Landing the blame: The influence of EU Member States on quota setting

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Highlights

- Total allowable catches (TACs) are a central tool for EU fisheries management.
- On average, EU TACs were set 20% above scientific advice between 2001-2015.
- Denmark and the UK received the largest increase to their TACs (in tonnes).
- Spain and Portugal received the largest percentage increase to their TAC.
- Greater transparency in decision-making is required.

Abstract

Fisheries in European Union (EU) waters have been managed under the Common Fisheries Policy since 1983. The main regulatory tool in EU fisheries management is the use of Total Allowable Catches (TACs). In principle, TACs are set according to biological scientific advice provided by the International Council for the Exploration of the Sea (ICES) which recommends catch limits with the objective of maximising catches in a sustainable manner. The objective of this paper is to compare TACs set by the EU and its Member States between 2001 and 2015 with those recommended by ICES in their annual scientific advice in order to a) investigate the level of compliance with scientific advice by the European Council and, b) consider whether particular Member States have received more TACs above advice than others. For the time-series analysed, the European Council set TACs above scientific advice by an average of 20% per year, with around 7 out of every 10 TACs exceeding advice. Of all Member States, Denmark and the United Kingdom received the highest TACs in volume above scientific advice. Relative to the size of their TAC however, Spain and Portugal exceeded advice by the greatest percentage. Greater transparency is required to determine what takes place during the closed door negotiations and to improve the fishery sustainability credentials of the EU and its Member States.

Keywords: Total allowable catch; Decision-making processes; Common Fisheries Policy; Political economy

1. Introduction

Decades of overfishing in the European Union (EU) have led to depleted fish populations and billions of euros in lost economic potential [1-4]. EU fisheries are managed under the Common Fisheries Policy (CFP) which uses Total Allowable Catches (TACs) are its main regulatory tool. How TACs are decided and at what level they are set is therefore of key importance to delivering improved fisheries management in the EU.

The CFP was established in 1983 in an effort to deal with complexities in management resulting from the shared nature of EU fish stocks and to address an increasing awareness of overfishing in EU waters. The 1983 regulation (EEC No 170/83) enshrined commitments to Exclusive Economic Zones, the concept of relative stability and established TACs as the main regulatory tool for EU fisheries management. The 1992 regulation (EEC No 3760/92) created structural measures to deal with fishing overcapacity and set up a licensing system. The 2002 regulation (EC No 2371/2002) saw the creation of multi-annual recovery and management plans, and the creation of Regional Advisory Councils (RACs), collectives of regional stakeholders including industry representatives and environmental groups, to account for the geographic diversity of fisheries and to facilitate management input from a diverse group of stakeholders. Most recently, the CFP celebrated its 30th anniversary in 2013 with the latest round of reforms (EU No 1380/2013) which included a discard ban and a commitment and timeline to achieving maximum sustainable yield by 2015 where possible and 2020 at the latest. These recent reforms (2002 and 2013) recognised that achieving maximum sustainable yield targets requires the management of fish stocks according to the best available science and affirmed the commitment of Member States to sustainable fishing [5, 6].

Throughout the history of the CFP, TACs have remained the main regulatory tool of the CFP. The objective of TACs is to deliver sustainable fisheries while extracting as much of the resource as possible [7, 8]. Nonetheless, despite reforms every decade designed to adapt management to changing socio-economic and environmental conditions, researchers have repeatedly drawn attention to the CFP's failures (e.g. [5, 9-15]). Many studies have linked the failure of the CFP to lead to stock recovery to problems with the implementation of the TAC management system, particularly with how scientific advice is treated [5, 11, 16-21]. Biais [16] found that between 1984 and 1992 there was good compliance with scientific advice only when proposed changes to TACs were small. Karagiannakos [11] and Patterson and Résimont [18] found that landings corresponded more with fish stock biomass than TACs, and the systematic disregard for scientific advice when it comes to setting TACs in the EU has been found across multiple stocks and timeframes [17, 19-21].

Recently the first signs of improvements in fish stocks have been documented in the EU waters [22-24] with 39% of assessed stocks in the Northeast Atlantic now considered to be within safe biological limits and 52% to be fished sustainably [25]. Yet while a stock recovery process is underway, European waters are still well below their economic potential. In addition, recent stock improvements may only be for closely monitored fish stocks under quota management, as the status of non-quota fish stocks, particularly those in Mediterranean, is still worsening [26-29].

In principle, TACs are set according to scientific advice provided by the International Council for the Exploration of the Sea (ICES) and the Scientific, Technical and Economic Committee on Fisheries. The former undertake annual stock assessments for the most important

commercial stocks, assess the biological status of species and recommend catch limits with the objective of achieving maximum sustainable yield [30], while the latter focus on the economic and social impacts of implementing TAC packages. Prior to formulating a draft proposal the European Commission (EC) then consult with RACs. Finally, the EC then negotiates with third countries (non-EU states with a vested interest in relevant stocks) through Regional Fisheries Management Organisations prior to finalising the proposal for consideration by fisheries ministers. Third countries include Iceland, the Faroe Islands, Norway and, to a smaller extent, other countries such as the Russian Federation. Based on this information, fisheries ministers of EU Member States then set the legally binding TACs over three days of discussion every year. As different Member States have vested interests in different stocks depending on historical fishing rights (upheld through the principal of 'relative stability' based on historical catches), TACs for different stocks are subject to discussions with different groups of ministers. The EU TAC is then divided between Member States according to relative stability, although quota swapping is commonplace after EU TACs, and each Member States' proportion, are agreed [31].

To our knowledge all time-series studies to date have only considered the relationship between scientific advice and the final TAC set for the whole of the EU. Therefore, this paper investigates not only how closely ministers across the EU are following biological (i.e. ICES) scientific advice and whether more recent decisions are more closely heeding such advice, but also whether particular Member States influence decision-making more than others. This follows the approach developed by Esteban and Carpenter [32-34] in analysing the 2015 TACs.

This paper is structured as follows. Section 2 describes the data collection method used to collect data on approximately 200 TACs per year across 15 years (2001-2015) totalling 3000 individual EU TAC decisions and analysis undertaken. Section 3 presents the results of the analysis between advised and agreed TACs and the influence of EU and non-EU Member States on the probability of setting higher TACs when a given country is included in the negotiation of TACs. Section 4 discusses the main management implications of the results.

2. Materials and methods

2.1 Data collection and preparation

Data on ICES scientific advice regarding TACs were obtained from the ICES Advice web portal (www.ices.dk). TACs allocated to the EU as a whole and across Member States were extracted from Council Regulations hosted on the EUROLEX (www.eur-lex.europa.eu) and FAOLEX (www.faolex.fao.org) online legal databases. At present there is no European or national authority that compiles data for third country agreements. Separate searches for these agreements were therefore undertaken of grey literature sources including news articles and government agency websites. Where no third country agreement was identified through searches or was successfully negotiated, the EU TAC was calculated based on the historical average allocated to the EU for years where an agreement was reached. For most stocks the share of the total TAC held by the EU remains fairly consistent with a range of a couple percentage points. Data were extracted for the 15-year period between 2001 and 2015 and the full dataset is provided in Annex I of the Supplementary Material.

In total, data were collected for approximately 200 TAC decisions per year (one decision counts as one record of scientific advice and one legally agreed TAC) covering 47 fish species (see Annex I and Table A.1 of the Supplementary Material). Note that in any one year the number of TACs may differ due to incomplete time-series for particular TACs resulting either from new species coming under TAC management or alterations to the areas for which particular TACs are set over time. EU Member States considered in this study include Belgium, Denmark, Estonia, Finland, France, Germany, Ireland, Latvia, Lithuania, the Netherlands, Poland, Portugal, Spain, Sweden and the United Kingdom. The 2004 accession countries (Estonia, Latvia, Lithuania and Poland) are only assessed from 2004-2015. In total, data on approximately 3000 EU-wide TAC decisions were gathered, covering approximately 12,000 Member State TAC sub-divisions with around half (1500 and 6000 respectively) that can be compared to relevant ICES advice.

In order to enable data comparisons between years, advice provided in number of individuals (e.g. Atlantic salmon) was converted to tonnes and where ICES provided a range for its TAC advice, the average was taken. In addition, adjustments were required in order to match ICES areas to TAC areas where these areas differ. No open-source description of how the EU matches scientific advice is available and formal requests for this information from the EU Commission to clarify it were unsuccessful. Consequently, where the ICES area is split across multiple TAC areas it was assumed that the advice is split in equal proportion amongst the TAC areas. Full details of all adjustments made to the raw data are provided in Annex I of the Supplementary material.

In instances where no TAC was agreed with third countries, all country level TACs were summed to reach a total unilateral TAC (e.g. mackerel 2010-2014) as reported by ICES in the advice files. Where no agreements between third countries and the EU were either reached or identified from searches, the EU share of the total TAC was estimated based on the average EU share for years where a TAC agreement was reached. For blue whiting however, a more conservative EU share of the total TAC was used for years 2001-2005 based on the relative share set in the 2006 agreement (30.5%) rather than the average share between 2006-2015 (19%) in order to ensure results were not unduly affected by the large TAC for this species.

2.2 Data analysis

Average excess TAC was calculated for the EU as a whole and for each EU Member State between 2001 and 2015. The excess TAC is defined here as the amount by which the agreed TAC set by ministers exceeds scientific advice produced by ICES. The excess TAC was calculated in tonnes by subtracting the TAC advised by ICES from the agreed TAC for the EU[1]. For each Member State, ICES advice was allocated based on that Member State's proportion of the total EU TAC in that year. Excess TAC for each Member State was then calculated by subtracting the (allocated) TAC advised by ICES from the agreed TAC for the Member State.

Where the agreed TAC was set at or below ICES advice this is recorded as a decision taken in accordance with ICES advice (i.e. a difference of zero) as the TAC recommended is a limit rather than a specific target. In practice, having one fish stock at a very high biomass level or with very low fishing mortality does not necessarily aid in the recovery and sustainable

[1] For example, if ICES advised a TAC of 4,900 t and the agreed TAC was 10,000 t, the excess TAC would be 5,100 t.

management of other stocks. With certain ecosystem dynamics and predator–prey relationships, the opposite may be the case [35].

Excess TAC was also calculated as a percentage above ICES advice for some of the analysis. The percentage excess TAC for each Member State and for the EU between 2001 and 2015 was calculated by summing the excess TAC in tonnes across all TAC decisions for the entire time period and then dividing this excess TAC amount by the total ICES advice in tonnes over the whole period and multiplying by 100. This calculation acts to weight the percentage excess TAC according to the size of the TAC, thereby taking into account that some TACs are thousands of times larger than others. An advantage of calculating the excess TAC by overall volume is it removes the problem previous studies have had in instances where ICES advice was a TAC of zero (moratorium). When calculated by percentage difference, any TAC set where advice was zero would be infinitely higher than advice; consequently, these studies have arbitrarily set these decisions to be 100% above scientific advice (e.g. [17, 20]).

Excess TAC by ecoregion was calculated in the same manner as Member State TAC, i.e. calculating the total volume of TAC above ICES advice in tonnes and converting this to a percentage of advice. This calculation allows for a geographic analysis of the results.

ICES advice was also analysed to determine whether some Member States were being indirectly advised to reduce their TAC from the previous year to a greater extent. For example, ICES may advise a reduced TAC for a particular fish stock but the burden of implementing this reduction would fall to one Member State more than another due to the relative proportions of that TAC assigned to different States. Advised ICES changes (both increases and decreases) from the previous year's agreed TAC were calculated by determining the change between each Member States share in ICES advice in year t for each species in each management area and each Member States agreed TAC from year t_{-1}. Note that where data for previous years TACs were not presented, the change could not be determined and therefore these data were excluded from this analysis, along with TAC increases. Advised changes were then summed across all species and management areas for each Member State and averaged by the number of years each State is represented in the time-series.

3. Results

3.1 Differences between advised and agreed TACs

On average, the European Council set TACs above scientific advice by 471,490 tonnes per year between 2001 and 2015. This equates to an average excess of 20% per year. Trends in decision-making indicate that scientific advice has been more closely followed in later years with a decrease in EU TACs set above scientific advice from 33% in 2001 to 7% in 2015 (Figure 1). However, the number of TACs set above scientific advice across the EU has remained consistent at approximately 7 out of every 10 TACs set (Figure A.1 of the Supplementary Material) indicating that, in general, TACs set over scientific advice are decreasing to fall more in line with advice (42% to 18%, see Figure A.2).

[INSERT FIGURE 1 HERE]

Analysing the results by species shows that some species are set above ICES advice by much greater amounts. By volume, blue whiting, horse mackerel, mackerel, sprat, herring and cod make up approximately 80% of the excess TAC between 2001 and 2015. The contribution of species to the excess TAC in tonnes each year is shown in Figure A.4. The top 20 species ranked by excess TAC are listed in Table A.3.

3.2 Excess TACs by Member States

In terms of volume, Denmark, the United Kingdom and Spain accounted for just under half of the EU's excess TAC between 2001 and 2015 (Figure 2). By percentage difference, Spain and Portugal obtained TACs the most above scientific advice (37%). Finland and Estonia receive the smallest amounts of excess TAC, although TACs are still over advice (10% and 12% respectively). This ranking also roughly aligns with the likelihood that a Member State will be part of negotiations that result in an excess TAC (See Table A.2).

From 2001 to 2015 nearly all Member States have a reduction in their excess TACs with the exception of the Baltic States (Poland, Lithuania, Latvia, Estonia) who have no clear trend in excess TAC since their ascension to the EU in 2004 (See Figure A.5).

[INSERT FIGURE 2 HERE]

3.3 Geographical trends

There is a clear geographic trend in excess TACs with Western Member States receiving TACs in greater excess of scientific advice compared to Member States in the Baltic region. A similar geographical pattern emerges when excess TAC is calculated for the major fishing areas in the Northeast Atlantic, grouped by ICES ecoregion (Figure 3).

[INSERT FIGURE 3 HERE]

3.4 ICES advised TAC change by Member State

Between 2001 and 2015, ICES provided advice which would require Spain and Portugal to reduce their TACs the most and Member States around the Baltic Sea the least (Table 1). Moreover, ICES advice enabled some Member States (Denmark, France and Finland) to increase their TACs on average.

Rankings of Member States by average percentage excess TAC and by the amount of change in TAC that ICES advice corresponds to are similar (Table 1), with a significant negative relationship between the percentage excess TAC obtained by each State and the percentage change advised by ICES (r^2=0.56, $p<0.05$, Figure A.3). Nonetheless, there are differences to be highlighted: Lithuania and Latvia have lower excess TACs given the ICES advised change in TAC while France, the United Kingdom, Denmark and Germany have larger excess TACs.

[INSERT TABLE 1 HERE]

3.5 Influence of third countries

While a paucity of data prevents substantial analyses, TACs in which third countries were involved (where the combined third country is large, i.e. above 33%) were set with a greater amount above scientific advice, on average by 24% (Table 2).

[INSERT TABLE 2 HERE]

4. Discussion

On average, EU TACs were set 20% above scientific advice between 2001 and 2015, comparable to findings of previous studies [17, 20]. In recent years the level by which TAC are set above scientific advice has fallen. With the number of TACs set above scientific advice (7 out of every 10 set) remaining consistent this indicates that TACs are being brought more in line with scientific advice.

In the EU, marine capture fisheries are worth €6.8 billion and employ approximately 145,000 people [36]. The total fish catch in 2013 was 4.7 million tonnes with the majority used directly for human consumption [37]. Fisheries in the EU, as well as globally, are therefore of huge socio-economic importance. This importance has often led to socio-economic considerations taking precedence over biological ones in discussions regarding TACs. Even last year, the UK fisheries minister George Eustice stated that "[a]lthough these were difficult negotiations, I am pleased that we were able to secure the best possible deal to ensure sustainable fisheries and a strong UK fishing industry. While fishermen had feared there would be major cuts, we were able to keep the same quota as last year for many species, in addition to important increases to the North Sea cod and haddock quota, which will benefit Scottish fishermen"[2]. The Rt. Hon. John Gummer, a previous UK fisheries minister put it best: "[t]he arguments [about TACs] are not about conservation, unless of course you are arguing about another country'' [38].

Understandably, reducing TACs is difficult for EU ministers because in that year it directly negatively affects those working in the fisheries sector of their country and is therefore both socio-economically and politically unfavourable. The declining trends of excess TACs indicate that in the last fifteen years, EU ministers have slowly been bringing quotas in line with scientific advice and that while fisheries ministers will claim success for their country's fisheries and fishers each year, reductions are being made.

Because of the principle of relative stability, Member States are only able to increase their TACs if either (i) the EU TAC is increased or (ii) an agreement can be made with another

[2] Harvey, F. & Nelsen, A. (2014). Fishing quotas defy scientists' advice. The Guardian, 16 December 2014. [online] http://www.theguardian.com/environment/2014/dec/16/fishing-quotas-defy-scientistsadvice [accessed 07/10/2015]

country. In the case of the former, all countries that have a share of the EU TAC receive the same percentage increase to their agreed TAC however this will translate into different tonnes due to their proportional share. Consequently, it is of interest to note which countries benefitted (i.e. were subsequently able to land a greater volume of fish) the most from EU TACs being set above scientific advice as, we believe, it is likely that these countries will have lobbied for the greater EU TAC.

While Spain and Portugal receive the greatest excess TACs in terms of percentage, Denmark and the United Kingdom receive the most in terms of volume, each obtaining quotas on average by an excess of over 75,000 tonnes between 2001 and 2015 (Figure 2). With Spain included, these three countries accounted for approximately half (47%) of the EU's excess TAC between 2001 and 2015, a share of volume just under to the total TAC received by these Member States (calculated from the database as 54%).

When these trends were analysed at Member State level, differences in the excess TAC received by Member States were found with a west (highest excess TAC) to east (lowest) trend in country rankings (Table 2 and Figure 3). In general, the greater the required reduction to bring TACs in line with scientific advice, the greater the excess TAC received by a Member State, although there is variation in this measure (Table 2, Figure A.3). Spain and Portugal topped the league table (Figure 2) with the largest percentage of excess TAC (37% over ICES advice on average between 2001 and 2015) however scientific advice was provided for EU TACs which, based on the proportion of EU TACs allocated to them, would have required them to reduce their TACs the most. This finding presents a situation where Member States are acting in a short-term cycle of exceeding advice, delaying stock recovery and having advised TAC reductions continue. This raises the question of whether Member States benefitting that year from larger excess TACs are benefitting in the longer-term. With the latter perspective, it may be the case that Member States negotiating larger TACs for their stocks are not benefitting at all [20].

Nonetheless, even these countries show improvement over time indicating incremental reductions (albeit subject to variability between years) in excess TAC (Figure A.5). While the relationship between the reductions required by Member States to bring EU TACs in line with scientific advice and the excess TAC explains some of the trend in results, some Member States (e.g. the United Kingdom, the Netherlands and Belgium) have comparatively larger excess TACs given the required reduction arising from advice. Accordingly, other factors than simply the burden of implementing advice require further consideration.

The western-eastern trend identified between the ranking of a Member State and their excess TAC indicates that geographical, ecological and socio-economic factors play a role in the level of excess TAC received (Figure 3). Consequently, further work should examine causality between these factors including, but not limited to, the biological status of stocks in each area, the high socioeconomic dependence on fishing activities in some countries, the number and nature of stakeholders involved in decision-making, the type of stocks different Member States have interest in (i.e. are widely migratory stocks more prone to TACs being set above advice than less mobile stocks).

4.1 The influence of third countries in negotiations

The role of third countries is an important consideration when discussing EU TACs. These third countries (e.g. the Faroe Islands, Iceland, Norway and Russia) bring additional stakeholders to the negotiations with vested interests. However, unlike European Council negotiations, it is not uncommon for third countries to leave or avoid negotiations altogether and set their own chosen TAC unilaterally – most notably in the prolonged 'mackerel war' between the EU and Norway and Iceland [39].

The EC proposal for TACs has been shown to be higher than ICES advice as third countries are incorporated [20]. Findings from this study indicate that TAC negotiations involving third countries are more likely to be set above ICES advice (Table 2). Consequently, incorporating third countries into these analyses could result in these countries topping the league tables although the order of EU Member States would simply be shifted downwards rather than changed. However, due to the lack of a centralised database on these decisions, incomplete data prevented this analysis.

4.2 Increasing transparency of the quota setting process

Transparency and openness are fundamental concepts to good governance enshrined in Article 1 ("decisions shall be taken as openly and as closely as possible to the citizen") and Article 15 ("the Union institutions, bodies, offices and agencies shall conduct their work as openly as possible") of the Treaty of the European Union (as amended by the Lisbon Treaty). However, EU TACs are still decided behind closed doors with discussions remaining secret and while annual ICES advice and EU TACs are published online, difficulties in aligning ICES advice areas with TAC management areas present obstacles to both openness and transparency. In addition, having no centralised database documenting outcomes from negotiations with third countries ensures the effects of these discussions are opaque and closed.

Greater transparency in the EU TAC decision-making process would therefore include, amongst others, the alignment of ICES advice and TAC management areas, the result of third country negotiations, more streamlined access to historical and future TAC decisions and, more fundamentally, opening annual negotiations to the public. This paper has used the results of these negotiations to estimate the Member States who are most responsible for raising TACs above scientific advice. The only way to verify these outcomes is with greater transparency in process.

5. Conclusions

The significant gap between the levels of TACs recommended in scientific advice and agreed by the European Council indicates the prevalence of short-term concerns over the long-term sustainability of fishery resources during the last decades. On average, the European Council set TACs above scientific advice by 20% per year and throughout the time period approximately 7 out of every 10 TACs were set above advice. However, trends indicate that the level by which TACs are set above scientific advice is falling and that TACs are being brought more in line with scientific recommendations – a positive trend occurring alongside signs of stock recovery in some EU waters.

Increasing transparency of the EU TAC decision-making process would improve not only the reputation of the European Commission in civil society but would also help to align the long-term interests of the fisheries sector with ICES advice. The CFP reform in 2013 opened new opportunities to navigate into sustainable and resilient pathways to ensure the ecological, economic and social contributions of fish stocks for the fisheries sector into the future. Although these findings indicate some important progress has been achieved during the last 15 years, it is essential for the gap between scientific advice and TACs to continue to narrow to ensure the sustainability of EU fisheries. While all Member States are contributing to EU excess TACs, these findings show some States are having greater influence than others. To improve fishery sustainability credentials of the EU and its Member States, and ensure scientifically appropriate quotas, principles of transparency and openness need to be adopted.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at: *address when published*

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Tables

Table 1: ICES advised change from the previous years' TAC by Member State compared with the ranking of Member States by percentage excess TAC (2001-2015).

Member State	ICES advised TAC change (tonnes)	ICES advised TAC change (%)	Level of advised change (ranking)	Excess TAC (ranking)	Ranking difference
Spain	-41,016	-23	2	1	1
United Kingdom	-36,028	-9	11	6	5
The Netherlands	-25,492	-14	3	3	0
Ireland	-24,301	-14	4	4	0
Sweden	-24,224	-12	6	7	-1
Portugal	-16,348	-24	1	2	-1
Germany	-14,842	-10	9	5	4
Poland	-11,931	-10	10	13	-3
Latvia	-6,968	-12	7	12	-5
Estonia	-5,886	-8	12	14	-2
Lithuania	-2,985	-12	5	11	-6
Belgium	-2,962	-12	8	10	-2
Finland	1,886	2	14	15	-1
France	4,123	2	15	8	7
Denmark	5,570	1	13	9	4

Table 2: Excess TAC split by third country share

Third country share	Excess TAC (tonnes)	Excess TAC (%)
Large combined third country share (>33%)	181,808	24
Small combined third country share (<33%)	289,682	19

Figures

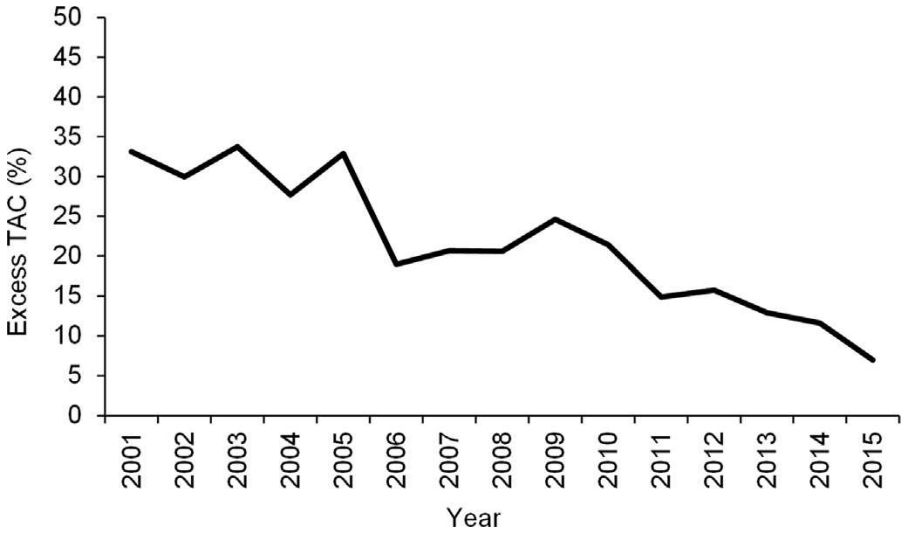

Figure 1: Annual excess TAC (%) between 2001 and 2015 set by the European Council.

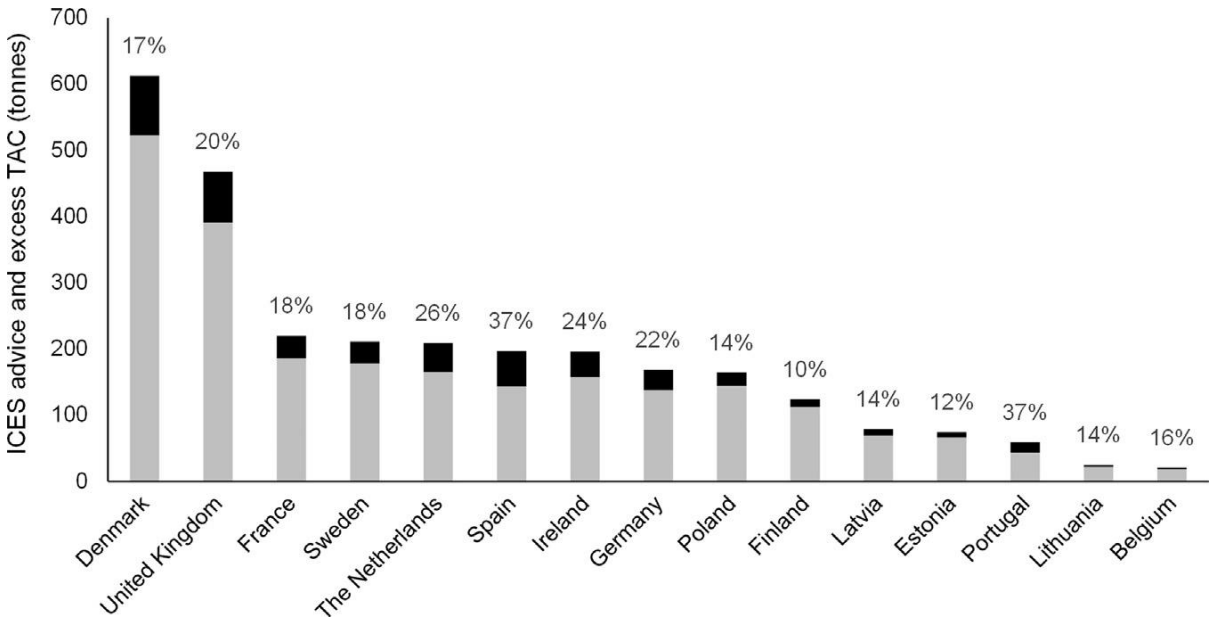

Figure 2: Average excess TAC for each Member State between 2001 and 2015. For each Member State the grey column represents the total advised TAC by ICES in tonnes across all stocks and the black column represents the total amount by which TACs were above advice. The entire column represents the agreed TAC. Labels represent the percentage excess TAC.

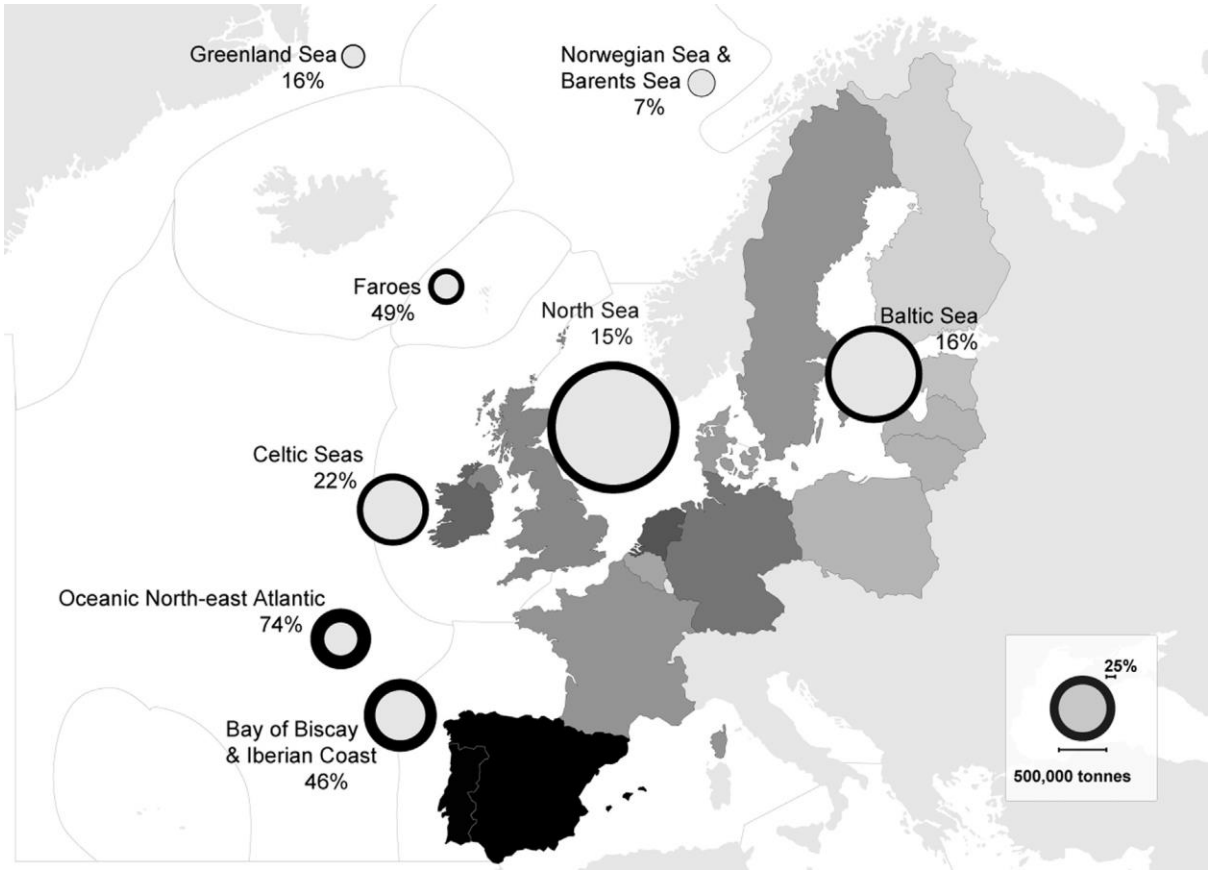

Figure 3: Average excess TAC for each ecoregion between 2001 and 2015. For each ecoregion the grey bubble represents the total advised TAC by ICES in tonnes across all stocks and the black border represents the total percentage by which TACs were above advice. The size of the entire bubble represents the agreed TAC (in tonnes) in that ecoregion. Labels indicate the name of each ecoregion and the average percentage excess TAC for that ecoregion. Greyscale indicates the ranking of Member States by excess TAC (%) with black showing countries with the greatest excess TAC and light grey the least, percentages are reported on Figure 2.

Supporting online material for

Landing the blame:

The influence of EU Member States on quota setting

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Figure A.1: Percentage (black line) and number of TACs above ICES advice (dark grey bars) and TACs for which there is ICES advice (light grey bars) between 2001 and 2015 across the EU.

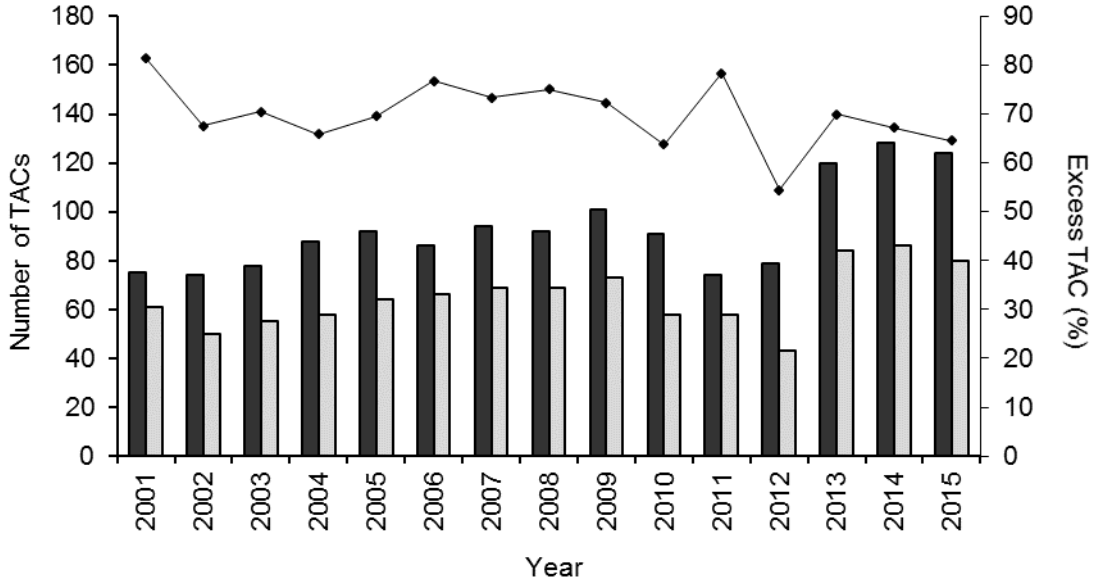

Figure A.2: Percentage by which EU TACs exceed scientific advice between 2001 and 2015. Note only data for TACs where ICES advice is exceeded are included.

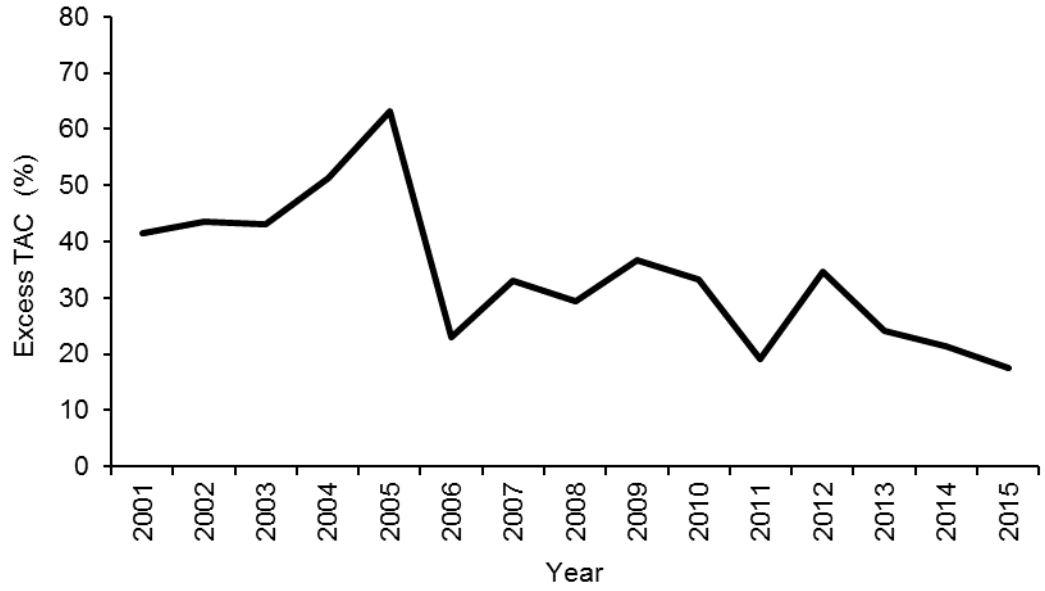

Figure A.3: Excess TAC and ICES advised TAC change by Member State

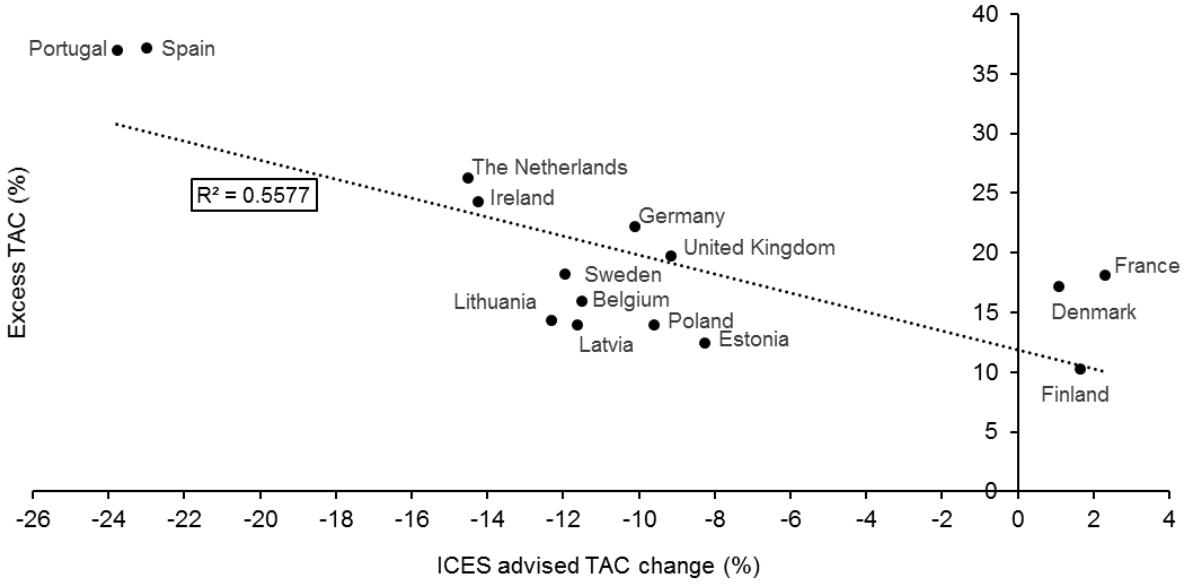

Figure A.4: Species composition of excess TAC. The layers represent the top six species (blue whiting [light blue], horse mackerel [orange], mackerel [light grey], sprat [yellow], herring [dark blue], cod [green]) and all other species [dark grey]).

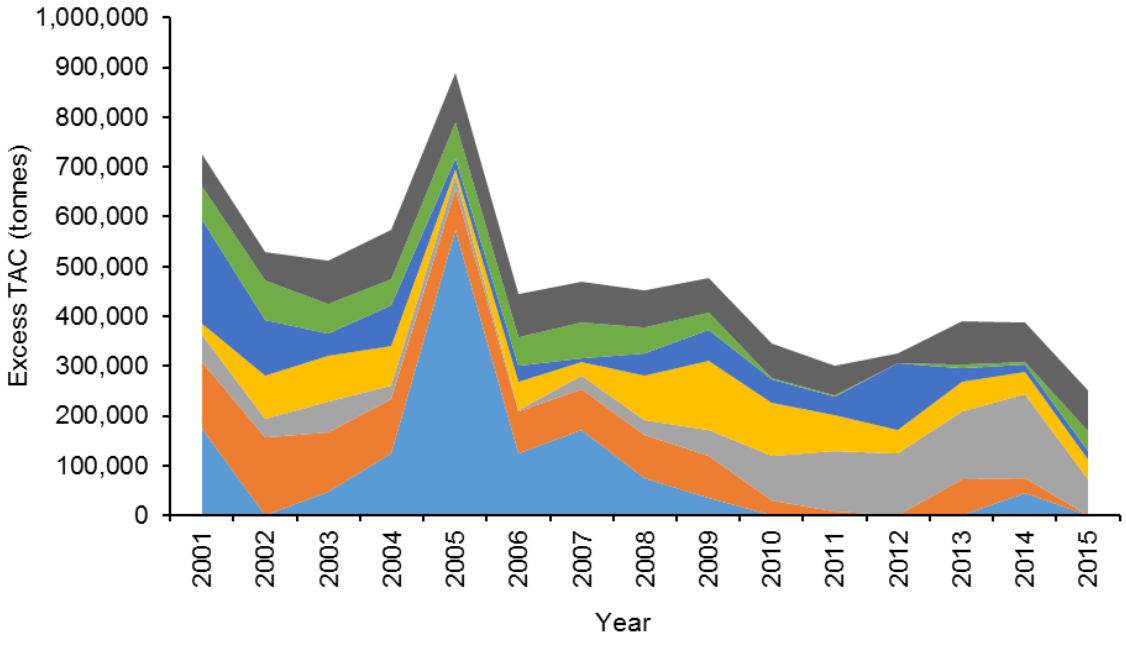

Figure A.5: Annual excess TAC from 2001 to 2015 of **(a)** Western European Member States (Spain [gold], Portugal [green]) **(b)** Northern European Member States (The Netherlands [orange], Ireland [green], Germany [black], UK [red], France [blue], Belgium [yellow]), **(c)** Nordic Member States (Sweden [gold], Denmark [red], Finland [blue]) and **(d)** Baltic Member States (Lithuania [green], Latvia [maroon], Poland [red], Estonia [blue]). Note the different y-axis scales. Excess TAC can be calculated to be in excess of 100% if the agreed TAC is more than twice as large as advice.

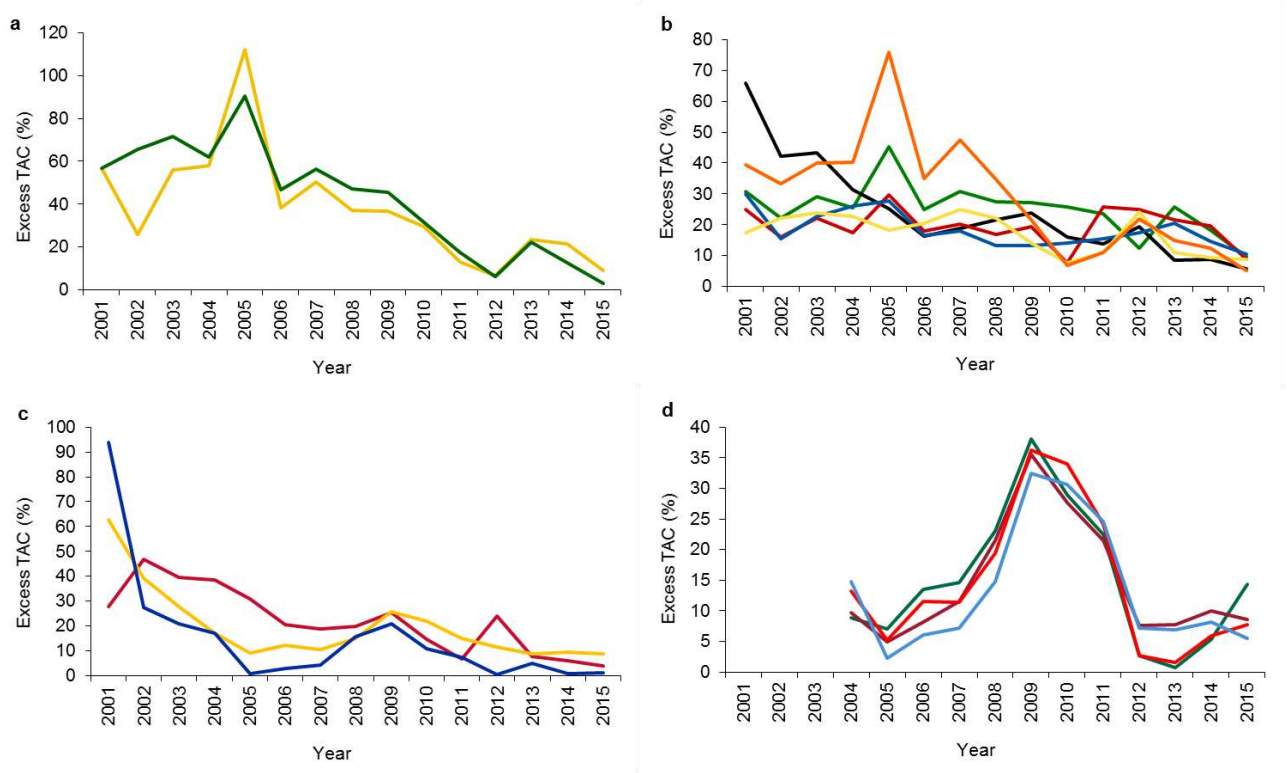

Table A.1: Species managed by TACs in the EU and included in analyses

Species name	Latin name
Alfonsinos	*Beryx spp.*
Anchovy	*Engraulis encrasicolus*
Anglerfish	*Lophiidae*
Atlantic halibut*	*Hippoglossus hippoglossus*
Atlantic salmon	*Salmo salar*
Basking shark*	*Cetorhinus maximus*
Black scabbardfish	*Aphanopus carbo*
Blue ling	*Molva dypterygia*
Blue whiting	*Micromesistius poutassou*
Boarfish	*Caproidae*
Capelin	*Mallotus villosus*
Cod	*Gadus morhua*
Dab	*Limanda limanda*
Deep-sea sharks*	*Selachimorpha*
Forkbeards	*Phycis blennoides*
Great silver smelt	*Argentina silus*
Greenland halibut*	*Reinhardtius hippoglossoides*
Haddock	*Melanogrammus aeglefinus*
Hake	*Merluccius merluccius*
Herring	*Clupea harengus*
Horse mackerel	*Trachurus spp.*
Lemon sole	*Microstomus kitt*
Ling	*Molva molva*
Mackerel	*Scomber scombrus*
Megrims	*Lepidorhombus spp.*
Northern prawn	*Pandalus borealis*
Norway lobster	*Nephrops norvegicus*
Norway pout	*Trisopterus esmarkii*
Orange roughy	*Hoplostethus atlanticus*
Penaeus shrimps*	*Penaeus spp.*
Plaice	*Pleuronectes platessa*
Pollack	*Pollachius pollachius*
Porbeagle	*Lamna nasus*
Red seabream	*Pagellus bogaraveo*
Redfish	*Sebastes spp.*
Roundnose grenadier	*Coryphaenoides rupestris*
Saithe	*Pollachius virens*
Sandeel	*Ammodytes spp.*
Skates and rays	*Rajiformes*
Snow crab*	*Chionoecetes spp*
Sole	*Solea solea / Solea spp.*
Spiny dogfish	*Squalus acanthias*
Sprat	*Sprattus sprattus*
Swordfish	*Xiphias gladius*
Turbot	*Psetta maxima*
Tusk	*Brosme brosme*
Whiting	*Merlangius merlangus*

Species name	Latin name

*No ICES advice available for analysis

Table A.2: Average excess TAC by quantity and likelihood 2001-2015

Member States	Excess TAC (tonnes)	Excess TAC (%)	Likelihood of Excess TAC
Denmark	89,943	17%	0.63
United Kingdom	77,077	20%	0.64
Spain	53,367	37%	0.70
The Netherlands	43,401	26%	0.60
Ireland	38,297	24%	0.67
France	33,775	18%	0.67
Sweden	32,538	18%	0.61
Germany	30,626	22%	0.57
Poland	20,116	14%	0.46
Portugal	15,892	37%	0.73
Finland	11,473	10%	0.57
Latvia	9,655	14%	0.69
Estonia	8,209	12%	0.65
Lithuania	3,100	14%	0.53
Belgium	2,849	16%	0.64
EU	**471,490**	**20%**	**0.69**

Table A.3: Average excess TAC by species 2001-2015 (Top 20)

Species	Excess TAC (tonnes)	Excess TAC (%)
Blue whiting	91,726	52
Horse mackerel	71,553	45
Mackerel	68,925	22
Sprat	65,399	16
Herring	59,324	12
Cod	40,288	45
Plaice	9,263	12
Hake	8,762	19
Anchovy	8,713	54
Whiting	8,626	36
Norway lobster	8,189	15
Megrims	6,327	37
Haddock	3,777	9
Anglerfish	3,732	14
Redfish	2,969	30
Common sole	2,514	11
Pollack	1,968	194
Northern prawn	1,665	33
Blue ling	1,458	3

Species	Excess TAC (tonnes)	Excess TAC (%)
Ling	1,454	18