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The European Landing Obligation

Reducing Discards in Complex, Multi-Species and Multi-Jurisdictional Fisheries

EXTRAS ONLINE

Springer Open

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Editors
Sven Sebastian Uhlmann
Flanders Research Institute
for Agriculture, Fisheries and Food
Oostende, Belgium

Clara Ulrich
Technical University of Denmark
Kgs. Lyngby, Denmark

Steven J. Kennelly
IC Independent Consulting
Cronulla, NSW, Australia

ISBN 978-3-030-03307-1 ISBN 978-3-030-03308-8 (eBook)
https://doi.org/10.1007/978-3-030-03308-8

Library of Congress Control Number: 2018966345

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Chapter 5
The Implementation of the Landing Obligation in Small-Scale Fisheries of Southern European Union Countries

Sebastian Villasante, Manel Antelo, Maria Christou, Laurence Fauconnet, Katia Frangoudes, Francesc Maynou, Telmo Morato, Cristina Pita, Pablo Pita, Konstantinos I. Stergiou, Celia Teixeira, George Tserpes, and Vassiliki Vassilopoulou

Abstract In the European Union, discards represent a major source of undocumented mortality, contributing to the overfishing of European fish stocks. However, little attention has been given by the scientific community to discards in the

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S. Villasante (✉)
Faculty of Political and Social Sciences, University of Santiago de Compostela, Santiago de Compostela, Spain
e-mail: sebastian.villasante@usc.es

M. Antelo · P. Pita
Faculty of Economics and Business Administration, University of Santiago de Compostela, Santiago de Compostela, Spain

M. Christou · K. I. Stergiou
Institute of Marine Biological Resources and Inland Waters, Hellenic Centre for Marine Research, Anavyssos, Greece

Aristotle University of Thessaloniki, Thessaloniki, Greece

L. Fauconnet
Departamento de Oceanografia e Pescas – Okeanos, Instituto do Mar (IMAR), Universidade dos Açores, Horta, Portugal

K. Frangoudes
University of Brest, Ifremer, CNRS, UMR 6308, AMURE, IUEM, Plouzané, France

F. Maynou
Institut de Ciències del Mar, CSIC, Barcelona, Spain

T. Morato
Marine and Environmental Sciences Centre (MARE), Institute of Marine Research (IMAR) and OKEANOS Research Unit, Universidade dos Açores, Horta, Portugal

C. Pita
Department of Environment and Planning & Centre for Environmental and Marine Studies (CESAM), University of Aveiro, Aveiro, Portugal

C. Teixeira
MARE – Marine and Environmental Sciences Centre, Faculdade de Ciências, Universidade de Lisboa, Lisbon, Portugal

S. S. Uhlmann et al. (eds.), *The European Landing Obligation*,
https://doi.org/10.1007/978-3-030-03308-8_5

European Union's small-scale fisheries (SSF). This is mainly due to the fact that discards are mostly generated by industrial fisheries, while SSFs were generally thought to have lower discard rates than industrial fisheries. A Landing Obligation (LO) is being introduced in European waters with the reform of the Common Fisheries Policy (CFP) (Article 15, EU regulation 1380/2013) to limit/reduce discarding. However, management recommendations are required to support its implementation. The reality and challenges to enforce the LO in SSF are analyzed in this chapter, gathering information from different small-scale fisheries and fishers from the Atlantic Ocean and Mediterranean Sea who were asked about their perceptions toward the LO. The objectives of this chapter are to (a) identify the reasons for discarding and (b) investigate the multiple ecological, economic, social, and institutional drivers which act as a barrier toward the implementation of the LO in SSF. Given the high importance of SSF in the southern countries of Europe, different case studies of SSF from France, Greece, Portugal, and Spain coasts are used to illustrate the reasons for discarding, the impacts of the LO on SSF, and the barriers for its implementation.

Keywords Common Fisheries Policy · Discards · Impacts · Landing Obligation · Small-scale fisheries · Southern Europe

5.1 Introduction

In the European Union (EU), discards represent a major source of undocumented (or poorly documented) mortality, contributing to the overfishing of European fish stocks. Discarding levels in EU fisheries vary between locations, gears, species, and fishing grounds (Uhlmann et al. 2013). However, data collection and estimates of discards for all commercial species in EU waters under the CFP are far from being complete and generally have low precision. This reflects the relatively low intensity of discard sampling and the high variability in amounts of fish discarded, even within a single fishery. The omission and/or poor discard data from stock assessments may also result in underestimation of exploitation rates and can lead to biased assessments and policy recommendations, hampering the achievement of resilient and sustainable fishery resources uses (Aarts and Poos 2009).

The implementation of a Landing Obligation (LO) was one of the key elements of the recent reform of the EU Common Fisheries Policy (CFP) (Regulation (EU) No 1380/2013). A phased LO was formally implemented in January 2015, and by 2019

G. Tserpes
Institute of Marine Biological Resources (IMBR), Hellenic Centre of Marine Research, Anavyssos, Greece

V. Vassilopoulou
Institute of Marine Biological Resources and Inland Waters, Hellenic Centre for Marine Research, Anavyssos, Greece

it will be in force in all EU waters, covering all fisheries that capture commercial species covered by the CFP regulation, including SSF. Landings from EU SSF are worth around €2 thousand million euros annually, i.e., 25% of the revenue generated by EU fisheries, and SSF therefore have a high value in the seafood supply chain. Around 80% of EU fishing boats and more than 40% of EU fishers (90,000) are engaged in SSF (Macfadyen et al. 2011), emphasizing that SSF is a sector with great social, economic, and cultural importance for coastal communities, especially in southern Europe.

The small-scale fleet has declined by 20% over the last 10 years, to just over 70,000 vessels. Small-scale vessels are on average between 5 and 7 m in length, weigh 3GT, and have engines with a power of 34 kW (Macfadyen et al. 2011). More than 90% primarily use passive gears (i.e., gears that are not towed or dragged through the water) such as drift and fixed nets, hook and lines, or pots and traps. Despite their importance, for decades, EU fishery policy (e.g., quotas, subsidies, management systems) has focused on large-scale fishing, and there is a lack of knowledge about biological, environmental, socioeconomic, management, and policy aspects of SSF. SSF faces diverse challenges and pressures, not least to establish appropriate governance systems.

However, little research has been done on the impacts of the LO on SSF (Villasante et al. 2015a; Veiga et al. 2016). Therefore, the specific objectives of this chapter are to (i) identify the reasons for discarding among SSF, (ii) determine the factors (ecological, economic, institutional) that act as barriers for the successful implementation of the LO, and (iii) identify the institutional arrangements and/or rules that either inhibit or facilitate an adaptation of the LO.

5.2 The Status of Discards in Small-Scale Fisheries

To examine research gaps regarding discards in SSF, we did a systematic literature search to identify relevant scientific papers published up to August 2018 in Scopus, by searching titles, abstracts, and keywords using the following terms: "fisher*" or "fishing"; "discard*"; and "artisan*" or "small-scale" or "traditional" or "subsistence" or "local" or "industrial" or "commercial" or "large." The results obtained show that the topic of discards in SSFs attracted little attention among the scientific community. A total of 1219 papers have been published on the topic of discards from 1950 to August 2018, of which 952 are related to industrial fisheries (78%) with only 267 papers focused on SSF (21%) (Fig. 5.1). The review also showed that the little attention paid by the scientific community to discards in SSFs is due to the belief that discard problems were mainly concentrated in industrial fisheries, while SSFs generally have lower discard rates (Villasante et al. 2016a).

Discarding occurs not only due to poor gear selectivity and the capture of unwanted "low value" fish but also due to the mismatch between catch composition and regulatory catch or size limits. Undersize fish may be discarded due to the MLS regulations; over-quota fish can be discarded in a multi-species fishery due to quota

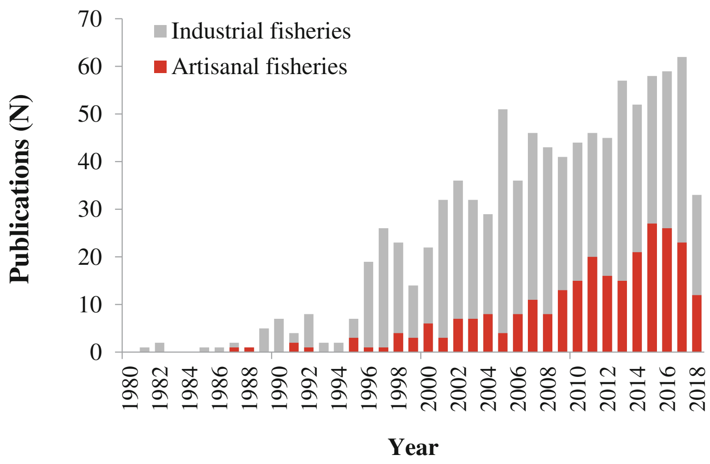

Fig. 5.1 Number of scientific papers published in relation to discards from industrial and artisanal fisheries (1950–2018). (Source: Scopus)

exhaustion of one species, and less valuable size classes of target species may be discarded to make room for more valuable size classes (high grading). Even if high grading has been legally forbidden, it is still known to occur on a regular basis. All these issues are reported to be present in EU SSF (Villasante et al. 2016a, 2016b, 2016c). These different reasons for discarding impact heavily on the willingness to comply with rules and regulations.

5.3 Impacts of the Landing Obligation in Small-Scale Fisheries

The term SSF implies small vessel size and, sometimes, low levels of technology and capital investment per fisher. For the purposes of the European Maritime and Fisheries Fund (Regulation (CE) No 508/2014, "small-scale coastal fishing" was formally defined as fishing done by vessels of an overall length < 12 m and not using towed gear. SSF are thus typically "artisanal" and coastal, using small boats, targeting multiple species using traditional gears.

To investigate the impact of the LO in SSF, we will focus on the impact of this measure on selected SSF in the EU – in France, Greece, Portugal, and Spain. We will describe these fisheries, their discards, the reasons for discarding, impact of the LO, factors that act as barriers for the successful implementation of the LO, and the institutional arrangements and rules that inhibit or facilitate the adaptation to the LO.

5.3.1 France

Small-Scale Fisheries in the British Channel, Celtic Sea, and Bay of Biscay
In France, the small-scale fleet is not legally defined. The number of hours spent at sea is the main criterion to classify the vessels rather than length or use of passive gears. For the purpose of this chapter, only vessels < 12 m of the length operating within territorial waters (12 nm) in the British Channel, Celtic Sea, and Bay of Biscay are taken into account. See Table 5.1 for the characteristics of this fleet and the main species landed. The majority of the target species in the Atlantic Coast/ Ocean are subject to Total Allowable Catch (TAC) regulations.

Interviews were done with small-scale fishers operating in the English Channel, Celtic Sea, and Bay of Biscay as part of the EU DiscardLess project (http://www.discardless.eu). All French fishers interviewed perceived the LO negatively not only because they felt that it will reduce their activity and increase expenditure on their boats but that it also shows that decisions were made at the top level without taking in account the good management practices implemented by the fisheries committees or POs over the last 15 years (van Hoof et al., this volume). That is, French small-scale fishers feel that European decision-makers satisfy claims and interests of lobbies (conservationists, aquaculture) rather those of fishers (De Vos et al. 2016).

According to interviewed fishers, the main reasons for discarding are regulatory, such as quotas, forbidden species, etc. Low market prices and high grading are also given as reasons for discarding (Table 5.2). Damaged fish was also mentioned by netters or long-liners. It is probably that because SSF implemented a quota system later than the larger fleet, and the fact that they have smaller amounts of quota, these fishers discard more. New fishers, who do not own quotas, have to fish under an open national quota system, managed by the national fisheries administration, and because these quotas are rapidly filled, they are obliged to discard all fishes over quota. Young fisherwomen using nets as the main fishing gear say: “As soon as the national quota closes, all fish caught under the quotas system are discarded. We are not members of the local PO, and we cannot access more quotas.” In some regions, POs manage quotas collectively; thus, the quota can be swapped among fishers, with the result that it is easier for them to avoid high discard rates.

Undersize fish, when mentioned, did not really represent a constraint to French small-scale fishers. They all say that the gears they use are more selective than those used by the industrial fleet. But they cannot avoid all undersize fish as “there is not a fishing gear which doesn’t catch undersize fishes.” For those using handline or traps, unwanted fish can easily be returned alive to the sea. The “lack of a good price” for some species, for example, European plaice (*Pleuronectes platessa*) in the Eastern Channel and European hake (*Merluccius merluccius*) or Atlantic horse mackerel (*Trachurus trachurus*) in the Bay of Biscay, is given as another reason for discarding. For fishers, discarding species without commercial value is not perceived as discards. It is the same when it comes to high grading practiced by fishers to

Table 5.1 Case studies characterization

Case study	Country	Fishing fleet	Gear used	Main species landed	Rules and regulations
SSF in the British Channel, Celtic Sea, and Bay of Biscay	France	Vessels less than 12 m operating mainly within territorial waters (12 nm) using mainly passive gear	Gillnets, trammel nets, longlines, handlines, nets, pots and traps, some SSF vessels using dredges or trawls	Common sole, European sea bass, pollack, and monkfish; total landings 80,000 tons (in 2013)	Most target species subject to TAC and MLS
SSF in the Thermaikos Gulf	Greece	Polyvalent passive gears	Nets, pots, longlines, traps	Lands a wide array of species, the most important being hake, common cuttlefish, mullets, annular seabream, saddled seabream, common octopus, common pandora, and scorpionfish; accounted for 18,152 tons (in 2016)	Most target species have minimum landing size (MLS). Plus spatial restrictions and temporal restrictions (e.g., vessels targeting hake and exceeding the limit of >20% of landings are not authorized to fish in February)
SSF in Catalonia	Spain	Polyvalent passive gears operating within 6 nm	Trammel nets, gillnets, boat seines, pots for octopus, and longline	Lands over 200 species, the most important being demersal species (cuttlefish, hake, pandora, sole, golden seabream), sand-eel, octopus, and bonito. Average landings of 3000 ton/year	Some species subject to MLS (e.g., hake, sole, Sparidae, octopus). Technical limitations to the size of fishing gear (e.g., maximum length of nets; maximum number of hooks; maximum number of traps)
SSF in Galicia	Spain	Vessels less than 12 m operating mainly within	Gillnet	Hake, horse mackerel, mackerel, pouting, surmullet.	Most target species subject to TAC, MLS, and fishing effort

(continued)

Table 5.1 (continued)

Case study	Country	Fishing fleet	Gear used	Main species landed	Rules and regulations
		6 nm using passive gear		Average daily catch of 3000 kg (in 2018)	
Deepwater hook-and-line fishery in the Azores	Portugal	Deepwater	Bottom long-lines, handlines	Blackspot seabream, European conger, Forkbeard, silver scabbardfish, bluemouth rockfish, wreckfish. Total landings of 4070 t (in 2014), 15–21 M€ between 2010 and 2017	Target and secondary species subject to TAC (e.g., blackspot seabream, alfonsinos). Deepwater sharks subject to TAC zero. MLS for several species, minimum hook sizes, area and temporal closures, and bans on the use of specific gear
Beach seine	Portugal	Purse seine	Trawling net to the beach; small fishery consisting of solely 143 vessels in the entire country	Small pelagic fish such as mackerel, Atlantic horse mackerel, and sardine	Horse mackerel (*Trachurus* spp.) subject to TAC

Note: SSF, small-scale fisheries; MLS, minimum landing size; nm, nautical miles; TAC, Total Allowable Catch

obtain better prices. Only the biggest individuals are landed; all the others, including those having legal size, are discarded.

The impacts of the LO will be different for fishers using different gears. Netters think that in some seasons they will have high rates of discards (e.g., Atlantic horse mackerel), that they will have to come to the harbor to land before returning back to their fishing areas. Handling and sorting fish will take longer, and they do not know if crew members will do it. For them, the need to employ one more crew member to deal with longer handling times means less income for the crew. All fishers want to know who will pay the different taxes related to auctions, dealing with trash, etc. Netters and long-liners consider that the LO will have a negative economic impact on their activity. But for the more selective handliners, the LO was felt to have little economic impact.

Table 5.2 Reasons for discarding and barriers to implementing the Landings Obligation (LO)

Case study	Country	Main reasons for discarding	Barriers to the implementation of the LO		
			Ecological	Economic	Institutional
SSF in the British Channel, Celtic Sea, and Bay of Biscay	France	Mainly regulations (quotas, MLS, and forbidden species). Also, low market value, lack of commercial value/market, high grading, and damaged catch	Mix fisheries, in some season's abundance of some species are not easy to avoid. Few vessels located in estuary areas deal with undersize fish	The LO will increase operation costs for netters and long-liners (more trips to land all catch, increase in crew to deal with extra work). Worries about who will pay for taxes related to the auction, trash, etc.	Most target species subject to quota and many small-scale fishers operate under the national open quota system, which ends fast
SSF in the Thermaikos Gulf	Greece	Low market value of the landings, damaged catch, mishandling on board, undersize fish, small catch	Many factors, mostly caused by the nature of the Greek SSF (multi-fleet and multi-species). Recent data show that discards have risen and are dominated by alien species	Economic incentives seem to contribute to discarding practices; high local market demand for fish contributes to the regular selling of undersized fish in the black market	Loose enforcement; lack of spatial monitoring system for vessels < 12 m (the majority of SSF fleet). Unknown number of recreational vessels hardens the role of fisheries managers
				Fishers do not perceive an increase in operation costs due to the LO because they have little discards	Fishers oppose the LO because it will decrease their catch. There is the need to decrease the MLS for some species to avoid discards
SSF in Catalonia	Spain	Damaged catch; low market value	Largely mixed fisheries with relatively small quantities of discards of regulated species; very	Increased cost of sorting; inexistence of economic outlet for unwanted catches brought to land	Loose monitoring, control, and enforcement capacity by the fisheries administration; lack of

(continued)

Table 5.2 (continued)

Case study	Country	Main reasons for discarding	Barriers to the implementation of the LO		
			Ecological	Economic	Institutional
			difficult to optimize operations to completely avoid unwanted catches		incentives for compliance
SSF in Galicia	Spain	Lack of quotas for harvested commercial species	Largely mixed fisheries with relatively small quantities of discards of regulated species; very difficult to optimize operations to completely avoid unwanted catch	The hold space on board is currently optimized, and it would not be possible to expand the hold space without affecting the navigability of the fishing vessels. Small-scale fishing vessels hold their catches on board in boxes classified by species and size, and the potential increase on their number would increase insecurity of the vessels	Fishers strongly oppose the LO and the mandatory measure to annotate all catches in the electronic logbook, because it will be very difficult and impractical during the fishing activities
Deepwater hook-and-line fishery in the Azores	Portugal	Undersize fish (< MLS), quota in the case of “alfonsinos,” low market value, damaged catch	Difficult to avoid unwanted catch due to mixed resources, especially juveniles of blackspot seabream; fishers perceived high abundance of deepwater sharks	Fishers strongly oppose that unwanted undersize catch cannot be sold for direct human consumption; Representatives of fish auctions concerned about the economic costs of collecting and dealing with the unwanted catch	Fishers strongly oppose that catch will count against quota; limiting quota for “alfonsinos” and TAC zero for deepwater sharks could prematurely choke the fishery

(continued)

Table 5.2 (continued)

Case study	Country	Main reasons for discarding	Barriers to the implementation of the LO		
			Ecological	Economic	Institutional
Beach seine	Portugal	Undersize fish (< MLS), low market value	Difficult to implement the LO due to fishery being carried out on the beach	Fishers strongly oppose the fact that catches of juvenile horse mackerel (*Trachurus* spp.) cannot be sold for human consumption	Fishery carried out in areas of great ecological sensitivity (nursery areas, spawning zones, and/or growing areas) and undersize fish constitute an important part of the catch, but these can survive

Note: SSF, small-scale fisheries; MLS, minimum landing size; LO, Landing Obligation

It was felt that the ecosystem will also likely be negatively impacted by the LO because discards returned to the sea are often eaten by birds, other fish, mammals, or benthic scavengers (Depestele et al., this volume). Small-scale fishers wonder what will happen to the ecosystem if discarding practices are ended. They also prefer to continue discarding as usual rather than supporting the aquaculture sector which they perceive is bound to benefit from the implementation of the LO.

For the moment, SSF avoids unwanted catches, especially undersize fishes, by changing fishing areas. Their main concern is the avoidance of seasonal species like mackerels (*Scomber* spp.) for which they have little or no quota at all. Choke species are the most important constraint because there is always the risk of the fishery to choke, rendering a continuation of operation impossible. Until now, the LO has not been fully implemented, with exemptions having been implemented in all regional seas, but discards are still not landed nor registered officially.

5.3.2 *Greece*

Small-Scale Fisheries in the Thermaikos Gulf

SSF accounts for the majority of SSF vessels operating in Greek waters (94%) with a fleet numbering 12,762 vessels in 2014. They are active along the extensive Greek coastline, using polyvalent passive gears and catching a multitude of species (Stergiou et al. 2002; Gonçalves et al. 2007; Tzanatos et al. 2007; Brodersen et al. 2016), and the SSF métiers exhibit significant spatiotemporal variations in catch composition (Tzanatos et al. 2007; Palialexis and Vassilopoulou 2012a, b;

Table 5.1). Landings are channeled to the market through short supply chains, or directly to restaurants, and sold at an average value of 9 €·kg^{-1}. However, landings per vessel as well as income per fisher are generally very low, and each business has low invested capital.

The Greek SSFs are mostly family-owned vessels with one or two people on board, sometimes the husband and wife together. Based on the Data Collection Framework in 2014, this is the largest fishing fleet in European waters, with a steady decrease since 2008, following the general trend in the overall Greek fleet. This segment had a combined gross tonnage of 24.8 thousand GT and a total power of 238.3 thousand kW (STECF 2016).

SSFs are characterized by their multi-gear nature and the targeting of multiple species, with *Sepia officinalis*, *Mullus surmuletus*, *Diplodus annularis*, *Oblada melanura*, *Octopus vulgaris*, *Pagellus erythrinus*, and *Scorpaena porcus* being landed in high numbers (Stergiou et al. 2002; Gonçalves et al. 2007; Tzanatos et al. 2007; Brodersen et al. 2016) and the SSF metiers exhibit significant spatio-temporal variations in the catch composition (Tzanatos et al. 2007; Palialexis and Vassilopoulou 2012a, b).

In relation to discarding practices, SSF in Greece documents relatively low discarding, with estimates ~10% of the total catch (Tzanatos et al. 2007; Vassilopoulou et al. 2007). More recent data show that discards have risen (17% of the catch in 2014–2016, compared to 7.5% of the catch in 2004–2006) and have been dominated by alien species catches: *Siganus luridus* – which is commercial in some regions – represented 18% of discards in weight, while three more alien species (*Siganus rivulatus*, *Stephanolepsis diaspros*, *Balistes capriscus*) have also been documented in a SSF in the Saronikos Gulf (Brodersen et al. 2016).

SSF discards are a result of (i) low commercial value of the landings (e.g., Atlantic lizardfish (*Synodus saurus*); (ii) fishing practices, i.e., damage to individuals before being brought on board (e.g., European hake); (iii) mishandling on board; (iv) the catch of undersize individuals for species under MLS regimes (e.g., annular seabream (*Diplodus annularis*); and (v) fish having commercial value but not caught in adequate numbers to be sold (Tzanatos et al. 2007; Gonçalves et al. 2007) (Table 5.2). Other factors such as soaking time, depth of the fishing operations, and the mesh used affect considerably the discard numbers in the trammel net fisheries of the Ionian Sea (Vassilopoulou, unpublished data). In Table 5.1 more information is given on the studies dedicated to the investigation of discard practices of SSF in Greece. They all showed that the overall discarded fraction from SSF is considered as far from being negligible.

There are many factors that act as barriers for the successful implementation of the LO, mostly caused by the nature of the Greek SSF (i.e., different gear used with different species being targeted simultaneously) (Table 5.2). Economic incentives to not discard result in undersized fish being sold regularly on the black market (Damalas and Vassilopoulou 2013).

Interviews with small-scale fishers operating in the Thermaikos Gulf were done in 2015 and 2017 as part of two H2020 projects (MINOUW http://minouw-project.eu and DiscardLess). Small-scale fishers in the Thermaikos Gulf said that they never heard about the LO (Christou et al. 2017; Maynou et al. 2017; Fitzpatrick et al. 2017). But as soon as it was explained to them what the LO means, all of them declared to be against it. The rule is perceived as an additional threat for their activity. Small-scale fishers operating in the area say that they are currently in competition with dolphins which constantly destroy their fishing gear (nets) and damage captured fish. They said that dolphins leave little fish in the nets. “If we want to bring fish home, we have to watch our nets; therefore, we stay on the spot.” To avoid nets being destroyed due to the presence of the dolphins, fishers never set their nets for several hours. Sometimes soaking time is less than an hour, and fishers of this region have problems earning a living. Within this short time of operation, discards are very low.

Fishers did not know that the LO is already implemented in Greece and had never heard about the ongoing exemptions already granted to them. For them, the main reason for discarding is regulatory and principally the MLS. The other reasons are damaged fish and lack of market prices for some species. They considered that the discarded quantities are low, and they would not have problems to land them if they had to do so. Nowadays, unwanted catches are often landed for human consumption. For example, undersized fish may be offered as a present to clients, to family members and friends, especially when practicing direct sales. Species used to make fish soups, or undersize fish appreciated by the local market (e.g., surmullet *Mullus surmuletus*) are often given as gifts.

They do not have any problem moving to another fishing area when the quantity of MLS individuals is high because they stay near the nets during the fishing operation “to chase dolphins attacking their gear.” If catches contain a lot of small fish, they turn to other fishing grounds. They do not face the same problem when they use pots because unwanted catches remain alive, and as soon as they are put on board, they are released into the sea. They think that live individuals have a high survival rate as soon as they are back into the water. In this way, small-scale fishers think that the LO is not a problem compared to the threat represented by dolphins. For them, the daily struggle against dolphins makes LO a softer constraint. LO doesn’t really impact their activity due to their low rates of discards. It is observed that this latter finding contradicts their first negative vision of the LO.

According to fishers, the LO will impact more on trawlers, which generate more discards. For SSF fishers it is a good thing that these boats will have to reduce discards. These two métiers do not operate in the same areas, and little competition for space occurs. But both fleets are targeting the same species, and during the months that trawlers are operating (trawling activity is forbidden in territorial waters between June and the end of September), SSF fishers have problems selling their catch at a good price.

When asked whether they record discards, fishers respond that until the end of 2017 “nobody asked them to record them.” And if somebody tells them to do so, they will not comply because they “don’t want to complicate their life by adding more administrative tasks.” From the interviews, it appears that small-scale fishers of the Thermaikos Gulf are against the LO by principle, but an analysis of their discourse demonstrates the opposite. This is due to the fact that such a rule will have little impact on their activities. In the case of effective implementation, they can easily adapt to the LO. The gears that fishers use are among the most selective, and they do not think that they will need to make more effort under the LO (Table 5.2).

The current conditions of SSF in the Thermaikos Gulf may be different from other areas in Greece, but in terms of discards, it seems to be similar to the results of other studies undertaken in that country. Yet, it is crucial to investigate discard levels specific for each métier and quantify the discards problem among the whole SSF sector, using robust indices (Stergiou et al. 2007). The low discards generated by Mediterranean fisheries (Tsagarakis et al. 2014) and also by other fisheries (including areas under a quota system) should prompt authorities to claim a specific exemption at the EU level, as SSF is an important activity for coastal communities and provides income and employment for local populations in areas with few alternative economic activities (Pita et al. 2010), particularly in small, isolated islands. The ongoing financial recession in Greece has further hardened the socioeconomic state of these fisheries. Thus, it is important to safeguard the sector and maintain the social and economic sustainability of the coastal communities.

5.3.3 Portugal

Two examples are provided for the impact of the LO in the Portuguese SSF sector: the beach seine fisheries in mainland Portugal, an ancient activity registered in the National Archive of Intangible Cultural Heritage (e.g., in Costa da Caparica beach seine fishery; Diário da República, 2nd series, N° 34, of 16 February 2017), and the deepwater hook-and-line fisheries in the Azores islands.

5.3.3.1 The Beach Seine Fishery

The beach seine fishery is an ancient commercial fishing activity on the Portuguese coast, with reports dating as far back as the early fifteenth century (Franca and Costa 1979; Martins et al. 2000). Nowadays, the beach seine fleet is composed of 143 vessels, distributed along the Portuguese mainland coast, mainly on the northwest coast (European Commission 2018) (Table 5.1). Each vessel employs ~12 people, 5 working on board the vessel, and 7 working on land. This is a seasonal fishery, typically occurring from March to November. The main target species of the fishery are small pelagic fish such as Atlantic chub mackerel (*Scomber colias*), Atlantic horse mackerel, and European pilchard (*Sardina pilchardus*) (Gaspar and Pereira 2014). In Portugal, official fishing statistics landings are presented by fleet component (divided into trawling, purse seine, and multi-gear); therefore, it is not possible to know the proportion of landings (in volume and value) by the beach seine fishery.

The beach seine fishery operates in a coastal zone of great ecological sensitivity, as this fishing activity occurs in nursery areas, spawning zones, and/or growing areas for many species of high economic interest. As a consequence, juveniles constitute an important fraction of captures, which commercialization is not allowed by law, as individuals are < MLS, and are thus discarded (Jorge et al. 2002). In addition to capture large numbers of juveniles, this fishing technique is not selective and also captures a wide variety of bycatch species (Faltas 1997; Lamberth et al. 1997; Cabral et al. 2003), despite having seasonally target species (Fagundes et al. 2007). The low commercial value of bycatches and legal constraints results in bycatches not being traded and mostly discarded (Cabral et al. 2003). In this fishery, the LO was implemented on January 1, 2015, and applies to catch of horse mackerels (*Trachurus* spp.) and blue whiting (*Micromesistius poutassou*).

5.3.3.2 The Deep-water Hook-and-Line Fishery in Azores

The Azores is a Portuguese oceanic archipelago in the North Atlantic Ocean, with a one million km^2 exclusive economic zone (EEZ), no continental shelf and great depths, with an important demersal fishing around the island slopes and the many seamounts present in the area (Silva and Pinho 2007; Morato et al. 2008). The bottom hook-and-line fishery is the most important fishery in the region, employing about 60% of all professional fishers in the archipelago (Carvalho et al. 2011). This fishery is mostly small-scale, with 92% of the vessels < 12 m (N = 478 in 2016) (Table 5.1). Two main fishing gears are used: (i) bottom longlines targeting mainly deep-sea demersal fishes, such as blackspot seabream (*Pagellus bogaraveo*), alfonsinos (*Beryx* spp.), or blackbelly rosefish (*Helicolenus dactylopterus*), or deeper species such as common mora (*Mora mora*), and (ii) handline targeting mostly blackspot seabream and wreckfish (*Polyprion americanus*). Both gears operate all year round. The bottom longline and handline fishery is by far the most valuable in terms of landed value, with an annual landed value varying from 15 to 21 million € for the period 2010–2017, around 58% of all landed value in the Azores (SREA, http://estatistica.azores.gov.pt).

Unreported catch for this fishery was estimated to amount to 830 t per year on average over the period 2000–2014, i.e., 10.3% of the total catch (Pham et al. 2013). Around half (47%) of this unreported catch is used as bait, kept for crew consumption, or offered, while the remaining was discarded at sea (447 t·year^{-1}) (Fauconnet et al. in press).

Discard practices are believed to be similar between handlines and bottom longlines. Observer data suggest that the catch of individuals smaller than the MLS is the main cause for discarding in this fishery, followed by low market value (Canha 2013). About 90 species are regularly discarded by this fishery, 40%

of which due to low commercial value (Canha 2013). However, 61% of the discards can be attributed to six species of commercially important fish, such as silver scabbardfish (*Lepidopus caudatus*), European conger (*Conger conger*), blackbelly rosefish, splendid alfonsino (*B. splendens*), blackspot seabream, and thornback ray (*Raja clavata*). At least ten species of deepwater sharks are occasionally caught by this fishery. Even if limited, this bycatch is of concern since many deepwater sharks such as *Deania* spp., *Centrophorus* spp., *Etmopterus* spp., *Centroscymnus* spp., and kitefin shark (*Dalatias licha*) are listed in the IUCN red list of endangered species. Due to their vulnerability, the EU has set their TAC to zero in 2010 (EC Reg. N° 1359/2008). Since then, discard of those species has been compulsory. Deepwater sharks accounted for 8% of the discards of the fishery over the period 2010–2014 (Fauconnet et al. 2016).

The implementation of the LO in Azorean demersal fisheries will only take place from January 2019 onward. Several factors were identified, in semi-structured interviews and meeting with stakeholders, as part of the DiscardLess project, to potentially act as barriers for the successful implementation of the LO in the Azores (Table 5.2).

5.3.4 Spain

Two cases from Spain illustrate the complexities of the implementation of the LO in different regions of Spain: the case of SSF in Catalonia (NW Mediterranean) and the gillnet fishery in Galicia (NW Atlantic).

5.3.4.1 Small-Scale Fisheries in Catalonia

SSF in Catalonia is carried out by a relatively high number of fishing units (365 out of a fleet of 727 vessels in 2016) operating from 32 fishing harbors. Landings of the SSF fleet oscillate between 1800 and 3800 $t{\cdot}year^{-1}$ in recent years (average 2960 $t{\cdot}year^{-1}$ for the period 2000–2016), with a corresponding value of landings around 15 million € (Table 5.1). This fisheries production corresponds to ca. 10% of the production/landings in Catalonia but employs ca. 50% of the fishing fleet and 25% of the labor/fishers. The fleet operates in coastal waters, typically within 6 miles of the coast, uses a multitude of gears, and lands over 200 species, the most important being demersal species and sand eels (*Gymnammodytes* spp.), common octopus (*Octopus vulgaris*), and Atlantic bonito (*Sarda sarda*). Refer to Table 5.1 for detailed information about the fleet, gear and main species landed. In general, the commercial catches of each individual vessel are very low (20–50 $kg{\cdot}day^{-1}$) but of high value, with ex-vessel prices of the target species oscillating between 10 and 20 $€{\cdot}kg^{-1}$.

Compared to other segments of the fleet, SSF is highly selective, and the amount of discards is relatively low. The fractions of the catch that are discarded are usually noncommercial species, such as epibenthic invertebrates, or damaged fish. Commercial species that could be otherwise sold are discarded when they are damaged due to scavengers preying on the catch. This problem is particularly acute for set net fishing gear (trammel nets and longlines). Undersize fish are usually not discarded but sold on the black market. Field studies carried out in the MINOUW project show that the amount of catches below legal size is generally low, but for certain species and certain gear deployments, the proportion of catches that will fall under the remit of the Landing Obligation can be high. Trammel nets employing inner panels of 40–60 mm mesh can produce a relatively high proportion of undersize European seabass (*Dicentrarchus labrax*), Sand steenbras (*Lithognathus mormyrus*), blackspot seabream (*Pagellus bogaraveo*), or common sole (*Solea solea*). In the case of the blackspot seabream, its large legal size (33 cm TL) results in all catches from all fishing gears studied being undersize. Several barriers for the implementation of the LO have been identified such as low quantities of discards, the lack of capacity to monitor SSF by the regional administration, and increase costs of sorting, among others (Table 5.2).

5.3.4.2 The Gillnet Fishery in Galicia

Fishing is a major contributor to gross domestic product in Galicia (an autonomous community in northwestern Spain), the main fishing region in Spain (Villasante 2012). The artisanal/SSF fleet is comprised mainly of small vessels (on average 6 m long), fishing with a great variety of passive gears, the so-called *artes menores* (traps, hooks and lines, gill and trammel nets, and small seines), and exploiting a diverse range of species, most of which are subjected to TACs.

The fleet using gillnets comprises 1000 fishing vessels, operating in a multispecific SSF, mainly harvesting European hake, pouting (*Trisopterus luscus*), horse mackerels, and surmullet at depths of 30–140 m and up to 8–10 miles from the coast. Based on results from interviews started in 2015 and updated until 2018, the reasons for discarding are the precautionary closure and the full closure of the fishery due to the full harvest of the TAC (Villasante et al. 2016a, b).

Recently, Villasante et al. (2015b) estimated the total removals of fisheries catches (including IUU catches, subsistence catches, and discards for commercial and recreational fisheries) for the 1950–2010 period. The authors demonstrated that the discard rate for SSFs ranges between 5–18% depending on the type of commercial species harvested. However, the authors also found that the discard rate for some sedentary resources (e.g., goose barnacle (*Pollicipes pollicipes*) 74% and razor clams *Ensis* spp. 49%) can be significantly higher than for other SSFs.

However, the species under TAC and quota regulations present high discard rates which ranged between 0 and −50% (European hake, mackerels) and/or 50−200%

(horse mackerels). Catches of horse mackerels and mackerels are highly variable due to migratory movements from Portuguese to Galician waters and can sometimes lead to high discard rates. Harvesting of immature individuals was reported to be very low or nonexistent for all species caught by this fishery (Villasante et al. 2015b, 2016c).

Regarding the compliance to the LO, the expert's opinion and the participatory consultation made with the small-scale fisheries sector show that changing the fisheries management system based on the TAC regulation would be the most important reason to comply with the LO (Villasante et al. 2016a, b) (Table 5.2).

5.4 Conclusion

Despite the increased recognition of SSFs, there is a still need to ensure that policy-makers receive robust scientific data about such fisheries on which to base decisions and thus ensure coherent policy. Our results show that only 21% of 1219 papers that have been published until 2018 focused on the discard problem in SSF.

Key SSFs from around Europe selected to investigate the reasons for discarding, impact, and barriers to implementing the LO illustrate that discard rates vary greatly from fishery to fishery and species to species. However, the main reasons fishers discard are relatively similar from fishery to fishery and are mostly due to regulations (mainly TACs, quotas, and MLS), low market value of some catch components, capture of noncommercial species, high grading, and damaged catch.

Small-scale fishers perceive that it will be difficult to comply with the LO and could identify ecological, economic, and institutional barriers to the implementation of the LO. From an ecological perspective, most fishers are of the opinion that resources are largely mixed, and unwanted catch is very difficult to avoid. For example, the fact that the beach seine fishery in Portugal is carried out in areas of great ecological sensitivity, such as nursery areas, results in the capture of large numbers of juveniles. From an institutional perspective, the lack of monitoring, control, and enforcement capacity by fisheries jurisdictions, combined with lack of incentives for compliance, are critical barriers perceived by fishers for the implementation of the LO in all case studies. Plus, some fishers identified that the implementation of the LO requires the adoption of more selective gear technology (Galicia and Azores). Azores fishers think they are already using one of the most selective gear in European fisheries and as such that the LO should not apply to them.

From an economic perspective, fishers state that the LO will increase the operational costs of fishing activities. They strongly oppose the fact that unwanted undersize catch cannot be sold for human consumption and that this catch will count against their quota. In general, the potential socioeconomic impacts of the LO could be high for SSF. For example, it is estimated that the future yield (catches) under the LO in Galicia (Spain) would be only 50% of catches expected in the absence of the LO, regardless of the total volume of quotas allocated to the fleet.

Acknowledgment The authors acknowledge the financial support from the European COST Action "Ocean Governance for Sustainability – challenges, options and the role of science" and by the ICES Science Fund Project "Social Transformations of Marine Social-Ecological Systems", and MINOUW (Grant Agreement 634495). C. Pita acknowledges FCT/MEC national funds and FEDER co-funding, within the PT2020 partnership Agreement and Compete 2020, for the financial support to CESAM (Grant no UID/AMB/50017/2013). C.M. Teixeira had the support of the Fundação para a Ciência e a Tecnologia (FCT) (Pest-OE/MAR/UI0199/2011); and C.M. Teixeira and C. Pita were supported by the Research Project "LESSisMORE – LESS discards and LESS fishing effort for BETTER efficiency on the small-scale fisheries" (Ref. "LISBOA-01-0145-FEDER-028179"), support by the FEDER Funds through the COMPETE 2020, by the PIDDAC through FCT/MCTES. TM thanks the support from the European Union's Horizon 2020 research and innovation project DiscardLess (Grant Agreement No 633680), the Fundação para a Ciência e Tecnologia (FCT) strategic project UID/MAR/04292/2013 granted to MARE. He is also supported by the Program Investigador FCT (IF/01194/2013/CP1199/CT0002).

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Chapter 6
Potential Economic Consequences of the Landing Obligation

Ayoe Hoff, Hans Frost, Peder Andersen, Raul Prellezo, Lucía Rueda, George Triantaphyllidis, Ioanna Argyrou, Athanassios Tsikliras, Arina Motova, Sigrid Lehuta, Hazel Curtis, Gonzalo Rodríguez-Rodríguez, Hugo M. Ballesteros, Julio Valeiras, and José María Bellido

Abstract To assess the likely economic outcomes to fishing fleets of the Landing Obligation (LO), bioeconomic models covering seven European fisheries, ranging from the North East Atlantic to the Mediterranean, have been applied to estimate the

A. Hoff (✉) · H. Frost · P. Andersen
Department of Food and Resource Economics (IFRO), University of Copenhagen, Frederiksberg C, Denmark
e-mail: ah@ifro.ku.dk

R. Prellezo
AZTI, Sukarrieta, BIZKAIA, Spain

L. Rueda
Centro Oceanográfico de Baleares, Instituto Español de Oceanografía, Palma, Spain

G. Triantaphyllidis · I. Argyrou
NAYS Ltd., Kallithea, Athens

A. Tsikliras
Laboratory of Ichthyology, School of Biology, Aristotle University of Thessaloniki University Campus, Thessaloniki, Greece

A. Motova · H. Curtis
Seafish, Edinburgh, UK

S. Lehuta
Ifremer, Fisheries Ecol & Modelling Unit, Nantes, France

G. Rodríguez-Rodríguez · H. M. Ballesteros
Fisheries Economics and Natural Resources Research Unit, Department of Applied Economics, Faculty of Economics and Business Administration, University of Santiago, Santiago de Compostela, A Coruña, Spain

J. Valeiras
Instituto Español de Oceanografía (IEO), Centro Oceanográfico de Vigo, Vigo, Spain

J. M. Bellido
Instituto Español de Oceanografía, Centro Oceanográfico de Murcia (IEO), San Pedro del Pinatar, Murcia, Spain

S. S. Uhlmann et al. (eds.), *The European Landing Obligation*,
https://doi.org/10.1007/978-3-030-03308-8_6

economic performance of fleets before and after implementing the LO. It is shown that for most of the analysed fisheries, their economic outcome will be negatively affected in the long term by the LO, when compared to the expected outcome with no LO. Efficient mitigation strategies (exemptions, quota uplifts, improved selectivity, effort reallocation and others) may, for some of the analysed fisheries, reduce the negative economic effect of the LO. Moreover, the possibility to trade quotas, both nationally and internationally, may also reduce the economic losses caused by the LO. However, even with mitigation strategies and/or quota trade in place, most of the analysed fisheries are worse off under the LO than what could be expected if the LO was not implemented.

Keywords Costs and earnings · Discards · Economic repercussions · Fisheries management · Fleet adjustment

6.1 Introduction

Commercial fisheries in Europe are diverse, with fish being caught for varied purposes ranging from high-value species for human consumption to fish used for fishmeal and fish oil. Technological and biological interactions make it difficult to catch target species completely selectively. For almost a century, landings of immature fish have been prohibited by regulations. Discarding fish below a minimum conservation reference size (MCRS) has been mandatory in European waters since the adoption of the Common Fisheries Policy (CFP) in 1983. The CFP Landing Obligation (LO) of 2013 requires fish under the MCRS to be landed, with implementation being phased in from 2015 to 2019. Similarly, before 2013, it was forbidden to land species for which quota was exhausted, and discarding of catches at or above MCRS was therefore required, a logical practice in mixed species fisheries.

Many businesses expect significant short-term negative economic repercussions of the LO due to increased operating costs, decreased income from landings and underutilisation of quotas (Condie et al. 2014). However, the actual outcomes of the LO will depend on several factors, including (i) the management system in place, (ii) application of exemptions (e.g. *de minimis* allowance of discards up to 5%), (iii) interannual transfers, (iv) catch allowances of stocks without TACs, (v) quota adjustments and quota swaps/movements, (vi) application of selectivity measures, (vii) costs of landing unwanted catch, (viii) prices obtained for unwanted fish and (ix) compliance of the sector. It is hoped that short-term losses could be mitigated by longer-term gains, given the desired reduced pressure on fish stocks and anticipated increases in quota and catch rates.

This chapter considers economic outcomes for fleets by analysing possible economic effects of the LO for seven diverse European case studies comprising (i) UK and Danish North Sea demersal fisheries, (ii) the French demersal trawl fishery in the Eastern English Channel, (iii) the Spanish trawl fishery in the Bay of Biscay, (iv) the Spanish trawl fishery in the Cantabrian-NW region, (v) the Greek trawl and small-scale coastal fishery in the Thermaikos Gulf (Eastern Mediterranean) and (vi) the Spanish demersal trawl fishery in the Western Mediterranean. Common for all these fleets is that they have a history of substantial unwanted catches before the LO; therefore it can be expected that the LO would affect them substantially.

6.2 What Can the Literature of Economics Tell Us?

The literature tells us that fishers tend to use more fishing effort than socially optimal due to market failures such as the tragedy of the commons (Hardin 1968). An unregulated, open-access fishery leads to overexploitation of fish resources; therefore the EU has attempted to prevent this by use of total allowable catches (TACs), limited fishing effort, MCRS and technical specifications for fishing gears, closed areas and seasons, among other measures. However, in mixed fisheries, these restrictions may also, in some cases, encourage a 'race to fish' and may increase incentives to discard because low quotas of some species prevent full exploitation of species with higher quotas. Quotas may also increase incentives to high-grade (discard lower-value fish) to maximise profit.

Although the CFP has a common approach to managing the fishing opportunities of the European Union including rules of compulsory discard, the management and organisation of fleets differ between Member States. Therefore, the economic repercussions of the LO not only depend on the rules of the LO but also on the national management system to which fishing businesses are subjected.

When interest for the discard issue arose in the 1990s, four general types of factors that encouraged discarding were identified (FAO 1996b; Nordic Council of Ministers 2003): (i) *institutional*, e.g. management measures such as quotas, effort restrictions, minimum landing size of fish and mesh size regulations; (ii) *biological*, e.g. species interaction and characteristics of the fish (e.g. gender, and size); (iii) *technological* such as gear selectivity (e.g. prohibited gear, damage to fish); and (iv) *economic*, for example, price and cost relationships determined on the market and high-grading (discarding low-value fish, both regulated and unregulated) to maximise profit by using quota and room on-board for more valuable fish (Batsleer et al. 2015).

Discarding originates primarily from non-selective catch and high-grading practices. These form the basis for the empirical and theoretical economic research that has been done regarding discarding over the last 20 years.

This research began in the 1990s (e.g. Flaaten and Larsen 1991; Frost 1996; Christensen 1996; Pascoe and Revill 2004). Empirical approaches also appeared in conferences and research programmes (FAO 1996a, b; Clucas 1997). In the FAO context, the economics of discarding can be found in Pascoe (1997) with an update in Kelleher (2005). The Nordic Council of Ministers (2003) investigated incentives to discard and options to reduce it. An EU Framework 7 project, NECESSITY, investigated options to reduce discarding by using increased mesh sizes or panels in fishing gear (Frost et al. 2007).

Alongside empirical research, theoretical work based on socio-economic modelling has developed. One approach concerns unwanted catch in open-access and individual transferable quota (ITQ)-managed fisheries (Ward 1994; Ward et al. 2012; Boyce 1996; Turner 1996, 1997). These analyses usually include two species (target and nontarget) and two fleets and deal with the optimal use and allocation of effort subject to a profit- (or resource rent-) maximising objective. In this context, bycatches of nontarget species constitute an endogenous externality, i.e. an outside impact influenced by fishers. In a simple situation where harvest of the target and nontarget species is in fixed proportions, fishing effort used to harvest target species can simply be scaled up and down to reach a first-best optimum. However, harvest of target and nontarget species may take place in variable proportions. Boyce (1996) compares maximisation of welfare in situations governed by open access and ITQs of harvesting two such species by two fleets. He finds that open access leads to excessive bycatches and that an ITQ system can only secure a first-best optimum if imposed on both target species and bycatches. Segerson (2007) extends this analysis to include stochastic bycatches and shows that neither landing fees nor ITQs on both target species and bycatches can secure an expected first-best optimum in which all market failures are corrected in an economically optimal way. A different approach to analyse bycatches is adopted in Abbott and Wilen (2009) where actual regulation, as opposed to estimated economically optimal regulation, is introduced. A given fishery is regulated with quotas for both target and nontarget species combined with limited entry programmes, and this actual regulation generates excessive bycatches and too short harvest seasons.

Another theoretical approach deals with high-grading. High-grading may occur for several reasons, e.g. to extend a quota that is nearly exhausted, to get the best value per tonne of quota or to make room on-board the vessel for more valuable fish. Arnason (1994) and Anderson (1994) show that a traditional ITQ system strengthens the incentive to high-grade. However, Turner (1997) shows that a value-based ITQ system (quotas measured in value instead of volume) secures a welfare optimal level of high-grading in a similar way that open access does. Under open-access or effort management, the distance between fishing grounds and ports of landing affects vessel operators' decisions about catching patterns; limited hold or processing capacity may be increased in the short term for high-priced fish through discarding of low-priced fish, and this discarding can thus pay for one or two more hauls per trip (turnaround cost) (see Vestergaard 1996). In the market policy of the CFP, the suppression of withdrawal prices in 2014 also constituted an incentive to discard, as the removal of a fixed minimum price increases the economic propensity to discard.

Analysing high-grading requires the inclusion of high- and low-priced fish. This can be done by including age-structured fish stocks in the model or simply dividing the stock in two parts: a low-priced and a high-priced part.

Fish sales prices relative to fishing costs also influence the incentives to discard: if the price of fish is lower than the costs of putting the fish on the market, then the fish should be discarded – at least from an economic point of view. However, it may pay to land fish even when handling costs are higher than the total value. That is, if costs of discarding are higher than the loss likely to be incurred by putting the fish on the market, then the fish should be landed.

When it is illegal to discard fish while incentives to discard remain, monitoring and control must be effectively invoked to offset incentives to discard (Sutinen and Andersen 1985; Nuevo et al., this volume). Also, social norms, trust and cooperation play a role (Sutinen and Kuperan 1999; Kraak and Hart, this volume). When it is difficult to monitor vessel operations at sea, vessel operators may decide not to comply with regulation. Jensen and Vestergaard (2002) consider discarding in a moral hazard context, i.e. when fishers hide their actions at sea; when these actions cannot be detected, repercussions are placed on them based on common elements such as estimated changes in target fish stocks.

To discourage non-compliance, measures are required to assist enforcement, including penalties, incentives to adapt to social norms, increased acceptance of management rules (Sutinen and Kuperan 1999; Kraak and Hart, this volume) and a governance structure which addresses diverging perceptions about the legitimacy of discarding in the first place (Fitzpatrick et al., this volume; van Hoof et al., this volume). In theory, a premium can be introduced, e.g. an increase in the price of fish that would otherwise be discarded because of a low price. It could also be invoked as a penalty placed on the (estimated) net benefit from discarding. In such a case, the vessel operator will include the benefit/penalty in their decision function. However, he/she will also consider the probability of being detected and the likelihood and size of any fine. If the risk of being detected and the penalty are low, fish will probably be discarded and vice versa.

6.3 The European Case Study Fisheries

Possible economic implications of the LO are presented through seven diverse European fishery case studies. Characteristics of each case are summarised in Table 6.1. Cases are divided into three groups: (i) demersal fisheries in the North Sea, West of Scotland and English Channel, represented by fleets from Denmark, the UK and France, (ii) Spanish Atlantic fisheries represented by the Basque mixed demersal fishery in the Bay of Biscay and the Galician trawl fleet in the Cantabrian-NW region and (iii) Mediterranean fisheries represented by two mixed demersal trawl fisheries from the Balearic Islands (Spain, Western Mediterranean) and the Greek trawl and small-scale coastal fishery in the Thermaikos Gulf (Eastern Mediterranean).

All cases have different management systems on top of which the LO is imposed. However, all have a certain degree of MCRS regulation, and before the LO, it was compulsory to discard fish below MCRS, with a few derogations in certain pelagic

Table 6.1 Base characteristics of the European case study fisheries with respect to the type of fishery, its target species, a brief description of the management system and key reasons for discarding

	Fishery	Target species	Fleet	Management system	Reasons for discarding
North Sea, West of Scotland, Eastern English channel	Danish North Sea demersal fishery	Cod, plaice, haddock, sole and Norway lobster	Netters and trawlers, with length groups from 12 to 40 metres	TACs allocated in ITQs, MCRS	Quota utilisation optimisation Fish below MCRS High-grading
	UK mixed demersal fisheries in the North Sea, West of Scotland and area 7	73 main UK stocks targeted by different fleets in different areas. Pelagic species and non-quota species representing around 58% of value and 75% of weight landed by UK fleet are excluded	All UK active vessels grouped in 99 producer organisation fleet segments	TACs allocated in fixed quota allocation units that can be pooled within a PO, traded by vessel owners, or can be leased by other vessels in the same or other PO, MCRS	Quota utilisation optimisation Fish below MCRS High-grading
	French demersal fishery in the Eastern English Channel	Sole, scallops, whiting, cephalopods, cod, red mullet, sea bass and plaice	Bottom trawlers, mixed trawlers and trawl-dredgers, with length groups from 12 to 40 metres	TACs, MCRS, seasonal closures for scallops and effort limitation	Quota utilisation optimisation Fish below MCRS High-grading
Mediterranean	Spanish demersal fishery in Western Mediterranean	Four different fishing tactics are used, depending on the main target species (Palmer et al. 2009): (1) shallow shelf (striped red mullet), (2) deep shelf (European	Mixed demersal trawl	MCRS and other technical measures	Hake below MCRS High-grading Discard of low-value species

(continued)

Table 6.1 (continued)

	Fishery	Target species	Fleet	Management system	Reasons for discarding
		hake), (3) upper slope (Norway lobster) and (4) middle slope (red shrimp)			
	Greek demersal trawl and small-scale fishery in the Thermaikos Gulf	Mainly hake and red mullet (also surmullet and deep-water rose shrimp)	Bottom trawlers and small-scale coastal vessels using gill nets and trammel nets	Spatial and temporal restrictions, MCRS, other technical measure	Hake and red mullet below MCRS High-grading
Spanish fishery in the Atlantic	Spanish mixed demersal trawl fishery in the Bay of Biscay	Pair trawlers: mainly hake. Otter trawlers: hake, megrims, horse mackerel, blue whiting, mackerel, rays, red mullet, seabass, squids and cuttlefish	Pair and otter trawlers using different métiers	The fleet is managed with fishing rights, TACs and Total allowable Effort, together with mesh and MCRS limitations	Quota utilisation optimisation Fish below MCRS
	Spanish demersal trawl fishery in the Cantabrian-NW region	Hake, megrim, anglerfish, blue whiting, horse mackerel and mackerel	Otter bottom trawlers (average length 28 metres)	The fleet is managed with fishing rights and Total allowable Effort together with mesh and minimum landing size limitations	Quota utilisation optimisation Fish below MCRS

fisheries. Under the LO, it has become obligatory to land these fish, but they cannot be sold for human consumption. On top of this new obligation to land small fish, the North Sea, West of Scotland and English Channel fisheries are regulated by TACs, in some cases combined with effort regulation and technical conservation measures. While TACs are set at the European level, national quotas (i.e. fixed shares of the TACs) are managed differently by the Member States. They are managed as ITQs in Denmark, are distributed between producer organisations (POs) and vessel owners in the UK in a system that is essentially a quasi-ITQ system and are distributed between POs in France. Swaps and quota exchanges are allowed between organisations in the UK and France. The Atlantic Spanish fisheries are regulated with Total Allowable Effort (Prellezo et al. 2016) and TACs. The Mediterranean fisheries are regulated through technical gear specifications and MCRS for the main target species, temporal and spatial closures and other technical measures (Stergiou et al. 2016).

Demersal fishing activities in the North Sea, West of Scotland and in the English Channel have highly mixed catches of species, and therefore it is not possible to fully catch all quotas at the same time in the year, leading to either underutilisation of quota or discarding of fish for which quotas are exhausted first. Under the LO, the risk of a choke situation, i.e. having to stop fishing when the quota of a low-quota stock is exhausted, is a great concern to managers and vessel operators alike (Ulrich et al. 2011). This is especially expected to be a problem for French vessels, operating with fixed quota shares within producer/fishery organisations, while this problem may be less severe for UK and Danish fleets, where quota trade may mitigate the problem to some extent. For Spanish demersal fisheries in the Bay of Biscay, mackerel and horse mackerel are discarded because of low-quota allocations, i.e. to optimise quota utilisation of other species, while hake is primarily discarded because of being below MCRS. Thus, in these fisheries choke situations may also be an issue. In the Mediterranean fisheries, discarding is primarily due to fish below MCRS and to high-grading. As such, all cases face lower revenues under the LO given that previously discarded fish of low value and below MCRS must now be landed, combined with increased handling costs of these unwanted catches.

6.3.1 Mitigation Strategies

Given the different challenges that the selected fishing fleets face under the LO, different scenarios have been analysed, mainly addressing (i) how fleets will respond given the threats faced and (ii) how economic losses can be reduced through mitigation strategies most relevant for that fleet. Table 6.2 gives an outline of the scenarios analysed for each case study.

In all case studies, the economic situation was analysed for the fleet, given the current management system (cf. Table 6.1), i.e. if the LO had not been implemented (named ‘business as usual’). This scenario is used as a first benchmark when analysing the effects of the LO. In all case studies the full implementation of the LO with no exemptions was also analysed, i.e. the economic situation for the fleets given their current management system with the LO superimposed. This is a second benchmark against which the effects of introducing mitigation strategies are compared. Application of full implementation in the case study models was based on different assumptions for each case study:

Table 6.2 Scenarios analysed for the European case study fisheries

	North Sea, West of Scotland and English Channel			Spanish Atlantic fisheries		Mediterranean fisheries	
	Denmark	UK	France	Bay of Biscay[1]	Cantabrian -NW	Spain (W. Med)	Greece (E. Med)
Business as usual (no LO)	■	■	■	■	■	■	■
Full LO implementation, no exemptions	■	■	■	■	■	■	■
De minimis	■			■	■		
Year Transfer				■			
Mesh size selectivity				■		■	■
Effort reallocation[2]/Flexibility	■		■		■		
Quota adjustment		■	■				
Decrease minimum landings size	■						
Catch allowance for stocks with zero TACs		■					
Vessel effort movements between métiers		■					
Quota movement (swaps)		■					

Notes: [1]Quota adjustments assumed in all LO scenarios for the Bay of Biscay

[2]Effort reallocation can be seasonal and between fleets (the Danish case) and spatially (the French case) or more efficient effort use (the Cantabrian-NW case)

- In the Danish North Sea demersal case, fish below MCRS must be landed, with gradual implementation from 2016 to 2019 depending on species.
- In the UK mixed demersal fleets, each vessel in a PO has its initial quota available, and by 2019 no demersal species below MCRS can be discarded. The LO is implemented gradually towards 2019 depending on the fish stock.
- In the French mixed demersal case, vessels in métiers are forbidden to continue fishing as soon as the quota of one of their target stocks is reached, and fishing effort is then allocated between the remaining métiers. Fish under MCRS are landed but cannot be sold (price set to zero).
- In the Bay of Biscay Basque mixed demersal trawl case, the fishing activity of a given métier is stopped when the most binding quota share is reached.

- In the Galician mixed trawl case, all catches of species subject to TACs or MCRS must be landed.
- In both Mediterranean cases, a 10% increase in daily variable costs and one more crew member on-board are assumed to reflect the extra effort needed to bring ashore unwanted catches. Three full implementation scenarios were examined for the Greek case (Eastern Mediterranean) based on varying discard rates: (i) 5% increase of daily costs, no extra crew member; (ii) 10% increase of daily costs, 10% extra crew (the original full implementation scenario); and (iii) 20% increase of daily costs, 20% extra crew (based on the discard rates reported in the literature). The reason for the extra full implementation scenarios was that, according to official reports (DCF 2016), the percentage of hake and red mullet discards in Greece had dropped to less than 5% since 2013; thus, this case differs substantially from initial estimates that were based on the literature (e.g. Tsagarakis et al. (2014)).

The analysed mitigation strategies (see Table 6.2) are different for each case, reflecting the specific challenges each fleet faces when the LO is introduced.

In the UK, Danish and French cases, the focus is on maximising quota utilisation. For the Danish demersal fishery, the effect of introducing a 5% *de minimis* exemption is analysed. In addition, economic effects of lowering the MCRS for cod (making it possible to sell some fraction of cod below the previous MCRS) are analysed. For the UK North Sea and West of Scotland mixed demersal fleets, a number of mitigation strategies are analysed: (i) allowance for catching and landing species with zero TAC; (ii) as scenario (i) but with quota adjustment to all TAC species; (iii) as scenario (ii) but with the possibility to reallocate effort to other areas of operation to better utilise producer organisation (PO) quota; (iv) as scenario (iii) but with quota reallocation allowed within the UK to maximise use of quotas; and (v) as scenario (iv) but with international and national swaps at the level of the baseline year incorporated and UK end of year quota reallocated to PO fleets in need of quota. The French mixed demersal fishery in the English Channel case focused on (i) quota adjustments for sole, plaice, cod and whiting and (ii) assuming that fishers can shift to fish in other areas.

The choke situation and having to land fish below MCRS are also issues in the Spanish Atlantic cases. Thus the focus is on quota utilisation optimisation and on fishing gear selectivity. For the Spanish Bay of Biscay mixed demersal fishery, the focus is on investigating the economic effects of implementing (i) 5% *de minimis* exemption, (ii) inter-year quota flexibility, (iii) combining *de minimis* and inter-year flexibility and (iv) selectivity changes for the pair trawlers, given the single-species nature of their catches (90% hake), assuming a change in minimum mesh size from 100 mm to 120 mm. For the Spanish demersal trawl fishery in the Cantabrian-NW region, the focus is on (i) 5% *de minimis* exemption and (ii) effects of improved selectivity, e.g. through effort reallocation or non-compliance, assuming this will reduce unwanted catches by 50%.

The two Mediterranean cases focus predominantly on selectivity issues, given their high catches of unwanted species and fish below MCRS. For the Spanish demersal trawl fishery around the Balearic Islands (Western Mediterranean), several selectivity possibilities for hake are analysed: (i) no fishing mortality for hake at age 0, (ii) no fishing mortality of hake below MCRS (by decreasing the fishing mortality of age 1 individuals by 10%) and (iii) no fishing mortality of immature individuals (through modification of age-selectivity parameters).

For the Greek demersal trawl and small-scale coastal fishery in the Thermaikos Gulf (Eastern Mediterranean), three selectivity scenarios are applied to both hake and red mullet: (i) no fishing mortality at age 0, (ii) no fishing mortality below MCRS (by additionally decreasing the fishing mortality of age 1 individuals by 10%) and (iii) no fishing mortality for hake and red mullet at ages 0 and 1 through modification of age-selectivity parameters.

6.3.2 The Model Tools

The analyses were done using different bioeconomic models constructed for the geographical areas of the case study fleets (Table 6.3). Given the level of detail and complexity of each model, model descriptions are not provided in this chapter but can be found in the references listed in Table 6.3. All but one of the models are dynamic, evaluating the development of fleet capacity, economic performance and effort, together with stock dynamics, during the period 2015–2025. The exception is the analysis of the Spanish trawl fishery in the Cantabrian-NW region, which is based on input-output models.

6.4 Results

Analyses of the economic consequences of implementing the LO include two parts, firstly the economic outcome under the LO relative to the outcome if the LO had not been introduced and secondly the LO mitigation scenarios benchmarked against the LO scenario with no exemptions or other mitigation strategies included. These results differ depending on whether they are evaluated in the short or long term. Short term is defined as a period in which only variable inputs can change (e.g. fuel and crew) but not fixed inputs such as vessels, equipment and gear, while in the long term, all inputs can change.

Generally, some short-term negative economic effects of the LO can be expected. The main reasons for this are (i) the choke species issue for fisheries regulated with quotas, whereby catch of some species is constrained once catch of another species has reached its total quota, (ii) that landing of unwanted fish below MCRS and of low market value will replace landings above MCRS and of high value and (iii) the higher costs created by landing instead of discarding. The scale of these short-term losses is case-specific. In the long term, choke situations and displacement of vessels to other areas are expected to reduce fishing pressure, leading to biomass increases and thus improved fishing possibilities. However, ensuing economic improvements

Table 6.3 Model tools applied to evaluate the consequences of the LO for European case fisheries

	Fishery	Model
North Sea, West of Scotland, Eastern English channel: Mixed demersal	Danish North Sea demersal fishery	Fishrent: A bioeconomic profit maximisation model integrating, and allowing feedback between, the economy and the biology of the fishery (Frost et al. 2013)
	UK mixed demersal fisheries in the North Sea, West of Scotland and area 7	SEAFISH: Based on the Fishrent structure, the SEAFISH simulation model is developed to analyse the activity of the total UK fleet (Mardle et al. 2017)
	French demersal fishery in the Eastern English Channel	ISIS-Fish: A spatialised operational simulation model which simulates the dynamics of fish populations and fleets of the mixed fisheries in the Eastern Channel (Pelletier et al. 2009; Lehuta et al. 2015)
Mediterranean	Spanish demersal fishery in the Western Mediterranean	MEFISTO (Mediterranean Fisheries Simulation Tool): A bioeconomic fisheries simulation model with an age-structured biological component (Lleonart et al. 2003, https://mefisto2017.wordpress.com/)
	Greek demersal fishery in the Thermaikos Gulf (Eastern Mediterranean)	
Spanish Atlantic fisheries	Spanish mixed demersal trawl fishery in the Bay of Biscay	FLBEIA: A management strategy evaluation model coupling economic, biological and social dimensions; it shares economic structure with Fishrent but with an age-structured biological component (Garcia et al. 2017)
	Spanish demersal trawl fishery in the Cantabrian-NW region	Input-output analysis: Based on input-output tables for the Galician Fishing and Preserved Fish Sectors 2011 (García-Negro et al. 2016), the function of production of the fleet was recalculated considering the LO and the biological data obtained from IEO (Spanish Institute of Oceanography) campaigns

will differ for individual fleet segments and vessel businesses, depending on catch composition and on whether TACs increase proportionally when biomasses increase. If the latter is not the case, the choke situation may be enhanced.

Here we present a single year view of the economic outcome of the LO for the considered fisheries in 2025 assuming that the LO has been fully implemented (Table 6.4). The exception to this is the Cantabrian-NW case that represents a static view of the impact of the LO in an average year (based on 2014–2016) in the

Table 6.4 This table displays the economic outcomes in 2025 for the LO scenarios relative to the scenario assuming no LO (business as usual)

Mitigation measures[3]	North Sea, West of Scotland and English Channel			Spanish Atlantic fisheries		Mediterranean fisheries	
	Denmark	UK	France	Bay of Biscay	Cantabrian-NW	Spain (W. Med)	Greece (E. Med)
Full LO implementation, no exemptions	P	R	R	P	P	P	P
De minimis	P			P	P		
Year Transfer				P			
Mesh size selectivity				P		P	P
Effort reallocation[2]	P		R		P		
Quotaadjustment		R	R				
Decrease minimum landings size	P						
Catch allowance for stocks with zero TAC		R					
Vessel effort movements between metiers		R					
Quota movement (swaps)		R					

For most scenarios the economic outcome is measured as the total profit in 2025 for the included fleets, while for the UK and French cases, the economic outcome is measured in total revenue for the included fleets. Results at a glance: total economic result (profit='P', revenue='R') in 2025 with LO implemented relative to the business-as-usual case (no LO)

Note: [1]For the Spanish Cantabrian-NW case, the results represent the expected outcome in 2017 given the assumed scenario
[2]Effort reallocation can be seasonal and between fleets (the Danish case) and spatially (the French case) or more efficient effort use (the Cantabrian-NW case)
[3]Yellow indicates less than 5% change, red indicates more than 5% decrease and green indicates more than 5% increase

scenarios considering full implementation and *de minimis*, while the scenario considering flexibility is a longer-term view, assuming a 50% reduction of catches in the long term given improved effort reallocation or other means. Whether 2025 corresponds to a long term will, to some degree, depend on the specific case study, i.e. on whether adjustments are ongoing in the given fleet or whether equilibrium is reached. Theoretically, a better measure of impacts would have been the net present value (NPV) covering the whole period from 2015 to 2025. However, not all models included in the present synthesis are able to provide NPVs over that period, and it has therefore been chosen to present the outcomes for 2025 alone.

In 2025, four of the seven case studies are expected to be negatively affected by the LO, when no exemptions are assumed (see Table 6.4). The exceptions are the Danish North Sea demersal fleet, the Spanish Bay of Biscay fleet and the Eastern Mediterranean fleet. The reasons for the expected economic losses are increased daily and crew costs (Western Mediterranean case), the industry being unable to process the previously discarded fish, and lost landings value due to cessation of fishing after choke situations (the UK and French cases). The assumption of constant TACs in the French case probably exacerbates the problems and results in overly pessimistic scenarios. For the Danish case, where choking on low-quota stocks is the greatest concern, possible negative economic consequences of the LO are reduced through (i) quota trade under the ITQ system in place and (ii) seasonal effort flexibility. In the Spanish mixed demersal fleet in the Bay of Biscay, possible economic losses are reduced by the effects of choke situations reducing mortality and increasing stock size, i.e. under full implementation of the LO, other fleets face choke situations and cease fishing before catching quotas of other stocks, such that the target species stock size increases in the long term, thus increasing catch possibilities (Prellezo et al. 2016). In the Eastern Mediterranean case study, the percentage of discards for hake and red mullet that are officially reported is below 5% for trawlers and even lower for netters (DCF 2016). For that reason, the full LO implementation scenario will result in very low increase (< 5%) in the daily costs and will not necessarily require an extra crew member to handle the extra catch.

Compared with how the case study fisheries would have evolved without the LO, the LO implemented with mitigation measures is, in some cases, expected to make the fisheries equally or better off in 2025. This is so for the Danish North Sea demersal fishery, as the ITQ management system makes it possible for the fleets involved to avoid choke situations through quota trade and seasonal effort flexibility. For the Spanish demersal fishery in the Bay of Biscay, interannual quota flexibility (with a limit of 10% of the initial quota) and increased selectivity (assuming an increase in minimum mesh size from 100 mm to 120 mm) also limit the possible negative economic effects of the LO. However, the application of the *de minimis* exemption has a negative effect in the long term. The application of the *de minimis* exemption increases the fishing mortalities compared to the case with no LO and the harvest control rule will then reduce the advised TAC for the next year (which then happens every year). Thus, the penalty imposed, given increased fishing mortalities, is higher than the flexibility gained by the exemption itself.

Increased selectivity also makes the fishery better off for the Spanish fishery around the Balearic Islands (Western Mediterranean) and for the Greek trawl and small-scale coastal fishery in the Thermaikos Gulf, especially if the catch of immature hake individuals is totally avoided, which raises the profit in 2025 above what could be expected without the LO.

At a glance Table 6.4 shows that for most of the analysed fisheries, their economic outcome will be negatively affected in the long term by the LO. But the