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DiscardLess

Strategies for the gradual elimination of discards in European fisheries

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Conflicts and trade-offs in implementing the CFP discard policy

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Box 1: Report highlights

- NGOs see the LO implementation as the first step for more sustainable fisheries.
- The introduction of the LO produced several policy changes in associated fisheries regulations: TACs removals and increases, reduction in minimum sizes, prohibited species listing, among others.
- The exemptions contemplated in Art. 15, namely the de minimis and high survival, with the additional regulatory changes detailed, associated to a delay in control, have provided sufficient flexibility for the fishing industry to *deal* with the LO.
- Progress towards achieving the objectives of the LO of reducing unwanted catch and changing fishing practices has been imperceptible due to a combination of policy changes and insufficient monitoring and control.

Box 2: The methods/approaches followed

- Continuous analysis of relevant policy statements, regulatory documents and academic literature.
- Interviews with environmental NGOs and DiscardLess partners.
- Attendance at relevant national, regional and EU level meetings.
- Millennium ecosystem assessment's ecosystem service framework

Box 3: How these results can be used and by who?

- The question of what has happened in policy since the LO was introduced is of interest to all groups of stakeholders from local to EU level.
- The policy analysis is relevant to policy makers and higher level stakeholders as they seek to build on previous successes and avoid past mistakes with the completion of the LO to all fisheries in 2019.
- All three sections of the report (NGOs, policy study, ecosystem services) will originate scientific papers and will contribute to different chapters in the DiscardLess book.

Box 4: Policy recommendations

- Limitation on the use of additional LO regulatory changes (such as MCRS reductions, TACs removals and increases, bycatch provisions, among others) as to not undermine further the objectives of the LO.
- Implementation of the LO by adoption of effective monitoring and control provisions.

Executive Summary

The introduction of the Landing Obligation (LO) is one of the most significant reform elements in the 2013 Common Fisheries Policy (CFP). In order to assess how the LO performs as a policy instrument, it is essential to understand the background, objectives and motivation that led to the policy being adopted. With these objectives in mind, a desk-study was first carried out to review relevant policy statements, regulatory documents and academic literature. Secondly, since the EU discard policy was driven by NGOs campaigns and public support, a subsequent analysis was performed based on interviews of key environmental NGOs on their perception of the LO, its objectives, goals and state of its implementation (from legislation to control and enforcement). This study of the views of environmental NGOs complements the perspectives of other stakeholders as captured in workpackage 4 (i.e. the “fishermen’ story”, the “scientists’ story” and the “managers’ story”), as well as work realised in workpackage 2 to monitor the changes of stakeholder perceptions in relation to the LO during its progressive application to European fisheries.

Possible conflicts and trade-offs in the introduction of the LO were then assessed based on two different approaches: a policy study and on an ecosystem service perspective. The objective of the policy analysis was to enumerate and discuss the interlinkages between the different management measures taken to date to deal with the LO, in order to identifying its strengths and weaknesses and, at the same time, evaluate potential conflicts. Finally, the ecosystem service approach was used conceptually to map the services that may be affected by the discard policy and again to identify potential objective conflicts and trade-offs between the landing obligation and other policies, with a special focus on the CFP and the MSFD.

The landing obligation was motivated by concerns of stock sustainability, a desire to avoid wasteful practices, and a need to improve the quality of fisheries data for stock assessment purposes. The LO has a clear objective to reduce unwanted catch by changing fishing practices, but it is also an instrument to achieve the overall objectives of the CFP of stocks and fisheries sustainability. The interviews show that NGOs are frustrated with slow and inflexible governance process regarding the validation of technical innovations and selective gears, and the reluctance of the sector to change. NGO representatives also expressed concern that control and monitoring regimes for the LO are insufficient. However, NGOs have high expectations from the results from the DiscardLess project and many are already working collaborative with the fishing industry to find solutions to the envisage issues with the practical implementation of the LO.

The policy study shows that implementation of the LO to date can be summarised by a slow uptake of some exemptions already provisioned in Art. 15, in association with additional policy changes not originally foreseen in the CFP. However, fishing practices have not yet changed and there has been no significant reduction of unwanted catch, as these policy measures in combination allowed for the fishing industry to continue operating as before.

Finally, regarding ecosystem services approach, considering fisheries in terms of the services that can be affected by the management decisions governing the fisheries SECAS (socio-ecological complex adaptive systems) could be a useful approach that can potentially generate innovative ways to approach fisheries governance issues. This understanding can enrich the

discussions around the necessity to alter or even discontinue the human activity that affects or is affected by the services, facilitating comparisons of management alternatives.

This document constitutes deliverable 7.3 of work package 7 of the DiscardLess project, and at the same time describes progress with the development of task 7.1, i.e. the EU discard policy: background and objectives and assessment of potential conflicts.

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1 Introduction

The introduction of the Landing Obligation (LO) is one of the most significant reform elements in the 2013 Common Fisheries Policy (CFP), and represents a fundamental shift in the management approach to European Union (EU) fisheries from landings to catch.

In order to assess how the discard policy performs as a policy instrument, it is essential to understand the background, objectives and motivation that led to the policy being adopted. The analysis expands and updates existing reviews of the development of the EU's discard policy (e.g. Borges, 2015). Firstly, with a desk-study that reviewed relevant legislation, STECF reports, Advisory Councils advice, NGOs (Non-Governmental Organizations) position papers and national administrations public statements relating to the LO. Since the EU discard policy was driven by environmental NGOs campaigns and public support, a posterior analysis was carried out based on interviews of key environmental NGOs (in collaboration with workpackage 2) on their perception of the discard policy, its objectives, goals and state of its implementation (from legislation to control and enforcement). This study of the views of environmental NGOs complements the perspectives of other stakeholders as captured in workpackage 4 (i.e. the "fishermen' story", the "scientists' story" and the "managers' story"), as well as work realised in workpackage 2 to monitor the changes of stakeholder perceptions in relation to the LO during its progressive application to European fisheries.

Possible conflicts and trade-offs in the implementation of the landing obligation were assessed based on a policy study and based on an ecosystem service approach. The objective of the policy study was to enumerate and discuss the interlinkages between the different management measures taken to date to deal with the LO, in order to identifying its strengths and weaknesses and, at the same time, evaluate potential conflicts. In addition, available insights on the economic outcomes and tradeoffs from case studies (from work package 2) were also used to support the overall assessment of strengths and weakness of the landing obligation. Finally, the ecosystem service approach was used conceptually to map the services that may be affected by the discard policy and again to identify potential objective conflicts and tradeoffs between the landing obligation and other policies, with a special focus on the CFP and the Marine Strategy Framework Directive (MSFD).

This document constitutes deliverable 7.3 of work package 7 of the DiscardLess project, and at the same time describes progress with the development of task 7.1, i.e. the EU discard policy: background and objectives and assessment of potential conflicts.

2 Background and objectives of the LO

2.1 History of the EU policy on discards

The discard problem has a long history in the EU and may be traced back to the foundation of the conservation policy of the CFP in 1983, which established Total Allowable Catches (TACs) and relative stability as the main instruments for resource management and the allocation of resources between member states (Holden and Garrod, 1996). In the subsequent 10-year review of the CFP the European Commission (EC) described the CFP as "a resource

management/conservation policy founded exclusively on the fixing of TACs and their allocation in the form of quotas, leading - in the absence of any real control over fishing capacity - to a race in terms of vessels and catches, with inevitable discards at sea" (CEC, 1991).

The EC analyzed the discard problem in detail in a report on causes, impact and solutions regarding the discard problem, which it published the following year (CEC, 1992). The regulatory framework included an obligation to discard fish not covered by available quota. In a mixed fisheries context, fishermen were therefore allowed and required to discard fish they do not possess quota for, or have filled the quota for, while fishing for species for which they have remaining quota. Further, fishermen were required to discard individuals below minimum landing sizes. In addition to obligatory discarding, fishermen may illegally discard fish with low market value in order save onboard storing space or preserve quotas for higher valued specimens (highgrading). Finally, fishermen may discard damaged fish (see also Crean and Symes, 1994). The ECs comprehensive analysis of the discard problem considered a discard ban as one alternative, but did not consider such a ban to be effective way to reduce discards, mainly because of problems with controlling and policing it. The EC hence concluded: *"in theory, the simplest response to the problem posed by discards is to ban them. However, it is not possible to propose an outright ban for all Community fisheries. If measures banning discards are to be acceptable and effective, they should be taken only under certain conditions, as regards both economics and controls"* (European Commission, 1991). Instead of a ban, the EC recommends that a set of measures should be taken to reduce the discard problem, such as measures to improve the selectivity of fishing gears, increase regulatory flexibility and increase the marketability of fish that would otherwise be discarded.

In 2001, the green paper preparing the 2002 reform of the CFP, recommended the testing of discard bans in pilot projects (CEC, 2001a) but it was only in march 2007 that the EC published a communication with the objective of initiating a discussion on a policy "to reduce unwanted by-catches and progressively eliminate discards in European fisheries" (CEC, 2007). The communication recognized that discarding is a serious problem in European fisheries, and noted that the main drivers of discarding was the use of single species TACs in mixed fisheries, which obligates fishers to discard species for which they do not have quota. Further, fishers were obliged to discard individuals below minimum landing size. The policy initiative was welcomed by the European Parliament (EP), and received feedback from various stakeholder organizations.

In august 2008, a UK trawler was filmed in EU waters by the Norwegian Coastguard discarding considerable amounts of whitefish that it had caught in the adjacent Norwegian zone. The event was released in public media¹, and increased public awareness and critique relating to the discard problem in European fisheries management.

The discard problem was subsequently highlighted in the EC's green paper (CEC, 2009), which provided the basis for a broad consultation on the reform of the CFP. While a discard ban was advocated by a significant number of citizens, the Commission's summary of the received

¹ <http://www.theguardian.com/environment/2008/aug/13/fishing.endangeredspecies> (last accessed 08.06.2016).

contributions noted that the ban appeared to be controversial. For instance, the NWWAC warned that a discard ban could be counterproductive, and recommended that discard reduction of discards should be planned for on a fisheries basis through increased selectivity and market measures. Along similar lines, the European Parliament recommended that a progressive elimination of discarding should be pursued through creating incentives to enhance selectivity, but if those incentives would render ineffective a discard ban should be implemented (European Parliament, 2009). On the other hand, some stakeholders groups such as the BSAC and the PELAC did not address discards in their submissions.

Nevertheless, a significant public pressure to end discarding was building up (Borges, 2015). In particular the UK TV chef Hugh Fearnley-Whittingstall launched a highly influential public campaign against discarding, known as “Fish Fight”² in October 2010, arguing the need for banning discards.

In 2011 the Commission launched a proposal for a reformed basic regulation of the CFP, which included an obligation for the industry to land catches of regulated species (CEC, 2011a). The landing obligation was defined in relation to species, with specific timelines, starting from January 2014 for main pelagic species, to be followed by cod, hake and sole in January 2015 and demersal species in the subsequent year. The proposal was accompanied by an impact assessment (CEC, 2011b), which considered the possible effects of landing obligation, although these were not evaluated or assessed in detail.

In summary, the timeline of significant events leading to the EU landing obligation was:

- 2007 - Commission published a communication on a policy to “reduce unwanted by-catches and progressively eliminate discards” and subsequent public consultation;
- 2009 - Green paper and public consultation on the reform of the CFP;
- 2011 - CFP reform proposal includes landing obligation; further consultations with stakeholders;
- 2013 - The basic regulation of the CFP is adopted including Art. 15 on the landing obligation;
- 2015 - The landing obligation is introduced in the Baltic Sea and pelagic fisheries.

2.2 Objectives of the landing obligation: a study of the views of NGOs

As described in the previous section, the EU LO was mainly driven by environmental NGOs campaigns and public support. In this context, the perception of key European environmental NGOs of the discard policy, its objectives, goals and state of its implementation (from legislation to control and enforcement) are therefore crucial to understand and evaluate the LO.

This study aims first at increasing knowledge on the actions and participation of European environmental NGOs during the last CFP revision, and second discovering how these actions have influenced the drafting of Article 15 of the CFP, i.e. the landing obligation. The analysis of the NGOs discourse will clarify past and current actions regarding LO introduction, including those undertaken within different Advisory Councils. Through the example of the LO, NGOs vision about the European decision making process will provide new elements to improve EU fisheries governance, a management system often viewed as top/down despite the important

² <http://www.fishfight.net/> (last accessed 08.06.2016).

changes generated by the introduction of the principles of the EU White Paper on Governance (CEC, 2001b) on the 2013 CFP.

Finally, this NGOs views study complements the industry and managers “stories” capture in WP4 and the work realised in 2.5.

2.2.1 Methods

Ten semi-structured interviews were conducted, through skype, with environmental NGO's at EU and regional seas levels throughout April-May 2016. Seven main questions guided the interviews which were divided in three main themes: opinion on article 15, implementation process including the actions undertaken by NGOs and opinion on the use of discards, and how sciences can support LO implementation. All text in italics below is quotations from the interviews.

2.2.2 Results

NGOs' vision and lobby on the CFP Art. 15

During the consultation process of the CFP revision, a large number of environmental NGOs were regrouped in a coalition called “Ocean 2012” to act collectively for European sustainable fisheries. Some others did not join the coalition and acted alone towards the same objective.

“Fully documented catches” (recording of all catches), *“unwanted catches should be solved in the water”*, *“discard ban ideally to all species”* were NGOs claims heard during the consultation process of the CFP.

The ideas that regionalization of the CFP could facilitate a *“discard ban or elimination of unwanted catches”* or that a *“discard ban for all species”* could facilitate control, without resorting to exemptions, were also arguments used by conservationist NGOs to draw the attention of decision makers (European and National) and European citizens. None of these NGOs expected to reach such objective, but article 15 and its provisions came out to the European public space as a result of political compromise rather than a conservation objective.

Article 15 is not a response to conservation claims but aims at decreasing discard rates at least for all species under the quota system or under legal minimum size. This article was received positively by the NGOs because it is considered as the first step to achieve sustainable fisheries within the EU. But all of them consider it *“unclear”* in terms of objectives, probably because it was not a subject of discussion during the CFP consultation process.

For them, it is viewed as a *“top down decision”*; and some think that it is responding more to the refusal of decision makers (Council of Ministers and MEP) to endorse the transferable concessions than to conservation of resource objectives. The article was *“decided by the politicians”* who *“didn't agree to a strong legal text”*; and of course this result supports all those who do not want *“strong measures”*. So probably its lack of clarity is based on the fact that is a political agreement, without taking into account scientific evidence and conservation objectives. The lack of consultation makes Art. 15 illegitimate mainly for fishing industry and, to a lesser extent, for NGOs.

During the discussion of the draft version of the article, one NGO argued that the income earned from *“undersize catches shouldn't be reverted to fishing industry”* but should support scientific work or monitoring efforts. This measure wants to avoid creating an incentive for catch of small fish.

The progressive implementation of the LO is perceived *“as help to the fishing sector”*; and it is probably for that reason that the LO was firstly implemented in *“easy”* regional seas (e.g. Baltic) and to *“easy”* pelagic fisheries. The most difficult species and areas were left for the second phase because the fishing industry needs time to modify its practices. The timeframe of implementation is also considered by some NGOs *“good because deadline is clearly defined for species and areas”*. So it is easy to follow the implementation process.

At the same time, progressive implementation of LO is used as a good excuse by the fishing industry using the argument of confusion between species and areas to which LO is applied to justify their negative attitude towards LO. The example of MEDAC was given to illustrate this type of arguments. It seems that MEDAC did not know when the provisions of Art. 15 were applied to Mediterranean fisheries. Since then, MEDAC understood the main provisions of the article and reacted by producing a position on MED fisheries that later became the joint recommendation, which was not voted by one NGO members of the Advisory Council.

The possibility of exemptions is also discussed by the NGOs. For them, exemptions illustrate well the weakness of the objectives of Art. 15. The use of exemptions is not clearly defined in the article and it is the basis of the current exemption demands formulated by the industry and Member States. The wording used for some exemptions is perceived by a few NGOs as clear regarding high survival or de minimis exemptions. But one NGO wonders what *“high survival”* means and how it *“is proved scientifically”*, although concludes by saying that the provision is *“good”*.

The planned progressive implementation of the LO was viewed as positive because deadlines were fixed and gave enough time to the industry to implement this new rule by changing practices. But the issue of discards should be solved *“in the water and not in the land”*. Experience shows that the implementation process did not target this objective as it is focusing on landings and not on avoidance in the sea. This idea is defended by all the NGOs: for them *“decrease of discards”* is the main priority, and if Art. 15 targets this objective they will support its implementation.

For one of the NGOs, discards is not a matter of *“waste”* (an argument used by the Commission to justify Art. 15 to the fishing industry) but of *“sustainable fisheries”*. So the objective is not to move discards from the sea to the land, but to incentivize the use of more selectivity gears. NGOs think that there is room to improve the LO and achieve reduction of discards, if regional discards plans and a roadmap to the LO implementation are established. But, at the same time, they observe that people are not yet convinced by the opportunities offered by LO.

NGO's vision about other stakeholders and LO implementation

In 2002, the CFP reform established Advisory Councils (AC) at regional seas levels. NGOs and other stakeholders like consumers associations, recreational fishers, women associations and others can become members, and represent 40% of the seats in the executive committees of the

ACs. Within ACs, NGOs are defending their own positions, and they are frequently opposed to the positions of the fishing industry which represents 60% of the seats in the executive committees. NGOs often consider that AC advices are representing fisheries interests; and this seems to be the case also concerning LO implementation due to the lack of clear objectives in Art. 15.

Interventions of environmental NGOs in the implementation of LO usually take place through Advisory Councils. During the discussions undertaken within these institutions to formulate advices, NGOs expressed their ideas which often pertain to sustainable fisheries or the end of overfishing. Reducing or avoiding discards is frequently discussed as part of LO implementation.

Intergovernmental groups (e.g. Scheveningen/North Sea) discussing regional discards plans shall consult Advisory Councils in the working groups dealing with technical issues, phasing of LO, choke species, etc. According to one of the NGOs, this invitation is probably explained by the following reason: *"MSs realised that EC is following the LO"*, and the *"reputation of the regionalization of CFP"* was based on their capacity to build discards plans. MSs had to consult ACs to produce the joint recommendations on discard plans. Apart from the transnational and diverse knowledge found within the AC thanks to the presence of the fishing industry and NGOs originating from different MSs, these institutions have also better experience in transnational collaboration than civil servants of intergovernmental groups. And this helps to have broader knowledge than MSs and provides more acceptable advices to the Working Groups.

Participation in these groups increased the awareness of the fishing industry concerning LO in the case of North Sea. The AC positioning towards LO evolved from the claim of *"abolishment of Art. 15"* because the choke species problem *"will kill the industry"* to *"more mature advice"* and technical discussion thanks to knowledge provided by NGOs. Understanding the reasons of choke species and acting was done thanks to the action of NGOs. *"The fishing industry brings information of the problems to the table and we are trying to get solutions and trying to overcome problems"*. This quotation shows the type of collaboration occurring within AC, or at least in some of them. It is noticed that the fishing industry trusts NGOs, and confidence relations were established between the two groups. But all fishers' representatives don't have the same vision about LO: *"some saying you can't gently implement the LO and others suggest the opposite"*.

Collaboration within Advisory Councils offered to both groups the possibility to understand each other as well as the benefits that they can get from experiences and knowledge. For example, NGOs understand why the fishing industry resists to changes necessary for LO implementation. They know that fishers will be heavily impacted by the LO from an economic point of view, and fishing practices are the reason why fishers resist changes. Implementing LO at legal level may be an easy task, but in practice it is very difficult and requires MSs to make choices. For example, regarding species with 0 quotas and choke species, one has to find solutions to solve the problem and go further into the process of implementation. For the moment, few MSs try to be simultaneously progressive and defending their industry. The others are defending only their industry without trying to implement LO. And that despite the fact that Art. 15 gives MSs a very important role. Only MSs where authorities *"are good in consulting people"* try to go further in the implementation. In places where this tradition does not exist, it is difficult to identify what is happening. This is the case in south European countries where the authorities do not have the will to change the current situation. This no-will is found also in that fact that SWW AC was not really consulted during the drafting of the joint recommendations. On the contrary, in the

Mediterranean Sea, MEDAC took the initiative to draft the joint recommendations probably because MSs did not have the capacity to reach an agreement. For one NGO, MSs of south Europe “ignore LO implementation” and did not do a lot to “increase awareness” within the industry.

NGO's views on the use of exemptions

The first years of the progressive introduction of LO showed that MSs have a high preference for exemptions instead of using more effective tools, as for example higher selectivity of fishing gears. This choice is criticized by NGOs because “exemptions for de minimis are short term temporary measures to ease the implementation of LO” and do not constitute adaptation strategies for discards elimination. They just show that MSs are not yet ready to change the situation. Once the exemptions are granted, MSs do not inform correctly about discarding levels. In the past, they reported “high discards” and now “they report lower percentage, so there is an underreporting of discards”. Fishers still do not have to report the quantity of discards, as for example in the pelagic fleet. Since they got the exemption, no data on discards is available.

The acceptance of exemptions by the EC is also criticized by NGOs. Despite the reservations made by STECF, exemptions were granted by the Commission. One of the NGO acts to clarify the issue of exemptions in the next reform of the CFP by focusing its work “on exemptions and their legal point of view”.

The European Parliament is another institution that is not really acting for LO implementation. For some of NGOs, this institution is just asking the fishing industry to record discards, and then they will take some decision. Probably this attitude is explained by the fact that MEPs have now more socio-economic objectives in their mind than resource conservation. Discussions are concentrating on “what we do on land and not about what we do at sea to avoid discards”.

Adaptation strategies and tools

NGOs have a lot of ideas about the strategies for the gradual elimination of discards. Here is a brief presentation of some of them to show the multitude of proposals.

For NGOs, the objective of LO is the elimination of discards, and for that it is necessary to introduce more selective gears. In some regional seas, the fishing industry was involved in trials to increase selectivity, but in general only a few trials were carried out as MSs privilege exemptions rather than selectivity. Examples of trials on selective gears were given by the different NGOs. Increased selectivity of the gears will produce modification of fishing practices. The objective is to reduce discards at sea. According to them, MSs do not give enough attention to selectivity, and neither do the EU institutions, despite the fact that LO real objective is “to make fisheries more selective and leave more fish in the water”. This original objective is not yet perceived and “many vessels continue business as usual”.

Mapping areas with high discards and high number of juveniles is also perceived as necessary because it will help to close these areas to fishing activity. Some seasonal closures are also suggested as a solution to decrease discards.

Better management of quotas should be applied, even a review of quotas allocations. MSs with few quotas have high rates of discards, and with the issue of choke species they should stop fishing. For some, the relative stability should be re-discussed, but for that one needs political decisions. MSs like Belgium or Spain, having few quotas, are questioning the relative stability; but countries having enough quotas, like France, do not want to change it.

The European Commission thought that LO will increase the number of swap of quotas between MSs; but in reality the opposite took place. MSs stopped exchanges of quotas because *“they have now different values, added values”*. For some of the NGOs, lack of quotas and highgrading are causes of discards; so it is necessary to meet and discuss how we can avoid that in a way to obtain LO implementation. The choke species issue is very important for *“truly mixed fisheries and how to manage the quota”*. Renegotiation of relative stability is needed.

Monitoring

Since the introduction of LO, monitoring has not really been on the agenda of MSs and EU decision-makers. For NGOs, the installation of cameras on board is probably the best solution. Few examples related to this use were given to prove the benefits. One of the NGO conducted a study about the use of different monitoring tools which showed the effectiveness of cameras. Cameras can be used by vessels more than 10 meters of length; and particularly in the Mediterranean others solutions should be found. The idea of cameras as a monitoring tool was abandoned as soon as France and Spain said no to this use in the CFP reform negotiations.

EMFF can provide financial support to the European fleet either for more selective gear or for monitoring tools.

Opinions about the use of discards

NGOs did not focus on the use of unwanted catches because their objective is foremost to avoid catches and not land them. *“Discards, unwanted catches should be reduced before landed”*.

Use of unwanted catches should be discussed at EU level because it is necessary to clarify how that can be done. In NGOs opinion, a political decision is necessary; but in case of use of discards for human consumption, *“there is need for discussion, and of course these fishers should not go for waste”*.

Human consumption of unwanted catches does not meet a consensus between NGOs, first because one has to know which category of unwanted catches should be used, and second because there is always a risk of creating or maintaining markets for undersized fish in MSs where consumers appreciate them. For some, only undersized fish could be used by industries already using wild fish (e.g. fishmeal, pet food, etc.), and unwanted catches due to highgrading should be forbidden for such use. *“Highgrading marketable catch should be dealt with and ways to be sold should be found”*. All NGOs want to avoid creating black market for undersized fish but particularly the NGOs in the Med. *“Undersized fish should not be caught. But if caught, it must not create a market nor give profits to fishers”*.

Of course, NGOs are well aware that unwanted catches cannot be completely eliminated, especially in mixed fisheries. For that reason, all of them more or less put forward the following arguments: *“No profit should be made from undersized fish”*, and do not exclude the possibility *“to*

compensate fishers for their work, but the amount of such compensation should be very small”, just enough to “cover their extra expenditures”. The objective is not to create incentives for catch of small fish. For that reason, some of the NGOs suggest that income of the sale of unwanted catches should be given to other purposes such as “fisheries management”, “to monitoring agency” or even to “scientific work”, and not directly to fishers.

Expectations from science

For environmental NGOs, science (and specifically the DiscardLess project) has a key role to play in the LO implementation because it can provide information of what is happening at sea. And also its results may help to improve selectivity of fishing gear or to improve quotas swapping. But to achieve that, scientific advice and project results should be well formulated and be understandable by stakeholders. For that reason, it is necessary to avoid too academically formulated results or to be able to popularize them in a way that is comprehensible for the industry, decision-makers, administration, and usable by ACs or intergovernmental groups. This type of results can fill the gap between NGOs action and the fishing industry perception about LO implementation and use of more selective gear. The final objective is indeed to reduce unwanted catches.

Communicate scientific results in the public space can support better decisions if they are well presented. This type of communication is challenging; so they suggest that the project *“brings good real stories”* to the EU public space. *“Share good stories”* and *“flag best practices to avoid unwanted catches”* that can contribute to LO implementation. The stories should bring out results of trials and implications, lessons learnt and recommendations to move forward. For them, the project is seen as a good umbrella: a mediator between fishers and NGOs. *“Communication is essential to achieve sustainable fisheries objectives!”*

2.2.3 Conclusions

The landing obligation was motivated by concerns of stock sustainability, a desire to avoid wasteful practices, and a need to improve the quality of fisheries data for stock assessment purposes. The LO has a clear objective to reduce unwanted catch by changing fishing practices, but it is also an instrument to achieve the overall objectives of the CFP of stocks and fisheries sustainability.

The interviews show that NGOs are frustrated with slow and inflexible governance process regarding the validation of technical innovations and selective gears, and the reluctance of the sector to change. NGO representatives also expressed concern that control and monitoring regimes for the LO are insufficient. However, NGOs have high expectations from the results from the DiscardLess project and many are already working collaborative with the fishing industry to find solutions to the envisage issues with the practical implementation of the LO.

3 Policy trade-offs and conflicts

3.1 Policy study

As established in the previous section, the objective of the LO was foremost to reduce unwanted catch, mainly by way of changing fishing behaviour. At the same time, however, it was recognized that the industry needed flexibility mechanisms to adapt to such a significant change in the way they operate. Therefore, several regulatory measures and provisions were originally agreed and included in the CFP regulation as a priori possible policy exemptions of the LO, while other measures were adapted through 2015 till 2018 with the phased introduction of the LO. These provisions are intended to deal with several issues that came into light with the LO such as: premature closure of fisheries as one species quota runs out, no access to fisheries due to nonexistence quotas share for bycaught species, and/or fisheries subjected to a 0 TAC species, among others.

3.1.1 CFP LO regulatory provisions (Art. 15)

The landing obligation introduced in the 2013 CFP in its article 15 includes four specific exemptions: species for which fishing is prohibited (dealt with in section 1.2.1.2), species that have high survival rates after being discarded, catches which fall under the de minimis exemption, and catches damaged by predators.

High survival

Species with scientific evidence of high survival rates after being discarded can have an exemption on the obligation to be landed. However, the definition of what is high survival is still unclear, while STECF (2013) has concluded that defining a single value cannot be scientifically rationalised and therefore assessing proposed exemptions on the basis of "high survival" need to be considered on a case-by-case basis taking account the specificities of the species and fisheries involved.

This provision has nevertheless been adopted in many fisheries since 2015. In pelagic fisheries, the application of the exemptions for survival (and the de minimis) in some fisheries have provided the flexibility that allowed the industry to adapt to the LO without any significant change in their operations (PELAC, 2015; MEDAC, 2017).

De minimis exemption

The de minimis exemption is applicable under two conditions: if there is scientific evidence that increases in selectivity are very difficult to achieve, or to avoid disproportionate costs of handling unwanted catches, but only where the bycatch of the gear in question does not represent more than a certain percentage of the catch.

As stated above, in pelagic fisheries, the application of the exemptions for survival and the de minimis in some fisheries have provided the flexibility that allowed the industry to adapt to the LO without any significant change in their operations (PELAC, 2015; MEDAC, 2017).

Inter-species quota flexibilities

Catches that are caught in excess of quotas or for which the Member State has no quota, may be deducted from the quota of the target species provided that they: i) do not exceed 9 % of the quota of the target species and ii) the stock of the non-target species is within safe biological limits (i.e. $F < F_{lim}$ and $SSB > B_{lim}$).

The inter-species quota flexibility (and de minimis) can provide flexibility in the system to better adjust catch compositions to resemble fishing opportunities and increase both ecological and economic sustainability. However, STECF (2013) warns that these provisions could be used to legally increase catches well in excess of desired or intended levels, and that they will require careful consideration if negative and unintended consequences are to be avoided.

In practice, inter-species quota flexibility was not used in 2016 and until April 2017 (Veits, 2017).

Predators damaged fish

A further exemption to the LO was introduced with the Omnibus regulation (European Union, 2015a), where caught fish damaged by predators should be returned to sea. The reason detailed in the regulation was that such catches “can constitute a risk to humans, to pets and to other fish by virtue of pathogens and bacteria which might be transmitted by such predators”.

Nevertheless, this exemption was seen as particularly important for Baltic Sea fisheries targeting salmon, due to the increase in the predatory behaviour of seals consuming salmon caught mainly in longlines (Fitzpatrick and Nielsen, 2016). This exemption has indeed been applied to salmon fisheries in the Baltic Sea.

3.1.2 Discard plans and minimum sizes

Discard plans

With the delay in the agreement of the multispecies multiannual plans foreseen in the 2013 CFP between European institutions, and with the objective of introducing the LO progressively, several so-called discard plans were, in accordance with the CFP, adopted by the EC between 2014 and 2017 through delegated acts. The discard plans identify the specific fisheries entering the LO and applicable exemptions by sea area for a period of three years, based on joint recommendation by regional Member States groups in consultation with the relevant Advisory Councils.

Although the discard plans were originally planned as an intermediate legislative measure to be substituted gradually by the agreed multiannual management plans in each sea basin, these are now well established legislative procedures that continue to be adopted and amended regardless if the corresponding multiannual plan has already been adopted.

Reduction of minimum sizes

The 2013 CFP reform introduced specific provisions which allow changing minimum landings/conservation sizes under discard plans and multiannual plans, still with the prevailing aim of ensuring the protection of juveniles of marine organisms. Catches below minimum conservation reference sizes (MCRS, comparable, but not equivalent, to the previously known

MLS) have also limited use and cannot be sold for human consumption to avoid creating markets for undersized fish.

In the Baltic Sea, the size at which cod can be sold for human consumption was reduced in 2015, i.e. the MLS of 38 cm change to MCRS of 35 cm (European Union, 2014a). As expected, there was an increase in cod landings between 35-38 cm, which in turn caused an increase in national quota consumption, since Baltic cod stocks size composition is small (MRAG, 2016). At the same time, the industry reported difficulty in increasing gear selectivity due to the restrictions in the trawl gear allowed in the Baltic Sea (Baltic Sea Advisory Council, 2016). This resulted in a decreased fishing selectivity by incentivizing commercialization of smaller size eastern cod, while there was no apparent reduction in discard rates (ICES, 2017a).

In south western Atlantic waters, anchovy caught in CECAF area 34.1.2 and in ICES subarea 9 also had a reduction in minimum size with the introduction of the LO in 2015, from a MLS of 12 cm to a MCRS of 9 cm (European Union, 2014b). In the Skagerrak and Kattegat in 2016, Nephrops human consumption size was also reduced from 130 mm and 40 mm to 105 mm total and 32 mm carapace length, respectively (European Union, 2015b); while clams (*Venus* spp.) size in the Adriatic Sea went from 25 mm to 22 mm in 2017 (European Union, 2016a).

3.1.3 Additional regulatory mechanism: TACs and prohibited species

With the phased introduction of the LO between 2015 and the beginning of 2018, several other regulatory mechanisms have since been used to deal with the LO.

TAC footnotes

Historically, the TAC & quota regulations have included footnotes in some pelagic stocks TACs (e.g. horse mackerel) detailing specific percentages (2% or 5%) of catches of non-target species (e.g. boarfish, haddock, whiting and mackerel) that can be taken as bycatch in pursue of that target TAC, without being accounted for in the respective non-target stock but on the target pelagic TAC. However, only in 2018 have the footnotes included the LO provisions on interspecies flexibility and its 9% maximum combined catch, and more importantly that the non-target stocks be within safe biological limits.

As the catches of non-target stocks are not necessarily accounted for in their respective TACs, there is a risk of overexploitation on those non-target stocks. STECF (2013, 2017b) highlighted there is the potential to significantly increase the mortality on non-targeted bycatch species to levels inconsistent with achieving F_{MSY} and to the extent that stock biomass could be reduced below safe biological limits.

TAC increases

Since 2015, catches by fisheries subject to the phased introduction of the LO (with some exemptions) should have been brought to shore and landed. To accommodate the predicted increase in landed catch from such fisheries, the relevant 2015, 2016 and 2017 TACs were increased in accordance with the estimated catch that formerly would have been discarded (Borges, 2018). According to the European Commission (2017) TAC adjustments are part of the overall package of measures to implement the LO but they should nevertheless not jeopardise the F_{MSY} objective or increase fishing mortality.

According to Borges (2018) of the 40, 64 and 88 TACs under the LO between 2015-2017, respectively; around 30%, the majority of which being TACs for demersal stocks, were increased in 2016-2017 to account for the LO, and of these 10 TACs were set already above landings advice before any adjustments were made. Therefore, the author concludes that the LO is likely to have contributed to TAC increases above maximum advised catch in 2016 and particularly in 2017, to accommodate the predicted increase in landed catch, and will continue to do so until 2019 when all EU TAC regulated stocks and fisheries in the Atlantic come under the LO.

TACs suppression

Removing TACs from annual TAC regulations so that associated stocks are removed from the LO has been put forward by several stakeholders as a way to deal with problematic stocks, i.e. where discarding are high due to low commercial value and/or where quotas are insufficient to cover catches.

In 2017, following a request from the EC, ICES assessed the sustainability risk to the stock of dab and flounder of having no catch limits to be low as long as dab and flounder remains largely bycatch species (ICES, 2017b). With this advice, the EC proposed, and Council agreed to delete the combined TAC for dab and flounder in the North Sea (European Commission, 2017). With the suppression of the TAC, these two stocks were removed from the LO and no longer constitute a risk for premature closure of the target fisheries for plaice and sole where they are bycaught. However, they continue to be discarded in high numbers, have low survival after discarding and low commercial value, but continue to be caught in fisheries that no longer have the incentive to improve selectivity.

It is expected that several more TACs will be deleted from the TAC & quota regulations during 2018, according to the positions voiced by industry and DG MARE (European Commission, 2017) representatives.

Zero TAC

In the TAC 2017 regulation (European Union, 2017), picked dogfish (spurdog, *Squalus acanthias*) was listed as a prohibited species. Specimens should therefore not be harmed and if caught should be released immediately, with the exception for vessels operating in a specific area where landings up to 270 tonnes of dead picked dogfish are allowed, as long as vessels are engaged in a members state 'bycatch avoidance programmes'. Furthermore, a vessel engaged in the by-catch avoidance programme may land not more than 2 tonnes per month of picked dogfish that is dead at the moment when the fishing gear is hauled on board.

The listing of spurdog in the prohibited species list, but with a TAC, has initiated a discussion on how to deal with zero TAC species under the LO: in which regulation species should be listed as prohibited, how species are chosen to be in the prohibited species list, their level of protection and the different levels of enforcement. NGOs position is that designating stocks with zero TAC advice as prohibited species will not protect them from overfishing, and in itself provides little incentive for fishers to improve the selectivity of their fishing practices.

In summary, at least one elasmobranch species has been recently added (and removed) from the prohibited species list when it posed a specific issue with the implementation of the LO, namely on not allowing fisheries to begin or closing fisheries prematurely. Listing however a species in the prohibited species list means discarding can continue, and without a post-release high survival, this measure adds little to the sustainability of the stock.

Prohibited species list

Both the annual TAC and the technical measures regulations include a list of species for which the deliberate catching, retention on board, transshipment or landing is prohibited. Furthermore, when caught, specimens should not be harmed and should be promptly released back into the sea. Species listed in CITES Appendix I are included in the prohibited list. However, except for when listed in CITES, no other specific criteria is known granting inclusion. As stated in the previous section on zero TACs, several species and stocks have been recently added and removed from the list when they pose a specific issue with the implementation of the LO.

According to STECF (2017c), the prohibited species list should ideally only be used for species which are biologically sensitive to any exploitation. Without additional management measures to improve survival, listing a species will not necessarily lead to a decrease in mortality. Furthermore, the decision to include, or remove, any species onto or off the prohibited species list should be made according to transparent criteria developed in a participatory process.

3.1.4 Technical measures

Technical measures at EU level are specified through several regulations dating back to 1998, when the original technical measures regulation was adopted (Council Regulation (EC) No 850/98). This regulation specifies areas and seasons where fishing is prohibited, prohibited fishing methods, minimum landing sizes, minimum mesh sizes, among many other measures to minimise the impact of fishing in the marine environment.

In light of the reformed CFP, to simplify rules and to allow for the introduction of the LO, the EC has put forward a new framework proposal for technical conservation measures (European Commission, 2016a). In this proposal specific targets are set, namely that catches of marine organisms below MCRS do not exceed 5% by volume. The regulation is still in negotiations between European institutions, and trilogue has yet to begin, but both the Council and the EP have somewhat weakened the targets proposed by the EC: for Council catches under MCRS “are reduced as far as possible” (Council of the European Union, 2017), while for the EP catches under MCRS “are progressively reduced to specific levels for key fisheries” but it is left for MSs to decide on the levels and fisheries (European Parliament, 2018). Furthermore, while the proposed regulation is not yet adopted, the regulatory changes necessary to allow for different gear configurations to be used to increase selectivity have not been made, rendering at present several gear modifications that decrease unwanted catches illegal.

3.1.5 Multiannual management plans

There has also been indirect effects of the LO in other fisheries management measures. The argument that the reality of mixed fisheries associated with the LO and reaching Maximum Sustainable Levels (MSY) is incompatible has been gaining momentum at European level.

F_{MSY} upper range

The management plans in the reformed CFP have no explicit harvest control rules (HCRs) but include F_{MSY} ranges between which fishing opportunities can be set when pre-determined conditions are met (European Commission, 2016b; European Union, 2016b).

The use of the F_{MSY} upper range has been justified to allow for mixed fisheries to adapt to the LO. Managers argued that extra flexibility is needed to cope with the LO and avoid premature fisheries closures, while NGOs defend that the objective of “above MSY levels” enshrined in the CFP is not in line with any F value above F_{MSY}. It seems clear that the harvest control provisions detailed in the multiannual plans already agreed and proposed, i.e. when F_{MSY} ranges and additional management measures are applicable, are not clear and leave many unanswered questions.

Target and bycatch species

In 2016, the EC proposed a new multiannual management plan for the North Sea basin for several commercial target species (European Commission, 2016b). The new plan proposal considers species: a) that should be managed according to MSY (F_{MSY} by 2020), b) species that may be managed according to the precautionary approach if MSY scientific advice is not available, and c) other species not subject to catch limits to be managed based on the precautionary approach.

De facto, these new provisions establish a difference between target and bycatch species, and to what level they should be managed under the CFP. The argument that flexibility is needed from industry and managers is contra-balanced by NGOs that the CFP MSY objective is applicable to all species, regardless if they are commercial or not.

3.1.6 Monitoring, control and enforcement

Postponement of serious infringement

Failing to comply with the landing obligation is categorized as a serious infringement under the control regulation (Regulation (EC) No. 1224/2009; European Commission, 2009), but a 2-year delay was agreed in the so-called Omnibus regulation in 2015. Sanctions only took effect from the 1 January 2017 (European Union, 2015a); from this date MSs had to start applying the points system for illegal discarding.

Although the omnibus regulation did not delay the enforcement and control of the LO, MSs have taken a soft approach in these two first years of the introduction of the LO and have focused on information sharing and training activities rather than on the LO compliance (STECF, 2017a).

Reporting on the implementation of the LO

The Omnibus regulation (European Union, 2015a) introduced the obligation to the EC to submit an annual report, starting in 2016 until 2020, on the implementation of the landing obligation. This report should be based on information given by the Member States, the Advisory Councils and other relevant sources.

The 2015 and 2016 MSs reports were reviewed and summarised by STECF (2016, 2017a) and show a qualitative analysis of the efforts made by MSs on the different areas of the LO implementation. Nevertheless, in 2017 STECF notice that, “overall, Member States indicate that difficulties encountered so far have been minimal but several reports have highlighted that the most significant issue they face is the industries’ reluctance to implement the landing obligation, despite considerable efforts to disseminate information to them. They also report that fishers seem slow to change fishing practices; and in many areas, a “business as usual” mentality seems to prevail”.

Revision of the control regulation

EC is proposing a revision of the Control Regulation (EC) No. 1224/2009 (European Commission, 2009) with a draft proposal predicted to be released publicly by May 2018. The EC has started a discussion on the elements of this review, and have stated their intention to include the use of Remote Electronic Monitoring (CCTV and sensors system) to monitor the implementation of the LO, on selected fisheries on a voluntary basis (European Commission, 2017b).

In this context, and in a letter inviting inputs from Advisory Councils on its proposal for establishing Specific Control and Inspection Programmes, the EC (European Commission, 2018a) stated that “independent research, audits of the MS control systems conducted by the Commission, and the 'last-haul' and other project initiatives driven by the EFCA alongside the MS authorities, all indicate a general lack of compliance with the LO and that illegal and unrecorded discarding is widespread”.

3.1.7 Conclusions

It is clear that the implementation of the LO to date can be summarised by a slow uptake of some exemptions already provisioned in Art. 15, in association with additional policy changes not originally foreseen in the 2013 CFP. However, fishing practices have not changed and there has been no significant reduction of unwanted catch, as these policy measures in combination with insufficient monitoring and control allowed for the industry to continue operating mostly as before.

3.2 Ecosystem services approach

Finally, possible conflicts and trade-offs in the implementation of the landing obligation were assessed based on an ecosystem service approach. Fisheries are socio-ecological complex adaptive systems (SECAS, Levin et al., 2013; Ostrom, 2009) embedded in various services and disservices provided by ecosystems (Armstrong et al., 2012; Liqueste et al., 2013; Dunn, 2010). The flow of all these services (and disservices) can be potentially affected by any management measure that modifies the collective behaviour of fish and humans (i.e. the main agents in this SECAS) and the emergent properties of the fisheries SECAS, as these behaviours and properties feedback influencing the environment in which the SECAS is embedded. This understanding can enrich the discussions around the necessity to alter or even discontinue human activity that affects or is affected by the services (Huntsinger and Oviedo, 2014), facilitating comparisons of management alternatives (Granek et al., 2010), as services that are valued may be perceived to have particular power as an advocacy tool for environmental concerns (Waylen et al., 2014).

If the decision context for utilizing the concept of ecosystem services (ESSs) is to promote understanding and to educate a larger public about the services and benefits that well-functioning ecosystems provide to humans, then the ESSs domain specialty literature recommends the use of the Millennium Ecosystem Assessment's (MEA, 2005) Ecosystem Service framework (Fisher et al., 2009). Thus, services emanating from ecosystems associated with fisheries potentially include supporting (i.e. services that are necessary for the production of all other ESSs, i.e. they feed into provisioning, regulating and cultural services (e.g. soil formation, nutrient cycling, production of oxygen, primary production, resilience)), provisioning (i.e. the products (goods) directly obtained from ecosystems (e.g. food, such as fish, water, fuel, genetic resources)), regulating (i.e. the benefits obtained from the regulation of habitats and ecosystem processes (e.g. climate regulation, water purification, natural carbon sequestration and storage, waste absorption)), and cultural (i.e. the nonmaterial benefits people obtain from ecosystems through e.g. spiritual enrichment (artistic inspiration, reflection, cognitive development, marvel at the emergent properties of natural processes), recreation, or aesthetic experiences) services as described by the Millennium Ecosystem Assessment (MEA, 2005). Ecosystem disservices (ESDs) are understood as all negative effects (i.e. harmful, unpleasant or unwanted) on human well-being caused by natural or semi-natural ecosystems, natural conditions or biological organisms (Lyytimäki, 2014). The identification of these aspects are important for knowledge-based decision making in relation to policies for human interactions with nature, and also to better assess the outputs of policies.

Using the ESSs and ESDs framework to analyse a fishery management measure such as the EU LO (European Commission, 2018b) enables a richer and more encompassing view of the benefits and costs emanating from this policy change. The push for the LO largely came from outside of fisheries, where public outcry regarding the wasteful practice of discarding initiated the policy change in EU fisheries (Borges, 2015). The underlying idea is however based on the understanding that human welfare is linked to marine organisms in more ways than just purely based on what we eat, i.e. fisheries incorporate more than solely provisioning services. This is however a concept we claim is still not well included in fisheries management, where even newer management focus is still largely based on single stocks (Eikeset et al., 2013; Gullestad et al., 2014), in spite of the push for ecosystem based management, including broader ecological and social issues. The reason for this state of affairs may of course be due to fisheries management being largely sectorial, without incentives for a broader view on the marine services than purely the provisioning of fish. However, the reasons may be even more fundamental in relation to how relevant scientists and managers view the ocean and its resources.

The success of the LO, as of any policy measure, depends on the involved parties, in our case fishers, fisheries managers, fisheries scientists (and possibly other stakeholders), realizing the socio-cultural aspects of the LO origins, but also the socio-cultural workings of the fishing activity itself, i.e. how fishers understand and consequently respond to the LO will determine its success. Using a ESSs approach might provide the stakeholders with broader toolset to explore, if not even achieve, this realization. However, looking at fisheries through the lenses of ESSs is not an easy task, especially when one has to evaluate the impact of a specific policy on such services. This fact is proven by the mapping exercise we have employed as part of the DiscardLess (DiscardLess, 2018) project during the 2016 project annual general meeting in

Boulogne-Sur-Mer, France. Building on a concise conceptual description of ESSs and ESDs from the scientific literature and the preliminary results of the DiscardLess exercise, the specific objective of this study is twofold: 1. to identify and characterize the most important ESSs and disservices in which fisheries SECAS are embedded; 2. to map the services/disservices that may be affected by the discard policy (i.e. the landing obligation).

3.2.1 Methodology

At the DiscardLess annual project meeting in March 2016, the project members covering a variety of domains, but mainly natural scientists, were given a brief PowerPoint presentation about ESSs, which were further referred to in the questionnaire, cultural aspects, and the questionnaire itself, which was subsequently distributed. Forty four out of the 46 project members present handed in the filled in questionnaires. The first section of the questionnaire consisted of personal information (though not sufficient to identify persons). One central section of the questionnaire requested identification of ESSs in a specified ocean area that the respondent was most familiar with, how these services were perceived affected by the fishery and the landing obligation, and how important the services were deemed to be.

Through literature review we have identified literature describing the most important ecosystems in which fisheries as SECAS are embedded. Employing content analysis of this literature (Silverman, 2004), we have identified and characterized the most important ESSs and ESDs in which fisheries SECAS are embedded. Using the data from the DiscardLess 2016 survey and theoretical reasoning (Harman, 2009), we have mapped the ESSs/ESDs that may be affected by the landing obligation. The effects of the landing obligation should be read with caution, as the results presented in this study are based only on the perception about the topic of the DiscardLess 2016 survey participants and of the authors of the study, and not on empirical research.

3.2.2 Results

The main group of scientists replying the DiscardLess ESS questionnaire were fisheries biologists, as well as a large group of ecologists, besides social scientists/economists and some more technology-oriented scientists (engineering, mathematics, chemistry, food technology, computer sciences), with two respondents indicating a multidisciplinary background in fisheries biology/ecology and social sciences (Figure 1 in Annex).

Employing this MEA framework we have identified 39 ESSs and 17 disservices in which fisheries SECAS are embedded (Table 2 in Annex). The participants identified some of these ESSs, but for the most part they identified provisioning services of fish, and the supporting services of biodiversity and habitat (Figure 2 and 3, Table 1 and 3 in Annex). A vast majority of these can be expected to be affected by the landing obligation, even though it is not clear in which way, as can be interpreted from the responses to the survey (Figure 6 and 7, Table 4 in Annex). As further exploration tracks, it would be interesting to repeat the exercise of crossing ESSs/ESDs with any other management objective proposed by the Common Fisheries Policy or the Marine Strategy Framework Directive and afterwards analyse the ESSs/disservices found at the intersection between the effects of landing obligation and the effects of the other management objective.

3.2.3 Conclusions

Considering fisheries in terms of the services that can be affected by the management decisions governing the fisheries SECAS could be a useful approach that can potentially generate innovative ways to approach fisheries governance issues. This understanding can enrich the discussions around the necessity to alter or even discontinue the human activity that affects or is affected by the services, facilitating comparisons of management alternatives. Employing the MEA framework we have identified 39 ESSs and 17 disservices in which fisheries SECAS are embedded. The participants identified some of these ESSs, but for the most part they identified provisioning services of fish, and the supporting services of biodiversity and habitat. A vast majority of these can be expected to be affected by the landing obligation, even though it is not clear in which way.

4 Overall conclusions

The landing obligation was motivated by concerns of stock sustainability, a desire to avoid wasteful practices, and a need to improve the quality of fisheries data for stock assessment purposes. The LO has a clear objective to reduce unwanted catch by changing fishing practices, but it is also an instrument to achieve the overall objectives of the CFP of stocks and fisheries sustainability.

The interviews show that NGOs are frustrated with slow and inflexible governance process regarding the validation of technical innovations and selective gears, and the reluctance of the sector to change. NGO representatives also expressed concern that control and monitoring regimes for the LO are insufficient. However, NGOs have high expectations from the results from the DiscardLess project and many are already working collaborative with the fishing industry to find solutions to the envisage issues with the practical implementation of the LO.

It is clear that the implementation of the LO to date can be summarised by a slow uptake of some exemptions already provisioned in Art. 15, in association with additional policy changes not originally foreseen in the 2013 CFP. However, until now fishing practices have not changed and there has been no significant reduction of unwanted catch, as these policy measures in combination allowed for the industry to continue operating as before.

Finally, regarding ecosystem services approach, considering fisheries in terms of the services that can be affected by the management decisions governing the fisheries SECAS could be a useful approach that can potentially generate innovative ways to approach fisheries governance issues. This understanding can enrich the discussions around the necessity to alter or even discontinue the human activity that affects or is affected by the services, facilitating comparisons of management alternatives. Employing the MEA framework we have identified 39 ESSs and 17 disservices in which fisheries SECAS are embedded. The participants identified some of these ESSs, but for the most part they identified provisioning services of fish, and the supporting services of biodiversity and habitat. A vast majority of these can be expected to be affected by the landing obligation, even though it is not clear in which way.

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6 Annex I

Applying the ecosystem services framework to the marine fisheries system in a landing obligation context

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Introduction

Fisheries are socio-ecological complex adaptive systems (SECASs) in which macroscopic properties emerge from local actions that spread to higher scales due to agents' (fish and humans) collective behavior; these properties then feed back, in a nonlinear way, influencing individuals' options and behaviors, but they typically only do so diffusely and over long timescales (Levin et al. 2013; Ostrom 2009). A fishery can be defined as "the complex of people, their institutions, their harvest and their observations associated with and including a targeted stock or group of stocks (i.e. usually fish), and increasingly, the associated ecosystems that produce said stocks" (Link 2010). As such, there is "an obvious and important need to identify and value a fishery and its associated ecosystem" (Link 2010). In addition there is a need to identify and value services emanating from the fishery and the ecosystems, with these services potentially including supporting, provisioning, regulating, and cultural services as described by the Millennium Ecosystem Assessment (MEA 2005). Thinking about fisheries in terms of the services that can be affected by the management decisions governing the fisheries SECAS could be a useful approach that can potentially generate innovative ways to assess fisheries governance. Even though the ecosystem services (ESSs) approach is different to an ecosystem approach, the former could be helpful for understanding a system in terms of flows of services, and this understanding can support holistic and equitable management, particularly because it allows valuation of changes in specific ESS flows and comparison of previously incomparable resources (Waylen et al. 2014). Furthermore, services that are valued may be perceived to have particular power as an advocacy tool for environmental concerns (Waylen et al. 2014). This understanding can enrich the discussions around the necessity to alter or even discontinue human activity that affects or is affected by the services (Huntsinger and Oviedo 2014), facilitating comparisons of management alternatives (Granek et al. 2010). Increased operationalization of an ESSs framing could lead to a greater understanding of the trade-offs between elements of the fisheries system, cross-scale dynamics, and impacts on resilience (Hoddbod and Adger 2014). In this study we argue that fisheries SECASs are embedded in ecosystem services (ESSs) and disservices (ESDs) whose flows can be affected by any human decision that brings changes in the SECAS processes. Using the ESSs and ESDs framework to analyze a fishery regulation such as the European Union (EU) Landing Obligation (LO) (European Commission 2018) enables a richer and more encompassing view of the benefits and costs emanating from this policy change.

Discards are fish and other organisms which are caught accidentally in fishing gear and are thrown back in the sea (European Commission 2007). In most cases discarded organisms do not survive. A study performed by the International Council for the Exploration of the Sea (ICES) showed a very low rate of discards in the Mediterranean and the Black Sea (4.9%) compared to a much higher rate (13%) in the northeast Atlantic (European Commission 2007). Within EU fisheries, discard rates ranged widely, from negligible in the herring and sprat fishmeal fisheries in the Baltic Sea, to 70-90% in a number of major demersal trawl fisheries (European Commission 2007). Sometimes, in those fisheries which have the worst records for discarding, the practice can destroy almost as much economic value as the fishery is able to create (European Commission 2007). The EU LO, put in place in 2015 to reduce the bycatch and discarding of unwanted or unmarketable fish, lies within the realm of management defined as ecosystem-based management, though not necessarily emanating from it. Indeed, the push for the LO largely came from outside of fisheries, where public outcry regarding the wasteful practice of discarding initiated the policy change in EU fisheries (Borges 2015). The underlying idea is however based on the understanding that human welfare is linked to marine organisms in more ways than just purely based on what we eat, i.e. fisheries incorporate more than solely provisioning services. This is however a concept we claim is still not well included in fisheries management, where even newer management focus is still largely based on single stocks (Eikeset et al. 2013; Gullestad et al. 2014), in spite of the push for ecosystem based management, including broader ecological and social issues. The reason for this state of affairs may of course be due to fisheries management being largely sectorial, without incentives for a broader view on the marine services than purely the provisioning of fish. However, the reasons may be even more fundamental in relation to how relevant scientists and managers view the ocean and its resources.

The success of the LO, as of any policy measure, depends on the involved parties, in our case fishers, fisheries managers, fisheries scientists (and possibly other stakeholders), realizing the socio-cultural aspects of the LO origins, but also the socio-cultural workings of the fishing activity itself, i.e. how fishers understand and consequently respond to the LO will determine its success. Using an ESSs approach might provide the stakeholders with broader toolset to explore, if not even achieve, this realization. However, looking at fisheries through the lenses of ESSs is not an easy task, especially when one has to evaluate the impact of a specific policy on such services. This fact is proven by the mapping exercise we have employed as part of the DiscardLess (DiscardLess 2018) project during the 2016 project annual general meeting in Boulogne-sur-Mer, France. Building on a concise conceptual description (Section 2) and the preliminary results of the DiscardLess exercise (Section 3), the specific objective of this study is twofold: 1. to identify and characterize the most important ESSs and disservices in which fisheries SECAS are embedded (Section 4); 2. to map the services / disservices that may be affected by the discard policy (i.e. the landing obligation) (Section 4).

Conceptual framework

Ecosystem services and disservices

Although extensively criticized for being anthropocentric (Silvertown 2015), for not including intrinsic values (Davidson 2013), for not including indigenous and local knowledge (Díaz et al. 2018), and for the commodification of nature (McCauley 2006), the ESSs concept has gained considerable interest inside and outside of science (Schröter et al. 2014; Tancoigne et al. 2014).

There are several ESS classification schemes (Hattam et al. 2015) and the choice of using one scheme over another has to be based on both the characteristics of the ecosystems of interest and a decision context for which the concept of ESSs is being mobilized (Fisher, Turner, and Morling 2009). If the decision context for utilizing the concept of ESSs is to promote understanding and to educate a larger public about the services and benefits that well-functioning ecosystems provide to humans, then the ESS domain specialty literature recommends the use of the Millennium Ecosystem Assessment's (MEA 2005) Ecosystem Service framework (Fisher, Turner, and Morling 2009). Thus, considering the objectives of this study, we will in the following use the Millennium Ecosystem Assessment (MEA) in our discussion of fisheries. This framework includes supporting services that feed into the direct services to humans, the provisioning, regulating and cultural services. A number of newer frameworks, such as TEEB, CICES and IPBES do not include supporting services explicitly in their ESSs portfolio (CICES 2013; IPBES 2017; TEEB 2010). The motivation for not including the supporting services is largely due to the issue of double counting values. When monetarily estimating the value of ESSs, supporting services cannot be valued separately, as their values are inherently included in the value of the direct services that they feed into. We have however chosen to apply the MEA framework due to this inclusion, as in fisheries, the stock and flow elements, such as fish stock and harvests, are central. Though "regulating contributions" in the IPBES "Nature's Contributions to People" concept may be thought to include such stocks and their maintenance, this is not explicitly described, as only habitat maintenance is included (IPBES 2017). In our study, stock maintenance will in addition to habitat maintenance, be central ESSs, which in the MEA framework can both be included in supporting services.

ESSs are the direct and indirect benefits people obtain from ecosystems (MEA 2005); in this study we consider as ESS any such benefit regardless if it is supported by living organisms or not (e.g. dredge materials, oil or aggregates, wind), i.e. both biotic and abiotic aspects. The MEA identified four main categories of ESSs (MEA 2005; Kragt and Robertson 2014; Armstrong et al. 2012):

Provisioning services = the products (goods) directly obtained from ecosystems (e.g. food, such as fish, water, fuel, genetic resources);

Supporting services = services that are necessary for the production of all other ESSs, i.e. they feed into provisioning, regulating and cultural services (e.g. soil formation, nutrient cycling, production of oxygen, primary production, resilience). Their impacts on people are usually indirect, both physically and temporally, whereas changes in the other categories have relatively direct impacts on people.

Regulating services = the benefits obtained from the regulation of habitats and ecosystem processes (e.g. climate regulation, water purification, natural carbon sequestration and storage, waste absorption);

Cultural services = the nonmaterial benefits people obtain from ecosystems through e.g. spiritual enrichment (artistic inspiration, reflection, cognitive development, marvel at the emergent properties of natural processes), recreation, or aesthetic experiences.

One more aspect of the ESSs concept is that it potentially opens for the idea that nature not only provides benefits to humans, but may also reduce our utility in some situations, or, in fewer

words, it opens for ecosystem disservices (ESDs) (Dunn 2010), i.e. all negative effects (i.e. harmful, unpleasant or unwanted) on human well-being caused by natural or semi-natural ecosystems, natural conditions or biological organisms (Lyytimäki 2014). Though sometimes a controversial concept (Villa et al. 2014), ESDs are well-known, also historically (Friess 2016). In our case, the concept of dis-services is less problematic, as treating fisheries as a part of human interaction with nature, thereby providing ESSs, clearly must open for fisheries also providing ESDs, i.e. reducing benefits to humans from ecosystems. Indeed, the discussion as to whether fisheries or other human impacts altering the structure of marine ecosystems, similar to what agriculture does on land, actually provides ESs or ESDs, is an ongoing debate regarding many ocean areas (Howarth et al. 2014; Falk-Petersen 2014). In economic theory the uncompensated impact of one agent's behavior upon another agent, is called an externality or an external effect. Regardless whether dis-services are the result of the natural functioning of an undisturbed ecosystem or they are the effects or side-effects of human influence, the one and same ecosystem function can be perceived as a service or dis-service depending on the context, knowledge, and values of the person making the evaluation (Lyytimäki 2014). The identification of these aspects are important for knowledge-based decision making in relation to policies for human interactions with nature, and also to better assess the outputs of policies.

The ecosystem service Discardless 2016 survey

At the DiscardLess annual project meeting in March 2016, the project members covering a variety of domains, but mainly natural scientists, were given a brief PowerPoint presentation about ESSs (see Appendix 1) for an overview of the ESSs, which were further referred to in the questionnaire, cultural aspects, and the questionnaire itself, which was subsequently distributed. Forty four out of the 46 project members present handed in the filled in questionnaires. The participants spent up to 45 minutes filling in this form. Most of the respondents had no comments to the questionnaire, but a handful expressed that it was demanding.

The first section of the questionnaire consisted of personal information (though not sufficient to identify persons). One central section of the questionnaire requested identification of ESSs in a specified ocean area that the respondent was most familiar with, how these services were perceived affected by the fishery and the landing obligation, and how important the services were deemed to be (see Appendix 2 for the ESS segment of the questionnaire).

The motivation for the survey was to assess the presence of ESSs, how well known different services were for different scientists, and how fisheries and the landing obligation might impact these services. Some preliminary central results from this survey are presented in the following.

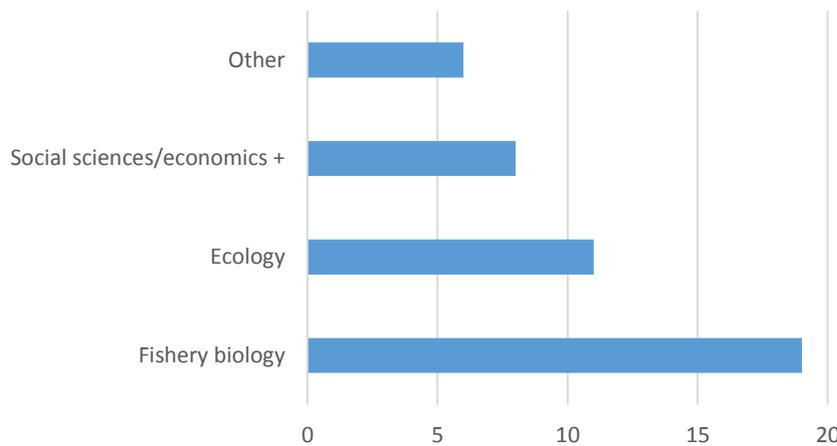


Figure 1 Disciplinary area of survey participants (N=44).

The main group of scientists were fisheries biologists, as well as a large group of ecologists, besides social scientists/economists and some more technology-oriented scientists (engineering, mathematics, chemistry, food technology, computer sciences), with two respondents indicating a multidisciplinary background in fisheries biology/ecology and social sciences. (Figure 1).

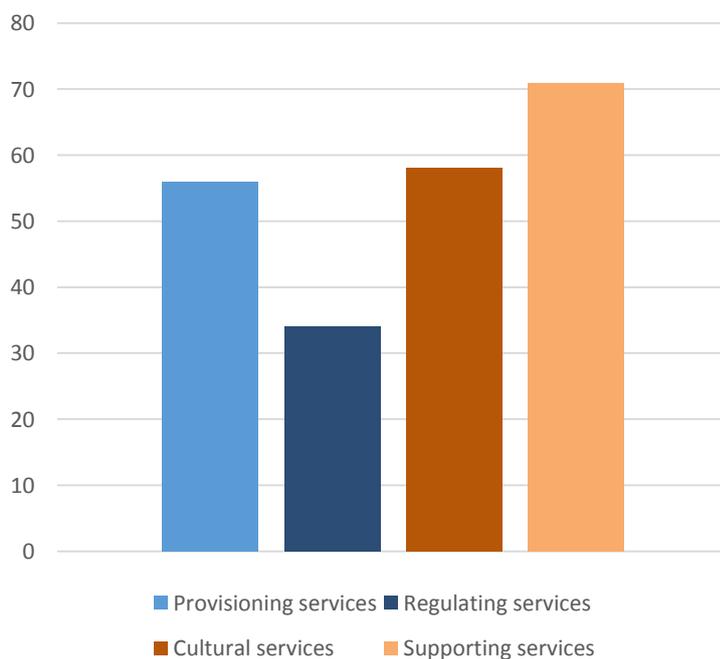


Figure 2. Total number of ecosystem service types mentioned by participants (N=219).

Amongst the four Millennium Ecosystem Assessment (MEA 2005) services (provisioning, regulating, cultural, and supporting), it is the supporting services that are most often mentioned by the participants in the survey, followed by cultural services, then the provisioning and finally the regulating services (Figure 2). However, within the four service groups, the number of

specific service types are highly diverging (Figure 3). Thus, fish is the most mentioned ESS, mentioned by just about all the scientists present. This is followed by the supporting service of biodiversity, gas, and climate regulating services and spirituality. The supporting services of habitat and recreation are mentioned by just less than half of the participants, while the remaining services are mentioned by substantially fewer.

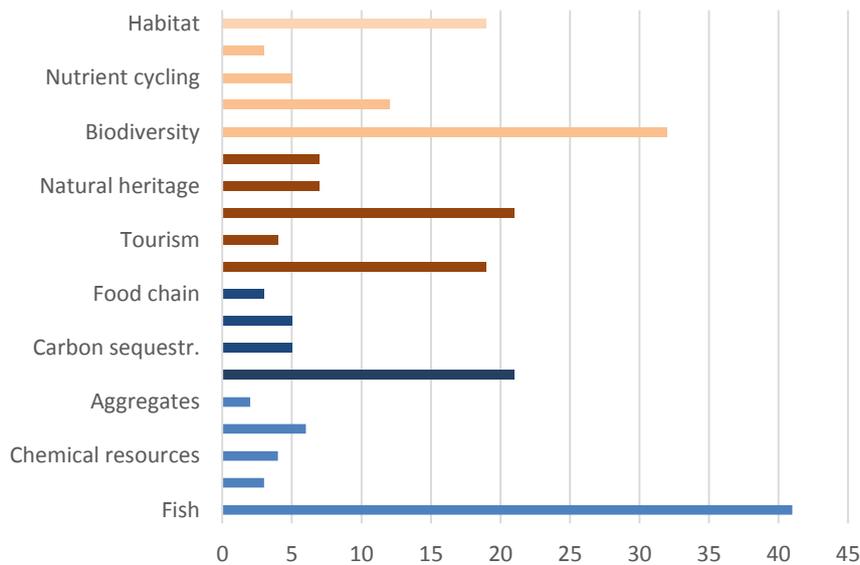


Figure 3. Number of scientists that identified different specific services (colors reflect the four Millennium Ecosystem Assessment service types in Figure 2).

The percentage of the respondents agreeing to the presence of different ESS is summarized in Table 1. Here we observe that, with the exception of fish and the supporting service of biodiversity, less than 50% of the respondents agreed to the presence of any ESS in the ocean area of their choice. And indeed for a number of services, such as genetic resources, chemical compounds, waste disposal sites, spirituality, and resilience, less than 10 % agreed to their presence in the case study areas in DiscardLess. We do however note that the respondents suggested a number of other services not mentioned in the presentation held before the respondents were asked to fill in the questionnaire, especially as regards cultural services.

Table 1. Percentage of respondents who answered “yes” to the presence of specific ecosystem services (N=44). Services in *italics* were suggested by the respondents in addition to the services included in the presentation that preceded the implementation of the questionnaire.

Ecosystem service type	Ecosystem service example	% yes
Provisioning	Fish	90,9
	<i>Genetic resources</i>	6,8

	Chemical compounds for industrial and pharmaceutical use	9,1
	Waste disposal sites	0,0
	<i>Energy, oil/gas, aggregates</i>	
Regulating	Gas and climate regulation	47,7
	Carbon sequestration	31,8
	<i>Pollution treatment/ dilution</i>	
Cultural	Recreation	47,7
	Tourism	43,2
	Spirituality	6,8
	Natural heritage	45,5
	<i>Regional development, cultural patrimony, fishing communities and their wellbeing, fishery traditions, family gathering for a meal, global food security, coastal natural heritage, human health and wellbeing</i>	
Supporting	Biodiversity	72,7
	Primary production	27,3
	Nutrient cycling	11,4
	Resilience	6,8
	Habitat	43,2
	<i>Juveniles/reproduction, maritime traffic, animal health and wellbeing</i>	

There are differences between the different participant groups' identification of the presence of services in the ocean (Figure 4). Thus, there may be some variations in the probability of identifying some specific services, dependent on what kind of academic background one may have. All have, unsurprisingly, a large probability of identifying the provisioning service of fish, while the ecologists are substantially more prone to identify the supporting services of biodiversity than the other two groups. Fisheries biologists are much more likely to identify the supporting service of habitats, and the cultural services of natural heritage and tourism, but the least likely to identify recreation. Interestingly, the Other group was most likely to identify primary production. This is most likely reflecting the diversity of the participants in this group.

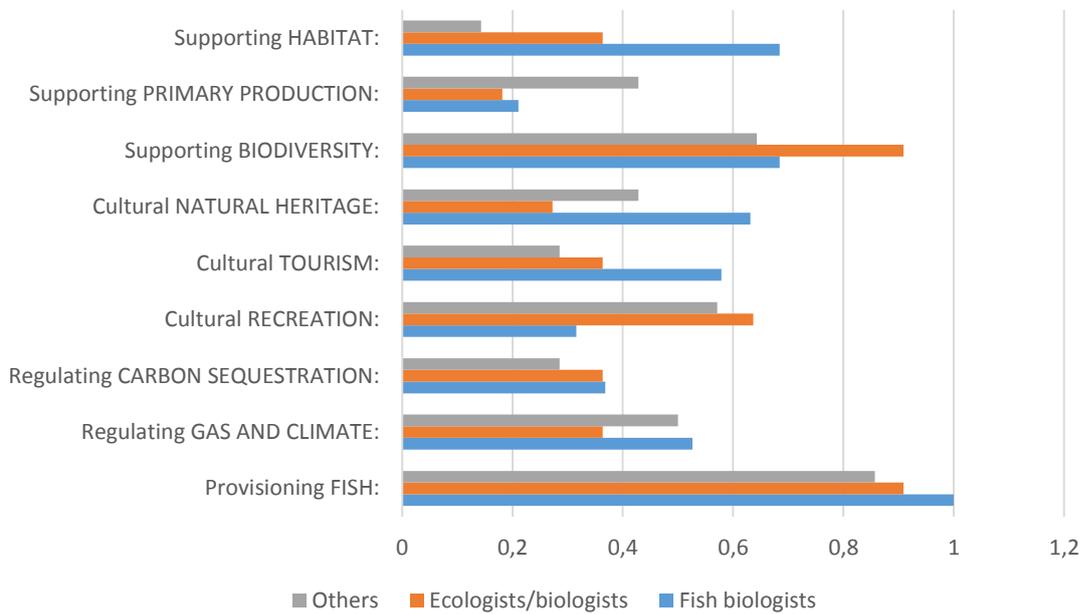


Figure 4. Probability of different groups identifying the presence of specific ecosystem services in the ocean. The group Others includes social scientists, economists, and other participants.

Identification of ESSs is one thing, but the perceived importance of services is another. Thus, fish is perceived to be the most important service, followed by biodiversity (Figure 5). Many respondents believe primary production and habitats to have large importance, but when summing the two higher importance levels, we see that natural heritage surpasses these two.

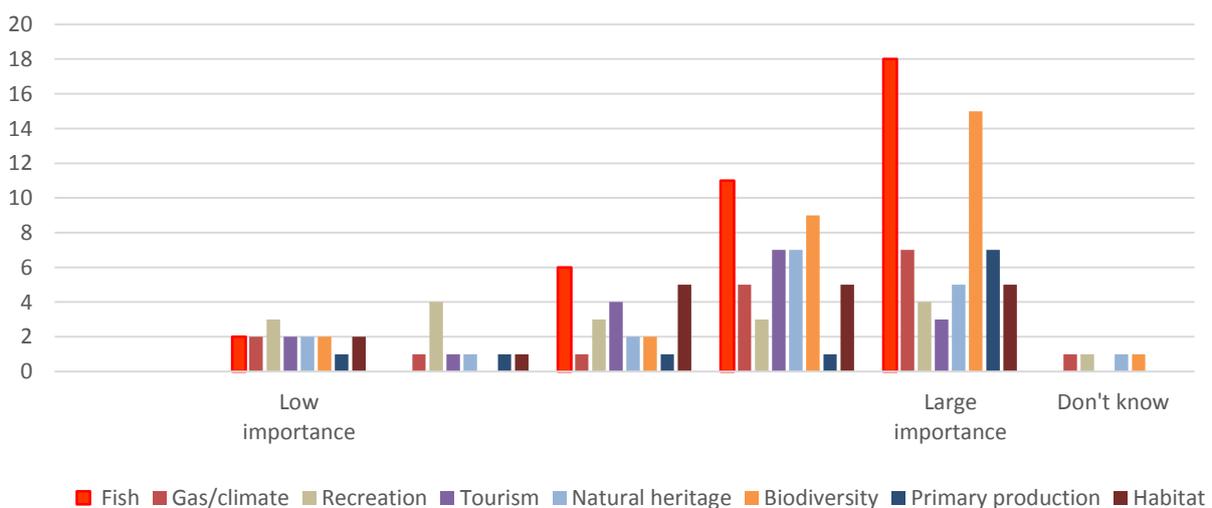


Figure 5. Stated importance of eight top ecosystem services, from low importance to large importance. The y-axis presents the number of participants in each category.

The perception of fisheries and the discard ban/landing obligation varies substantially amongst the participants (Figure 6). Though there is quite a spread of perceptions regarding how fisheries and the discard ban/landing obligation affect specific ESSs, most respondents see the fishery as having a negative impact on the provisioning of fish, while the discard ban/landing obligation has a somewhat positive effect (Figure 6).

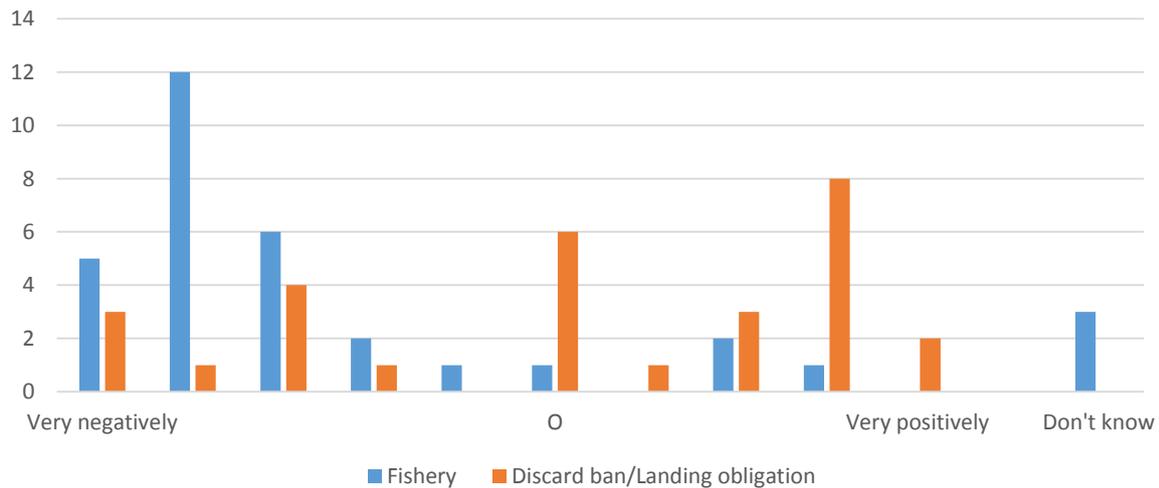


Figure 6. How the provisioning service of fish is affected by fisheries and the discard ban/landing obligation. The y-axis presents the number of participants in each category.

The different scientist groups' perception of whether fisheries have a negative effect and the discard ban/landing obligation has a positive effect on fisheries is summarized in Figure 7. Thus, fisheries biologists will most probably identify fisheries as negatively impacting the provisioning of fish. Ecologists have the lowest probability in this regard, and also have the lowest probability of identifying positive effects of the discard ban/landing obligation.

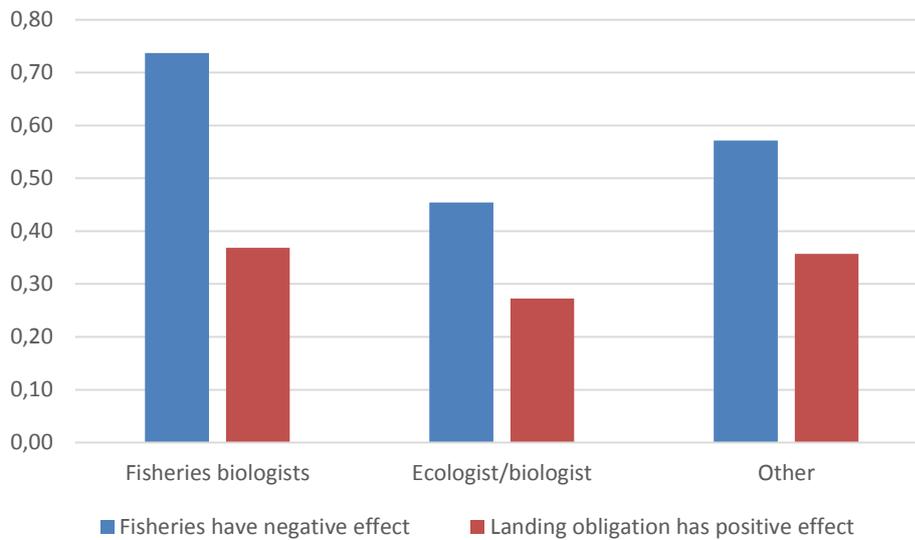


Figure 7. Probability of different participants perceiving there to negative effects of fisheries and positive effects of the discard ban/landing obligation on the provisioning of fish.

Ecosystem services and disservices in which fisheries SECAS are embedded and how they might be affected by the discard ban / landing obligation

Fisheries SECAS are embedded in a variety of services provided by ecosystems (Armstrong et al. 2012; Liqueste et al. 2013), communities and species such as fish populations (Holmlund and Hammer 1999; Lynch et al. 2016), marine biodiversity (Beaumont et al. 2007), or waterbirds (Green and Elmberg 2014), but also disservices. The flow of all these services (and disservices) can be potentially affected by any management measure that modifies the collective behavior of fish and humans (i.e. the main agents in this SECAS) and the emergent properties of the fisheries SECAS, as these behaviors and properties feed back influencing the environment in which the SECAS is embedded. Through a literature review we have identified and characterized the most important ESSs and ESDs in which fisheries SECAS are embedded (Table 2). Using the data from the DiscardLess 2016 survey and theoretical reasoning (Harman 2009), we have mapped the ESSs / ESDs that may be affected by the discard policy / landing obligation (Table 2). The effects of the landing obligation should be read with caution, as the results presented in this study are based only on the perception about the topic of the DiscardLess 2016 survey participants and of the authors of the study, and not on empirical research.

Table 2. Services offered by marine and coastal ecosystems (after Liqueste et al. 2013; MEA 2005; Beaumont et al. 2007; Armstrong et al. 2012; Green and Elmberg 2014; Holmlund and Hammer 1999; Lynch et al. 2016) and disservices (after Shackleton et al. 2016; Vaz et al. 2017; Piwowarczyk, Kronenberg, and Dereniowska 2013) in which fisheries SECAS are embedded (in random order), their description, and whether they might be affected by the discard ban / landing obligation. Items in italics were additionally suggested by the respondents of the DiscardLess 2016 survey. The list is not exhaustive.

N	Ecosystem service type and	Description	How the ecosystem service
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o	specific service / disservice		/ disservice might be affected by the discard ban / landing obligation
SERVICES			
Supporting			
1	<i>Life cycle maintenance</i>	Biological and physical support to facilitate healthy and diverse reproduction of species.	Yes, negatively (N=1)
2	Ocean nourishment	Natural cycling processes leading to the availability of nutrients in the seawater for the production of organic matter.	Yes
3	Coastal protection	Protection against floods, droughts, hurricanes and other extreme events. Also, erosion prevention in the coast.	No
4	Water purification	Biochemical and physicochemical processes involved in the removal of wastes and pollutants from the aquatic environment.	No
5	<i>Resilience and resistance (life support)</i>	The extent to which ecosystems can absorb recurrent natural and human perturbations and continue to regenerate without slowly degrading or unexpectedly flipping to alternate states	Yes, negatively (N=2) Do not know (N=3)
6	<i>Biologically mediated habitat</i>	Habitat which is provided by living marine organisms.	No (N=5) Yes, negatively (N=3) Yes, positively (N=2) Do not know (N=3)
7	<i>Nutrient cycling</i>	The storage, cycling and maintenance of nutrients by living marine organisms.	Yes, negatively (N=1) Yes, positively (N=1)
8	<i>Primary production</i>	Production of biomass.	No (N=3) Yes, negatively (N=1)

			<p><i>Yes, positively (N=3)</i></p> <p><i>Do not know (N=2)</i></p>
9	<i>Biodiversity</i>	Promotion of coexistence of different species.	<p><i>No (N=5)</i></p> <p><i>Yes, negatively (N=7)</i></p> <p><i>Yes, positively (N=8)</i></p> <p><i>Do not know (N=3)</i></p>
10	<i>Maritime traffic</i>	Abiotic service.	<i>Do not know (N=1)</i>
	Provisioning		
11	<i>Food provision</i>	The provision of biomass for human consumption and the conditions to grow it (fisheries, aquaculture, waterbirds etc.)	<p><i>No (N=5)</i></p> <p><i>Yes, negatively (N=8)</i></p> <p><i>Yes, positively (N=11)</i></p> <p><i>Do not know (N=3)</i></p>
12	Water storage and provision	The provision of water for human consumption and for other uses.	No
13	<i>Biotic materials and biofuels, including genetic resources and chemicals</i>	The provision of biomass or biotic elements for non-food purposes.	<p><i>No (N=4)</i></p> <p><i>Yes, positively (N=2)</i></p>
14	<i>Carbon capture and storage (artificial)</i>	Capture and storage of CO ₂ emitted from fossil fuel combustion in the deeper areas of our oceans and in sub-seabed geological formations.	<p><i>No (N=5)</i></p> <p><i>Yes, negatively (N=2)</i></p> <p><i>Yes, positively (N=2)</i></p> <p><i>Do not know (N=2)</i></p>
15	<i>Energy: oil, gas, minerals, wind, waves</i>	Oil, gas and minerals under the ocean floor are ecosystem services created over geological time periods. Wind and waves as renewable energy.	<p><i>No (N=5)</i></p> <p><i>Yes, negatively (N=1)</i></p>

16	Bioindicators	Provide a low-cost shortcut for monitoring the general ecological status of an ecosystem	No
17	Long-term environmental recorders	The present marine fauna is living witness to climatic changes in the past, a fact that gives us information about past climate	No
	Regulating		
18	Biological regulation and disease surveillance	Control of fish pathogens especially in aquaculture installations; role of cleaner fishes in coral reefs; biological control on the spread of vector borne human diseases; control of potentially invasive species.	No
19	Weather regulation	Influence of ecosystems and habitats on the local weather conditions such as thermoregulation and relative humidity.	No
20	<i>Climate regulation</i>	Regulation of greenhouse and climate active gases. The most common proxies are the uptake, storage, and sequestration of carbon dioxide.	<i>No (N=14) Yes, positively (N=1) Do not know (N=1)</i>
21	Air quality regulation	Regulation of air pollutants concentration in the lower atmosphere.	No
22	Disturbance prevention (flood and storm protection)	The dampening of environmental disturbances by biogenic structures. Living marine flora and fauna can play a valuable role in the defence of coastal regions. The presence of organisms in the front line of sea defence can dampen and prevent the impact of tidal surges, storms and floods.	No
23	<i>Bioremediation of waste</i>	Removal of pollutants through storage, burial and recycling.	<i>No (N=3) Yes, negatively (N=1)</i>
24	Dispersal of seeds, invertebrates and non-pathogenic	For example waterbirds are now known to be vectors of a whole range of aquatic invertebrates, including crustaceans, molluscs, annelids.	Maybe

	microbes		
25	Ecosystem engineering	Bioturbation effects (for example when foraging or feeding) that can radically change the distribution of sediments.	Maybe
26	Regulating food web dynamics and nutrient balances	Regulatory influence on food chain relationships by marine species, varying with physical and climatological preconditions, including stream flow, temperature, upwelling fronts, storms, seasonal variability, and also with nutrient content and water depth.	Yes
27	Active links between ecosystems	Fish generate a large number of services related to their movement patterns, including daily, seasonal, and yearly migration patterns in lakes, rivers, estuaries, and oceans.	No
28	Passive links between ecosystems	When fed upon by other organisms, fish, including eggs, fry and carcasses, serve as passive links between aquatic, aerial and terrestrial ecosystems, contributing to other food webs.	Yes
	Cultural		
29	<i>Symbolic, spiritual, and aesthetic values</i>	Exaltation of senses, emotions, and spiritual experience by landscapes, habitats or species.	No (N=2) Yes, negatively (N=0) Yes, positively (N=0) Do not know (N=1)
30	<i>Recreation and tourism</i>	Opportunities that the natural environment provide for relaxation and amusement. The refreshment and stimulation of the human body and mind through the perusal and study of, and engagement with, living marine organisms in their natural environment.	No (N=7) Yes, negatively (N=2) Yes, positively (N=3) Do not know (N=4)
31	Cognitive effects	Trigger of mental processes like knowing, developing, perceiving, or being aware resulting from natural landscapes or living organisms. Cognitive development, including	Yes

		education and research, resulting from marine organisms.	
32	Future unknown and speculative benefits	Currently unknown potential future uses of marine biodiversity.	Yes
33	<i>Cultural heritage and identity</i>	Benefit of biodiversity that is of founding significance or bears witness to multiple cultural identities of a community.	No (N=3) Yes, negatively (N=4) Yes, positively (N=6) Do not know (N=5)
34	Feel good or warm glow (non-use benefits)	Benefit which is derived from marine organisms without using them.	Yes
35	Existence/bequest	Some people may have in the sense of experiencing mental satisfaction from knowing that certain deep-sea animals or ecosystems exist, even if they will never physically experience them.	Yes
36	<i>Improving human health</i>	Improvement of human health in terms of food protein and medicine supply.	Do not know (N=3)
37	"Green food"	Sustainable food production if managed in a sustainable way.	Yes
38	Empowerment	Millions of people rely upon marine resources exploitation as a source of livelihood and women represent over half the individuals in marine resources supply chains.	Yes
39	<i>Knowledge transfer and capacity building</i>	The value of inland fisheries has led to conflict, but also to cooperation opportunities cross cultures and political jurisdictions over access, control, and harvest in modern times. Knowledge transfer and cooperation can also occur between distant ecosystems experiencing common challenges.	No (N=1) Yes, negatively (N=4)
DISSERVICES			

1	Invasive species	No
2	Fisheries pests and diseases	Yes
3	Algal blooms	Yes
4	Human diseases from pathogens, allergens	Yes
5	Dangerous or poisonous plants and animals	No
6	Seabirds droppings on stonework and outdoor sculptures	Yes
7	Unpleasant odours from rotting organic matter	Yes
8	Siltation	No
9	Leaching of nutrients	No
10	Direct attacks by wild animals causing human injury or death	No
11	Fear and risks associated with marine areas	No
12	Species perceived as disgusting and irritating by people	Yes
13	Species and landscapes considered unpleasant by people	Yes
14	Unpopular species due to religion, tradition or cultural legacies	Yes
15	Salt wedge intrusions into groundwater	No

Compared with the total number of possible ESSs in which fisheries SECAS are embedded, the knowledge of ESSs of various types varied in the group participating in the DiscardLess 2016 survey (Table 3). Thus, the supporting services were more known to the respondents, followed (in descending order) by the provisioning services, cultural services, and regulating services. However, when reflecting over these results, one has to also take into considerations those reported in Table 1: with the exception of fish and the supporting service of biodiversity, less than 50% of the respondents agreed to the presence of any ESS in the ocean area of their choice. And indeed for a number of services, such as genetic resources, chemical compounds, waste disposal sites, spirituality, and resilience, less than 10 % agreed to their presence in the case study areas in DiscardLess.

Table 3. Total number of ESSs in which fisheries SECAS are embedded as suggested in Table 2 and how many of these were indicated by the respondents of the DiscardLess 2016 survey.

Ecosystem service type	Total number	How many were indicated by survey participants (%)
Supporting	10	7 (70%)

Provisioning	7	4 (57%)
Regulating	11	2 (18%)
Cultural	11	5 (45%)

Not all the ESSs and disservices identified in this study can be expected to be affected by the discard ban / landing obligation (Table 4). However, it seems that a large majority could be, especially the cultural services. Note also that our list of services is most likely far from exhaustive, making it possible that the LO may potentially have a much larger impact.

Table 4. Total number of ESSs and disservices in which fisheries SECAS are embedded and how many of these might be affected by the discard ban / landing obligation.

Ecosystem service type / Disservice	Total number	Number (percentage) of services affected by the discard ban / landing obligation
SERVICES	39	29 (74%)
Supporting	10	8 (80%)
Provisioning	7	4 (57%)
Regulating	11	6 (54%)
Cultural	11	11 (100%)
DISSERVICES	15	8 (53%)

Trade-offs between ESS have been described terrestrially (Power 2010; Rodríguez et al. 2006) and can also be observed in the ocean. Clearly the provisioning service of fish provided by some fisheries may result in impacts on for instance habitats, where bottom trawling is the classical example (Watling and Norse 1998). Marine habitats have been shown to hold values for the general public, something we observe in the large push to conserve vulnerable marine environments (VMEs) and other marine habitats (Armstrong et al. 2014). Hence, the provisioning services of fish are traded off against cultural and supporting services of habitat, where such habitats are not protected, or where for instance fisheries that impact benthos are not regulated. Indeed, the fisheries effects on habitats may even feedback on the fisheries themselves, as some habitats impacted by fisheries may also be important for the growth and density of harvested fish (Foley et al. 2012; Foley et al. 2010). Trade-offs may also occur in relation to policies implemented. For instance, an LO may potentially reduce the provisioning of fish, in that the regulation may make some fisheries become more costly, and hence less lucrative. At the same time the LO may encourage changed behavior in order to reduce bycatch, and thereby increase the cultural services emanating from the existence of fish and ocean habitats. In a similar vein of thought, it would be interesting to repeat the exercise of crossing

ESSs / ESDs with any other management objective proposed by the Common Fisheries Policy or the Marine Strategy Framework Directive and afterwards analyze the ESSs / ESDs found at the intersection between the effects of the landing obligation and the effects of the other management objective.

It would be interesting to have the possibility of adding a specific value (even if approximate) to each ESS / ESD included in Table 2 and thus to the effect of the respective management approach. However, this is not an easy task. The measurement of provisioning ESS of fish is well developed and market oriented, applying metrics such as weight, value or employment, depending on what type of values one is interested in. ESDs, in the sense that they reduce provisioning ESS, are measurable in the same fashion. The measurement of regulating, cultural and supporting services is more complex. The valuation of supporting services is especially demanding, as the value is already included in the final services, be they provisioning ESSs, regulating ESSs or cultural ESSs. As has been suggested, supporting services are highly important to identify, as impacts on their supply feeds into the final, direct services, but their monetary valuation may be less relevant (Armstrong et al. 2014). Values connected to regulating ESSs and cultural ESSs are less easily come by (Garcia Rodrigues et al. 2017). We leave this possible valuation exercise to future research.

The ESSs frameworks are usually applied to identify or categorize the services that ecosystems provide (MEA, 2005; CICES, 2013). The frameworks also provide an overview that can be used to identify tradeoffs between services, especially in the face of policies implemented. The LO focuses on regulated commercial species, i.e. stocks that are managed with quotas, or species with minimum conservation reference size (MCRS) regulations. The background for the push to limit discards can however be perceived to be more encompassing than purely in relation to commercially interesting fish. Studies show the public have a broader set of values in relation to fish, than solely through what enters their stomach. Indeed, people have non-use values connected to fish and their habitats, in the sense that they value their existence, without reference to own consumption (Aanesen et al. 2015). Hence, the public reaction to waste in relation to discards can be seen to be deeper than purely the throwing overboard of edible fish. It relates to the wasteful killing of fish or other organisms, that supply value, either indirectly as habitat for fish, or directly as cultural services providing existence values from fish or habitats. Indeed, option values, i.e. the valuation of potential future forgone services, that we may not have full knowledge of today, are also relevant for the ocean, and have been identified to be something people put value on (Jobstvogt et al. 2014). However, the LO may also lead to ESSs losses, in the sense that previous discarding provided feed for birds and other organisms in the sea that have value, potentially also storing carbon, that now upon bringing to land, increases global carbon emissions.

In a broader governance setting, these trade-offs are important, not only due to the potential costs or benefits, but also in relation to who gains and who loses. The legitimacy of management options in a governance perspective is often dependent on both the assessment of gains and losses, and whether the outcomes of the process are deemed acceptable. Hence, the background for the LO, i.e. the general public's perception of waste in fisheries that the previous EU discard rule produced, may be substantially broader than purely in relation to commercial species. In this context, focusing solely on impacts for commercial species does not fully identify the benefits and gains of the LO. In this study we have attempted to more broadly identify some of

the many ESS in the ocean areas of the LO, how they are affected by the fishery, and how the LO may impact on them. Using the ESSs framework expands the view of the services provided from the ocean and opens up for the LO having much broader effects than would otherwise be apparent when focusing purely on commercial values.

Conclusions

Fisheries are socio-ecological complex adaptive systems embeded in various ecosystem services and disservices. Thinking about fisheries in terms of the services that can be affected by the management decisions governing the fisheries SECAS could be a useful approach that can potentially generate innovative ways to approach fisheries governance issues. This understanding can enrich the discussions around the necessity to alter or even discontinue the human activity that affects or is affected by the services, facilitating comparisons of management alternatives. Building on a non-exhaustive conceptual description of ESSs and ESDs, and the preliminary results of a survey about the perception of these services implemented during the 2016 annual meeting of the DiscardLess project, this study: 1. identified and characterizes the most important ecosystem services and disservices in which fisheries SECAS are embedded; and 2. mapped the services / disservices that may be affected by the discard policy / landing obligation. Considering these objectives, we used the Millennium Ecosystem Assessment (MEA)) in our discussion of fisheries. This framework includes supporting services that feed into the direct services to humans, the provisioning, regulating and cultural services.

Employing this MEA framework we have identified 39 ESSs and 17 disservices in which fisheries SECAS are embedded. The participants identified some of these ESSs, but for the most part they identified provisioning services of fish, and the supporting services of biodiversity and habitat. A vast majority of these can be expected to be affected by the discard ban / landing obligation, even though it is not clear in which way, as can be interpreted from the responses to the survey. As further exploration tracks, it would be interesting to repeat the exercise of crossing ESSs / ESDs with any other management objective proposed by the Common Fisheries Policy or the Marine Strategy Framework Directive and afterwards analyze the ESSs / disservices found at the intersection between the effects of landing obligation and the effects of the other management objective.

Sometimes, the degradation of an ecosystem can be attributed to the habit of seeing every ecological debate as a contest between biodiversity and socio-economic benefit, where the resulting compromise decisions diminish ecosystem health (Pittock, Cork, and Maynard 2012). Using this framework to identify a greater diversity of ecosystem services and management options could help stakeholders engage in richer debates and could help institutions choose actions to provide a broader range of benefits for people (Pittock, Cork, and Maynard 2012). When an ecosystem-service perspective is used for setting objectives in aquatic habitat conservation, speciality literature from the ecosystem services domain recommends following the next actions: 1. explicitly list and evaluate full suites of ESSs; 2. identify current and future potential trade-offs; 3. specify time frames within which particular strategies might protect or enhance desired services; 4. predict how different proposed strategies might affect each ESS (Boulton, Ekeboom, and Gíslason 2016). This study links with actions 1 and 4. Using the ESSs framework to analyze a fishery regulation such as the European Union (EU) Landing Obligation

(LO) (European Commission 2018) enables a richer and more encompassing view of the benefits and costs emanating from this policy change.

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Appendix 1. Ecosystem services presented at the DiscardLess 2016 annual meeting.

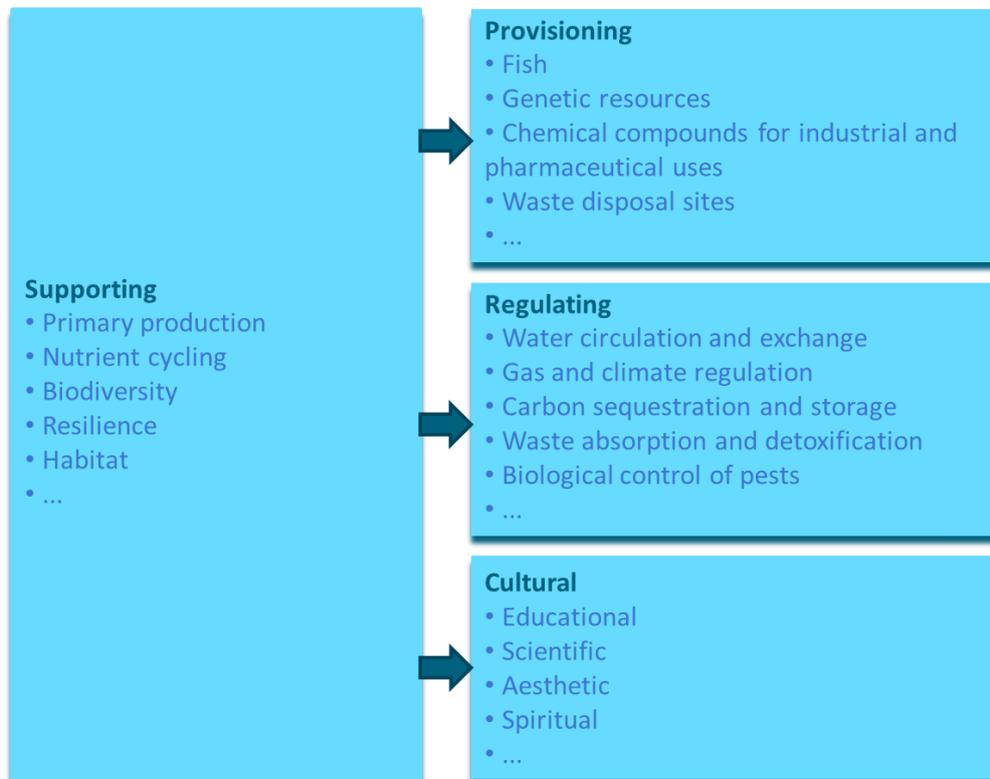


Figure A1. Millennium Ecosystem Service framework for the marine environment, presented at the Discardless annual meeting 2016.

Appendix 2. Questionnaire form about ecosystem services implemented at the DiscardLess 2016 annual meeting

Please consider the **ocean area where you are working** and the **most economically important fishery** in that area.

Write down the ocean area and fishery you are thinking of?

I. Identify possible ecosystem services in the area.

II. a. Identify the *effect* of the fishery on the sustainability of the services, where **P= Positive effect, N= Negative effect, 0 = no effect, DK= Don't know**.

b. If positive or negative effect, identify the *degree* to which the services are affected by the fishery, where **1= very little or not at all and 5 = a lot**.

III. a. Identify the effect of the landing obligation/discard ban on the services, where **P= Positive effect, N= Negative effect, 0 = no effect, DK= Don't know**.

b. If positive or negative effect, identify the *degree* to which the services are affected by the landing obligation/discard ban, **1= very little and 5 = a lot**.

IV. Identify how important you think these services are, where **1= very little and 5 = a lot**.

		I.					II.					III.					IV.				
		How are the services affected by the fishery?					How are the services affected by the landing obligation/discard ban?					How great importance do you think the services mentioned have?									
Specify services:		P/N/O/DK	1	2	3	4	5	P/N/O/DK	1	2	3	4	5	1	2	3	4	5			



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Provisioning	1.																		
	services	2.																	
Regulating	1.																		
	services	2.																	
Cultural	1.																		
	services	2.																	
Supporting	1.																		
	Services	2.																	