



NOT IN THE SAME BOAT

THE ECONOMIC IMPACT OF BREXIT
ACROSS UK FISHING FLEETS

CONTENTS

SUMMARY	2
SECTION 1: INTRODUCTION	8
SECTION 2: THE POTENTIAL IMPLICATIONS OF BREXIT FOR UK FISHING FLEETS	10
2.1 BREXIT WILL FUNDAMENTALLY CHANGE FISHERIES MANAGEMENT	10
2.2 THE POLITICAL REALITIES OF BREXIT	13
2.3 BREXIT IMPACT: CHANGE IN ACCESS TO WATERS (MODELLED)	17
2.4 BREXIT IMPACT: CHANGE IN QUOTA (MODELLED)	22
2.5 BREXIT IMPACT: CHANGE IN QUOTA SETTING AND OVERFISHING (MODELLED)	26
2.6 BREXIT IMPACT: CHANGE IN TARIFFS TO ACCESS THE EU MARKET (MODELLED)	29
2.7 BREXIT IMPACT: CHANGES TO NON-TARIFF BARRIERS TO TRADE (MODELLED)	30
2.8 BREXIT IMPACT: MACROECONOMIC CHANGE (NOT MODELLED)	30
2.9 BREXIT IMPACT: CHANGES IN THE FREE MOVEMENT OF EU LABOUR (NOT MODELLED)	34
2.10 BREXIT IMPACT: CHANGES IN FREEDOM OF ESTABLISHMENT (NOT MODELLED)	35
2.11 BREXIT IMPACT: REGULATORY CHANGE (NOT MODELLED)	36
2.12 SUMMARY OF POTENTIAL FACTORS AFFECTING UK FISHERIES POST BREXIT	39
SECTION 3: COMBINING BREXIT SCENARIOS	41
3.1 MAIN SCENARIOS	41
3.2 WHY AN ECONOMIC SCENARIO ANALYSIS IS NECESSARY	44
3.3 THE DIVERSITY OF THE UK FLEET REQUIRES DISAGGREGATED ANALYSIS	45
SECTION 4: RESULTS	48
4.1 RESULTS	48
4.2 SENSITIVITY ANALYSIS	55
4.3 SUMMARY OF FINDINGS	60
SECTION 5: DISCUSSION	65
5.1 UNDERSTANDING THE RESULTS IN THE CONTEXT OF ENTHUSIASTIC INDUSTRY SENTIMENT FOR BREXIT	65
5.2 COULD OVERFISHING REALLY HAPPEN HERE?	69
SECTION 6: POLICY RECOMMENDATIONS	71
SECTION 7: CONCLUSIONS	77
ANNEX A: SCENARIO COMBINATIONS	79
ANNEX B: METHODOLOGY	81
B1: BREXIT IMPACTS AND FLEET COST STRUCTURE	81
B2: THE BIO-ECONOMIC MODEL OF EUROPEAN FLEETS	82
B3: MODELLING THE CHANGE IN QUOTA	82
B4: MODELLING THE CHANGE IN ACCESS	85
B5: MODELLING THE IMPACT OF EU TARIFFS	89
B6: MODELLING THE QUOTA SETTING OUTCOMES AND OVERFISHING	
SENSITIVITY ANALYSIS	98
B7: MODELLING SENSITIVITY TO QUOTA UPTAKE	99
B8: MODELLING SENSITIVITY TO DEPRECIATION	100
ENDNOTES	101

SUMMARY

1. FISHING IS A TOTEMIC ISSUE FOR BREXIT. ITS POLITICS MATTER.

Few issues better symbolise the politics of Britain's exit from the EU (Brexit) than fisheries. Fishing, like the sea itself, is deeply interwoven into the perception of the UK as a coastal nation separated from its neighbours. Fisheries policy, it has been claimed, is a visible and visceral area where the UK can 'take back control'.

2. BIG CLAIMS ARE BEING MADE – BUT IS BREXIT REALLY A 'SEA OF OPPORTUNITY' FOR UK BOATS?

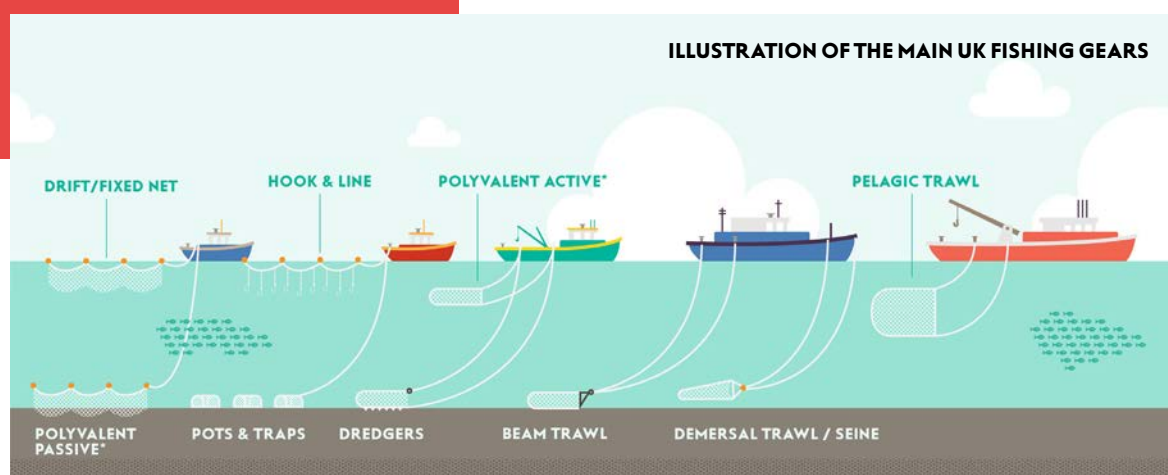
Some fishing groups are excited by the opportunities Brexit presents. The Scottish Fishermen's Federation (SFF) refers to Brexit as a 'sea of opportunity' and the lobby group Fishing for Leave calls it a 'golden opportunity'. For others, Brexit is a 'sea of risk', whether due to possible tariffs on traded products, non-tariff barriers, or the threat of overfishing. The reality of how these risks and opportunities balance out is unclear and depends on what kind of Brexit is agreed.

Brexit is being presented as a beacon of hope for small-scale fishers. Many coastal communities are looking to Brexit for a way out of their urgent economic crisis. Are they right to look to Brexit for hope? That is what this report sets out to examine.

3. THE REALITY IS BREXIT WILL PROBABLY CREATE MORE LOSERS THAN WINNERS IN FISHERIES

This report is the first attempt to weigh the risks and opportunities of Brexit for UK fishers, analysing six different possible scenarios for Brexit – from the hardest to the softest final deal, from a fishing perspective. These scenarios (No Brexit, Hard Brexit, Soft Brexit, Fishing First Brexit, Fishing Last Brexit, and No Deal Brexit) are based on how the negotiations proceed and how the fishing industry is prioritised within them.

The results show that it is only in the highly unlikely Fisheries First scenario where Britain puts fisheries above all other interests in Brexit negotiations that there will be benefits across the UK fleet. In the more likely scenarios, Brexit – as has long been the case – will see some fishers (mainly smaller boats) do far worse than others. And the rest of the fishing supply chain – processors, wholesalers, retailers – which are closer to trade in fish products, are even more exposed to the risks of Brexit.



BREXIT SCENARIOS AND STUDY RESULTS

Scenario	Description	Assumption	Winners	Losers
No Brexit	No Brexit (serves as a base case).	The UK remains in the EU Common Fisheries Policy and single market.	No change.	No change.
Hard Brexit	A Hard Brexit increases quota and access based on the UK's new Exclusive Economic Zone, but results in the EU continuing its fishing pressure on stocks and applying the highest tariff rates.	The UK can claim territorial waters without historical access rights. The EU would respond with tools available.	Approximately half the fleet experiences an improvement in economic performance (earnings, profits, wages). These vessels have significant quota holdings and include most large and small-scale vessels using trawls, nets, and hooks.	There is a reduction in economic performance for fleets where the impact of tariffs outweighs gains in quota and access. This includes approximately half the fleet, mostly small-scale pots & traps – the largest fleet segment by number of vessels.
Soft Brexit	The UK cedes some of its claimed quota shares and access to the UK's new Exclusive Economic Zone in exchange for lower tariffs on UK fish exports to the EU.	Lower tariffs and barriers are worth trading-off against access rights and quota shares.	There is little change in economic performance. Despite the trade-off, it is still the vessels holding the large quota shares that improve performance.	There is little change in economic performance. With lower tariffs, most of the economic impact is lessened. Most vessels are worse off but most fishers better off.
Fisheries First Brexit	The UK avoids any trade-offs in fisheries, securing increases in quota and exclusive access with the EU responding by reducing its quota share and not imposing import tariffs.	The fishing industry is prioritised as a key UK sector and ignored by the EU.	The largest gain in economic performance (earnings, profits, wages) for the UK catching sector as a whole. All UK fleet segments are better off.	There are no losses in the UK fleet compared to the status quo.
Fisheries Last Brexit	Left out of negotiations, there is no change in quota or access to waters and tariffs are not negotiated down for fish products.	Other, larger, UK sectors are prioritised.	There are no gains in the UK fleet compared to the status quo.	The largest loss in economic performance (earnings, profits, wages) for all fleet segments. All UK fleet segments are worse off.
No Deal Brexit	The UK claims high quota shares and access to waters, but the EU responds with high tariff and non-tariff barriers, and fails to reduce its own quota share or fishing pressure.	Brexit negotiations turn sour and the most adversarial outcomes prevail.	Improvement in economic performance (earnings, profits, wages) for fleet segments with large quota holdings. Similar to Hard Brexit, but with smaller gains.	Reduction in economic performance for fleets segments with small quota holdings. Similar to Hard Brexit, but with larger losses.

Above all, the type of Brexit that is negotiated hugely affects the prospects for UK fishing. The process of determining winners and losers is far from straightforward and depends on what outcomes are valued and for whom: the fishing industry is not one single entity but thousands of unique fishing vessels.

4. WINNERS: BOATS THAT FISH 'QUOTA' SPECIES

Under some of the Brexit scenarios, fishing quotas (quantity limits for commercial species such as haddock, sole, and mackerel) for the UK fleet increase substantially; fishing resources are likely to be divided based on the

national waters where fish reside (zonal attachment) rather than the current division based on fixed, historical fishing patterns. This increase in UK fishing quota raises fishing revenues, profits, and wages in turn for fishers who currently hold significant fishing quotas. The larger the quota holder, the less likely they are to land their catches into UK coastal communities or to employ a UK crew.

5. LOSERS: BOATS THAT DON'T – MOSTLY SMALL VESSELS

Many fishing vessels have little or no quota, however. One of the starkest divides in the UK fishing industry is that while small-scale vessels (under 10 metres) make up 77% of the UK fishing fleet, they hold only 1.5% of the quota. Owing to complex historical reasons, as well as a specialisation in non-quota species (e.g. crab, scallops, seabass), these vessels have been shut out of the system.

This divide in quota ownership is one of the contributing factors to a sharp divide in current economic performance, with the large-scale fleet recording profit margins of 19% and the small-scale fleet operating at a profit margin of 0%. As the gains from quota increases accrue to those who hold the quota rights, these gains further entrench the 'haves and have nots' of UK fisheries. Small-scale vessels also see little benefit from exclusive access out to 200 nautical miles, as they fish exclusively in inshore waters.

The only Brexit scenario which improves outcomes for these smaller vessels is the Fisheries First scenario, which is highly unlikely to be pursued by the government as it balances multiple competing interests in the negotiation process. Brexit therefore does not seem likely to be of much benefit to the small-scale fleet.

6. TARIFFS OUTSIDE THE SINGLE MARKET COULD DEVASTATE SOME FISHING BUSINESSES

Under some of the Brexit scenarios, there is also the application of tariffs to UK fish exports entering the EU. Tariffs would impact every fleet segment, as the majority of UK fish is exported (76%) and the majority of that is destined for the EU (75%). For fishers holding quota, quota gains can offset the application of tariffs in terms of overall economic performance, but not for those fishers – including the majority of the small-scale fleet – who do not hold quota.

There is no scenario with a better trade deal for fisheries than the status quo. Norway, which has the closest trade relationship with the EU for fish products, still pays tariffs on 70% of its fish sent to the EU market. Retaining tariff-free access to the EU market as is currently the case is extremely unlikely.

7. FEWER EU BOATS IN UK WATERS IS NOT LIKELY TO LEAD TO MORE PROFITS

Besides quota and tariffs, a third pillar of managing post-Brexit fisheries is how access to UK and EU territorial waters is shared. The scenario results show that restricting access to UK waters for EU vessels has a small impact for existing UK vessels, as any reduction in fishing by EU vessels in UK water is likely to be compensated by an increase in new UK vessels.

8. COASTAL COMMUNITIES RELY ON THOSE BOATS LIKELY TO BE HARDEST HIT

The majority of ports around the UK (59% of ports above £100,000 in landings) receive most of their landed value from pots and traps or dredgers. Most of these landings are from small-scale vessels using pots and traps – the largest fishing fleet by

number of vessels and employment. But these vessels catch shellfish mainly for European export, which means that with any scenario that involves the imposition of tariffs (all scenarios except the unlikely Fisheries First Brexit), these ports and the communities that they link to may be worse off as a result of post-Brexit fisheries.

9. BREXIT ALONE WILL NOT LEAD TO MORE SUSTAINABLE FISHING

There is also the question of environmental impacts of fishing and whether Brexit will affect this important dimension. Different types of fishing have different levels of impact on the marine environment. There is no clear trend in the results between whether the winners and losers of Brexit are more likely to be active gears (towed fleet segments such as trawls and dredges) or passive gears (static fleet segments such as hooks, pots, or fixed nets).

As a result, Brexit alone will not substantially change the environmental impact of the UK fishing fleet. Like fleet economic performance, continuing to allocate fishing quota in the same way serves to reinforce the status quo. Creating more sustainable and equitable outcomes requires extra measures to be taken. How quota is allocated, one of the most important tools to incentivise outcomes, is a power that has always rested with Westminster – a power largely unused to date. Determining access to waters, for example what type of vessels can access sensitive, inshore waters, is another important tool.

10. IF THE UK AND THE EU TAKE TOO MUCH FISH, OVERFISHING RESULTS – AND EVERYONE LOSES

The scenario results drastically change if Brexit leads to overfishing. Whereas different scenarios create winners

and losers depending on how quota and tariffs balance out, an increase in overfishing from the UK taking more without the EU taking less means that all fishing fleets lose out post Brexit.

That Brexit could lead to an increase in overfishing is a very real possibility. Simultaneous promises are being made at present by UK politicians and industry leaders that there will be more fishing post Brexit and by EU politicians and industry leaders that there will not be any less.

The history of negotiations with countries outside of the EU that share some fish stocks (the ‘third countries’ of Iceland, the Faroe Islands, and Norway) only adds to the concern. Quota negotiations over these shared stocks depart even further from scientific advice than those within EU waters, as outside of the EU framework there is always the threat of a negotiating country simply leaving the table and fishing as much as they desire.

IMPLICATIONS

11. THE TYPE OF BREXIT MATTERS, BUT THERE WILL BE WINNERS AND LOSERS

It cannot be said with any certainty what the future of Brexit holds for the fishing industry. The scenario analysis in this report shows a full range of potential outcomes depending on how integrated fisheries management is post Brexit and how the industry is prioritised during negotiations. The type of Brexit clearly matters.

It is also the case that under most realistic Brexit scenarios there are both winners and losers. The results of the scenario analysis confirm that Brexit will not improve the economic performance of many of small-scale fishers that are currently struggling, due to the application of EU tariffs and a lack of quota held by these fishers.

Many of these reforms have always been possible at the national level, but this has thus far avoided the spotlight of attention generated from Brexit. Reforms at both levels are required to create a fair and sustainable fisheries system for the whole fishing fleet.

12. CONSTRUCTIVE, REALISTIC NEGOTIATIONS WITH THE EU – NOT POSTURING – MUST GUIDE THE UK’S POSITION

The first conclusion of the research is therefore straightforward. The current tone of UK-EU negotiations must change immediately, as aggressive posturing puts fish stocks and the UK and EU fishing industries in jeopardy. Rather than romanticising a battle at sea, it is imperative that negotiations are done constructively with the EU and the self-defeating and falsely reassuring positions ministers are giving out are abandoned.

This also applies beyond the Brexit negotiations and to the quota negotiations themselves. Policy-making structures should prevent parties having the ability to leave the table and set their own unilateral quota limits. This could be achieved through fixed shares agreed for a medium-term period (5–10 years).

It may even be the case that a more cooperative relationship could set the groundwork for two important outcomes: access to the EU market with minimum tariffs/non-tariff barriers, and a post-Brexit fisheries transition deal. With over half of UK-caught fish destined for EU plates, low tariffs are extremely important, with UK fish processors and wholesalers highlighting this issue as their top priority in Brexit negotiations. With several key EU policies on sustainable catches, discarding, and subsidies expiring in the next couple of years, a transition deal would also bring greater confidence to the UK fishing industry.

13. THE UK MUST BRING IN NEW POLICIES BEYOND BREXIT TO GIVE MORE POWER TO FISHERS ‘LEFT BEHIND’

Fishing policy, which has for too long seen power concentrated in the hands of a few boats, excluding many smaller boats, looks set to continue this way under Brexit unless domestic policies are changed. As the bold promises for a brighter fishing future post Brexit have been made to the whole fishing industry, large and small, quota holders and non-quota holders, these changes are an absolute prerequisite for a successful outcome. Adjusting fishing quota, as well as access to waters, can also be used to incentivise better environmental practices.

This should be true of the process of decision-making as well. There is an important role for the UK government to deliver forms of adaptive co-management that empower fishers to really take control. Replicating power structures from Brussels to national administrations will simply replicate the animosity towards management.

A new peer-to-peer quota swapping system would also allow fishers to take control and shape their own quota portfolios, including those fishers without the resources to benefit from markets for leasing or purchasing quota.

The opportunity of Brexit to rethink core aspects of the UK fisheries policy should be directed towards the issue of paying for fisheries management. Currently the management of fisheries is paid for through general taxation while the fishing industry has avoided the resource access fees that characterise industries like oil & gas, water, and forestry. This is despite the limits on fishing licences to prevent new entry and the large profits that are accruing in several fleet segments. A landings tax would be one potential

method to pay for management. This tax could also be differentiated, for example on landings in the UK versus landings abroad.

From the scenario analysis and research, the following policy recommendations for the UK government, supported by all stakeholders, are put forth:

- Drop combative rhetoric to match the collaborative reality.
- Set sustainable catch limits.
- Use a rise in quota to help all boats.
- Seek a post-Brexit transition deal for at least two years.
- Secure access to the EU market with minimum tariffs and non-tariff barriers.
- Create a platform for continued quota swapping.
- Make access to waters conditional.
- Empower fishers through co-management and increased representation for the small-scale fleet.
- Generate funding for management through a landings tax.

Taken together, these policies recognise the current imbalances in UK fisheries and drivers of unsustainable behaviour and help ensure that, whatever happens with Brexit, we have a fishing policy designed for the needs of all UK fishers, as well as the communities who rely on them.

SECTION 1: INTRODUCTION

The exit of the United Kingdom (UK) from the European Union (EU) (Brexit) presents what could be the greatest change to fisheries management the industry has ever seen. The management of EU fisheries is by-and-large an EU competency, with some notable policy areas (e.g. vessel licensing, permit schemes, and quota allocation) remaining in the hands of member states serving as the exception to the rule. It has now been confirmed that the UK government will draw up a fisheries bill of its own to replace the EU's Common Fisheries Policy (CFP).

Despite forming a small percentage of the economy (0.05% of GDP),¹ the association of fisheries with the identity of the UK as an island nation and the early announcement that the UK would withdraw from the London Fisheries Convention have put fisheries in the spotlight of Brexit negotiations. The UK's approach to fisheries is viewed as totemic of the kind of Brexit being pursued.

For some in the fishing industry – the catching sector more than in processing or wholesale – this is an exciting time, and a chance to reform or even scrap parts of the CFP. For these fishers, Brexit represents a 'sea of opportunity'. Others are much less enthusiastic, pointing out the risk of greater barriers to trade as a result of the UK losing its place in the Single Market. Environmental groups are worried about Brexit contributing to overfishing and increased marine impact.

This is a highly complex issue with many uncertainties, as reflected by the detail of our analysis. Indeed, this complexity is precisely the point. In reality, Brexit is both a *sea of risk* and a *sea of opportunity* for the UK fishing fleet. There is significant uncertainty, yet also many bold and optimistic claims capturing headlines about the post-Brexit prospects for the fishing industry. It is also the case that there is no single, homogenous UK fishing fleet, but various groupings of vessels that can be characterised by their fishing gear, vessel length, target species, fishing grounds, access to fishing rights, and market orientation, among other dimensions. Unless everything stays the same – which Brexit rules out – there will be winners and losers. How the risks and opportunities of Brexit weigh

against each other may depend on which fleet segment is in question. This report provides the first attempt to answer the question of how the risks and opportunities of Brexit balance against each other, or, to answer a headline in the *Financial Times*: ‘Will Britain’s fishermen be better off after Brexit?’² Section 2 outlines the relevant Brexit developments and their impact on UK fishing fleets. The developments that can be quantified at this stage are combined into Brexit scenarios in Section 3. These scenarios are then modelled for their impact on fleet economic performance in Section 4 and discussed in Section 5. The report concludes with policy recommendations in Section 6 and a summary in Section 7.

SECTION 2: THE POTENTIAL IMPLICATIONS OF BREXIT FOR UK FISHING FLEETS

2.1: BREXIT WILL FUNDAMENTALLY CHANGE FISHERIES MANAGEMENT

Brexit will end the four freedoms

The European Union means many things to many people, but at its core it is a political and economic bloc bound by what are termed the 'four freedoms': freedom in the movement of goods, services, capital, and people. For the fishing industry, the most significant of these freedoms is the movement in goods, as fish is a highly traded product with large volumes of fish moving from UK producers to EU consumers. Impacts will also be felt from any restrictions to the flow of labour (mostly through the fish processing sector) and potentially the flow of capital, although the UK has typically allowed the free flow of capital through open markets.

The UK will claim an Exclusive Economic Zone (EEZ) for fisheries

Much of the discussion on post-Brexit fishers has not been about the four freedoms, however, but about how the UK may claim its own EEZ outside of the EU. This possibility requires some historical context; indeed, the entire history of EU fisheries policy is bound up in the history of EEZs.

On 1 January 1973, at the time of UK accession to the European Economic Community (EEC), the precursor to the EU, coastal states had exclusive access to 12 nautical miles (NM) from their coastline, although some countries like Peru, Chile, and Iceland had begun to expand their claims.

As a condition for accession, the UK accepted that waters would be shared. Regulation 2141/70 states:

Rules applied by each Member State in respect of fishing in maritime waters coming under its sovereignty or within its jurisdiction shall not lead to differences in treatment of other Member States.

Member States shall ensure in particular equal conditions of access and use of fishing grounds in the waters referred to in the preceding subparagraph for all fishing vessels flying the flag of a Member State and registered to the Community territory.³

This regulation was put into force just six hours after negotiations with the accession countries (UK, Ireland, and Denmark) began. This is no coincidence. In his book, *The Origin of the CFP*, Ernesto Penas Lado notes that this sharing of waters extends from the 'idea of the CFP as a basic deal between those having the resources and those having the markets'.⁴

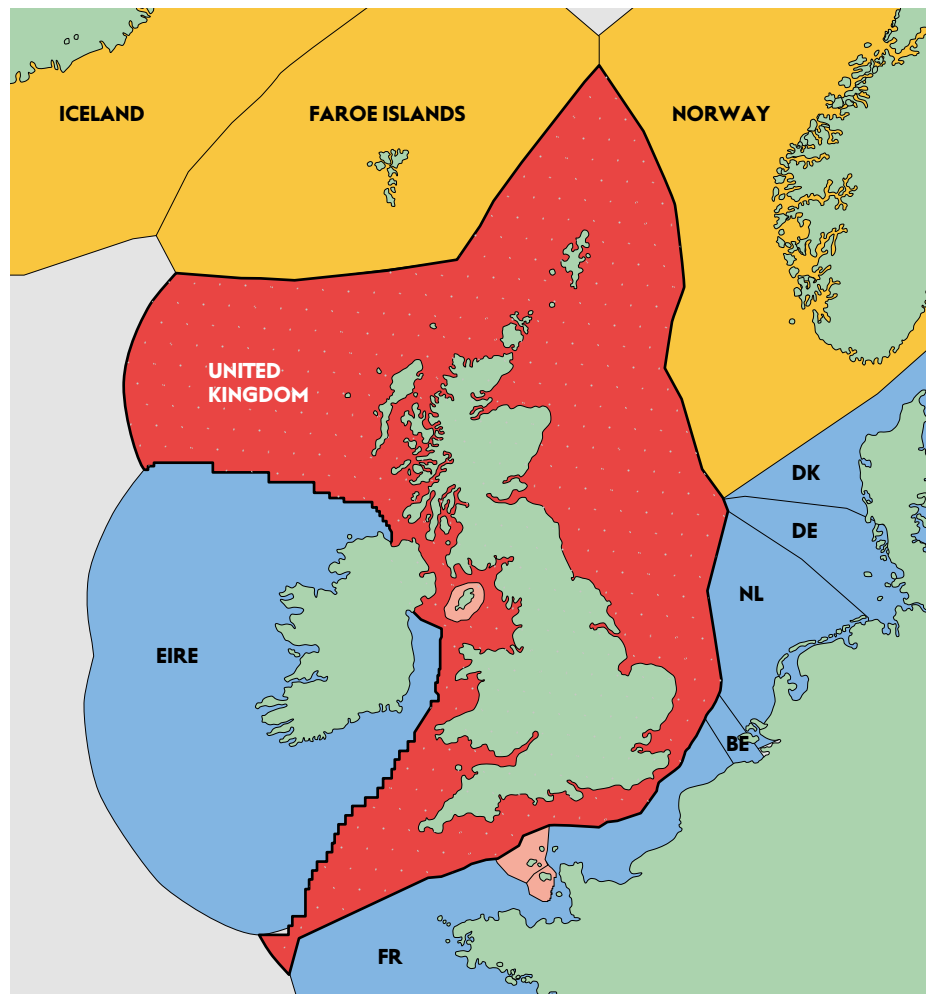
On 1 January 1977, when all EEC member states declared their EEZs out to 200 NM, the result was to create one large, shared EEZ for the EEC.

This historical development of EEZs in European waters has led to confusion over the language of 'taking back' British waters used during the Brexit referendum campaign. According to the Brexit lobbying group Fishing for Leave, 'We have the right to 200 nautical miles that surround our coast. We want to get back the waters that were taken away from us when Edward Heath, the then-prime minister, entered us into the EU.'⁵

Although in today's international law, the UK could seek to claim 200 NM or the midpoint (Figure 1), before UK accession to the EU, as described, the UK EEZ extended to only 12 NM.⁶ This confusion even appeared in the 2017 Conservative Election Manifesto,

UK fishing industry. The distinction between UK and EU EEZs would then mean that access to those fishing waters needs to be re-determined, creating a maritime border of sorts, and may also weigh in to discussions on how quota (quantity limits for

FIGURE 1. THE UK 200 NM EXCLUSIVE ECONOMIC ZONE



Source: House of Lords (2017)⁷

which states that the UK 'will be fully responsible for the access and management of the waters where we have historically exercised sovereign control'.⁸ While vague, this pledge appears to refer to 12 NM only, but it remains unclear.⁹

Regardless, the understanding that the UK may seek an EEZ of 200 NM, at least as an initial negotiating position, could have profound effects on the

commercial species such as haddock, sole, and mackerel) should be split for shared fish stocks that straddle or migrate across the EEZ boundary. It is expected, at least on the part of the UK fishing industry, that fishing quota will change from a system based on historical catches (termed 'relative stability') to a system based on how the biomass of fish stocks is split between the respective EEZs (termed 'zonal attachment').

The UK may seek regulatory change outside of the EU's Common Fisheries Policy

The EU's CFP currently governs much of UK fisheries law. The European Union (Withdrawal) Bill – known as the Repeal Bill – intends to initially transpose this legislation, to the extent possible, into UK law. However new UK fisheries legislation could have far broader consequences – for example, reforming technical regulations (mesh size, minimum landing sizes), management strategies (fishing quota, the landing obligation, subsidies), or overarching policy objectives (maximum sustainable yield (MSY) – the largest catch that can continue indefinitely). These changes in regulation and governance would have important impacts on all active fishing fleets as well as marine ecosystems.

These developments will inevitably have secondary impacts to consider

There are also indirect changes from Brexit outside of the policy space, as the sheer scale of Brexit is expected to have impacts across economic, environmental, social, and cultural spheres. The macroeconomic impacts of this change are likely to have the most significant economic impacts for UK fishing fleets. The weakened economic outlook associated with leaving the EU is worrying in terms of the consumer market for fish products as well as fleet investment. The depreciation in sterling impacts fleet economics by making British-sold products more attractive in foreign markets, but also raising the prices of key input costs, in particular fuel. These macroeconomic factors are deepened by the significant amount of uncertainty that surrounds Brexit.

Changes to the UK EEZ that result in increased quota shares and/or restricted access to UK waters may also lead to increased overfishing, particularly if the EU does not accept the proposed reduction of the quota share that is

available after the UK claims its share. This risk to the health of fish stocks then feeds back to fleet economics in the form of reduced future yields and economic performance. Changes to fishing regulations are likely to go through a similar policy-environment-fleet economics feedback loop if there are negative ecosystem impacts – such as the removal of mesh sizes or minimum landing sizes for fish species.

The three big factors: access to waters, quota, and trade

Several stakeholder workshops on Brexit and fisheries have identified access, quota, and trade as the key issues of Brexit.^{10, 11, 12} They will have significant direct effects on the UK fishing industry. There are also likely indirect impacts from these and other changes that could, in turn, impact fleet economic performance. Table 1 summarises these factors.

Analysis focuses on catching sector, just one link in the seafood supply chain

Discussions on fisheries tend to focus on the production/catching sector. This sector is the most visible and directly impacted by fisheries policy, but it is by no means the largest by value, employment, or other metrics.

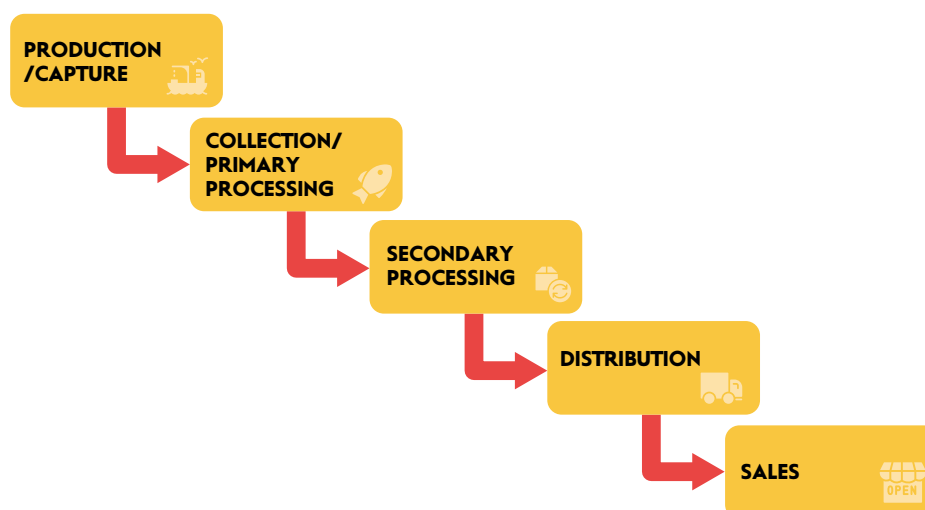
The seafood supply chain can be illustrated many ways, with a simplified version in Figure 2.¹³ It is important to note that impacts on sales or distribution, as may be seen through Brexit, can work backwards (e.g. through demand and prices) to, in turn, impact production.¹⁴ It is not a one-way chain of impacts.

This report focuses on UK fishing fleets – the first link in the seafood supply chain. Total separation between sectors is not possible, however, and the impacts of Brexit on the latter stages of the supply chain will be described in cases where the knock-on effects

**TABLE 1. BREXIT CONSEQUENCES AND THEIR POTENTIAL EFFECTS
 ON THE UK FISHING INDUSTRY**

Potential Brexit consequence	Factors that directly affect the UK fishing industry	Factors that indirectly affect the UK fishing industry
Ending the four freedoms	<ul style="list-style-type: none"> • Imposition of tariffs* • Imposition of non-tariff barriers* • Reductions in EU labour • Restrictions to the establishment of EU businesses 	<ul style="list-style-type: none"> • Depreciation of sterling • Changes to consumer spending on fish products • Changes to investment by fishing companies and businesses
Changes to the UK EEZ	<ul style="list-style-type: none"> • Extent of and access to UK waters* • Quota shares* 	<ul style="list-style-type: none"> • Overfishing*
Regulatory change	<ul style="list-style-type: none"> • New or amended UK fishing policies and regulations 	<ul style="list-style-type: none"> • Ecosystem impacts

* In this study, the five starred impacts in Table 1 will be explicitly modelled, while the other changes will be described later and an indication of the direction of change provided.

FIGURE 2. THE MULTI-SECTOR FISHERIES SUPPLY CHAIN


to the catching sector is likely to be significant. Note that the focus on UK fishing fleets also excludes aquaculture, although this industry should be analysed in future studies as it is dramatically increasing production and is a major exporter to the EU.

2.2 THE POLITICAL REALITIES OF BREXIT

The UK will face trade-offs in Brexit negotiations

There is widespread recognition among industry experts that trade-offs will have to be made. After the Brexit

referendum, the National Federation of Fishermen's Organisations (NFFO) issued a clear warning:

Promises have been made and expectations raised during the referendum campaign and it is now time to examine if and how they can be delivered. Unfortunately perhaps, the UK's geo-political position means that it is not politically or legally possible just to ring-fence most of our fish resources in the way for example that Iceland can. The reality is that most of our stocks are shared with other countries to some degree or other.

We can certainly seek to renegotiate quota shares as well as access arrangement, but it is realistic to expect that there will be a price of some sort. Who will pay that price is a critical question.¹⁵

Not dissimilar to the four fundamental freedoms of the EU (goods, services, capital, people), fisheries policy also contains four main areas that the EU will link together as part of a deal: policy, access, quota, and trade. Several EU actors have already been clear about using the threat of trade to keep existing arrangements on access and quota. According to Danish MEP Ole Christensen, 'If we are not able to fish in UK waters and the UK cannot export their catch to the EU27, it will hurt everyone, not least the people who make their living in the sector. For the sake of everyone, we need to keep an open mind and work on getting a fair deal.'¹⁶

That any post-Brexit arrangement will likely involve trade-offs is explored further under each Brexit impact in the rest of this section.

Fisheries is just one issue in a much larger negotiation

It is accepted that many aspects of post-Brexit fisheries will not be dealt

with on their own terms, but instead as part of a broader fisheries deal. Going further, even fisheries policy as a whole will be swept up in the larger negotiations. This reality of negotiations is that just as there will likely be difficult trade-offs between aspects of a post-Brexit fisheries deal, there may also be trade-offs between whole sectors. How the EU and the UK will prioritise their respective sectors is difficult to determine, although a leaked memo from the UK government's negotiation team lists the fishing sector as 'medium-priority'.¹⁷

This report will not dwell on the trade-offs between industries in negotiations, however inevitable. Just analysing the fishing industry provides ample scope for analysis. All issues outside of fisheries are implicitly incorporated into the Brexit scenarios for the fishing industry in Section 3.1

The UK needs the EU more than the EU needs the UK, especially when it comes to fisheries

In trade relationships, it is generally the case that the larger country holds the market power as smaller countries are forced into the position of 'price takers'.^{18, 19} This dimension has often been overlooked when some UK politicians and commentators focus on the volume of trade and conclude that 'they need us more than we need them'.²⁰

It is true that the EU sells about £60 billion more to the UK than the UK sells to the EU (£290 billion versus £230 billion), so the UK runs a trade deficit with the rest of the EU,²¹ but this is only one – rather limited – concept of 'need' and market power. As a percentage of exports, the UK relies on the EU market for 41% of its exports, whereas the EU relies on the UK market for only 17% (or 8% if you include intra-EU trade) of its exports.^{22, 23} The Economist explained the numbers game: 'As many a supplier to a big supermarket knows, if one

customer has half your business, they have a lot of power over you.’²⁴

Put another way, as a percentage of the economy, the UK relies on exports to the EU for 12% of GDP, whereas the EU relies on exports to the UK for 3% of GDP.^{25, 26} These relative indicators of market power indicate that the exact opposite is true: the UK needs the EU for trade more than the EU needs the UK. This is not surprising as increasing market size and thus market power is one of the key principles of acting as a trading bloc.

This is the overall picture, but there are also dynamics specific to the trade in particular product categories. The UK may act as a monopoly for some products where it dominates the market as a producer, or the EU may act as a monopsony (where there is only one buyer) for some products where it dominates the market as a

consumer. Tariff incidence is explored for individual seafood products as part of the report methodology in Annex B.

Priorities for post-Brexit fisheries vary by stakeholder

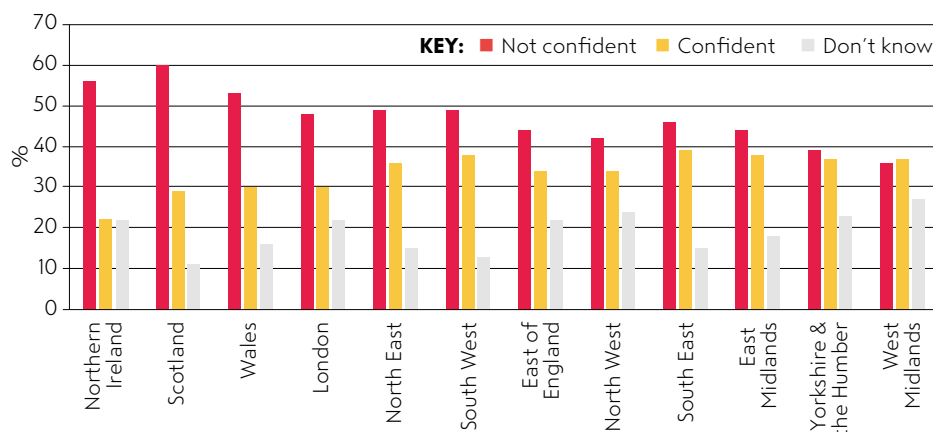
There will be hard choices for the UK to balance various Brexit demands, made harder by the fact that different stakeholders have expressed different priorities. The SFF, for example, has expressed the view that tariffs are not a significant problem for them given the potential scale of quota increases,²⁷ whereas the Seafood Industry Alliance cited zero or low tariffs as its top Brexit priority.²⁸

An analysis by researchers at the University of York ranked stakeholder priorities across six sectors (Table 2).²⁹ The divergent view between stakeholders are explored further in discussing the results in Section 5.2.

TABLE 2. RANKING OF STAKEHOLDER PRIORITIES FOR UK FISHERIES POST BREXIT (1 LOW – 4 HIGH)

Priorities / Stakeholders	Commercial fisheries	Seafood processors & suppliers	Inshore managers (IFCAs)	Recreational fisheries	Scientists / academics	Environmental NGOs
Sustainable fisheries	4	4	4	4	4	4
Strong governance and well-enforced management	3	4	4	4	4	4
Ecosystem protection	2	2	4	4	4	4
Reformed regional and flexible management	4	2	4	4	3	3
Shared management/collaboration with the EU	2	4	2	3	4	4
Strong and well-funded science	2	3	3	3	4	4
Access to zero/low-tariff export markets	3	4	2	2	3	3
Better deal for inshore commercial fisheries	3	2	4	2	3	2
UK exclusive zone inside 12 NM	4	2	3	2	2	2
Full control of UK EEZ	4	2	2	2	2	2
Increased share of quotas	4	2	3	1	2	2
Improved marketing of UK seafood	3	3	3	1	2	2
Replacement of European Maritime Fisheries Fund	3	2	2	1	2	2
Resolution of devolved management issues	2	1	2	1	3	2
Stricter rules on foreign-owned vessels	3	1	2	1	2	2
Access to zero/low-tariff imports of raw materials	1	4	1	1	2	1
Continued access to EU labour	2	4	1	1	1	1
Better deal for recreational fisheries	1	1	1	4	1	1

Source: Stewart & O’Leary (2017)³⁰

FIGURE 3. CONFIDENCE IN THE UK STOPPING OVERFISHING COMPARED TO THE EU

Source: Author's calculations from Oceana (2017)³¹

Note: Survey question: How confident, if at all, are you that the UK government will be better at stopping overfishing in the UK post Brexit, compared to the existing guidance from the European Union (EU)?

Sustainable fisheries may limit what actions are taken

The only issue that all stakeholders view with the highest priority is 'sustainable fisheries'. This creates a complicated political reality, however, as some of the other priorities may undermine sustainability – especially as the EU is likely to be acting on the demands of its own industry.

There seems to be wide recognition of this point. Despite the vote to leave the EU, public opinion surveys reveal a UK public that believes that leaving the EU is likely to have a negative impact on fisheries and the marine environment. A poll carried out by YouGov for Oceana found that the majority of respondents were not confident that the UK government would be better at stopping overfishing than the EU.³²

Environmental experts are particularly worried about Brexit degrading the marine environment. A survey by the Chartered Institute of Ecology and Environmental Management (CIEEM) of its membership found that 93% thought the EU was positive for the UK's natural environment and 74% thought Brexit would be bad for the recovery of marine fisheries.³³ Several

environmental and marine NGOs have also warned about the negative implications of Brexit for the marine environment.^{34,35} As of October 2017, the Greener UK risk tracker assessed fisheries as 'medium risk'.³⁶ The reality of overfishing as a key Brexit risk is explored further as a sensitivity analysis in Section 4.2 and in a discussion of the results in Section 5.2.

The large-scale fishing fleets have the largest voice in UK fisheries

Finally, it is important to recognise that even within the catching sector there are diverse priorities. Much of the media coverage to date has focused on the large-scale fleet as it has more power and lobbying representation, but its priorities are not universally held. Some fishers do not hold quota, do not fish out to 200 miles, but do export to the EU, for example. This report goes on to explain the implications of this diversity.

Issues of devolution severely complicate the Brexit process

How fisheries management will be shared between Westminster and the devolved administrations of Scotland, Wales, and Northern Ireland is still uncertain. Scotland, and to a lesser

extent Wales and Northern Ireland, have expressed the view that they would like greater competencies in fisheries management. It may even be the case that the devolved administrations will make claims that principles the UK is arguing for in Brexit negotiations, like dividing quota shares based on EEZs, should apply within the UK as well.³⁷ Scotland has already floated the idea of requiring its vessels to land 55% of their catch within Scotland.³⁸

Tensions between administrations increased in the last year with the Department for Environment, Food and Rural Affairs (Defra) shifting 1,500 tonnes of Arctic cod quota to Scotland, a move the NFFO, based in England, called 'opportunistic and nakedly political' as well as 'massively to the disadvantage of England'.³⁹ Brexit looks set to increase the frequency and intensity of these power struggles over fisheries management.

2.3 BREXIT IMPACT: CHANGE IN ACCESS TO WATERS (MODELLED)

Leaving the EU and declaring an EEZ would most directly impact on which fishing vessels can access these waters. In the past, when countries have declared an EEZ it has been to exclude foreign activity, including fishing, such as when Iceland excluded UK fishing vessels from its EEZ in the 1970s. The ensuing conflict led to militarised intervention and what has been termed the 'cod wars', with Iceland emerging as the eventual victor, nearly wiping out the entire UK distant-water fishing fleet based in ports like Grimsby, Hull, and Fleetwood.

The experience of the cod wars and the loss of historic fishing grounds is etched in the collective memory of the UK fishing fleet. Many in the UK fishing fleet are excited by the prospect of role reversal and taking Iceland's position, this time extending its waters,

whereas at the time it protested that anything beyond 12 NM was 'ocean grabbing'.⁴⁰

While UK fishers do fish in the EU EEZ and sometimes land in EU ports due to closer proximity and/or higher prices, many of the most productive European waters are in the UK EEZ. That EU fleets are currently the larger beneficiary of shared waters has generated a perception of unfairness and anger from the UK fleet at the sight of foreign trawlers in British waters. However, just because the benefits of shared waters are less for the UK, it does not follow that the UK loses out of the arrangement. Whether benefits are evenly balanced between actors and whether the benefits exceed the costs for each actor are two distinct questions as sharing waters is not zero sum.

Divided waters but shared stocks

Historically, countries excluding foreign boats has meant more fishing opportunities for the domestic fleet. After excluding the UK fleet from Icelandic waters during the cod wars, the UK fleet could no longer target the Icelandic cod stock (as the Icelandic cod stock is contained within the Icelandic EEZ) and the Icelandic fleet could fish the stock exclusively.

This is not the case for UK fisheries as every single stock fished under quota (except for one Nephrops - known also as Norway lobster, Dublin Bay prawn, langoustine, or scampi - stock off the coast of Scotland) will continue to be shared between the EU EEZ and the UK EEZ. That is: fish such as cod, sole, and mackerel spend some of their lives in EU waters, and some in UK waters. The UK cannot replicate the experience of Iceland and exclude all other fishers. The EU will continue to fish these stocks even if the larger possible EEZ of 200 NM is claimed by the UK. It is quota shares, rather than access to waters, that determines how the

exploitation of shared stocks is divided (Section 2.4). The conflation between access to waters and quota shares may explain some of the enthusiasm in the press coverage and in the fishing industry for post-Brexit restrictions on foreign fleets in the UK EEZ.

Access to waters does have some effect on fishing performance, even for shared stocks. Fish populations can be more abundant, easier to catch, or at later stages of their lifecycle (larger and higher value) in different areas. As a result, highly productive waters become sought after for profitable trips. As an example, while some of the sole stock spawns near the shores of Belgium and France, the fish grows and matures in the Western English Channel and in the Celtic Sea. Belgian and French fleets target the stock in these more productive waters and land in Welsh and Cornish ports. Targeting fish stocks where they are more productive (and away from spawning grounds) has both economic and ecological benefits.

Fishing grounds can sometimes be crowded in productive areas (explored in Annex B). This conflict typically, though not exclusively, occurs in inshore waters (less than 12 NM from the coast). While these waters remain nationally controlled under EU law, the London Convention, which predates the CFP and has been replicated in EU law, has granted reciprocal rights within the 6–12 NM zone to different fishing fleets based on historical fishing patterns. The UK government has withdrawn from the London Convention, which will take effect in June 2019. Both changes in access have the potential to relieve gear conflict (the damaging of fishing gear, often unintentional, by other fishers) by limiting vessel access for non-UK vessels and opening up UK waters.

Is it possible?

There is a legal question as to whether the UK would need to recognise historical fishing rights within its EEZ. The view of the government, based on the fisheries minister's comments and publications from Defra, is that exclusive access should not be assumed, even with an EEZ.⁴¹

Much of this uncertainty revolves around international obligations. Professor Richard Barnes and Ms Mercedes Rosello, researchers of fisheries law at the University of Hull, have explained that, 'Under international law, coastal states are stewards, not owners, of their EEZ, and obliged to cooperate in fisheries management. This may entail allowing foreign fleets access to fish stocks in coastal waters.' The authors conclude: 'In our view, Brexit is unlikely to produce a radical revolution in fishing regulation and allocation. At least in the short to medium term.'⁴²

Andrew Oliver of Andrew Jackson Solicitors reached a similar conclusion about the likelihood of a softer border, writing in Fishing News that:

While the obvious starting point is UK waters for UK vessels, such a position would be politically untenable and potentially in breach of UNCLOS (the United Nations Convention on the Law of the Sea) and, therefore, access rights would have to be negotiated, both in respect of EU member state vessels in UK waters as well as UK vessels in EU waters.⁴³

This view, or at least this tone, is not unanimous. The SFF published a legal opinion on the issue from Professor Robin Churchill of the University of Dundee. Professor Churchill writes that:

Other EU Member States have not accrued any rights to fish in the UK's EEZ that will survive the UK's departure from the EU. If it can be shown that the EU will suffer economic dislocation when its vessels that have habitually fished in the UK's EEZ are no longer able to do so post Brexit, the UK should consider giving the EU access to that part of the allowable catch surplus to the UK's harvesting capacity. The same will apply, *mutatis mutandis*, to fishing by UK vessels in the EEZs of other EU Member States.

Of course, post Brexit it would be always open to the UK to permit EU vessels to fish in its EEZ in exchange for the access of British vessels to the waters of other EU Member States. However, that is a completely different matter.⁴⁴

On the EU side, the Danish Fishermen's Association is reported to be building its own legal case on access rights.⁴⁵ Niels Wichmann, the chief executive of the Danish Fishermen's Association, was clear about the relevance about the EEZ: 'The British claim of getting back your waters is a nonsense, because you never had them. Maybe for oil or gas but not for fish.'⁴⁶ Flemish politicians have pointed to 'eternal rights' to fish in British waters due to a 1666 Royal decree issued by King Charles II.⁴⁷

Despite this uncertainty and the differences in legal opinion over historical rights, the broad summary seems to be there are requirements in The United Nations Convention on the Law of the Sea (UNCLOS) to coordinate over shared stocks (Article 63), but these requirements do not specify how this would look in practice or how access claims would be assessed (Article 62).^{48,49,50}

Besides the legal opinion, and likely more significant, is the political reality of European fishing. Michael Creed, the Irish Minister for Agriculture, Food and the Marine has said that, 'Any changes to existing rights for the Irish and EU catching sector must be resisted strenuously.'⁵¹ The leaked document from the EU Parliament holds 'reciprocal access for the EU and UK fleets to the fishing grounds in the UK and EU waters' as a condition for a post-Brexit UK-EU fishing agreement. The EU is expected to hold tariff-free access to markets as leverage.

Valentin Schatz writes on the Blog of the European Journal of International Law that it is these political realities that are likely to matter more than any legal case at the end the day:

To ignore the nature of these stocks and the importance of these obligations would likely lead to mismanagement and overfishing. Based on all these considerations, a negotiated solution between the UK and the EU that involves some form of reciprocal fisheries access seems to be more likely than not.⁵²

At the political level, there is also the question of how much the UK government will be willing to pay to enforce a maritime border. The Economist notes that given the current squeeze on incomes and the relatively small economic size of the fishing industry, that willingness to pay for additional enforcement costs may be too small.⁵³ As such, both the political and legal reality make the idea of a maritime border extremely complicated – if not impossible – to effectively implement.

Is it desirable?

There is a question as to whether a rigid border between UK and EU waters is desirable. To a large extent, different national fishing fleets have specialised in particular fish species more than geography. The UK fishing fleet, for example, has specialised in mackerel and whitefish like cod and haddock more than low-value pelagic species like sandeel, blue whiting, or Norway pout, even though the latter species exist in high quantities in UK waters.^{54,55}

The UK fishing fleet also fishes in EU waters, and 15% of the landed value of UK vessels is from EU waters.⁵⁶ According to Andy Lebrecht, a former director-general for food and farming at the Defra, retaining access to those waters will be an essential demand for the UK.⁵⁷

While some pro-Brexit reports in the lead up to the referendum vote called for a militarised maritime border,⁵⁸ sharing waters in some form is widely recognised, at least within the fishing industry, as necessary. Bertie Armstrong, chief executive of the SFF,

has estimated that, post Brexit, even non-EU fishing states like Norway might take around 25% of the fish in the UK EEZ through quota and access.⁶⁰

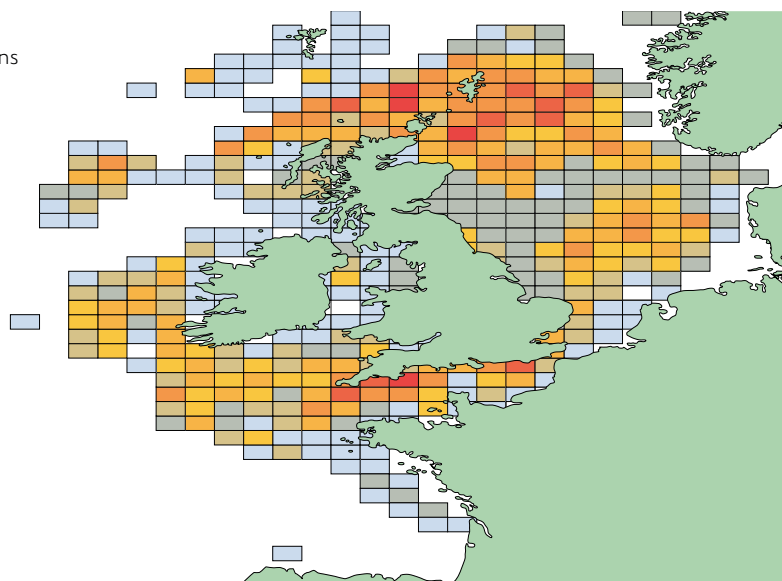
On 4 August 2017, Secretary of State for Environment, Food and Rural Affairs Michael Gove (hereafter Secretary of State) made comments to Danish fishers that they would continue to have access to UK waters post Brexit. According to Niels Wichmann, managing director of the Danish Fisheries Association, who attended the meeting, 'Gove said the British do not have the capacity to catch and process all the fish in British waters. Therefore, fishermen from Denmark and other EU countries will continue to have access to British waters after Brexit.'⁶¹

This was covered in *The Express* under the headline 'Brexit fisheries BOMBSHELL: Gove vows EU fishermen can STILL use UK waters AFTER divorce',⁶² while the BBC noted that 'Mr Gove's remarks in Denmark follow an appearance on the BBC's Andrew Marr Show last month, when

FIGURE 4. VALUE OF UK LANDINGS BY STATISTICAL RECTANGLE (30° BY 1°)**KEY:**

Value in millions

- >0 - 0.1
- >0.1 - 0.2
- >0.2 - 0.4
- >0.4 - 0.8
- >0.8 - 1.6
- >1.6 - 3.2
- >3.2 - 6.4
- >6.4 - 12.8



Source: Marine Management Organisation (2016)⁵⁹

he said no foreign boats would be allowed to fish within six to 12 miles of the UK coast.⁶³

Far from being a big reveal, this message to the Danish fishers is entirely consistent with what government officials have been saying about ‘mutual access to waters’ in media interviews, although perhaps confused due to the emphasis of ‘taking back’ British waters.⁶⁴ Minister of State for Agriculture, Fisheries and Food, George Eustice attempted to clarify the government’s position:

The only point I would make is that sometimes when it is said, ‘We are going to take back control of our EEZ out to 200 nautical miles or the median line’, it sounds perhaps more dramatic than it might be, in that even having established control of our EEZ we would then still engage in international negotiations around mutual access rights, mutual shares and the like.⁶⁵

The minister later echoed this sentiment on ceding access rights in a House of Commons evidence session:

What we cannot say is that we will have an exclusion zone and that no-one can come into our waters. There will be a sense of saying that we will grant some access, but it might not be the same sort of access that they are used to.⁶⁶

As for the withdrawal from the London Fisheries Convention and Gove’s appearance on The Andrew Marr Show, it is clear that ‘taking back control’ has never meant exclusive access, despite the resulting coverage.

Andrew Marr: The headline says, ‘no foreign fishing in our waters.’ Is it going to be completely banned once we leave the London Convention?

Michael Gove: Well, fishing within the immediate area around our waters, six to 12 miles, yes, we will be saying that we’re taking back control and we will in due course –

Andrew Marr: No French, no Spanish boats at all in those waters?

Michael Gove: We will have control. We can decide the terms of access.⁶⁷

This outcome of ‘mutual access rights’ may in fact resemble something close to the current situation with third countries like Norway. This existing model has generally worked well, and the UK can be expected to exchange quota (blue whiting) with Norway for access to its waters (for cod and mackerel). This is another reflection of the mutually beneficial arrangements that can arise from national specialisation in different fisheries. A maritime border forbidding access is likely not desirable for the UK or for other fishing nations.

Besides the existence of a border, debate has also begun over payments for access, as some have suggested for UK waters and are used in other international jurisdictions.⁶⁸

ACCESS TO WATERS: OUTCOMES

For the modelling of Brexit scenarios in this report, three different access outcomes are used:

1. Status quo (shared waters)
2. A partial border preventing free access to 200 NM and the exclusion of EU fleets
3. An enforced border preventing vessel access to 200 NM and the exclusion of EU fleets

These outcomes are detailed in Annex B4.

2.4 BREXIT IMPACT: CHANGE IN QUOTA (MODELLED)

One of the potential impacts in post-Brexit fisheries with significant implications for economic performance, and one that has received a great deal of attention in the media, is how quota (quantity limits for commercial species such as haddock, sole, and mackerel) on fish stocks will be shared post Brexit. In the early days of the Brexit vote, UK Fisheries Minister George Eustice, promised hundreds of thousands of tonnes of additional quota post Brexit, according to the Daily Telegraph.⁶⁹ Several studies (detailed in Table 3) have also calculated a significant increase in landings if the UK were to claim its share of fishing quota based on the portion of fish stocks in the UK EEZ, shares that are significantly less than what is granted through the EU system of 'relative stability'. Much like access to waters, however, things are not as simple as they may seem, and much like the history of EEZs and British waters, it is important to understand the history of quota shares and how such an unequal situation came to be.

The history behind relative stability

In the late 1970s, given the growing appreciation both within the EEC and internationally that fish stocks were not infinite and fishing pressure could not keep expanding, the EEC was in discussions about how to introduce a limit on the amount of fishing pressure and how it should be shared between the EEC members, including the UK.

Over six years (1973–1978), EEC members negotiated these shares. The way this was done was termed 'relative stability'. It comprised three elements:

- Recorded catches from 1973 to 1978.
- Losses of fishing opportunities as a consequence of EEZs.

- Special needs of coastal communities with a high dependency on fishing.

The UK was a beneficiary under the latter two conditions, with extra quota granted in recognition of losing access to Icelandic waters, and the creation of The Hague Preferences for the UK and Ireland to guarantee a quota floor (in quantity) for certain stocks that override the percentage shares based on historical catches.

While this was agreed at the time by all EU members, looking back decades later many UK fishers feel hard done by through the relative stability shares. The concept of zonal attachment, where quota shares are determined by the share of the biological stock inside the EEZ, has grown in prominence and is currently used for negotiating quota shares with third countries like Norway. The UK position on post-Brexit quota shares is that they should align with zonal attachment rather than relative stability or historical catches.

The 1982 UNCLOS, which sets out a framework for shared fish stocks, is not specific on how quota rights should be divided. Much like access to waters, it is expected that the EU will vigorously fight to keep its existing quota shares, arguing that the UK accepted these shares initially and did not even raise the issue of renegotiating relative stability during previous rounds of CFP reform.

Again, much like access to waters, there are certain fish stocks that are found within the UK EEZ that the UK fleet does not target and there may be a middle scenario where zonal attachment is invoked by the UK as a starting position, but quota shares are renegotiated based on the priority stocks for each side. There is already an indication of these priority stocks from quota swaps that take place every year between the UK and other EU member states.

It is noteworthy that the idea of revisiting relative stability within the EU has been building momentum due to shifting stocks because of climate change and the difficulties associated with the landing obligation (the requirement to bring all catches to shore to eliminate discarding). It is possible that Brexit may force the issue and the EU may renegotiate quota shares internally at the same time as the UK exits. That said, it took six years to negotiate relative stability, so Brexit presents extremely difficult timelines for the EU to respond.

Is it possible?

There is little doubt that *some* change in quota shares post Brexit is possible; indeed it may have been on the cards regardless. What is debated is to what extent the UK can unilaterally define what 'fair shares' would look like.

An increase to the UK's share of the fish stocks will meet resistance from the EU side, and experts have warned that quota increases would be subject to negotiation.⁷⁰ Former Minister of State for Agriculture, Fisheries, and Food Ben Bradshaw has emphasised that the position of the EU is being ignored or forgotten in statements being made about quota gains post Brexit.

George Eustice blithely asserts Britain could unilaterally impose a 200-mile fishing limit and that our fishermen would get bigger quotas if we left the European Union. Any sensible person considering these wild claims would understand them to be complete nonsense. The idea that if we voted to leave the EU, our neighbours Ireland, the Netherlands, Belgium, Germany, France and others would simply fall over and allow us to impose a 200-mile limit is for the birds.⁷¹

This view is supported by a leaked document from the EU Parliament's Fisheries Committee (PECH) that states that there should be 'No increase to the UK's share of fishing opportunities for jointly fished stocks (maintaining the existing quota distribution in UK and EU waters)'.⁷² There has also been caution from other parties, with Audun Marå, managing director of the Norwegian Fishing Vessel Owners' Association (Fiskebaat), warning: 'I think it is unrealistic of the British to believe they will receive larger quotas than those they had as a member of the EU.'⁷³

For his part, besides the promise of 'hundreds of thousands' of extra tonnes, Eustice has given little detail on what should be expected. When pressed in a House of Commons evidence session about increases to quota, the Minister would not confirm that there would be any.

Neil Parish: That does not really answer the question, yes or no. Are there going to be more fish for our fishermen? It is a fairly straightforward question, and I think you alluded to it during the campaign. Most of our fishermen went away from your meetings thinking they were going to get a lot more fish, so where is it?

George Eustice: We have not started the negotiations yet.⁷⁴

Is it desirable?

Despite citing quota shares as one of the greatest changes that should be made to post-Brexit fisheries, Eustice has never fully committed to the idea of determining quota based on zonal attachment, instead presenting zonal attachment as the mere starting position:

When it comes to haddock and cod, France gets about three or four times more than English fishermen. [But] if we were to leave the EU, we would re-establish control of our waters out to 200 nautical miles, and this would give us a starting point to renegotiate quota allocations for the UK.⁷⁵

An increase in UK quota shares, all else being equal, would bring more fishing opportunities and revenue for

UK fishers. However, an issue that seems to have gone unnoticed is that an increase in quota share and UK fishing activity would erode the main benefits (reduced crowding) associated with restricted access to UK waters for EU fishing fleets (Section 2.3). For each UK vessel, the benefits of excluding EU vessels disappear if this fishing activity is simply displaced by UK vessels and the degree of crowding remains unchanged.

TABLE 3. FISH LANDINGS BY UK AND EU EEZ

Papers on UK fisheries post Brexit	Unit	Data year(s)	EU landings from UK EEZ	UK landings from EU EEZ	UK current	UK zonal	Net change	Net change (%)	Corrections
Napier (2017)	1000 landed tonnes	2011-2015	700	92	626	1234	608	97%	
HM Government (2017)	1000 landed tonnes	2015	683	111	671	1243	572	85%	Landings reported as catches.
Fishing for Leave (2017)	1000 landed tonnes	2010-2014	675	88	603	1328	725	120%	Source contains calculation error that overestimates net change by 100%. Landings reported as catches.
Goulding & Szalaj (2017)	1000 landed tonnes	2014	802	131	989	1660	671	68%	Source contains calculation error that overestimates UK zonal share by 175 thousand tonnes. Landings reported as catches.
Napier (2017)	£mn landed value	2011-2015	530	110	800	1220	420	53%	
HM Government (2017)	£mn landed value	2015	484	114	775	1145	370	48%	Landings reported as catches.
Fishing for Leave (2017)	£mn landed value	2010-2014	711	102	796	1583	787	99%	Source contains calculation error that overestimates net change by 100%. Landings reported as catches.
Goulding & Szalaj (2017)	1000 tonnes of cod equivalent	2014	468	81	630	1017	387	61%	Source contains calculation error that overestimates UK zonal share by 118 thousand tonnes of cod equivalent. Landings reported as catches.
Fishing for Leave (2017)	1000 tonnes of quota	2010-2014			502	1220	718	143%	Source contains calculation error that overestimates percentage change by 100%.
Fishing for Leave (2017)	£mn quota landed value	2010-2014			636	1396	760	119%	Source contains calculation error that overestimates percentage change by 100%.

Sources: Napier (2017), HM Government (2017), Fishing for Leave (2017), Goulding and Szalaj (2017)

Note: ■ Calculated from source or Marine Management Organisation (MMO) data. ■ Correction made to source.

It is clear that due to the UK's large EEZ relative to the size of its historic fishing (and therefore quota shares under relative stability), the UK should expect larger quota shares under zonal attachment. Several studies have analysed current landings based on recorded location and reported that the UK would receive a much larger share of the fishing resource if quota were shared between the UK and EU based on EEZs.

Table 3 compares these calculations of landings by EEZ for four different studies, all of which use the same data reporting from the European Commission's Scientific, Technical and Economic Committee for Fisheries.

^{76,77,78,79} Some adjustments have been made in this table to report the results as a net change and to correct for calculation errors.

The equation for net change is as follows:

$$\text{Net change} = \frac{(\text{EU landings from UK EEZ} - \text{UK landings from EU EEZ})}{(\text{Current UK landings})}$$

An issue with all the quota comparisons is that they are based on landings by area, and as such are not directly linked to quota shares under zonal attachment. All four studies assume the landings by area reflect biomass, but this is not necessarily true. A study by the University of Aberdeen for the SFF on biomass by EEZ differs significantly from the estimates by landings in the Fishing for Leave study. All four studies also group quota and non-quota species together in the results. In the current management of fisheries, there are no limits on non-quota species that are shared and so there is no mechanism from which to arbitrate fair shares post Brexit.

In fairness, the Napier, UK government, and Goulding and Szalaj reports do not imply any policy implications in their studies of landings by EEZ, with only the Fishing for Leave study claiming that future quota should and will be based on this division. As many of these quotas, especially the largest ones like sandeel, Norway pout, and blue whiting, do not have a market in the UK, it is unlikely that the UK will want to stick closely to zonal attachment for post-Brexit quota shares. How relevant the concept of zonal attachment is will be determined during negotiations over post-Brexit fisheries management.

The Goulding and Szalaj report attempts to model how UK quota would change with respect to third country negotiations. There is a concern that the UK will be in a much weaker negotiating position with countries outside of the EU bloc, like Norway. While interesting to note, the modelling in this report (described in Annex B3) keeps these shares with third countries fixed, as does the Fishing for Leave report.

Comparable top line results are found in this report to most of the corrected estimates (Sections 4.1 and 4.3).

Quota outcomes

For the modelling of Brexit scenarios in this report, three different quota outcomes are used:

1. Status quo (relative stability).
2. Quota shares renegotiated between the EU and the UK based on preferred fish stocks.
3. Quota shares divided between the EU and the UK based on zonal attachment.

These outcomes are detailed in Annex B3.

Another issue with post-Brexit quota shares is that the EU currently negotiates a deal with Norway and the Faroe Islands, and pays for quota from Greenland through a fishing partnership agreement.⁸⁰ Post Brexit, the UK could continue to seek this quota, but Defra has clarified: 'Without collective EU negotiation, it would be challenging to get the favourable access we have now.'⁸¹ This aspect of post-Brexit quota shares has been excluded from the economic modelling due to its complexity and because the most likely scenario is that the UK will seek to replicate the status quo.

2.5 BREXIT IMPACT: CHANGE IN QUOTA SETTING AND OVERFISHING (MODELLED)

Overfishing risks the health of fish stocks and may result in lower catches in the long run as well as in lower economic performance from increased fishing effort for a smaller biomass of fish stocks. Even if an agreement on quota shares is reached between the UK and the EU, there is still the possibility of overfishing if the total quota is set above scientific advice in order to deliver high quota limits for both sides.

It is possible, especially as the EU seeks to maximise the quota it can allocate to its own fleet, that agreements over the division of quota will break down and result in the UK and the EU setting their own respective shares of a finite, shared resource. If these shares sum to more than 100%, then systematic overfishing will take place.

This potential for increased overfishing due to a looser management structure is one reason many environmental organisations and the majority of surveyed environmental professionals are worried about the prospect of Brexit for the future of the marine environment (Section 5.2).

Breakdown of negotiations and unilateral quota setting with third countries

Currently, EU ministers meet in December each year to set fishing quota in the Northeast Atlantic for the following year. Scientific advice is provided on the level of total catches (the total allowance catch: TAC) that will allow fish stocks to rebuild to population levels that will ensure their long-term sustainability (MSY).

Frequently, however, this advice is not followed. From 2001 to 2016, EU fishing quota exceeded scientific advice by an average of 20%, as ministers sought to 'win' quota for their national industries.⁸² By ending the use of relative stability, quota could potentially depart from scientific advice to an even greater extent. This can happen via two routes, both of which have plagued the management of shared stocks between the EU and third countries (Iceland, Norway, the Faroe Islands, and Russia).

The first risk is that the negotiations over quota shares between the EU and UK (i.e., a new relative stability) break down entirely. In this situation, each party then sets a quota for its own fishing fleet unilaterally. In previous decades, negotiations over shared stocks between the EU and third countries (i.e., mackerel, herring, and blue whiting) have sometimes broken down with negotiating parties walking away from the table. The cumulative unilateral quota that are set in this failed framework are usually much higher than the scientific advice – frequently by large amounts. These turbulent negotiations between the EU and third countries over quota shares have come to be known as the mackerel wars and the herring wars.

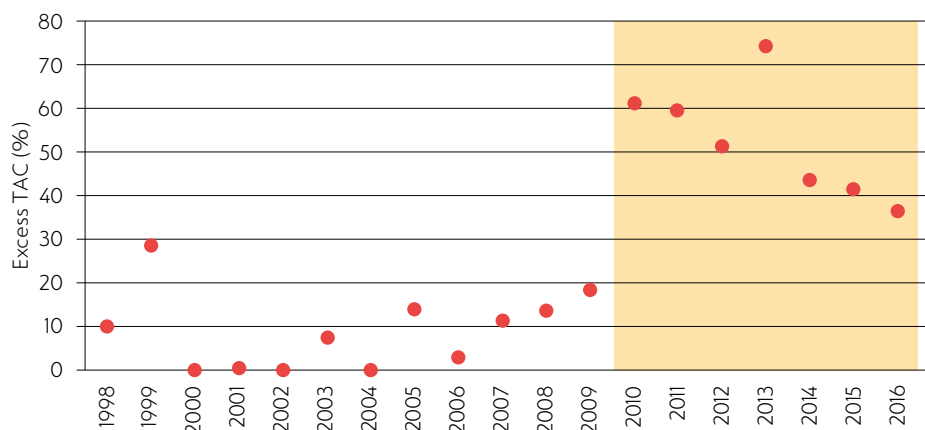
Unilateral quota setting and increased fishing pressure have had adverse effects on the sustainability of the shared fish stocks as well as serious

economic repercussions through other channels. At their height, the mackerel wars led to the mackerel fishery losing its Marine Stewardship Council (MSC) certification due to the failure of the management regime to ensure sustainable quota limits.⁸³ Regarding herring, the EU responded to the Faroe Islands' increased unilateral quota share by imposing an import tariff on Faroese fish products. Eventually the Faroese relented and lowered their quota limit.⁸⁴ Across the previous two

decades, unilateral quota for mackerel, herring, and blue whiting were set 33% above scientific advice as a weighted average.⁸⁵

The following set of graphs indicate the percentage by which quota for the shared mackerel, herring, and blue whiting stocks have exceeded scientific advice.⁸⁶ The periods in orange indicate the years in which unilateral quota were set by at least one negotiating party.

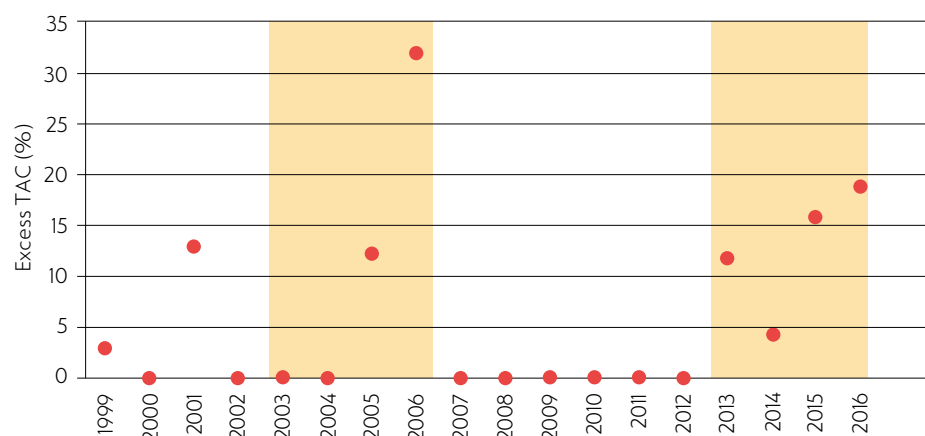
FIGURE 5A. MACKEREL TOTAL ALLOWABLE CATCH IN EXCESS OF SCIENTIFIC ADVICE



Source: Author's calculations from Carpenter (2017)⁸⁷

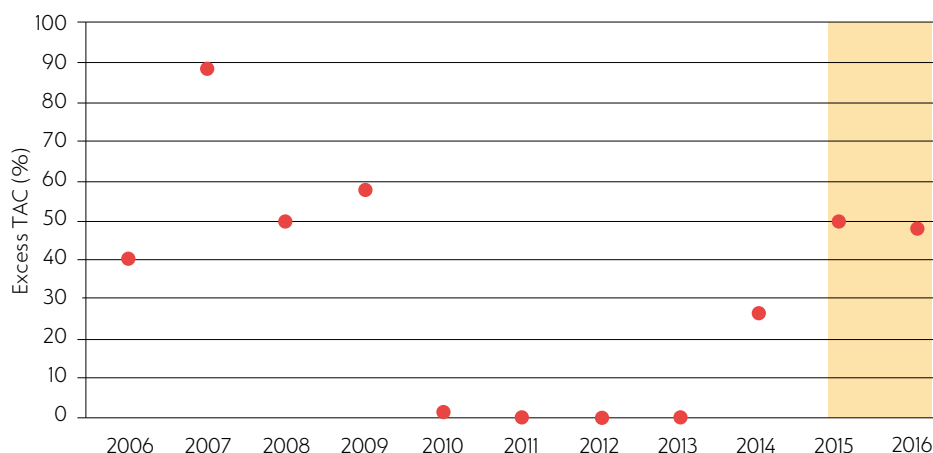
Note: Orange periods indicate unilateral TACs set by at least one negotiating party.

FIGURE 5B. HERRING TOTAL ALLOWABLE CATCH IN EXCESS OF SCIENTIFIC ADVICE



Source: Author's calculations from Carpenter (2017)⁸⁸

Note: Orange periods indicate unilateral TACs set by at least one negotiating party.

FIGURE 5C. BLUE WHITING TOTAL ALLOWABLE CATCH IN EXCESS OF SCIENTIFIC ADVICE

Source: Author's calculations from Carpenter (2017)⁸⁹

Note: Orange periods indicate unilateral TACs set by at least one negotiating party.

Agreeing on quota jointly with third countries

This risk of negotiations breaking down leads to a second overfishing risk: a rise in the overall agreed total allowable catch (TAC) for shared fish stocks to appease parties and prevent them from leaving the negotiating table. As mentioned, this already occurs within the EU. While quota *shares* are fixed, member states often seek to win more quota in absolute terms for their domestic industry.

However, the EU must reach an agreement. As decisions on the setting of quota are made jointly, a member state cannot leave the negotiating table and set their own TAC. Negotiated quota with a third country presence at the table (at least a one-third share from non-EU countries) were set 25% above scientific advice from 2001 to 2016, whereas quota with a minor share from non-EU countries (less than a one-third share) were set 19% above scientific advice over the same period. Exceeding scientific advice by a larger amount in order to prevent negotiations breaking down comes at the expense of those without a voice in the negotiations: fish stocks themselves and future generations of fishers and society.

Whether the UK could overcome these problems that have plagued other third countries outside the EU is detailed in Section 5.2.

Quota-setting outcomes

While the risk of increased overfishing is clear, there are several potential outcomes. Here a direct relationship is drawn between TACs set in excess of scientific advice and overfishing. Three different overfishing outcomes are included for the scenario modelling:

1. Status quo (no change in quota setting behaviour).
2. An increase in overfishing in line with current third country practice.
3. An increase in overfishing as unilateral total allowance catch limits are set by the UK without the EU lowering its own limit accordingly.

These outcomes are detailed in Annex B6. A further set of outcomes is included in the sensitivity analysis in Section 4.2 under the circumstance where the EU does not reduce its share of the overall TAC.

2.6 BREXIT IMPACT: CHANGE IN TARIFFS TO ACCESS THE EU MARKET (MODELLED)

The critical importance of EU fish trade for the UK industry

By value, seafood is the most traded food commodity in the world.⁹⁰

Consumer tastes are stubborn, particularly in the UK, where the majority of fish caught is exported and the majority of fish consumed is imported.⁹¹ In this respect, the EU market for fish is of higher importance to UK fishers than the domestic UK market. Forging new markets, to the extent that this is possible, is a costly proposition. When it comes to fisheries, the importance of trade cannot be overstated.

Typically, it is estimated that 80% of UK commercial landings are exported, with two-thirds of this (53% of the total) destined for the EU market.^{92,93,94}

This figure, based on MMO landings and export data, is problematic as it includes exports from aquaculture and exports originally sourced from other countries (re-exportation), which would lower the estimate, and weight loss from UK landings during processing, which would raise the estimate. No official estimate is available, but calculations in Annex B put the figure in the same region: 76% of wild-caught fish exported with 75% of that destined for the EU market (57% of the total).

In the context of Brexit, the possibility of tariffs restricting trade flows and/or cutting into profits concerns many in the UK fishing industry. Processors and wholesalers, the parts of the supply chain closer to the final market, are lobbying to keep the free flow of seafood products as open as possible.⁹⁵

Tariffs can vary depending on the agreement reached

If a tariff agreement with the EU is not reached, the UK can expect to pay tariff rates as set by the World Trade Organization (WTO) for Most Favoured Nations (MFN). Technically, the UK would still need to apply to become a WTO member, independent of the EU, so MFN tariffs might not be the worst-case scenario, although for modelling purposes it is assumed that the UK would be able to quickly and easily become a member.

Alternatively, some EU trade partners have secured tariff reductions for many products (including fish products). The European Economic Area (EEA), one possible post-Brexit relationship, has reduced rates for many fish products in Protocol 9 of the EEA Agreement. In addition to this agreement, Norway also has a bilateral trade agreement with the EU where fish products feature significantly, although no tariff concessions were granted for some of the most important Norwegian fish exports including farmed salmon, herring, mackerel, shrimp and prawns, and Nephrops.⁹⁶ Canada, which recently secured a reduction in tariffs for several important fish exports to Europe including lobster, crab, and shrimp, provides another example similar to this model.

Tariff outcomes

For the modelling of Brexit scenarios in this report, three different tariff outcomes are used:

1. Status quo (no tariffs).
2. EEA tariff rates.
3. WTO MFN tariff rates.

These outcomes are detailed in Annex B5.

2.7 BREXIT IMPACT: CHANGES TO NON-TARIFF BARRIERS TO TRADE (MODELLED)

For some in the UK fishing industry, non-tariff barriers to trade (sometimes referred to as non-tariff measures) pose as great a threat as tariffs. These are many so-called barriers to trade outside of import or export duty, which include import quota, local content requirements, subsidies and industry bailouts, customs delays and inspections, licensing, packaging and label requirements, among others.

As a perishable good, the quality of fish products (and therefore prices) quickly deteriorates with age. Fish products are thus particularly vulnerable to non-tariff barriers that generate inspections and border delays. John Buchan, a former skipper in Peterhead, explains:

I've heard it said that premium products like top quality Scottish langoustine will find its way to market because of demand. The problem is that it won't be prime quality if it's had to sit several days in a lorry at Calais, or in a customs warehouse, waiting to be cleared.

It's not tariffs that will make life really difficult for exporters, it's the other barriers the EU puts in place for third countries. If they want to make problems for us, they will.⁹⁷

It is difficult to determine, and therefore quantify, the potential impact of non-tariff measures, although studies on non-tariff barriers between the USA and the EU have found that non-tariff barriers impact trade more than tariff barriers. These non-tariff barriers vary significantly by sector, with the food industry, and processed food in particular, experiencing the largest barriers.⁹⁸

In the context of Brexit, the UK is starting from a position of low non-

tariff measures as markets are currently linked and standards harmonised (e.g. labelling), but this may change with changes to regulations (Section 2.8). The EU also has some leverage to generate barriers, like product inspection, despite this history of harmonisation.

One significant concern is that fish products would need to enter the EU via a Border Inspection Post. Not only would these delays harm the economic value of the product, there may not be the capacity at these posts to handle the quantity of fish from the UK. The major port for UK goods to enter France, Calais, is not a registered inspection post, and the nearest inspection post of Dunkirk only has capacity for 15 inspections a day.⁹⁹

Non-tariff barrier outcomes

An additional outcome is added to the list of tariff outcomes, applying non-tariff barriers as well as WTO MFN tariffs:

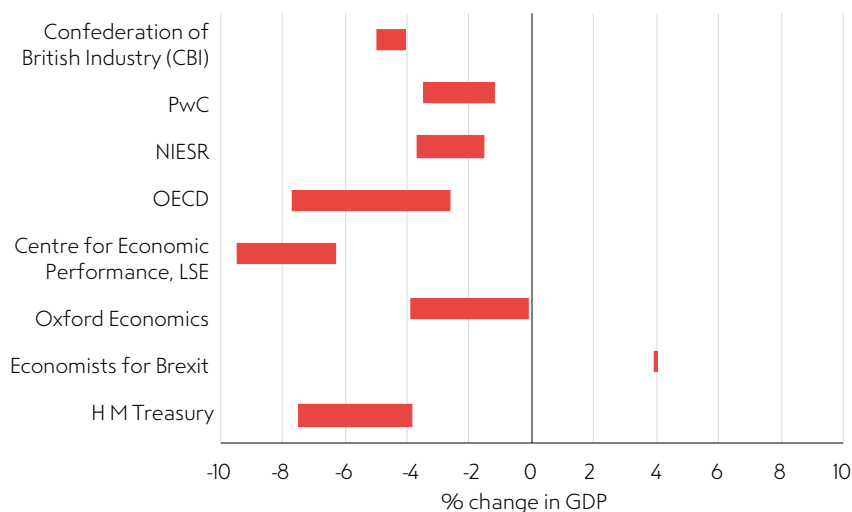
1. WTO MFN tariff rates and non-tariff barriers

This outcome is detailed in Annex B5.

2.8 BREXIT IMPACT: MACROECONOMIC CHANGE (NOT MODELLED)

Post-Brexit reductions in GDP, consumption, and investment for the UK economy

Several of the most prominent economic research organisations produced economic forecasts of Brexit compared to the business-as-usual scenario. Figure 6 summarises the forecasts produced since 2016 and a literature review of studies from the preceding decade (produced by the CBI).^{100,101,102,103,104,105,106,107} As Brexit represents an end to the four freedoms, as well as a great deal of uncertainty in the years to come, it is unsurprising that nearly every model

FIGURE 6. ESTIMATES ON THE IMPACT OF BREXIT ON UK GDP IN THE LONG-TERM (2030)

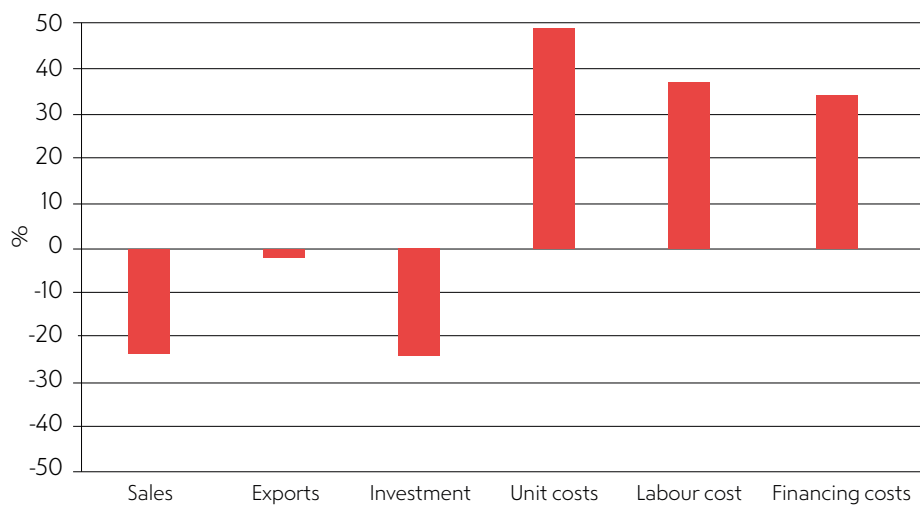
Sources: Confederation of British Industry (2016),¹⁰⁸ PwC (2016),¹⁰⁹ NIESR (2016),¹¹⁰ OECD (2016),¹¹¹ Centre for Economic Performance LSE (2016),¹¹² Oxford Economics (2016),¹¹³ Economists for Brexit (2016),¹¹⁴ and HM Treasury (2016)¹¹⁵

reveals a reduction in GDP resulting from Brexit. In an Ipsos Mori survey, the vast majority of economists (72% to 11%) thought that Brexit would have a negative impact on UK GDP in the long-term.¹¹⁶

Inevitably, there will be ranges in these estimates of economic impacts. Here, the difference in the ranges between models are primarily due to scope (e.g. whether immigration was included) and key assumptions around future trade agreements and the extremely uncertain terrain of regulatory change. The models with wide ranges within their own estimates tended to be those that used a series of alternative scenarios. For example, the HM Treasury analysis model results are a combination of EEA (-3.4 to -4.3%), negotiated bilateral agreement (-4.6 to -7.8%), and WTO (-5.4 to -9.5%) potential arrangements.¹¹⁷ Under most models, even a close UK-EU relationship has a reduction in GDP compared to the business-as-usual scenario.

In more tangible sense, this reduction in GDP flows from a reduction in investment and consumption – important economic drivers for UK fishing fleets. Modelling results show that Brexit leads to an immediate and drastic reduction in investment as a result of uncertainty and credit risk coupled with shifting foreign direct investment elsewhere, potentially within the Single Market.^{118,119} The change in post-Brexit consumption is also expected to fall by a greater amount than the change in GDP. This is due to lower real wages from lower industrial output and income coupled with higher inflation, as well as a deterioration in the terms of trade, and a shift towards savings.^{120,121,122}

In the Bank of England's Decision Maker Panel surveys 2,500 business across industry sectors. On Brexit, most businesses are expecting lower sales at the same time as higher unit costs (Figure 7).¹²³

FIGURE 7. ADDITIONAL PROBABILITY OF BREXIT HAVE A POSITIVE EFFECT RATHER THAN NEGATIVE

Source: Survey of the Bank of England's 2,500 business Decision Maker Panel (ONS, 2017)¹²⁴

For the UK fishing industry, there may not be as large a risk to investment as other sectors. While this report documents the complex trade-offs regarding Brexit and fleet economic performance, there are some potential channels to increases to production post Brexit that are not present for other industries.

The reduction in consumption has a direct impact on fleet economic performance through a weakened market and demand for fish products. One small positive is that demand for fish tends to be expenditure inelastic, meaning that a change in household income will not affect fish consumption as much as other products, all else being equal.¹²⁵ However, in general, the conclusion is that the macroeconomic implications are significant and almost entirely one-directional.

Depreciation of sterling has countervailing effects for the industry

Perhaps the most dramatic economic effect of the vote for Brexit thus far has been the fall in sterling following the vote to leave the EU. At the time of writing in August 2017, the pound is still 13% of its pre-referendum level

compared to the euro. On paper, this could potentially be good news for UK exporters, including the fishing industry. However, it is critically important to analyse why a price change occurs. Economists are keen to point out that 'people should never reason from a price change', a phrase popularised by Scott Sumner, Director of the Program on Monetary Policy at the Mercatus Center at George Mason University,¹²⁶ that applies directly to celebrations of currency depreciation.^{127,128}

Primarily, the depreciation can be understood as reflecting the fact that, at least according to market actors, Brexit will make exporting more difficult and thus costlier. To counteract this, the value of the exporting currency (the pound) needs to fall to make UK exports more competitive.¹²⁹ It may also be the case that the depreciation reflects an expected economic downturn and thus lower interest rates. In both cases the depreciation in sterling is in anticipation of a future negative shock to the UK economy. Applying this fuller macroeconomic picture, the depreciation of the pound is less of a blessing for exporters and more of a consolation.

Another reason for UK exporters to pause before celebration is the fact that global demand is low at present, so possible gains from depreciation are unlikely to be realised. This is particularly problematic given the low price elasticity of demand for UK exports,¹³⁰ with one study finding that ‘the long-run level of export appears to be unrelated to the real exchange rate for the UK’.¹³¹

The other side of a currency depreciation is that imports become more expensive, which then leads to inflationary pressure. This has a negative shock on real wages and living standards, but it also impacts many UK exporters who are actors in much longer global supply chains and rely on imports as inputs in their own production.¹³² This is certainly the case for the global seafood market where catching, processing, preparing, and consumption can all take place in different countries.

There is also the countervailing issue of inputs to production that are imported. The most concerning of these is fuel given the high fuel-intensity of fishing industry, consuming approximately half a litre of fuel to produce a kilogram of fish. On average, fuel costs form a quarter of total production costs (despite an exemption on duty).¹³³

However, the export-orientation and fuel-reliance of fleets does not correlate, the implication being that the potential gains or losses from the depreciation in sterling will be felt differently across UK fleet segments. The impact of depreciation is revisited as a sensitivity analysis on the modelling results in Section 5.2.

Uncertainty as the enemy of business

Policy and macroeconomic certainty is far from a neutral impact on economic performance. While it is typical to think about uncertainty as simply widening potential economic outcomes, uncertainty also has a secondary effect through lowering confidence, which in turn reduces economic performance in its own right.¹³⁴

This confidence shock can take many forms from households postponing consumption, to firms delaying investments or entry into new markets, to raised risk premia in financial markets. Indeed, many of the economic model forecasting the economic impact of Brexit dealt with uncertainty explicitly, in particular the HM Treasury analysis.

Even where the uncertainty surrounding Brexit quickly subsides (fisheries is unlikely to be one of these areas given the volume of EU legislation in this space), short-term uncertainty comes with a long-term cost. For example, lower investment in the short-term will result in a permanently small capital stock for the UK.¹³⁵ Beyond economic impacts, an unstable policy environment has also been linked to poor health (mental and physical) and for fishers.¹³⁶

All this uncertainty is one reason other EU fishing businesses, particularly the processors and exporters are not looking at Brexit with envy. Lorcán Ó Cinnéide of the Irish Fish Processors and Exports Association put this risk clearly: ‘Uncertainty is an enemy of any business. We mightn’t like exactly every aspect of what we have, but one thing we have is stability – and this is instability.’¹³⁷

2.9 BREXIT IMPACT: CHANGES IN THE FREE MOVEMENT OF EU LABOUR (NOT MODELLED)

Like many industries in the UK, the fishing industry has a significant number of workers from EU countries. Leaving the EU thus creates potential problems both in terms of the existing migrants working in the EU fishing industry as well as attracting EU migrants in the future. The status of EU migrants within the UK and the movement of potential future EU migrants is very uncertain in the context of the Brexit negotiations.

Approximately 15% of UK fishers are EU nationals (based on Seafish training courses).¹³⁸ South West England is purported to have the highest percentage of fishers from EU member states, whereas in Scotland, 8% of fishers are EU migrants, most of whom are Romanian and Latvian.¹³⁹ These workers tend to be employed as deckhands or engineers, rather than skippers and/or owners.¹⁴⁰ This employment level is higher than the percentage of EU migrants in the UK population (5%)¹⁴¹ or EU workers in the UK workforce (7%).¹⁴²

At the fleet segment level, Marine Scotland documents some variance in the use of non-local labour, but this is largely the use of non-EU crew, with Filipinos making up the largest percentage. The use of EU crew does not vary substantially by fleet segment, at least in Scotland.¹⁴³

While no survey of EU labour exists for fish processing, EU nationals make up 41% of the employment in for the food processing sector as a whole.¹⁴⁴ A high dependence has also been suggested in the UK fish processing industry, with figures in the range of 79% (Macduff Shellfish)¹⁴⁵ and 84% (Ian Duncan MEP).¹⁴⁶ These figures are significantly higher than the fishing industries of other EU member states.¹⁴⁷

The processing industry has cited the recruitment of EU nationals as one of their top Brexit priorities.^{148, 149} In their submission to the Migration Advisory Committee's call for evidence, a major Scottish fish processor explained that 'Fresh Catch like most of the seafood processing sector in the North East of Scotland need to use EEA and non-EEA workers to function properly.'¹⁵⁰ In their submission to the European and External Relations Committee, Macduff Shellfish, the largest processor of shellfish in Europe, was equally unequivocal: 'The European labour market is a vital resource to Macduff and our continued success will be dependent upon the future flow of European workers.'¹⁵¹

In some part of the industry, particularly more isolated areas of the UK, the dependence of UK fish processing on EU labour also puts the UK catching sector at risk. Stewart Crichton, Chair of the Orkney Fishermen's Society, has stressed that in Orkney there is no food industry without EU labour. 'What happens in Orkney will be mirrored in every seafood processing factory throughout the UK...the whole food industry in the UK would collapse.'¹⁵²

In terms of economic impacts for the UK fishing fleet, the ending of free movement of EU labour would be expected to increase crew wages to attract local workers and as a result, decrease profitability.

Unfortunately, there is no information on the flow of product from different fleet segments, specifically between fleet segments and UK fish processors. This makes the impact of barriers to EU labour, which occur predominately in the processing sector, difficult to analyse in terms of fleet economic performance. This lack of a link between the catching and processing sector has presented major challenges

for holistic analysis of the seafood industry. Without being quantified, it is clear that all fleets will be affected indirectly as market dynamics would likely increase the cost of labour (as there will be a glut of UK crew) and decrease the price of fish that processers can offer (as their labour costs will increase and margins further narrow). As a result, profits are likely to decrease but crew wages, if vessels can remain profitable, may increase.

2.10 BREXIT IMPACT: CHANGES IN FREEDOM OF ESTABLISHMENT (NOT MODELLED)

One of the most controversial issues in UK fisheries is ‘flagged vessels’ that are registered in the UK and have access to UK fishing quota, but are ultimately owned and operated out of other countries. It is estimated that there are 26 Dutch-owned and 40 Spanish-owned vessels in the UK fleet. These are some of the largest trawlers in the UK fleet, so their share of the quota is significant.¹⁵³

This situation has come about from the sale of fishing vessels that have quota rights attached to them. In many cases (e.g. Colne Shipping in Lowestoft) there was no interested buyer in the UK. Unfortunately, this issue of flagged vessels is widely misunderstood and often conflated with the issue of relative stability and the amount of quota each member state receives (Section 2.4), which in turn is often conflated with access to waters (Section 2.3). As with access to quota and water, foreign ownership of fishing vessels is often characterised as other countries ‘stealing British fish’, with the headline of one of the mostly widely shared articles on UK fisheries proclaiming: ‘EU lets one Dutch ship net A QUARTER of England’s fishing quota.’¹⁵⁴

While many of the foreign owners of UK-flagged vessels are EU nationals (primarily Dutch and Spanish), this issue of flagged vessels is not strictly an issue of EU governance.¹⁵⁵ There are also Icelandic and other non-EU owners. Business ownership and the movement of capital is free-flowing even outside of the EU and it is obvious in many industries, such as the ownership of British football clubs.

Still, the UK government could potentially restrict ownership of fishing licences to UK nationals post Brexit, either through confiscation of these licences or through a tightening of ownership conditions, termed the ‘economic link’.

Foreign ownership of UK vessels is likely to undergo reform rather than confiscation

It is unclear if the UK government would need to pay compensation (and how much) to foreign owners of UK-flagged vessels if their fishing quota were to be repatriated. Both European and UK case law recognise the existence of the principle of ‘substantive legitimate expectation’ – that individuals and businesses should be protected from changes in public policy – including cases involving fishing rights.¹⁵⁶ Denying such protection could lead to lawsuits in which vessel owners sue for jurisdictional protection of their substantive legitimate expectation. Legal experts note that British case law is currently evolving towards support of the substantive side of legitimate expectation.¹⁵⁷ There is also the risk of creating a perception that the UK is closed for investment, as this policy change could have ripple effects across other sectors. The UK government will be keen to avoid that perception.¹⁵⁸

If vessels and their associated quota were repatriated, there would then be a decision over whether to gift this acquired quota to the UK fishing fleet through existing quota shares, auction it off to UK fishers and/or UK nationals, or allocate it through another mechanism.

An alternative approach is to tighten the conditions under which a UK vessel can be registered and operated. Currently at least one of the three following criteria must be met in order to fish against UK quota:

1. Land over 50% of quota species in the UK,
2. Employ a crew of whom at least half are UK residents, or
3. Incur a certain amount of expenditure on goods and services in UK coastal areas.¹⁵⁹

These criteria are known as the 'economic link'. UK Fisheries Minister George Eustice has confirmed his view that 'strengthening the economic link would be a better way to start than to try to start taking away the rights that people have ultimately bought'.¹⁶⁰ Several UK fishing organisations have also expressed their support for tightening the economic link to support coastal communities or simply to make foreign fleets less competitive.¹⁶¹

There are also alternative options to target more directly the objective that is trying to be achieved. This could be done by ensuring that a wider public benefit is being generated from fisheries, which are a public resource, as well as providing incentives to generate economic activity in UK posts. One proposal is a landings tax that deducts port levies and other dues if landings occur within the UK.¹⁶² This would create a two-tiered approach that would incentivise landings of UK vessels into the UK, while avoiding

complicated and discriminatory nationality requirements. Some of these regulatory changes to foreign ownership may not be strictly related to Brexit.

2.11 BREXIT IMPACT: REGULATORY CHANGE (NOT MODELLED)

The most difficult area of fisheries to analyse with respect to Brexit is the prospect that the UK's post-Brexit fisheries policy could lead to significant regulatory change. As the EU's CFP currently governs most aspects of UK fisheries, the potential for policy change is vast.

A race to the bottom in marine protection is possible, but will be resisted

In general, many of the regulatory changes that have been suggested in statements on Brexit and UK fisheries, especially in the context of fleet economics, are changes to environmental policies – either making the policies more lax or more stringent. At this point it is unknown exactly which regulations in the CFP will be altered in UK law, but fisheries scientists have already noted that many regulations in EU fisheries that are primarily environmental in nature have either a direct or indirect effect of enhancing ecosystem resilience and thereby boosting fisheries productivity. This means that for the UK fishing fleet, the short-term compliance costs of conservation measures and long-term economic benefits may move in opposite directions, again complicating economic analysis.¹⁶³

There will also be difficulties in weakening existing EU marine conservation measures as other stakeholders outside of the catching sector will lobby against such an approach. The pressure to maintain high environmental standards in fisheries comes from environmental organisations but also seafood

processors worried about reputational risk and sea angling groups that want more abundant fish populations.^{164,165,166} Some EU fisheries standards may also need to be kept in order to avoid non-tariff barriers to trade in the EU market – something the EU fishing industry will be keen to see implemented if UK fish products continue to be sold in the EU market.

Despite the vast scope for change with respect to fishing regulations, the resulting changes may be extremely minor. UK Fisheries Minister George Eustice has stated that the landing obligation and commitment to sustainable levels of fishing (MSY) will stay,¹⁶⁷ while the Secretary of State, Michael Gove, stated in his July 2017 ‘Green Brexit’ speech that ‘[he has] no intention of weakening the environmental protections we have put in place while in the EU’.¹⁶⁸ One area of potential divergence is in Scotland over the future of the landing obligation.

The future of post-Brexit subsidies is highly uncertain

The EU currently provides structural funding to UK fishing communities and fishers. In 2016, the UK was allocated £200 million from the European Maritime and Fisheries Fund (EMFF).¹⁶⁹ The UK’s Operational Programme for this funding includes initiatives in the areas of data collection, control, enforcement, advice, energy efficiency, training, networking, recruitment, and many other areas including funding for coastal communities and small-scale fleet segments.¹⁷⁰

It is unclear if this funding will continue at a similar level post Brexit, especially given the cuts to Defra and the MMO in recent years.¹⁷¹ Some UK fishing organisations are now stressing the importance of this funding to continue. The Orkney Fisheries Association (OFA) has emphasised the importance of EMFF

funding for supplies all their members with emergency beacons, life-rafts, and research into scallop stocks.¹⁷² The issue has also been highlighted as major concern for fisheries in Northern Ireland.¹⁷³

Some want days-at-sea management, but the track record is poor

The Fishing for Leave lobby group has made one of their key Brexit demands a shift in management from quota (limits on the quantity of fish that can be caught) to days-at-sea (limits on the amount of fishing time that is permitted).¹⁷⁴ Some fishers are interested in this proposal (technically hours-at-sea) as it may grant them more fishing opportunities if they can continue to fish despite reaching their quantity threshold for any one species (the ‘choke’) in a mixed fishery. Under this proposal, there are no catch limits, just limits on the amount of time at sea.

A fundamental objection to days-at-sea management is the pressure it places on the sustainability of fish stocks,¹⁷⁵ and days-at-sea limits are often set much higher than scientific advice.¹⁷⁶ Following sound science is the very foundation of responsible fisheries management; it is notable that proponents of days-at-sea, predominately Fishing for Leave, see a more limited role for fisheries science in management, while groups that are opposed to days-at-sea, like The Angling Trust, would like a greater role for science in management.^{177,178}

Others point to the practical difficulties of effort-based management and the poor track record of these systems. The National Federation of Fishermen’s Organisations has commented that while appealing on the surface, ‘a leap into an unworkable system of effort control could be a lot worse’.¹⁷⁹ This has certainly been the case historically as most fisheries systems worldwide have abandoned days-at-sea in

favour of quota management. The few remaining management systems using days-at-sea (e.g. Faroe Islands, the Mediterranean basin) are not performing well environmentally or economically.^{180, 181}

A change to days-at-sea management post Brexit has not been included in the economic modelling. A full economic analysis of the proposed system is not provided in this study as it relies, at a minimum, on a scientific assessment of how many days at sea would be a realistic cap. It is likely that fishers' support for this management system crucially depends on this estimate.

The proposal has also had little traction as a post-Brexit possibility. UK Fisheries Minister George Eustice has confirmed that management through fishing quota will remain post Brexit, while Marine Scotland has rejected the idea of applying days-at-sea in any mixed fishery.^{182, 183} Bertie Armstrong, chief of the SFF, has dismissed the idea of days-at-sea management as a 'complete non-starter'.¹⁸⁴

Post-Brexit fisheries face an enforcement problem

As detailed, Brexit is associated with a weakened macroeconomic outlook, which includes impacts on public finances. According to the forecasts by the Office for National Statistics, and confirmed in analysis by the Institute of Fiscal Studies, over the next five years the UK government will need to borrow heavily because of Brexit.¹⁸⁵ This is the result of the national income effect of lower trade, migration, and productivity and higher inflation outweighing the mechanical effect of lower contributions to the EU budget. In fact, these effects are so imbalanced that outside of the Bank of England's liabilities, Brexit is forecast to be the biggest contributor to increases in public sector debt.¹⁸⁶

The significance for UK fisheries is that weakened public finances may, in turn, weaken the ability of the UK government to cope with necessary regulatory and enforcement responsibilities in fisheries and other sectors, especially with new policy competencies and possibly expanded territorial waters in which UK authorities shoulder the entire burden. Fisheries enforcement is extremely expensive, especially considering the £9 million spent on the 0–6 NM the UK currently manages.¹⁸⁷ Already EU fishing representatives have warned that under the current regime, 'If our boats were suddenly barred from UK waters, we would just carry on fishing there regardless.'¹⁸⁸ Former Royal Navy Admiral Lord Alan West has described plans to police post-Brexit fishing waters as 'amazingly complacent'.¹⁸⁹

Note that even before the referendum the UK's MMO was undergoing budget cuts and vessel inspections had plummeted.¹⁹⁰ This governance risk posed by Brexit is most obvious through Boyes and Elliot's work illustrating the 'horrendogram' of marine governance, which has been updated and expanded (i.e., made 'more horrendous') in the post-Brexit context.¹⁹¹

Sovereignty over fisheries policy is inherently misguided

Caught up in the language of Brexit as a means to take back control is the idea of a sovereign country having full control over its own policy and regulations. This is a limited understanding of sovereignty, however. As *The Economist* has argued, this intuitive drive has its limitations:

The flaw in this case lies in the tradition's idealistic definition of sovereignty. For Mr Johnson and Mr Gove, being sovereign is like being pregnant—you either are

or you aren't. Yet increasingly in today's post-Westphalian world, real sovereignty is relative. A country that refuses outright to pool authority is one that has no control over the pollution drifting over its borders, the standards of financial regulation affecting its economy, the consumer and trade norms to which its exporters and importers are bound, the cleanliness of its seas and the security and economic crises propelling shock waves—migration, terrorism, market volatility—deep into domestic life.¹⁹²

The limitations of focusing internally is perhaps most obvious for fisheries than in other policy areas. As the UK shares over 100 quota species with its neighbours, there is no way to exclude their impact on fish stocks. As Professor Michel Kaiser of the University of Bangor explains, 'what the French fleet does affects the UK, whether we're in the EU or not. Once we're out, our ability to affect other countries is very limited.'¹⁹³

And given the amount of existing disagreements and conflict between the UK and other EU member states on fishing, this lack of influence becomes even more important. Within EU fisheries policy, the UK has led on many significant reforms of fisheries policy including the commitment to MSY and the landings obligation.¹⁹⁴

The UK already has examples in both the Isle of Man and the Falkland Islands of waters with absolute sovereignty but not relative sovereignty, as there are significant adjacent

fisheries. Both areas are encountering management challenges due to fishing pressure of fishing fleets that are outside of their maritime border but are still having significant impacts on their fish stocks.^{195,196}

2.12 SUMMARY OF POTENTIAL FACTORS AFFECTING UK FISHERIES POST BREXIT

Table 4 summarises the factors identified in this report, whether they are explicitly modelled, the anticipated direction of change they may bring about for fleet economics, and whether their impact varies across the fleet segment level. Note that some of these factors (e.g. access restrictions, tariffs) are expected to be reciprocal with similar impacts for the EU fishing fleet.

They are summarised in Table 4 individually, and are then combined into scenarios (a combination of impacts) in Section 3.

TABLE 4. SUMMARY OF BREXIT IMPACTS, THE DIRECTION OF CHANGE, AND WHICH FLEETS WILL BE AFFECTED

Brexit impact	Description	Modelled in this report	Expected change in fleet economic performance	Fleet-level variance
Change in access to waters	Restricting access of EU fleets to UK waters (and vice versa)	Yes	Lower costs from reduced crowding (+)	Species-dependent, mostly positive for inshore fleets
Change in quota	Change in the division of quota (e.g. based on abundance in UK waters)	Yes	Higher revenues from increased limits (+)	Fleets targeting most quota species
	Overfishing resulting from the UK (unilaterally) increasing its fishing pressure	Yes	Lower revenues from decreased limits and higher harvesting costs (-)	Fleets targeting most quota species
Change in tariffs	EU tariffs on UK exports	Yes	Lower revenues from decreased prices (-)	Fleets exporting to the EU
Change in non-tariff measures	Other barriers to trade (e.g. customs inspections)	Yes	Lower revenues from decreased prices (-)	Fleets exporting to the EU
Macroeconomic change	Weakened UK consumer demand	No	Lower revenues from decreased prices (-)	Fleets selling in the domestic market
	Weakened UK investment	No	Unclear how significant (~)	Fleets requiring capital
	Depreciation of sterling	No	Mixed effect of higher export prices and higher input costs (+/-)	Short-term benefit for fleets exporting to the EU, negative impact for fleets with significant fuel use
	Policy and macroeconomic uncertainty	No	Uncertainty shock and transition costs (-)	All fleets
Change in the movement of labour	Ending the free movement of EU labour to the UK	No	Higher costs for owners, higher wages for crew (+/-)	Fleets employing EU labour indirectly through fish processing
Regulatory change	Changes to policies that govern UK fisheries	No	Unclear changes and effects (~)	Uncertain

SECTION 3: COMBINING BREXIT SCENARIOS

Applying three Brexit impacts (access, quota, tariffs) modelled with three or four potential outcomes (different versions of a high-medium-low spectrum) produces a total of 36 Brexit scenarios for fisheries covering the different combinations of impacts and outcomes. This figure increases to 72 given how the EU might respond, or not, to the UK increasing its share of fishing quota, which in turn could increase overfishing (Annex A).

3.1 MAIN SCENARIOS

Across the modelled Brexit impacts of quota, tariffs, access, and overfishing, there are several different outcomes, which then combine to form Brexit scenarios for analysis.

Brexit impacts and outcomes:

Quota

- Status quo (relative stability)
- Quota shares divided between the EU and the UK based on zonal attachment
- Quota shares renegotiated between the EU and the UK based on preferred fish stocks

Tariffs

- Status quo (no tariffs)
- WTO MFN tariff rates
- EEA tariff rates
- WTO MFN tariff rates and non-tariff barriers

Access

- Status quo (shared waters)
- An enforced border preventing vessel access to 200 NM and the exclusion of EU fleets
- A partial border preventing free access to 200 NM and the exclusion of EU fleets

Overfishing

- Status quo (no change in quota setting behaviour)
- An increase in overfishing in line with current third country practice
- An increase in overfishing as unilateral total allowance catch limits are set by the UK without the EU lowering its own limits accordingly

Six scenarios are analysed here, which can be taken as demonstrating a range of different 'real world' possible Brexit outcomes. There are, of course, many more potential scenarios from different combinations of impacts. These are

detailed in Annex A. The six scenarios chosen characterise some of the most referred to potential combinations, as well as span a wide range of positive and negative potential impacts.

The status quo plus the five alternative scenarios take the following form:

NO BREXIT (STATUS QUO)

This scenario assumes that no Brexit takes place and serves as a base case. The UK remains part of the CFP and there are no external changes, like trade barriers.

Change in quota: Status quo (relative stability)

Change in tariffs: Status quo (no tariffs)

Change in waters: Status quo (shared waters)

Change in overfishing: Status quo (no change in quota setting behaviour)

HARD BREXIT

This scenario assumes that the UK withdraws from the CFP to the maximum possible extent. This leads to increases in quota and access but results in the EU continuing its fishing pressure to stocks by setting its own quota limits. The WTO MFN tariff rates are applied.

Change in quota: Quota shares divided between the EU and the UK based on zonal attachment

Change in tariffs: WTO MFN rates and non-tariff barriers

Change in waters: An enforced border preventing vessel access to 200 NM and the exclusion of EU fleets

Change in overfishing: An increase in overfishing as unilateral total allowance catch limits are set by the UK without the EU lowering its own limits accordingly

SOFT BREXIT

This scenario assumes that the UK cedes some of its claimed quota shares and access to the UK's new EEZ in exchange for lower tariffs on UK fish exports to the EU.

Change in quota: Quota shares renegotiated between the EU and the UK based on preferred fish stocks

Change in tariffs: EEA tariff rates

Change in waters: A partial border preventing free access to 200 NM and the exclusion of EU fleets

Change in overfishing: An increase in overfishing in line with current third country practice

FISHERIES FIRST BREXIT

This scenario assumes that the UK government can avoid any trade-offs in fisheries and secure increases in quota and exclusive access with the EU responding by reducing its quota share and without imposing import tariffs.

Change in quota: Quota shares divided between the EU and the UK based on zonal attachment

Change in tariffs: Status quo (no tariffs)

Change in waters: An enforced border preventing vessel access to 200 NM and the exclusion of EU fleets

Change in overfishing: An increase in overfishing in line with current third country practice

FISHERIES LAST BREXIT

This scenario assumes that the fishing industry is not prioritised in the Brexit negotiations. There is no change in quota or access to waters, and tariffs are not negotiated down for fish products.

Change in quota: Status quo (relative stability)

Change in tariffs: WTO MFN tariff rates and non-tariff barriers

Change in waters: Status quo (shared waters)

Change in overfishing: An increase in overfishing in line with current third country practice

NO DEAL BREXIT

This scenario assumes that Brexit negotiations turn sour and the most adversarial outcomes prevail. The UK claims high quota shares and access to waters, but the EU responds with high tariff and non-tariff barriers, as well as failing to reduce its own quota share or actively preventing its fleet from entering the UK EEZ.

Change in quota: Quota shares divided between the EU and the UK based on zonal attachment

Change in tariffs: Non-tariff barriers and WTO MFN tariff rates

Change in waters: A partial border preventing free access to 200 NM and the exclusion of EU fleets

Change in overfishing: An increase in overfishing as unilateral total allowance catch limits are set by the UK without the EU lowering its own limits accordingly

Timeframe

In the modelling, the results are not time-dependent but refer to a future steady state where a transition has taken place in European fisheries. It is unclear how long this transition will take or what the transition costs would be, although these are important considerations to determine the net present value of any change.

3.2 WHY AN ECONOMIC SCENARIO ANALYSIS IS NECESSARY

Although the details of UK fisheries management post Brexit are just beginning to emerge, many reports have already gone a long way towards identifying the key risks and opportunities for the UK fishing industry. The most comprehensive of these reports is the House of Lords European Union Committee report on fisheries.¹⁹⁷ It is now the time to move from *identification* to *measurement*, as it is not intuitively clear how the risks and opportunities for the fishing industry trade off against one another. In the following sections, the potential economic impact on the UK fleet as a whole is analysed, and across different type and size of boat.

Four studies have calculated the share of catches by the UK EEZ (summarised in Table 3 of Section 2.4). While these studies provide an interesting reference point, this information alone does not indicate economics performance. UK and EU fleets are not identical, and it is not clear if the zonal share attributed to the UK could be harvested by the UK fleet in the near future, if ever. Also the EU and UK have different seafood markets and consumer demand. Prices are also likely to change in a post-Brexit future, especially if tariffs are applied.

As far as economic analysis beyond simple calculations of zonal share goes, there is one study for the European Parliament with a focus on trade using the concept of economic surplus to estimate potential changes.¹⁹⁸ However, these impacts are not necessarily linked to the UK catching sector, as illustrated by the importance of salmon and tuna to UK exports (discussed further in Annex B).

There is only one study with a focus on the UK thus far: a calculation of post-Brexit potential by the Brexit lobby group Fishing for Leave in the booklet *The Robbery of UK Resources*.¹⁹⁹ In their analysis, the author(s) use spatial data on landings to determine the quantity of landings from EU countries in what would be the UK waters outside of the EU. It is assumed that the UK fishing industry will then catch this quantity of fish post Brexit, minus what is currently caught in EU waters – in other words there is the same uptake of these fishing opportunities for all species, including those without a domestic market. A 4:1 ratio is applied to the value of these additional landings as well as current UK landings to estimate the value through the supply chain and compared to various public expenses.

This economic analysis suffers from several fundamental methodological issues. First, the assumption that the UK will catch the same species at the same levels as the EU fishing fleet does in UK waters is questionable – especially as some of these species have a limited market in the UK. This issue of quota uptake is further

compounded by the simple fact that some quota will not be profitable to fish. Puzzlingly, the issue of fishing costs is not considered anywhere in the analysis, nor is the issue of transition costs. Landed value is not value added unless costs are accounted for (e.g. fuel, capital, repairs), and nor is the cost of regulation or enforcement (Section 2.11) considered.

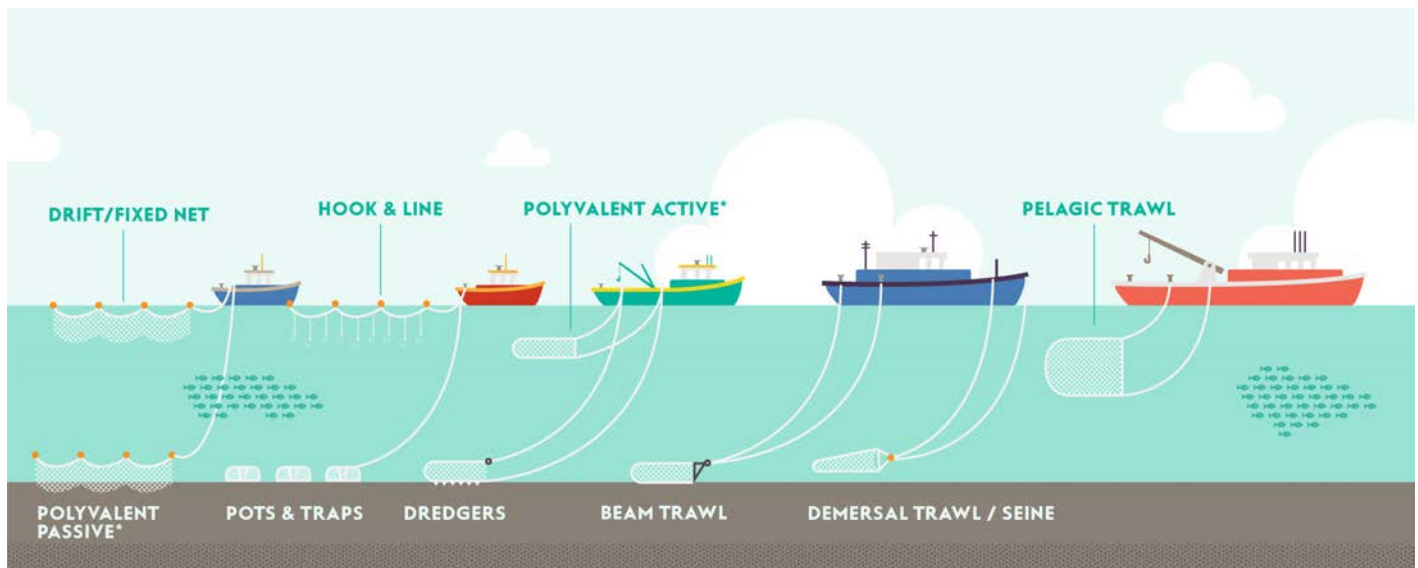
The 4:1 value chain of fisheries is problematic, not least because some of that value will not occur within the UK. A large portion of UK landings are exported, so much of the retail value will occur in the country of import. Another problematic aspect is the assumption that the total value from the fishing industry accrues to the government and can be spent on public projects.

3.3 THE DIVERSITY OF THE UK FLEET REQUIRES DISAGGREGATED ANALYSIS

For public policy questions, superficial cost-benefit analysis at the macro level is common practice. Such analysis tells us little about the reality of what a particular scenario might mean for different actors in the economy. This report pursues a more granular line of inquiry, analysing the potential impact of Brexit specifically at the level of individual fleet segments.

A fleet segment – a group of vessels that share a length category and fishing gear category – is the most disaggregated form of data reporting. Standard EU reporting of fisheries economic data defines 29 distinct UK fleet segments. Figure 8 illustrates the main fishing gear types that each uses, and Table 5 summarises their current economic performance.²⁰⁰

FIGURE 8. ILLUSTRATION OF THE MAIN UK FISHING GEAR TYPES



*Polyvalent passive and active segments are generalised categories rather than a specific type of fishing gear.

TABLE 5. THE ECONOMIC PERFORMANCE OF UK FLEET SEGMENTS

Fleet segment	Number of vessels	Number of FTE fishers	Landings (tonnes)	Earnings (£)	Net profit (£)	Net profit margin
Drift/fixed net 0–10m	622	175	4,015,932	9,544,148	-583,684	-6%
Drift/fixed net 10–12m	15	75	2,348,757	4,134,734	820,645	20%
Drift/fixed net 24–40m	16	272	5,323,974	13,991,700	2,958,938	21%
Dredgers 0–10m	105	76	3,298,674	5,821,918	417,473	7%
Dredgers 10–12m	32	52	2,627,702	5,121,013	879,118	17%
Dredgers 12–18m	114	312	17,153,080	24,023,378	3,460,799	14%
Dredgers 18–24m	25	160	10,644,565	12,900,206	1,523,518	12%
Dredgers 24–40m	31	307	13,265,569	21,225,543	2,844,251	13%
Demersal trawl/seine 0–10m	257	290	4,794,036	11,206,112	405,166	4%
Demersal trawl/seine 10–12m	89	164	3,386,989	8,049,016	1,067,898	13%
Demersal trawl/seine 12–18m	208	818	17,590,155	40,852,055	5,027,754	12%
Demersal trawl/seine 18–24m	171	1,087	42,426,070	83,194,670	12,185,905	15%
Demersal trawl/seine 24–40m	86	909	72,135,080	126,636,917	28,800,954	23%
Demersal trawl/seine 40m+	10	137	26,513,163	39,262,660	5,131,041	13%
Pots & traps 0–10m	1,739	1,190	25,452,792	57,905,610	-50,858	0%
Pots & traps 10–12m	166	378	9,573,686	20,047,772	5,174,123	26%
Pots & traps 12–18m	81	358	15,245,745	25,341,827	3,721,884	15%
Pots & traps 18–24m	14	155	7,823,939	12,029,787	2,084,487	17%
Hook & line 0–10m	527	216	2,274,052	6,224,460	-524,932	-8%
Hook & line 10–12m	17	34	305,567	1,139,538	-220,083	-19%
Hook & line 24–40m	13	263	8,301,350	22,722,546	2,068,231	9%
Polyvalent active gear 0–10m	30	27	2,272,339	1,606,735	52,181	3%
Polyvalent active gear 12–18m	37	58	8,262,978	3,981,629	498,926	13%
Polyvalent passive gear 0–10m	70	22	361,899	921,199	-53,711	-6%
Beam trawl 0–10m	12	10	163,265	345,280	-2,292	-1%
Beam trawl 12–18m	10	38	815,895	1,793,639	159,571	9%
Beam trawl 18–24m	18	132	4,758,097	12,530,091	2,030,584	16%
Beam trawl 24–40m	33	365	16,782,785	36,923,838	2,102,258	6%
Pelagic trawl 40m+	28	55	380,912,449	203,487,658	55,774,390	27%
Total	4,576	8,135	708,830,584	812,965,679	137,754,533	17%

Source: Author's calculations of GBP based on STECF (2017).²⁰¹ Figures in 2015 constant GBP.

As Table 5 reveals, there is significant variance between the UK fleet segments, not just in size, but also in economic performance – indicated here by the net profit margin. This variance shows the importance of economic analysis at this level. Overall profit margins average 17%, but some fleets, particularly the small-scale (under 10m) fleets, are considerably more vulnerable. Average profit margins for the large-scale fleet is 19% compared to 0% for the small-scale fleet. The data suggests that some segments are even running at a loss – reflecting that fact that for some fishers fishing is as much a recreational activity as a commercial one. This economic outcome can also persist as the number of vessels/enterprises is in decline.

It is also likely given the characteristics of the different fleet segments (e.g. species targeted, cost structure) that the impacts of Brexit will be felt very differently on their operations.

SECTION 4: RESULTS

The full methodology for the modelling of fleet economic performance under the different scenarios is available in Annex B. The following section outlines the results across different scenarios for the UK fleet as a whole and for individual fleet segments. The results are also tested for their sensitivity to quota uptake, depreciation, and overfishing. All values are reported in constant 2015 GBP.

4.1 RESULTS

Variance by scenario and fleet segment

The potential impact of Brexit on the UK fishing fleet as a whole, and on individual segments, significantly depends on the scenario used (Section 3.1).

Hard Brexit: Overall there is a large increase in landings (+70%), earnings (+37%), and net profit (+45%). This is mostly due to the increase in quota under the assumption of zonal attachment. At the vessel level, about half the fleet experiences an improvement in economic performance and half the fleet experiences a reduction.

Soft Brexit: Overall there is little change in economic performance (landings +7%, earnings +3%, net profit +5%) as increases in quota and exclusive access roughly balance with lower tariffs. Again, fleets holding quota are the net winners and fleets exporting to the EU are the net losers.

Fisheries First Brexit: This scenario has the largest gain in economic performance (landings +77%, earnings +49%, net profit +73%). All UK fleet segments are better off compared to the status quo.

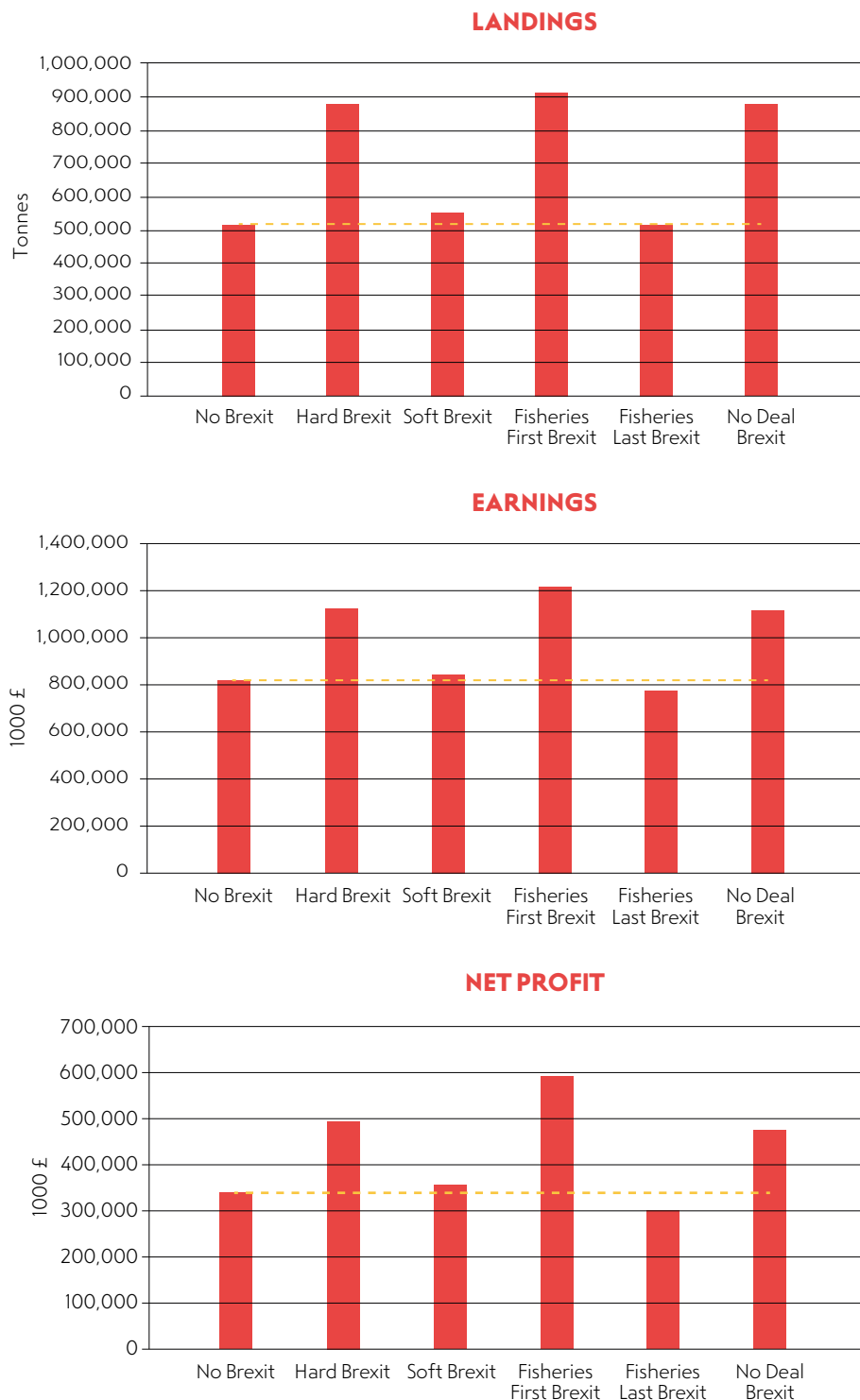
Fisheries Last Brexit: This scenario has the largest reduction in economic performance (landings 0%, earnings -6%, net profit -12%). All UK fleet segments are worse off compared to the status quo.

No Deal Brexit: The overall results (landings +70%, earnings +37%, net profit -+39%) are similar to the Hard Brexit scenario as both scenarios assume that quotas are shared based on zonal attachment and the application of tariffs. For No Deal Brexit, the existence of additional non-tariff barriers and a weaker border lowers net profit slightly.

Figure 9 illustrates that compared to the No Brexit scenario, a Hard Brexit, Fisheries First Brexit, and No Deal Brexit improve key performance indicators; the Soft Brexit scenario has a small improvement; and the Fisheries

Last Brexit scenario has a small decrease in performance. The difference between Hard and Soft Brexit are more varied at fleet level with some net winners and some net losers under both scenarios.

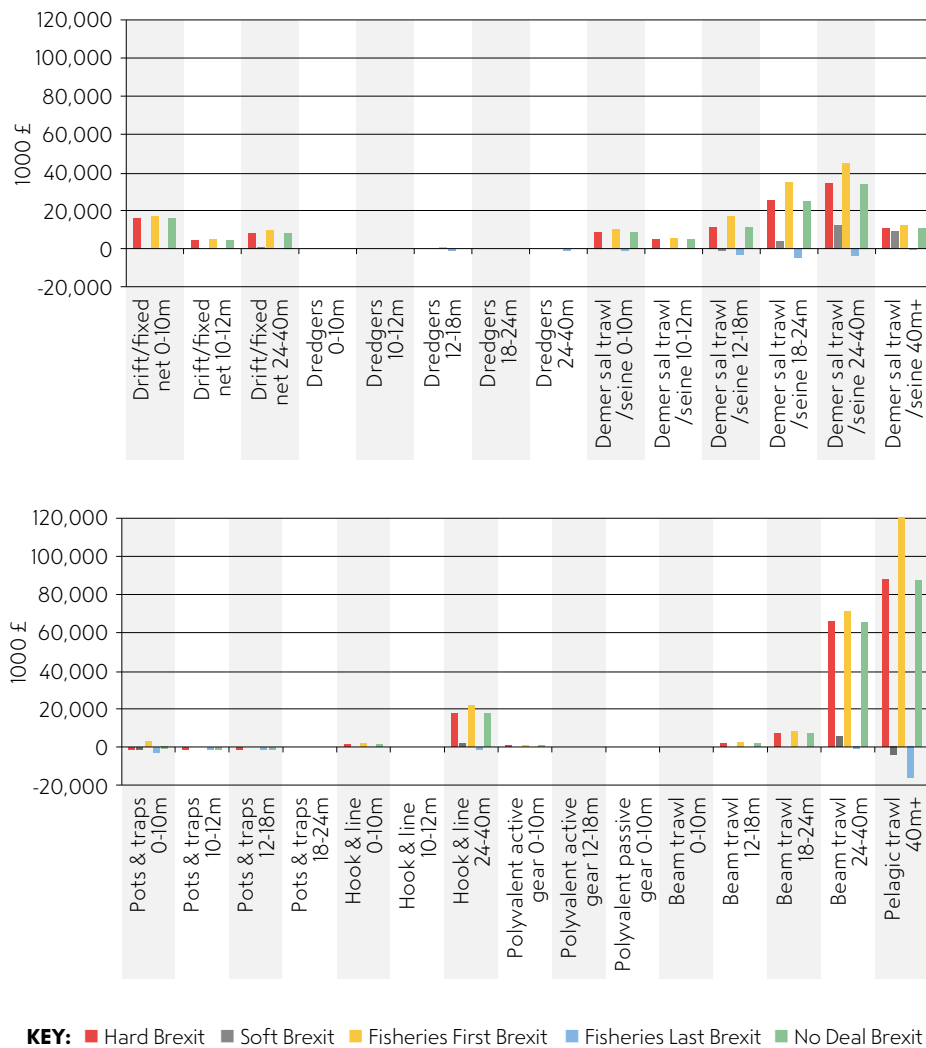
FIGURE 9. TOTAL FLEET LANDINGS, EARNINGS, AND PROFITS UNDER SIX SCENARIOS



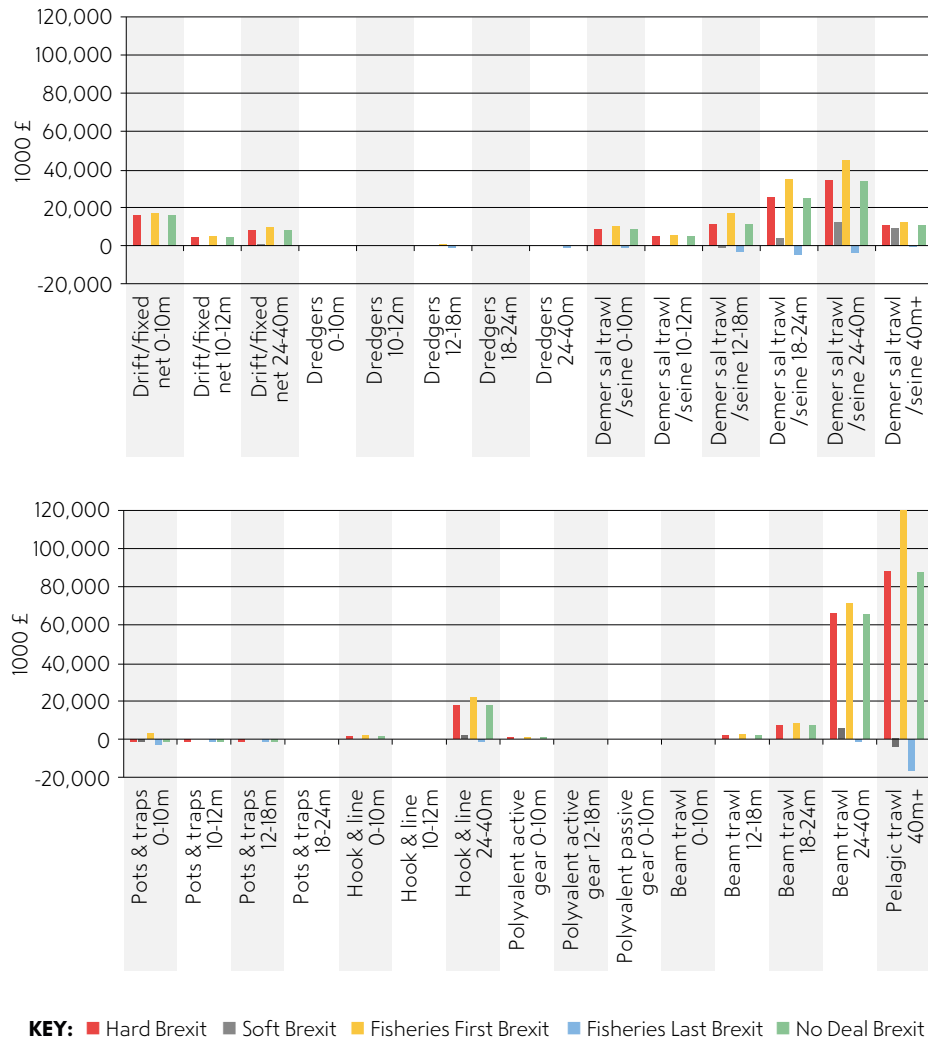
At the fleet segment level, some important trends also emerge. Some fishing gears, notably dredgers and pots & traps, have reduced landings, earnings, and profits across the major scenarios except for Fisheries First Brexit. This is due to the species

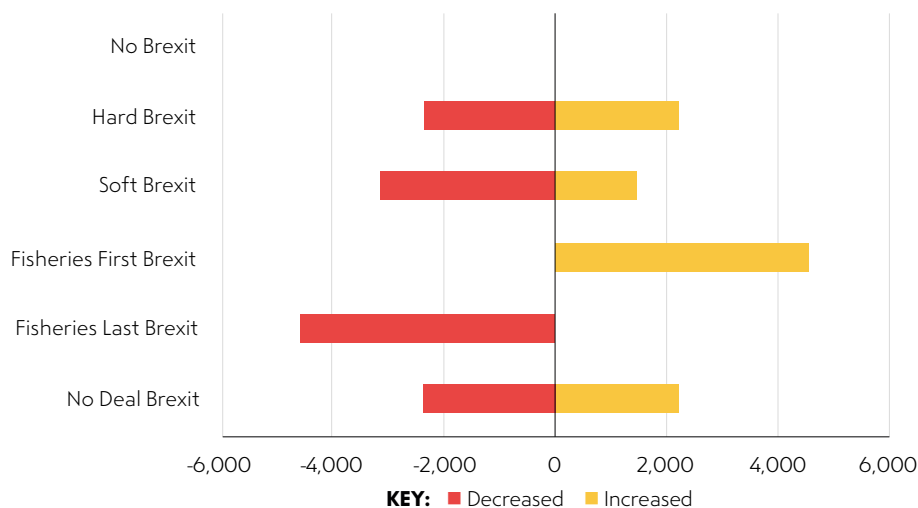
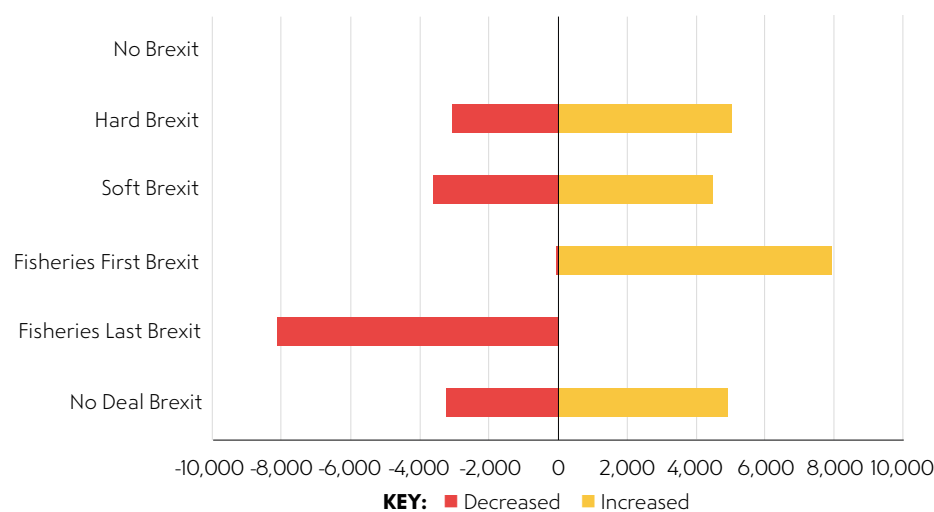
composition of these gear types with few increases in fishing opportunities but a high level of exports to the EU market. Figure 10 illustrates the changes in earnings and net profits compared to the current performance.

FIGURE 10A. CHANGE IN EARNINGS BY FLEET SEGMENT UNDER SIX BREXIT SCENARIOS



KEY: ■ Hard Brexit ■ Soft Brexit ■ Fisheries First Brexit ■ Fisheries Last Brexit ■ No Deal Brexit

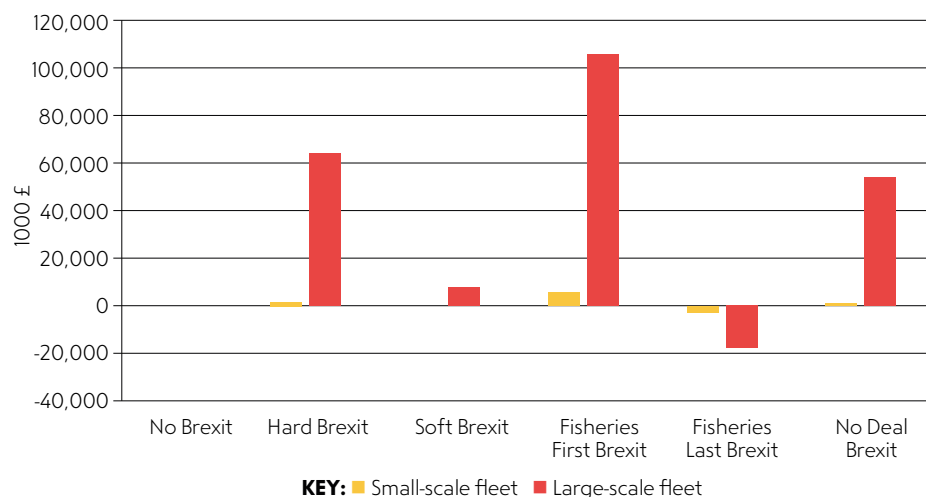
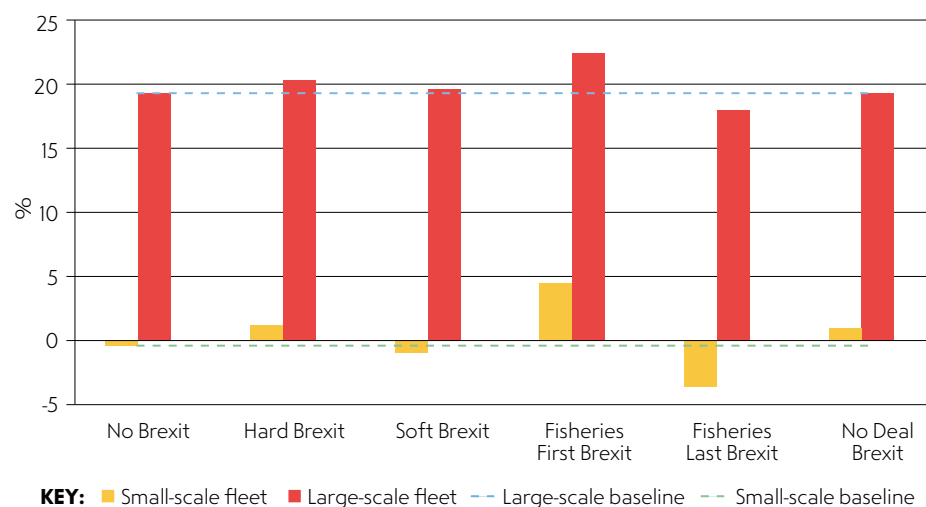
FIGURE 10B. CHANGE IN NET PROFIT BY FLEET SEGMENT UNDER SIX BREXIT SCENARIOS

**FIGURE 11A. NUMBER OF VESSELS WITH INCREASED/DECREASED PROFITS
UNDER SIX BREXIT SCENARIOS****FIGURE 11B. FTE FISHERS WITH INCREASED/DECREASED PROFITS UNDER
SIX BREXIT SCENARIOS**

Not all fleet segments are the same size or significance. Figure 11 illustrates the positive (green) or negative (red) change in net profit across the six Brexit scenarios by number of vessels and the number of full-time equivalent (FTE) fishers. The bars indicate the number of vessels and number of fishers and therefore indicate the probably of a vessel or fisher yielding higher profits (and potentially wages).

By number of vessels, only the Fisheries First Brexit scenario benefits most vessels, although the division is very close in many scenarios with nearly half the vessels doing better and half the fishers doing worse. By number of FTE fishers, the results show more positive results for Hard Brexit, Soft Brexit, and No Deal Brexit scenarios.

Comparing the large and small-scale fleet segments, the division in performance between the two appears to be reinforced. This is due

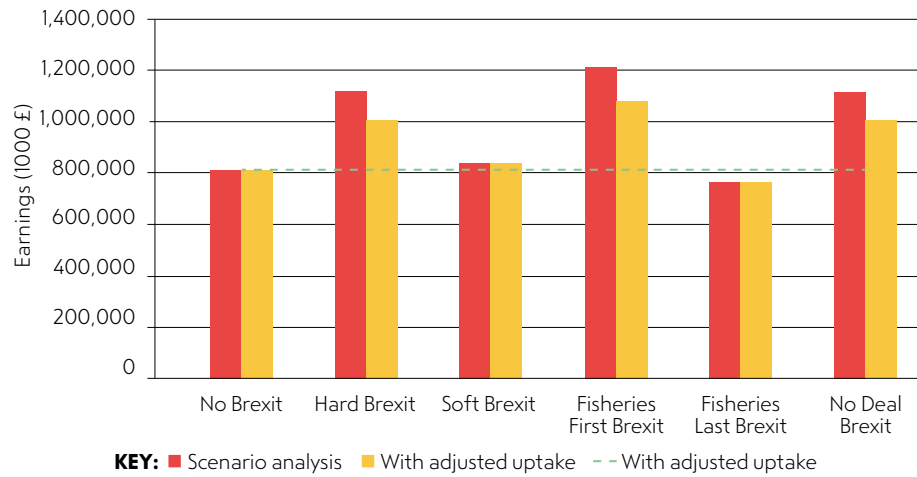
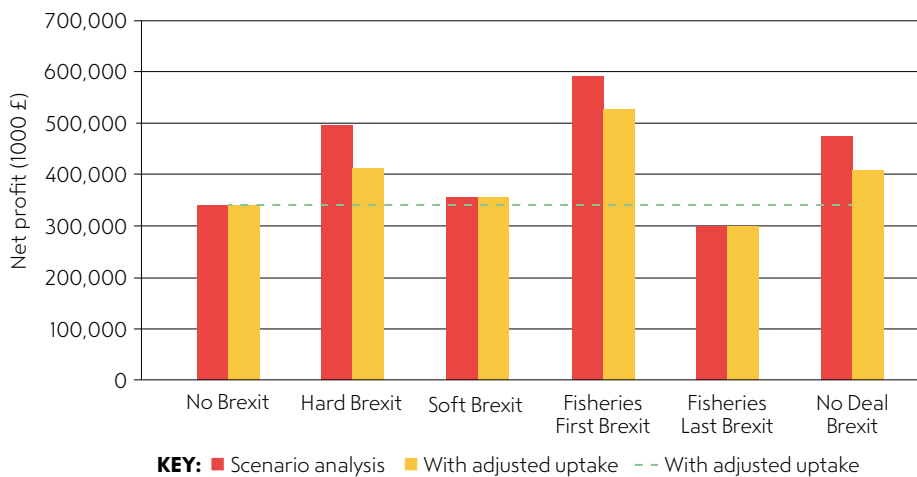
FIGURE 12. CHANGE IN PROFIT BY SMALL-SCALE AND LARGE-SCALE FLEET SEGMENTS UNDER SIX BREXIT SCENARIOS**FIGURE 13. NET PROFIT MARGIN BY SMALL-SCALE AND LARGE-SCALE FLEET SEGMENTS UNDER SIX BREXIT SCENARIOS**

to the ability of fleet segments to take advantage of the different types of access to waters set out in some of the scenarios. Figure 12 aggregates the performance by the small-scale fleet (under 10m) and large-scale fleet (over 10m) across fishing gears.

Impact versus outcome

There is an important distinction between the impact and the outcome of Brexit scenarios on the UK fleet segments. Because UK fleet segments

are starting from very different economic positions (Section 3.3), the impact of Brexit described may lead to sustainable or unsustainable economic outcomes depending on current performance. Figure 13 illustrates that regardless of the impact of Brexit, the outcome of Brexit is a highly unequal fishing sector with small-scale fleet segments at major financial risk. Under all scenarios, the existing disparities in the fishing sector between large- and small-scale are perpetuated.

FIGURE 14A. CHANGES TO EARNINGS USING A PARTIAL RATE OF QUOTA UPTAKE**FIGURE 14B. CHANGES TO PROFITS USING A PARTIAL RATE OF QUOTA UPTAKE**

Even within the small-scale fleet segment, there are a diversity of impacts. While drift/fixed net and demersal trawl/seine benefit from any potential increases to quota for many of the stocks they fish (e.g. sole, cod, and whiting in the Channel), other small-scale fleets, such as pots & traps and dredgers, do not fish quota species already, so do not stand to gain.

4.2 SENSITIVITY ANALYSIS

What if quota increases are not used?

One of the most significant uncertainties in terms of translating changes to quota (Section 2.4) into economic performance revolves around quota uptake. For example, the UK currently receives around 5,000 tonnes of sandeel quota, of which it uses 65%.²⁰² If quota allocation was changed to zonal attachment, it would suddenly receive nearly 200,000 tonnes of sandeel quota (an increase of around 4,000%), and it is highly unlikely that there would be enough capacity in the UK fleet to continue to catch 65% of that far higher amount – UK vessels are currently not specialised to catch sandeel, nor is there a market in the UK or existing supply chains. This lack of capacity has been cited as one reason why access and quota shares are unlikely to be determined directly from the UK EEZ alone.²⁰³

To test how sensitive the results are to the assumption of constant quota uptake, an adjusted rate of quota uptake is used that equates to harvesting half of the quota change (Annex B7: Methodology). This level of post-Brexit quota uptake is a much more likely outcome, at least for the short term, before major structural changes can be made to the UK fishing fleet. The sensitivity analysis only applies to the three scenarios (Hard Brexit, Fisheries First Brexit, and No

Deal Brexit) that are based on zonal attachment, as it is assumed that under the renegotiation outcome (Soft Brexit) the UK would prioritise quota that it has the capacity to harvest.

The results of the sensitivity analysis reveal that quota uptake is an important variable, resulting in reductions to earnings and net profits for these three scenarios and putting them much closer, especially in terms of net profits, to the status quo. The ranking between the scenarios does not change.

The risk of non-cooperation and overfishing

In these results, the impact of changes in quota setting includes a status quo outcome, an outcome based on shared management with third countries, and an outcome based on unilateral quota setting. These latter two outcomes involve the EU or the UK increasing its share of quota so that the total catch is higher than scientific limits, leading to overfishing, that subsequently reduces biomass and yield. The level of quota set above scientific advice is based on the current experience of quota setting between the EU and third countries including Norway, Iceland, and the Faroe Islands.

The EU's CFP has a central objection to reach MSY for all stocks by 2020 – the largest average catch that can be indefinitely sustained. UK Fisheries Minister George Eustice is on record as intending to adhere to this policy post Brexit.²⁰⁴ In this modelling, the different quota outcomes are analysed as deviations from a pathway to the MSY (Annex B). It is worth noting that as the EU is fiercely seeking to protect its share (Section 2.4) and the UK is seeking to increase its share, there will be a departure from the pathway to the MSY as quota gains take priority over sustainable stocks.

To test this case, the six Brexit scenarios are re-run but with the increases in fishing effort applied to the current level of fishing rather than along the assumed pathway (i.e., reductions in fishing pressure) to the MSY. This results in an increase to current fishing pressure as neither side is willing to cede ground, and as a result, it is a third party, the health of fish stocks, that yields.

Again, the modelling results refer to a steady state where a (higher) level of fishing mortality has reached a new equilibrium. There is a time-dependent dimension in that the results use the current level of fishing effort and mortality.

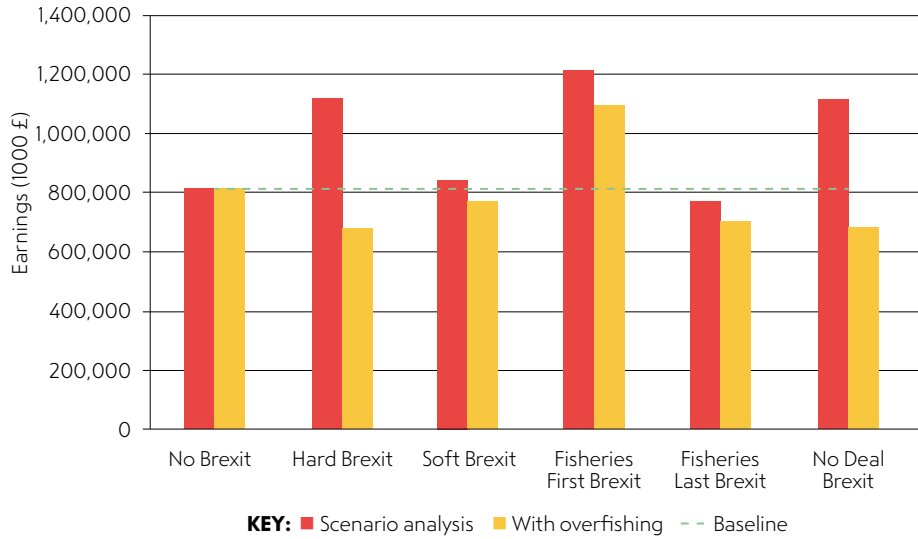
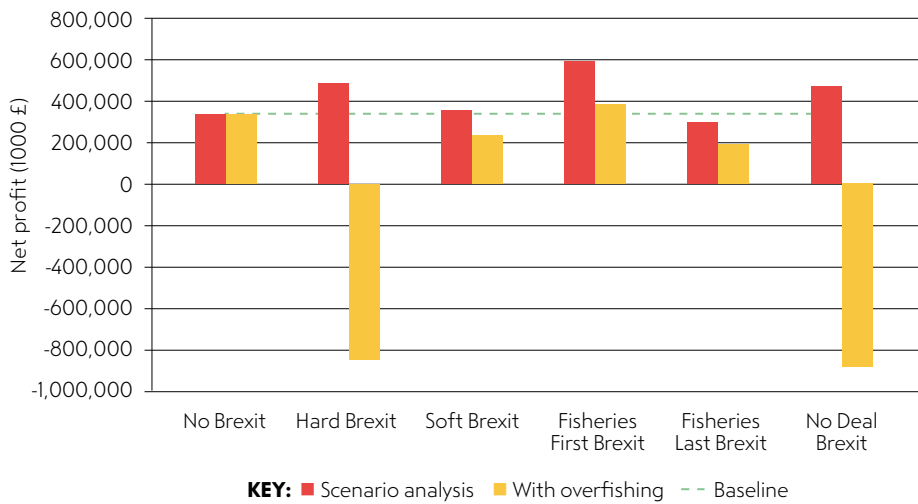
The results in Figure 14 show a dramatic difference in the economic performance of the UK fishing industry under the scenarios that deviate from the MSY. For the Hard Brexit, Soft Brexit, and No Deal Brexit scenarios, this driver would push total earnings and profits below the No Brexit scenario. The Fisheries First Brexit scenario continues to yield higher economic performance than the No Brexit scenario, although this scenario is still assuming the EU reduces its quota share. The Fisheries Last Brexit scenario continues to yield lower economic performance than the No Brexit scenario. What is especially notable is the large decrease in net profits under the Hard Brexit and No Deal Brexit scenarios.

At the fleet segment level, reductions in biomass and yield from overfishing decrease the profitability for every fleet segment (less for fleets not targeting quota species) and force a significant structural change to rebalance the fishing fleet in line with the overfished resource.

These results indicate that the results of the modelling are highly sensitive to the possibility of overfishing during this critical state where fish stocks in the Northeast Atlantic are in a state of recovery but still vulnerable. An increase in overfishing because of Brexit is a real possibility and is explored further in Section 5.2. Will

UK currency depreciation offset the potential imposition of export tariffs?

The fall in the value of sterling since Brexit – the pound was 13% lower against the US dollar as of October 2017 than before the referendum²⁰⁵ – presents both risks and opportunities for the UK fishing fleet (Section 2.8). It is not intuitively clear how a rise in the competitiveness of exports on the one hand could be offset by a rise in input costs. The cost of fuel as an input cost is particularly significant as fisheries are highly fuel intensive (although this is currently subsidised through a tax exemption). Given the time-dependent nature of depreciation, it is analysed here as sensitivity test of the main results rather than as a Brexit outcome.

**FIGURE 15A. SENSITIVITY OF EARNINGS TO FIXED EU QUOTA
AND OVERFISHING****FIGURE 15B. SENSITIVITY OF NET PROFITS TO FIXED EU QUOTA
AND OVERFISHING**

WTO tariffs could be applied on UK fish exports to the EU post Brexit (Section 2.6 and Annex B5); the tariff, and thus its effect, depend on the species and product (ranging from 0% to 30%; Table 6). Another important element is that UK exports outside of the EU will benefit from depreciation without punitive tariffs – making British exports more cost competitive in these markets. This is significant for some species (e.g. herring, mackerel) with a large share of non-EU exports.

In Table 6, a fall in the value of the pound against the dollar of 13% is compared with different tariffs that could be applied by species. The percentage indicates the expected price change for the fish exports of UK fishing fleets based on the combination of effects (a higher percentage is preferred for UK fishing fleets).

Table 6 shows no generalised effect of depreciation and tariffs on UK fish exports. The price effect of depreciation is generally stronger when compared to EEA tariff rates, but the results are

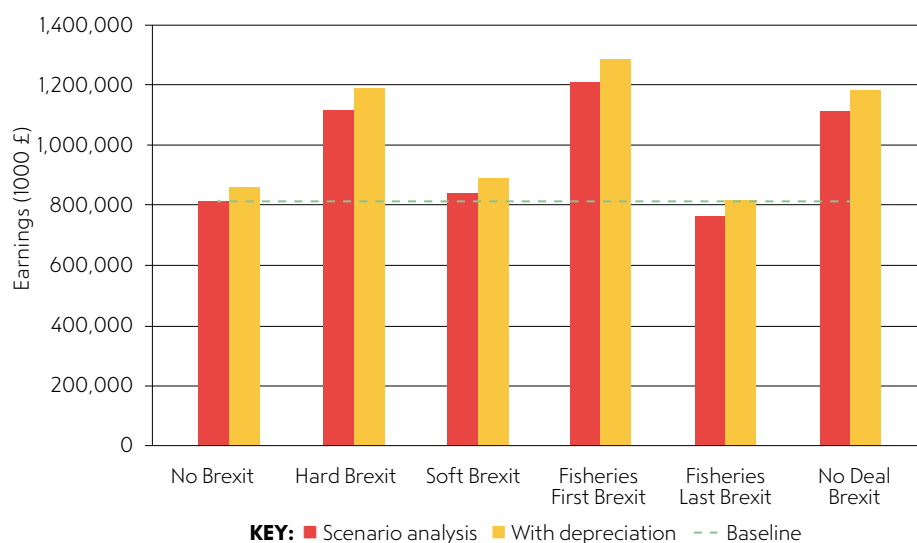
more mixed for WTO tariffs. For some species (dogfish, cuttlefish, scallops, whiting), the depreciation effect is always stronger than the tariff effect, whereas for a couple of species (shrimp, Norway lobster), the opposite holds.

There is also the important impact of currency depreciation on input costs, in particular fuel costs, as fuel comprises around 25% of production costs across the UK fishery. The industry is certainly a 'price taker' in the global market for fuel, which means they will bear the cost of the price change as a result of depreciation, rather than force the price of oil markets down.

This analysis tests how depreciation impacts the results of the previous section.

Across all six Brexit scenarios, the impact of depreciation has a positive effect on earnings as exports become comparatively more valuable (Figure 15a), but this benefit is almost completely offset by the rise in input costs (Figure 16a).

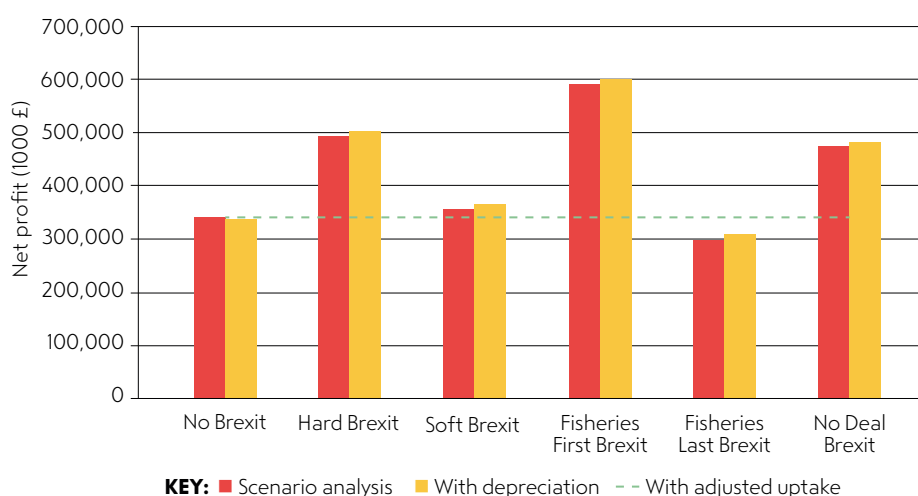
FIGURE 16A. SENSITIVITY OF SCENARIO TO DEPRECIATION



**TABLE 6. EXPECTED PRICE CHANGE: DEPRECIATION VERSUS EEA, WTO,
WTO + NON-TARIFF BARRIERS**

Species	Depreciation - WTO	Depreciation - EEA	Depreciation - WTO + Non-tariff
Anchovy	-4%	8%	-7%
Atlantic halibut	0%	9%	-2%
Bass	-1%	3%	-1%
Blue whiting	3%	3%	3%
Cod	0%	2%	0%
Shrimp	-6%	-3%	-8%
Crab	3%	7%	3%
Cuttlefish	4%	10%	2%
Dogfish	4%	10%	3%
Haddock	0%	1%	0%
Hake	-1%	3%	-2%
Herring	2%	2%	1%
Horse mackerel	1%	7%	0%
Ling	1%	6%	0%
Lobster	2%	6%	1%
Mackerel	1%	1%	1%
Megrim	-2%	5%	-3%
Monkfish	0%	3%	0%
Norway lobster	-2%	-2%	-3%
Octopus	1%	2%	1%
Plaice	0%	0%	0%
Pollack	1%	3%	1%
Redfish	-1%	9%	-3%
Saithe	2%	5%	1%
Sandeel	-2%	8%	-2%
Sardine	-1%	1%	-1%
Scallops	2%	6%	2%
Skates and rays	0%	1%	0%
Sole	-1%	3%	-1%
Sprat	0%	5%	0%
Squid	2%	5%	1%
Turbot	0%	3%	-1%
Whiting	3%	7%	2%

Source: Author's calculations, see Annex B for details.

FIGURE 16B. SENSITIVITY OF NET PROFITS TO DEPRECIATION

At the fleet segment level, there is variation due to the different fuel intensities and export orientation of different fleet segments. In Table 7, the effects of depreciation are compared at the fleet segment level (under the status quo).

The fleet segments that are better off because of currency depreciation (all else held equal) are those that export a significant share of their product (e.g. dredgers, pots & traps), while the fleet segments that are worse off as a result of depreciation are those that are highly fuel-intensive per product value (e.g. beam trawl, hook and line, demersal trawl).

In summary, the potential depreciation of sterling has a small impact – although there are some differences at fleet segment level. Depreciation could in general be expected to improve the performance of export-oriented fleet segments and reduce the performance of fuel-intensive fleet segments.

4.3 SUMMARY OF FINDINGS

Different Brexit scenarios lead to very different results

An important finding from the modelling results is that the broad impact of Brexit depends significantly on which version of Brexit manifests (Figure 8).

The Fisheries First Brexit scenario (Figure 14) – where it is assumed that the fishing industry is prioritised as the key UK sector and ignored by the EU – appears to bring the most economic benefit to the fleet as a whole. But this scenario depends on the UK securing increases in quota and exclusive access and the EU responding by decreasing its quota share and granting tariff-free access to the EU market – which may be simply politically unrealistic. To avoid overfishing, under which everyone loses, it assumes that the EU willingly reduces its fishing quota to create the space for the UK to take more; statements from influential EU actors (Sections 2.4 and 5.2) show the distance to go here.

TABLE 7. EFFECTS OF CURRENCY DEPRECIATION ON NET PROFIT

Fleet segment	No Brexit (no depreciation)	No Brexit (with depreciation)	Change in profits
Drift/fixed net 0–10m	-584	-677	-94
Drift/fixed net 10–12m	821	773	-48
Drift/fixed net 24–40m	2,959	2,761	-198
Dredgers 0–10m	417	512	94
Dredgers 10–12m	879	985	105
Dredgers 12–18m	3,461	3,903	442
Dredgers 18–24m	1,524	1,741	218
Dredgers 24–40m	2,844	3,232	388
Demersal trawl/seine 0–10m	405	323	-82
Demersal trawl/seine 10–12m	1,068	1,054	-14
Demersal trawl/seine 12–18m	5,028	4,516	-512
Demersal trawl/seine 18–24m	12,186	10,276	-1,910
Demersal trawl/seine 24–40m	28,801	26,444	-2,357
Demersal trawl/seine 40m+	5,131	3,915	-1,216
Pots & traps 0–10m	-51	651	701
Pots & traps 10–12m	5,174	5,677	503
Pots & traps 12–18m	3,722	4,256	535
Pots & traps 18–24m	2,084	2,402	317
Hook & line 0–10m	-525	-556	-31
Hook & line 10–12m	-220	-240	-20
Hook & line 24–40m	2,068	1,737	-331
Polyvalent active gear 0–10m	52	64	12
Polyvalent active gear 12–18m	499	460	-38
Polyvalent passive gear 0–10m	-54	-57	-3
Beam trawl 0–10m	-2	-10	-7
Beam trawl 12–18m	160	132	-27
Beam trawl 18–24m	2,031	2,046	16
Beam trawl 24–40m	2,102	832	-1,270
Pelagic trawl 40m+	55,774	57,517	1,743
Total	137,755	134,670	-3,084

Source: Author's calculations, see Annex B for details.

The Fisheries Last Brexit scenario analysis shows the exact opposite results, with decreased economic performance across all fleet segments and indicators. This scenario, which assumes that other, larger UK sectors are prioritised, may also not be realistic; the UK government has made statements that fisheries management will be improved post Brexit. There is a widespread view in the UK catching

sector that fisheries were given a low priority when the UK joined the EU and the consequences are still being felt today. Given the decline in fisheries as a share of the economy since this time and the 'medium priority' assigned to fisheries by the UK government (Section 2.2), it is not clear that this situation will repeat itself. Much of the devil, of course, will be found in the detail of the negotiations themselves.

The Hard Brexit and No Deal Brexit scenarios show large economic gains for the UK catching sector, and the Soft Brexit scenario shows small gains. These results are largely driven by the increase in potential quota outweighing the increase in potential tariffs. Under these scenarios, fishing activity is increased in the UK fleet, but profitability remains unchanged. These narrow economic results could hide stings in the tail, however, depending on whether increased UK quota leads to overfishing of stocks that will still be shared with the EU. The overall economic gains also become much more complex when broken down by fleet segment and when testing for sensitivity to key assumptions, such as an increase in overfishing. If this takes place, for instance if the EU does not agree to reduce its quota share while the UK increases its own, these scenarios perform much worse than the status quo (No Brexit).

The top line results under the Fisheries First scenario for landings (+77%) and earnings (+49%) are similar to most of the previous Brexit studies (Table 3 in Section 2.4), although these studies tend to focus on quota (sometimes multiplied by price), rather than landings and earnings for all species.

Variance by fleet segment: Many losers, including most small-scale vessels

When the results are analysed at the fleet segment level a much more nuanced picture emerges. While Brexit could benefit some fleets under some scenarios, it could also reduce the economic performance of several of the largest fleet segments by number of vessels.

Given the existing dynamics of UK fleet segments, these findings should not be surprising. Fishing quota are not evenly distributed at the moment with the

small-scale fleet representing 77% of the vessels but only receiving 1.5% of the quota.²⁰⁶ Small-scale fleet segments also fish closer to shore and have less spatial interaction with EU fleet segments. The bulk of these small-scale vessels are in the pots & traps fleet segment. All fleet segments export in large quantities to the EU market and are thus exposed to EU tariffs.

As the gains from quota increases accrue to those who hold the quota rights, these gains further entrench the haves and the have nots of UK fisheries. The majority of UK vessels, are net losers under the Hard Brexit and No Deal Brexit scenarios. The same is true for the majority of ports around the UK as 59% of ports (above £100,000 in landed value) receive most of their landed value from these pots & traps or dredgers that feel the impact of tariffs more than the impact of quota gains.

This divergence in performance between fleet segments (small versus large, quota fishers versus non-quota fishers) holds across all modelled scenarios. Given the existing divergence in economic performance between the large-scale and small-scale fleet segments, it seems clear that Brexit alone will not solve the issue of low viability in the small-scale fleet.

Whether any UK quota gains lead to overfishing depends on how the EU responds

The results are highly sensitive (Figure 15b) to the risks of overfishing, which would happen if the UK and/or the EU abandon a commitment to reducing their fishing pressure to rebuild fish stocks and reach the MSY. Relaxing this assumption means that for all but one of the scenarios, economic performance decreases, in some cases (Hard Brexit and No Deal Brexit) sharply. This includes the Soft Brexit

scenario which assumes that quota shares are renegotiated but, as a result of a management structure with the UK now outside the legal structure of the CFP, the TAC is likely to be set further above scientific advice. The only exception is the Fisheries First Brexit scenario, which assumes that the EU would decrease its fishing effort unilaterally in response to the UK taking more quota. It is imperative in practice that a relationship over the sustainable catch of shared resources with the EU is reached and adhered to, otherwise the performance of all fleet segments is at serious risk.

Most vessels and most ports lose if EU tariffs are not kept low

Some of the largest fleet segments by number of vessels and employment do not have large quota shares but do export to the EU market. For these fleet segments – also less able to take advantage of an increase in the extent of UK waters, and without much quota from which to make marginal gains – the sea of opportunity from Brexit is small, so the sea of risk must also be minimised. The results indicate that for most fishing vessels – or most fishers – to benefit economically from Brexit, tariffs must be kept low.

The majority of ports around the UK (59% of ports above £100,000 in landings) receive most of their landed value from pots & traps or dredgers. Most of these landings are from small-scale vessels using pots & traps – the largest fishing fleet by number of vessels and employment. But these vessels catch shellfish mainly for European export, which means that with any scenario that involves the imposition of tariffs (all scenarios except the Fisheries First Brexit scenario), these ports and the communities that they link to may be worse off as a result of post-Brexit fisheries.

Currency depreciation is unlikely to help economic performance

Reasoning that a fall in the value of sterling will have a positive effect for fishers exporting their product is dangerous if it does not ask why the fall in value is occurring. Primarily, the depreciation can be understood as reflecting the fact that, at least according to market actors, Brexit will make exporting more difficult and thus costlier. To counteract this, the value of the exporting currency (the pound) needs to fall to make UK exports more competitive.

There is also the counteracting effect of depreciation on input costs. The scenario analysis shows that while falls in the value of sterling can offset increases in export tariffs on one hand, this currency depreciation also increases input costs, in particular fuel. Given the high fuel-intensity of fishing, depreciation cannot be expected to yield much economic benefit to many fleet segments. The biggest losers of all here will be those with a high fuel intensity but a small export market.

The UK fleet is not presently equipped to take advantage of a new system of 'zonal' quota allocation

Three of the scenarios (Hard Brexit, Fisheries First Brexit, No Deal Brexit) assume zonal attachment is used for the division of quota between the UK and the EU after Brexit. Zonal attachment is a system of dividing quota shares between countries based on how the biomass of fish stocks is split between the respective EEZs. These scenarios show large economic gains at the headline level as a result of what would be large increases to the UK quota. Some of these effects may not manifest due to the limited capacity (and desire) of the UK fleet to fish some quota species. There is a countervailing effect through crowding, however; a lower rate of quota uptake

for unwanted species reduces fishing pressure and thus increases catch per unit of effort. Balancing these effects, the sensitivity results (Section 4.2) indicate that a more realistic quota uptake could erase a significant portion of the economic gains from the three scenarios using zonal attachment.

Some quota are much more economically important than others for the UK fishing fleet

Some fishing quota – cod, sole, and mackerel in particular – proved critical in determining the direction of change for several fleet segments – including those from several small-scale fleet segments. This is worrying given the apparent differences in the estimates of zonal attachment based on landings that have been produced as estimates (Section 2.4) and data on the spatial distribution of fish stocks from the International Council for the Exploration of the Sea (ICES; Annex B3). Proper biological assessments of zonal attachment, preferably those by an independent body like ICES, would greatly aid Brexit analysis in this area by providing a closer approximation of what quota shares based on zonal attachment could be.

This analysis only looks at fishers – but other fishing stakeholders have different needs

This report is focused on Brexit impacts for the UK catching sector, ignoring many other sectors outside the scope of analysis. UK fish processors and retailers in particular, as well as ports, auctions, shipyards, and suppliers, have a very different perspective on Brexit to the catching sector (explored in Section 5.1). This report has also not attempted to analyse the economic implications of Brexit for fleet segments within the rest of the EU. Here, the economic outlook from most Brexit scenarios is almost certain to be negative due to potential disruptions in access and trade.^{207,208}

It is difficult to generalise the impact of Brexit on UK fisheries. While the inherent uncertainty of Brexit negotiations on fisheries is widely recognised, the results in this report also point to the need to focus on the variance of impacts within the sector and the potential for both winners and losers.

SECTION 5: DISCUSSION

5.1 UNDERSTANDING THE RESULTS IN THE CONTEXT OF ENTHUSIASTIC INDUSTRY SENTIMENT FOR BREXIT

The EU's CFP is a much-maligned policy. It has long been criticised for failing to deliver on the three pillars of sustainability (environmental, economic, and social). Fishers often complain about the management of their industry and frequently point to Brussels as the source of the problem. In media stories about Brexit and fisheries, industry representatives have been quoted celebrating the prospect of Brexit and the changes it may bring to the UK industry. Yet the reality is far more complex, as the economic modelling of the Brexit scenarios reveals. This gap between rhetoric and reality requires a deeper understanding of industry attitudes on fisheries management and Brexit.

The pain and gain of fish stock recovery

The 2013 reform of the CFP added an objective to end overfishing by 2015 where possible and by 2020 at the latest.²⁰⁹ For almost a decade now, EU fisheries have seen stocks moving towards sustainability, although currently not on pace for the 2020 deadline.²¹⁰

These improvements have not come easily, however. The basic tenet of managing overfished stocks is to reduce fishing pressure (through quota and decommissioning of fishing vessels) to allow fish stocks to rebuild, which in turn leads to larger populations and larger harvests in the future. This transition meant an initial and essential reduction in fishing activity through quota cuts, but now quota, landings, and profits are increasing. In fact, fishing profit margins for the UK fleet are amongst the highest in the EU and much higher than other sectors of the economy.²¹¹ Last year, Scotland set a record for the value of landings at over £560 million.²¹²

This long path to recovery has not only been a difficult one, but it has entrenched perceptions about European fish stocks that are dwindling and beyond repair. It takes time for the changes to alter conceptions and there is a danger that management conclusions are reached without new information. As Andrew Charles from the Scottish Seafood Processors Federation summarised: 'We are leaving [the Common Fisheries Policy] just at the point that it is working.'²¹³

The decline in employment in the UK fishing sector began as far back as 1938, when records began, and has continued at a similar rate as other countries both inside and outside the EU.²¹⁴ This decline in fisheries employment has largely been driven by a better balancing of fishing activity

with the fisheries resources (i.e., a reduction in overfishing), technological changes, and the concentration of fishing rights.^{215,216} How fishing rights are distributed within the UK to different fleet segments and vessels, including policies around concentration and other means of maintaining fisheries employment, is, despite common perception, entirely a competency of the UK government.²¹⁷

One fishing industry, many fleet segments

As emphasised in this report, the UK fishing fleet is composed of many distinct fleet segments, all with their own unique operations. The impact of Brexit cannot be adequately summarised for the UK fishing fleet as a whole given the divergence in Brexit impacts and economic position at the fleet segment level.

Unfortunately, this variance between fleet segments has not been made clear in the discussion thus far on Brexit and fisheries, partly due to differences in representation and power between the fleet segments. The vast majority of statements on Brexit have come from representatives of fleet segments that, according to the results of the modelling, benefit the most from several potential Brexit scenarios. These are the current quota holders and larger vessels that can fish out to 200 NM.

In light of these results, it thus makes sense that the SFF, which represents many large-scale pelagic vessels, is welcoming Brexit in their post-Brexit communications.²¹⁸ Some statements from the SFF have been clear that they accept there will be tariffs on exports to the EU post Brexit but that they accept this trade-off with quota increases as in the interest of their members.²¹⁹

While the SFF grabbed headlines with their weighing of the balance between risks and opportunities, little has been heard from representatives of the other fleet segments. When fishers are asked about the broader fishing industry, there is a mood that ‘the little man will probably end up losing out’.²²⁰

The fleet segments that according to the results of this analysis may be worse off as a result of Brexit, typically small-scale fleets and those targeting shellfish, do not have this same lobbying power or access to media coverage. These fleet segments have a large number of vessels, but are spread out across many small ports. Some organisations representing these fleet segments have markedly different statements on Brexit to the SFF and other organisations presenting the large-scale fleet.

The OFA, which represents mostly small-scale vessels catching crab and lobster, is significantly more uncertain about the prospects of Brexit, highlighting significant risks to their business from loss of subsidies and EU crew as well as the potential of tariffs on exports.²²¹

The Scottish Creel Fishermen’s Federation (SCFF), representing inshore boats creeling for Nephrops, crab, and lobster, has warned that not all fishers support Brexit and pointed to the issues of tariff and non-tariff barriers: 80–90% of their catch is currently destined for EU member states.²²² These are higher EU export percentages than are observed for these species across the UK fleet, suggesting that there may be important variance in fleet segment export exposure – something that was not possible to analyse with existing data.

The New Under Ten Fishermen's Federation (NUFTA), representing small-scale fishers around the UK, noted that there will likely be some economic losses in fleet segments catching shellfish (reflected in the modelling results of this study) – but there is an opportunity with quota gains to benefit the small-scale fleet with 'some movement on the repatriation of quota'.²²³ Both the SCFF and NUFTA point to problems with the distribution of fishing opportunities within the UK as a significant issue, although this point has largely been ignored in coverage of Brexit and UK fisheries.^{224,225}

This problem of concentrated power and voice in the UK fishing industry has even manifested itself in surveys that have been conducted on UK fishers and their views on Brexit. The first survey, conducted by researchers at the University of Aberdeen, revealed that fishers were overwhelmingly (97%) in favour of Brexit. However, despite constituting the majority of the fleet (77%), only 11% of the survey responses were from the small-scale fleet.²²⁶ This lack of size-based representativeness is significant, given the position of the small-scale fleet segments as net losers from some Brexit scenarios.

The second survey, conducted by a student at Cardiff University, was reported as showing that most fishers wanted alternative management systems, such as effort management (restrictions on the number of days/ hours/vessels used in a fishery).²²⁷ Once again, the survey suffered in getting a representative sample as the primary means of survey response was through Fishing for Leave, a Brexit lobby group (that supports effort management instead of catch quota), and their registered members.²²⁸

The diversity of fleet segments and the power of representation are important lenses for understanding the modelling results in the industry context. This problem is so endemic that from media input to survey responses, the voice of the fishing industry has overwhelming come from lobby groups that represent the large-scale sector and a pro-Brexit lobby group.

Differing perceptions over likelihood of trade-offs

Delving further into the University of Aberdeen survey results provides an insight into why so many fishers are keen on the prospect of leaving the EU despite the modelling results in this report. When asked about changes to quota, 77% thought leaving the EU would increase their fishing opportunities, 1% thought fishing opportunities would decrease, and 22% thought it would make little or no difference. On trade, 17% thought leaving the EU would increase trade to European countries, 6% thought it would hinder trade, and 77% thought it would make little or no difference.

With only 6% of survey respondents considering Brexit a hindrance to European trade, despite the majority expecting an increase in fishing opportunities, fishers do not seem to expect trade-offs within Brexit. These survey results seem closest to the Fisheries First Brexit scenario. In fact, more fishers (17%) thought leaving the EU would increase trade to Europe than decrease (6%). This possibility is outside the scenarios considered as no mechanisms have been identified for increased EU trade post Brexit, as opposed to the tariff and non-tariff barriers identified in Section 2.

These survey results indicate that the fishers surveyed are overwhelming in favour of Brexit, but also that their expectations are aligned with the modelling results closest to the Fisheries First Brexit scenario. This is perhaps not surprising given some of the signals that have come from senior representatives of industry and government. Bertie Armstrong from the SFF is cited as wanting the UK to leave all fishing discussions to one side until Brexit is over and then to negotiate on fishing as an independent nation state with its own legal 200-mile limit.²²⁹ Ruth Davidson, leader of the Scottish Conservatives, has both promised as much access to the single market as possible while also promising that a 200NM EEZ for fishing would be a red line in negotiations.²³⁰ It is highly likely that a hierarchy of preferences will be required between access to the single market and access to UK waters.

The rest of the seafood supply chain is far more sceptical about Brexit

The views of fish processors, wholesalers, and retailers can also shed some light on the results from the scenario analysis – all sectors that expressed very different views from the large-scale fleet on many key issues relating to Brexit.²³¹ These sectors of the fishing industry tend to receive less media attention than the catching sector, despite being much larger economically (as indicated by the Fishing for Leave 4:1 multiplier in Section 3.2). There are certainly concerns from the enormous Scottish salmon industry, although this report focuses on the UK (wild) catching sector.

In almost a complete reversal of the University of Aberdeen survey of the large-scale catching sector, a survey of the members of the Food and Drink Federation responded 86% to 14% that in their professional capacity it would be in the best interest of the UK to remain in the EU.²³² This divergence in views is at least partly explained by the fear of restrictions to EU labour and the EU market within the rest of the seafood supply chain. The UK Seafood Industry Alliance (SIA), which represents seafood processors and traders, explained in their evidence to the House of Lords committee: ‘A future relationship with the EU must maintain existing market access and our ability to import zero or reduced tariff supplies from both EU and non-EU countries.’²³³

Macduff Shellfish, the largest processor of shellfish in Europe, echoed this view in their submission to the Scottish Government’s European and External Relations Committee: ‘In recent years, our business has expanded its capacity, employment levels, and profitability as a result of the European single market. As such, Macduff Shellfish considers it imperative that the UK retains access to the European single market in the future.’²³⁴

This view is echoed by the seafood industries outside of the EU. Norway, which has the closest fisheries relationship with the EU, still pays tariffs on 70% of its fish sent to the EU market, totalling 1 billion Norwegian kroner (£91.5 million) a year to the EU.²³⁵ Kristin Alnes of the Norwegian Seafood Federation noted: ‘The lack of free trade with the EU is very difficult for us and has been a problematic area for years. Our fish become more expensive and our exporters have less income.’²³⁶ For Norwegian seafood, her view is that full EU membership ‘would be the best solution’.²³⁷

It may be that the latter stages of the supply chain are closer to the end consumer (often in the EU) and are thus particularly attuned to the significance of the EU market and the associated risks involved, if barriers to trade are imposed.

5.2 COULD OVERFISHING REALLY HAPPEN HERE?

It may not have featured much in the media coverage around Brexit and fisheries, but the risk of Brexit leading to overfishing is to be expected. The UK desires more quota, and the EU does not easily want to give it. The experience of quota setting between the EU and third countries (Section 2.5), where limits are set above scientific advice due to negotiators playing hardball, shows the reality of what happens when individual actors pursue their individual self-interest at the expense of the resource as a whole. This underlying drive can best be countered through shared governance structures, such as the one the EU provides through the CFP.

Shared resources without shared management create obvious conflicts of interest – a problem that already plagues quota negotiations with third countries like Norway, Iceland, and the Faroe Islands.

Bertie Armstrong, chief executive of the SFF, expressed this view clearly in his personal support for staying within EU management (pre-referendum vote):

Common sense suggests that collective action is better than a load of individuals competing, and in the fishing industry that's largely true. Collaborative action, so that no one individually overfishes or you don't have what could be referred to as the tragedy of the commons of everyone trying to fish a little more than their neighbour – the

negotiations to have a sensible place outside the tent would be very complicated and full of hazard, particularly full of hazard for us.²³⁸

The UK's assumed position in the negotiations with the EU over fisheries is for quota shares to be based on zonal attachment. Some voices in the UK fishing industry present the view that zonal attachment is obvious and straightforward, but there is nothing in international law stating that zonal attachment is how fish stocks should be shared. The current sharing of stocks with third countries based on zonal attachment gives pause for concern as these sharing arrangements have been fraught with controversy and political reality. The choice of reference period for the calculation, whether this period is revisited as the climate changes, and the life stage of the fish stock in each area are but a few issues that significantly complicate the process and turn what could appear to be a simple calculation into a protracted and difficult negotiation. Internationally, there are dozens of diverse arrangements to share fish stocks between countries.²³⁹

It is also possible that the principle of sharing quota based on zonal attachment will be disputed by the EU. As described in Section 2.4, the view of the EU Parliament Committee on Fisheries (PECH) is that there should be no change in the system used to distribute quota.

Recently, several of the largest European fishing organisations have come together to form the European Fisheries Alliance to advocate on their behalf, particularly on the issues of changes in quota and access to waters. Gerard van Balsfoort, chair of the Alliance, has echoed the warnings that a failure to agree on quota shares risks overfishing:

The cake is the cake. If the UK wants more part of the cake by prohibiting access, renegotiating shares, it will come off our shares. It could lead to many years of non-collaboration and in the end, that is to the detriment of the fish stocks.²⁴⁰

This view implicitly supports the idea that the EU would not reduce its share of the resource even if it recognised that the result would be unsustainable (just as the UK would increase its own share with the same recognition). This aligns with the setting of unilateral TACs described in Section 2.5, in which negotiating parties set their share of the TAC at a level they feel is fair, even if the result is that the total quota exceeds scientific advice. There have even been cases where one party increasing its TAC share has led to other parties not just holding their share constant, but seeking to increase their share. Scottish MEP Ian Duncan and Dutch MEP Peter van Dalen called on the Commission to do exactly this when Norway increased its share of the 2015 blue whiting quota.²⁴¹

In a technical sense, if there is a hard maritime border, it may be difficult for overfishing to increase significantly if one side is not able to harvest the share that they set themselves. This is particularly true if the EU is shut out of UK waters. This dynamic is often overstated, however. While the EU fleet currently catches a significant portion of many stocks in UK waters, this is not to say that the stocks do not exist in EU waters, only that it is more profitable to catch them in UK waters. Fishing pressure could still continue on the EU side, just with a lower rate of profitability. Many of the large-scale EU fleets, much like the large-scale UK fleets, are currently highly profitable.²⁴² There is also the possibility that EU fleets will not respect a border, as control and enforcement of fisheries is extremely costly and currently under resourced (Section 2.11).²⁴³

SECTION 6: POLICY RECOMMENDATIONS

Based on the research compiled and the results of the economic modelling, several policy recommendations emerge. These recommendations are centred on delivering a post-Brexit fishery that improves the economic performance of as many of the different parts of the UK fishing fleet as possible while targeting the objectives for fisheries defined by the UK government in the policy paper *Fisheries 2027 – A long-term vision for sustainable fisheries*.

RECOMMENDATION 1: DROP COMBATIVE RHETORIC AND PURSUE COLLABORATIVE SOLUTIONS.

More than any one policy, it is important for the UK government to move beyond bold promises to the catching sector and combative rhetoric towards the EU. It makes for good politics, especially given the prominence of fisheries in the British identity, but it is also setting up dangerous expectations that do not match the realities of the negotiation. An adversarial relationship with the EU could set up a situation of overfishing (Sections 2.5 and 5.2) and closed markets (Section 2.6) – either of which would undermine the very promises the government has been making.

RECOMMENDATION 2: SET SUSTAINABLE CATCH LIMITS BY AGREEING TO FIXED SHARES OF FISHING LIMITS WITH THE EU FOR SHARED FISH STOCKS TO AVOID EITHER PARTY SETTING UNILATERAL QUOTA.

A healthy marine ecosystem underpins the economic performance – indeed the entire existence – of the UK fishing fleet. Delivering sustainable fish stocks must sit as the top priority for Brexit negotiations as all policies about managing the resource depend on the health of the resource as a prerequisite.

Despite countless example of overexploitation of a resource and economic hardship, this lesson appears not to have been learned; there are still headlines like ‘Brexit changes could be good news for fishermen – but bad for fish.’²⁴⁵ Ultimately if post-Brexit fisheries is bad for fish stocks, there will be less fish to harvest, which is bad news for fishers as well. Here, there is a lesson to be learnt from fisheries management in the USA, where scientific advice on sustainable catch limits must be followed.²⁴⁶ Some

stakeholders, like the angling sector and environmental groups, would like to see fish stocks grow in size, by fishing well below such limits (i.e., beyond the MSY biomass).²⁴⁷

To ensure sustainable catch limits, lessons must be learnt from the poor experience managing shared fish stocks between the EU and third countries. One key lesson is for the UK and the EU to quickly establish fixed shares of fishing limits (i.e., a new relative stability key for sharing quota) that can only be renegotiated in intervals (e.g. every ten years, as indeed is the case for reviews and reforms of the CFP) to allow for changes in fish migrations as a result of warming waters or within the target stocks of national fleets.

What must be avoided is a system where a party can end negotiations and set their own unilateral quota. Given the large number of stocks shared between the EU and the UK, the probability of talks breaking down is much higher as disagreement over any one stock could risk the entire deal. This emphasises the importance of agreement on fixed quota shares. Worryingly, the government seems headed in the opposite direction on this point; UK Fisheries Minister George Eustice testified before a House of Commons committee that he envisions that quota shares and access to waters will 'become a feature of annual UK-EU negotiations'.²⁴⁸

RECOMMENDATION 3: USE A RISE IN QUOTA TO HELP ALL BOATS AND GIVE ANY QUOTA GAIN FROM LARGER UK WATERS TO FISHERS WHO HAVE BEEN LEFT OUT OF THE QUOTA SYSTEM.

The small-scale fleet in the UK has long suffered from low quota allocations as a total of the UK share of the TAC. Despite making up 77% of the fleet they hold rights to just 1.5%

of the UK's quota.²⁴⁹ For the small-scale fleet, this ongoing problem has been identified as their main grievance, above (and distinct from) any Brexit issue.²⁵⁰

How quota and other fishing opportunities are split within a country has always been up to each EU member state. In a letter to *The Times* on Brexit, 13 fisheries experts, including former fisheries ministers Richard Benyon (Con) and Ben Bradshaw (Lab), explained:

It is true that many small vessels in the UK are suffering from low quotas, but the UK has the second largest allocation of quota in the EU. Plus, on the whole, fishing profits in the UK are increasing and are higher than for any other EU member state. The minister omits to mention that it is entirely his responsibility to allocate more UK quota to small vessels over large.²⁵¹

Regardless of Brexit, this is an issue that must be addressed to secure a fair system that supports all fishers.²⁵² Yet under Brexit scenarios that result in UK quota gains, the inequality would be compounded without actively correcting for it. At present, quota are held not as tonnage but as percentage shares of the total UK quota. Unless there is quota reallocation alongside quota increases, the quota would simply accrue to the existing quota holders, furthering the inequality of quota holdings in the UK fleet (Gini coefficient of 0.88).²⁵³

As these quota are gains, it is also possible to reallocate quota so that no fisher is worse-off after the reallocation process. Over the previous decades, the large-scale fleet has argued that reallocation would amount to robbing Peter to pay Paul and that some fishers took out bank loans against their current quota.²⁵⁴ These

counterarguments do not apply in this situation, as this is extra free quota on top of existing holdings. This is also the case for EU fish stocks and quota that are increasing in size, where quota reallocation can still result in a larger tonnage for all.

Beyond using quota gains to benefit the most vulnerable fleet segments, the UK must significantly reform the UK's system of how and to whom it allocates quota. The New Economics Foundation has proposed a criteria-based allocation system or sustainability scorecard.²⁵⁵ This approach would ensure that UK fisheries are delivering across the breadth of the different objectives society has for the stewarding of a shared and vital national resource.

RECOMMENDATION 4: SEEK A POST-BREXIT FISHERIES TRANSITION DEAL LASTING AT LEAST TWO ADDITIONAL YEARS, DURING WHICH IMPORTANT EU DEADLINES CAN BE MET.

It is unrealistic to think that all the issues surrounding post-Brexit fisheries can be concluded by 2019. The experience of Greenland leaving the EU in 1985, a much smaller economy, supports this. But the lack of a comprehensive deal could create a legal vacuum that presents significant risks to fishing fleets and to fish stocks. As similar concerns have been expressed for other policy areas, a transitional deal to provide temporary cover may be on the cards, with some analysts suggesting a period of 2019–2025.²⁵⁶ The components of such a transition deal would be negotiated alongside Article 50.

Given the difficult timing of Brexit with regards to some key components of the CFP, it would add clarity to confirm that the CFP will apply at least until the end of 2020. This would see through:

- the commitment to fish at no more than the MSY for all harvested species (by 2020),
- the full implementation of the landing obligation (by 2019),
- the conclusion of subsidies under the EMFF (in 2020).

Depending on what is included in the transition deal, it may make sense to negotiate a longer-term fisheries deal alongside the next reform of the CFP, which is expected to begin shortly and conclude in 2023. This is particularly important, especially on the EU side, if relative stability is going to be revisited for all countries as part of the next CFP reform.

In his paper for the Bar Council Brexit Working Group, Daniel Owen explains that such a transition deal for fisheries would be entirely consistent with the Queen's Speech, which provided clarity on a number of bill-base changes 'on exit', but with respect to a new fisheries bill the language changed to 'as the UK leaves the EU' and 'once it has left the EU'.²⁵⁷

RECOMMENDATION 5: SECURE THE BEST POSSIBLE ACCESS TO THE EU MARKET TO AVOID OR REDUCE TARIFFS AND DISRUPTION.

The scenario analysis shows that the EU market is of critical importance to UK fish products. To the maximum extent possible, the UK government should seek a negotiated deal that minimises tariffs. In addition, while not modelled in this report, other new obstacles to selling to the EU market – such as product standards and port inspections – are also a significant concern for the future economic performance of the UK fishing fleet. Fortunately, the UK is starting from a good position: current product

standards are harmonised. However, to avoid border delays and inspections, there will need to be a continued close relationship between the EU and the UK on fisheries and the avoidance of an adversarial relationship that could ultimately force the EU to retaliate with a strong and obstructive hand.

RECOMMENDATION 6: CREATE A PLATFORM FOR QUOTA SWAPPING BETWEEN UK AND EU FISHERS.

Quota swaps between the UK and EU countries already exist, and ease the pressure on any one country to push for unsustainable quota. If the UK fishing industry felt that it was allocated an insufficient amount of quota for one species, it could swap quota for a different species held by another country. If future quota are based on a new system of zonal attachment, in practice there will be some quota held by the UK that are unlikely to be used (Section 2.4).

Existing systems need improving. Direct quota swaps are not the current arrangement with non-EU countries such as Norway. Instead, quota swaps are negotiated with the European Commission centrally, rather than through member states, producer organisations, or any other level of quota holding. This limits the amount of swapping that takes place and has been criticised for privileging certain fleets or member states.

A new platform should be created for quota swapping between any nations that fish in EU waters. Potentially, the system could ultimately enable peer-to-peer quota swapping at the vessel level to empower fishers.

RECOMMENDATION 7: NO HARD BORDERS – AGREE MUTUALLY BENEFICIAL ACCESS TO THE UK AND EU’S WATERS.

There should not be a hard border between the EU and any future UK EEZ. Both sides benefit from having larger waters to access and the freedom to land fish that have been caught in the closest port, regardless of nationality. Neither British fishers nor British markets have much of an interest in sandeel, for example, so there is a clear benefit to having Danish fishers enter the UK EEZ to fish for sandeel in exchange for a more prized species for the UK fleet, such as mackerel or saithe fished in Danish waters.

Some Brexit lobby groups have responded saying that proposals to allow access to foreign vessels within 200 NM, such as the indication by Secretary of State Michael Gove, are ‘astonishing and disappointing’.²⁵⁸ Regardless, the government should seek practical solutions over bluster. Norway, which has its own EEZ, functionally shares waters with the EU. Some UK vessels spend most of their fishing days in Norwegian waters and land into Norwegian ports at present and some EU vessels may do the same in UK waters post Brexit.

Within territorial waters, that is 0–12 NM, the situation is different, and spatial access can and should be altered through the London Convention. This agreement, signed in 1964 before the UK joined the EU, granted access to UK inshore waters (6–12 NM) to five countries in exchange for other, much smaller, access rights in other country’s waters. The UK government announced in July 2017 that it is leaving the Convention, which has a required two-year leaving period (although there is a legal debate over whether the Convention is a ‘sleeping or dead dinosaur’ in its applicability post Brexit).²⁵⁹

Repealing the London Convention presents an interesting opportunity to reform inshore waters in a more radical fashion. Peter Aldous MP (Con), speaking in Parliament in support of the East Anglian fishing fleet, has proposed that the entire 0–12 NM zone should be ‘exclusively available’ for the small-scale fleet.²⁶⁰ The S SCFF, which represents small-scale creelers, is lobbying for exclusive access to a more modest 3-NM zone.²⁶¹

This approach has the potential to deliver improved economic performance for the small-scale fleet while minimising the issue of gear conflict (i.e., the damaging of fishing gear, often unintentional, by other fishers) in these crowded, inshore waters. There may, however, be instances where large-scale vessels can demonstrate a low environmental impact and a lack of competition with small-scale vessels. A definition of small-scale and low-impact should therefore be defined in pursuing this approach, potentially using a sustainability scorecard approach rather than vessel length as the sole criterion.

RECOMMENDATION 8: EMPOWER FISHERS TO REALLY TAKE CONTROL – BOOST REPRESENTATION FOR THE SMALL-SCALE SECTOR AND BUILD CO-MANAGEMENT.

While many fishers express frustration with how fisheries are managed at the EU level, it may be the case that these attitudes will simply be redirected to Westminster post Brexit. Some of the elements of fisheries policy that are the most criticised are those that are and always were the UK’s national competency, such as quota allocation between fleets and vessels. It is clearly not a case of ‘job done’ if power is simply transferred from Brussels to Westminster institutions, and in some cases Edinburgh, Cardiff, and Belfast.

This dissatisfaction with national management is also reflected in the surveys of fishers detailed in Section 4. In a University of Aberdeen survey (Section 5.1), over half (56%) of fishers disagreed with the statement that their ‘voice counts in the UK’. This compares with 43% for the UK population as a whole.²⁶² In a student survey for Cardiff University (Section 5.1), 92% of fishers said relations between fishers and the government were ‘poor’ or ‘very poor’ and 84% thought that quota allocations were not spread fairly across the fishing fleet by the UK government.²⁶³

Considering these poor attitudes towards national governance, post-Brexit fisheries policy should be designed to give fishers a voice and develop systems of co-management. This refers to systems of sharing management responsibility among multiple parties such as governments, user groups, scientists, local communities, and other stakeholders who operate at different levels. They may result from explicit efforts by governments to move away from top-down fisheries management or may simply arise through a bottom-up process of self-organisation.

Recently, there has been a significant development for the small-scale fleet with the formation of a producer organisation (PO) exclusively for the small-scale fleet – the Coastal PO.²⁶⁴ POs are recognised bodies that collectively manage the activities of their members, help them access fishing opportunities, and help them access markets.²⁶⁵ A dedicated PO for the small-scale fleet was one of the recommendations in the New Economics Foundation’s report, *Who gets to fish? The allocation of fishing opportunities in EU member states*.²⁶⁶ The Coastal PO should help the small-scale fleet gain more control of their own management and more flexibility

in accessing quota from each other and through international swaps. It could also help provide a desperately needed voice for small boats as a balance to the power of the large-scale fleet has through existing producer organisations and lobby groups.

Now the government must ensure the PO has a proper place in the UK's management structure, especially given the uncertainty around post-Brexit changes.

RECOMMENDATION 9: GENERATE FUNDING FOR FISHERIES MANAGEMENT THROUGH A LANDINGS TAX.

Post Brexit there is a need to increase funding for the domestic management of fisheries to deal with what are currently EU competencies. This will require a dramatic shift in thinking as in recent years the Defra and the MMO have faced cutbacks that have affected their operations, including reductions in the number of vessel inspections.²⁶⁷

For the size of the industry, the costs of management are high, compounded by the fact that little direct revenue is received. Quota is currently allocated for free. Yet a substantial resource rent is being generated; fishing licences are capped to restrict new entry, and so profits are increasing to high levels (as much as 27% for the largest vessels; Section 3.3) for some fleet segments. The government should share the costs of management with the industry and, over time, shift this balance to obtain some of the resource rent which has been generated through limited entry (e.g. vessel licensing).

A landings tax can help shift this balance, although heed should be paid to the financial vulnerability of some fleet segments even before the potential economic shock of Brexit. Other recommendations (notably Recommendation 8) address this fact. By way of illustration, covering control and data collection would require approximately 10% of current profits,²⁶⁸ whereas this is funded presently through EMFF subsidies.

The advantages of a landings tax over a quota auction are that it would be broader and thus fairer as almost a quarter of landings are for non-quota species²⁶⁹ and there are already the mechanisms in place to levy a fee. Seafish – a body that promotes the activities of the fishing industry – is 80% funded through a levy on landings.²⁷⁰

A landings tax applied to all vessel landings, both in the UK and abroad would remove the incentive to land outside of the UK if a tax were brought in unilaterally. Going further, a landings tax could also address the issue of foreign-owned vessels that have purchased a UK licence ('flagged vessels' in Section 2.10) by setting a lower rate for domestic landings either through a two-tiered rate or by subtracting port and harbour dues to effectively discount landings into the UK. This is both administratively simpler than the current requirement that British vessels have 50% British crew or 50% of their landings into the UK (the economic link) and may prove much more effective. This proposal is described in more detail in the New Economics Foundation report, *Who gets to fish? The allocation of fishing opportunities in EU member states*.²⁷¹

SECTION 7: CONCLUSIONS

Brexit presents a radical change to fisheries management. It is complex to analyse, although the debate thus far has been prone to simplistic talking points. Ministers are being pressured into making promises that they may not be able to keep. Fisheries research, meanwhile, has identified several risks and opportunities for the UK fishing fleet.

This report seeks to move from identification to quantification by developing six potential Brexit scenarios and measuring their economic impact on the UK fishing fleet. These scenarios (No Brexit, Hard Brexit, Soft Brexit, Fisheries First Brexit, Fisheries Last Brexit, No Deal Brexit) differ in their assumptions about the priority that fisheries is given in the negotiations and how the negotiations will conclude with respect to access to waters, sharing of quota, and tariff and non-tariff barriers.

The modelling results reveal a range of results by Brexit scenario. Unsurprisingly, the higher the priority given to fisheries, the better the result for the UK fishing fleet. The results also show the importance of sustainability and avoiding adversarial Brexit scenarios where both parties set their own quota limits unilaterally. An increase in overfishing, possible under these circumstances, would erode the potential benefits and lead to worse results than the status quo.

An important result from the scenario analysis that has been unexplored to date is the divergent impacts at the fleet segment level. Different Brexit scenarios generated winners and losers amongst the fleet segments, as the importance of trade, quota, and access are not felt evenly across the fleet. In general, the large-scale fleet segments have more to gain from most Brexit scenarios whereas the small-scale fleet segments have more to lose. This extends from the composition of fleet segments, where some fleets target species, like shellfish that is mostly exported to the EU, and do not hold quota shares to benefit from any quota increases. To ensure a Brexit that benefits all fleet segments, existing issues of inequity in the UK fishing fleet should be addressed. The power to do so has always been in the UK's purview.

From scenario analysis and broader discussion, this report puts forward a set of policy recommendations for the UK government, supported by all stakeholders, to pursue:

- Drop combative rhetoric to match the collaborative reality.
- Set sustainable catch limits.
- Use a rise in quota to help all boats.
- Seek a post-Brexit transition deal for at least two years.
- Secure access to the EU market with minimum tariffs and non-tariff barriers.
- Create a platform for continued quota swapping.
- Make access to waters conditional.
- Empower fishers through co-management and increased representation for the small-scale fleet.
- Generate funding for management through a landings tax.

Brexit is a negotiation and there are several political realities that need to be recognised, chief among these the fact that fisheries, by their very nature, are a transboundary problem. This feature necessitates that European fisheries are managed in a collaborative manner. The direction and tone of the Brexit negotiations is thus extremely worrying for the future of European fisheries. There must be a transformation in approach away from taglines and tough appearances, towards the establishment of a new form of shared management over this shared resource.

ANNEX A: SCENARIO COMBINATIONS

Scenario name and abbreviation of impacts	Quota change	Tariff change	Area change	Overfishing
No Brexit: Q/T/A/O/	Status quo	Status quo	Status quo	Status quo
Q/T/AB O/	Status quo	Status quo	Border	Status quo
Q/T/AP O/	Status quo	Status quo	Partial	Status quo
Q/TW A/O/	Status quo	WTO	Status quo	Status quo
Q/TN A/O/	Status quo	WTO + Delay	Status quo	Status quo
Q/TE A/O/	Status quo	EEA	Status quo	Status quo
Q/TN AB O/	Status quo	WTO	Border	Status quo
Q/TN AP O/	Status quo	WTO	Partial	Status quo
Q/TB AB O/	Status quo	WTO + Delay	Border	Status quo
Q/TB AP O/	Status quo	WTO + Delay	Partial	Status quo
Q/TE AB O/	Status quo	EEA	Border	Status quo
Q/TE AP O/	Status quo	EEA	Partial	Status quo
Q/T/A/O/	Status quo	Status quo	Status quo	Third country
Q/T/AB O/	Status quo	Status quo	Border	Third country
Q/T/AP O/	Status quo	Status quo	Partial	Third country
Fisheries Last Brexit: Q/TW A/O/	Status quo	WTO	Status quo	Third country
Q/TN A/O/	Status quo	WTO + Delay	Status quo	Third country
Q/TE A/O/	Status quo	EEA	Status quo	Third country
Q/TN AB O/	Status quo	WTO	Border	Third country
Q/TN AP O/	Status quo	WTO	Partial	Third country
Q/TB AB O/	Status quo	WTO + Delay	Border	Third country
Q/TB AP O/	Status quo	WTO + Delay	Partial	Third country
Q/TE AB O/	Status quo	EEA	Border	Third country
Q/TE AP O/	Status quo	EEA	Partial	Third country
QR T/A/O/	Renegotiation	Status quo	Status quo	Status quo
QR T/AB O/	Renegotiation	Status quo	Border	Status quo
QR T/AP O/	Renegotiation	Status quo	Partial	Status quo
QR TW A/O/	Renegotiation	WTO	Status quo	Status quo
QR TN A/O/	Renegotiation	WTO + Delay	Status quo	Status quo
QR TE A/O/	Renegotiation	EEA	Status quo	Status quo
QR TW AB O/	Renegotiation	WTO	Border	Status quo
QR TW AP O/	Renegotiation	WTO	Partial	Status quo
QR TN AB O/	Renegotiation	WTO + Delay	Border	Status quo
QR TN AP O/	Renegotiation	WTO + Delay	Partial	Status quo
QR TE AB O/	Renegotiation	EEA	Border	Status quo
QR TE AP O/	Renegotiation	EEA	Partial	Status quo
QR T/A/OT	Renegotiation	Status quo	Status quo	Third country
QR T/AB OT	Renegotiation	Status quo	Border	Third country
QR T/AP OT	Renegotiation	Status quo	Partial	Third country
QR TW A/OT	Renegotiation	WTO	Status quo	Third country
QR TN A/OT	Renegotiation	WTO + Delay	Status quo	Third country

QR TE A/ OT	Renegotiation	EEA	Status quo	Third country
QR TW AB OT	Renegotiation	WTO	Border	Third country
QR TW AP OT	Renegotiation	WTO	Partial	Third country
QR TN AB OT	Renegotiation	WTO + Delay	Border	Third country
QR TN AP OT	Renegotiation	WTO + Delay	Partial	Third country
QR TE AB OT	Renegotiation	EEA	Border	Third country
Soft Brexit: QR TE AP OT	Renegotiation	EEA	Partial	Third country
QZ T/ A/ O/	Zonal attachment	Status quo	Status quo	Status quo
QZ T/ AB O/	Zonal attachment	Status quo	Border	Status quo
QZ T/ AP O/	Zonal attachment	Status quo	Partial	Status quo
QZ TW A/ O/	Zonal attachment	WTO	Status quo	Status quo
QZ TN A/ O/	Zonal attachment	WTO + Delay	Status quo	Status quo
QZ TE A/ O/	Zonal attachment	EEA	Status quo	Status quo
QZ TW AB O/	Zonal attachment	WTO	Border	Status quo
QZ TW AP O/	Zonal attachment	WTO	Partial	Status quo
QZ TN AB O/	Zonal attachment	WTO + Delay	Border	Status quo
QZ TN AP O/	Zonal attachment	WTO + Delay	Partial	Status quo
QZ TE AB O/	Zonal attachment	EEA	Border	Status quo
QZ TE AP O/	Zonal attachment	EEA	Partial	Status quo
QZ T/ A/ OT	Zonal attachment	Status quo	Status quo	Third country
Fisheries First Brexit: QZ T/ AB OT	Zonal attachment	Status quo	Border	Third country
QZ T/ AP OT	Zonal attachment	Status quo	Partial	Third country
QZ TW A/ OT	Zonal attachment	WTO	Status quo	Third country
QZ TW A/ OT	Zonal attachment	WTO + Delay	Status quo	Third country
QZ TE A/ OT	Zonal attachment	EEA	Status quo	Third country
QZ TW AB OT	Zonal attachment	WTO	Border	Third country
QZ TW AP OT	Zonal attachment	WTO	Partial	Third country
QZ TN AB OT	Zonal attachment	WTO + Delay	Border	Third country
QZ TN AP OT	Zonal attachment	WTO + Delay	Partial	Third country
QZ TE AB OT	Zonal attachment	EEA	Border	Third country
QZ TE AP OT	Zonal attachment	EEA	Partial	Third country
QZ T/ A/ OU	Zonal attachment	Status quo	Status quo	Unilateral
QZ T/ AB OU	Zonal attachment	Status quo	Border	Unilateral
QZ T/ AP OU	Zonal attachment	Status quo	Partial	Unilateral
QZ TW A/ OU	Zonal attachment	WTO	Status quo	Unilateral
QZ TN A/ OU	Zonal attachment	WTO + Delay	Status quo	Unilateral
QZ TE A/ OU	Zonal attachment	EEA	Status quo	Unilateral
Hard Brexit: QZ TW AB OU	Zonal attachment	WTO	Border	Unilateral
QZ TW AP OU	Zonal attachment	WTO	Partial	Unilateral
QZ TN AB OU	Zonal attachment	WTO + Delay	Border	Unilateral
No Deal Brexit: QZ TN AP OU	Zonal attachment	WTO + Delay	Partial	Unilateral
QZ TE AB OU	Zonal attachment	EEA	Border	Unilateral
QZ TE AP OU	Zonal attachment	EEA	Partial	Unilateral

ANNEX B: METHODOLOGY

The modelling exercise applies these Brexit scenarios to the 29 UK fleet segments identified through Data Collection Framework (DCF) for standardised reporting (Table 2). This is the furthest level of disaggregation to report information on key economic variables (e.g. fuel costs, crew costs) alongside effort data (e.g. days at sea, landings).

B1: BREXIT IMPACTS AND FLEET COST STRUCTURE

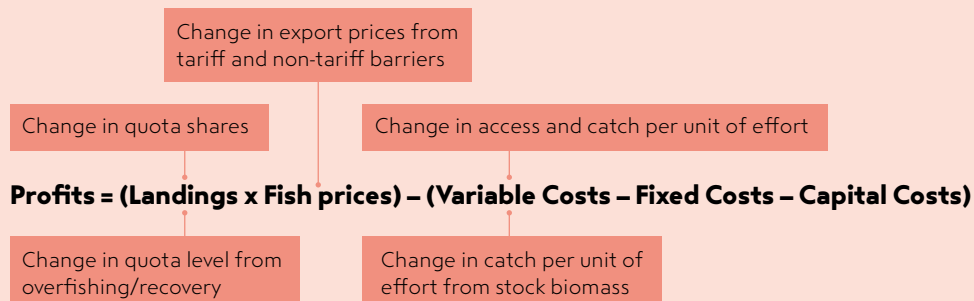
The modelling takes a financial approach, measuring fleet performance in terms of costs, revenue, and profits.

Equation 1: Basic cost function

$$\text{Profits} = \text{Revenues} - \text{Costs}$$

In the context of fisheries, revenues are determined by the quantity of landings and fish prices received. Fishing costs can be categorised in terms of variable costs, fixed costs, and capital costs.

Equation 2: Elaborated cost function with modelled Brexit drivers



The impact of a change in quota share is relatively straightforward, raising or decreasing landings, subject to assumptions about quota uptake (explored in the sensitivity analysis in Section 5).

The impact of a change in access is more indirect. Changes to access will impact the density of vessels as well as the localised abundance of fish populations. In turn, variable costs will be impacted as a function of 'catchability' or catch per unit of effort.

The impact of overfishing influences the cost function through two channels. A change in stock size, and in particular stock density, will impact catch per unit of effort and the associated variable costs. In turn, a change in stock size will also affect the available yield that can be harvested.

The following section describes the methodology used to quantify these impacts in more detail. Note that this is not a dynamic modelling approach, meaning that the fleet structure is assumed to remain similar. A large impact like Brexit may radically change these dynamics, for example by adding or removing vessels, although much is still uncertain.

The impact of a change in tariffs and non-tariff barriers influences prices that are received for exports to the EU. The precise impact requires estimates of tariff incidence and exports by fleet segment.

B2: THE BIO-ECONOMIC MODEL OF EUROPEAN FLEETS

BEMEF (Bio-Economic Model of European Fleets) is a simulation model for the economic performance of fleets based on historical data and scaled by external drivers. The model is an extension of the EIAA (Economic Interpretation of ACFM Advice) model that has previously been used to make short-term projections and analyse the short-term economic impact of TAC scenarios.²⁷²

BEMEF is used in the Annual Economic Reports on the EU fishing fleet to make 'nowcasts' on the economic performance of fishing fleets in EU member states.^{273,274} BEMEF has also been developed and used in publications by the New Economics Foundation to analyse the economic impact of rebuilding fish stocks to their MSY potential and member states applying a criteria-based approach to the allocation of fishing quota.²⁷⁵

The model's structure is built around the information from the DCF economic data call for fleet segments. The most significant of these drivers is the changes in TAC, of which 150 are currently included in the model. These TAC changes are converted through national and fleet allocations to estimate the change in TAC and landings at fleet level. The change in TAC also impacts prices and revenues by applying a price flexibility per species. On the cost side, the change in TAC impacts the amount of effort exerted (through a Cobb-Douglas production function) and thus the variable costs (fuel, labour, other) associated with fishing effort. Other drivers include stock biomass, reported fish prices, fuel prices, vessel numbers, and real interest rates. The model is not dynamic, and only comparative between multiple, independent time periods.

A complete set of model equations and methodology can be found in the Annual Economic Reports or on the BEMEF website.²⁷⁶

For this modelling exercise, some key adaptations were made to the model, as described in this report:

- Alternative quota shares for the UK in the relative stability key based on analysis of landings by ICES rectangle and current swaps.
- An adjusted effort function to incorporate a fleet-specific crowding effect based on analysis of effort by ICES rectangle.
- Adjusted prices for UK fleet segments based on exports and tariff analysis.
- Alternative biomass and yield based on effort and overfishing analysis.
- A partial rate of quota uptake.
- Change of repair and non-variable costs into variable costs to reflect large structural change that would take place over a significant time period.

B3: MODELLING THE CHANGE IN QUOTA

For the modelling of Brexit scenarios in this report, three different quota outcomes are used:

1. Status quo (relative stability)
2. Quota shares renegotiated between the EU and the UK based on preferred fish stocks
3. Quota shares divided between the EU and the UK based on zonal attachment

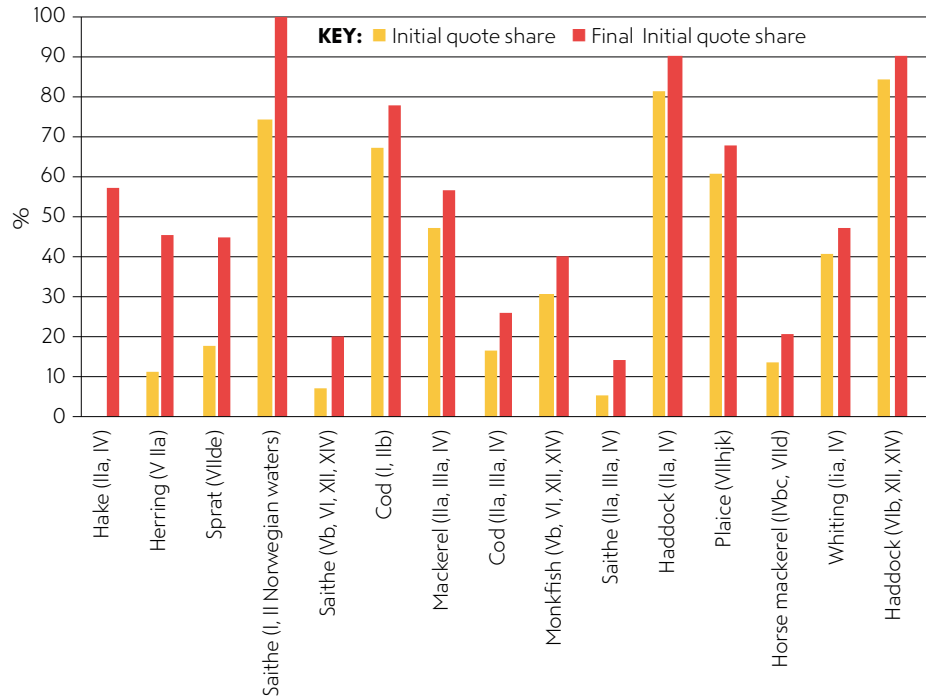
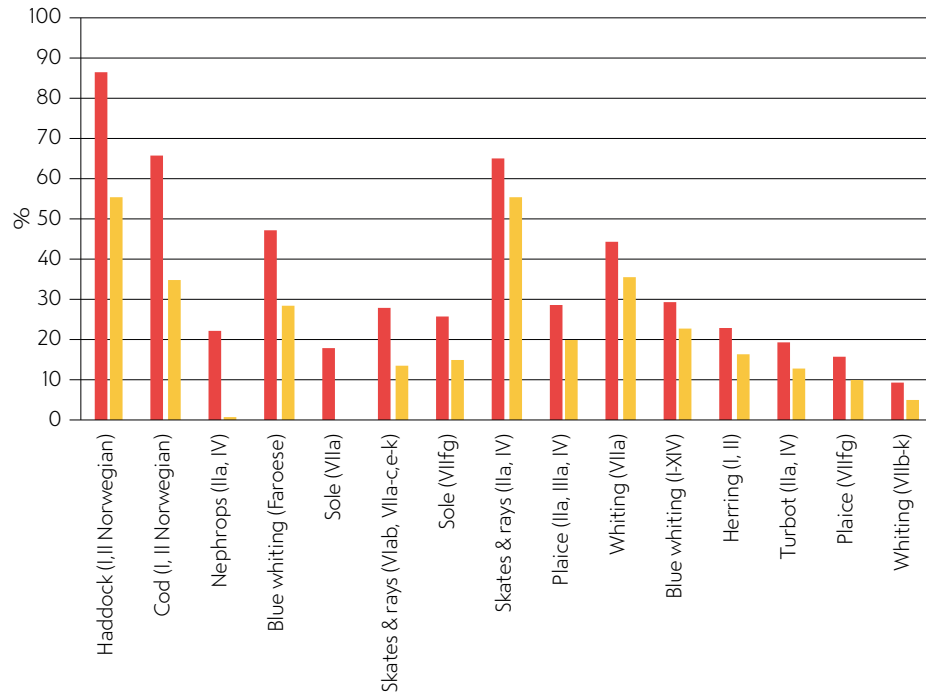
**FIGURE 17A. UK SHARE OF EU QUOTA BEFORE AND AFTER QUOTA SWAPS
– LARGEST SWAPS IN****FIGURE 17B. UK SHARE OF EU QUOTA BEFORE AND AFTER QUOTA SWAPS
– LARGEST SWAPS OUT**

TABLE 8. STUDIES ESTIMATING UK SHARE OF QUOTA BY INDIVIDUAL STOCK UNDER ZONAL ATTACHMENT

Study	Data used	Level reported
University of Aberdeen/Scottish Fishermen's Federation (2017)	Biomass by ICES rectangle	Fish stocks in Scottish waters
Fishing for Leave (2017)	Landings by ICES rectangle	All UK TACs

The calculations to arrive at these quota outcomes are described in the following section.

Quota division based on a renegotiation of relative stability

The methodology for a division of shared fish stocks based on a renegotiation of relative stability assumes a position of the UK government in a renegotiation that (1) prioritises fish stocks of importance to the UK fishing fleet, and, (2) has negotiating power.

Under EU law, after relative stability takes place member states may swap quota with each other. These quota swaps have become a critical feature of fisheries management in the EU as member states seek to better align their quota portfolio with the needs and requests of their fishing fleet. The UK share of quota before and after quota swaps is indicated for largest quota changes in Figure 17a.

Using collected data on the UK share of TACs before and after quota swaps, the importance of different TACs for renegotiation is estimated. Where quota is swapped in (more quota for the UK), the post-Brexit UK share is modelled as twice this historical increase (i.e., a historical increase in quota share of 3% would become an increase of 6%). Where quota is swapped out (less quota for the UK), the post-Brexit UK share is modelled as half this historical decrease (i.e., a historical decrease in quota share of 3% would become a decrease of 1.5%).

Quota division based on zonal attachment

Zonal attachment, as explained in Section 2, is the principle that shared fish stocks should be divided between parties based on the portion of the fish stock that exists in each EEZ. While simple in theory, this has proven extremely difficult in practice as different parties have incentives to emphasise the use of different biological factors in the calculations, for example the reference period or whether to include juvenile fish or eggs.

Two studies, summarised in Table 8, attempt to estimate the UK share of quota under zonal attachment.^{277,278} Ideally, estimates of UK TACs based on zonal attachment would be calculated from biomass (under some definition), but this has not been completed yet.

For the scenario modelling, the Fishing for Leave estimates will be used for the UK share of each TAC under zonal attachment instead of the University of Aberdeen estimates where they are available. This ensures a consistent approach across fleet segments regardless of whether they are in Scottish or other UK waters. Additionally, the University of Aberdeen estimates do not provide estimates of the EU share under zonal attachment, so it cannot be discerned if some of the UK change is due to a renegotiation with other third countries that would need to take place – a change that is outside the scope of this report.

It may be the case that landings per ICES rectangle is not a reliable indicator of stock biomass by ICES rectangle. Note that where comparisons can be made between data on biomass by EEZ and the Fishing for Leave estimate on landings by EEZ, the relationship can vary significantly. In particular, in the few cases where the estimates can be compared, the estimates based on landings overestimate the UK zonal attachment for North Sea saithe, North Sea anglerfish, Western Waters hake, Western Waters cod, and English Channel cod.^{279,280} Refined estimates of zonal attachment based on stock biology is a much-needed development for further research on Brexit and fisheries. Analysis by Defra has been confirmed and will be released later in the year.

Quota uptake

With changes to the amount of quota received by the UK fishing fleet, one of the most important assumptions relates to quota uptake. If, for example, the UK finds itself with a significant increase in quota for a species it has not historically fished, it may be the case for technical or economic reasons that quota uptake is very low – certainly lower than for the EU fishers that currently target the species. The critical aspect relating to quota uptake under a very different allocation of quota is the transition time and whether the UK would invest in new vessels and/or gear to target different species and in potentially larger amounts. For the economic modelling, the current UK quota uptake is used, although this assumption is revisited in the sensitivity analysis.

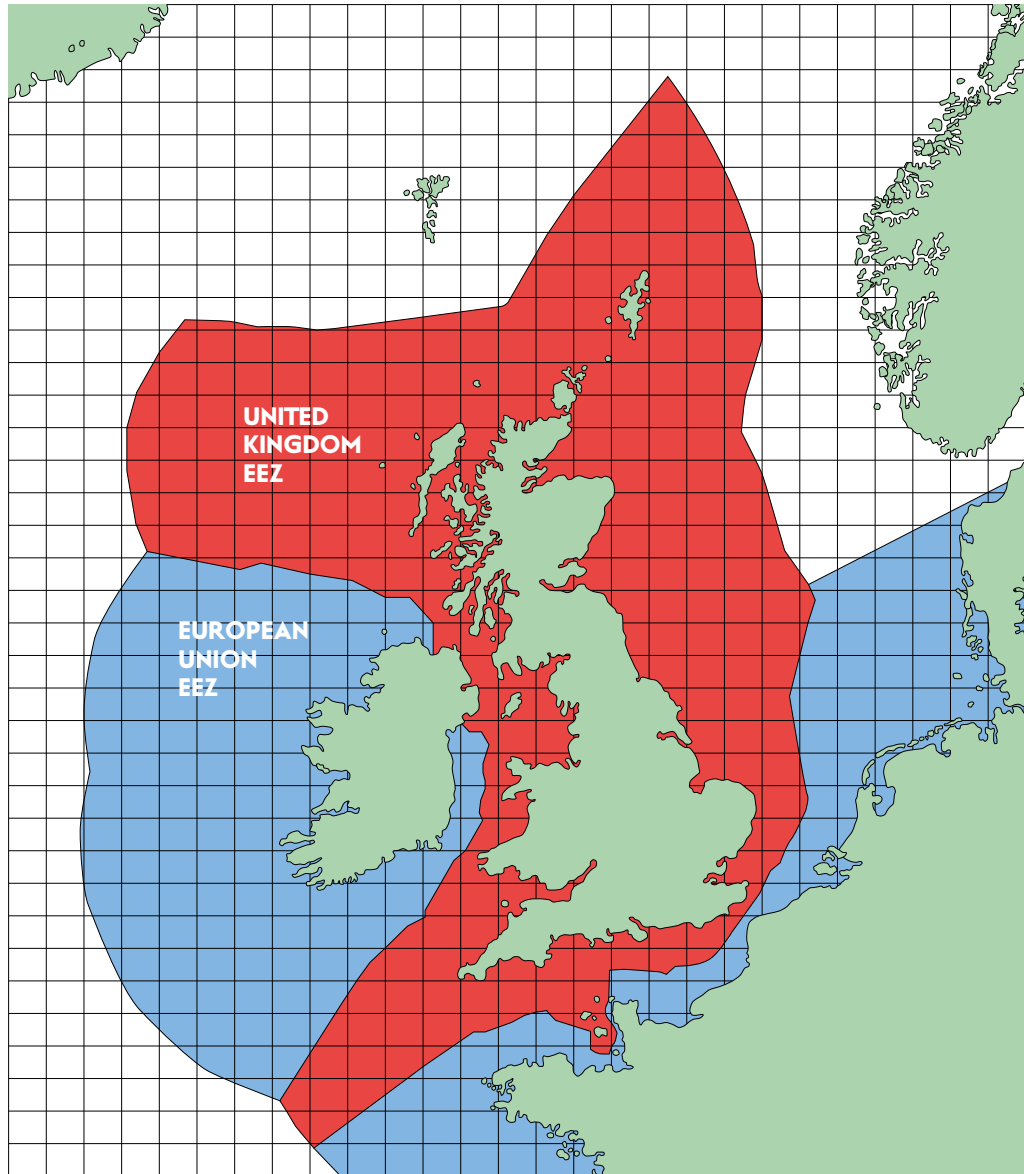
B4: MODELLING THE CHANGE IN ACCESS

Restricting access to waters can have beneficial impacts by reducing crowding. This crowding effect, termed ‘interference competition’, is hypothesised to reduce fleet economic performance through prey depression (fish burying deeper after passage of fishing gear), vessel interference (altering optimal fishing track), and/or localised race-for-fish behaviour.^{281,282,283,284} There is also the countervailing potential for a ‘search effect’, where the reduced density of vessels in UK waters (with the exclusion of EU vessels) makes it more difficult for fishers to locate the areas of stock abundance. This latter effect is expected to be small and is not included in this analysis.

For the modelling of Brexit scenarios in this report, three different access outcomes are used:

1. Status quo (shared waters)
2. A partial border preventing free access to 200 NM and the exclusion of EU fleets
3. An enforced border preventing vessel access to 200 NMs and the exclusion of EU fleets

The calculations to arrive at these access outcomes are described in the following sections.

FIGURE 18. MAP OF UK AND EU EEZS

Source: Napier (2017)²⁸⁵

Estimating changes in crowding from activity in ICES rectangles

Using the STECF data on Fisheries Dependent Information (FDI), data on landings by ICES rectangle can be mapped against the UK and EU EEZs. Shapefiles to categorise ICES rectangles by EEZ are available at Marine Regions.²⁸⁶

Comparing the share of current landings by ICES rectangle and the share of each EEZ by ICES rectangle produces an estimate of percentage change if a maritime border were implemented. Figure 18 indicates the relative change in crowding by ICES rectangle, which is then calculated as a weighted average (by landings) at the

fleet segment level. UK fleet segments with a spatial overlap with EU fleet segments inside the UK EEZ are the beneficiaries from excluding vessels from UK waters.

Estimating changes in catch per unit of effort

To quantify this relationship, information is used from studies that use natural experiments that test this effect, the most relevant being the religious observances of Dutch fishers who do not fish on the weekends while Belgian fishers continue to do so. This generates a lesser crowding effect for Belgian fishers. There is evidence that this reduction in crowding for Belgian fishers (an 114% increase in space per vessel trip) results in a 10% improvement in revenue per unit of effort.²⁸⁷ Other studies have shown that this effect is non-linear,²⁸⁸ including a natural experiment in the waters surrounding a closed area in the North Sea.²⁸⁹

This quantification is for one fishery and there are issues with generalising for the crowding effect across UK and EU waters. This study was for two fleets that are in direct competition for a resource, whereas many fleets operating in the same space are not in direct competition and the results of crowding are expected to be lower. Alternatively, it may also be expected that schooling fisheries may have even larger crowding effects than what was observed in the Dutch-Belgian flatfish fishery, and so some effects may be greater if generalised.

Ideally, for this analysis, a crowding index would be generated for each ICES rectangle and a functional relationship between crowding and catchability could be developed, as some studies have generated for particular fisheries.²⁹⁰ This could potentially be developed across European waters in a more focused study, but for this report, a 0.09% change in landings per unit of effort will be used for every 1% change in access based on the Dutch-Belgian study and the idea of Brexit as a 'permanent weekend' for UK fishers in British waters. Landings per unit of effort are used instead of revenue due to the dynamic prices in the Brexit modelling.

Trade-off in crowding between restricting access to EU fleets and increasing quota for UK fleets

Complicating the Brexit modelling, this crowding effect also creates a dynamic between the Brexit outcomes on changes in quota and changes in access. If the UK is both shutting its maritime border while simultaneously increasing its quota share, then some of the gains won from reduced crowding would be lost by increased activity associated with increases in quota shares (an increase in UK-UK interference competition). A change in zonal attachment completely cancels out the crowding effect as the change in quota is calculated as the exact quantity of landings by EU fleets in the UK EEZ. Where the quota share between the UK and the EU is determined through renegotiated, the trade-off in the crowding effect between changes to access and changes to quota balances differently depending on the fleet segment.

TABLE 9. CHANGE IN CROWDING FROM A HARD BORDER AND ASSOCIATED CATCH PER UNIT OF EFFORT UNDER QUOTA SCENARIOS

Fleet segment	Change in crowding (EU removal)	Change in catch per unit of effort (EU removal)	Change in crowding with UK quota change (zonal)	Change in catch per unit of effort (zonal)	Change in crowding with UK activity increase (renegotiated)	Change in catch per unit of effort (renegotiated)
Drift/fixed net 0–10m	-28%	2%	0%	0%	-22%	2%
Drift/fixed net 10–12m	-28%	2%	0%	0%	-22%	2%
Drift/fixed net 12–18m	-90%	8%	0%	0%	-84%	7%
Drift/fixed net 24–40m	-126%	11%	0%	0%	-120%	10%
Dredgers 0–10m	1%	0%	0%	0%	7%	-1%
Dredgers 10–12m	-17%	1%	0%	0%	-11%	1%
Dredgers 12–18m	-16%	1%	0%	0%	-10%	1%
Dredgers 18–24m	-16%	1%	0%	0%	-10%	1%
Dredgers 24–40m	-16%	1%	0%	0%	-10%	1%
Demersal trawl/ seine 0–10m	-10%	1%	0%	0%	-4%	0%
Demersal trawl/ seine 10–12m	-25%	2%	0%	0%	-19%	2%
Demersal trawl/ seine 12–18m	-65%	6%	0%	0%	-59%	5%
Demersal trawl/ seine 18–24m	-66%	6%	0%	0%	-60%	5%
Demersal trawl/ seine 24–40m	-66%	6%	0%	0%	-60%	5%
Demersal trawl/ seine 40m+	-66%	6%	0%	0%	-60%	5%
Pots & traps 0–10m	-13%	1%	0%	0%	-7%	1%
Pots & traps 10–12m	-16%	1%	0%	0%	-10%	1%
Pots & traps 12–18m	-24%	2%	0%	0%	-18%	2%
Pots & traps 18–24m	-36%	3%	0%	0%	-30%	3%
Hook & line 0–10m	-13%	1%	0%	0%	-7%	1%
Hook & line 10–12m	-89%	8%	0%	0%	-83%	7%
Hook & line 24–40m	-44%	4%	0%	0%	-38%	3%
Polyvalent active gear 0–10m	-10%	1%	0%	0%	-4%	0%
Polyvalent active gear 12–18m	-65%	6%	0%	0%	-59%	5%
Polyvalent passive gear 0–10m	-28%	2%	0%	0%	-22%	2%
Beam trawl 0–10m	-11%	1%	0%	0%	-5%	0%
Beam trawl 12–18m	-19%	2%	0%	0%	-13%	1%
Beam trawl 18–24m	-72%	6%	0%	0%	-66%	6%
Beam trawl 24–40m	-72%	6%	0%	0%	-66%	6%
Pelagic trawl 40m+	-41%	4%	0%	0%	-35%	3%

Table 9 documents the change in crowding taken as an average across activity in all ICES rectangles (weighted by landings) and the resulting change in landings per unit of effort at the fleet level. The effect is positive for all fleet segments except one and are fairly correlated with vessel length categories.

A partial border is calculated as half the change of the full border, absent any information on what such an agreement would look like. This is a more fluid border than current arrangements with third countries, but reflects the proximity of the UK to several EU member states as well as the fact that both sides will likely seek to retain their historical access developed over many decades and beyond.

B5: MODELLING THE IMPACT OF EU TARIFFS

For the modelling of Brexit scenarios in this report, four different tariff outcomes are used:

1. Status quo (no tariffs)
2. EEA tariff rates
3. WTO MFN tariff rates
4. WTO MFN tariff rates and non-tariff barriers

These tariffs are applied to the share of UK landings, by species that is exported to the EU. As tariff rates by species vary by product and processing stage, an average tariff rate for each species is calculated based on the share of exports related to each product.

The calculations to arrive at these tariff outcomes are described in the following sections.

Who bears the cost of tariffs on fish products?

In the many scenarios where a tariff is applied to UK fish exports entering the EU, it is not immediately intuitive who bears the cost of the tariff. Strictly speaking, it is EU importers who pay the tariff when the product enters the EU market, but it is also possible that UK exporters will lower their prices to compensate for the tariff to keep the effective price paid by EU importers at a stable level. This question of tariff incidence depends on the market power of UK exporters and EU importers and their respective elasticities for the fish products being traded.

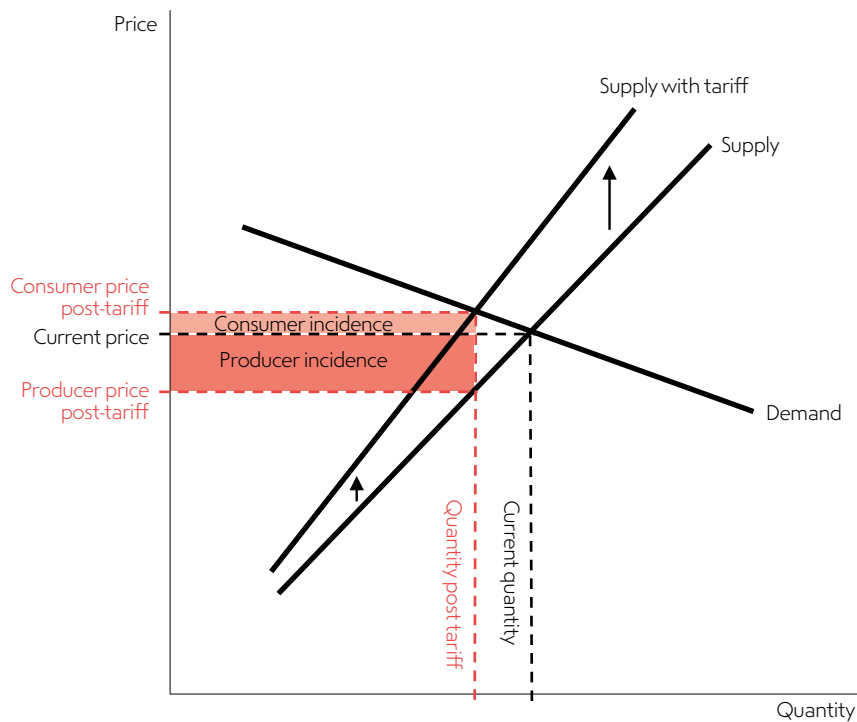
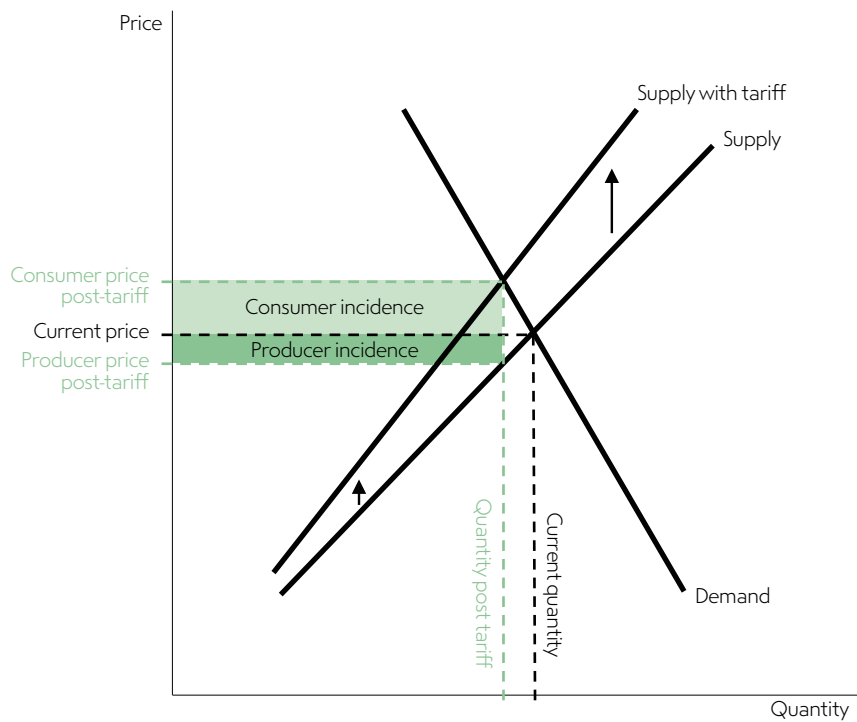
In Section 2.6, it was noted that, in general, the larger market holds power when it comes to tariff incidence.

This may vary by market or category, however, and it is important to conduct analysis at this, more granular, level.

The market for seafood

Food products tend to have high price elasticities of demand as consumers readily switch between products and new suppliers are available for most commodities.²⁹¹ Worryingly for UK producers, these high elasticities in the food market, combined with high MFN tariffs in the food category, has led sectoral trade analysis on Brexit to estimate catastrophic effects for the future of UK-EU seafood trade.²⁹²

Specific seafood products may prove an exception to this as they are luxury products that restaurants and other outlets cannot drop from their offering. It may also be the case that due to the biology of fish stocks, there simply is no other producer of a particular seafood product.

FIGURE 19A. TARIFF INCIDENCE FOR A PRODUCT WITH ELASTIC DEMAND**FIGURE 19B. TARIFF INCIDENCE FOR A PRODUCT WITH INELASTIC DEMAND**

As a result, analysis at the level of consumer product category is necessary to resolve the question of market power and whether it is UK producers or EU consumers who bear the cost of the tariffs. Some products may have high price elasticity, where the UK fishing industry acts as a 'price taker' and bears the brunt of most of the tariff. Other products may have a low price elasticity, where the UK fishing industry acts as a 'price maker' and passes on most of the cost of the tariff to EU consumers.

Figure 19 illustrates the application of a tariff on the value of imports (an ad valorem tariff) on a product with elastic demand and a product with inelastic demand. Elasticity is a function of the steepness of the demand curve.

Estimating market power and tariff incidence

Tariff incidence is estimated by product category, of which 14 distinct categories are defined. This is informed by three considerations: trade dependency, production (and consumption) importance, and whether it is a premium product.

The two trade dependency measures indicate the UK share of the EU imports (the percentage of EU imports for that product category that is sent from the UK) and the EU share of UK exports (the percentage of UK exports for that product category that is sent to the EU). This is the primary measure used to determine market power as it indicates the ability of each side to absorb a hit, should prices become unviable.

For every single product category, the UK is more dependent on the EU as a consumer market than the EU is dependent on the UK as a producer. While there is a degree of variation, no product group comes close to a balance. This result extends naturally from the vast size of the EU and the multiple entry points to the EU market from other global producers. It also supports the general assumption in trade economics that the smaller market has less market power in trade relationships and is thus likely to bear the brunt of tariffs and other protective measures.

The production-based measures Table 10 indicate the UK share of European production and world production for the respective product category. These measures of UK production importance indicate whether the EU would have difficulties in finding alternative producers, if a certain product was only available in British coastal waters.²⁹³ For some products, where the UK exports primarily fresh product, the share of the world market is not relevant (based on the assumption it would be too costly for producers outside of Europe to compete at scale on fresh product). Several shellfish product categories stand out as having significant UK production and thus there are few large-volume alternative producers, at least within Europe.

Lastly, import price by product group gives an indication of whether the product category is premium and thus more likely bear the cost of a price increase. For some markets, such as high-end restaurants, having fresh product from certain categories is a near necessity. Here, again, several shellfish product categories stand out as being largely fresh and fetching a high price.

TABLE 10. ESTIMATING MARKET POWER FOR PRODUCT CATEGORIES

	Current trade dependency		UK production importance		Premium product	Classification of UK producers	
Product group	UK share of rEU imports	EU share of UK exports	UK share of European production	UK share of world production	Import price	Market power	Estimated tariff incidence
Fishmeal	3%	56%	0%	0%	2.03	Price taker - strong	90%
Bluefish	10%	67%	8%	3%	1.09	Price taker - strong	90%
Cephalopod	1%	98%	9%	1%	3.76	Price taker - strong	90%
Whitefish	2%	97%	3%	2%	3.95	Price taker - strong	90%
Skates and rays	4%	100%	1%	0%	3.24	Price taker - strong	90%
Shrimp	3%	100%	1%	0%	6.35	Price taker - strong	90%
Herring	8%	75%	7%	6%	0.78	Price taker - strong	90%
Bivalve	6%	96%	48%	17%	5.64	Price taker - medium	75%
Flatfish	5%	100%	18%	17%	5.46	Price taker - medium	75%
Seabass	1%	95%	11%	10%	9.14	Price taker - medium	75%
Monkfish	7%	99%	24%	22%	7.30	Price taker - medium	75%
Crab	30%	90%	42%	2%	4.35	Price taker - weak	60%
Scallops	24%	100%	50%	6%	11.24	Price taker - weak	60%
Nephrops	47%	99%	54%	54%	9.46	Price taker - weak	60%
Lobster	10%	63%	65%	2%	16.44	Price taker - weak	60%

Note: This table does not include EU consumption importance due to data limitations on global consumption of fish products.

This distinction in tariff incidence for luxury products was also applied in the European Parliament study on post-Brexit trade in fish products. On the prospective of tariffs, Jim Wood, a Scottish skipper, said for his Nephrops he was not worried:

It shouldnae affect us. We have a luxury product that is in high demand, and even if the tariffs go up and make our prawn more expensive, we're confident people will still buy it. For those outside of the luxury I couldnae say what will happen.²⁹⁴

Taken together, these measures indicate that UK producers have some market power for several shellfish species, in particular, lobster, Nephrops, scallops, and crab. UK producers also have a small amount of market power in other species that are premium and/or fresh, in particular, monkfish, seabass, flatfish, and bivalves.

Still, the market dependency measures indicate that across product categories, UK producers are in the position of price taker. Unfortunately, while there is detailed data from the Food and Agriculture Organization (FAO) on the production of fish species by country, this data does not exist for consumption. This means that while it is possible to indicate the importance of UK production for different product categories, it is not possible to complete the inverse and indicate the importance of EU consumption for the same product categories. It is important to make this caveat, as the role of the EU market as the world's largest consumer of fish has been cited by the EU seafood sector as why they think the UK is in a position of weakness on trade, in particular for the very shellfish species mentioned.²⁹⁵

The tariff incidence within the UK industry

The analysis of tariff burden has thus far not distinguished between the industry sectors that make up the UK producer. For the tariff incidence on UK producers, it is expected that the majority of the burden will fall on the UK catching sector rather than on processors or wholesalers – the other sectors that make up the UK supply chain.

There are a couple reasons for this outcome. First, just as large countries tend to hold maker power over small countries, the same trend holds true for large firms and small firms.²⁹⁶ This relationship works against the UK catching sector, characterised by a large number of heterogeneous fishing vessels, many of whom operate as their own firm. In addition, there has been a shift in the past two decades away from the auction format of fish sales in favour of direct sales through long-term contracts, further compounding this effect the direct competition between buyers is reduced, as are prices.²⁹⁷ More and more, it is large retail chains exerting their significant influence on supply chains. Lastly, profit margins in the catching sector (17% on average) are currently much higher than those in the subsequent UK supply chain (4% in fish processing),²⁹⁸ meaning that the catching sector has the most capacity to reduce prices while remaining in business.

On this question of market power, again there is important variance at the fleet segment level. Small-scale vessels are more likely to operate as their own firm and thus less likely to hold market power. Small-scale vessels are also much less likely to be members of POs who work to secure better marketing opportunities for their members.²⁹⁹ Profit margins are significantly lower than in the large-

scale fleet, which either means a muted price reduction for small-scale vessels compared to large-scale vessels after a tariff is imposed, or, more likely, export-exposed small-scale vessels going out of business.

Non-tariff barriers

The threat of non-tariff barrier is potentially very serious, especially if Brexit negotiations turn sour. Some in the fishing industry have pointed to more risk from non-tariff barriers than tariffs (Section 2.5). These barriers are, however, more difficult to quantify in terms of likely economic impact and involve estimating the price premium of freshness in the market for fish product.

There are some studies that analyse how extra time between catch and sale reduces the freshness premium. Unfortunately, most data sources and studies do not control for product size and other price factors and so cannot be used. A study on pricing of Atlantic cod noted that a delay of 2 days reduces the price by around 3% and a delay of 4–5 days reduces the price by around 6%.³⁰⁰ This delay can be applied to the export of fresh fish products from the UK, where the impact of delays will be particularly problematic. The same calculations for tariff incidence are applied for the incidence of non-tariff barriers. More restrictive tariff barriers that halt trade (rather than delay it) are not considered.

A reduction in price rather than quantity

Notice that in Figure 19 both the product with elastic demand (the price taker) and the product with inelastic demand (the price maker), there is a reduction in quantity sold. This follows directly from the upward sloping supply curve of producers who will opt to supply a lower quantity at a lower price. It is also the standard model of impacts of tariff on production,

including cross-sectoral analysis of Brexit impacts.³⁰¹ There are, however, key features of fisheries management to prevent against ‘open access’ and ‘the tragedy of the commons’, i.e., a reduction in price rather than a reduction in quantity should be expected in the fishing industry.

Unlike most industries, the output in fisheries has hard limits through the use of fishing quota on many, but not all, species. Quota limits constrain the ability for fisheries to increase their supply even if prices increase (or costs decrease). There is also a restriction on the number of commercial fishing licences that are available, forming something close to a one-in-one-out barrier to entry in the fishing industry. As new fishers cannot enter the industry (and would have difficulty acquiring quota if they did), there are currently high and sustained profits in the UK fishing industry, although the level varies significantly by fleet, as illustrated in Table 5. Because there are healthy profit margins generated from these input and output controls, it is unlikely that there will be significant quantity reductions to EU tariffs as vessels/firms can continue to supply fish at a marginal cost below the post-tariff price. This also reflects the inelastic supply in the fishing fleet that has accompanied historical price changes.³⁰²

Limited sales opportunities in the UK domestic market and non-European markets

If UK producers are largely bearing the cost of EU tariffs, they may look to alternative markets, although the potential here is severely limited.

The most obvious alternative market is the UK domestic market. However, there is little reason to think that Brexit would change the reasons why larger domestic sales are not currently taking place. Kait Bolongaro argues in *Taking back control? Not unless you eat more fish*, that, ‘Simply put, the British fleet can catch as many fish as it wants but they won’t be able to sell it without access to the lucrative EU market. Domestic demand simply isn’t high enough.’³⁰³ UK fish consumption is low and UK consumers are particularly stubborn in their attitudes. Over the past few decades, there have been many campaigns to expand British diets to little effect. Nothing suggests that post Brexit this would be any different.

Further afield, while some new export markets are currently in rapid expansion, such as bivalves to Eastern Asia, there is also an expansion from other importers into markets historically supplied by the UK fleet. The recently signed free trade agreement with Canada is one potentially large shock. Some Canadian exporters, particularly of shrimp, cod, crab, and lobster, are keen to increase their supply to the EU market over the coming years as tariffs are being phased out.³⁰⁴

The UK is not the lowest cost producer of fish products, so it cannot produce on this front, but does fare well in higher-end fish products. These products, however, are valued for their freshness (or live trade) and do not travel long distances particularly well. In this sense, fisheries can be seen as the ultimate gravity model where trade is largely determined by the size and distance of participants.

It is also not clear that accessing these emerging markets as the UK would yield any greater access than through the EU. Fish processors have expressed the exact opposite view, that leaving the EU would jeopardise existing global trade agreements negotiated by the EU and thus present a risk more than an opportunity.³⁰⁵

Neither the UK domestic market nor establishing new markets looks particularly promising for UK fish products currently destined for the EU. If either option was viable without an economic hit, it would already be established.

Applying tariffs to the catching sector

There is no link between data on landings and data on exports, which makes modelling the impact of tariffs from the perspective of the catching sector extremely difficult. To measure the impact of a tariff at the fleet segment level, the percentage of landings that are exported to the EU must be derived. For this report, landings data comes from STECF to match with the economic data used and export data from the European Market Observatory for Fisheries and Aquaculture Products (EUMOFA) as it is broken down by processing stage.

Data on exports includes species from aquaculture as well as re-exportation. As such, to create a link between the catching sector and exports, species that are predominately produced through aquaculture are removed from the export data. Additionally, to account for re-exportation, the export of processed fish is removed from the export data where this volume is greater than the amount landed by the UK fishing industry.

To account for weight loss between landings and export, multipliers are used to convert from product weight back to landings weight. The live weight to landed weight multiplier per species is derived from the MMO landings data and the live weight to frozen weight multiplier and live weight to processed weight multiplier per species are taken from an FAO handbook.^{306, 307} The conversion is made to live weight of landings as this is how landings are reported for the STECF economic data that is used for the economic modelling.

While it is possible to analyse tariffs at the species level and thus differentiation at the fleet segment level depending on species composition, the unconnected nature of landing and export data makes it impossible to determine if fleet segments have differing levels of export orientation for the same species. As such, the estimated rate of export per species is applied across all fleet segments.

The WTO tariff rate and the EEA tariff rates differ by processing stage. Typically, food products that have undergone processing have a higher tariff rate than fresh or frozen products. The recorded tariff rates are matched by species and one of the five EUMOFA processing stages:

- PS1: Fresh
- PS2: Frozen
- PS3: Dried – Salted – Smoked
- PS4: Prepared – Preserved
- PS5: Unspecified

From this matching, the percentage of landings exported, the average tariff rate applied, and the tariff incidence estimated are used to adjust the price of sale post Brexit. The following equation illustrates the relationship for species S:

$$\text{BrexitPrice}_s = \text{TariffIncidence}_s (\text{Exported}_s * \text{Tariff}_s + \text{Freshexport}_s * \text{Non-tariff}_s) + (\text{Domestic}_s * \text{Price}_s)$$

All these considerations are summarised in Table 11, including the estimates of price reduction per species based on the different tariff and non-tariff outcomes.

**TABLE 11. TARIFF, EXPORTS, INCIDENCE, AND EXPECTED PRICE
CHANGE BY SPECIES**

Species	Percentage of landings exported to the EU	Estimated tariff incidence	Percentage of landings exported to the EU fresh	WTO tariff (weighted avg by species-product)	Standard barrier (two day delay)	WTO outcome: average price reduction all landings	EEA tariff (weighted avg by species-product)	EEA outcome: average price reduction all landings	Non-tariff barrier (five day delay)	WTO + border outcome: average price reduction all landings
Anchovy	99%	90%	99%	15	3%	16%	5	4%	6%	19%
Atlantic halibut	99%	75%	99%	10	3%	10%	2	1%	6%	12%
Bass	38%	75%	34%	15	3%	5%	5	1%	6%	5%
Blue whiting	12%	90%	6%	8	3%	1%	2	0%	6%	1%
Cod	20%	90%	20%	12	3%	2%	0	0%	6%	2%
Shrimp	99%	90%	99%	17	3%	17%	17	15%	6%	20%
Crab	87%	60%	28%	8	3%	4%	2	1%	6%	5%
Cuttlefish	96%	90%	51%	8	3%	8%	2	2%	6%	9%
Dogfish	99%	90%	49%	7	3%	8%	2	2%	6%	9%
Haddock	6%	90%	1%	8	3%	0%	0	0%	6%	0%
Hake	43%	90%	34%	15	3%	6%	4	2%	6%	7%
Herring	68%	90%	11%	15	3%	9%	15	9%	6%	10%
Horse mackerel	69%	90%	14%	15	3%	10%	5	3%	6%	10%
Ling	68%	90%	48%	11	3%	8%	3	2%	6%	8%
Lobster	70%	60%	62%	12	3%	6%	3	1%	6%	6%
Mackerel	46%	90%	4%	18	3%	8%	18	8%	6%	8%
Megrim	73%	75%	73%	15	3%	9%	4	2%	6%	11%
Monkfish	39%	75%	23%	11	3%	3%	3	1%	6%	4%
Norway lobster	97%	60%	25%	16	3%	10%	16	9%	6%	10%
Octopus	26%	90%	26%	8	3%	2%	2	1%	6%	2%
Plaice	3%	75%	2%	10	3%	0%	3	0%	6%	0%
Pollack	27%	90%	24%	8	3%	2%	2	1%	6%	2%
Redfish	99%	90%	99%	11	3%	12%	3	3%	6%	15%
Saithe	47%	90%	37%	8	3%	4%	0	0%	6%	4%
Sandeel	99%	90%	0%	15	3%	13%	5	4%	6%	13%
Sardine	16%	90%	16%	17	3%	2%	5	1%	6%	3%
Scallops	93%	60%	13%	9	3%	5%	3	2%	6%	5%
Skates and rays	18%	90%	7%	15	3%	3%	5	1%	6%	3%
Sole	40%	75%	38%	15	3%	5%	4	1%	6%	5%
Sprat	46%	90%	5%	17	3%	7%	5	2%	6%	7%
Squid	56%	90%	56%	7	3%	5%	2	1%	6%	5%
Turbot	36%	75%	28%	15	3%	4%	5	1%	6%	5%
Whiting	68%	90%	5%	10	3%	6%	3	2%	6%	7%

**TABLE 12. OVERFISHING POSSIBILITIES ASSOCIATED WITH QUOTA
CHANGE OUTCOMES**

Quota change modelled	Overfishing change modelled
No change	No change
Renegotiation	No change Third country
Zonal attachment	No change Third country Unilateral

**B6: MODELLING THE QUOTA
SETTING OUTCOMES AND
OVERFISHING SENSITIVITY
ANALYSIS**

For the modelling of the Brexit scenarios in this report, three different quota setting outcomes are used:

1. Status quo (relative stability)
2. Quota shares renegotiated between the EU and the UK based on preferred fish stocks
3. Quota shares divided between the EU and the UK based on zonal attachment

The calculations to arrive at these quota setting outcomes are now described.

In the Unilateral outcome, effort increases at a level proportional to the increase in quota. This assumes that the EU keeps its share of the quota fixed. On average, this is an increase of 22% across all UK TACs. In the Third country outcome, overfishing increases by 6%. This is the difference (25% vs 19%) between quota with a large third country share (more than one-third) and current EU quota with a small third country share (less than one-third). Under the No change outcome, there is no increase in overfishing.

Under the zonal attachment quota setting outcome, all three overfishing outcomes are possibilities in the scenario modelling. Under the renegotiation quota setting outcome, it is assumed that one of the overfishing outcomes, unilateral TACs, would not take place. Where there is no change to quota shares there is no change in overfishing. This is summarised in Table 12 and listed in full in Annex A.

In the sensitivity analysis, the same quota setting patterns were applied, but the resulting increase in effort was applied to the current reference point for effort rather than to the MSY effort. This results in an increase in effort and a significant decline in biomass and yield as the waters of the Northeast Atlantic are still in a state of rebuilding.

Using a bio-economic model of the current reference point with respect to the MSY developed by Guillen *et al.*,³⁰⁸ an increase in effort corresponding to the quota-setting outcomes was applied. This assumes a direct relationship between quota and effort, as is the case throughout this report. Under this assumption, the bio-economic model can translate a change in quota setting at current levels of fishing mortality into a change in biomass and yield. These changes are incorporated into another model, BEMEF, used throughout this report and described in Annex B2.

TABLE 13. OVERFISHING FROM QUOTA SETTING IF THE EU DOES NOT REDUCE ITS QUOTA SHARE

Framework	Quota setting	Quota setting above advice	Change to biomass and yield
MSY	Status quo	0%	0%
MSY	Third country	6%	-1%
MSY	Unilateral	22%	-5%
Current	Status quo	0%	0%
Current	Third country	6%	-21%
Current	Unilateral	22%	-81%

Source: Author's calculations based on Carpenter et al. (2016)³⁰⁹ and Guillen et al. (2016)³¹⁰

B7: MODELLING SENSITIVITY TO QUOTA UPTAKE

For each TAC that increases under zonal attachment, a new short-term quota uptake is calculated as:

$$\text{ZonalUptake}_{\text{TAC}} = \frac{(\text{Uptake}_{\text{TAC}} * \text{TAC}_{\text{TAC}}) + (0.5 * \text{Uptake}_{\text{TAC}} * (\text{ZonalTAC}_{\text{TAC}} - \text{TAC}_{\text{TAC}}))}{\text{ZonalTAC}_{\text{TAC}}}$$

This partial uptake rate is equivalent to the halfway point in landings between the current quantity and future potential quantity.

$$\text{Crowding}_{\text{Adjusted_uptake}} = 1 - \frac{\sum(\text{ZonalUptake}_{\text{TAC}} * \text{ZonalTAC}_{\text{TAC}})}{(\sum \text{Uptake}_{\text{TAC}} * \text{ZonalTAC}_{\text{TAC}})}$$

Recalculating the results (Figure 12) shows that earnings and profits both decrease under the three Brexit scenarios that with zonal attachment: Hard Brexit, Fisheries First Brexit, and No Deal Brexit. For these three scenarios, there is also an adjustment made to crowding effect and the resulting change in catch per unit of effort as there is a reduction in UK-UK vessel interference by the difference in quota uptake.

This adjustment to quota uptake (22%) is only used under the scenarios with zonal attachment, as it is assumed that under the renegotiation scenario the UK would prioritise quota that it has the capacity to harvest.

What is not modelled here is that lower quota uptake may also lower quota leasing prices and improve accessibility for many fleet segments.

B8: MODELLING SENSITIVITY TO DEPRECIATION

In Table 14, A depreciation in the value of sterling of 13% (as of October 2017) is applied to exports (both EU and non-EU), to 100% of fuel costs and to 25% of capital/variable/non-variable costs (an estimate of imported input costs). These changes work through difference channels to raise the value of exports while also raising input costs. For exports, the same level of incidence is used as for tariffs, while an incidence of 100% is used for fuel costs (UK fishers being price takers in the global market for fuel) and 50% for capital/variable/non-variable costs (as no analysis of market dynamics for these input costs was completed).

TABLE 14. DEPRECIATION APPLIED TO EXPORTS AND INPUT COSTS

Driver	Depreciation	Application	Incidence
Exports	13%	100%	60–90% (Table 15)
Fuel costs	13%	100%	100%
Capital/Variable/ Non-variable costs	13%	25%	50%

Source: Author's calculations based on October 2017 exchange rates

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