SPECIAL REQUEST BACKGROUND DOCUMENT: LEMON SOLE, WITCH, TURBOT AND BRILL - REVIEW OF ICES ADVICE PROVIDED IN 2018 ON THE CONTRIBUTION OF TACS TO FISHERIES MANAGEMENT AND STOCK CONSERVATION.(AD HOC)

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1 Special request: TAC Management for brill and turbot

1.1 Introduction

In 2018 the European Commission submitted a Special Request to ICES to investigate the contribution of Total Allowable Catches (TACs) to fisheries management and stock conservation for brill (27.3a47de), turbot (27.4), lemon sole (27.3a47d), witch (27.3a47d) and whiting (27.3a). ICES was requested to analyse the role of the Total Allowable Catch (TAC) instrument and to assess the risks of removing TACs in light of the requirement to ensure that the stock concerned remains within safe biological limits in the short and middle term.

In 2022 the EU and UK submitted a new request to ICES to investigate whether conclusions from 2018 remain valid, and to update the advice if needed. The request concerns four WGNSSK stocks: brill (27.3a47de), turbot (27.4), lemon sole (27.3a47d) and witch (27.3a47d). It was agreed to answer the request by updating the answers to a series of six questions addressed in the 2018 request. The six questions were as follows:

1. Was the TAC restrictive in the past?
2. Is there a targeted fishery for the stock or are the species mainly discarded?
3. Is the stock of large economic importance or are the species of high value?
4. How are the most important fisheries for the stock managed?
5. What are the fishing effort and stock trends over time?
6. What maximum effort of the main fleets can be expected under management based on F_{MSY} (ranges) for the target stocks, and has the stock experienced similar levels of fishing effort before?

This document describes the analysis for brill and turbot, first covering each of the above questions, then providing a concluding section.

1.2 Material and methods

Several data sources were consulted to address this special request. To answer the first question, official landings as reported to ICES and published TACs were used, which are both listed in the ICES advice sheets (ICES, 2022a, b). For the second question, ICES estimates on landings and discards served as input. Similarly, questions 4, 5 (partly) and 6 were answered using data and analyses done for the calculation of the ICES advice (ICES, 2022c).

For questions 3 and 5 (partly), the most recent data as submitted to the 2021 DCF Fisheries Dependent Information (FDI) data call were used (STECF, 2021). These data contain information from 2014–2020 and still include information on the United Kingdom. However, a number of fields were marked as confidential. These were excluded from the analyses, which may cause a slight underestimation of the totals.

1.3 Answering the questions for brill and turbot

1. Was the TAC restrictive in the past?

The combined TAC for brill (BLL) and turbot (TUR) was overshot by 10% in 2007 and 2016 and by 1% in 2015 (Table 1.1 and Figure 1.1). From 2018 to 2022, brill and turbot landings have remained at or under 67 % of TAC.

Table 1.1. Overview of TAC and official landings of brill and turbot in the TAC area (2a and 4). Red text shows years when the combined TAC was overshot. The figures in the table are rounded. Calculations were done with unrounded values.

Year	TAC	SUM landings TUR and BLL	usage of TAC (%)	BLL landings			TUR landings		
	2a, 4	2a, 4		2a	4	Total TAC area (2a, 4)	2a	4	Total TAC area (2a, 4)
2000	9000	5540	62	0	1508	1508	7	4025	4032
2001	9000	5680	63	0	1573	1573	7	4100	4107
2002	6750	5055	75	0	1302	1302	4	3749	3753
2003	5738	4725	82	0	1346	1346	5	3374	3379
2004	4877	4571	94	0	1249	1249	5	3317	3322
2005	4550	4362	96	0	1160	1160	7	3195	3202
2006	4323	4157	96	0.01	1175	1175	6	2976	2982
2007	4323	4754	110	0	1239	1239	7	3508	3515
2008	5263	4015	76	0	1004	1004	6	3005	3011
2009	5263	4258	81	0	1162	1162	6	3090	3096
2010	5263	4201	80	0.02	1499	1499	7	2695	2702
2011	4642	4312	93	0.05	1496	1496	5	2811	2816
2012	4642	4529	98	0.06	1532	1532	6	2991	2997
2013	4642	4480	97	0.05	1390	1390	5	3085	3090
2014	4642	4132	89	0.04	1255	1255	5	2872	2877
2015	4642	4677	101	0.12	1695	1695	4	2978	2982
2016	4488	4953	110	0.04	1526	1527	6	3421	3426
2017	5924	5106	86	0.04	1460	1460	6	3641	3647
2018	7102	4422	62	0.08	1188	1188	5	3228	3234
2019	8122	4514	56	0.08	1387	1378	7	3119	3126
2020	6498	4370	67	0.06	1183	1183	7	3180	3187
2021	5848	3750	64	0.17	932	932	9	2809	2818
2022	5487								

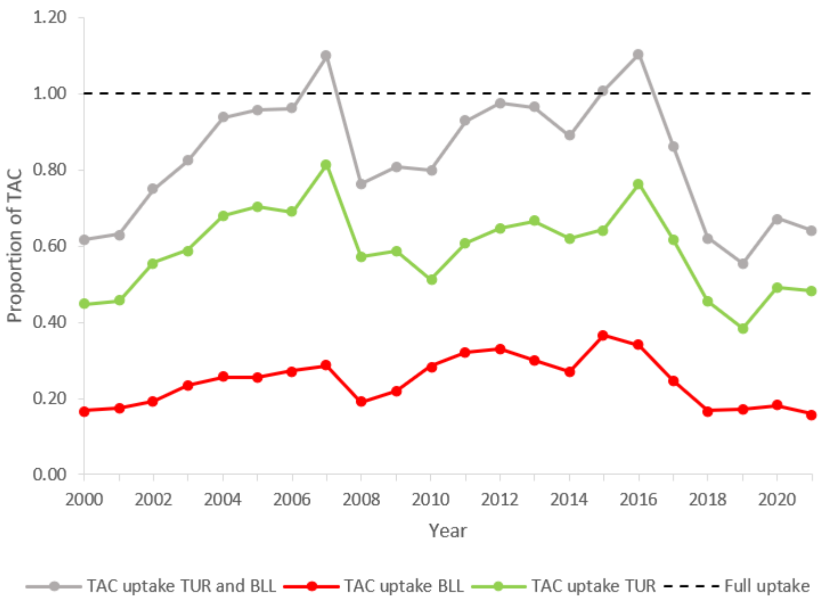

Figure 1.1. TAC uptake for brill and turbot over the period 2000–2021

No restriction on the minimum length for landing turbot and brill is imposed by the EU. Some national authorities or producer organisations have however introduced Minimum Conservation Reference Sizes (MCRS). Dutch Producer Organisations (POs) introduced a trade-based MCRS of 27 cm in 2013. In 2016, catches of turbot increased substantially and the Dutch PO's decided to increase the MCRS to 30 cm to prevent an early exhaustion of the quota (Table 1.2). However, these measures were not sufficient and in May 2016, the MCRS was further increased to 32 cm. This was followed by a prohibition of landing the smallest market category in summer, and finally capping of weekly landings to respectively 375 kg and 600 kg per week in October.

Due to a fear of overshooting the turbot and brill quota in 2016 and 2017, The Netherlands (responsible for more than 50% of the landings of turbot and brill) and some other countries asked for an advance of their 2017 and 2018 quota, respectively.

Table 1.2. Measures taken (from 2016 onwards) by the Dutch Producer Organizations to limit the landings of turbot and brill to prevent an early exhaustion of the quota.

Dutch PO-measures			
Year	**Date**	**Max kg per week/trip**	**MCRS**
2016	January-March	-	27 cm
2016	April-May	-	30 cm
2016	May-September	-	32 cm
2016	October-November	375 kg	32 cm
2016	November-December	600 kg	32 cm
2017	January-February	-	32 cm
2017	March-October	800 kg	32 cm
2017	November-December	2000 kg	30 cm
2018	January-August	2000 kg	30 cm
2018	September-October	2500 kg	27 cm
2018	October-December	3000 kg	27 cm
2019	January-December	3000 kg	27 cm
2020	January-December	3000 kg	27 cm
2021	January-December	3000 kg	27 cm

Turbot had an inter-benchmark in 2017 to reconsider input data and improve the assessment, and if warranted, to revise the advice. The inter-benchmark resulted in a new turbot advice for 2018 and 2019 (including an upward revision of the previous 2017 advice), providing a difference of +148% compared to the previous advice (for 2016 and 2017). The TAC for turbot and brill increased for 2017 and 2018 by approximately 20%. The request of countries for an advance on their quota for 2018 was therefore nullified (Table 1.1 and 1.2). Nonetheless, Dutch PO measures persisted with a minimum landing size of 30 cm and limiting the landings to 2000 kg per week. In 2019, the Dutch PO measures were relaxed following a further increase in TAC (+14%).

Management of brill and turbot under a combined species TAC prevents effective control of the single-species exploitation rates. Furthermore, the areas for which the TAC applies (Division 2.a and subarea 4) is different to those for which stock advice is issued. For brill, the stock area includes subarea 4 and divisions 3.a, 7.d and 7.e, while for turbot, the stock area covers only subarea 4. In addition, the advice for brill, based on catches in the entire stock area, is applied to the TAC area (2.a, 4). Thus, no reduction in the advice is applied to account for differences between stock and TAC area. This could lead to overexploitation of the brill stock, when turbot catches are lower. Table 1.3 shows the official landings in their respective stock areas. When comparing the total landings in the respective stock areas for turbot and brill with the TAC set for Division 2.a and subarea 4 in the period 2000–2021, the TAC was overshot in 11 out of 21 years (52%).

Table 1.3. Official landings of brill and turbot in their respective stock areas. The figures in the table are rounded. Calculations were done with unrounded values.

Year	TAC	BLL landings					TUR landings	SUM landings TUR and BLL	usage of TAC (%)
	2a, 4	3a	4	7d	7e	**Total stock area (3a47de)**	4 (=stock area)	for their respective stock area	
2000	9000	142	1508	363	315	2328	4025	6353	71
2001	9000	98	1573	405	333	2409	4100	6509	72
2002	6750	89	1302	358	358	2107	3749	5856	87
2003	5738	129	1346	353	406	2234	3374	5608	98
2004	4877	156	1249	277	389	2071	3317	5388	110
2005	4550	133	1160	242	369	1904	3195	5099	112
2006	4323	140	1175	294	354	1962	2976	4939	114
2007	4323	160	1239	335	408	2142	3508	5650	131
2008	5263	181	1004	250	345	1781	3005	4786	91
2009	5263	146	1162	244	350	1902	3090	4992	95
2010	5263	122	1499	290	409	2320	2695	5015	95
2011	4642	131	1496	271	394	2292	2811	5104	110
2012	4642	120	1532	253	371	2276	2991	5267	113
2013	4642	92	1390	258	348	2088	3085	5173	111
2014	4642	79	1255	284	361	1979	2872	4850	104
2015	4642	145	1695	270	428	2538	2978	5516	119
2016	4488	168	1526	254	467	2415	3421	5836	130
2017	5924	170	1460	215	448	2292	3641	5933	100
2018	7102	125	1188	200	514	2027	3228	5255	74
2019	8122	139	1387	156	504	2186	3119	5305	65
2020	6498	162	1183	135	415	1895	3180	5075	78
2021	5848	142	932	113	435	1623	2809	4432	76
2022	5487								

The landings of brill and turbot for the TAC area (Figure 1.2) and in their respective stock areas for which ICES advice is issued (Figure 1.3) show the same trend over the 21-year period as most landings originate from subarea 4. However, brill landings in the stock area are of course higher than brill landings in the TAC area because a substantial part of the catch comes from the English Channel area (Divisions 7.d and 7.e) (Table 1.3).

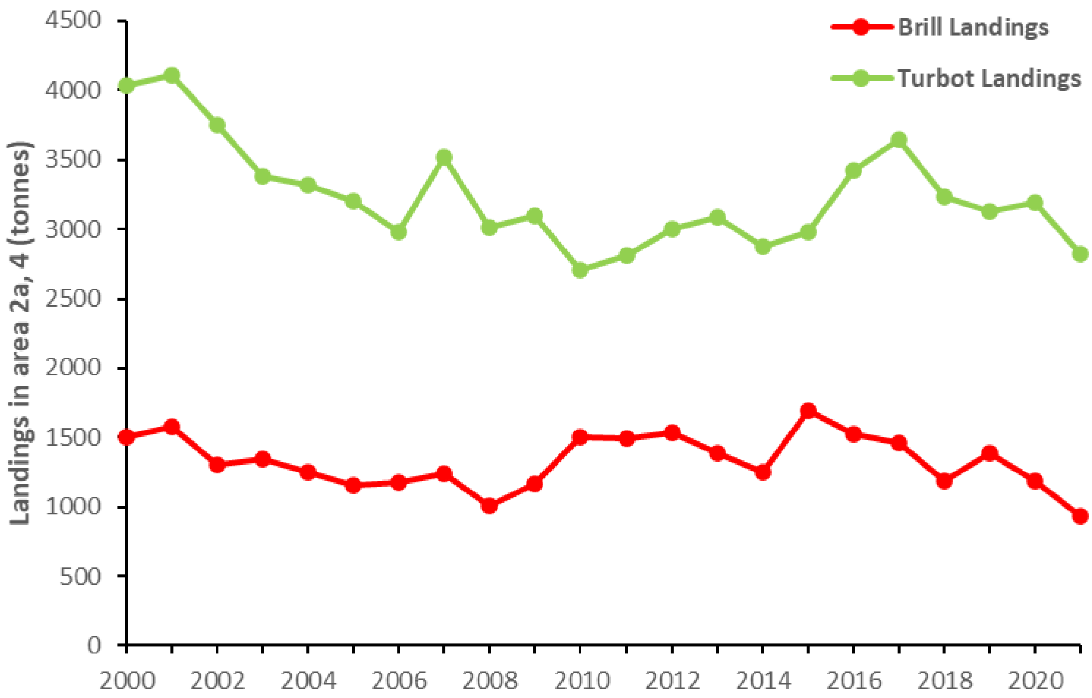

Figure 1.2. The official landings of brill and turbot in the TAC area (2a, 4) over the period 2000–2021.

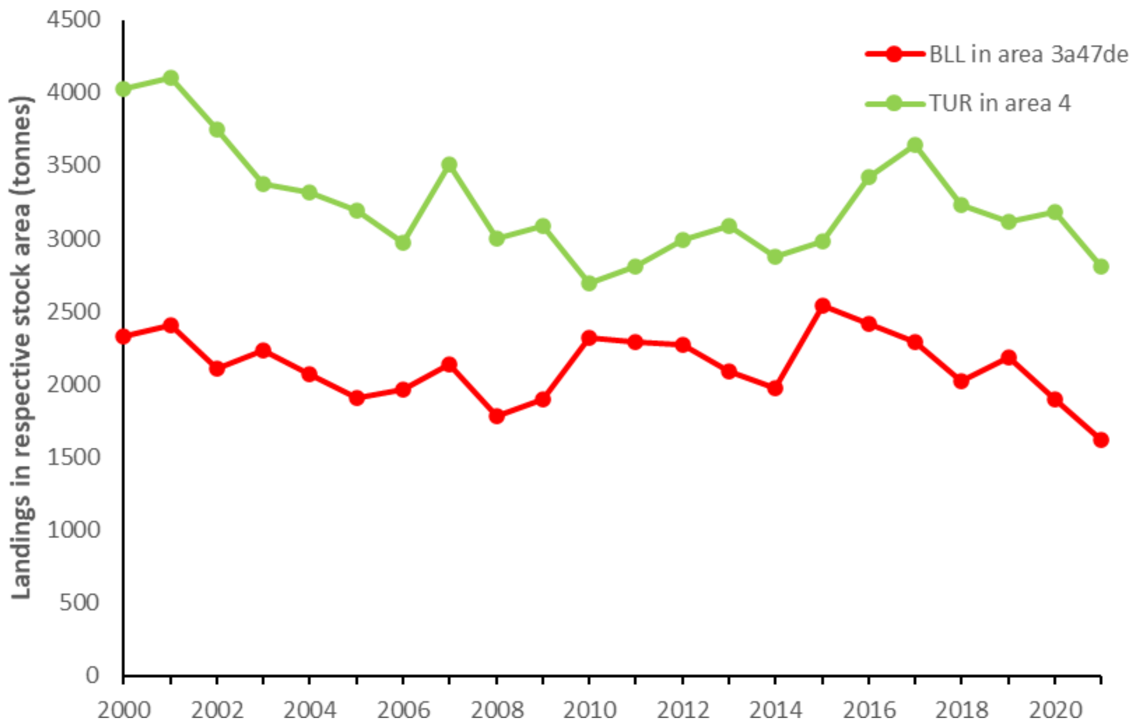

Figure 1.3. Official landings of turbot and brill in their respective stock area over the period 2000–2021: area 4 for turbot and area 3a47de for brill.

2. Is there a targeted fishery for the stock or are the species mainly discarded?

According to ICES estimates, brill and turbot are not heavily discarded, with discard rates generally lower than 11% (the exceptions being 15.1% and 16.3% for brill in 2018 and 2019; and 16.0%, 12.6% and 13.4% for turbot in 2016, 2017 and 2018 respectively; this was the period during which a series of PO measures were instituted to help control catches of turbot – see response to Question 1 above).

Table 2.1. ICES estimates of landings and discards (including BMS).

Year	Brill in 3a47de			Turbot in 4		
	Landings	Discards	Discard rate	Landings	Discards	Discard rate
2014	1920	231	10.7%	2834	158	5.3%
2015	2470	230	8.5%	2922	112	3.7%
2016	2444	267	9.8%	3493	666	16.0%
2017	2207	208	8.6%	3441	496	12.6%
2018	1956	349	15.1%	3140	486	13.4%
2019	2147	417	16.3%	3045	230	7.0%
2020	1872	229	10.9%	3104	199	6.0%
2021	1547	152	8.9%	2659	129	4.6%

ICES WGMIXFISH data from the Greater North Sea area were explored in order to analyse the targeting behaviour of fleets catching brill and turbot; Appendix 1.1 describes the method used.

Brill

When considering subarea 4, less than 5% of total brill landings (by volume) is taken in strata that make up 5% or more of brill (by volume) in their landings (with the exception of the year 2020; Figure 2.1). However, this percentage is much higher in division 7.d (on average 25%). For the higher thresholds, this percentage is around 20% in 2010, but decreases in the more recent years. The previous dataset (2018 TACMAN) showed some targeting of brill in area 3a20, but this is no longer visible due to changes in métier aggregation and the consideration of more species. The effect is even stronger when considering the analysis by value instead of volume (Figure 2.2). This indicates that targeting of brill does indeed occur in division 7.d (Figure A1.2 in Appendix 1.1) and that less targeting occurs in the areas where catches are constrained by a TAC (here, subarea 4). It would therefore be reasonable to assume that if the TAC were to be removed for brill, that targeting behaviour would emerge in subarea 4.

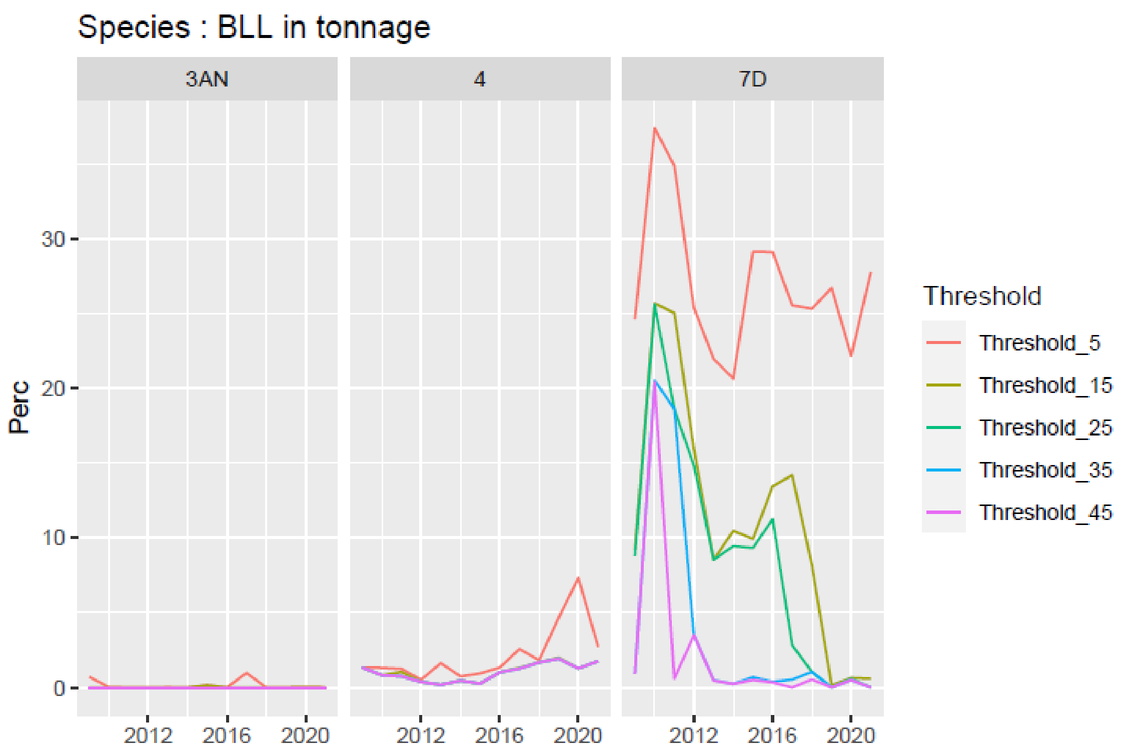

Figure 2.1. Percentage of total brill landings (by volume) for those strata for which brill makes up 5% (red), 15% (yellow), 25% (green), 35% (blue) or 45% (pink) of the landings of all species (by volume), for the period 2009–2021. [Note that 3AN refers to subdivision 3a20.]

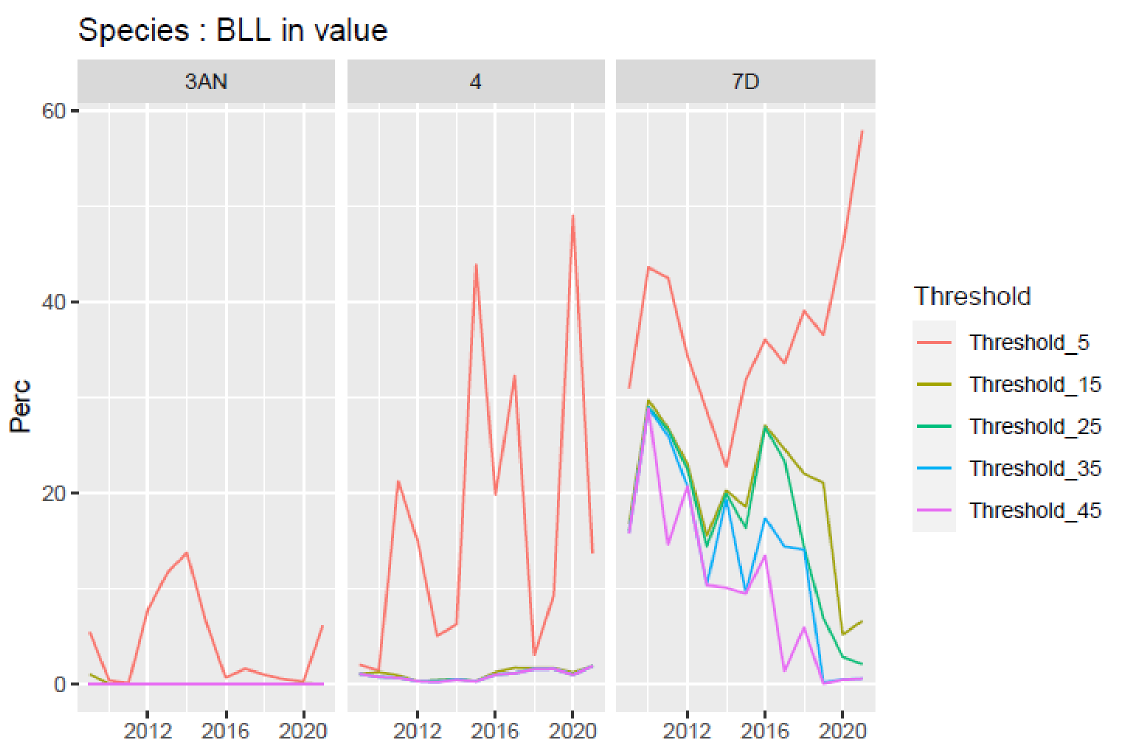

Figure 2.2. Percentage of total brill landings (by value) for those strata for which brill makes up 5% (red), 15% (yellow), 25% (green), 35% (blue) or 45% (pink) of the landings of all species (by value), for the period 2009–2021. [Note that 3AN refers to subdivision 3.a.20.]

Turbot

In the beginning of the time series, around 10% of total turbot landings (by volume) in subarea 4 occur in strata where turbot comprises up to 45% of landings (by volume) (Figure 2.3), which offers some moderate evidence that targeting behaviour occurs in subarea 4. However, this percentage decreases in the most recent years to 1%, although the TAC becomes less restrictive in this period (2018–2021) (Table 1.3). The decrease is likely linked to the stabilisation of the SSB of turbot (Figure 5.5). Nevertheless, when doing this analysis by value (Figure 2.4), up to 90% of total turbot landings occur in strata where turbot comprises up to 5% of the landings (by value). This indicates that when turbot is caught, it is often landed because of its high value (see question 3). Additionally, around 10 to over 25% of turbot landings (by value) occur in strata where turbot comprises up to 15 and 25% of the landings (by value). Finally, Figure A1.1 in Appendix 1.1 also gives an indication of targeting behaviour (where the diagonal turbot cell was light red).

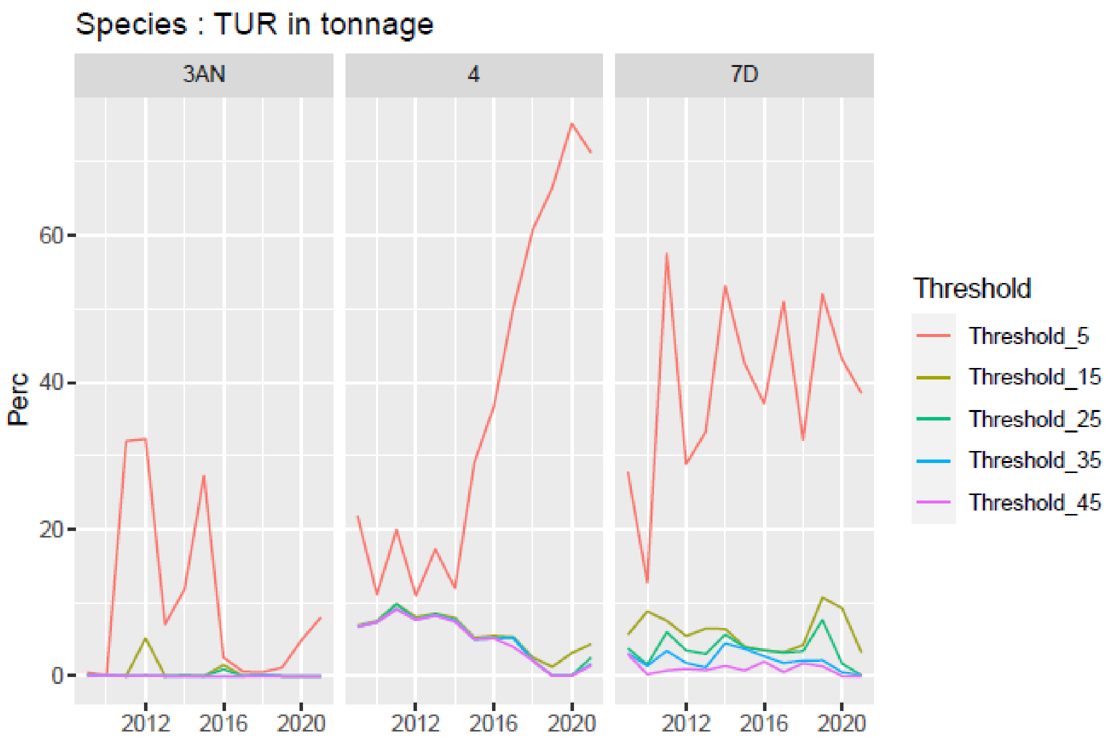

Figure 2.3. Percentage of total turbot landings (by volume) for those strata for which turbot makes up 5% (red), 15% (yellow), 25% (green), 35% (blue) or 45% (pink) of the landings of all species (by volume), for the period 2009–2021. [Note that 3AN refers to subdivision 3.a.20.]

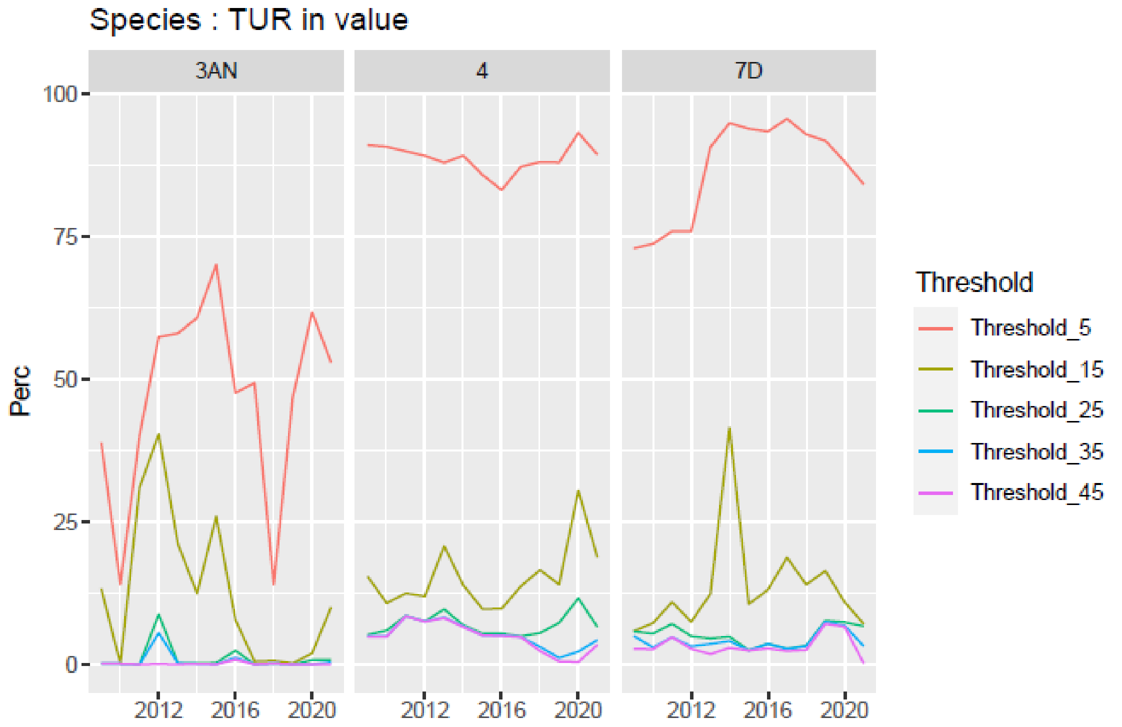

Figure 2.4. Percentage of total turbot landings (by value) for those strata for which turbot makes up 5% (red), 15% (yellow), 25% (green), 35% (blue) or 45% (pink) of the landings of all species (by value), for the period 2009–2021. [Note that 3AN refers to subdivision 3.a.20.]

3. Is this stock of large economic importance or are the species of high value?

North Sea demersal fishing activities of the EU Members States bordering the North Sea (*i.e.* Belgium, Denmark, Germany, France, Netherlands and Sweden) and the United Kingdom generated a total landing value of more than €850 million in 2012 (EPRS, 2018). According to the latest STECF data, the total demersal[1] landings value ranged between €642 and €913 million over the period 2014–2020 (STECF, 2021). Both turbot and brill are present in the list of the 20 most important demersal species contributing to this value: sole, brown shrimp, plaice, cod, Norway lobster, haddock, edible crab, saithe, European lobster, anglerfish, sand eel, turbot, scallops, whiting, hake, lemon sole, common edible cockle, brill, sprat and whelk.

The 2018 TACMAN request showed that the total economic landing value of turbot in the North Sea is almost three times higher compared to brill (ICES, 2018b). In addition, in the period 2008–2016, the annual economic value for brill has been relatively stable around €9 million per year, while annual economic values for turbot showed larger fluctuations ranging between €22 and €28 million (ICES, 2018b). From the most recent STECF data similar conclusions can be drawn (STECF, 2021). Economic landing values for turbot and brill in the North Sea in the period 2014 to 2020 range from €23 to almost €28 million and from €7 to almost €10 million respectively (Figure 3.1). It is important to note that brill generates on average €6 million in areas 27.3.a, 27.7.d and 27.7.e over the period 2014–2020. These areas are part of the brill stock area, but not part of the brill and turbot TAC area (i.e. areas 27.2.a and 27.4) (cfr. question 1).

[1] Following gears were excluded: "FYK", "GEF", "GNC","GND", "LHM", "LHP", "LLD", "LLS", "LNB", "LTL", "NK", "NO", "SB", "OTM", "PTM", "PS", "SV", "SPR"

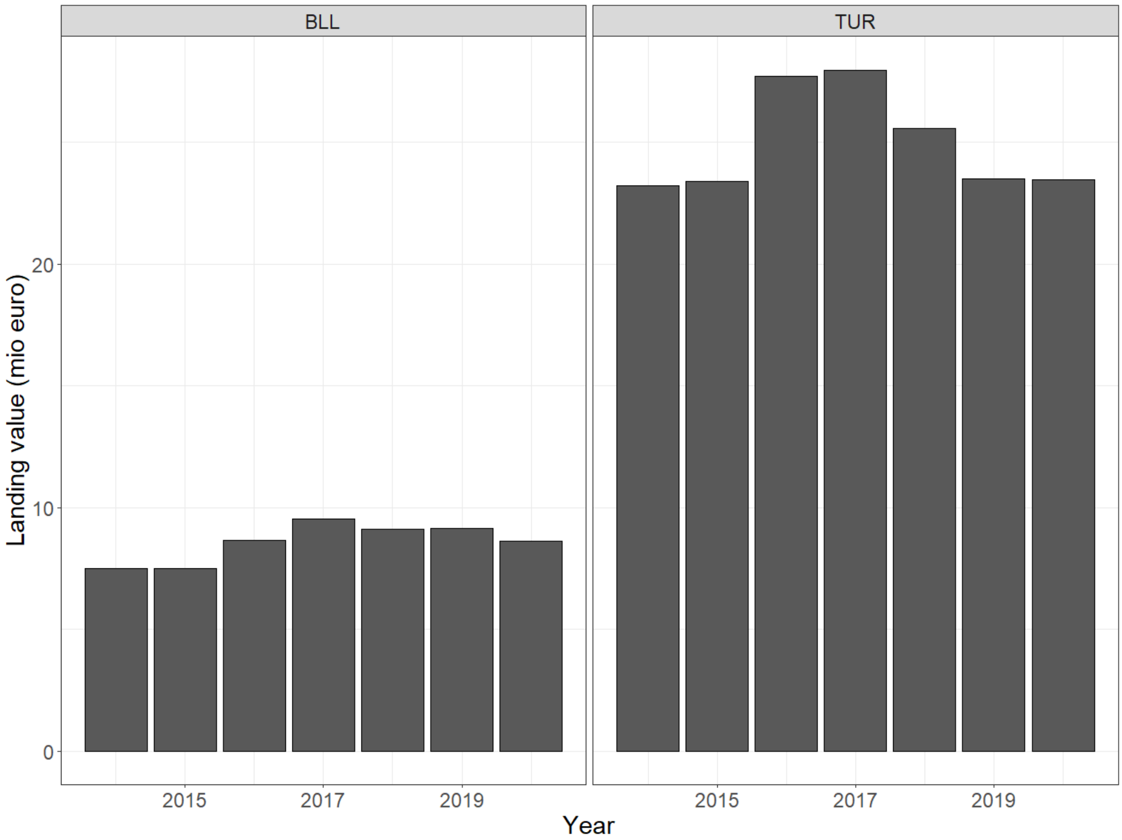

Figure 3.1. Total annual landing value for turbot and brill in the period 2014–2020 for the North Sea (area 4). Data are obtained from STECF FDI (STECF, 2021).

The contribution of turbot and brill to the overall economic value of the demersal fleet in the North Sea is lower compared to the main target species: sole and plaice (Table 3.1; Figure 3.2). Most landings come from subarea 4, where the average landings value of sole and plaice in the period 2014–2020 lies around €105 million and €88 million, respectively (Table 3.1). In subarea 4, the average price per kg of plaice is low (€1.75 kg^{-1}) compared to sole (€10.5 kg^{-1}), turbot (€9.14 kg^{-1}) and brill (€6.87 kg^{-1}). However, plaice has the highest landings of all flatfish catches over the period 2014–2020, making it the second most important commercial flatfish species in terms of value.

The price per kg differs between the different areas (Table 3.1). Generally, sole has the highest price. However, in Divisions 7.d and 7.e, turbot gets a higher price than sole. Compared to sole and plaice, the price per kg for brill and turbot is more variable across areas (Table 3.1).

An analysis of sale slips showed that the average price of the largest market size category of turbot can fetch a higher price than the largest market class of sole (Rijnsdorp *et al.*, 2012). Large fish get a higher price, except during the months prior and during spawning (Rijnsdorp *et al.*, 2012, Zimmermann and Heino, 2013). In this context, turbot can certainly be regarded as a high value species. Price per market size category for brill also varies with fish size, but is generally lower than the price for sole. However, the price is quite constant over the year across categories (Rijnsdorp *et al.*, 2012).

Table 3.1: The average landings, landings value and price per kg for plaice, sole, turbot and brill in areas 3a, 4 and 7de over the period 2014 – 2020. Data are obtained from STECF FDI (STECF, 2021).

Species	Sub region	Average landings (tonnes)	Average landings value (€)	Average price (€ kg^{-1})
Plaice	3a	6988	13 694 752	1.96
Brill	3a	118	604 435	5.14
Turbot	3a	136	1 173 985	8.64
Sole	3a	254	2 686 613	10.6
Plaice	4	50482	88 483 406	1.75
Brill	4	1249	8 576 442	6.87
Turbot	4	2732	24 969 135	9.14
Sole	4	10091	105 486 298	10.5
Plaice	7de	5495	10 090 429	1.84
Brill	7de	646	5 251 528	8.12
Turbot	7de	805	9 814 952	12.2
Sole	7de	3525	39 794 409	11.3

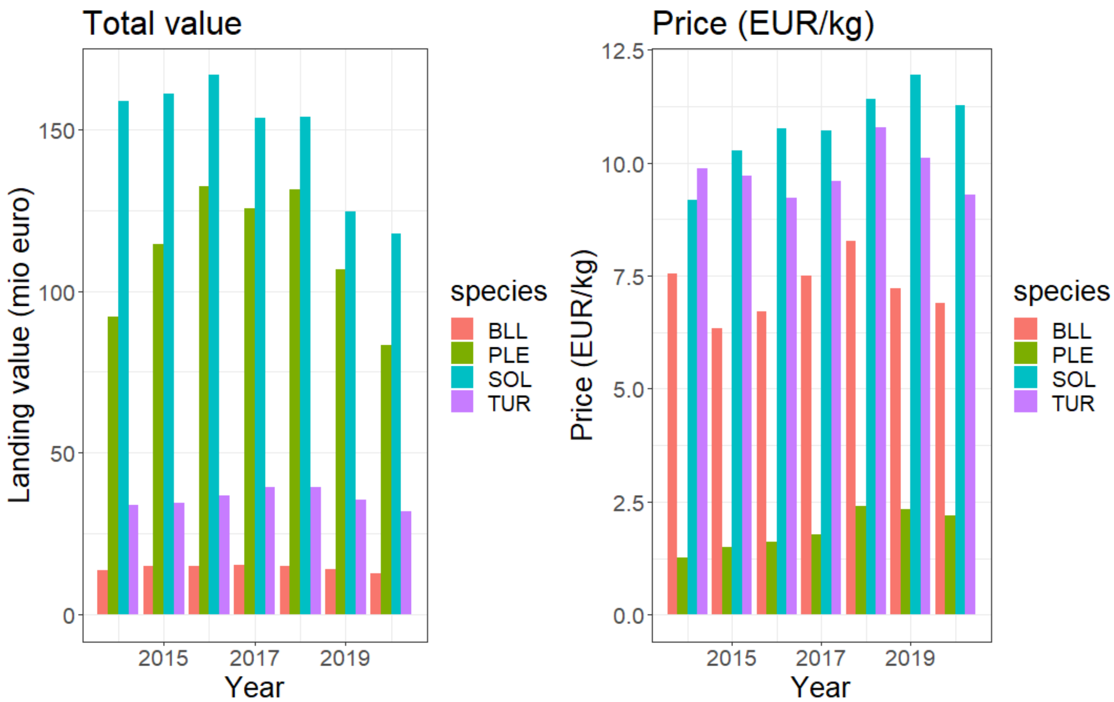

Figure 3.2. Comparison of the total annual landing value and price per kg landed sole, plaice, turbot and brill for the period 2014–2020 for the greater North Sea (areas 3a, 4, 7.d and 7.e). Data are obtained from STECF FDI (STECF, 2021).

4. How are the most important fisheries for the stock managed?

Flatfish in the North Sea are mainly targeted by the beam trawl fleet using small mesh sizes (i.e. 70–99 mm). Catches consist mainly of sole and plaice, with bycatch of turbot and brill. The beam trawl fishery is responsible for 66% of turbot landings and 58% of brill landings in the Greater North Sea (2021 data as reported in ICES 2022a, b). Beside the beam trawl fishery (TBB), also other gears such as otter trawls and passive gears including trammel and gill nets land approximately 34% of turbot and 39% of brill (2021 data as reported in ICES, 2022a, b).

From January 2019 onwards, the landing obligation is fully implemented. The Scheveningen Group, including Belgium, Denmark, France, Germany, the Netherlands, Sweden and the United Kingdom, submitted Joint Recommendations to detail the implementation of the landing obligation. Within these Joint Recommendations, several exemptions have been granted applicable for the period 2021–2023 (EU 2020/2014). These exemptions include discard plans for plaice, sole and turbot. <u>Plaice</u> has a high survivability exemption granted for Division 3.a and subarea 4 when the species is caught with gill nets and trammel nets, Danish seines, bottom trawls with a mesh size of at least 120 mm, bottom trawls with a mesh size of at least 90–99 mm equipped with a Seltra panel (only Division 3.a), bottom trawls with a mesh size of 80–119 mm (only in subarea 4) and for beam trawls using 80–119 mm equipped with a flip-up rope or Benthos Release Panel (BRP) and engine power of more than 221 kW (or less than 221kW (or less than 24 m in length) when fishing in the 12 miles zone and trawl duration of less than 90 min) (only in subarea 4). In addition, a *de minimis* exemption is granted for undersized plaice caught with bottom trawls targeting Northern prawn and Norway lobster in subarea 4.

For <u>sole</u> two d*e minimis* exemptions apply. One for undersized sole caught with gill and trammel nets in ICES divisions 2.a, 3.a and subarea 4, and one for undersized sole caught with 80–119 mm beam trawls equipped with a Flemish panel in ICES subarea 4. Additionally, a survivability exemption is in place for undersized sole caught with otter trawls with a cod-end mesh size of 80–99 mm in Division 4c, fishing within 6 nautical miles of the coast outside nursery areas in waters with a depth of 30 m or less and tow durations of no more than 90 min. Vessels should have a maximum length of 10 m and a maximum engine power of 221 kW.

<u>Turbot</u> is exempt from the landing obligation when caught with beam trawls (TBB) with a cod-end equal to or larger than 80mm in ICES subarea 4. No exemptions are in place for <u>brill</u>. It is important to note that these exemptions only apply until the end of 2022 and the Scheveningen Group must provide further scientific support to justify continuation of the exemptions.

Within the ICES advisory framework, the North Sea sole and plaice stock are defined as category 1 (ICES, 2022e). This means that these stocks have a full analytical assessment and forecast that are either age-/length-structured or based on production models. Advice on North Sea sole and plaice is provided using the MSY approach.

A total allowable catch (TAC) is used to regulate the exploitation rate of both species individually and a minimum conservation reference size (MCRS) is in place (27 cm for plaice and 24 cm for sole).

Within the ICES advisory framework, turbot is defined as category 1 (upgraded during the Interbenchmark in 2018; ICES, 2018a, 2022c,e) using an age-based model including both commercial and survey data. Brill is defined as category 3, i.e., stock for which a survey-based assessment or exploratory assessment indicates trends (ICES, 2022d). The brill assessment uses a commercial LPUE biomass index and applies the constant harvest rate (*chr)* rule for advice (ICES, 2020b; 2022a). Advice on both stocks is provided using the MSY approach.

In contrast to the single species TACs for sole and plaice as main target species, turbot and brill are managed under a combined TAC. Although, there is no European restriction in landing size for turbot and brill, some authorities and producer organisations have introduced a minimum conservation reference size (MCRS) in order to regulate quota uptake and market prices (cfr. Question 1). The most frequently applied MCRS for brill and turbot is 27 cm (e.g., in the Netherlands, Table 1.2) and 32 cm (e.g. in Belgium) (ICES, 2022c).

5. What are the fishing effort and stock trends over time?

Effort trends

The 2018 TACMAN request showed that fishing effort of the dominant demersal gears in the North Sea ecoregion decreased substantially since the early 2000s (Figures 5.1 and 5.2, STECF 2017). The decrease in fishing effort is most evident in the BT2 (Subarea 4 and Division 7.d) and TR2 fisheries (Subarea 4 and Divisions 3.a and 7.d). These fisheries are responsible for most of the brill and turbot catches. In subarea 4, where most turbot and brill are caught, fishing effort for the BT2 (beam trawls with mesh sizes ≥ 80 mm and < 120 mm; Figure 5.1) fleet has decreased significantly (-51%) up to 2014, where after fishing effort has been relatively stable (Figure 5.3). Note that due to discontinuity in the FDI datasets, effort values are not entirely comparable in absolute terms. In Division 3.a and 7.d, the TR2 fleet (bottom trawl and seines with mesh sizes ≥ 70 mm and < 100 mm) shows the biggest decrease with 52% and 49%, respectively. However, the most recent data series shows a slight increase in fishing effort of these bottom trawls and seines in Division 3.a from 2015 onwards, whereas the effort has stabilized in 7.d (Figure 5.3). The fishing effort of both beam trawls and nets has however largely decreased in division 7.d, while the effort of dredges (included in the 'other' category) appears to have increased since 2015. For Division 7.e, being part of the brill stock, there was a 31% decrease in fishing effort for bottom trawls and seines (OTTER in Figure 5.2). While the decrease in effort for these gears has continued over time, fishing effort of beam trawls has slightly increased since 2014, while it has remained relatively stable for nets (Figure 5.3).

Overall, the reductions and stabilization to lower levels in the most recent years of the fishing effort, especially by the beam trawlers in area 4, correspond to a reduction in fishing pressure on the plaice and sole stock, which are the main target species (see table 6.1).

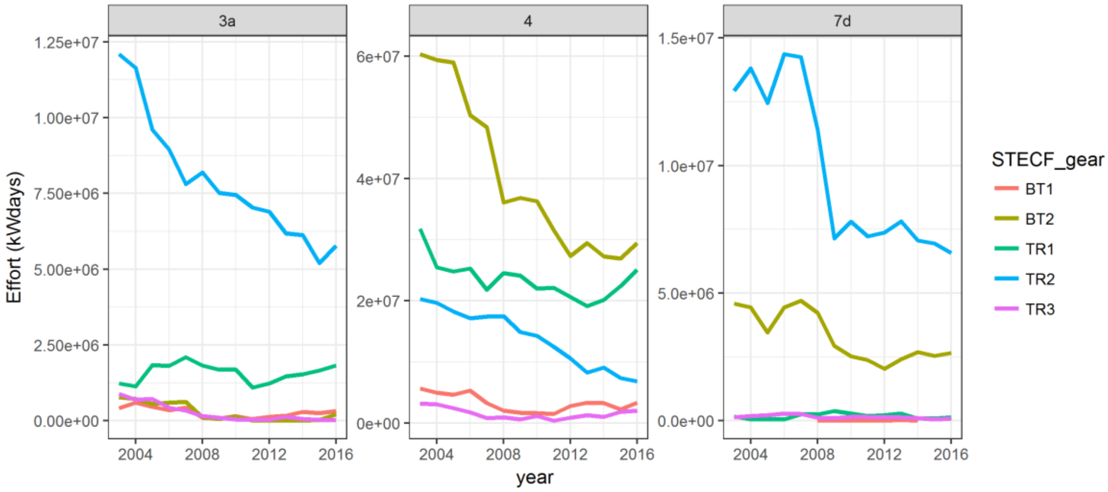

Figure 5.1. Trends in fishing effort from the 2018 TACMAN request for different STECF fishing gear groups in ICES division 3a, ICES subarea 4 and ICES division 7d for the period 2003–2016 (STECF 2017). Regulated gears: BT1 are beam trawls with mesh sizes ≥ 120 mm. BT2 are beam trawls with mesh sizes ≥ 80 mm and < 120 mm. TR1 are bottom trawl and seines with mesh sizes ≥ 100 mm. TR2 are bottom trawl and seines with mesh sizes ≥ 70 mm and < 100 mm. TR3 are bottom trawl and seines with mesh sizes ≥ 16 mm and < 32 mm.

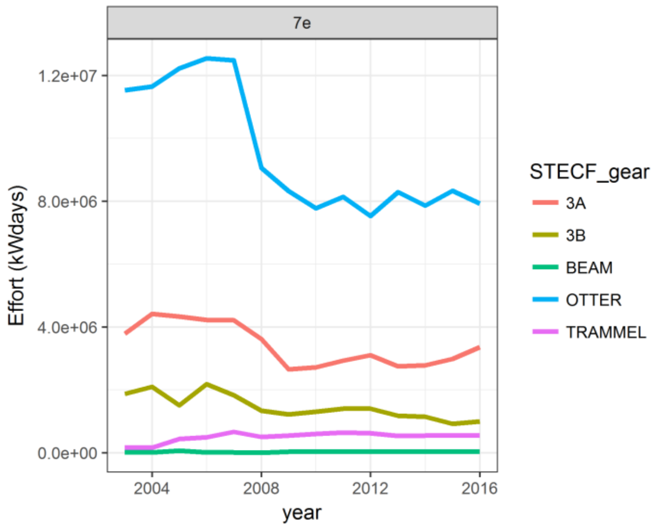

Figure 5.2. Trends in fishing effort from the 2018 TACMAN request for different STECF fishing gear groups for ICES division 7e for the period 2003–2016 (STECF 2017). Regulated gears: 3A are beam trawls with mesh sizes ≥ 80 mm. 3B are gill nets, entangling nets or trammel nets ≤ 220 mm. BEAM are beam trawls with mesh sizes < 80 mm or missing mesh size. OTTER are otter trawls all mesh sizes. TRAMMEL are trammel nets with mesh sizes > 220 mm or missing mesh size.

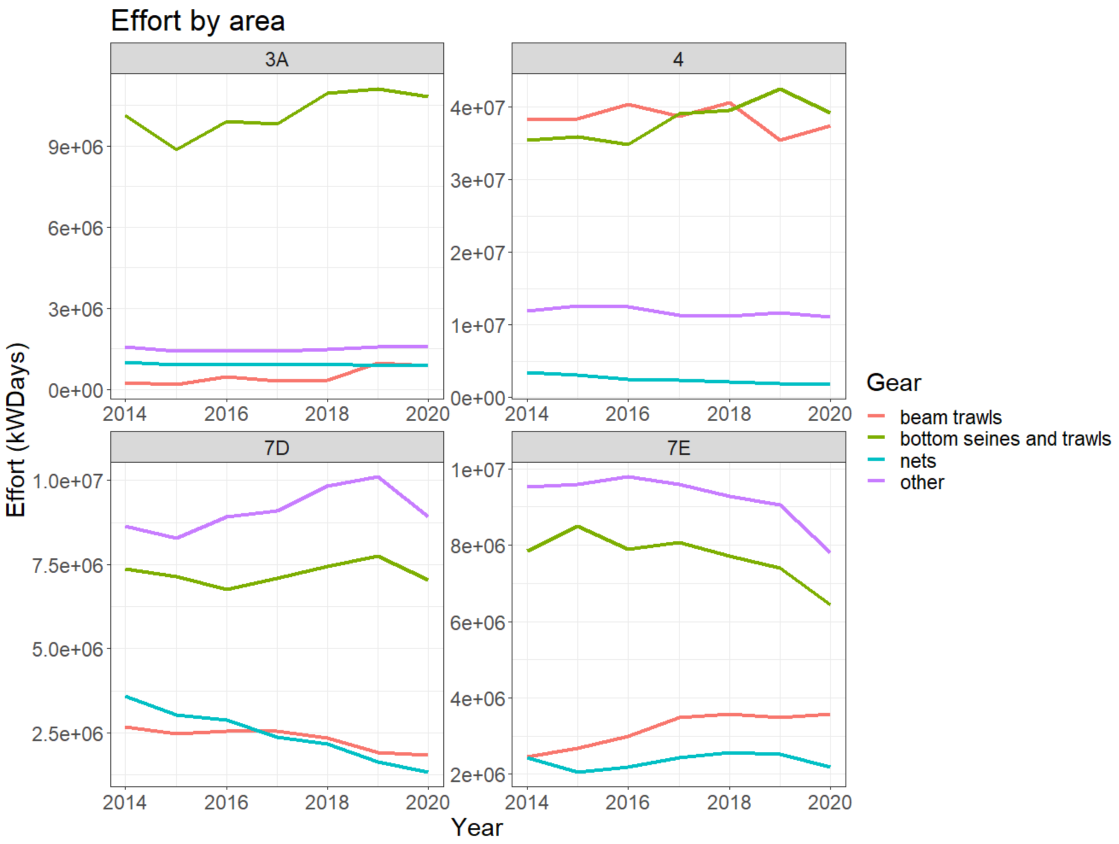

Figure 5.3. Trends in fishing effort for different STECF fishing gear groups in ICES division 3.a, ICES subarea 4 and ICES divisions 7.d and 7.e for the period 2014–2020 (STECF, 2021). Regulated gears are beam trawls (all mesh sizes), nets including gillnets and trammel nets and bottom trawls and seines. The 'other' category contains dredges and pots and traps.

Stock trends

Brill is defined as category 3 in the ICES framework, i.e., stock for which a survey-based assessment or exploratory assessment indicates trends. Most recent advice is based on the constant harvest rate (*chr*) rule to provide MSY advice (ICES, 2022a, d). The assessment uses the standardized landings per unit effort (LPUE) from the Dutch beam trawl fleet (vessels > 221 kW) as a biomass index of stock development (Figure 5.4). This index shows a gradual increase from 20 kg per day in the late 1990s to 60 kg per day in 2015. From 2016 onwards, the index decreased to 32 kg per day in 2021, which is at a similar level as in 2007.

The advice for fishing opportunities in 2023 is based on the biomass index for 2021, multiplied by a constant harvest rate, a biomass safeguard, and a precautionary multiplier. The stability clause was considered and applied because the change from the previous advice was more than 30%. The length-based indicator (LBI) analysis shows that fishing mortality is above the $F_{MSYproxy}$ in 2021 (Figure 5.4). This points to overexploitation. However, the actual stock size is unknown.

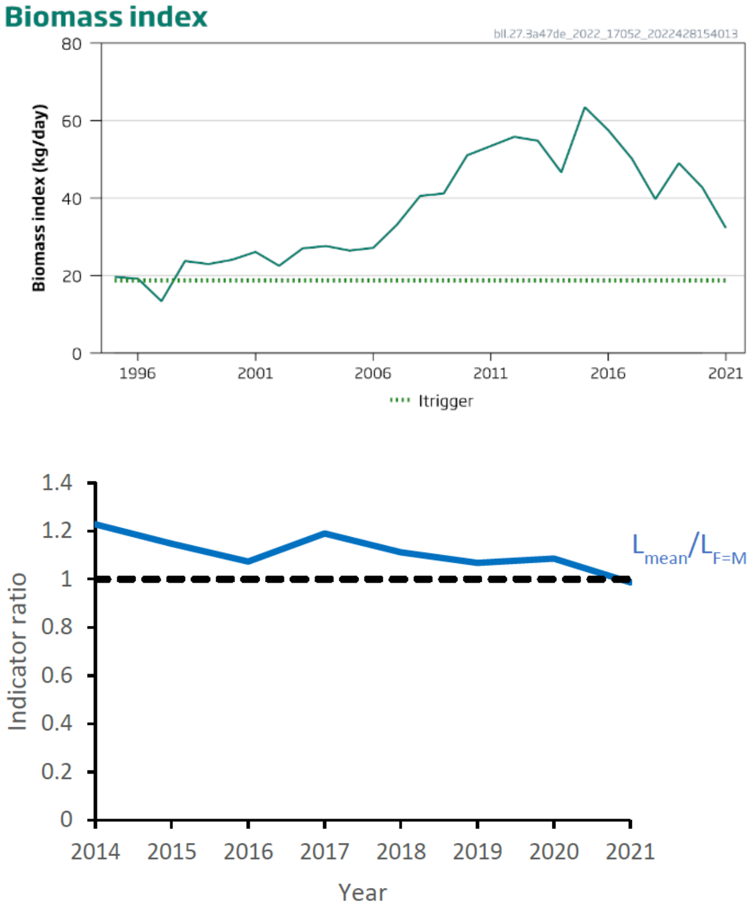

Figure 5.4. Top: Biomass index is the standardized landings per unit effort (LPUE) from the Dutch beam trawl fleet for vessels > 221 kW as used for the advice issued in June 2022 for fishing opportunities for 2023. Bottom: Exploitation status as indicator ratio (L_{mean} / $L_{F = M}$) from the length-based indicator (LBI) method for brill. The exploitation status is below the $F_{MSY\ proxy}$ when the indicator ratio value is higher than 1 (shown by a dashed black line) (ICES, 2022a).

Turbot in Subarea 4 was inter-benchmarked in 2017 (ICES, 2017), and again in 2018 (ICES, 2018a) upgrading the stock ICES Category 1. Age information is mainly derived from the age composition of Dutch (1981–1990, 1998, 2003–present), Danish (2014–present) and Belgian (2017–present) commercial landings. In addition, two fisheries-independent indices, i.e., SNS and BTS-Isis surveys, as well as one standardized commercial biomass index of the Dutch beam trawl (BT2) fleet are included.

The latest assessment shows that fishing pressure has decreased since the early-2000s and has been stable at and below F_{MSY} since 2012 (Figure 5.5). An increasing trend in SSB has been estimated for turbot since the mid-2000s, and the stock has been above MSY $B_{trigger}$ since 2013 (Figure 5.5) (ICES, 2022b).

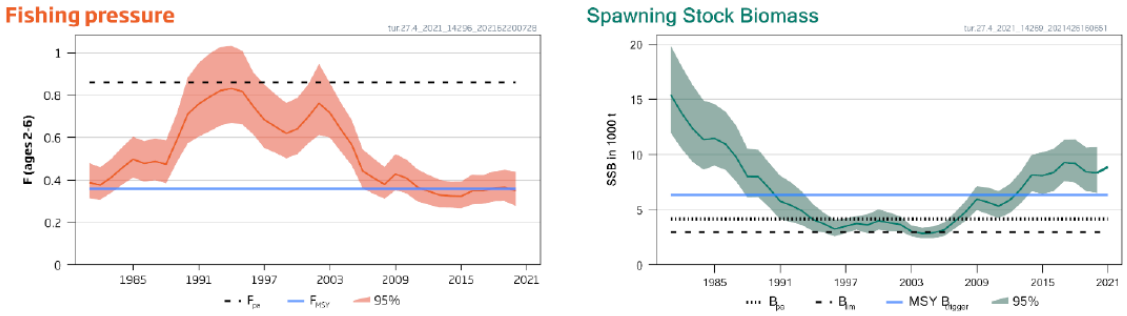

Figure 5.5: Fishing mortality (left panel) and Spawning Stock Biomass (SSB) (right panel) for turbot (ICES, 2022b), with 95% point-wise confidence bounds. F_{MSY} is at 0.36 and MSY $B_{trigger}$ is estimated at 6353 tonnes.

6. What maximum effort of the main fleets can be expected under management based on F_{MSY} ranges for the target stocks, and has the stock experienced similar levels of fishing effort before?

To address this question, the analysis as done in the 2018 TACMAN request was updated by adding the data from 2017–2020 for effort and updating ICES catch estimates and assessment results of plaice, sole, turbot and brill obtained from the latest ICES advice for these stocks (ICES, 2022a,b,f,g). Effort information from beam trawlers in the North Sea (mesh sizes 70–119 mm) were extracted from the Fisheries Dependent Information (FDI) database of STECF (STECF, 2021). Only the effort information from these smaller mesh size beam trawlers were used because this fleet mainly targets flatfish. Note that effort information from 2017–2020 was estimated using the updated STECF database and added to the values from 2003–2016 as available for the 2018 TACMAN request (Table 6.1). Values for 2014–2016 differed on average by 26 x 10^5 kW days comparing the new and old STECF FDI dataset, with the new version resulting in lower estimates of effort.

The turbot assessment gives estimates of the fishing pressure at age ($F_{bar} = F_{(ages2\text{–}6)}$). For brill, however, such information is lacking. Nonetheless, for both stocks, the relative stock trends are related to possible changes in effort of the fleets targeting plaice and sole. When fishing pressure increases for sole and plaice to the upper bound of the F_{MSY} range, pressure on the brill and turbot stocks are likely to increase as well (ICES, 2022c; Table 6.2).

Table 6.1: Estimated catch (tonnes; ICES 2022c), effort (kW days × 10^5; by beam trawlers with mesh size 70–119 mm); STECF 2017, STECF, 2021), and assessment estimates of fishing pressure (F) for plaice, sole and turbot.

Year	Catch				Effort	F(ages 2–6)		
	Brill	Turbot	Sole	Plaice	(STECF area 4; kWdays)	Plaice	Sole	Turbot**
2003			19284	153997	603	0.31	0.58	0.73
2004			20938	127989	594	0.23	0.56	0.65
2005			17696	119046	590	0.21	0.53	0.57
2006			13588	131303	504	0.180	0.50	0.45
2007			15506	100949	484	0.143	0.48	0.41
2008			14616	105329	361	0.113	0.46	0.38
2009			15213	108262	368	0.102	0.46	0.43
2010			14849	116910	362	0.101	0.48	0.41
2011			13188	118100	315	0.104	0.49	0.37
2012			14696	141932	273	0.111	0.47	0.35
2013			15958	126247	295	0.104	0.43	0.33
2014	2150	2993	14640	133697	273^	0.111	0.41	0.32
2015	2700	3034	14589	134585	269^	0.118	0.42	0.32
2016	2711	4159	15323	136995	294^	0.134	0.47	0.35
2017	2415	3937	13573	114300	281*	0.125	0.52	0.35
2018	2305	3626	12265	105800	301*	0.132	0.54	0.35
2019	2564	3276	10607	86121	279*	0.109	0.47	0.36
2020	2101	3303	10490	79158	282*	0.095	0.33	0.35
2021	1698	2788	9144	73453		0.080	0.21	0.35

*** Values for effort originated from the updated STECF FDI data (STECF, 2021) and were added to the data used for the 2018 TACMAN request (2003–2016).**
**** Values based on landings**
^ Values for 2014–2016 differed on average by 26 x 10^5 (SD ±12 x10^5) kW days comparing the new and old STECF FDI dataset, with the new version resulting in lower estimates of effort.

Table 6.2: Fishing pressure for plaice and sole for different scenarios.

	F_{2020}	F_{2021}	Current F_{MSY}**	Upper bound F_{MSY} **	Lower bound F_{MSY} **	Highest observed F (ages 2–6)**
Plaice	0.095	0.08	0.152	0.182	0.117	0.46 (1997 and 1987)
Sole	0.33	0.21	0.207	0.311	0.123	0.69 (1996 and 1997)
Turbot	0.35	0.35	0.361	0.482	0.252	0.83 (1994)

**** WGNSSK report (ICES 2022c).**

A linear regression was applied between estimated fishing pressure of plaice, sole and turbot and the effort of the main fleet catching these flatfish (beam trawls targeting demersal fish, mesh sizes 70–119 mm) (Figure 6.1). This analysis allows to investigate the potential impact on the stocks when fishing with high effort in terms of F ranges and sustainability. It should be noted that a linear relationship between fishing pressure and effort was assumed, while this may not be the case if fishing patterns or selectivity change.

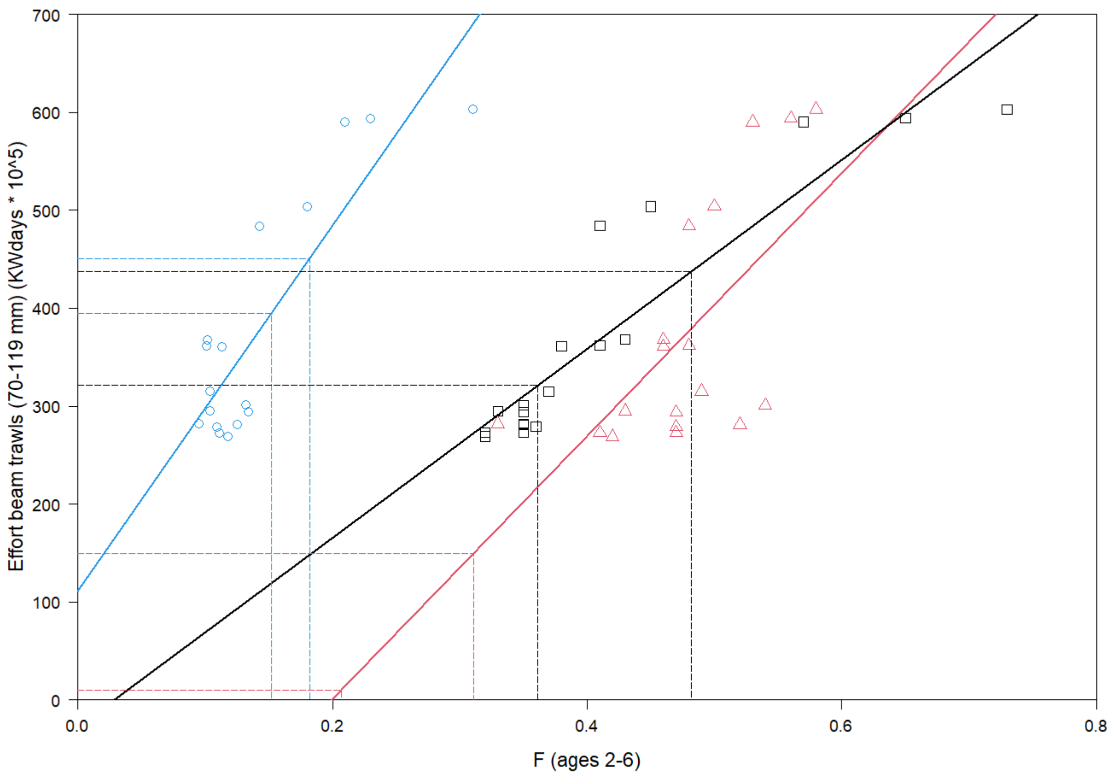

Figure 6.1. Relation between plaice (blue), sole (red) and turbot (black) fishing pressure (F) and effort (kWdays x 10^5; beam trawls (70–119 mm)). Solid lines represent linear regressions, dashed lines display F_{MSY} and $F_{MSY\ upper}$ values for plaice, sole and turbot. Plaice: effort x 10^5 = 111.33 + 1865.77 x F (R^2 = 0.75); Sole: effort x 10^5 = -268.5 + 1344.3 x F (R^2= 0.42) and Turbot: effort x 10^5 = -27.13 + 964.74 x F (R^2 = 0.85).

From 2003 to 2005, turbot experienced high fishing pressure (range: 0.57 to 0.73; but higher values occurred before this – see Figure 5.5), correlating with high values of fishing effort observed in the beam trawl fleet (R^2 = 0.85, Figure 6.1). The impact of these high fishing pressures is reflected in the low Spawning Stock Biomass (SSB) in the first part of the time series, having the lowest observed value (2825 tonnes) in 2004 (Figure 5.5 and 6.2).

Since 2003, the effort of the beam trawl fleet (70–119 mm) gradually decreased, which is also shown in decreasing fishing pressure for plaice, sole and turbot (Table 6.1), for plaice more linearly than for sole (Figure 6.1; R^2 = 0.75 and 0.42 respectively). Under the assumption of a linear relationship between fishing pressure and effort, the effort at F_{MSY} (0.152) for plaice would be 395 kW days x 10^5 and would be 451 kW days x10^5 at the upper bound of F_{MSY} (0.182); for sole this would be 9.8 KW days x 10^5 and 150 kW days x 10^5, respectively (Figure 6.1). Fishing at the upper bound of the F_{MSY} range would correspond to an increase in effort of 60% for plaice and a 47% reduction in effort for sole compared to the effort in 2020. These values are quite different compared to the 2018 TACMAN request (i.e. 41% increase for plaice and 19% increase for sole). Both plaice and sole have been benchmarked in 2022 and 2020, respectively (ICES, 2020a; 2022h), resulting in a change in the perception of the stocks and revision of reference points (Table 6.2). For plaice, the benchmark led to changes in the trajectory of SSB and recruitment of the stock while fishing pressure was scaled down (Figure 6.4). The update of the North Sea sole assessment has led to an upward revision of the fishing pressure compared to the new reference points, with fishing pressure oscillating above the upper level of the F_{MSY} range until 2020 (Figure 6.4). Fishing pressure at levels higher than F_{lim} resulted in low biomass estimates with the exception of years when recruitment was higher than average (ICES, 2022g). This likely explains the lower R^2 value for the linear regression. Fishing pressure has however decreased to levels close to F_{MSY} in 2021.

From 2006 onwards, fishing effort was lower than 451 x 10^5 kWdays, which is the effort corresponding to the upper level of the F_{MSY} range for plaice. From 2006 onwards, SSB estimates from turbot and the biomass index from brill start to increase (Figure 6.2 and 6.3). This could indicate that managing plaice under MSY could simultaneously allow sustainable management of turbot and brill. Although, the effort corresponding to the upper level of the F_{MSY} range for turbot lies a little bit lower: 438 x 10^5 kWdays. In addition, the reduction in effort cannot explain why the brill index decreases from 2015 onwards. Considering the poor state of the North Sea sole stock and the long period of overfishing, no such link between managing the sole stock and turbot and brill can be made (Figure 6.2 and 6.3).

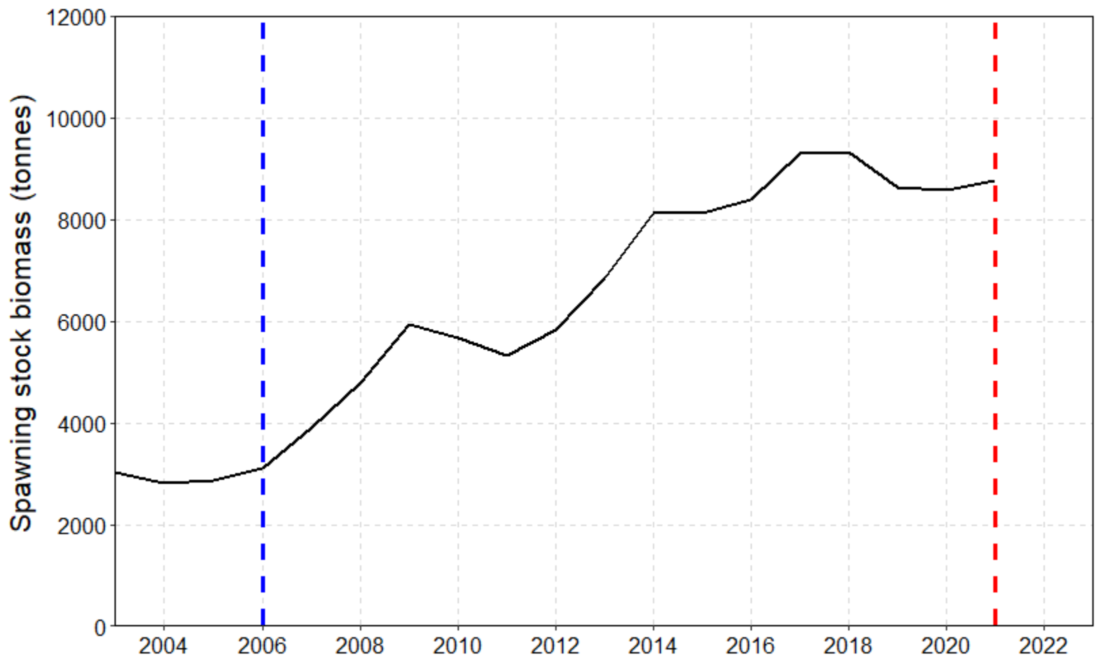

Figure 6.2. The estimated Spawning Stock Biomass (SSB) for turbot in the period 2003–2021 (black line). The vertical lines denote the first year at which the effort of the beam trawl fleet was below the fishing effort corresponding to the upper level of the F_{MSY} range for plaice (blue) and sole (red).

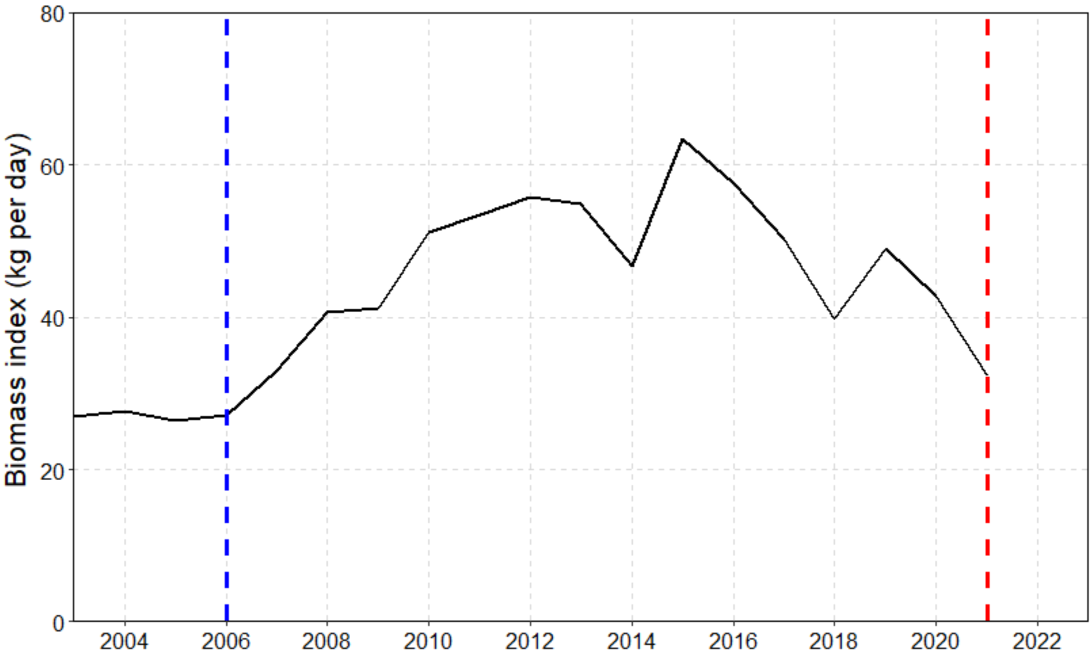

Figure 6.3. The estimated Biomass index (kg d^{-1}) for brill in the period 2003–2021 (black line). The vertical lines denote the first year at which the effort of the beam trawl fleet was below the fishing effort corresponding to the upper level of the F_{MSY} range for plaice (blue) and sole (red).

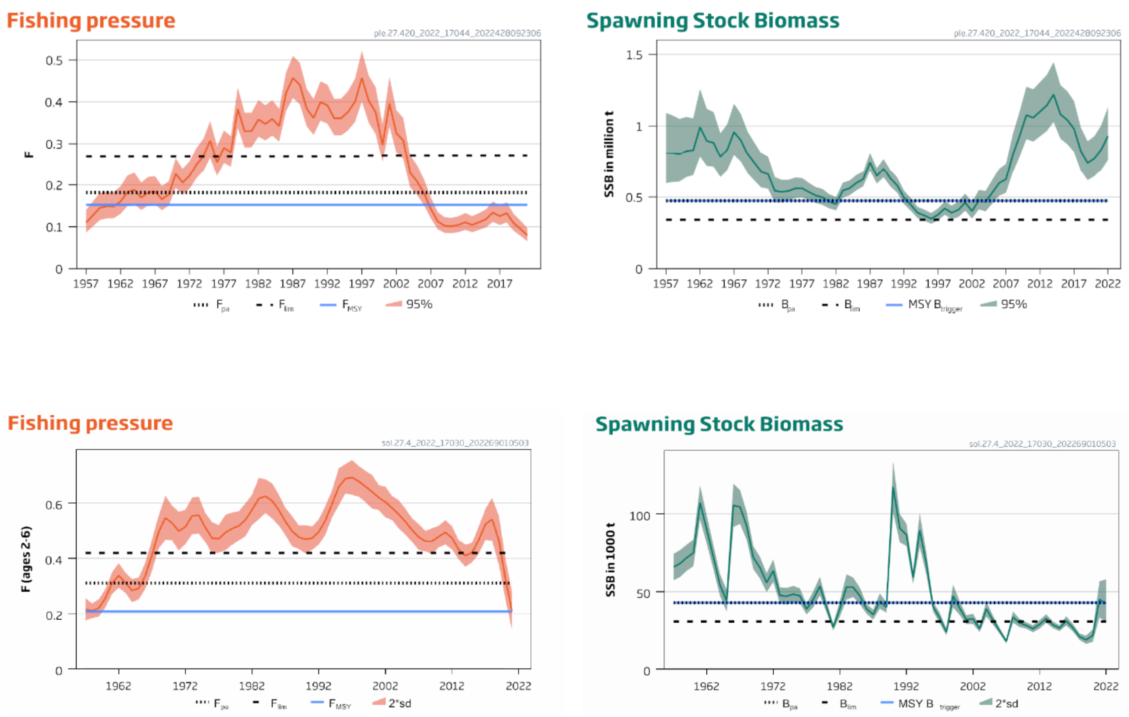

Figure 6.4. Fishing mortality and spawning stock biomass (SSB) trends for plaice (ple.27.420, top) and sole (sol.27.4, bottom) in the North Sea (ICES, 2022f,g).

1.4 Conclusions for brill and turbot

The general conclusion is the same as formulated in the 2018 TACMAN request, meaning that we cannot recommend the removal of the TAC for brill and turbot, without implementing other management measures. When keeping the TAC, we strongly recommend to implement an individual TAC for brill and turbot. This will also allow to align the TAC of brill with the actual stock area of the species (i.e., in addition to subarea 4, include divisions 3.a, 7.d and 7.e). It should be noted that catches in division 2.a are negligible for both stocks and it is not part of the stock area for either stock. Management of brill and turbot under a combined TAC prevents effective control of the single-species exploitation rates and could potentially lead to the overexploitation of either species.

This general conclusion relies on several factors:

a) The joint TAC for brill and turbot is sometimes restrictive when considering only subarea 4 and division 2.a, but even more so when considering the other areas for brill that are not currently covered by a TAC. Furthermore, PO measures were needed (limiting minimum landings size and weekly landing capacity per trip; e.g. in 2016 and 2017) to avoid overshooting the national quota when the TAC became restrictive.

b) Evidence shows that targeting behaviour occurs in certain fisheries for turbot, mostly related to its high value, and for brill especially outside the TAC area. It would therefore be reasonable to assume that if the TAC were to be removed, targeting behaviour would increase particular given the value of these species.

c) Both brill and especially turbot are high-value species when considering their value per kg, and their substantial contribution to the total value of demersal landings.

d) The removal of the brill and turbot TAC encompasses that management of turbot and brill would rely on managing the main target species (plaice and sole) to within their F_{MSY} ranges. Although the analysis shows that managing plaice under MSY could simultaneously allow sustainable management of turbot and brill, the upper level of the F_{MSY} range for turbot lies a little lower than the effort corresponding to MSY effort for plaice. In addition, effort has been sustainable for plaice, while the brill index has decreased from 2015 onwards. Considering the poor state of the North Sea sole stock and the long period of overfishing, no such link between managing the sole stock and turbot and brill can be made.

For these reasons, removing the TAC for brill and turbot may compromise the ability of managers to keep both stocks within safe biological limits in the short- and medium-term.

Other conservation tools, such as minimum landing size, gear and effort restrictions, could be used in the absence of TACs to keep the stocks within safe biological limits. However, these tools need proper investigation regarding their effectiveness.

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Appendix 1.1

Method for analysing targeting behaviour

Targeting can be seen as a proportion of a given species in the landings. If a species is targeted, it should contribute to a high proportion of the landings. However, a “high” proportion of a species in the landings is hard to define. This proportion can be impacted by lots of different factors, the main ones being the gear, its selectivity and the diversity of species in the fishing grounds in terms of number of species and abundance. This proportion can be expressed in either volume or value.

Method

Fix a threshold of a given species in the landings by stratum to define the targeting behaviour. The percentage of landings with a proportion of that given species over the total landings of that species (in volume and in value) higher than the threshold is then computed. The threshold is varied from 5 to 45% representing the “targeting” behaviour. Figure A1.1 and Figure A1.2 only provide an analysis for the 5% threshold for 2021 for subarea 4 and division 7d respectively; this method applied in the main document explores each cell in the diagonal of Figure A1.1 and A1.2 for temporal trends and several thresholds.

Limitations

The proportion is computed over strata that are here defined by métier/quarter/area as submitted for the ICES WGMIXFISH data call. This level of aggregation does not allow for fine exploration of the fishing behaviour. Some targeting might exist/happen at the trip scale and may not be reflected in the stratum used, which averages the trips over the same quarter/area. Other factors will impact the landings profiles (TACs, fish abundances, market).

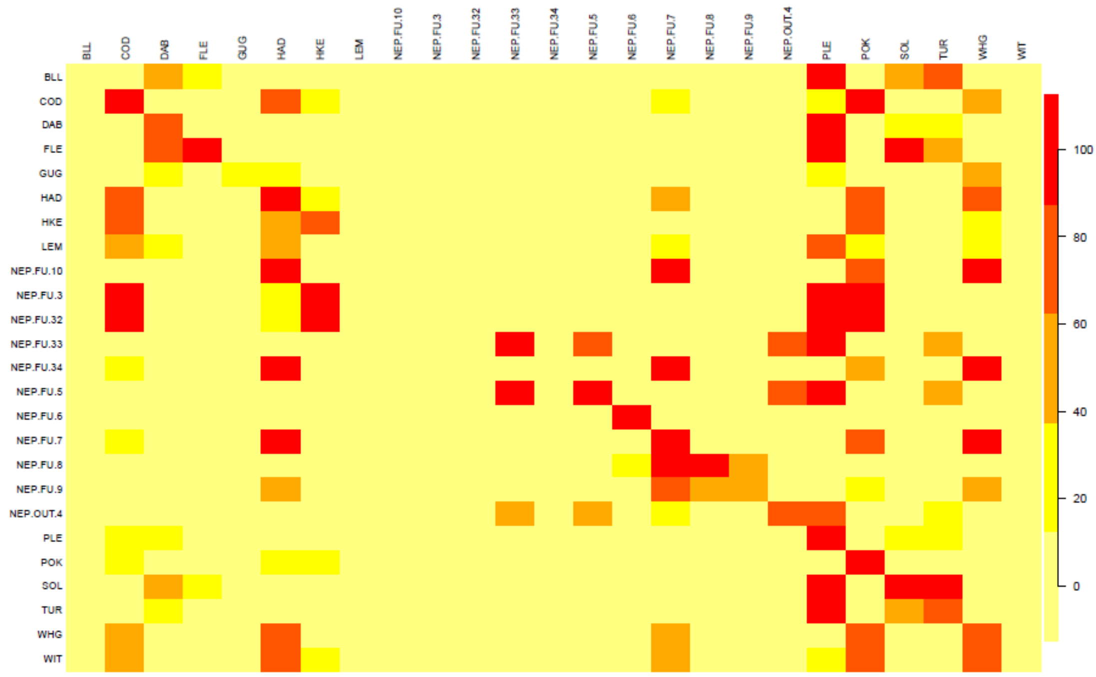


Figure A1.1. Technical interactions (Subarea 4 only) amongst Greater North Sea demersal stocks. Species A refer to species in the rows, and Species B in the species in the columns. Each row shows the fisheries where the species A was caught. The color of the cells indicates increasing interactions starting from low (yellow), medium (orange), to strong (red). Each column shows the degree of mixing in fisheries where species B accounts for at least 5% of the total landings. The diagonal indicates if there is targeting for a specific species.

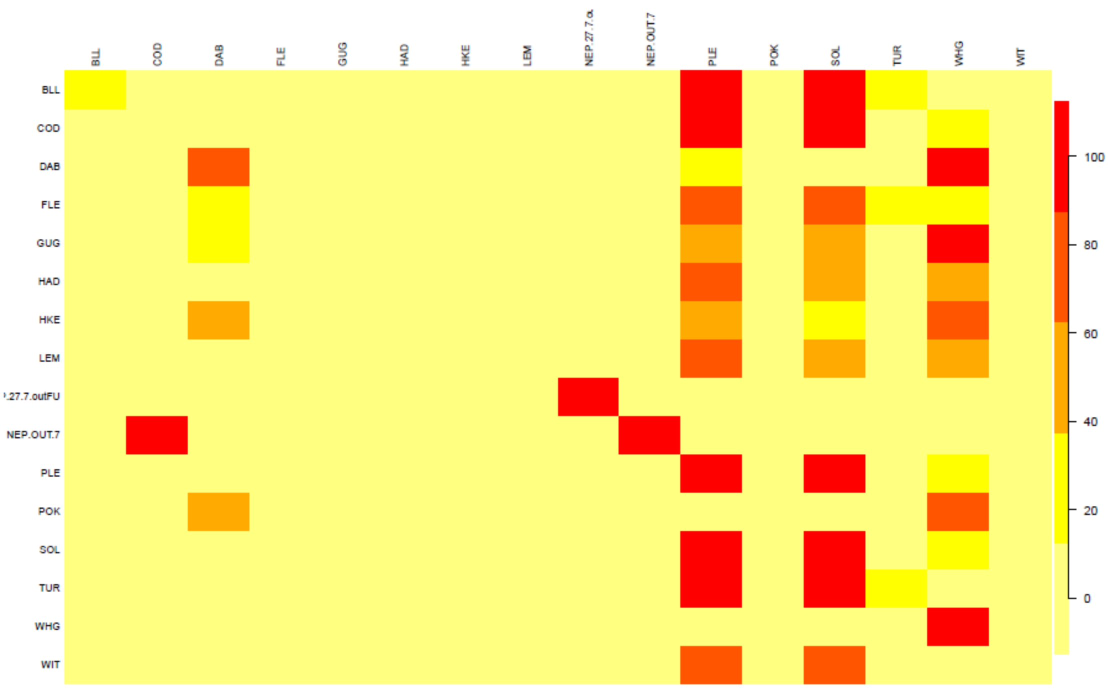


Figure A1.2. Technical interactions (Subdivision 7.d only) amongst Greater North Sea demersal stocks. Species A refer to species in the rows, and Species B in the species in the columns. Each row shows the fisheries where the species A was caught. The color of the cells indicates increasing interactions starting from low (yellow), medium (orange), to strong (red). Each column shows the degree of mixing in fisheries where species B accounts for at least 5% of the total landings. The diagonal indicates if there is targeting for a specific species.

2 Special request: TAC Management for witch flounder and lemon sole

2.1 Introduction

A Special Request was submitted to ICES by the European Commission to investigate the contribution of TACs to fisheries management and stock conservation. The request in full is as follows:

> *ICES is requested to analyse for witch (Glyptocephalus cynoglossus) and lemon sole (Microstomus kitt) the role of the Total Allowable Catch instrument. It is asked to assess the risks of removing the TAC for each case in light of the requirement to ensure that the stock concerned remains within safe biological limits in the short and middle term. ICES is further requested to assess the potential contribution of the application of other conservation tools in the absence of TACs to the requirement that the stock concerned remains within safe biological limits.*
>
> *In cases where the uses of TAC should be continued, ICES is asked to analyse a possible approach to contribute to inter-annual stability of TACs.*

It was agreed with ICES that the main request would be handled by answering a series of six questions originally developed when responding to a similar request for dab and flounder in 2017, and used for witch and lemon sole in 2018. The six questions were as follows:

1. Was the TAC restrictive in the past?
2. Is there a targeted fishery for the stock or are the species mainly discarded?
3. Is the stock of large economic importance or are the species of high value?
4. How are the most important fisheries for the stock managed?
5. What are the fishing effort and stock trends over time?
6. What maximum effort of the main fleets can be expected under management based on FMSY (ranges) for the target stocks, and has the stock experienced similar levels of fishing effort before?

This document gives qualitative answers for witch flounder and lemon sole and provides a conclusion to the request.

The available information is insufficient to do a quantitative evaluation of the risk of having no catch limits for witch and lemon sole. The advice is therefore based on a qualitative evaluation.

Management of witch flounder and lemon sole under a combined TAC prevents effective control of the single-species exploitation rates and could potentially lead to the overexploitation of either species. Furthermore, the stock area does not match the area for which the advice is issued. The TAC area includes areas 4 (North Sea) and 2.a (Norwegian Sea), whereas the ICES stock area for both witch flounder and lemon sole includes the areas 3.a (Kattegat and Skagerrak), 4 (North Sea) and 7.d (eastern English Channel).

1. Was the TAC restrictive in the past?

In order to answer this question, the percentage of the TAC that was utilised each year is calculated first using the landings inside the TAC area[2] and then using the total stock area.

The combined TAC for witch and lemon sole has not been restrictive in the past when only the TAC area is considered (Table 1.1). Taking into account the landings from the whole stock area, i.e. including areas 3.a and 7.d, the TAC has been overshot in 2006, 2007 and 2016 (Table 1.2). Furthermore, looking at the total catch, i.e. including the discards, and considering the whole stock area, the TAC was overshot in most of the years since 2006, but not so in the last three years (Table 1.3). Figure 1.1 shows the TAC utilisation percentage for all the years considering only landings in the TAC area, landings in stock area, and catches in the stock area.

Table 1.1: Overview of TAC and official landings of witch (WIT) and lemon sole (LEM) in area 4 (North Sea)).

Year	WIT	LEM	WIT + LEM	TAC	TAC utilisation (%)
2006	1260.210	3627	4887.210	6175	79
2007	1286.720	3892	5178.720	6175	84
2008	1170.120	3466	4636.120	6793	68
2009	1044.020	2693	3737.020	6793	55
2010	814.340	2625	3439.340	6521	53
2011	837.450	3365	4202.450	6391	66
2012	790.520	2119	2909.520	6391	46
2013	992.460	2981	3973.460	6391	62
2014	1086.180	3017	4103.180	6391	64
2015	945.060	2871	3816.060	6391	60
2016	1436.470	3266	4702.470	6391	74
2017	1676.420	2822	4498.420	6391	70
2018	2028.037	2635	4663.037	6391	73
2019	1868.874	2805	4673.874	7874	59
2020	1308.863	2219	3527.863	6785	52
2021	1276.008	1774	3050.008	5428	56

[2] Landings in area 2.a for both stocks and landings in area 7.d for witch are considered negligible and are not included.

Table 1.2: Overview of TAC and official landings of witch (WIT) and lemon sole (LEM) in the stock area that includes Skagerrak and Kattegat (3.a), North Sea (4) and eastern English Channel (7.d).

Year	WIT 3a	WIT 4	WIT Total	LEM 3a	LEM 4	LEM 7d	LEM Total	Combined	TAC	TAC utilisation (%)
2006	1043	1260	2303	417	3627	246	4290	6593	6175	107
2007	949	1287	2236	432	3892	164	4488	6724	6175	109
2008	782	1170	1952	276	3466	234	3976	5928	6793	87
2009	773	1044	1817	262	2693	442	3397	5214	6793	77
2010	674	814	1489	350	2625	223	3198	4687	6521	72
2011	693	837	1530	251	3365	403	4019	5549	6391	87
2012	1105	791	1895	482	2119	358	2959	4854	6391	76
2013	1000	992	1992	289	2981	491	3761	5753	6391	90
2014	1562	1086	2649	315	3017	356	3688	6337	6391	99
2015	1251	945	2196	269	2871	253	3393	5589	6391	87
2016	1248	1436	2684	299	3266	240	3805	6489	6391	102
2017	1189	1676	2865	343	2822	158	3323	6188	6391	97
2018	978	2028	3006	280	2635	99	2014	5020	6391	79
2019	697	1869	2566	329	2805	104	3238	5804	7874	74
2020	624	1309	1933	340	2219	95	2655	4588	6785	68
2021	548	1276	1824	256	1774	90	2121	3945	5428	73

Table 1.3: Overview of TAC and ICES estimated catches of witch flounder (WIT) and lemon sole (LEM) in the stock area that includes Skagerrak and Kattegat (3.a), North Sea (4) and eastern English Channel (7.d).

Year	WIT	LEM	Total	TAC	TAC utilisation (%)
2006	2631	5809	8440	6175	137
2007	2470	4919	7389	6175	120
2008	2317	5051	7368	6793	108
2009	2319	4401	6720	6793	99
2010	2090	3907	5997	6521	92
2011	2114	5055	7169	6391	112
2012	2509	6560	9069	6391	142
2013	2267	9663	11930	6391	187
2014	2992	5335	8327	6391	130
2015	2690	5116	7806	6391	122
2016	3135	5000	8135	6391	127
2017	3086	3966	7052	6391	110
2018	3209	3376	6585	6391	103
2019	2797	3878	6675	7874	85
2020	2135	3044	5179	6785	76
2021	2015	2589	4604	5428	85

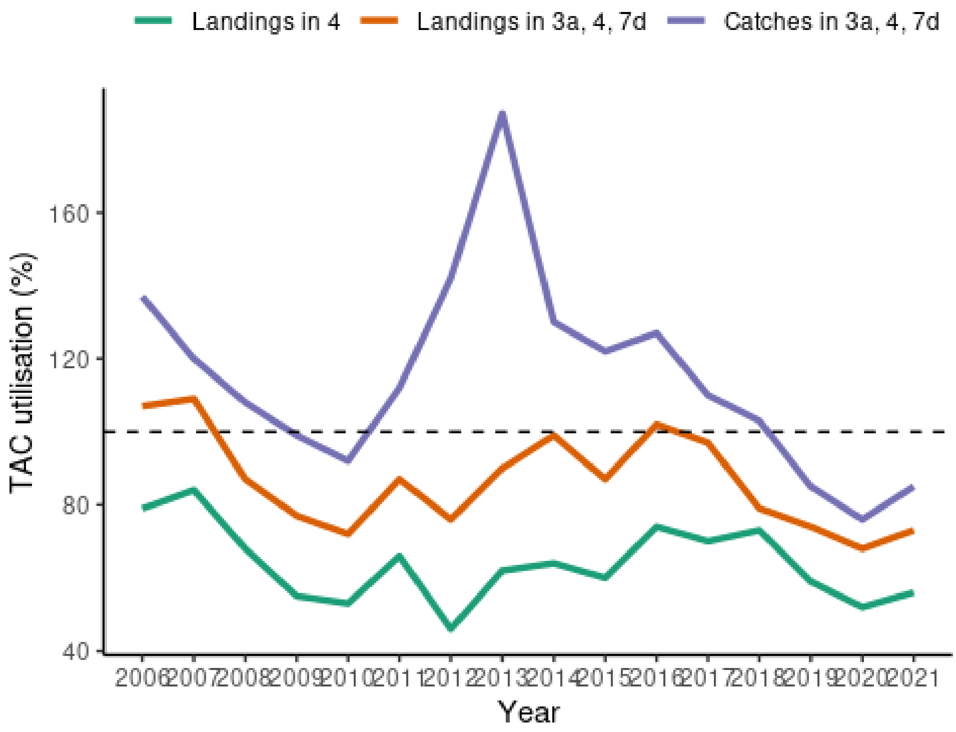


Figure 1.1: TAC utilisation for landings in 4 (green line), landings in 3.a, 4 and 7d (orange line), and catches in 3.a, 4 and 7.d (purple line). The horizontal dashed line shows the full uptake of the TAC.

2. Is there a targeted fishery for the stock or are the species mainly discarded?

There is no targeted fishery for lemon sole in any of the areas covered here, as shown in the targeting behavior analysis in Appendix 2.1.

A directed fishery for witch has been identified in Division 3.a (Feekings, 2011, Figure A1.2), which encompasses all the fleets catching more than 30% of this species. Furthermore, the targeting behaviour analysis shown in Appendix 2.1 shows moderate interactions for witch (diagonal element, Figure A1.1) that suggests some targeting in Subarea 4.

Discards for lemon sole and witch flounder have been fluctuating around 20% in most years, although lemon sole discards were lower in the early 2000s and from 2017 onwards. Lemon sole discards were above 30% between 2012 and 2016 reaching a peak of 61% in 2013 (Table 2.1, Figure 2.1), although WGNSSK noted that there were problems with data submissions in that year which may have artificially inflated the discard estimate.

Both witch and lemon sole are high value species (particularly lemon sole), so a high discard rate would be unlikely to arise through fishermen choosing to discard. The discard rate could be due to a combination of the often-restrictive total quota (see Section 1), or a lack of local markets or processing options. Witch flounder are predominantly caught in the beam-trawl fishery. Lemon sole are usually caught in mixed-species demersal trawls which would not directly target the species, but will land them opportunistically.

Witch

In Subarea 4, less than 2% of the landings (by volume) of witch are from strata where witch makes up 5% or more of the landings of all species (Figure 2.2). By value, the percentage of the landings is slightly higher and for most years less than 3% of the landings value comes from strata where witch makes up 5% or more of the total value of all landings (Figure 2.3). That suggests low or no targeting in Subarea 4. The above contradicts the indication of targeting from the targeting behaviour analysis in Appendix 2.1, where the diagonal element for witch shows medium interactions (orange cell, Figure A1.1). The principal fisheries that land witch in Subarea 4 are mainly targeting plaice, cod, haddock and saithe (red boxes in the witch row in Figure A1.1).

In subdivision 3.a.20 (Skagerrak), there are indications of targeting, as there are years (2013–2018) where around 10% of the landings of witch (by weight) are from strata that make up 25% or more of witch (Figure 2.2). By value, the effect is stronger around 20% of witch landings come from strata that make up 25% or more witch in most of the years (Figure 2.3).

Lemon sole

In Subarea 4, and on average during 2009–2017, 30% of lemon sole landings (by volume) came from fishery strata for which lemon sole made up a threshold of 5% or more of all species landings, while the average was less than 5% for all other thresholds considered (15%, 25%, 35%, 45%; Figure 2.4). Around 70% of lemon sole landings came from strata for which lemon sole made up less than 5% of all species landings. By value, around 55% of landings came from strata for which lemon sole made up 5% or more of all species landings, while around 15% came from strata for which lemon sole made up 15% or more of landings (Figure 2.5). That is: in terms of volume in Subarea 4, most lemon sole is landed by fleets for which lemon sole is not a large component of the catch. However, in terms of value, there are parts of the fleet which make a reasonable return on lemon sole landings. This is consistent with the observation that lemon sole is not landed in great numbers, but that there is a high unit value. This is supported by the analysis in Appendix 2.1.

The picture is similar in area 3.a (Figure 2.4 and 2.5). In area 7.d, the percentage of lemon sole landings (by volume and value) coming from strata for which lemon sole make up 5% or more of all landings is less than in areas 4 and 3.a, while the higher thresholds are roughly similar – this suggests that in 7.d, the bulk of lemon sole landings come from strata for which lemon sole make up less than 5% of total landings.

In conclusion, lemon sole are a very small part of the landings (by volume) of fleets operating in areas 4 and 3.a, and form an even smaller part of the landings for fleets in area 7.d. The species is of more importance when considered in terms of value, but the income generated is still rather small on average. The Figure in Appendix 2.1 (for area 4) shows that lemon sole landings are most frequently associated with plaice landings. The low association between lemon sole in both the rows and columns of this Figure indicates that it is seldom directly targeted, although this conclusion is from data taken over all fleets and over a full year – targeting may occur on discrete trips. We also note that less than 10% of lemon sole landings come from the beam trawl fleet (WGNSSK report, ICES 2022), which land most of the plaice in area 4, so it would be appropriate to suggest that lemon sole is generally a bycatch species.

Table 2.1: ICES estimates of landings and discards for witch (WIT) and lemon sole (LEM) in areas 3a, 4 and 7d.

Year	WIT landings	WIT discards	WIT discard rate	LEM landings	LEM discards	LEM discard rate
2002	3813	1529	28.6	4011	511	11.3
2003	3308	349	9.5	4575	1036	18.5
2004	3059	369	10.8	4394	635	12.6
2005	2960	419	12.4	4429	527	10.6
2006	2335	296	11.3	4294	1515	26.1
2007	2271	199	8.1	4468	451	9.2
2008	1999	318	13.7	4153	898	17.8
2009	1863	455	19.6	3405	996	22.6
2010	1531	559	26.7	3234	673	17.2
2011	1567	547	25.9	4030	1024	20.3
2012	1952	557	22.2	4099	2461	37.5
2013	2013	254	11.2	3725	5938	61.5
2014	2685	307	10.3	3645	1690	31.7
2015	2240	449	16.7	3480	1636	32.0
2016	2744	390	12.4	3834	1167	23.3
2017	2850	236	7.6	3315	651	16.4
2018	3010	199	6.2	3046	331	9.8
2019	2580	217	7.8	3273	605	15.6
2020	1937	198	9.3	2653	391	12.8
2021	1827	279	13.2	2092	407	16.3

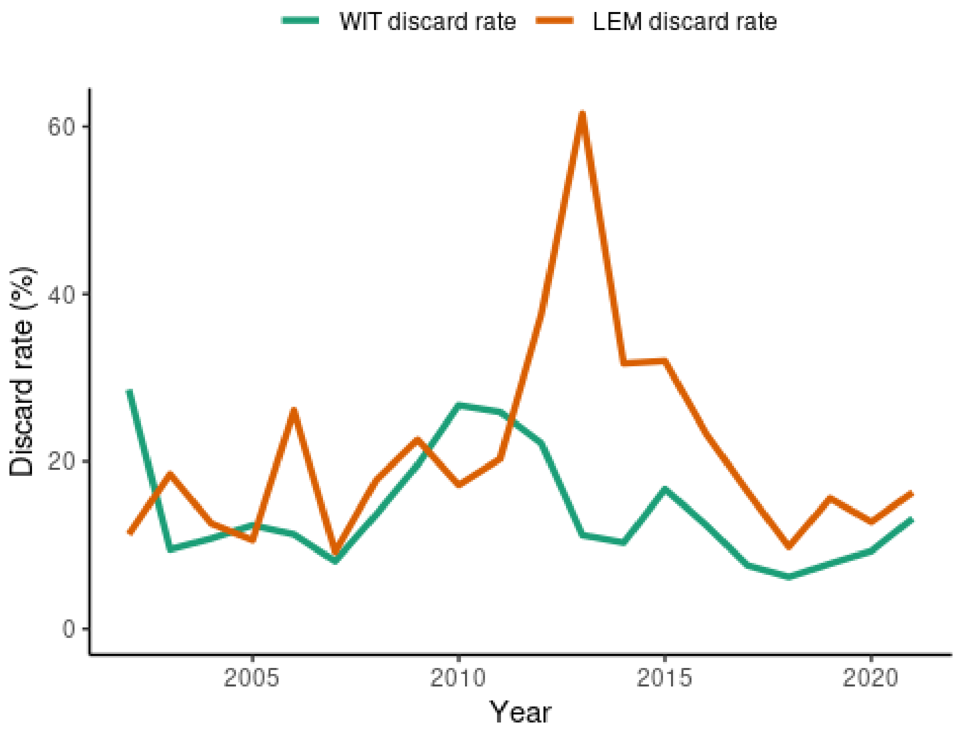


Figure 2.1: Discard rate of witch and lemon sole based on ICES estimates of landings and discards.

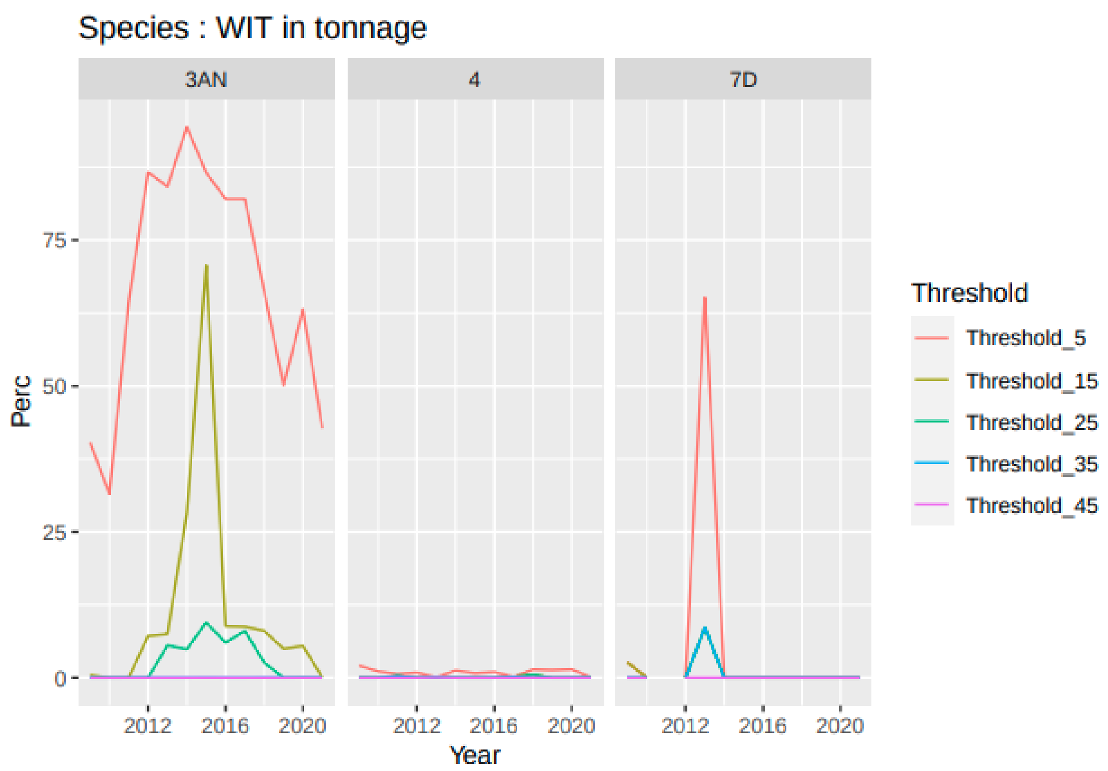
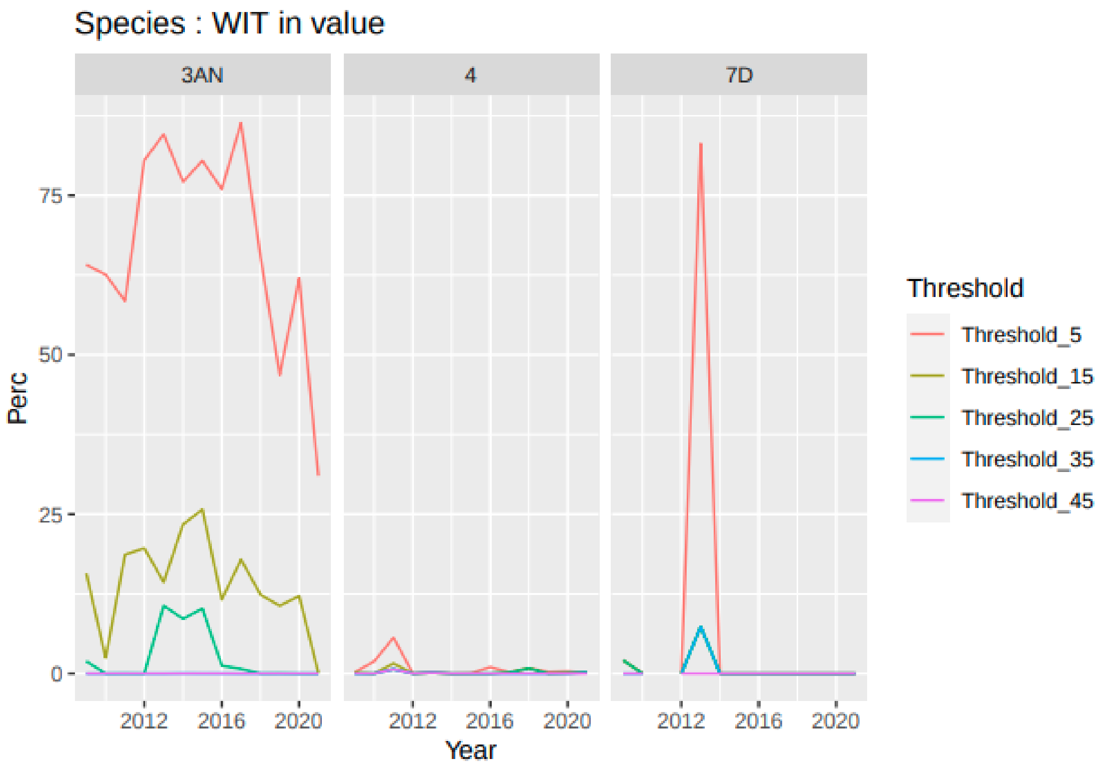


Figure 2.2: Percentage of total witch landings (by weight) for those strata for which witch makes up at least a threshold (ranging from 5 to 45%) of the landings of all species (by weight), for the period 2009–2021.



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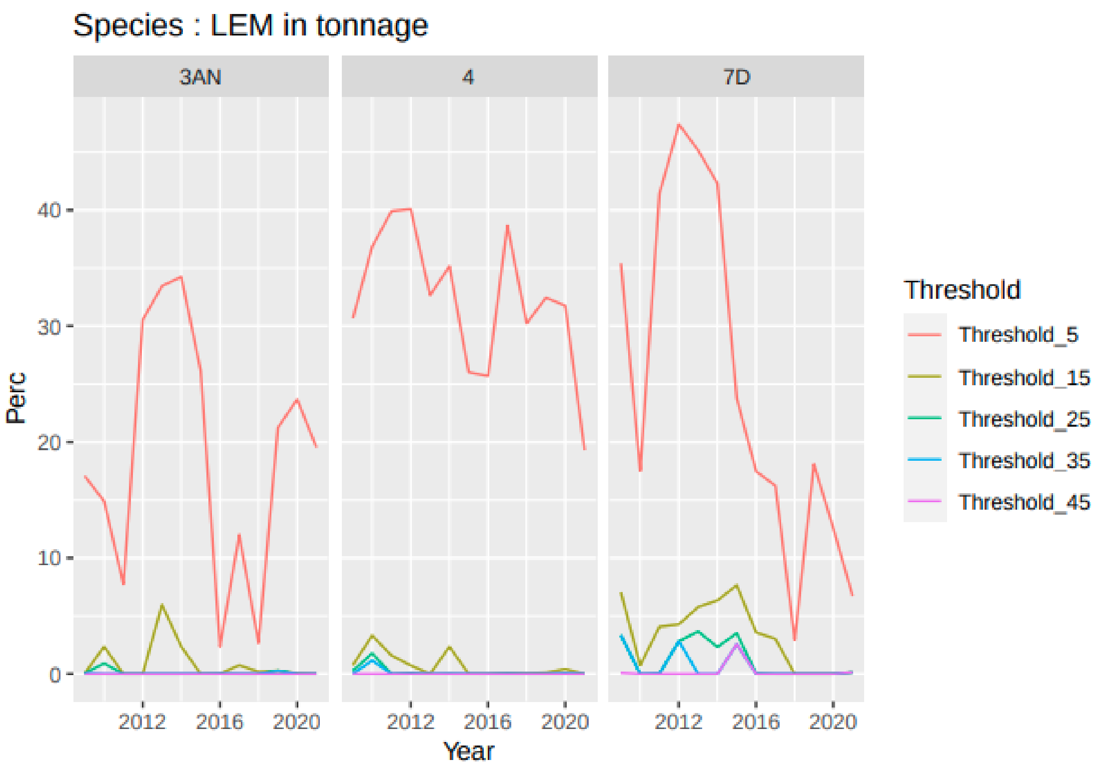

Figure 2.4: Percentage of total lemon sole landings (by weight) for those strata for which lemon sole makes up at least a threshold (ranging from 5 to 45%) of the landings of all species (by weight), for the period 2009–2021.

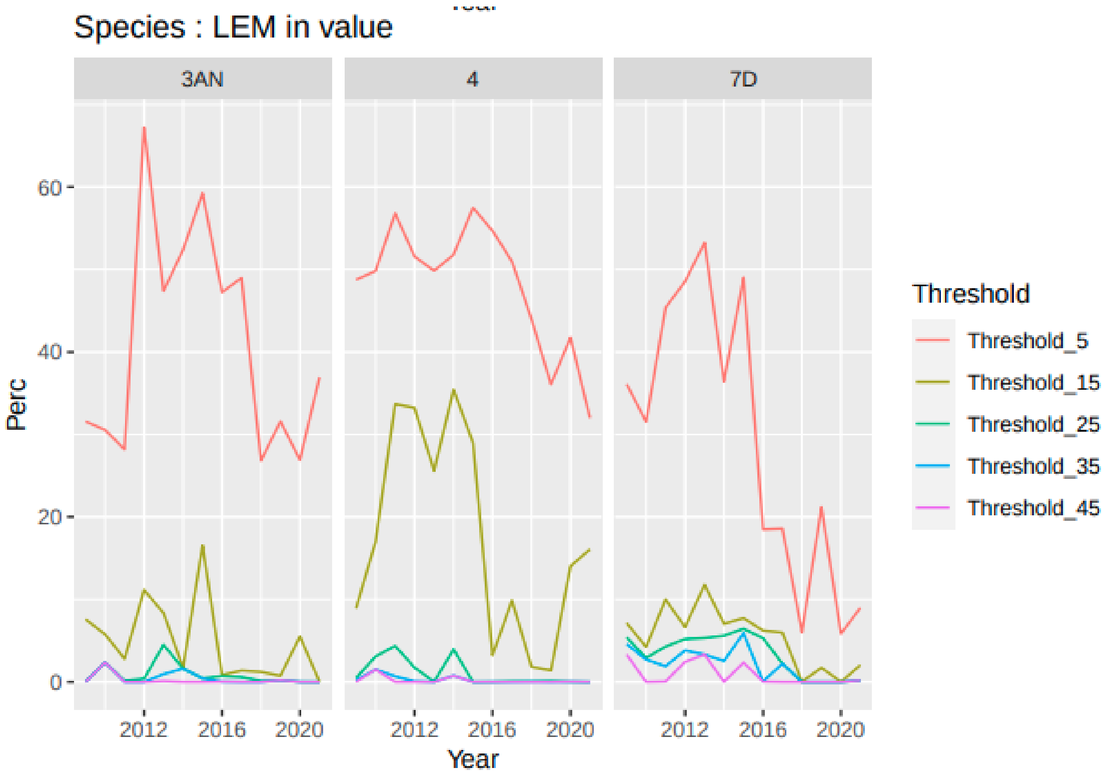

Figure 2.5: Percentage of total lemon sole landings (by value) for those strata for which lemon sole makes up at least a threshold (ranging from 5 to 45%) of the landings of all species (by value), for the period 2009–2021.

3. Is the stock of large economic importance or are the species of high value?

Figures 3.1 and 3.2 show, respectively, the landed value and weight per year for four key flatfish species (witch, lemon sole, sole and plaice) and the three main demersal species (cod, haddock and whiting) for the three areas under consideration (3.a, 4 and 7.d). The data are also summarized in Table 3.1, and for all areas in Figure 3.3. In terms of landed value, sole is the most valuable stock in areas 4 and 7.d, while plaice and cod are the most valuable in area 3.a. In area 4, the landed value of lemon sole is around 1/10th that of sole, while the landed value of witch is around 1/100th that of sole. In area 3.a, the landed value of witch is greater than that of lemon sole, but both are lower than sole, plaice and cod. In area 7.d, sole is by far the most economically valuable stock, with the other species all some way behind.

The landed yields of lemon sole and witch are both very low in comparison with plaice, sole, cod, haddock, and whiting. The unit price is relatively consistent across the three areas: sole is the most valuable fish, followed by lemon sole at roughly half the value, cod at around a third, witch flounder at around a fifth, and then plaice, haddock and whiting at roughly 1/10th or less (Table 3.1).

In conclusion, the landed values and yields of lemon sole and witch are generally much less than those of the comparative stocks. Lemon sole commands a high price per unit, but overall the landed quantities are too low for the stock to be of real economic importance across the sea basin. The fishery for witch in area 3.a does provide landed value almost equivalent to sole and haddock in that area, but this is still much less than plaice and cod. For both lemon sole and witch, economic importance is likely to be limited to smaller discrete areas (such as 3.a).

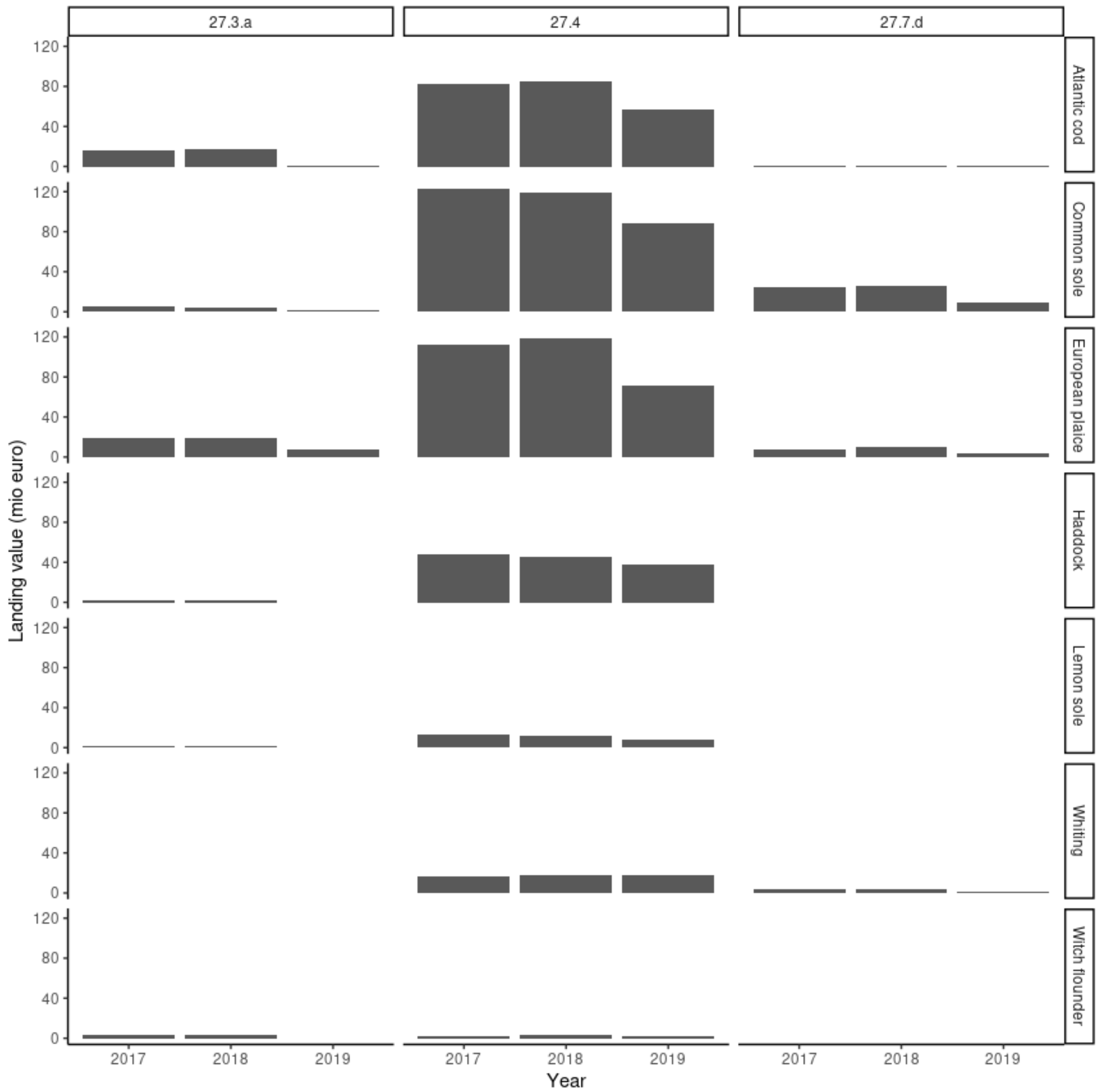

Figure 3.1. Landing value (in million €) for the most important demersal target species in areas 3a, 4, and 7d, during 2017–2019.

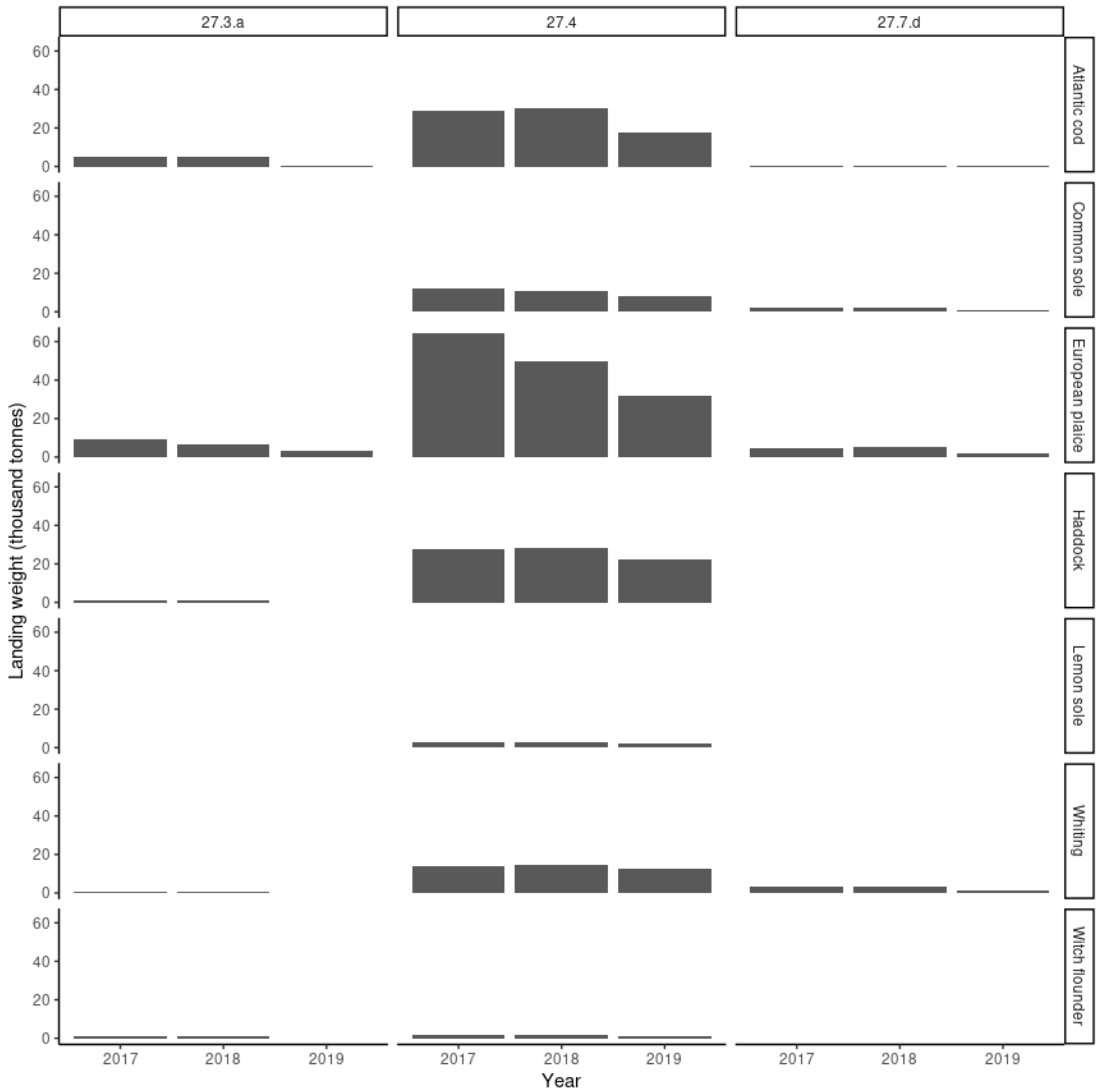

Figure 3.2: Landing weight (in thousand tonnes) for the most important demersal target species in areas 3a, 4, and 7d during 2017–2019.

Table 3.1: Total value (million €) and average price in euro / kg of cod, sole, plaice, haddock, lemon sole, whiting, and witch flounder in areas 3a, 4 and 7d.

Species	Area	Total value	Price
Atlantic cod	27.3.a	33.3	3.28
Common sole	27.3.a	10.1	11.10
European plaice	27.3.a	45.6	2.42
Haddock	27.3.a	3.8	2.01
Lemon sole	27.3.a	3.5	4.75
Whiting	27.3.a	0.7	1.11
Witch flounder	27.3.a	6.4	2.97
Atlantic cod	27.4	224.1	2.93
Common sole	27.4	331.1	10.90
European plaice	27.4	301.6	2.13
Haddock	27.4	131.5	1.68
Lemon sole	27.4	32.2	4.22
Whiting	27.4	52.6	1.28
Witch flounder	27.4	7.3	1.69
Atlantic cod	27.7.d	1.1	3.42
Common sole	27.7.d	59.9	11.11
European plaice	27.7.d	22.1	1.93
Haddock	27.7.d	0.0	1.88
Lemon sole	27.7.d	1.8	5.16
Whiting	27.7.d	9.0	1.06
Witch flounder	27.7.d	0.0	2.57
Atlantic cod	All areas	258.5	3.21
Common sole	All areas	401.1	11.04
European plaice	All areas	369.3	2.16
Haddock	All areas	135.3	1.86
Lemon sole	All areas	37.5	4.71
Whiting	All areas	62.3	1.15
Witch flounder	All areas	13.7	2.41

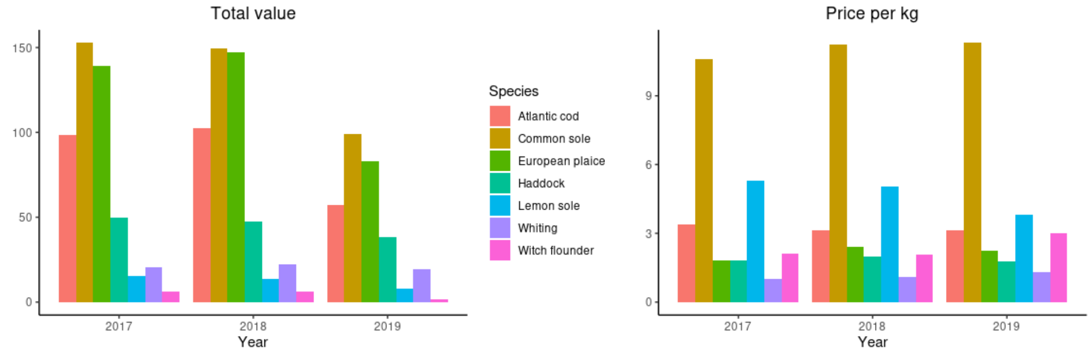

Figure 3.3: Comparison of total value (million €) and average price (euro per kg) for cod, sole, plaice, haddock, lemon sole, whiting, and witch flounder, during 2017–2019.

4. How are the most important fisheries for the stock managed?

Witch and lemon sole are managed under a combined TAC, which ICES advises increases the risk of overexploitation of either species. The TAC area does not coincide with the stock area, which also increases the risk of overexploitation of the stocks in the areas outside the TAC area. Witch is (since 2018) an ICES Category 1 stock assessed using an age-based analytical assessment (SAM). Lemon sole is an ICES Category 3 stock and is assessed with an age-based survey assessment (SURBAR). These assessments for the two stocks were evaluated and accepted by an ICES benchmark workshop in 2018 (WKNSEA report, ICES 2018).

Lemon sole are mostly caught by the mixed-species international demersal trawl fishery, with smaller amounts being landed by the corresponding beam trawl fishery. These are currently managed under the EU CFP and related EU-Norway agreements. Management instruments include quota, effort and gear regulations.

5. What are the fishing effort and stock trends over time?

Effort trends

As there is not a specific lemon sole fishery, lemon sole directed effort cannot be readily identified. Nevertheless, we describe the effort trends for the dominant gears targeting lemon sole and witch.

Since the early 2000s, there has been a large reduction in the effort of the dominant gears in the stock areas for witch and lemon sole (Figure 5.1, STECF 2017). Since 2003, a large reduction in effort (-51%) of the dominant BT2 gear was observed in Subarea 4 (BT2 includes beam trawls with mesh sizes between 80 mm and 120 mm; Figure 5.1). This reduction corresponds to a substantial reduction in fishing mortality for the main target species of plaice and sole. There have also been reductions in the TR2 and TR1 effort in Subarea 4 (albeit smaller for the latter, with a steady increase since 2013). In parallel, since 2003, there has been a large reduction in effort of the dominant gear in ICES division 3a (TR2, -52%) and in ICES division 7d (TR2, -49%) (Figure 5.1).

More recent data (2014–2020) from STECF do not have these fleet categories and the effort trends are presented here by grouping by gear type (beam trawls, other bottom trawls and seines, nets and all the others) (Figure 5.2). In Subarea 4, beam trawl and nets effort has decline slightly over this period, while bottom trawls and seines and the "other" category" have increased a little. In area 7.d, bottoms trawls, seines and "other" have fluctuated without overall trend, while beam trawls and nets have declined. In area 3.a, bottom trawls, seines and beam trawls have increased slightly, while nets and "other" gears are stable. In no case during 2014–2020 has there been very significant changes in recorded effort.

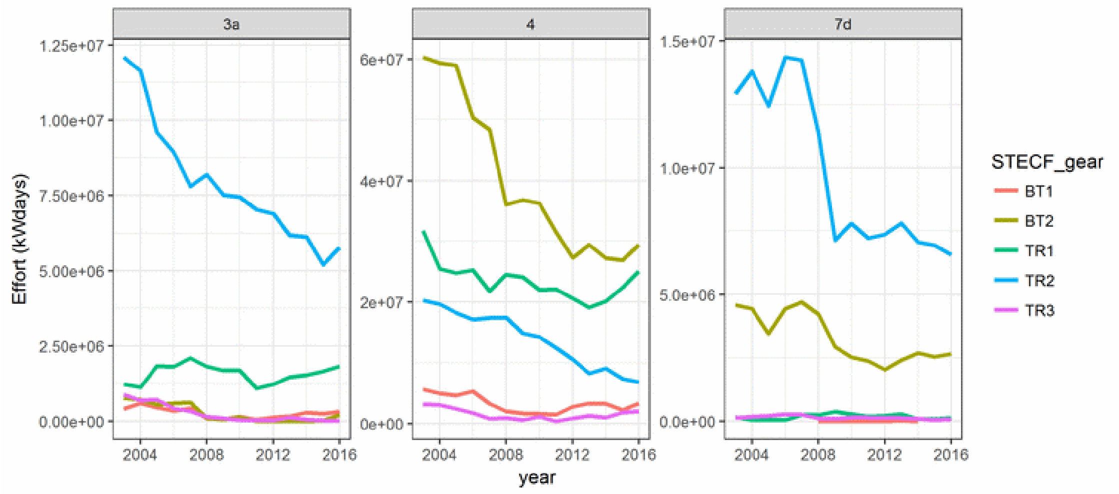

Figure 5.1: Trends in fishing effort for different STECF fishing gear groups in ICES division 3a, ICES subarea 4 and ICES division 7d for the period 2003–2016 (STECF 2017). Regulated gears: BT1 are beam trawls with mesh sizes ≥ 120 mm. BT2 are beam trawls with mesh sizes ≥ 80 mm and < 120 mm. TR1 are bottom trawl and seines with mesh sizes ≥ 100 mm. TR2 are bottom trawl and seines with mesh sizes ≥ 70 mm and < 100 mm. TR3 are bottom trawl and seines with mesh sizes ≥ 16 mm and < 32 mm.

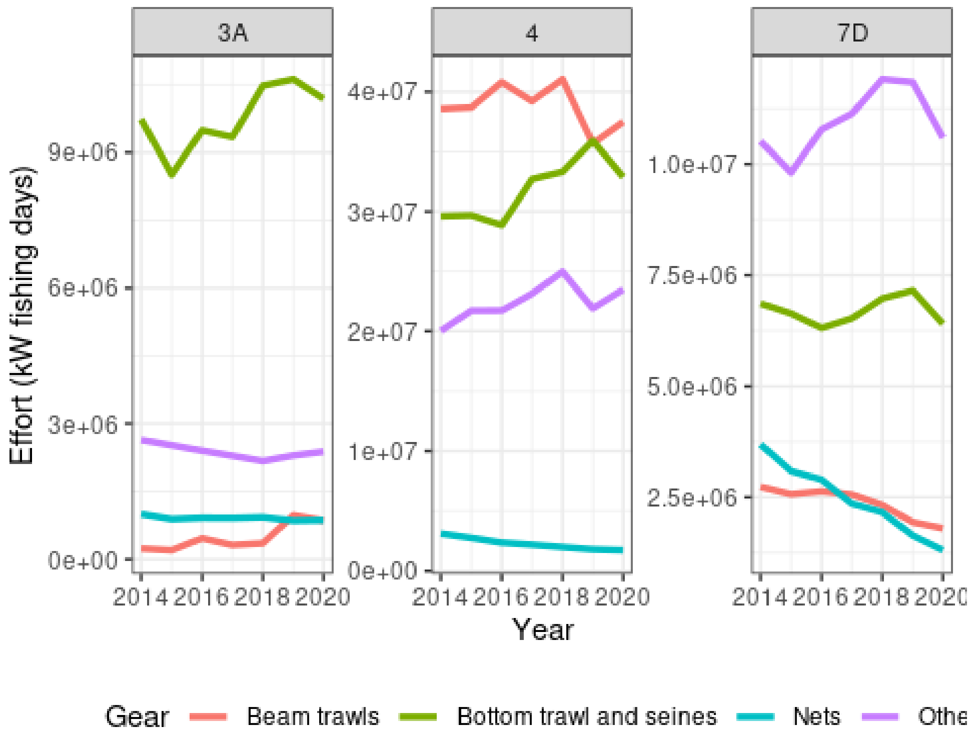

Figure 5.2. Effort in kW Days of fishing, per gear group and area for the period 2014–2020.

Stock trends

Witch

The assessment of witch was benchmarked in 2018 (WKNSEA report, ICES 2018) where a new assessment using SAM (State-space Assessment Model, Nielsen and Berg 2014) was accepted. An inter-benchmark process was necessary for the stock in 2021, where a new age-disaggregated index was tested and accepted to be used in the assessment. Only total catch and exploitable biomass index (non-age disaggregated) are available from the beginning of the time series until 2008. Age specific information is only available since 2009. The most recent assessment results show that the stock the SSB has been consistently below MSY $B_{trigger}$ reference point and fishing mortality above F_{MSY} (Figure 5.3). Recruitment seems to be increasing recently, but also the uncertainty around recruitment estimates is high in the same period.

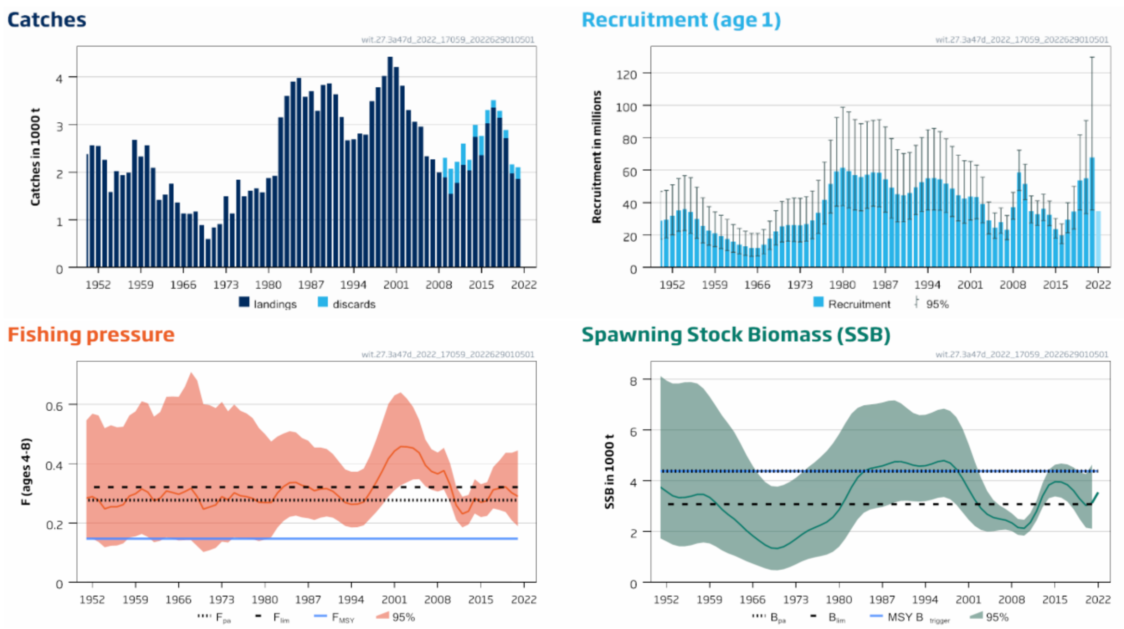

Figure 5.3: Latest assessment of witch in Subarea 4 and divisions 3.a and 7.d. Discard information is included in the assessment since 2009. The assumed recruitment value for 2022 is shaded in a lighter colour.

Lemon sole

The lemon sole assessment was benchmarked in 2018 (WKNSEA report, ICES 2018), and advice is provided on the basis of a survey-based assessment model SURBAR (Needle 2015). The most recent relative stock trends (WGNSSK report, ICES 2022) are given in the SURBAR assessment summary in Figure 5.4. Total mortality (mean Z) is uncertain, and firm conclusions about trends in mortality cannot be inferred from this analysis. SSB and total biomass have both increased steadily (albeit slowly) from 2009 to 2016, but have been declining since. The recruitment estimates in 2015 and 2017 were close to the lowest observed in the relatively short time series. Recruitment seems to be increasing in more recent years, but it the estimates are also becoming more uncertain in the same period.

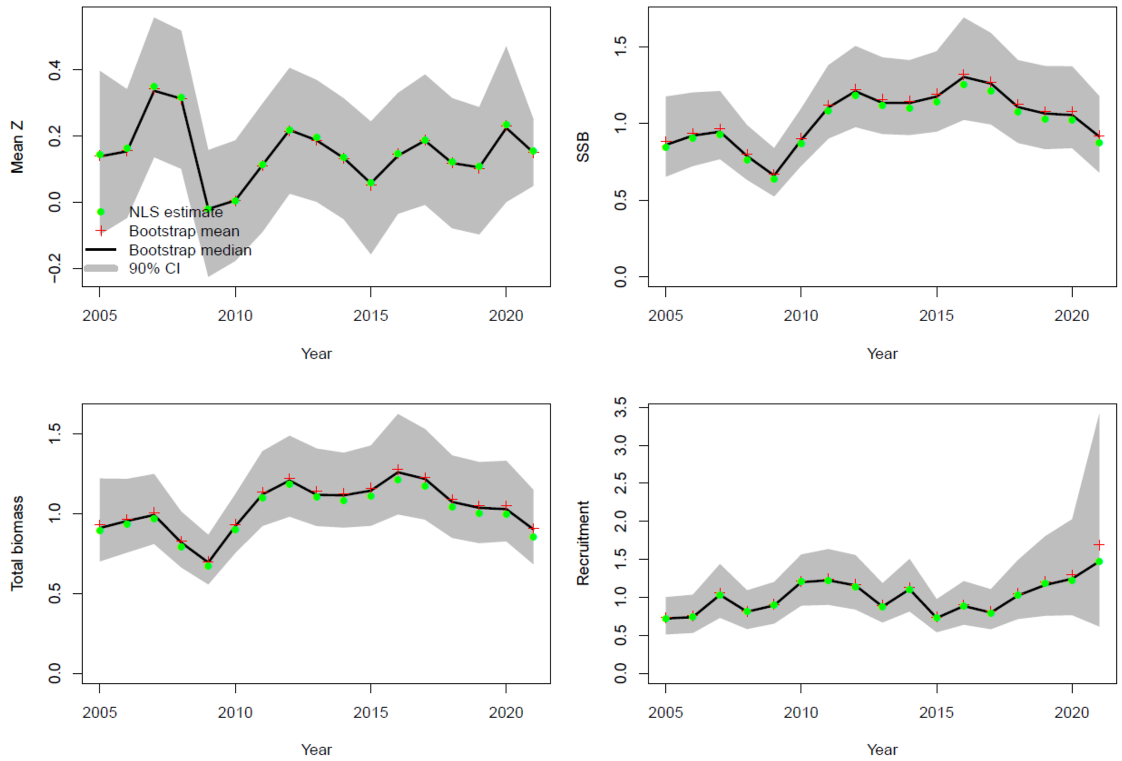

Figure 5.4. SURBAR assessment of North Sea lemon sole (ICES WGNSSK, 2022).

6. What maximum effort of the main fleets can be expected under management based on FMSY (ranges) for the target stocks, and has the stock experienced similar levels of fishing effort before?

Although TACs can be considered to have been restrictive (Section 1), there is no evidence of significant targeting behaviour in any of the fleets that land witch or lemon sole inside the TAC area, and both stocks can be considered to be bycatch species in the main prosecuting fisheries. The fishing mortalities exerted by these fisheries are therefore almost entirely driven by targeting activity towards other species: for the beam-trawl fleet (important for witch), these will be sole and plaice, while for the demersal fleet (important for lemon sole) these will be mixed whitefish species such as cod, haddock and whiting. In both cases, FMSY for the target stocks has been determined on a single-stock basis, so it is difficult to be certain a) what the resultant multi-fleet effort would be to achieve FMSY across all target stocks, and b) what that would imply for fishing mortality for witch and lemon sole.

The main landing fleet in area 4 for witch is the mixed demersal fleet (WGNSSK report, ICES 2022) and it is mostly caught by fleets targeting plaice, cod, haddock and saithe (Figure A1.1, Appendix 2.1). Effort of the plaice fishery fleet has declined in recent years resulting in lower fishing mortality rates. Currently plaice is exploited at around FMSY. Current effort levels do not seem to have a negative effect on witch biomass, as in recent years the biomass of the stock has increased.

For lemon sole, the main landing fleet is the mixed whitefish demersal fleet. The stock assessment for lemon sole extends back to 2005. During the period 2005–2021, estimated fishing mortality rates for the key demersal species (cod, haddock and whiting) have been much lower than historically, and are generally now at or below FMSY. We can say therefore that the lemon sole stock has coexisted with a demersal fisheries regime that has seen fishing mortality rates a little above

F_{MSY}. This indicates that were fisheries managers to be successful in achieving F_{MSY} across the key demersal stocks, then the implied mortality on lemon sole would be lower than that experienced recently. It is therefore unlikely that achievement of multi-stock F_{MSY} fishing would adversely affect the lemon sole stock.

2.2 Conclusions for witch and lemon sole

Our first conclusion is that continuance of a joint witch – lemon sole TAC is unlikely to contribute to the long-term sustainability of either stock. In Section 1 we showed that the combined TAC has been restrictive for most of the available time-series, but it is impossible to determine which (if either) of the two stocks is contributing most to this issue. If TACs are to remain, then they should be implemented for witch and lemon sole separately. We also recommend that if single-species TACs for witch and lemon sole are to be implemented, this should be done using (if possible) the same area as currently used for the stock assessments (areas 3.a, 4 and 7.d).

The main reasons supporting the implementation of single-stock, area-specific TACs for both stocks are as follows:

1. The combined TAC has generally been restrictive in the past. While Table 1.1 would suggest that it is lemon sole that is contributing most to this issue, it seems likely that the removal of a TAC for either could lead to an increase in exploitation and therefore mortality.
2. Lemon sole is a high-value species, intermediate in unit price between common sole and plaice. This could also lead to an increase in targeting and overexploitation were the TAC to be removed.
3. In Division 3.a, which is at the moment outside the TAC area, there are indications that witch is to some extent targeted. Removing the TAC could lead to further targeting of witch in area 4 and to the overexploitation of the stock.

We note there is currently no evidence of targeting for lemon sole, either now or in the past. Mortality on lemon sole therefore seems to be driven more by effort towards other species in the key demersal fisheries (bottom trawl with some beam trawl). In this regard, the removal of the lemon sole TAC may not necessarily lead to overexploitation. However, the considerations listed above still apply, and would argue for a continued lemon sole TAC.

2.3 References

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Appendix 2.1

Method for analysing targeting behaviour

Targeting can be seen as a proportion of a given species in the landings. If a species is targeted, it should contribute to a high proportion of the landings. However, a "high" proportion of a species in the landings is hard to define. This proportion can be impacted by lots of different factors, the main ones being the gear, its selectivity and the diversity of species in the fishing grounds in term of number of species and abundance. This proportion can be expressed in either volume or value.

Method

Fix a threshold of a given species in the landings by stratum to define the targeting behaviour. The percentage of landings with a proportion of that given species over the total landings of that species (in volume and in value) higher than the threshold is then computed. The threshold is varied from 5 to 45% representing the "targeting" behaviour. Figure A1.1 only provides an analysis for the 5% threshold averaged over the years 2019–2021; this method applied in the main document explores each cell in the diagonal of Figure A1.1 for temporal trends and several thresholds.

Limitations

The proportion is computed over strata that are here defined by métier/quarter/area as submitted for the WGMIXFISH data call. This level of aggregation does not allow for fine exploration of the fishing behaviour. Some targeting might exist/happen at the trip scale and may not be reflected in the stratum used, which averages the trips over the same quarter/area. Other factors will impact the landings profiles (TACs, fish abundances, market).

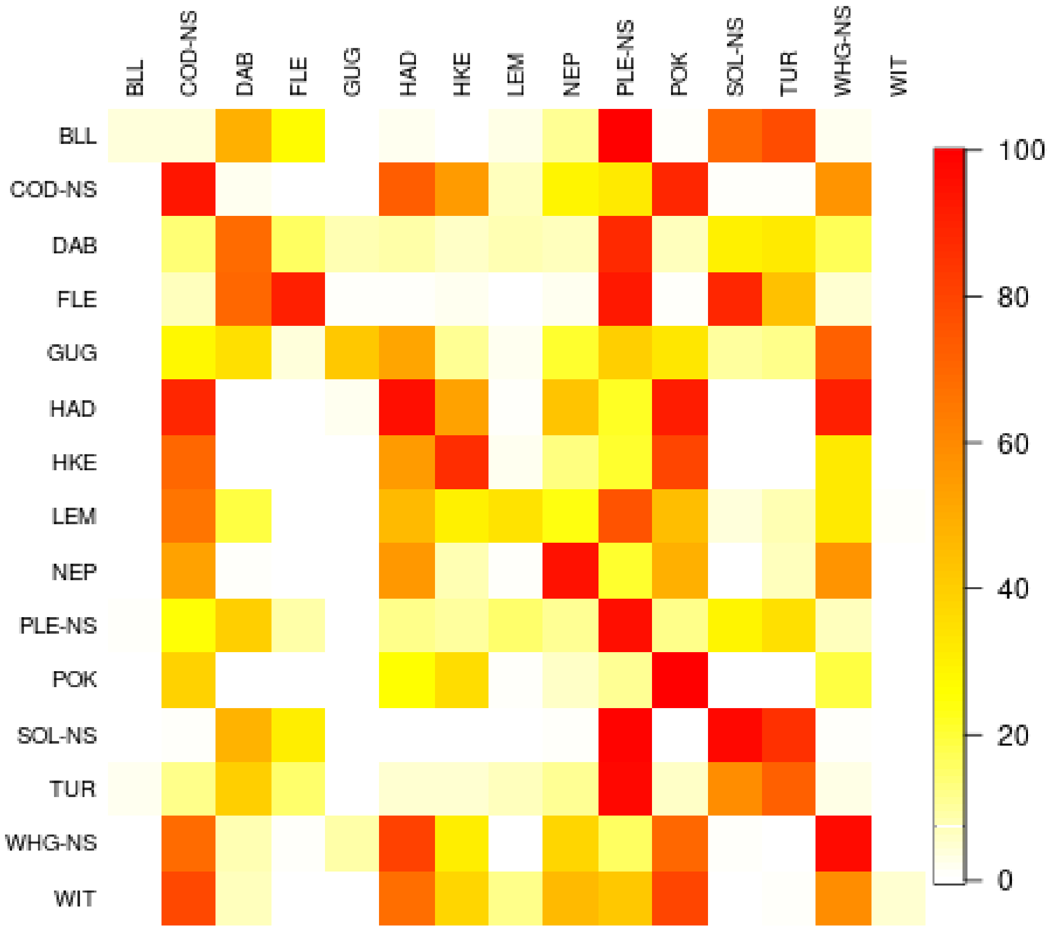

Figure A1.1: Technical interactions (Subarea 4 only) amongst Greater North Sea demersal stocks. Species A refer to species in the rows, and Species B in the species in the columns. Each row shows the fisheries where the species A was caught. The color of the cells indicate increasing interactions starting from low (yellow), medium (orange), to strong (red). Each column shows the degree of mixing in fisheries where species B accounts for at least 5% of the total landings. The diagonal indicates if there is targeting for a specific species.

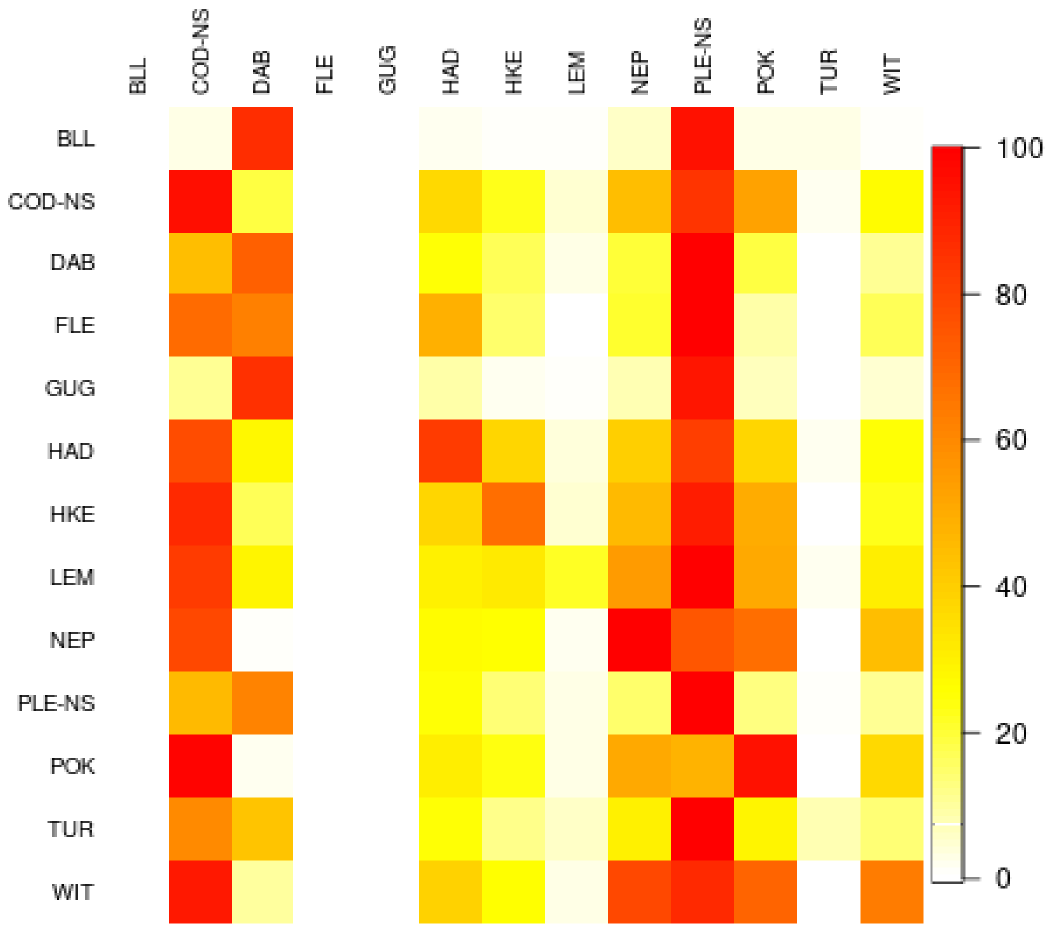

Figure A1.2: Same as in Figure A1.1 for subdivision 3a.20.

Annex 1: Reviewer's comments

TACMAN 2022 review

This review covers the two documents: TAC Management for brill and turbot, and TAC Management for witch flounder and lemon sole.

I find the analyses and results in the two documents to be clearly presented, and to constitute a sufficient basis for ICES to provide advice regarding the TACs for brill and turbot and for witch and lemon sole in response to the special request.

ICES agreed with the clients to answer the request by updating the answers to a series of six questions addressed in 2018 in a similar request. The six questions were as follows:

1. Was the TAC restrictive in the past?
2. Is there a targeted fishery for the stock or are the species mainly discarded?
3. Is the stock of large economic importance or are the species of high value?
4. How are the most important fisheries for the stock managed?
5. What are the fishing effort and stock trends over time?
6. What maximum effort of the main fleets can be expected under management based on F_{MSY} (ranges) for the target stocks, and has the stock experienced similar levels of fishing effort before?

The method used by the Expert Groups when answering the questions was the same as applied in 2018 when ICES was addressing a similar request.

Comments to the answers prepared by the two Expert Groups to each of the questions are provided below.

Review of the document TAC Management for brill and turbot:

1. Was the TAC restrictive in the past?

The Expert Group answered the question by comparing the combined landings of the two species in areas 2a and 4 in the period 2000 to 2021 with the TACs and concluded that the overshot in three out of the 22 years used in the comparison.

The use of landings in the comparison is appropriate as it is only the landings that are counted against the TAC. However, as discard data is available for both stocks it would be useful also to compare the catches with the TAC.

Noting that this goes beyond the questions asked to the Expert Group, I believe that a comparison of the catches and the advice for each stock would contain useful information on the risk to the stocks of the current TAC management. Such an analysis would show that the catches of brill in the stock area have been below the catch corresponding to the advice in the period, while the catches of turbot in some years have been above the advice.

2. Is there a targeted fishery for the stock or are the species mainly discarded

The figure texts for figures 2.1 – 2.4 seem not to be correct. The thresholds are lower thresholds and the texts "makes up x%" should read "makes up at least x%"

Brill

I see no justification for the statement in the last sentence in the paragraph on brill: "It would therefore be reasonable to assume that if the TAC were to be removed for brill, that targeting behaviour would emerge in subarea 4."

Turbot

There seems no justification for the statement in the fifth line: "The decrease is likely linked to the stabilisation of the SSB of turbot (Figure 5.5)". The decrease referred to is more likely linked to the decline in the gill net fishery targeting turbot in the northern North Sea.

3. Is the stock of large economic importance or are the species of high value?

No comments.

4. How are the most important fisheries for the stock managed?

Good and very comprehensive description of the management of the fisheries on turbot and brill

5. What are the fishing effort and stock trends over time?

Good description of trends in fishing effort and stocks.

6. What maximum effort of the main fleets can be expected under management based on F_{MSY} (ranges) for the target stocks, and has the stock experienced similar levels of fishing effort before?

The analysis done by the Expert Group seems appropriate.

Conclusions for brill and turbot

A few comments to the text under the factors in the conclusion section.

a) I do not think it is relevant to compare the TAC set for subarea 4 and division 2a with catches including brill catches from divisions 3a, 7.d and 7.e. The PO measures were followed by an increase in discards. The increase in discards would most likely have happened anyway. The reference to the PO measures is therefore not that relevant.
b) I have difficulties in seeing the justification for the statement in the second sentence ("It would therefore be reasonable to assume that if the TAC were to be removed, targeting behaviour would increase particular given the value of these species."). Why would targeting behaviour increase when removing the TAC when the TAC is not restrictive?

Review of the document TAC Management for witch flounder and lemon sole:

1. Was the TAC restrictive in the past?

The Expert Group answered the question by comparing landings and catches of the two species by TAC area and stock distribution area with the TAC.

In addition, although not part of the question, it would have been useful to have a comparison of the catches by stockwith the corresponding catch advice. A comparison of the catches and the catch advice for each stock would contain useful information on the risk to the stocks of the current TAC management.

2. Is there a targeted fishery for the stock or are the species mainly discarded

The conclusions seem well justified.

3. Is the stock of large economic importance or are the species of high value?

No comments.

4. How are the most important fisheries for the stock managed?

Limited and not very informative description of the management of the fisheries on witch and lemon sole.

5. What are the fishing effort and stock trends over time?

Good description of trends in fishing effort and stocks.

6. What maximum effort of the main fleets can be expected under management based on FMSY (ranges) for the target stocks, and has the stock experienced similar levels of fishing effort before?

The analyses on fishing effort and the conclusions are appropriate. No comments.

Conclusions for witch and lemon sole

While I do not disagree with Expert Groups conclusion, I have difficulties with the reasoning presented. The Group concluded in the response to question 2 that both species, in the TAC area, are caught as bycatch in fisheries targeting other species and there is no targeting of either species. It is therefore difficult to understand why the removal of a TAC could lead to an increase in exploitation and therefore mortality. There is no indication that the TAC is limiting the fishing effort in the fisheries exploiting witch and lemon sole, and it seems unlikely that removing the TAC would result in an increase in the fishing effort. Removing the TAC could result in less discards and more of the catches of the two species being landed. That may result in a minor increase in mortality if discard survival is high.

I do not understand the reasoning in point 3: "In Division 3.a, which is at the moment outside the TAC area, there are indications that witch is to some extent targeted. Removing the TAC could lead to further targeting of witch in area 4 and to the overexploitation of the stock."

3rd December, 2022
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