FISHING FOR KNOWLEDGE

An industrial survey for associated species

Report of Project Phase I

by

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Content

1 Introduction

In 2009 the Ekofish twinrig fishery for plaice was certified to the Marine Stewardship Council's (MSC) standard for sustainable and well-managed fisheries. Besides plaice, this fishery lands several bycatch species, in particular dab, lemon sole, brill and turbot. Ekofish wishes to have these bycatch species assessed under Principle 1 of the MSC standard and certified as part of the same unit of certification as the twinrig fishery for plaice. These species qualify as typical bycatch species, having very little directed fishing activity, and are classified as 'associated' or 'Category 11' species under the CFP. For these Category 11 species there is no management plan or comprehensive harvest strategy due to the lack of data and information required to carry out an analytical stock assessment. This presents an obstacle for getting these species assessed and certified under Principle 1 of the MSC standard.

To address the data-deficiencies of Category 11 species IMARES explored options to improve data collection efforts for these species in 2011, recommending commercial catch surveys as an option to improve data collection. Following from this Ekofish has taken the lead and has initiated a pilot data-collection project, in which commercial catch data will be collected aboard their twinrig vessels during one season for the species dab, lemon sole, turbot, and brill. The aim of this pilot project is to progress towards science-based management and MSC certification of the mentioned species. This project is carried out in collaboration with the NSF and IMARES.

Phase one of this project explores the hurdles and the opportunities for fisheries management and stock assessment for the North Sea species brill, turbot, lemon sole and dab. This will help identify next steps and inform the design of the commercial survey to be carried out in the subsequent phases of the project. The main question in this phase is: *What are the hurdles and opportunities for fisheries management and stock assessment for North Sea brill, turbot, lemon sole and dab?* This question is addressed in two subsequent chapters: chapter two reviews fisheries management. Chapter three reviews stock management.

2 Fisheries Management for associated stocks

This chapter reviews the main obstacles and opportunities for fisheries management of North Sea brill, dab, lemon sole and turbot. Central to this chapter is the question: *What are the current obstacles for fishery management of associated species brill, dab, lemon sole and turbot? What perspectives does the new Common Fisheries Policy provide?* This central question is broken down in into two sub-questions:

1. *How are associated species currently managed?* This question reviews EU regulation and policy documents and sets out the main management instruments and requirements. It also reviews data collection and management requirements under the Common Fisheries Policy (CFP).
2. *Which changes in management does the new Common Fisheries Policy foresee?* This question reviews the changes to fisheries management that the adoption of the new Common Fisheries Policy (EU Regulation 1380/2013) implies. This regulation replaces the former CFP and has reformed fisheries policy in several fundamental ways, with implications for how mixed fisheries and associated species are to be managed in future.

The chapter is composed around these two questions (section 2.1 and 2.2) and closes with a conclusion, a reflection on the central research question (section 2.3).

2.1 Management of associated species

The main policy instrument that European fisheries are managed under is the European Union's Common Fisheries Policy (CFP). The Common Fisheries Policy establishes a set of rules that controls EU fishing fleets and manages fish stocks in EU waters. The CFP was implemented in 1983 has been reviewed every 10 years. The most recent review, in 2013, has led to major CFP reform. This new CFP, EU Regulation 138/2013, replaces EU Regulation 2371/2002 and came into effect on January 2014.

The following section (2.1) describes the fisheries management situation for brill, dab, lemon sole and turbot as it was at the time of project initiation (2013), so prior to the implementation of the new CFP. To provide a context, this section begins with a brief description of the fisheries in which these species are caught (2.1.1). Management of these fisheries will be discussed in the remaining sections (2.1.2 and 2.1.3).

2.1.1 The fisheries

Brill (*griet*)

Brill *(scomthalmus rhombus)* in the North Sea, Skagerrak, English Channel (ICES Areas IV, IIIa and VIIde) are considered to belong to the same biological stock. Brill in this area is taken as a valuable by-catch species in beam trawl fisheries targeting flatfish (sole and plaice), and to a lesser extent in the otter trawl and fixed net fisheries. Very little directed fishing activity occurs in this area. Effort for the main fleet with brill by-catches (beam trawls) in the North Sea and Skagerrak has declined by almost 50% between 2002 and 2012. Landings however have been relatively stable and above historical values since 1998 (this suggests that abundance of this species is increasing). Landings are considered a reliable approximation of catches as only little discarding of brill occurs. (ICES Advice, book 6, 2013)

Dab (*schar*)

Common dab (*limanda limanda*) is a widespread demersal species on the Northeast Atlantic shelf and distributed from the Bay of Biscay to Iceland and Norway; including the Barents Sea and the Baltic. There is no information on the stock identity of this species. Dab is one of the most abundant demersal species in the North Sea with the centre of its distribution in the southern North Sea. Dab in the North Sea and Skagerrak is a by-catch in the fishery for sole, plaice, shrimp and other demersal species, mainly in beam trawl fisheries. The effort of the beam trawl fleet in the North Sea and Skagerrak has declined by almost 50% between 2002 and 2012. Dab catches are generally discarded based on the availability of target species, and market price. After peaking around the turn of the century dab landings show gradual decline. Landing data are not complete and are not indicative for catches since discard rates are high. (ICES Advice, book 6, 2013)

Lemon sole (*tongschar*)

There is little information available on the stock identity of lemon sole *(Microstomus kitt)*, although tagging information suggests that the English Channel stock can be considered a separate stock (Jennings et al. 1993). Lemon sole in ICES Subarea IV, IIIa and VIId is mainly a by-catch species and is generally caught in mixed fisheries using otter trawls (~75%) and beam trawls (~25%). Some targeted activity takes place using otter trawls in the spring and summer (Seafish, 2014). The effort of the main fleet with lemon sole by-catches (otter trawls) in the North Sea and Skagerrak has declined by 14% (TR1) and 45% (TR2) between 2004 and 2012. Total landings data show a declining long-term trend. Discards are known to take place but data are insufficient to estimate discards. (ICES Advice, book 6, 2013)

Turbot (*tarbot*)

Turbot *(Scophthalmus maximus)* occurring the North Sea, the southern coast of Iceland, the western coast of Scotland and Ireland, and the Celtic Sea, including the Western Approaches, belong to one separate, northern Atlantic stock. Turbot is an economically valuable by-catch species. In ICES Subarea IV, turbot is mainly caught by mid-class and large beam trawlers. These vessels mostly target flatfish. These species are also caught in otter trawls and static nets (gill and tangle nets) (Seafish, 2014). There is a targeted gillnet fishery that takes less than 10% of the total catch. Turbot is mainly caught in the southern and eastern part of the North Sea (60%) (Seafish, 2014). Landings of North Sea turbot have been stable since 1995 and fluctuate around 3000 tonnes. Discarding of turbot in the trawl fisheries is low and total discards are assumed negligible. (ICES Advice, book 6, 2013)

2.1.2 From stock assessment to catch advice

The International Council for the Exploration of the Seas (ICES) performs annual stock assessments and provides catch advice to the European Commission, which consults the European Council on annual fishing opportunities. ICES provides quantitative catch advice for brill, dab, lemon sole and turbot since 2012. To provide quantitative advice for data-limited stocks, ICES has developed special stock assessment methods. For brill, dab, and lemon sole ICES applies a 'survey trends based assessment'. This assessment uses (international) landings data and abundance or biomass indices[1] derived from scientific surveys (dab and lemon sole) or commercial landings and effort data. This assessment is indicative of trends in stock abundance or biomass, but does not provide absolute measures of biomass. For North Sea turbot, an analytical assessment was presented by ICES for the first time this year (ICES Advice, 2013).This was a trends-based statistical age-structured assessment, using data (age structured) commercial catch data, two survey indices, and a commercial index. This assessment provided an estimate of F_{MSY} (a proxy). The stock assessment units and methods used for the four species is summarised in table 1 below.

Tabel 1. ICES stock assessment units and approaches. ICES areas: IV= North Sea, IIIa = Skagerrak, VIIe Western English Channel, VIId Eastern English Channel

	Biological stock unit	ICES Stock assessment unit (ICES Areas)	ICES assessment method
Brill	North Sea, Skagerrak and English Channel	IV, IIIa and VIIde	Survey trends based assessment (data limited stock approach category 3.2.0)
Turbot	Northern Atlantic stock. Turbot in Skagerrak-Kattegat considered a separate stock.	IV	Trends-based statistical age-structured assessment (data limited stock category 2.1.1)
Lemon sole	Few information on stock identity. English Channel stock considered as a separate stock	IV, IIIa and VIId	Survey trends based assessment (data limited stock approach category 3.2.0)
Dab	No information on the stock identity.	IV, IIIa	Survey trends based assessment (data limited stock approach category 3.2.0)

[1] An **abundance** index is numbers of caught (or landed) fish per unit of fishing effort (fishing hours or days at sea). A **biomass** index is weight of caught or landed fish per unit of effort fished.

To provide quantitative catch advice for data-limited stocks that have no biomass or abundance index (such as for brill, dab and lemon sole), ICES uses an 'index adjusted status quo catch' as a harvest control rule (HCR): the three most recent index values are compared with the five preceding values, combined with recent landings data. Information on effort trends is used by ICES to adjust the catch advice with an additional precautionary reduction. A change limit of ±20% is applied to the advice. To provide quantitative catch advice for data-limited stocks with an analytical assessment that can only be used qualitatively (such as for turbot), ICES uses a short-term forecast applying the F_{MSY} proxy as a target to be reached by 2015. A change limit of ±20% is applied to the advice. The 2013 assessment results and catch advice provided by ICES for each species in 2014 is reviewed in the remaining paragraphs.

Brill - The average biomass index for brill over 2010-2012 is 56% higher than the average biomass index over 2005-2009, and shows a positive trend in the last decade. This implies catches are allowed to increase by 20% in relative to average catches over 2010-2012. This corresponds to catches of no more than 2727 t in 2014. Because effort of the main fleet with brill by-catches (beam trawls) in the North Sea and Skagerrak has almost halved in the last decade, no additional precautionary reduction of catches is applied by ICES.

Dab - The abundance index for dab over 2010-12 is 7% higher in the North Sea, and 16% in the Skagerrak-Kattegat, than the average over 2005-2009. Given that the North Sea is the main distribution area, and that both surveys show an increasing trend, this implies catches are allowed to increase by 7% in relative to average landings over 2010-2012. This corresponds to landings of no more than 7795 t in 2014. Because effort of the main fleet with dab by-catches (beam trawls) in the North Sea and Skagerrak has almost halved in the last decade, no additional precautionary reduction of catches is needed.

Lemon sole - The biomass index for lemon sole over 2010-12 is 16% higher than the average over 2005-2009. This implies that landings are allowed to increase by 16% relative to the average landings over 2010-2012. This corresponds to landings of no more than 4350 t. Because effort of the main fleet with lemon sole by-catches (beam trawls) in the North Sea and Skagerrak has declined substantially, no additional precautionary reduction of catches is needed.

Turbot - For turbot, fishing mortality is maintained at the F_{MSY} proxy. This implies fishing mortality should be kept at 0.34, resulting in landings of no more than 2978 t in 2014. This is expected to lead to an increase in SSB of 12% between 2014 and 2015.

2.1.3 From stock advice to catch control

Within the context of EU fisheries management, recourse has been set in recent years to manage EU fisheries at the Maximum Sustainable Yield (MSY) level and through multiannual management plans. This approach has however has been confined to major target species, such as sole and plaice in the North Sea. For associated, data-limited species such as brill, dab, lemon sole and turbot, no multiannual plans have been developed. An MSY target has only recently been set for turbot, but this is not laid down in within a management plan. There are no specific EU management objectives for these species.

To control fishing pressure on brill, dab, lemon sole and turbot, an EU mixed species Total Allowable Catch (TAC) is set in EU waters of ICES Division IIa (Norwegian Sea) and Subarea IV (North Sea). Fishing opportunities for brill and turbot are management in a combined TAC (since 2000). Fishing opportunities for dab are managed in a combined TAC with European flounder (*Platichthys flesus*), and fishing opportunities for lemon sole are managed in a combined TAC with witch flounder (*Glyptocephalus cynoglossus)* (both since 2006).

Annual fishing opportunities (TAC and effort) are fixed and allocated to Member States (through country quota) by the European Council, usually in January (see for instance EU Council Regulation 43/2014). The Council is consulted by the European Commission (DG Mare), which drafts the council's regulation on fishing opportunities. The principles that the Commission applies to set TAC and effort levels are defined in the Commission's annual Policy Statement (a Communication from the Commission to the Council,

published on the EU website)[2]. The final TAC are negotiated in the Council. Although the final Council decision on the TAC is based on scientific advice (involving both biological and socio-economic aspects), the Council also considers the opinions expressed during the consultation of stakeholders (in particular at the meetings of the Regional Advisory Councils).

According to the Commissions Communication to the Council concerning a consultation on fishing opportunities for 2014 (COM/2013/319), the 2014 TACs for stocks subject to multiannual plans are to be established in accordance with the rules laid down in the plans. For those stocks for which no multiannual plan has been developed, but for which a quantitative assessment is available and MSY reference points have been established, the 2014 TACs are based on achieving exploitation levels consistent with MSY by 2015 (this applies to turbot). For data limited stocks for which no full assessment is available (for instance brill, dab, lemon sole), management measures and TAC levels are set in accordance with the precautionary approach, whilst taking into account stock-specific factors, including, in particular, available information on stock trends and mixed fisheries considerations. The Commission is unclear in how this precautionary approach is applied in a mixed TAC context and for the species in question. The TACs fixed by the Council over the last years are summarised in table 2 below. Note that these TACs apply to the EU waters of the North Sea and Norwegian Sea, and thus do not correspond directly with ICES catch advice and landings data.

Information on quota uptake is not publically available and could not be retrieved for this report therefore it remains unclear to what extent the TACs are actually restrictive. Based on the figures in table 2, derived from ICES assessment reports (ICES Advice 2013, Book 6), there have been several years, most notably for brill-turbot where reported landings have exceeded the North Sea-Norwegian Sea TAC. However, because these landings figures include catches outside of the TAC area (ICES IIIa and VIIde), it is not possible to determine whether there has been TAC overshooting and/or whether the TAC has been restrictive. Nonetheless, in the absence of an effectively implemented discard ban, a TAC will unlikely serve as an effective instrument to curb catches and fishing mortality on by-catch species: if the by-catch quota is exhausted before the quota of the target species (e.g. sole and plaice) there is an incentive to discard by-catch species. ICES therefore questions whether a TAC is an appropriate management tool for these typical by-catch species (let alone a combined TAC).

Tabel 2. EU combined TACs for EU Area IIa (Norwegian Sea) and IV (North Sea) in thousand tonnes (**bold**). Combined landings according to ICES data (parentheses). ICES landings figures for brill-turbot refer to landings in ICES Subarea IV. ICES landings figures for dab and European flounder refer to landings in ICES Subarea IV and Division IIIa. ICES landings figures for lemon sole and witch flounder refer to landings in ICES Subarea IV and Divisions IIIa and VIId. Red indicates years where reported landings have exceeded the TAC.

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Brill-turbot (ICES IV,IIIa, VIIde)	**4.323** (4.877)	**4.323** (5.610)	**5.263** (4.807)	**5.263** (4.991)	**5.263** (4.992)	**4.642** (5.007)	**4642** (5.214)	**4.642**	**4.642**
Dab-flounder (ICES IV, IIIa)	**17.100** (14.922)	**17.100** (14.195)	**18.810** (11.792)	**18.810** (10.148)	**18.810** (11.193)	**18.434** (10.544)	**18.434** (8.978)	**18.434**	**18.434**
Lemon sole- witch (ICES IV, IIIa, VIId)	**6.175** (6.593)	**6.175** (6.725)	**6.793** (5.929)	**6.793** (5.212)	**6.521** (4.691)	**6.391** (5.552)	**6.391** (5.922)	**6.391**	**6.391**

TAC and effort controls are just one way through which fishing mortality can be controlled. Fishing mortality can also be controlled through a set of technical measures, such as minimum landing sizes, gear restrictions and closed areas. For these associated species no such measures have been established at the EU level. However for brill and turbot, Belgian and Dutch producer organisations have adopted voluntary minimum landing sizes between 25–30 cm (ICES Advice, book 6, 2013). Moreover, for lemon sole the European Commission has set a Minimum Marketing Standard (180g or 25 cm). This means it can only be marketed when heavier than this weight (Seafish, 2014).

[2] See for instance COM/2013/319 (*Communication from the Commission to the Council concerning a consultation on Fishing Opportunities for 2014*)
http://ec.europa.eu/fisheries/cfp/fishing_rules/tacs/index_en.htm

2.1.4 Data Collection Framework

Good fisheries management relies on reliable and complete information. Council Regulation 199/2008, establishes a Community framework for the collection, management and use of data (biological, environmental, technical and socio-economic data) to support the implementation of the CFP. This framework is generally referred to as the 'Data Collection Framework'. Council Regulation 199/2008 will be revised in the coming years to ensure it continues to meet the data needs of the new Common Fisheries Policy.

Regulation 199/2008 requires all data collection, management and analysis activities by the Community and its Members to be described within Multiannual Programmes. The Commission Decision 2010/93 describes the Community Programme for data collection, management and use for the period 2011-2013. Member States, including the Netherlands, describe their activities in National Programmes (NP). These are evaluated by the Scientific, Technical and Economic Committee for Fisheries (STECF) and approved by the Commission. The national programme needs to include a program for multiannual sampling, a scheme for at-sea fisheries monitoring and research surveys at sea, a scheme for management and use of the data for scientific analysis purposes. All Member States are obliged to undertake scientific research at sea to evaluate the abundance and distribution of fish stocks independently of the data obtained from the commercial fisheries.

Member States report their data collection activities annually to the Commission. The programme by the Netherlands of 2011-2013 has recently been extended to 2016. The NP will be revised once the data collection regulation has been revised. This national NP of the Netherlands includes research vessel surveys (including the Beam Trawl Survey, Young Fish Survey, and Sole Net Survey), a programme for discard sampling and market sampling. These sampling programmes (or surveys) are described in chapter 3.

In addition to this, Dutch fishermen conduct a voluntary industrial survey ('*bedrijfssurvey*') aboard commercial vessels. These surveys focus on target species, such as sole and plaice. Data on associated species such as lemon sole, dab, brill and turbot are not collected.

Apart from these deliberate data collection programmes and surveys, fisheries data is generated through Council Regulation 1224/2009. This regulation establishes a Community monitoring and control system to ensure compliance with the CFP. Masters of fishing vessels are required to record all fishing operations in a (electronic) logbook. Logbooks need to contain information on species caught and retained on board, geographical area and date of this catch, gear type used, estimates of quantity of each species caught. This concerns catch on board, and does not include discard data. The record is shared with the national authorities, which store the information in a secure data base. The electronic logbook is part of the Electronic Recording and Reporting System (ERS) which is used to record, report, process, store, and send fisheries data (catch, landing, sales and transhipment). Vessels above 12 meters are also required to have a Vessel Monitoring System (VMS) on board, which allows identification and location of the vessel. The information generated though (electronic) logbooks (and the VMS) can be made available for stock assessment purposes on request.

2.2 Managing associated species under the new CFP

The new Common Fisheries Policy (EU Regulation no.1380/2013) came into effect on January the 1st of 2014. Regulation 1380/2013 foresees in several notable changes to fisheries management, which have implications for the way associated species will be managed into the future. The most significant changes are reviewed in the following sections, this includes: (i) the objective of maximum sustainable yield, (ii) management through multiannual plans, (iii) the landings obligation and, (iv) fully documented fisheries.

2.2.1 The maximum sustainable yield

In the new Common Fisheries Policy (Article 2 of EU Regulation 1380/2013) the European Union and its Member States commit to managing fisheries towards exploitation rates that allow harvested stocks to be restored and maintained above levels that produce maximum sustainable yield (MSY). These exploitation rates should be achieved by 2015. Exceptions are made in situations where achieving MSY

by 2015 would seriously jeopardise the social and economic sustainability of involved fishing fleets. After 2015, MSY should be reached as soon as possible and in any event no later than 2020. For stocks for which MSY reference points have not or cannot be determined due to insufficient data, proxies are determined (by ICES). Thus, data-limited stocks are not exempt from the MSY requirement. Due to greater uncertainty surrounding these alternative reference points, and in line with the precautionary approach, greater safety margins are taken when defining these proxies.

The MSY requirement of the CFP also sets a precedent for the management of mixed fisheries: The MSY requirement applies to all harvested stocks, so does not exempt associated species such as brill, dab, lemon sole and turbot. Applied in a mixed fisheries context the MSY approach implies that the most vulnerable species (the weakest link) determines the limits of exploitation for all other fish taken in the fishery (see the CFP Reform website[3]). This is considered the only way to ensure that MSY is achieved for all stocks taken in a fishery. In practice this may imply exploitation levels below MSY for some species. Regulation 1380/2013 recognises the difficulty of simultaneously fishing all stocks in a mixed fishery at MSY. In such circumstances, "appropriate scientific bodies should be requested to provide advice on the appropriate fishing mortality levels".

2.2.2 Multiannual (regional fishing) plans

Under the new CFP (EU Regulation 1380/2013) fish stocks will be managed through multiannual management plans (Article 9 and 10). Multiannual plans feature as a core element of the reformed CFP and are considered a key tool to achieve the objective of MSY: these plans lay down the conservation measures to restore and maintain fish stocks above levels capable of producing MSY. Where targets relating to the MSY cannot be determined, owing to insufficient data, the multiannual plans shall provide for measures based on the precautionary approach, ensuring at least a comparable degree of conservation of the relevant stocks.

Multiannual plans can cover a single stock and fishery, but in the case of mixed fisheries or where stocks interact with one another, can also cover a mixture of associated stocks and fisheries within a certain geographical area. These regional, multi-species and multi-fisheries plans take into account knowledge about the interactions between fish stocks, fisheries and the marine ecosystems and allow the specific problem of mixed fisheries to be addressed. Thus, under the new CFP, multiannual plans present an important tool to move toward integrated and ecosystem-based fisheries management (Article 2(3)). Whilst existing multiannual plans usually cover only a single stock (and are more species-based), the new CFP sets recourse to developing fishery-based multi-species plans, integrating the management of a set of interacting species and fisheries.

2.2.3 The landings obligation

In the North Sea the landings obligation (Article 15 of EU Regulation 1380/2013) applies to all species subject to catch limits and caught during fishing activities in Union waters or by Union fishing vessels fishing outside Unions waters (where these are not subject to third countries' sovereignty or jurisdiction). The landings obligation requires catches to be brought and retained on board the fishing vessel, recorded, landed and counted against the quota where applicable, accept when used as live bait. For non-pelagic and non-salmonid North Sea species that define the fisheries (such as sole and plaice) the landings obligation applies from 1 January 2016 (at the latest) and for all other species subject to catch limits from 1 January 2019 (at the latest). In conclusion, based on this interpretation of Article 15, the landings obligation applies to brill, dab, lemon sole and turbot. Fisheries catching these associated species will be required to start landing these species by the 1st of January 2019 at the latest.

2.2.4 Fully Documented Fisheries

As part of the landings obligation the new CFP sets recourse to full reporting of fishing and on board processing activity. This is often referred to as 'Fully Documented Fisheries' (FDF). When correctly applied FDF may deliver several benefits: (i) Increased quality and quantity of commercial catch data to complement traditional scientific data and support scientific assessment of stocks and fishing activity, (ii) improved monitoring and compliance with fisheries regulation (Dolder et al. 2013). To implement this

[3] http://ec.europa.eu/fisheries/reform/docs/msy_en.pdf

requirement of the CFP, various methods for FDF are currently being explored, including Remote Electronic Monitoring (REM), reference fleet and self-sampling.

2.3 Key insights and Conclusive points

This conclusive section draws together key insights from the previous section and reflects on these in the light of the central research question.

Fisheries management has traditionally focused on target species and is characterised by a single-species approach. Associated species of targeted-fisheries, such as the associated species subject of this study, have been more or less neglected: To this date, no management plans or objectives have been developed for dab, brill, lemon sole and turbot, and there are no management instruments in place that can effectively control fishing mortality on these associated species. The combined TACs that are applied are not effective at controlling species-specific fishing mortality and prove difficult to enforce, especially in the absence of an obligation to land. It is highly questionable whether a TAC-Quota system is a suitable management instrument to control fishing mortality on by-catch species.

The knowledge base for management of the associated species subject to this study is thin: stock status and characteristics remain poorly understood and management reference points have not been defined or are highly uncertain (for turbot). In general, major uncertainties surround the basic stock assessments that have been carried out by ICES since 2012. This makes fisheries management and planning difficult. The precautionary principle, a cornerstone of EU fisheries management, guides decision-making and fisheries management under uncertainty. It is actively applied by both the ICES and the Commission in developing catch advice and setting fishing opportunities. In practice, this has meant that the Commission has resorted to setting precautionary TACs (rather than science-based TACs) for the species subject to this study. These precautionary TAC imply generally more conservative fishing opportunities.

In practice, fishing pressure on North Sea brill, dab, lemon sole, and turbot stocks is predominantly driven by dynamics in the fishing fleet targeting sole and plaice as well as by developments in the management of these targeted fisheries. More conservative management approaches (e.g. managing towards MSY) and the implementation of recovery plans for sole and plaice, as well as changes in fleet composition and behaviour, have likely had a favourable effect on brill, dab, lemon sole and turbot stocks in terms of their exposure to fishing pressure. Most notable is the effect of the decimation of the beam trawl fleet over the last decade. However, the impact of new bottom fishing gears (such as flyshoot and pulse-trawl) on traditional by-catch species is poorly understood and needs to be researched. Whether a switch from beam trawl to new modes of fishing relieves by-catch species of fishing pressure depends on the selectivity of these new gear types as well as the exposure of by-catch species to these gears as these gears move into new or different fishing grounds (e.g. softer bottom-types and stony grounds). In sum, fishing pressure on the species subject of this study is the outcome of am interplay between stock dynamics, fleet dynamics and management. Therefore, effective management for associated species can only come through integrated, multi-species approaches to fisheries management that develops tools that can deal with the complexities of mixed-fisheries. In this respect the new common fisheries policy offers better perspectives.

Firstly, under the new CFP, the MSY objective applies to all harvested species. The CFP's MSY provision creates a legal instrument that should strengthen the commitment and accelerate the transition to Fmsy-based fisheries management. Importantly the MSY provisions include specific requirements for data-limited species and mixed fisheries, providing greater protection for associated and data-limited species.

Implementing the MSY provision in mixed fisheries, also for associated species, presents no easy task with no clear-cut solutions. Through the implementation of multiannual plans, a second major revision of the CFP, the complexities of managing mixed fisheries can be better addressed. By adopting a multi-species, fishery-based approach these plans provide a tool through which management towards MSY in mixed fisheries contexts can be better coordinated and achieved.

Thirdly, the landings obligation potentially makes a TAC easier to enforce and hence more effective as an instrument to control fishing mortality on individual stocks. Moreover, in combination with improved monitoring and catch documentation (full documentation), the landings obligation provides more

accurate catch data for better fisheries science. This is especially relevant for typical discard species such as dab.

One of the key questions that remains is what management tools should be applied to manage fishing mortality on associated species in mixed fisheries. The TAC system for associated species is widely criticized by fishers and scientists alike (for various reasons) and will be reviewed within the North Sea RAC in the coming years and within the process of moving towards multi-species, multiannual plans for North Sea fisheries. It is not unlikely that in future these combined TACs will be replaced by another catch control tool or a species-specific TAC (so a disaggregated TAC).

In conclusion, good fisheries management ultimately relies on complete and reliable information about fishery and fish stock dynamics and interactions. This remains a weakness in the management of brill, turbot, lemon sole and dab. Until science provides better information, these species will likely continue to be managed under a precautionary TAC, implying generally more conservative fishing opportunities. In a mixed fishery, and in combination with a landings-obligation and an MSY target, this could potentially restrict fishing opportunities on target species such as sole and plaice. This knowledge lacuna is something this (EKOFISH) project seeks to address, beginning with an identification the data collection and research efforts required to allow for more comprehensive stock assessment and science-based catch advice; the subject of the following chapter.

3 Stock assessments

To be able to detect knowledge gaps resulting in the qualification as data-limited stocks, it first should be clear what kind of information is needed to perform a stock assessment. Therefore, this chapter gives an overview on how stock assessments are performed (3.1) and which data is available in terms of scientific survey data (3.2). That results in an overview per species of data availability and knowledge gaps (3.3), which can be translated into conclusions and recommendations (3.4).

3.1 How to do a stock assessment

3.1.1 Population estimation and calibration

Stock assessments are estimations of how fish populations develop in time. This is an estimation, since no one can count all fishes in the oceans. However, one thing is certain; all individuals eventually die, due to fishing or other reasons (natural mortality; predation, age, sickness etc.). Therefore, we can back-calculate the numbers of fish that lived in the ocean (assuming no fish growing older than a certain age). For species with high discard rates, fishing mortality is estimated as the summation of landings and discards, in which discard data is collected in discard monitoring programmes, such as the self-sampling project IMARES coordinates. For most species, discard rates only have a small effect on fishing mortality, so fishing mortality is assumed to be equal to the landings. Commercial landings data give an accurate time series of fishing mortality. Since the landings are sampled for age-readings, the age-structure of all the deceased fishes per year class can be determined.

To estimate total mortality, total fishing mortality is raised with an estimated number of fishes that died of natural causes. For fishes from an old year class, which all have died already, this back-calculation is very precise. However, for the fishes from recent year classes, of which a part is still alive, this back-calculation is imprecise.

To get a more precise overview of recent developments in the population, the back-calculated population trends are calibrated with catch successes in surveys and commercial catch data. The catch success is calculated as the catch per unit effort over time. Since surveys are conducted with the same protocol each year, this effort is constant over years. For commercial data, catch efficiency is believed to increase over time, due to innovative gears, new insights in fish behaviour or different fishing locations, which is decreasing reliability of the time series.

Industrial surveys could be used to collect biological data (length-at-age, weight-at-age). Also trends within the catch success of scientific survey and commercial catch data can be compared with a new survey-based catch trend. However, since this survey is especially designed to target these species, catches will most likely be higher than in regular scientific surveys, which will increase accuracy of trends. These new time series can then be used to calibrate back-calculated population trends as well.

3.1.2 Biological reference points

To estimate whether a fish population is within safe biological limits, several biological reference points are set and tested. The most important reference points are B_{lim} and F_{lim}. “B” represents biomass (kg fish) with B_{lim} being the lowest amount of biomass to ensure a sustainable population which can regenerate itself. “F” represents fishing mortality, with F_{lim} being the maximum fishing mortality that a population can sustain. Derived from these reference points, are B_{MSY} and F_{MSY}, which, respectively, indicate at which biomass and fishing mortality the fish stock is reproducing at their maximum. In this situation, the fish stock growth is highest and therefore, more fishes can be caught.

Biological reference points are calculated from stock assessment output, like spawning stock biomass and recruitment. When stock assessments are performed for multiple years, calculations of the reference points becomes more accurate. For species without stock assessments, biological reference points cannot be determined.

3.2 Surveys for stock assessment

This section reviews the (scientific) surveys and both the sampling programmes that are carried out and can be used to preform stock assessments by ICES. Both the sampling programmes are conducted under the DCF-regulations.

3.2.1 The International Bottom Trawl Survey

The (North Sea) International Bottom Trawl Survey (IBTS) is an internationally coordinated scientific survey in the North Sea in which 8 countries participate. Each country operates its own survey. These national surveys are combined then into one large survey. This survey covers the entire North Sea. The IBTS is employs a (36/47) GOV-trawl, which does not target flatfishes. This results in very low turbot and brill catches. Lemon sole and dab are more abundant in the North Sea, and are caught more regularly in this survey. See appendix 1 for the sampled ICES rectangles during the IBTS.

3.2.2 The Beam Trawl Survey

The offshore Beam Trawl Survey (BTS) is a Dutch survey, carried out in the 3rd quarter, with the Tridens in the northern North Sea and the Isis in the southern and central North Sea. The BTS is specifically designed to target plaice and sole. During this survey however, data is collected for all caught fish species, including turbot, brill and lemon sole. ICES does not use the BTS-generated data for the stock assessment of every species. Germany and Belgium perform similar surveys. Although all surveys are coordinated by ICES (WGBEAM), the data of the Dutch, German and Belgian surveys are not (yet) combined into one large survey. In fact, during the Dutch BTS, samples are taken by the Isis and the Tridens, which results in two separate time series. For plaice, these time series are combined; however, for several species, the process of combining these two time series is very difficult. In appendix 2 the locations of the German, Belgium and Dutch BTS are shown.

3.2.3 Demersal Young fish Survey and the Sole Net Survey

The Demersal Young fish Survey (DYFS) and the Sole Net Survey (SNS) are Dutch surveys, especially targeting juvenile fish. The DYFS is performed in the shallow coastal zone and inshore waters (Wadden Sea, Oosterschelde and Westerschelde) while the SNS is performed in the somewhat deeper coastal zone. That is why the SNS catches more older juveniles and the DYFS is catches the very young juveniles. The DYFS is a collaboration with Germany and Belgium, who sample the German Wadden Sea, the German shallow coastal zone and the Belgium shallow coastal zone. The sampling locations of the DYFS and SNS are shown in appendix 3.

3.2.4 Market sampling

The market sampling program of IMARES falls within the stretch of the DCF, which obligates Member states to collect biological data of the commercial landings. In this project, all fishery-important ports in the Netherlands are sampled for several commercial fish species, including brill, lemon sole, turbot and dab according to a pre-determined schedule. When fishes are landed in size-categories, each category is sampled separately (only dab is not landed in categories, turbot, brill and lemon sole are). All sampled fishes are measured, aged, sexed and maturity stage is determined. These data are then used to ‘translate’ total national landings (in tonnes) into separate age-classified landing quantities.

3.2.5 Discard sampling

Under the DCF, all Member states are obligated to monitor discards and to estimate discarded quantities. In 2009, the DCF revised protocol, increasing sampling intensity and data precision. To cope with these changed requirements, IMARES set up a self-sampling project in cooperation with the fisheries sector. Within this project, fishermen retain a part of their discards for multiple trips throughout the year, according to a pre-determined schedule and sampling protocol. These samples are then transported to IMARES, who collects and analyses those samples. Discard rates per species and fleet segment are calculated on national fleet level, based on effort ratio in national fleet and reference fleet. These discard rates can then be used in stock assessments, to include discards in fishing mortality.

3.3 Data availability and knowledge gaps for associated species

ICES made a trends-based statistical age-structured stock assessment for turbot in the North Sea for the first time in 2013. For the other species, no statistical stock assessment have been done, due to various reasons. This section reviews what data is currently available to ICES for North Sea brill, dab, lemon sole and turbot and consequentially the knowledge gaps for these species.

3.3.1 Dab

Dab is a species with a high discard rate (up to 90%), due to its small size and low commercial value. Estimates of these quantities have improved since the more strict revisions of the DCF in 2009. However, for all years before 2009, these rates are not accurate. This is a major problem in estimating catch values. Moreover, a potential explanation for the missing stock assessment for dab would be that there was no collective urge to have a stock assessment. Most likely, it is already possible to do a stock assessment, however, no one took time to collect all existing data and to start the procedure of a stock assessment.

The biological data collected in the IBTS and BTS is sufficient. Also discard rates are nowadays covered for almost all fleet segments quite well in the Netherlands. For dab, this report therefore concludes that an industrial survey would be superfluous. It would be more useful to initiate a stock assessment proposal, which can deal with the missing historical discard rates. This process should include an assemblage of all (international) data available, the performance of a stock assessment models on these data and the organisation of a benchmark to 'sell' the new stock assessment method to ICES.

3.3.2 Turbot

Since 2013, ICES performs an annual stock assessment for turbot. In this assessment, discard rates are assumed to be negligible and SNS and BTS survey data are used to calibrate population trends. However, turbot is a species with low abundance, distributed over a large area, resulting in low catches (numbers per hour) in both scientific surveys, which is depicted in inaccurate time series. To compensate for this inaccuracy, reference points are defined using a precautionary method. Besides that, few biological data is available for turbot, which is translated into precautious assumptions on population growth and into extra uncertainty in the calculated population estimates. Therefore, ICES marks turbot in the North Sea still as a 'limited data stock' (category 2).

An industrial survey, specifically targeting turbot, will increase catches and with that, the accuracy of inter annual trends. At the same time, the industrial survey will result in more biological data, which will increase accuracy of population structure knowledge. Turbot is abundant in low numbers over a large area. Therefore, it will be difficult to collect large numbers of turbot, especially because it is important that the industrial survey is covering a large number of ICES rectangles.

Apart from the regular stock assessments and their required biological data, it would be interesting to collect stomach content for turbot as well during this industrial survey. Since fishes are already cut for otoliths and gender, this would require only a small amount of extra effort. ICES is working on mixed-fisheries advice, in which ecosystem approaches become more and more important. Turbot is believed to be a top predator, with a diet almost solely consisting of other fish species. It would be worthwhile to investigate the interest of ICES in stomach analysis of turbot and determine whether this industrial survey might increase in value by collecting stomachs as well. Broadening the interest in this project might prove important for the continuation of this industrial survey.

3.3.3 Brill

ICES does not perform stock assessments for brill. Yearly advice is based on international landings, IBTS and BTS data, however, similar problems as with turbot are present: Survey catches for brill are low (due to low abundance and a wide distribution), which results in inaccurate catch success time series to calibrate population trends. A potential explanation for the missing stock assessment for brill would be that there was no collective urge to have a stock assessment. Most likely, a similar approach as turbot might be performed, however, no one took time to collect all existing data and to start the procedure of

a stock assessment. It would therefore also be interesting to see whether already existing surveys could improve time series. Besides that, few biological data is available for brill.

For brill, data is available in the IBTS and BTS, however, both surveys do not catch brill in large numbers. Therefore, time series trends are inaccurate and biological data is scarce. This industrial survey could increase the numbers of brill caught in a survey, increasing accuracy of the time series and the biological data. Brill is abundant in low numbers over a large area. Therefore, it will be difficult to collect large numbers of brill, especially because it is important that the industrial survey is covering a large number of ICES rectangles.

3.3.4 Lemon sole

ICES does not perform stock assessments for lemon sole. A potential explanation for the missing stock assessment for lemon sole would be that there was no collective urge to have a stock assessment. Most likely, it is already possible to do a stock assessment, however, no one took time to collect all existing data and to start the procedure of a stock assessment. Since Scotland is the main producer of lemon sole; CEFAS should perform such an analysis. Yearly advice is based on IBTS data, however, BTS data probably is more suitable for lemon sole. The BTS is catching reasonable quantities of lemon sole, especially in the Northern areas. Therefore, biological data is already collected quite well, although it should be noted that juvenile lemon soles are not caught in any survey conducted by ICES or IMARES. Numerous species, for which a stock assessment is currently done, lack data on juvenile populations, so this does not have to be a problem in assessing the stock.

An industrial survey would improve the situation of lemon sole. The BTS catches lemon sole frequently, however, a second time series, which can be compared to the trend of the BTS, would increase accuracy of the calibration-process. Also the collection of more biological data will improve the current situation. For this industrial survey to really contribute to existing data, it is important to have a large coverage of lemon sole habitat.

3.4 Key insights and concluding points

All four species are described as data limited species, although ICES performs a stock assessment for turbot since 2013. Where dab is lacking data on (past) discard rates; turbot, brill and lemon sole have (insufficient) biological and survey data. This proposed industrial survey will increase (biological) knowledge of turbot, brill and lemon sole, and can be used for establishing reliable time series, which might help by establishing a stock assessment for brill and lemon sole. However, it is necessary to conduct the survey for several years (at least 5 years) before the results can be included in current stock assessments.

Since financial support is highly uncertain for the coming years, IMARES is questioning whether to start this industrial survey as a one-year survey will most likely have little results. Much data is already collected by individual member states, but not aggregated into one organized database. Therefore, aggregating already existing data and developing new stock assessment models would perhaps be an alternative method to stimulate management of these stocks.

Within ICES, all stocks are assigned to a stock coordinator, which runs and updates the stock assessment model each year with the most recent collected data. When new models are developed, cooperation with these coordinators would increase support for these models. Moreover, it would increase the likelihood that the stock coordinators will use and update the newly developed stock assessment models.

For brill, present data probably is sufficient to conduct a trends-based statistical age-structured assessment, as is already performed for turbot. Dab is lacking historical data on discards, which can never be re-measured. To create a stock assessment model for dab, a method to cope with this lacking data should be developed. Kelle Moreau (Belgium) is stock-coordinator for brill.

Lemon sole is coordinated by the United Kingdom, at CEFAS. Therefore, IMARES has less knowledge about data available. It might be possible to conduct an inventory and to run some preliminary test-models. However, at this time, a stock assessment model cannot be guaranteed. Dab is coordinated by Germany, and a similar story holds up as for lemon sole: It might be possible to conduct an inventory

and to run some preliminary test-models. However, at this time, a stock assessment model cannot be guaranteed.

ICES is working on data limited stocks as well, and in 2013 the availabilities for dab, lemon sole and brill were investigated by the workgroup WGNEW[4]. In this report, international data are aggregated and new stock assessment models are tested when available data is sufficient. For brill, this workgroup concluded that this stock could be categorized as a category 3 stock, for which it is possible to conduct a trends-based stock assessment. Also lemon sole was given a positive advice. The historical discard data gap is described for dab. No recommendations for any improvement of the stock assessment models are given.

[4] ICES (2013) Report of the working group on assessment of New MoU species (WGNEW). 18-22 March 2013, ICES HQ, Copenhagen, Denmark, ACOM.

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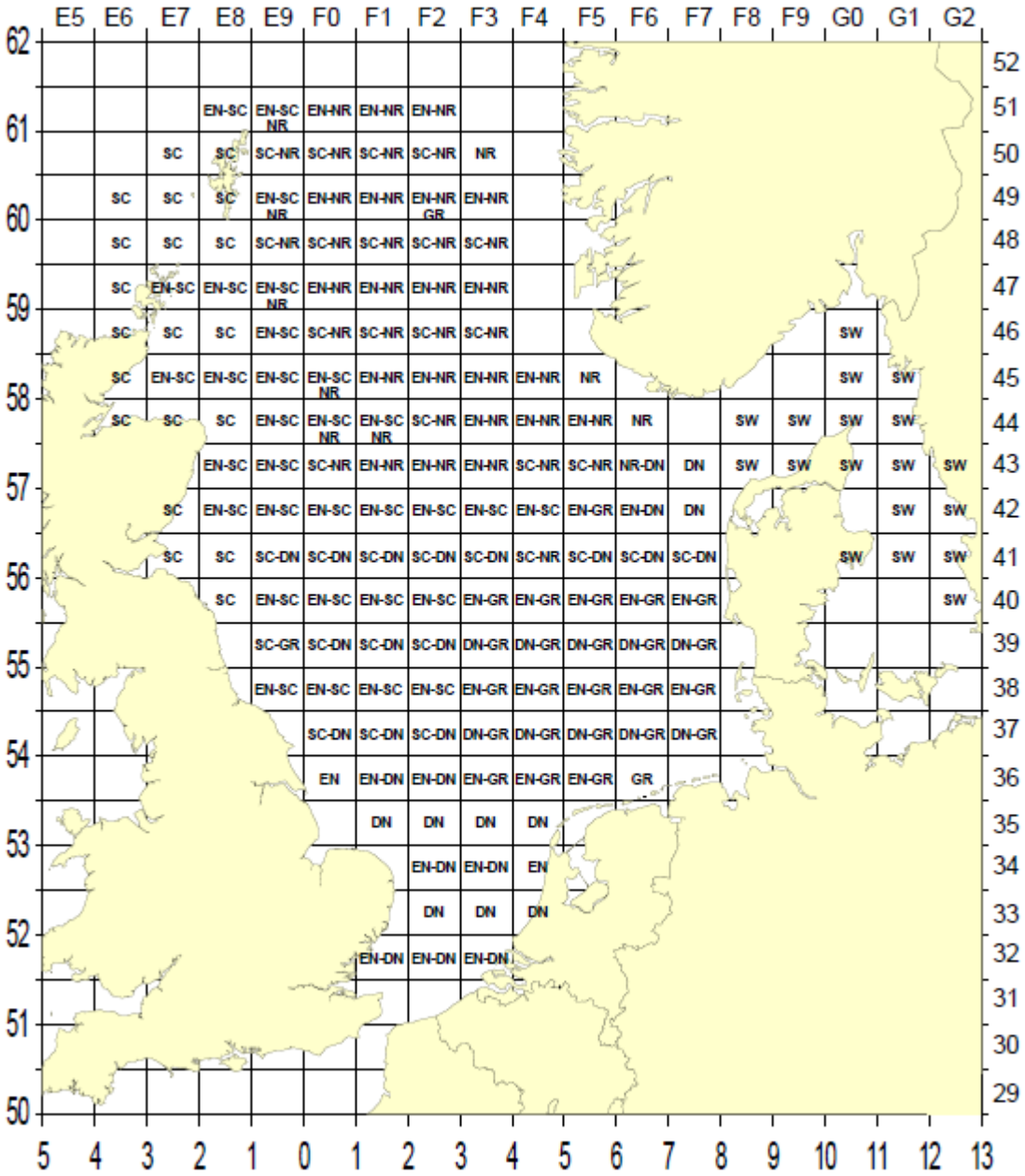
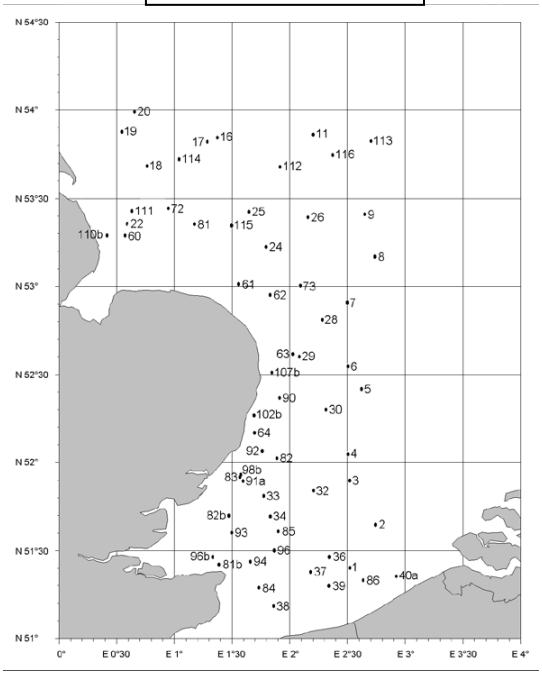
Appendix 1

IBTS locations.

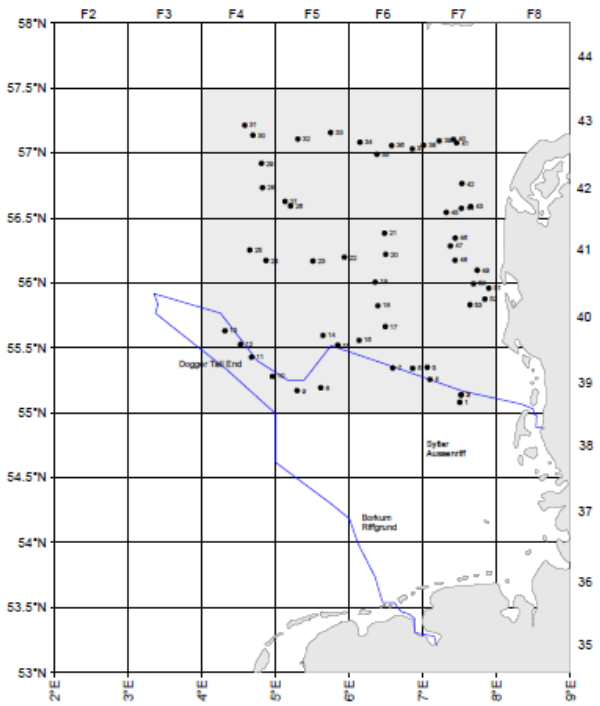


Appendix 2

BTS Belgium

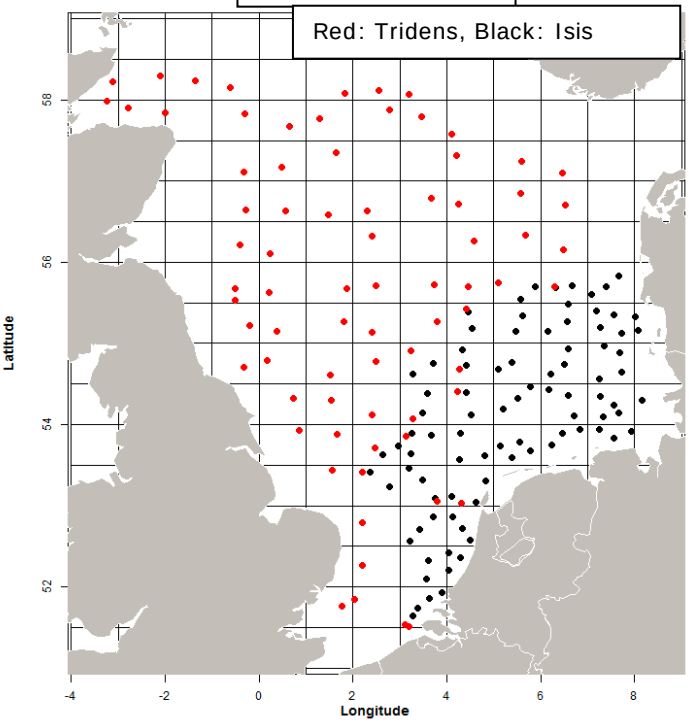


BTS Germany



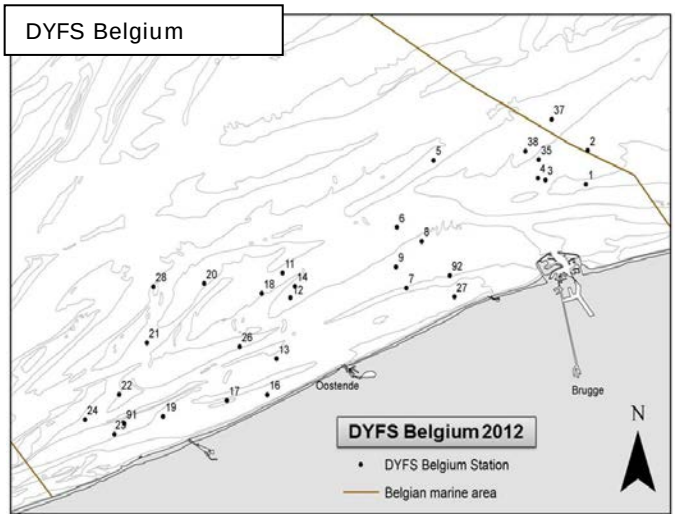
BTS the Netherlands

Red: Tridens, Black: Isis



Appendix 3

DYFS Belgium



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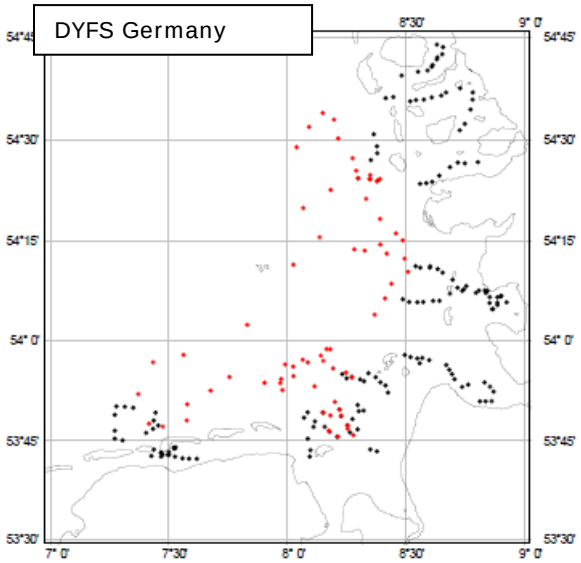

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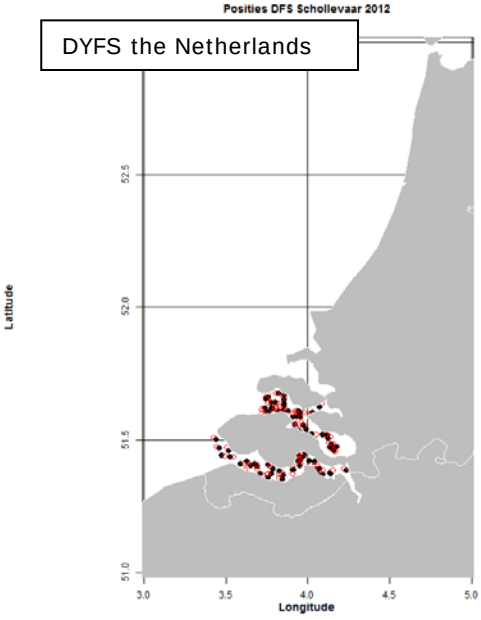

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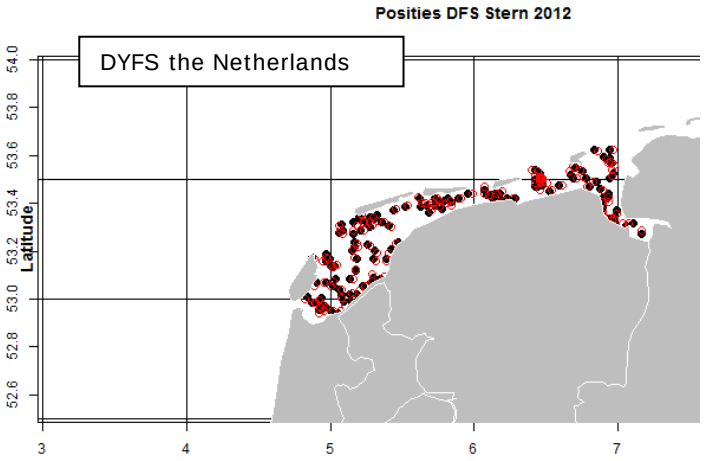

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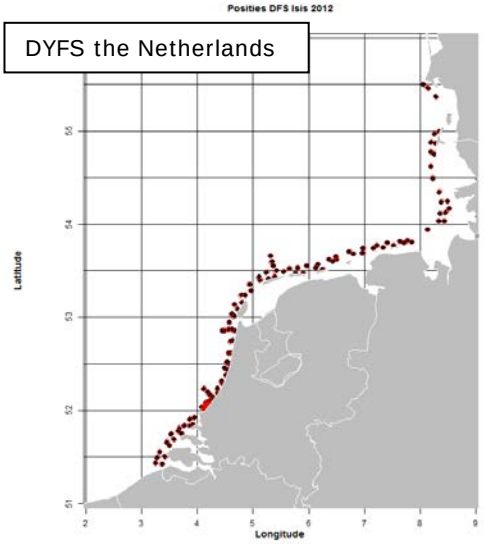

SNS the Netherlands