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Case Study Report, Task 7.3

Synthesis and suggestions for Discard Mitigation Strategies by case study

Year 2 : March 2016-February 2017

Case Study: Northern North Sea and Northwestern Waters

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1 What has been going on in this area during the last 12 months?

This case study covers the more northern parts of the North Sea (ICES IVa and deeper regions of IVb), the Skagerrak (ICES area IIIaN) and the west coast of Scotland and northern part of Ireland (ICES VIa). The main focus is on the various towed gear fisheries (mainly bottom trawls and seines) targeting various mixtures of demersal species (cod, haddock, whiting etc.), groundfish (e.g. anglerfish and megrim) and *Nephrops.*

In the past twelve months the case study has drawn on outputs from a number of work packages bringing these together in a framework involving modelling tools to investigate various potential discard reduction scenarios and sought input from a range of stakeholders. Stakeholder involvement from around the case study area is considered crucial in order to ensure the analysis is directed at the most relevant issues and to ensure there is common understanding during the dissemination of outputs from the case study work.

1.1 Important changes in stock development, discard data and ecosystem

Within the case study area the main source of information and advice on principle fish stocks is the International Council for the Exploration of the Sea (ICES). ICES also provide ecosystem overviews covering the North Sea and Celtic Seas areas.

http://www.ices.dk/community/advisory-process/Pages/Latest-advice.aspx

The most recent assessments of exploited stocks within the case study area were conducted by ICES in 2016. The left hand part of Table 1 illustrates the state of the main commercial stocks in the North Sea, with respect to their MSY target reference points, comparing the 2016 outcome with the year before. The majority of stocks are fished at or below F_{msy} and SSB has been improving (green shading).

	State of Stocks				Fishing Opportunities					
	2015		2016		2016			2017		
Stock	***F***	**SSB**	***F***	**SSB**	**Advice**	**%**	**Basis**	**Advice**	**%**	**Basis**
Cod					40 419	15	MSY	47 359	17	MSY
Haddock					61 930	30	MSY	39 461	-36	MSY
Whiting					13 678	-15	Man Plan	23 527	72	MSY
Saithe					68 601	-6	Man Plan	140 653	105	MSY
Plaice					159 197	15	Man Plan	158 201	-1	Man Plan
Sole					11 921	0.1	Man Plan	15 251	28	Man Plan
Hake					96 951	6	MSY	123 777	27	MSY
Herring					518 242	16	Man Plan	458 926	-12	Man Plan

Table 1. Trends in stock status (green – improving, red – declining) and fishing opportunities for key commercial stocks in the North Sea.

Fishing opportunities as shown on the right hand side of the diagram continue to improve for the majority of stocks, the decrease in haddock being attributable to an error in the 2015 assessment. This continues to foster a more favourable environment for the introduction of the Landing Obligation than

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might have been the case had catching opportunities decreased. The basis for advice for saithe and whiting in the North Sea was changed following benchmark meetings, and as a result, advice is now given for total removals, including discards, on the basis of an MSY reference point, rather than in accordance with the EU-Norway management plan used in previous years. On the west coast of Scotland the picture is also improving but at a slower rate and there are a number of notable exceptions including cod and whiting (Table 2). These two species are estimated to be below safe biological limits and in the case of cod, fished well in excess of F_{msy} – In both cases the states of the stocks attracts a zero TAC (bycatch only fishery). Some stocks, on the other hand have been increasing in recent years and catching opportunities have also increased. Good examples of these are anglerfish and megrim and also *Nephrops*.

	State of Stocks				Fishing Opportunities					
	2015		2016		2016			2017		
Stock	***F***	**SSB**	***F***	**SSB**	**Advice**	**%**	**Basis**	**Advice**	**%**	**Basis**
Cod					0	-	MSY	0	-	MSY
Whiting					0	-	MSY	0	-	MSY
Angler					18 435	25	PA	21 171	15	PA
Megrim					8567	22	MSY	8567	0	MSY
Mackerel					744 000		MSY	857 000	15	MSY
Nephrops					16 501		MSY	16 980	3	MSY

Table 2. Trends in stock status (green – improving, red – declining) and fishing opportunities for key commercial stocks to the west of Scotland.

Estimates of overall discards occurring in the key stocks within the case study area are available from the ICES assessments (see link above). For some species, particularly in the North Sea, the quantities of discarded fish have been falling and this is particularly noticeable in N Sea cod and haddock. For some species, however, discarding remains relatively high (for example whiting) and in the case of hake in the North Sea has actually been increasing in recent years owing to changes in the spatial distribution of this species coupled with restrictive TACs. On the west coast of Scotland, cod discarding remains a serious issue. These overall observations frequently mask particular issues connected with certain types of towed fishing gear and detail at a more disaggregated level is available in the report of the STECF EWG on Fisheries Dependent Information (https://datacollection.jrc.ec.europa.eu/dd/effort).

These publically available data have been combined with information from the ICES stock assessment database and from the GCFM, within the DiscardLess project to create an interactive discard atlas for fisheries in the north-east Atlantic and Mediterranean Sea (Guitton *et al.,* 2017., http://www.discardless.eu/atlas). The estimation of fisheries specific international landings and discards is based on linking the information about fisheries specific discards and catch and discards at age among countries and replacing poor or lacking values with aggregated information from other countries. Reported data by country are aggregated by fisheries and raised to the officially reported landings or discards in the format stipulated in the annual DCF fishing effort data calls. Fisheries definitions are based on area, year, quarter, gear, mesh size groups, special conditions as defined in Annexes IIA-C of the annual fishing opportunities regulation or the multiannual management plans, and national fisheries (metiers) definitions (Figure 1).

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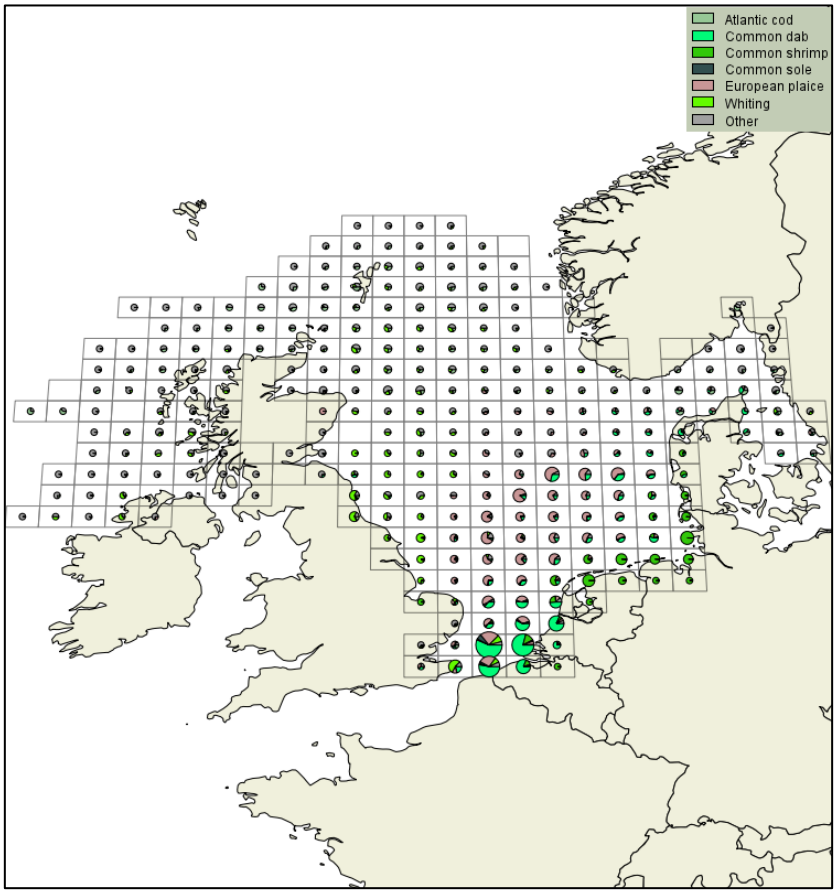

Figure 1. Discards by species (Average discards ratio applied to landings by rectangle) in the North Sea, Skagerrak and west of Scotland, from the DiscardLess discard atlas.

Data compiled by for the STECF for reporting progress on achieving maximum sustainable yield showed that, for the wider northeast Atlantic, progress up to 2015 has been too slow to allow all stocks to be maintained or restored at the precautionary B_{pa} level or above, and managed according to F_{msy} by 2020. The indicators provided show that many stocks are still overexploited, but also that stocks status is significantly improving. Trends of indicators in the Greater North Sea area are given in Table 3 (STECF, 2017).

No of stocks where:	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
$F>F_{msy}$	14	15	17	18	16	16	12	12	11	15	10	13	10
$F<<=F_{msy}$	7	6	4	3	5	5	9	9	11	7	12	9	11
Outside safe biological limits	6	6	6	8	8	7	6	6	8	3	4	6	4
Inside safe biological limits	6	6	6	4	4	5	6	6	4	9	8	6	7
$F>F_{msy}$ and/or $B<B_{pa}$ (ie. outside CFP requirements)	9	9	10	10	10	10	9	9	10	8	6	7	6
$F<=F_{msy}$ and $B>=B_{pa}$ (ie. inside CFP requirements)	3	3	2	2	2	2	3	3	2	4	6	5	5
Mean value of F/F_{msy}	1.57	1.55	1.5	1.58	1.47	1.33	1.21	1.14	1.09	1.01	0.95	1.04	1.05

Table 3. Trends in fishery and stock status indicators for the North Sea, 2003 – 2015 (STECF, 2017).

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1.2 Important changes in terms of fisheries and stakeholders perception

The STECF AER Report (STECF, 2016) provides insights on the profitability of EU fishing fleets until 2014. It indicates that in the North Sea there have been important changes in the fisheries in recent years. Overall the number of vessels of the North Sea fleet shows a decreasing trend between 2011 and 2014. Employment, measured in terms of Full Time Equivalents (FTE) showed a decreasing trend between 2010 and 2013, but stabilised in 2014 (+1%). Landings in weight and value remained at a relatively stable level throughout the period 2010-2014, although with some significant variation at national level. Compared to 2013, landings weight and value increased in 2014. The overall changes have been mostly driven by the large-scale fleets, whereas the trends for the small-scale fleet in the North Sea are less clear and points towards the status quo.

Comparable analysis for the West of Scotland component of the case study area is not separately available. Results for the NE Atlantic fishing fleet suggests that in the most recent years, gross profits have been recorded by most Member States including those operating regularly in the West of Scotland area. This represents an improved picture before 2011 when a number of countries recorded losses.

As regards stock status, feedback from stakeholders, largely through routine fisheries management discussions, suggests increased optimism for many North Sea stocks. On the west coast, improvements in groundfish (e.g. anglerfish and megrim) have also been viewed positively. On the other hand, the introduction of the Landing Obligation has raised a number of concerns, particularly relating to potential choke species (especially hake) and in cases where the TAC is currently zero (e.g. West Coast cod). In Denmark, quota management arrangements and higher TACs appear to have created a more favourable environment, where the fishing industry in the Greater North Sea region has reached in 2016 its highest revenue over the last fifteen years, 20% higher than in 2015 (Fiskeri Tidende, 7 January 2017). In Scotland, SEAFISH have been conducting analysis to investigate the extent and likely effects of 'choke' situations and the potential to find solutions to mitigate the problem. Some modelling suggests that swaps would be benefical but it is not clear yet to what extent this is happening already and how much more scope there is to use this approach.

Nevertheless, fishers' opinions on the landing obligation remain negative. Specifically, the North Sea Advisory Council has raised concerns in a number of areas regarding choke species, *de minimis* exemptions and those for species with high survival rates[1]. At a "Choke Species Symposium" held by the NSAC in October 2016, delegates considered the scale and complexity of chokes and discussed ways to identify how chokes could be better predicted and avoided. The limits of the current management "toolbox" available for choke avoidance (e.g. selectivity and avoidance, quota swaps and transfers, quota management systems, inter annual and inter species flexibility) were discussed, and the need for innovative approaches recognised (e.g. group TACs, removing species from TAC management,

[1] NSAC Advice Ref. 4-1516. NSAC Reflections on the Joint Recommendation of the Scheveningen Group Discard Plan for Demersal Fisheries in the North Sea http://www.nsrac.org/wp-content/uploads/2014/11/4-1516-Reflections-on-the-Joint-Recommendation-for-NS-Discard-Plan.pdf

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legislative change on the MSY timetable and flexibility in relative stability). The same viewpoints were expressed at the DiscardLess stakeholder conference in March 2017[2]

A DiscardLess project workshop was held by Marine Scotland in March 2017 to identify modellable scenarios for discard reduction that would have the support of the industry and that could be quantitatively evaluated with models. This workshop confirmed that in the UK the implementation of the landing obligation, and the willingness of the industry to explore its feasibility, has been undermined by the uncertainty around the withdrawal of the UK from the European Union (Brexit), and the potential for UK vessels to be no longer subject to the landings obligation before its full implementation.

In both Denmark and Scotland, Fully Documented Fisheries trials have been running since 2010, leading to technological developments in terms of video data quality and of software applications, while at the same time the unit costs of the camera systems has decreased significantly; leading to an efficient and cost-effective system allowing to monitor and measure a great number of species and hauls with limited man power (Mortensen *et al.*, 2017). Work carried out in by Marine Scotland and the University of East Anglia, applying convolutional neural networks to analysis of CCTV footage is delivering promising results, with the software now able to identify and count fish passing along a discard belt (**Error! Reference source not found.**). A follow up study, training the network to identify individual species of fish is underway. This has the potential to greatly reduce the staff time required to obtain quantitative estimates of discards from REM-equipped vessels.

Figure 2. Convolutional neural network identification of fish passing along a discard belt, with running count (top left) of the number recorded going overboard. A demonstration of the system can be viewed at: https://www.youtube.com/watch?v=zHoaV_bLA2c

A survey of perception of the Landing Obligation and the use of Remote Electronic Monitoring among Danish fishers and fisheries controllers (Plet-Hansen *et al.*, 2016) revealed that fishers had a negative

[2] http://www.discardless.eu/home/presentation/discardless-stakeholders-conference-in-fao-rome-on-9-10-march-2017

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perception of the Landing Obligation which was seen as a regulation that would impact the fisheries negatively and provide no positive results for the marine environment and fish stocks. Danish fisheries controllers had a more positive opinion on the effect of the Landing Obligation but virtually none of the fisheries controllers believed the regulation could be enforced with the current methods applied in the Danish fisheries control (at-sea control, control of landings and self-reported catches in the Electronic Logbook). Fisheries controllers saw the use of REM as a possible monitoring tool to increase compliance with the Landing Obligation, although several stated that this method had to be backed by other control methods too. Both fisheries controllers and fishers stated that privacy rights were at stake when using REM but fishers who had participated in trials using REM expressed little concern on this matter. In general, fishers who had experience with REM and fisheries controllers were positive towards the use of REM as a means to ensure compliance with the Landing Obligation whereas those with no REM-experience were against it. Indeed, some fishers participating in the Danish Cod Catch Quota Management trial expressed a wish to keep the camera systems on-board and even relay video data without a quota uplift if this may help in the assessment of fish stocks.

1.3 Important changes in management

The case study area has been subject to fundamental changes in fisheries management over the last 10 years or so. Following the decline of the cod stocks in the area, a cod recovery plan was developed and introduced stringent TAC constraints and an effort regime designed to reduce fishing mortality. This remains in place at present although is subject to legal discussion on its continuity and nature in the frame of the new CFP.

In 2015 the Landing Obligation scheme was introduced for pelagic species, and Discard Plans were developed for the first round of introductions of demersal species in 2016. Discussions were progressed within Regional Groups and by the ACs operating in the two areas of the case study, NSAC and NWWAC. Plans were submitted to the EU Commission in spring 2015 and evaluated by STECF during the summer. In the North Sea, a gear based approach was adopted and for TR1 vessels haddock and plaice were the selected species. For TR2 vessels the species introduced were *Nephrops* and sole. Saithe was also introduced but only for vessels where the proportion of saithe in the catch was high. In the West of Scotland, the approach was based on catch thresholds with vessels required to land all haddock when their catch of demersal species exceeded 10% of the total catch and required to land all *Nephrops* when their catch of *Nephrops* exceeded 30% of the total catch. The Discard Plans contained some applications for the use of the high survivability exemption and for the use of *de minimis* provision.

Alongside the developments of the plans, activity in Member States has included regular conversation with industry and NGO stakeholders in groups such as the Scottish Discards Steering Group and the Danish CFP DialogForum. These have been formed to consider the problems created by the Landing Obligation and to start to develop methods (improved selectivity etc.) in order to address the issue.

In 2017, the demersal landings obligation in western waters was extended to include haddock, megrim, plaice, *Nephrops,* hake and pollack, and in the North Sea to include cod, haddock, hake, plaice, saithe, sole, whiting, *Nephrops* and northern prawn (*Pandalus*). Exemptions are available for species and situations where high survivability has been demonstrated or where more selective gears have been

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used. Details of requirements are shown for the North Sea in Table 4, and waters to the West of Scotland in Table 5.

Discussions have started on the next stage of the Landing Obligation in preparation for 2018 and the incorporation of additional species. Arguably, the first year of the regulation saw the introduction of the 'easier' species. As the deadline of 2019 approaches when all TAC species will be introduced, some of the difficulties discussed above (choke species etc.) will likely become more acute. To this end the North Sea (Scheveningen) Regional Group has hosted two workshops (open to other Regional Groups) to explore topics such as quota exchange and mitigating choke effects. There remains considerable concern over the timing of the introduction of cod to the scheme and whether, by then, it will no longer be the subject of a cod recovery plan. There is a strong belief that measures within the cod plan confound the successful introduction of the Landing Obligation for this species. This is a particular problem on the West coast of Scotland where there is currently a zero TAC and where cod is frequently caught alongside haddock, anglerfish and a variety of other species.

Gear	Species which must be landed	Who it applies to	Exemptions available
Trawls & Seines ≥ 100mm	Cod, Haddock, Whiting, Sole, Plaice, *Nephrops*	All using the specified gears	No
Trawls & Seines ≥ 100mm	Saithe	Those meeting a catch threshold	No
Trawls and seines 80-99mm	*Nephrops*, Sole, Haddock	All using the specified gears	Undersized sole must be discarded from <10m vessels operating within 6nm of the coast in ICES area IVc, with a maximum engine power of 180kw, caught in depths of <15 m with a towing time less than one and a half hours. This exemption is in place due to a high survival rate in this fishery. Undersized *Nephrops* can be discarded. Unwanted *Nephrops* can be discarded when using a netgrid selectivity device as there is a high survival rate.
Beam trawls ≥ 120mm	Cod, Plaice, Sole, Haddock, Whiting, *Nephrops*	All using the specified gears	No
Beam trawls 80-119mm	Sole, Haddock, *Nephrops*	All using the specified gears	Catches of undersized sole can be discarded when using selective trawls in which all meshes in front of the codend are at least 120mm.
Gill nets, Trammel nets, Entangling nets	Sole, Cod, Haddock, Whiting, *Nephrops*	All using the specified gears	Unwanted catches of sole can be discarded by vessels using trammel and gill nets.
Hooks, Lines	Hake, Sole, Cod, Haddock, Whiting, *Nephrops*	All using the specified gears	No
Pots, Traps	*Nephrops*, Sole, Haddock, Whiting	All using the specified gears	Unwanted catches of *Nephrops* can be discarded as they have a high survival rate
All gear types	Northern Prawn	All vessels	No

Table 4. Demersal landings obligation requirements and exemptions in the North Sea during 2017.

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Area	Gear	Species which must be landed	Who it applies to	Exemptions available
Vb and VI	Trawls Seines	Haddock, Sole, Plaice, Megrim	Those meeting a catch threshold	No
Vb, VI and VII	Trawls Seines	Hake	Those meeting a catch threshold	No
Vb, VI and VII	Gill nets, Trammel nets, Hooks, Lines	Hake	All using the specified gears	No
Vb, VI and VII	Trawls, Seines, Pots, Traps, Creels	*Nephrops*	Those meeting a catch threshold	Unwanted catches from pots and creels can be discarded as they have a high survival rate. Unwanted catches from trawls can be discarded.

Table 5. Demersal landings obligation requirements and exemptions in waters to the west of Scotland during 2017.

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2 The Year behind us (2016-2017): What has DiscardLess produced in this case study during the last 12 months?

Various work package activities have contributed to the Northern North Sea - West of Scotland case study.

2.1 Impact assessments

2.1.1 Ecosystem scale

DTU has produced and released a short video capturing the fate of discards in the ecosystem, which highlights that many species opportunistically scavenge on discards when available (Figure 3). The footage shows flatfish scavenging on dead *Nephrops*, *Nephrops* and spider crabs scavenging on dead flatfish, and hagfish being observed to be a major scavenger. Discards were rapidly eaten in a short period, leaving almost no remains. The video can be found at:

http://www.discardless.eu/video

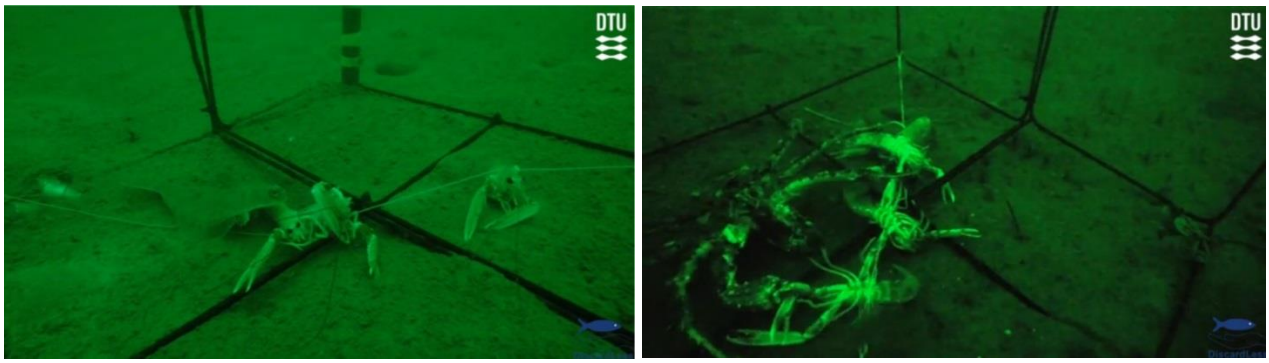

Figure 3. Still images from the videos created by DTU, of flatfish (left) and a spider crab (right) feeding upon discarded Nephrops.

Strathclyde University have been further developing their E2E model (End to End ecosystem model). The case study will consider mainly the demersal round fish fleets fishing in the North Sea and West of Scotland. During 2015 an existing ecosystem model , StrathE2E, developed for the North Sea (Heath, 2012; Heath *et al*. 2014) has been configured to include the West of Scotland. The model aggregates fish stocks and other biological components of the ecosystem into trophic groups but identifies distinct 12 fleets. To examine the effects of discarding the model requires estimates of the weight of fish discarded per unit weight caught by fleet. Preliminary work has begun on a fleet based model that will use length frequency data by ICES rectangle from the IBTS to derive discard rates by fleet and area that can be input to StrathE2E to explore new discarding scenarios. In addition during 2016 further work on estimating discards of data poor species using the approach published by Heath and Cook (2015) was undertaken. The new model enables estimation of discards, stock biomass fishing mortality and recruitment for species such as common dab, lemon sole, flounder and witch.

Marine Scotland and Strathclyde have begun developing a spatial fisheries model. It is hoped this will permit the relative benefits of various scenarios for reducing discards to be compared. Scenarios

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involving spatial measures such as closed areas or short term avoidance measures and selectivity changes are obvious candidates to consider. The principle elements are illustrated in the Figure 4.

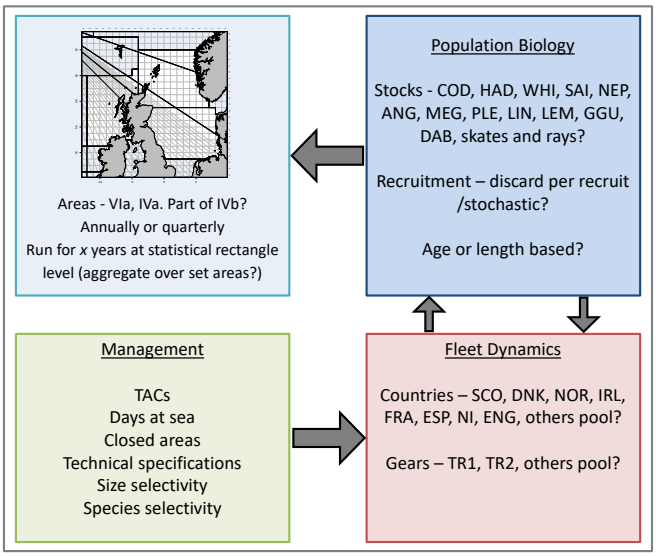

Figure 4. Conceptual framework of the Strathclyde/Marine Scotland spatial model.

2.1.2 Fishery scale assessment

KU-IFRO has conducted and extensive literature review on the economic and social aspects of discarding has been performed in WP2 (Deliverable D2.1 and D2.2). As under 2.1, the review by Ulrich (2016) further summarised this knowledge together with additional publications and reports. It is noted that the linkages between MSY and the landing obligation are unclear. The landing obligation is not a direct mean to achieve MSY, but rather an objective in itself. Several North Sea stocks are already fished at F_{msy} in spite of important discards. Many bioeconomic impact assessments have been performed on several North Sea mixed-fisheries fleets. They mainly highlight the impact of "choke species", where the early TAC exhaustion of the least productive stock or of a stock with limited historical fishing rights in the region would lead to fishery closure and under-exploitation of the most productive stocks compared to their single-stock management objectives. The increased fishing costs have also been estimated for some fisheries. The various policy adjustments possible in the frame of the landing obligation can though mitigate or even nullify the short-term negative economic impact for some fleets. Additionally, it is noted that with the recovery of the North Sea cod, some "choke effects" might be less severe than predicted by the available economic models.

There are many ways by which fishers could improve their fishing patterns to better adjust to fishing opportunities. Many options already exist, and new industry-led solutions could be developed. But proper mechanisms incentivising them to do so are needed; otherwise the risks of non-compliance are real. At this stage, it is thus not possible to predict how the fishing industry will actually react, and practical experience will be gained over the next five years.

Fcube (North Sea – West of Scotland, Clara Ulrich):

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A study overarching both H2020 DiscardLess and FP7 MYFISH as well as ICES WGMIXFISH and STECF 15-04 has been completed, investigating the use of MSY ranges to reduce the potential choke effects using FCube as a contribution to a potential mixed-fisheries management plan (Ulrich *et al.*, 2016). It shows that when stocks are within safe biological limits, it may be possible to find an annual compromise within the MSY ranges that minimise mismatches across single-stocks TACs. Mixed fisheries work is in constant development, including inclusion of by catches species, better economic data and improved inclusion of uncertainty. The FCube model runs so far either as Business as Usual (discard ratios as in ICES) or Full Implementation (all discards landed, no changes in selectivity). A lot of this is shaped by, and translated directly into the ICES advice on mixed-fisheries, which can be found at:

http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2016/2016/mix-nsea.pdf

Fishrent (North Sea – West of Scotland, Ayoe Hoff and Hans Frost):

The Fishrent model is being calibrated for the the Danish demersal fishery in the North sea. The model has been set up to allow gradual introduction of the landings obligation, with some species included in 2016 and all in 2019. Calibration is in progress and updated in parallel with calibrating a model for the long term consequences of the landings obligation for the total Danish fishery (following up on the study by Ravensbeck et al., 2015). In connection with the Danish project, the implementation of the landings obligation in Denmark is being reviewed for the species of interest for the Danish demersal fishery in the North Sea. Initial baseline scenarios have been run, covering Business as usual (long term MSY management plans, discard allowed) and full compliance (all quota species landed by 2019).

SEAFISH (North Sea – West of Scotland, Arina Motova Seafish)

The model developed by Seafish was updated to 2015 baseline adding metier level information, incorporating additional scenarios and making SEAFISH model easier to update with the new data. Two reports were drafted and published by Seafish.

- SEAFISH Bioeconomic Model Analysis of Choke Points and Problem Stocks for UK Fleet under the Landing Obligation, 2017-2019;
- SEAFISH Bioeconomic Model Methodology Report

Seafish also finished its modelling exercise to investigate potential impacts from the introduction of the landing obligation. The proposal to undertake an economic impact assessment was supported by stakeholders including government and industry. The project consisted of two main phases; a choke analysis of PO fleet segments and home nation fleet segments investigating what would have happened had the landing obligation been imposed in 2011, 2012 and 2013; and a bioeconomic scenario analysis for 50 UK fleet segments to estimate the potential future consequences of the landing obligation; and to assess the relative benefit that different policy levers could have on an annual basis up to and including 2022.

The bioeconomic scenario analysis is focused on the effect of policy decisions and assumes no change to other aspects, including how the UK fleet catches demersal quota stocks under the landing obligation. The analysis shows that the landing obligation is likely to have relatively limited impact on the UK fleet

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in 2016 and, despite some choke points, total revenue would exceed revenue earned in 2013 because the fleet can land and sell catch that was previously discarded (the analysis holds fish prices at 2013 levels). In 2017 and 2018, as more stocks become subject to the landing obligation, the landing obligation is likely to have a notable negative impact as more choke stocks would be encountered under baseline scenario by most fleet segments in 2017 and 2018. The policy levers of *de minimis* and interspecies flexibility, as defined in the bioeconomic scenario analysis, would create benefit compared to baseline scenario, however once all demersal quota stocks become subject to the landing obligation in 2019, the negative impacts on the UK fleet are likely to be substantially greater and policy levers included in the model do not address the choke points caused by data-poor quota stocks.

The two largest fleet segments in terms of landings, the English beam trawl and Scottish whitefish fleets, are also expected to experience substantial negative impacts under the best case scenario tested. Without further mitigation, revenue in 2019 could be three-quarters of that earned by the beam trawl fleet in 2013 and just over half of the revenue earned in 2013 by the Scottish whitefish fleet. In 2019, a substantial proportion of primary choke stocks identified in the model are data-poor stocks and for most fleet segments would be considered bycatch stocks. If choke points created by data-poor stocks can be removed, the outlook would improve but some challenges would remain. If UK vessels continue to fish as they did in 2013, 61% of the quota held by the six home nation fleet segments could remain uncaught in 2019 under the best case policy lever scenario. The potential impact of choke stocks on the activity and revenue of the UK fleet clearly demonstrates the need to find additional mitigating measures before 2019 in order to reduce the potential negative impacts of the landing obligation. The report is available at:

http://www.seafish.org/media/Publications/Seafish_LOEIA_Final_Report_290216.pdf

2.2 Avoiding unwanted catches

2.2.1 Gear Technology

MSS have been participating in and providing advice to the Gear Innovation and Technology Advisory Group 2 (GITAG 2). This is an industry group, funded by the EMFF, that has been set up to develop gears to help the Scottish fishing industry phase in the Landing Obligation, while protecting economic viability. Four gears were tested during 2016 by fishing skippers under the auspices of GITAG 1. One such set of trials were held to assess whether the unwanted by-catch of round and flatfish could be reduced in the *Nephrops* trawl fishery using a modified *Nephrops* trawl incorporating 200mm bobbins and a 200mm square mesh panel. These trials demonstrated that using the modified trawl lead to significant reductions in the quantities of smaller common dab (<19cm) and long rough dab (<21cm) that were caught. At present a number of proposals from fishing skippers and net makers are being considered and, if successful, will be trialled during the coming year. There is a similar initiative in Denmark (FAST-TRACK, http://www.fast-track.dk/). There are currently 5 gears being tested in the Fast-Track project; 2 looking at reducing the bycatch of fish in the *Nephrops* directed trawl fishery, 1 looking at reducing the catch of flounder in the Baltic cod fishery, 1 looking at optimising the size selectivity of cod in the Baltic cod fishery, and 1 gear trial in the brown shrimp beam trawl fishery which is looking at reducing the bycatch of juvenile fish.

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MSS have produced the DiscardLess selectivity manual and the associated factsheets (http://www.discardless.eu/selectivity_manual). The selectivity manual describes the different stages of the fish capture process, highlight how different parts of the gear may influence selection and identify possible design changes which can alter the selectivity of the gear. The intention is to make fishers, net makers and fisheries managers more aware of the possible modifications that can be made to their gears so that they can design and develop gears with a selective performance suitable for their particular fishery. The catalogue of fact sheets provide brief descriptions of more than 65 of the catch comparison and selectivity trials that have taken place in the North Atlantic and adjacent seas, of which 28 are particularly relevant for the North Sea – West of Scotland case study. The factsheets highlight the potential gear modifications that can be made and provide an indication of their likely effect (http://www.discardless.eu/selectivity_manual). There are ongoing discussions at an international level as to how the fact sheets can become a standard format for reporting catch comparison and selectivity trials which are available to a wide range of stakeholders.

DTU Aqua have carried out a review of collaborative science-industry partnerships which shows that a bottom-up approach to trawl gear development has a better success in implementing selective gears as opposed to those which employ a top-down approach where selective gears are enforced through legislation. The collaborative approach creates a sense of ownership and control over the gears developed and often results in a range of technical solutions which all achieve their objectives. In contrast, when new, more selective gears are introduced into legislation in a top-down approach, the selective performance of these gears is frequently negated.

Fishing trials to investigate the possibility of using innovative technologies to improve fish selection took place on the RV *Alba na Mara*. A fibre optic cable was used to illuminate the top, the bottom and all of a rigid grid fitted in the extension section of a trawl gear, with an unilluminated grid as a control (Figure 5). The grid was inclined at approximately 60° to the horizontal and fish which passed through the top half of the grid were directed to the upper codend and those that went through the lower half were directed to the lower codend. Preliminary analysis suggests that fish react differently to the illuminated grid and that more pass through the lower half when there is more light.

One of the objectives of this topic is to promote the use of technological developments to reduce the capture of unwanted species. In this regard MSS are participating in and providing advice to the Gear Innovation and Technology Advisory Group (GITAG). This is an industry group that has been established to stimulate innovation in the development of fishing gear technology that will assist the Scottish fishing industry phase in the Landing Obligation, while protecting economic viability. To date, four gear proposals are being developed and trialled by fishing skippers and net makers.

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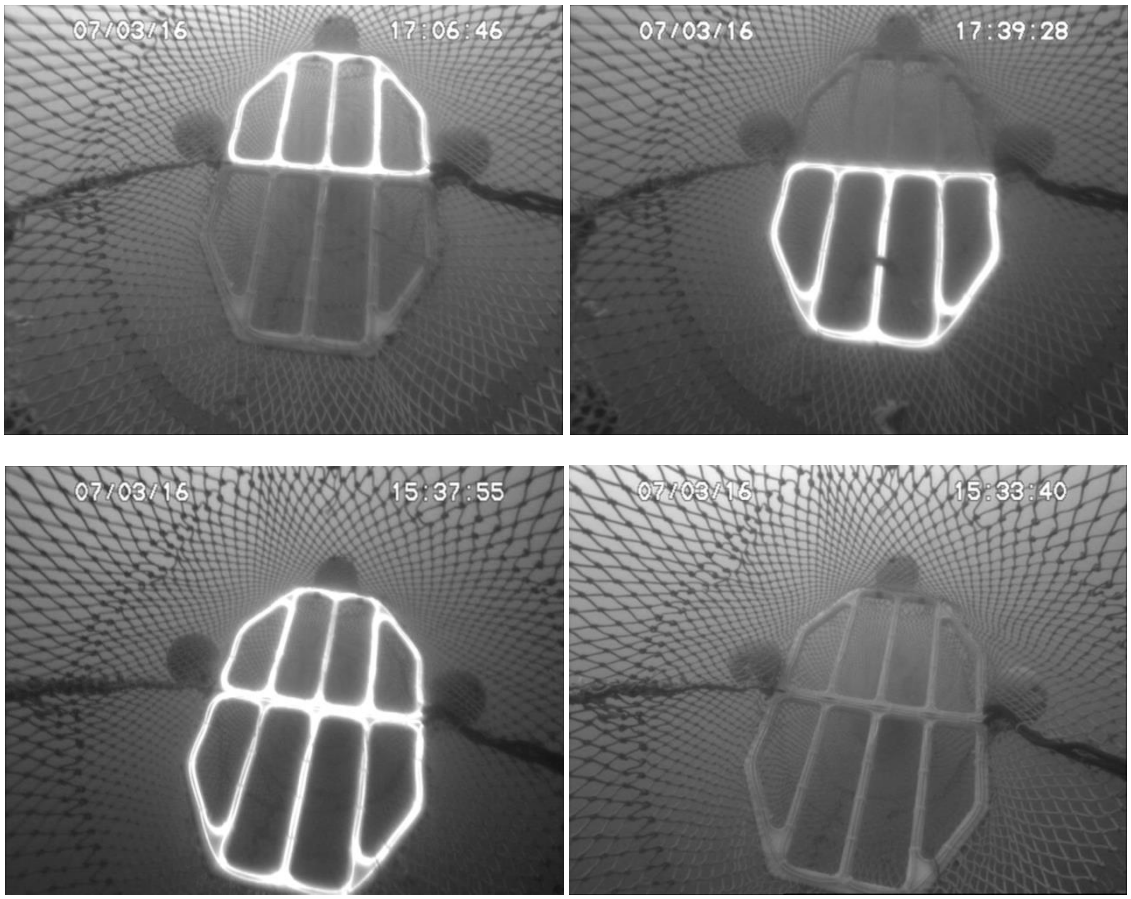

Figure 5. Soring grid illuminated with a fibre-optic light source, operating in top (top left) bottom (top right), whole (bottom left) and none (bottom right) configurations.

2.2.2 Fishing Strategies

Parallel to any developments of fishing strategies to tackle the demands of the landing obligation, Seafish has undertaken an economic impact assessment investigating existing or known policy measures. The assessment was undertaken in two phases, both of which assumed no changes to fishing patterns (fishing strategy change). The model examines the changes in fleet revenues due to the gradual introduction of landings obligation in 2016-2019. Results suggested that the landing obligation is likely to have relatively limited impact on the UK fleet in 2016 and, despite some choke points, total revenue could exceed revenue earned in 2013 because the fleet can land and sell catch that was previously discarded (the analysis holds fish prices at 2013 levels). Once all demersal quota stocks become subject to the landing obligation on 1 January 2019, however, the negative impacts on the UK fleet are likely to be substantially greater and policy levers included in the model do not address the choke points caused by data-poor quota stocks (Russell *et al.*, 2016). This work points to the need for the development of additional measures to cope with the landing obligation.

The results of nationally funded "challenge experiment" performed in Denmark in 2015 (the MINIDISC project) were analysed and the results were published (Mortensen *et al.*, 2016). 9 out of the 12 Danish trawlers which operated in a "free gear choice" trial managed to reduce their discards without reducing their profit.

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Another study was conducted to understand and document the differences between saithe and cod in the mechanisms by which they can "choke" a fisherman (Mortensen *et al*., subm.). The study illustrates how the combination of quota available, leasing price, patchiness and stability over time of the spatial distribution of the species as well as its overlap with other valuable species trigger the tactical choices of where to fish and how much displacement is needed to avoid the choke species. 'Challenge' experiments have also been conducted in Ireland and in Scotland. Results of these are being worked up and are expected to demonstrate the difficulty of consistently avoiding unwanted catch.

2.3 Optimal use of unavoidable unwanted catches

2.3.1 From deck to first sale

Key to the implementation of the landing obligation and understanding what vessels actually catch is the ability to record and have assurance that reported catches are precisely that. In other words that everything is accounted for. Towards this end, various pilot studies using CCTV have been underway for some time. Due to difficulties in adhering to the Landings Obligation following the end of the cod recovery plan and the extension of the Landings Obligation, many vessels which had been in the Scottish "cod catch quota" scheme withdrew and removed CCTV equipment. Some vessels are continuing to carry CCTV equipment and participating in a trial on saithe and monkfish, although the number of boats this year is limited. Similarly, in Denmark the CCTV scheme that has been in operation for some time has stopped in 2017.

In both Scotland and Denmark there has been some progress made on the handling of unwanted material on board vessels and the capacity of ports to deal with the material once it is brought ashore. A meeting was held on this topic with the Hanstholm harbour. One interesting development in Denmark is the design and build of a purpose built vessel for handling unwanted catches under a landing obligation. This work is in the early stages.

Regarding the control of catch using genetic tools, activities to date have included determination of exact experimental setup and preparation of experimental samples, including DNA extraction and DNA quality analysis for a North Sea fish silage scenario. The quality analysis has provided results on DNA yields which illustrate some intra- and interspecies variation between single species samples. Design and testing of species specific quantitative PCR (qPCR) assays for determining the relative contribution of individual species in mixtures of tissue have commenced for the three target species: Atlantic cod (*Gadus morhua*), Whiting (*Merlangius merlangus*) and Haddock (*Melanogrammus aeglefinus*). Quantitative and comparative qPCR analyses of samples are in the start-up phase. This will allow us to evaluate the precision of qPCR for detection and quantification of North Sea gadoids in silage and other mixed products.

2.3.2 Products to the value chain

Progresses on value chain adjustments in this case study area have not been reported in the present synthesis, but a number of initiatives are ongoing. Some analyses of existing landings facilities in Denmark were undertaken as part of Deliverable D6.1, and the quantity and variability of potential landings of what was previously discarded was mapped across harbours and seasons.

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2.4 Policy outreach

DISCARDLESS members have been involved at various levels in discussing with a variety of stakeholders the work of the project in the context of the landing Obligation. This discussion has taken place in national forums such as the Scottish Discards Steering Group and the Danish CFP DialogForum, in the ACs (various project members have been invited and presented information to the ACs, including the NSAC choke species symposium), in regional groups such as the Scheveningen Group and NWW group. A stakeholder workshop on discard reduction strategies (Figure 6) held by Marine Scotland Science was well attended by industry representatives, skippers, and policy colleagues. A report of the meeting is in preparation. The case studies was also discussed during the DiscardLess Stakeholders Conference held in Rome in March 2017.

Figure 6. Participants at the Marine Scotland Science DiscardLess Workshop.

2.5 Summary

A good deal of work is in progress at the moment and it remains too early to produce a cogent synthesis. One observation, however, is that it remains unlikely in this case study area that the measures available within the CFP Regulation to assist with dealing with unwanted catches and choke species will be adequate to tackle the many issues arising and that avoidance, compliance, selectivity, market uses and changes to management structures will be required.

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