarding practices, before the implementation of the LO: questions Q44-Q49;
2. Knowledge of the LO: questions Q50-Q54;
3. Short Term impacts: questions Q55-Q58;
4. Incentives for Compliance: questions Q59-Q66;
5. Utilization: question Q67;
6. Impacts of the LO: questions Q68-Q69.

Except for block 5 (Utilization: Q67), all questions were closed-ended. Questions Q44<sup>1</sup> to Q58 and Q68-Q69 were dichotomous (Yes/No), while Q59 to Q66 asked the level of agreement of the interviewee on a 5-point Likert scale, ranging from strong disagreement to complete agreement. No answer (N/A) was allowed. The question on utilization of former discards under the LO (Q67) was open-ended, although the interviewer expected 3 or 4 types of utilization.

Interviewees were fishers (ship masters, ship owners or crew members) selected from the main fleet segments operating in representative ports of the study areas where EU project MINOUW<sup>2</sup> takes place. The study was conducted in 6 areas, located in Greece, Italy, Portugal and Spain (Fig. 1). The questionnaire was designed to carry face-to-face interviews. The interview process started by signing a consent and confidentiality form, along with a short verbal description of the objectives of the project and handing over a paper copy of the project's brochure (available at <http://minouw.icm.csic.es/?q=outreach>). Both the interviews and the brochure were in the native language of the interviewee. The interviews were conducted from Oct 2015 to May 2016.

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<sup>1</sup> Questions Q1 to Q43 concerned technical characteristics of the vessel; estimates of costs and volume of catches; and other aspects that are not closely related to the perception of the Landing Obligation.

<sup>2</sup> Research and Innovation Action of the EU Horizon 2020 "Science, technology and society initiative to minimize unwanted catches in European fisheries", ref. 634495, March 2015 to February 2019.

## 2.2 Statistical analyses

Discrete choice modeling (binomial and multinomial regression) was used in order to examine any differences in perceptions between experienced fishers, large vessels, different gears and countries. The use of discrete choice modelling to explain fishers' behaviour is largely applied in fisheries science and economics (Tidd et al., 2011; Fitzpatrick et al., 2017, Christou et al., 2017).

The dichotomous responses (Yes/No) in blocks 1, 2, 3 and 6 were subject to a binomial test to examine whether the percentage of agreement was different from 50%. Additionally, these responses to these questions were analysed with logit regression models (Adkins and Hill 2011) to examine the possible influence of two continuous variables (years of experience in the fishery and size of the vessel, described by the length overall, LOA in m), and two discrete variables: main fishing gear used (DRB: bivalve dredges; GTR: trammel nets and other set nets; OTB: otter bottom trawl and PS: purse seine) and country (Greece, Italy, Portugal and Spain).

The ordered multinomial responses to the questions in block 4 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% in each category. Additionally, the ordered multinomial responses were analysed with ordered probit regression (Adkins and Hill 2011) to examine the influence of the same set of explanatory variables as in the logit model. All statistical analyses were performed with STATA 12.0 (StataCorp 2011).

## 3. Results

The characteristics of the case study fleets investigated and the number of interviews performed are reported in Table 1, and complemented with information in Appendix B.

The case studies fleets using DRB or GTR are examples of small scale fisheries and, as expected, are carried out by small vessels, generally with LOA smaller than 12 m (i.e. in vessel length class VL0612, following the DCF codes for vessel classes). Their engine power is smaller than 100 kW and the vessel sale value (as estimator of capital) is around 60,000 €; with the exception of the bivalve dredgers in Portugal, with sale value lower than 20,000 €. Bottom trawlers (OTB) and purse seiners (PS) range from 18 to 30 m length (VL1824 and VL2440), with the largest vessels in the long distance OTB fleet of Sicily. Engine power and vessel capital correlate well, as expected, with length

overall (LOA). Below follows a detailed description of the results, according to the question block as defined in the questionnaire (see Appendix A).

### Block 1 - Current discarding practices (Q44-Q49)

The majority of fishers in most case studies (75%; Table 2) claimed to be already taking steps to avoid unwanted catches (Q44), regardless of the implementation of the discards ban, especially larger vessels (with the statistically significant exceptions of Italian and Spanish OTB fishers) (Table 3). In particular, in the more productive fisheries of OTB in Portugal and Italy (Sicily) and PS in Portugal and Spain the agreement was 100%.

Most fishers responded negatively to Q45 (62%), and only in two case studies the majority of fishers interviewed declared that unwanted catches are a significant problem when sorting, once again related to the same more productive fisheries (Table 2, 3). Additionally, more experienced fishers significantly agreed with this question.

The majority of fishers (73%) did not agree that fishing costs increased when fishing operations produced large amounts of unwanted catches that must be hauled and kept on board (Q46), although in the case of Italian and Portuguese highly productive fisheries and for more experienced fishers the proportion of agreement was statistically higher (Table 2, 3).

The majority of fishers (69%) in most case studies declared that potentially commercial by-catch was discarded because of low price (Q47), with the significant exception of the two case studies in Greece. To the question of discarding due to quota caps (especially, Algarve OTB and PS) or minimum conservation reference size (Q48), the responses were in agreement (64%) in the majority of bottom trawl and purse seine case studies (with the exception of Greek PS), although the logit regression model estimated no significant coefficients.

The problem of storage capacity (Q49) was not perceived as particularly relevant in the majority of cases (16%), with only 2 case studies corresponding to highly productive fisheries (OTB in Italy (Sicily) and PS in Algarve showing high levels of agreement).

### Block 2 – Knowledge of the LO (Q50-Q54)

Only half of the interviewees were aware of the LO (47%, Q50). This is a striking result, especially for the case of the small pelagics fisheries, for which the obligation was already in force (since Jan. 1<sup>st</sup>, 2015) by the time of the field interviews. Awareness was significantly higher for experienced fishers and working in larger vessels, mostly based in Spain. Surprisingly, in most cases, the informative sessions of the project MINOUW carried out in the previous months were cited as the

main source of information. It can be deduced that the fishers' associations, producers' organization or regional/local administrations did not provide sufficient and timely information on Art. 15 of EU Reg. 1380/2013 to the fishers.

Regarding the perceived impact of the LO (Q51), only 58% of interviewees agreed that their activity would be impacted, but were a statistically significant majority in Spanish and Portuguese fisheries. The effect of vessel size and interviewee's experience was also significant. Purse seiners of the North Aegean (CS2.3) felt the landings obligation was inconsequential in their fishery because they harvest practically no unwanted catches (Kavala certified small pelagics fishery<sup>3</sup> in northern Greece, which belongs into a Fisheries Improvement project developed by MacAlister Elliott & Partners with WWF and local stakeholders).

Fishers are very sceptical on the potential benefits of the LO to their fisheries (Q52), with only 7% showing an agreement and no significant differences appearing among fishers' responses.

The majority was also sceptical on the general acceptance of the regulation by fishers (Q53), with a low 8% being in agreement and no statistical differences among them.

The majority of fisheries (74%) believed that the exemptions in Art. 15 are insufficient (Q54), with no statistically significant differences among fishers.

### Block 3 -- Short Term impacts

The responses to questions Q55-Q58 by Greek fishers practicing purse seining in the North Aegean were always negative for lack of unwanted catches, and they are omitted from the following discussion of these questions.

In Q55 the responses were equally split (50%) suggesting that sorting time or personnel needs will not increase homogeneously across fishing fleets with the implementation of the landings obligation, but none of the factors in the logit regression model were significant.

The majority of fishers (65%) responded positively to question Q56, indicating that fishing costs are expected to increase with the implementation of the LO, which was statistically significant for OTB and PS, and for Italian fishers.

The majority of respondents (79%) did not perceive the need for structural modifications of the fishing vessels to comply with the LO (Q57), although Italian and Portuguese fishers showed a significantly higher rate of affirmative responses, as well as fishers with more experience in the fishery.

Most fishers (80%) could not think of a strategy to bring unwanted catches to land (Q58), with no statistical differences among them, although in 2 case studies (GTR in Spain (Mallorca) and OTB in

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<sup>3</sup> <http://fis.com/FIS/Worldnews/worldnews.asp?monthyear=8-2014&day=14&id=70638&l=e&country=&special=&ndb=1&df=1>

Italy (Sicily)) all respondents claimed to be in a position to suggest a strategy. They suggested using standard fish boxes to bring back unwanted catches to land. However, in our opinion this may not be realistic as rental price for these boxes (capacity 14-20 kg) is of the order of 1 €, practically cancelling the sale value of the former discards brought in them.

#### Block 4 -- Incentives for Compliance (Q59-Q66)

The frequency of responses to the questions regarding incentives for compliance (Q59-Q66) are shown in Fig. 2. The option most frequently chosen in questions 60 to 66 was “strongly agree”. Regarding Q59 the responses were inconclusive because the proportion of fishers agreeing and disagreeing that changing the current fisheries management system would help comply with landings obligation was similar (45% disagreed or strongly disagreed, and 45% agreed or strongly agreed). Instead, reducing taxes to fishers (Q60) was perceived by a majority of fishers (87% agreed or strongly agreed) as a good way to incentivise compliance. The majority of fishers (71% agreed or strongly agreed) supported improving the marketing of landings (Q61) to incentivise compliance, because fishers believe that the present system disadvantages the producer. Only 51% agreed or strongly agreed with the proposition that enforcement of fisheries regulations should be improved (Q62). Increasing the cases of exemptions to the landings obligation also received a high share of support (60% agreed or strongly agreed to Q63). Working at market level, by correctly labelling the product of ‘discards-free fisheries’ or otherwise certifying the product (Q64), would help comply with the regulation according to a majority of fishers (79% agreed or strongly agreed). Training courses or other formative actions were also considered to be important in terms of complying with the landings obligation (Q65) by a majority of fishers (62% agreed or strongly agreed). The majority of fishers (73% agreed or strongly agreed) also supported the proposition that giving a prize to fishers complying with the landings regulation (Q66) would be a good incentive.

The chi-square test of proportions showed that responses to all questions deviated from a neutral 20% expectation for each category ( $p < 0.0001$ ). The ordered probit models of questions Q59 to Q66 did not show any significant effect of year of start in the activity, LOA or fishing gear (Table 4). The level of agreement varied significantly by country, with Portugal tending to deviate from the general pattern in all questions except Q60. Italy and Spain consistently deviated from the general pattern (i.e. higher tendency to disagree than average) in Q60, Q63, Q66 (Table 4).

#### Block 5 - Utilization Q67

In Q67 fishers were asked about possible types of utilization of former discards, focusing on mass markets (such as fish meal or fish oil, as opposed to niche markets for specialty products, such as fish collagen derivatives, enzymes or other subproducts not generally known to fishers in South European

waters). The question was open and several answers were possible; the frequency of responses is shown in Fig. 3. The most often cited type of utilization was “Charity” (i.e. destined for human consumption without creating a commercial outlet to the producer). However, note that the second most often cited utilization was “None”: i.e. many fishers are sceptical or ignorant on the possible utilization of discards for alternative uses. The classical utilization types, as foreseen in the provisions of the Landing Obligation, such as “fish meal / oil”, “pellets for farmed fish” or “pet food” were also frequently cited.

## Block 6 -- Impacts of the landings obligation for European fisheries

The majority of fishers (61%) answered that the Landings Obligation will not represent a major disruption to their activity (Q68; Table 2), although in the case of OTB positive responses were statistically significant and fishers with more experience in the fishery also tended to agree (Table 3). The majority of fishers (85%) disagreed with the proposition that the Landing Obligation will contribute to more sustainable European fisheries (Q69), with no statistically significant differences among fishers (Tables 2 and 3).

## 4. Discussion

Our results show that some operators in South European fisheries will face difficulties in adapting to the LO. Those fleet segments with high volume of catches, such as purse seiners or bottom trawlers with extended fishing trips, will have logistic problems related to storing and bringing to land the former discards, due to limited hold space. These fishers will have to cope with a reduction in the capacity to land products of higher economic value. Additionally, in most case studies a significant increase in sorting time or personnel as a direct effect of the LO is anticipated. The responses also revealed that the potential benefits of the LO were not evident to the fishing industry, which was not involved in its inception (de Vos et al. 2016), and many interviewees were sceptical to the acceptance of the LO by their peers and the fishing sector in general, in line with the results obtained by de Vos et al. (2016) in their Mediterranean case study (demersal fisheries in the Aegean Sea, Greece).

Our results agree in general with the findings of Villasante et al. (2016), who report that Galician small scale fishers found logistic difficulties in respecting the Landing Obligation. Increasing funding of monitoring and control agencies as well as providing incentives to encourage compliance by fishers were also important aspects to ensure the successful implementation of the Landing Obligation, according to Galician fishers. In our interviews, the responses also suggest that incentives for compliance should be sought in reducing taxes to fishers, improving the system of marketing fishery

products or setting price premiums for law-abiding fishers or “discards-free” certification schemes. Appropriate rewarding schemes for compliant fishers may stimulate adopting more selective practices in the short term (Condie et al. 2014a), reducing the amount of discards. However, monitoring and enforcement agencies would need to devote increased human and financial resources to control. Surveillance and enforcement is critical to acquire a high level of compliance since fishers in order to avoid any additional costs may discard illegally the unmonitored catch (Condie et al., 2014a). This is explained by the assumption that fishers’ incentives are dominated by economic incentives, enforcement is synonymous for compliance and fishers involvement influences the overall acceptance and support of the policy (Kraan et al., 2013).

The types of utilization most often cited by respondents, charity and none, are not contributing by their nature to helping offset the costs of bringing to land former discards. The second group of utilization types most often cited, fish meal, fish oil, food pellets or pet food, could create a positive incentive for compliance with the LO, but this will depend critically on the provision of necessary infrastructure on land for processing, which is currently lacking (Sartor et al. 2016). A comment often brought up by the fishers, although not adequately captured by the binomial / multinomial analysis carried out here, was that “discards belong to the sea”, i.e. many respondents felt that returning unwanted catches back to the sea was less detrimental to marine ecosystems than bringing this biomass to land (coinciding with responses reported by de Vos et al. 2016). This perception is probably not unfounded as many seabirds in Europe depend, at least for part of their life cycle, on fisheries discards (Bicknell et al. 2013). In fact, the reduction in nutrients income for the ecosystem causes ecological impacts, with adverse effects foreseen for all components of the trophic food web (Heath et al., 2014; Sardà et al., 2013). The removal of biomass from the food web could induce a shift in the predation pressure exerted by top predators on the different trophic groups (Kopp et al., 2016), as well as opportunistic predators and scavengers. Even, in many cases, some species which are returned alive to the sea have high probability to survive after being discarded (Guillen et al., 2014; Sardà et al. 2013). Thus, the implementation of the LO could have negative effects at the population level by increasing fishing mortality on these species. Nevertheless, exemptions from the discard ban are possible when a high survival rate of discards can be demonstrated (European Commission, 2013: Art.15), the application will require further investigation for each specific case. Incorporating discards survival and bycatch mortality when estimating fishing mortality by stock assessment models will have significantly implications for MSY targets (Guillen et al. 2014).

The analysis of Veiga et al. (2016) shows that the LO, in socioeconomic terms, is likely to be more negative than positive in the short and medium term for the small-scale European fisheries and our findings here suggest that this can be generalized to all South European fisheries. The landing obligation may not create enough incentives to reduce bycatch and may not change the status-quo if no supporting

measures and efficient enforcement is applied (Condie et al., 2014a). The key to change attitudes towards the LO and incentivise the adoption of more selective fishing practices is to incorporate fishers in the decision making process during the implementation steps embodied in the member states national discards plans. As discussed in de Vos et al. (2016) fishers' views and knowledge are vital to the successful implementation of the LO and other aspects of fisheries policy in general. Fisheries governance is moving away from a top-down process led by fisheries agencies (with the technical assistance of scientists) towards truly co-management decision-making schemes where all relevant stakeholders can express their views on the problems and formulate solutions in conditions of trust and transparency (de Vos and van Tatenhove 2011; Leonart et al. 2014).

In conclusion, the majority of fishers in South European fisheries were sceptical about the success of the LO and did not see any mid to long term benefits in this policy, as well as possibilities of utilization of former discards as a practical way to offset increased handling costs. The difficulty in incentivising compliance, together with other weaknesses in the discard ban as currently formulated (e.g. high cost of enforcement), suggests that the LO is associated with a high risk of failure (Eliassen et al. 2014; Sigurðardóttir et al. 2015). This risk can be mitigated by introducing measures to constrain fishing mortality and rebuild stocks (Condie et al. 2014b).

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Figure 1 – Map of southern Europe with the location and names of the case studies.

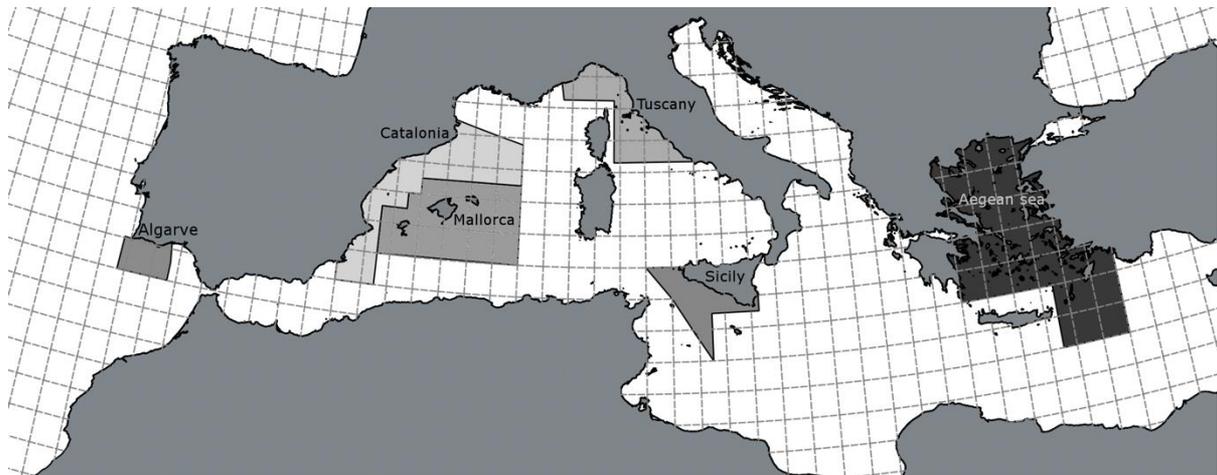


Figure 2. Frequency of responses to questions Q59 to Q66 (see Appendix A).

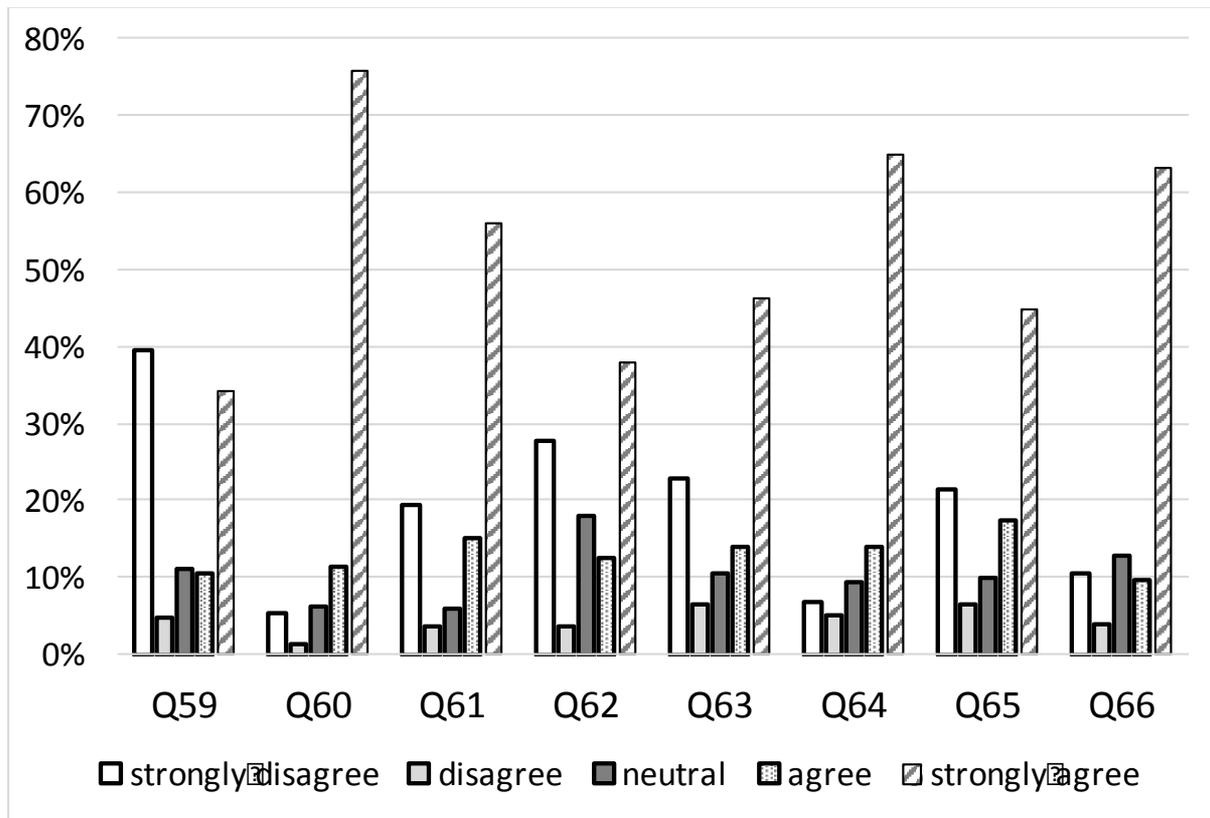


Figure 3. Frequency of responses to the utilization of former discards of regulated species under the Landings Obligation (question Q67).

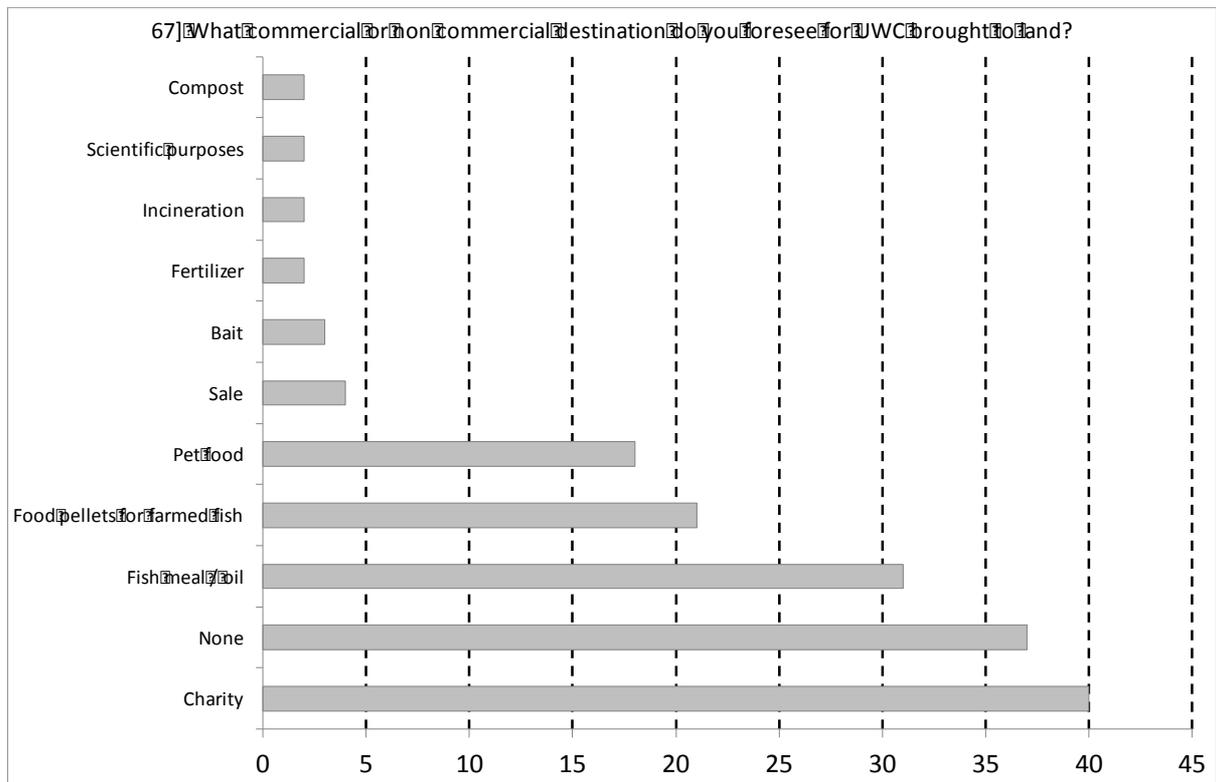


Table 1. Technical characteristics of the fleets investigated and number of interviews. Starting year in the activity of each interviewee was used as proxy for their experience in the fishery. LOA: length overall (m); LO: Landings Obligation. DRB: bivalve dredgers; GTR: trammel netters; OTB: bottom trawlers; PS: purse seiners.

<b>CASE STUDY</b>	<b>country</b>	<b>Average LOA</b>	<b>Average engine power (kW)</b>	<b>Average capital € (estimated sale value / vessel)</b>	<b>Nb of vessels</b>	<b>Nb valid interviews</b>	<b>Starting year in activity</b>	<b>% discarded under LO</b>
<b>Algarve DRB</b>	Pt	7.85	75.00	62,222	78	10	1997	1%
<b>Algarve GTR</b>	Pt	6.71	71.10	18,818	697	11	1978	0%
<b>Mallorca GTR</b>	Sp	8.56	66.50	59,300	260	10	1992	4%
<b>Catalonia GTR</b>	Sp	8.65	49.42	64,316	422	18	1986	2%
<b>Tuscany GTR</b>	It	9.52	77.56	101,444	250	33	1986	26%
<b>Algarve OTB</b>	Pt	23.25	569.00	790,625	46	8	1987	23%
<b>Catalonia OTB</b>	Sp	19.14	234.00	490,714	256	14	1987	4%
<b>Sicily OTB</b>	It	29.16	509.53	788,889	100	10	1983	9%
<b>Ligurian and N-C Tyrrhenian OTB</b>	It	19.29	192.10	354,615	330	19	1981	24%
<b>North Aegean OTB</b>	Gr	26.53	382.81	550,000	250	33	1991	4%
<b>Algarve PS</b>	Pt	17.68	271.54	321,154	46	13	1983	1%
<b>North Aegean PS</b>	Gr	22.03	333.17	512,500	18	22	1989	0%

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<b>Catalonia</b>	Sp	19.63	251.67	616,667	86	6	1986	7%
<b>PS</b>								
<b>TOTAL</b>						173		

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Table 2. Number of yes / no responses to each dichotomous question and percentage of yes (“% agree”). The total number of fishers was 173, but not all fishers responded every question. The question for each Question ID is displayed in Appendix A.

Block	ID	Yes	No	% agree	Binomial test
1. Current discarding practices	Q44	129	44	75%	<0.0001
	Q45	66	107	38%	0.00226
	Q46	47	126	27%	<0.0001
	Q47	118	53	69%	<0.0001
	Q48	109	61	64%	<0.0001
2. Knowledge of the LO	Q49	26	141	16%	<0.0001
	Q50	78	89	47%	0.43913
	Q51	99	72	58%	0.04646
	Q52	12	153	7%	<0.0001
	Q53	14	156	8%	<0.0001
3. Short Term impacts	Q54	41	116	26%	<0.0001
	Q55	84	85	50%	1.00
	Q56	112	59	65%	<0.0001
	Q57	36	135	21%	<0.0001
6. Impact of the LO	Q58	33	130	20%	<0.0001
	Q68	67	103	39%	0.0071
	Q69	24	136	15%	<0.0001

Table 3. Percentage of fishers in each case study showing agreement with questions Q44 to Q58 and Q68-Q69 (see Appendix A). Results of the logit regression model to these binomial questions are displayed. For continuous variables “start” and “LOA”, a cross shows when the effect was significant. For factor variables country (Gr: Greece, It: Italy, Pt: Portugal and Sp: Spain) and fleet (DRB: bivalve dredges; GTR: trammel nets and other set nets; OTB: bottom otter trawl and PS: purse seine), the name of the statistically significant countries or fleets are given.

gear	DRB	GTR				OTB					PS			effect signif5%			
CS	CS3.1. 2	CS3.1. 1	CS3. 2	CS3. 4	CS3. 5	CS1. 2	CS1. 4	CS1. 6	CS1. 5	CS1. 7	CS2. 2	CS2. x	CS2. 3				
countr y	Pt	Pt	Sp	Sp	lt	Pt	Sp	lt	lt	Gr	Pt	Sp	Gr	start effect	LOA effect	fleet	countr y
Q44	90%	64%	90%	44%	78%	100%	43%	26%	100%	97%	100%	100%	75%		+	OTB	lt Sp
Q45	30%	27%	40%	22%	33%	88%	21%	47%	100%	27%	62%	50%	0%	+	+		lt Sp Pt
Q46	40%	0%	30%	6%	22%	88%	14%	47%	90%	15%	31%	17%	0%	+			lt Sp Pt
Q47	100%	82%	70%	94%	56%	100%	86%	95%	100%	12%	100%	100%	8%				lt Sp Pt
Q48	50%	9%	70%	39%	22%	100%	57%	95%	86%	88%	92%	67%	17%				
Q49	0%	9%	0%	0%	22%	38%	14%	16%	75%	9%	62%	17%	0%				Pt
Q50	10%	9%	40%	28%	14%	88%	79%	13%	90%	48%	31%	83%	100%	+	+		Sp
Q51	50%	11%	60%	11%	22%	75%	79%	47%	90%	91%	100%	83%	0%	+	+		Sp Pt
Q52	0%	0%	11%	28%	22%	0%	0%	6%	0%	0%	15%	17%	0%				
Q53	0%	11%	0%	17%	11%	0%	7%	21%	0%	0%	8%	17%	17%				
Q54	13%	9%	70%	17%	33%	25%	7%	13%	0%	42%	31%	0%	36%				
Q55	56%	27%	30%	39%	67%	100%	79%	84%	100%	15%	75%	50%	0%				
Q56	30%	36%	50%	28%	78%	88%	64%	95%	100%	97%	67%	83%	0%			OTB PS	lt
Q57	10%	10%	0%	0%	0%	57%	21%	37%	100%	12%	31%	33%	0%	+			lt Pt
Q58	0%	20%	100%	0%	0%	25%	0%	16%	100%	33%	10%	0%	0%		+	GTR OTB PS	
Q68	30%	33%	0%	17%	22%	100%	36%	37%	100%	97%	83%	67%	8%	+		OTB	
Q69	0%	10%	0%	6%	22%	0%	7%	6%	0%	0%	17%	20%	18%				

Table 4. Probability of continuous (start; LOA) or discrete (fleet; country) effects being significant in the ordered probit regression models to questions Q59 to Q66. Reference fleet is DRB (bivalve dredge) and reference country is Gr (Greece). LOA: length overall; GTR: trammel netters; OTB: bottom trawlers; PS: purse seiners; It: Italy; Pt: Portugal; Sp: Spain.

	FLEET					COUNTRY		
	start	LOA	GTR	OTB	PS	It	Pt	Sp
<b>Q59</b>	0.673	0.910	0.345	0.223	0.758	0.159	<b>&lt;0.0001</b>	0.428
<b>Q60</b>	0.560	0.499	0.090	0.976	0.600	<b>0.013</b>	0.097	<b>&lt;0.0001</b>
<b>Q61</b>	0.880	0.249	0.659	0.237	0.969	0.117	<b>0.007</b>	0.081
<b>Q62</b>	0.441	0.563	0.092	0.167	0.626	0.250	<b>&lt;0.0001</b>	0.140
<b>Q63</b>	0.338	0.332	0.300	0.168	0.197	<b>0.015</b>	<b>&lt;0.0001</b>	<b>&lt;0.0001</b>
<b>Q64</b>	0.236	0.872	0.110	0.055	0.116	0.100	<b>0.002</b>	0.100
<b>Q65</b>	0.568	0.772	0.412	0.520	0.958	0.541	<b>0.044</b>	0.710
<b>Q66</b>	0.104	0.155	0.236	0.500	0.713	<b>&lt;0.0001</b>	<b>&lt;0.0001</b>	<b>&lt;0.0001</b>

## APPENDIX A

Table A. 1. QUESTIONS OF THE QUESTIONNAIRE SURVEY.

Block	Question ID	Question	Response type
1. Current discarding practices	Q44	Do you take steps to avoid UWC?	Yes/No
	Q45	Hauling UWC on board cause problems with sorting?	Yes/No
	Q46	Hauling UWC on board cause increased fishing costs?	Yes/No
	Q47	Potentially commercial UWC are discarded because of low price?	Yes/No
	Q48	Potentially commercial UWC are discarded because of quota or minimum size limits?	Yes/No
	Q49	Potentially commercial UWC are discarded because of lack of storage capacity?	Yes/No
	2. Knowledge of the LO	Q50	Are you aware that discarding of regulated UWC will be banned in European waters progressively in the period 2015 – 2019?
Q51		Do you know if your fishing activity will be affected by the landings obligation?	Yes/No
Q52		Do you think that the Landing Obligation will be positive for local fisheries?	Yes/No
Q53		Do you think that the Landing Obligation will be generally accepted by all fishers?	Yes/No
Q54		Do you believe that the exemptions covered in the Art. 15 are sufficient / adequate (i.e. survival, unbearable costs and “de minimis” exemptions)	Yes/No

3. Short Term impacts	Q55	Will sorting time or needs of personnel increase?	Yes/No
	Q56	Will your activity incur extra costs to comply with the Landings Obligation?	Yes/No
	Q57	Will your fishing vessel require technical / structural modifications to adapt to the Landing Obligation?	Yes/No
	Q58	Can you think of a strategy to bring to land former discards?	Yes/No
4. Incentives for Compliance	Q59	Do you agree that the successful implementation of the Landing Obligation will be facilitated by changing the current fisheries management system?	Likert 5-point scale
	Q60	Do you agree that the successful implementation of the Landing Obligation will be facilitated by reducing taxes to fishers?	Likert 5-point scale
	Q61	Do you agree that the successful implementation of the Landing Obligation will be facilitated by improving the system of selling fish landings?	Likert 5-point scale
	Q62	Do you agree that the successful implementation of the Landing Obligation will be facilitated by improving the enforcement of fisheries regulations?	Likert 5-point scale
	Q63	Do you agree that the successful implementation of the Landing Obligation will be facilitated by increasing the cases of exemptions to the Landings Obligation?	Likert 5-point scale
	Q64	Do you agree that the successful implementation of the Landing Obligation will be facilitated by	Likert 5-point scale

		working at the consumer level to promote “discards-free” fisheries products?	
	Q65	Do you agree that the successful implementation of the Landing Obligation will be facilitated by increasing fishers’ awareness through workshops and courses?	Likert 5-point scale
	Q66	Do you agree that the successful implementation of the Landing Obligation will be facilitated by working on new control and monitoring techniques that give a premium to compliant fishers?	Likert 5-point scale
5. Utilization	Q67	What commercial or non-commercial destination do you foresee for UWC brought to land	Open question
6. Impacts of the LO	Q68	Will the Landing Obligation represent a major derangement of your activity?	Yes/No
	Q69	Do you think that the Landing Obligation will help ensure sustainable EU fisheries?	Yes/No

## APPENDIX B

Table B.1. Characteristics of sampled fisheries

Characteristics of the case study fleets investigated. Summary quantities correspond to averages for the period 2012-2014, from EU Data Collection Framework, available at <https://stecf.jrc.ec.europa.eu/data-reports>. OTB: Otter bottom trawl; DRB: bivalve dredges; GTR: Trammel nets and other set nets; PS: Purse seine.

FLEET	Country	Main target species	Unwanted catches problem	Annual volume of landings (1000 t)	Annual value of landings (M Euro)	Employment (nb of FTE national)
Algarve OTB	Portugal	deepwater rose shrimp; Nephrops; other important species: blue and red shrimp, scarlet shrimp and giant red shrimp	low value finfish, some are regulated species (e.g. blue whiting, horse mackerel); undersize hake, undersize target species	21 521	42 740	932
Catalonia OTB	Spain	mixed bottom trawl fishery targeting finfish (hake, red mullet, cephalopods) and crustaceans	low value finfish, some are regulated species (e.g. blue whiting, horse mackerel); undersize	14 686	74 360	2 623

		(Nephrops; red shrimps)	hake or Nephrops			
Sicily OTB	Italy	deepwater rose shrimp; Nephrops; blue and red shrimp, and giant red shrimp	low value finfish, some are regulated species (e.g. blue whiting, horse mackerel, Sparidae); undersize hake, undersize target species	14 210	103 589	4 512
Ligurian and N-C Tyrrhenian OTB	Italy	mixed bottom trawl fishery targeting finfish (hake, red mullet, cephalopods) and crustaceans (Nephrops; deep water pink shrimp, red shrimps)	low value finfish, some are regulated species (e.g. horse mackerel); undersize hake, Nephrops or red mullet	7 047	57 943	2 153
North Aegean OTB	Greece	mixed bottom trawl fishery targeting finfish (hake, red mullet,	undersize specimens of some regulated species of fishes	11 479	65 643	2 405

		cephalopods) and crustaceans (Nephrops; deepwater rose shrimp caramote prawn)	(sardine, horse mackerel, hake, red mullet) and crabs			
Algarve PS	Portugal	sardine, horse mackerel, anchovy, Atlantic chub mackerel	undersize specimens of regulated species (incl. the target species)	66 783	55 641	1 562
Catalonia PS	Spain	sardine, anchovy	undersize specimens of regulated species (incl. the target species); unwanted catches of horse mackerels, mackerels	24 437	55 702	2 181
North Aegean PS	Greece	sardine, anchovy	low value round sardinella; unwanted catches of the target species are	14 418	48 691	3 102

			practically nil due to the highly selective fishing procedures			
Algarve GTR	Portugal	different metiers varying seasonally: cuttlefish; seabass; Sparidae, soles, monkfish	regulated species such as chub mackerel or sardine	7 217	23 553	974
Algarve DRB	Portugal	clams ( <i>Spisula solida</i> , <i>Donax trunculus</i> , <i>Chamelea gallina</i> ) and the razor clam <i>Ensis siliqua</i>	undersize specimens of target species	1 790	3 763	112
Mallorca GTR	Spain	different metiers varying seasonally: cuttlefish; striped red mullet and spiny lobster	specimens in poor condition; among them regulated species such as hake, striped red	31.6	362	823

			mullet or mackerel			
Catalonia GTR	Spain	different metiers varying seasonally: cuttlefish; caramote prawn, striped red mullet	specimens in poor condition or undersize; among them regulated species such as certain Sparidae, red mullet or hose mackerel	1 471	5 655	1 256
Tuscany GTR	Italy	different metiers varying seasonally: cuttlefish; Sparidae, caramote prawn; striped red mullet	specimens in poor condition or undersize; among them regulated species such as certain Sparidae, red mullet or hose mackerel			