




PotentShell

Sustainable shellfish farming in the blue economy

Vision + Roadmap

February 2025



PotentShell: Sustainable shellfish farming in the blue economy

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Prepared by **The Shellfish Association of Great Britain**

With industry participation by **Offshore Shellfish Ltd** and **Deep Dock Ltd**

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Foreword

As a company for the country, The Crown Estate is custodian of some of our most important, precious national assets, with a mission to maximise their value for the benefit of the whole nation. When it comes to the marine environment, this means playing our part in enabling the energy transition, driving economic growth and thriving communities, and – critically – sustaining and protecting biodiversity.

The jigsaw that makes up our marine economy is large and complex, with a wide range of sectors and industries all playing their part. Integral to this are resilient, regenerative marine aquaculture businesses which occupy an important place in our coastal economies.

The blue economy across England, Wales and Northern Ireland is an exciting mix of established and evolving markets, and there is the potential for farmed bivalve shellfish to play a significant role going forwards. However, realising this potential will not happen on its own. The path ahead will see specific demands placed on regulatory governance, market access, water quality improvement, environmental stewardship and the scope for future growth.

By supporting producers who are already harnessing innovative and sustainable cultivation methods, we can open up further opportunities to build and develop an industry that can contribute to the future prosperity and economic resilience of our coastal communities.

Through its work with The Shellfish Association of Great Britain (SAGB), The Crown Estate has led a project team that can assess this opportunity, identifying any challenges which need to be overcome and plotting a course towards the future success of this industry.

The rewards on offer are significant, not just for this one specific industry, but as part of the wider marine ecosystem and the coastal communities it supports.

We look forward to continuing our partnership with SAGB and building on the recommendations in this report to enable the future success of this growing industry and our role in it.

Peter Lawrence, Director, Coastal Infrastructure and Minerals, The Crown Estate

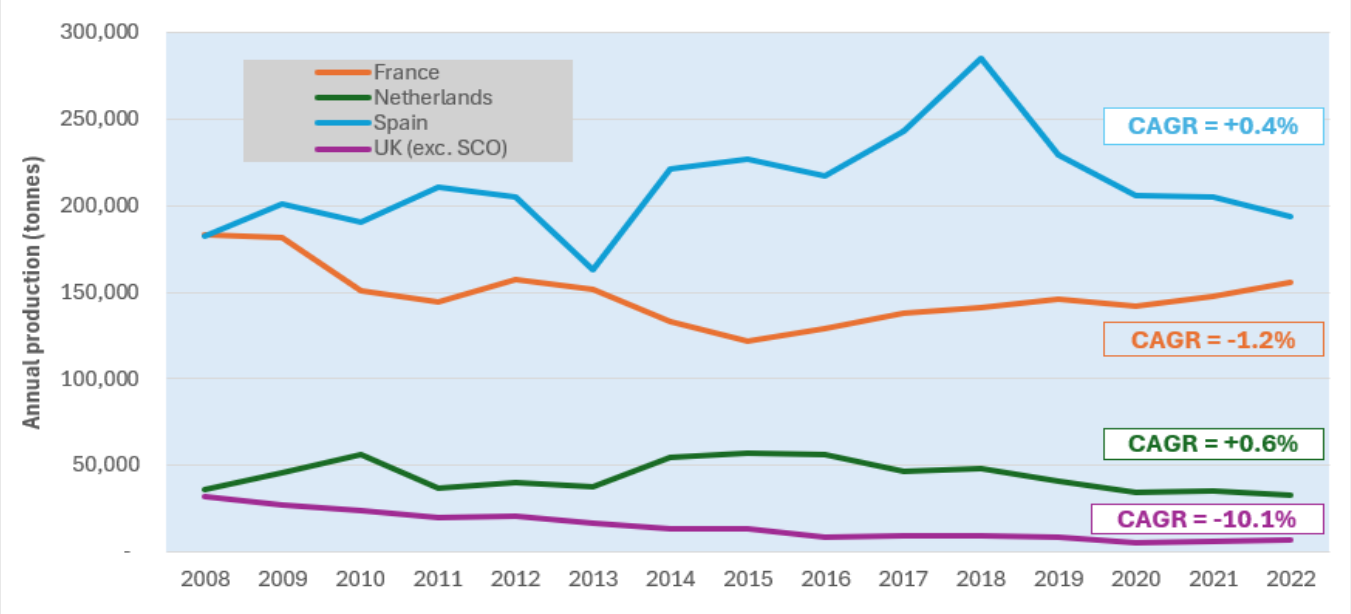
'Farmed bivalve shellfish are an established part of TCE's regenerative marine aquaculture portfolio and represent a marine sector that has the ability to meet the 21st century's demand for economic benefit and environmental enhancement.'

David Jarrad, Chief Executive Officer, The Shellfish Association of Great Britain.

'We are excited to have the many benefits of shellfish aquaculture clearly recognised and supported by The Crown Estate. What is not to love about an industry that enhances the environment, delivers ecosystem services, supports local communities and society in general - and produces a highly nutritious & delicious product. It is vital that we capitalise on the current project momentum to deliver clear and measurable benefits for all.'

Where we are now:

In contrast to Scotland and most other European producers, farmed shellfish production in England, Wales and Northern Ireland decreased by 10% per annum since 2008 from over 32,000 tonnes to just 7,500 tonnes in 2022.



This year-on-year decline stems from a **lack of support to the shellfish sector** from successive UK and devolved governments (excepting Scotland) and agencies, in particular:

- **Key European markets for live shellfish exports were lost with BREXIT.** Now the UK is classed as a third country, EU countries won't import molluscan shellfish from non-EU Grade B waters.

  Solution: A satisfactory renegotiation of the SPS and Veterinary Agreement with the EU

- **The system of classifying shellfish harvesting waters in the UK** differs hugely from other producer countries working under the same legislation, which disadvantages the UK, particularly England and Wales, to the detriment of the sector.

  Solution: Re-design a realistic, risk-based classification system which operates like our European neighbours

- **An unrealistic, unscientific and excessive policy on Pacific oysters.** The Pacific oyster, the mainstay of European oyster production, is widespread in European waters and is essentially naturalised in the UK. This species can increase UK aquaculture productivity and contribute to nature-based solutions. But the English and Welsh governments continue to severely limit or prevent its use due to maintaining the Pacific oyster's 'non-native' status.

  Solution: Like other European countries, the UK accepts the Pacific oyster as naturalised or ordinarily resident, and supports its use

- **Declining water quality is impacting shellfish waters and market confidence.** The growing population, inadequate water treatment infrastructure, climate change and failure to enforce legislation, and the polluter pays principle, mean that storm overflow events are more frequent, with severe negative consequences for shellfish production and trade.

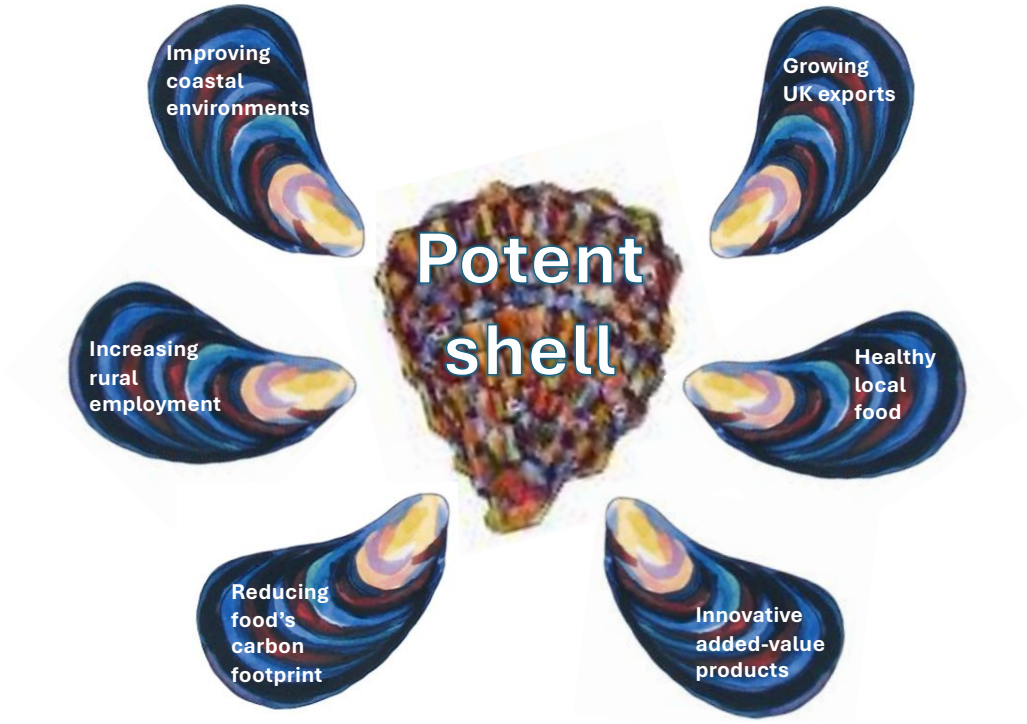
  Solution: Improve water treatment and enforce the polluter pays principle

- **Aquaculture is still tied to UK fisheries policy,** even though it differs substantially from wild capture fisheries. Aquaculture shows the greatest growth potential of all food production sectors but is given scant attention in UK government policy and no effective support for the sector to grow. **Solution: Develop a supportive and enabling shellfish aquaculture policy**

The growth of shellfish farming with support from the regulators really is a win-win for society, the economy and the environment. Non-fed shellfish aquaculture has the potential to grow substantially, producing healthy seafood with a very low carbon footprint and providing other benefits such as nutrient assimilation and carbon sequestration.

Where we should be:

- Shellfish farming is a key part of the UK's **food production** sector and fully valued for its **low-carbon** footprint and ecosystem services.
- Shellfish production makes a substantial contribution to the blue economy, **coastal communities** and environmental restoration.
- UK shellfish farming is actively **supported by government** with appropriate regulation and management.



- **Improving coastal environments**: providing substantial ecosystem services (absorbing nutrients, increasing biodiversity).
- **Growing UK exports**: improved access to EU and global trade.
- **Increasing rural employment**: sustainable economic activity creates rewarding jobs in coastal communities.
- **Healthy local food**: contributing to national food security and improved diets.
- **Reducing carbon footprint of UK foods**: growing one of the lowest carbon foods known will help meet climate targets.
- **Innovative added-value products**: Supply to non-food markets and income from shells.

What this could look like…

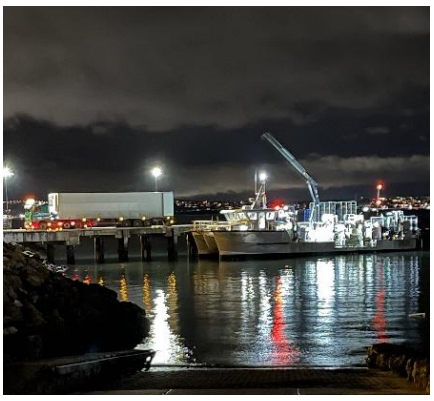
UK farmed shellfish is a major producer of local, low-carbon food

- England, Wales and Northern Ireland could produce more than 100,000 tonnes of shellfish with a supply chain value of more than £1.4 billion*.
- Climate change means that UK waters are advantageous for it to become a major European farmed shellfish producer.
- Like France and other major EU producers, Pacific oysters will be considered naturalised in UK waters and continue to drive growth in oyster farming.
- Shellfish farming is recognised in food production as a far more efficient use of space than land-based animal proteins and with much lower emissions.
- Production is in coastal and offshore waters, including co-location with fixed and floating offshore wind.

Farmed shellfish helps the UK meet its environmental and climate commitments

- Shellfish production is fully valued for its contribution to the UK's natural capital.
- Shellfish farms improve coastal water quality by absorbing nutrients and filtering particulates.
- Offshore shellfish farming will contribute to increased marine productivity and biodiversity and provide spatial protection to our national marine capital.
- Shellfish farms are part of blue carbon schemes, valued for sequestering carbon, absorbing nutrients and enhancing biodiversity.

Shellfish farming supports the UK's blue economy and coastal communities



- Shellfish farming is an important part of the UK's blue economy and coexisting with wild fisheries, offshore wind farming and coastal tourism.
- Our rural communities benefit from more than 4,000 satisfying, skilled and sustainable jobs within profitable businesses.
- The farmed shellfish value chain is diverse with added-value food, health and pharmaceutical by-products alongside traditional high-value markets.
- The UK will increase exports to the EU and beyond, complemented by a growing domestic market, to maximise the value meat and shells.

*based on 2022 UK av. price/ton, UK retail & food service values per ton (Seafood in Numbers, Seafish, 2022). Does not include value from ecosystem services.

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1. Shellfish farming in England, Wales and Northern Ireland

This document provides a roadmap to realise this vision: a future that sees major growth in the UK shellfish sector with all the economic, environmental and social benefits this will provide.

As this study is funded by The Crown Estate, which operates separately in Scotland, the roadmap covers England, Wales and Northern Ireland.

1.1 Status of the sector

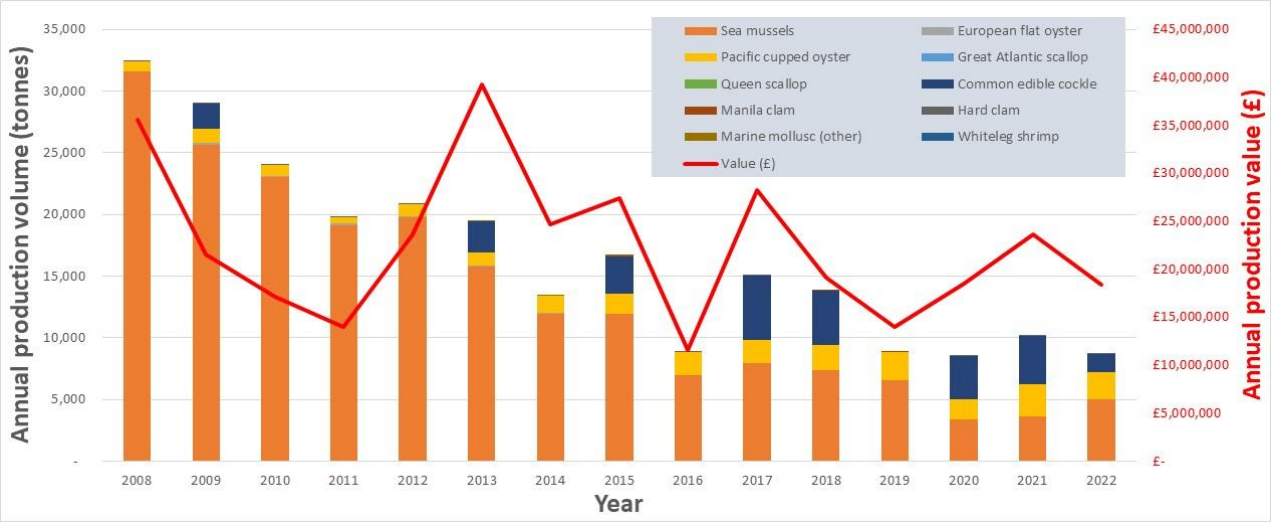
1.1.1 Production of farmed shellfish in England, Wales and Northern Ireland

Shellfish have been farmed in the UK's waters since the time of the Romans. For much of this time farming consisted of relaying mussel and oyster seed onto favoured areas of seabed for on-growing, which continues along with farming systems using suspended ropes. Shellfish farming differs from the farming of finfish such as trout and salmon, in that it is unfed and still largely depends upon natural spat.

Shellfish farming is dominated by the production of sea or blue mussel (*Mytilus edulis*) which now stands at around 5,000 tonnes (t) per annum (see Figure 1 below). However this is less than half the amount produced in Scotland and a big drop from the c. 32,000 t farmed in 2008, mainly from declines in mussel production in Northern Ireland and the Menai Straits in Wales (see Table 1 in Appendix A). Welsh shellfish farming has now almost vanished due to the loss of EU markets after Brexit.

Mussel production in England has remained between 2,500 and 6,000 t since 2008. The development of one offshore mussel farm has countered the loss of bottom-grown mussels farming seen elsewhere in the UK, including from the Wash and Morecombe Bay.

Figure 1: Farmed shellfish production in the UK (excl. Scotland) over 2008 - 2022



Apart from mussels, the main species farmed is the Pacific oyster (*Magallana gigas*) which was introduced into British waters in the 1890s and is now the mainstay of UK and EU farmed oyster production. The English Aquaculture Strategy sees this species as one of the future stars of UK shellfish aquaculture, but over-precautionary policy prevents this potential from being realised and production remains at around 2,000 t per annum.

1.1.2 Current markets for shellfish

Brexit has had a huge negative impact on the UK shellfish sector, which remains dependent on live exports. The value of UK shellfish exports fell year-on-year for a four-year period between 2018 and 2021, to a low of £368 million in 2021. In 2022, the value of UK shellfish exports to the EU increased by 14% in cash terms, due to higher prices, but this is still well below the pre-Brexit values, which reached £481 million in 2017.

Distance to market means that Europe will remain the key export destination for UK farmed shellfish. Other trade agreements could create additional export opportunities for UK shellfish in the future, particularly with further development of added-value products.

Shellfish exports from the UK to the EU are affected by restrictions on imports from third countries (which the UK is classified as since leaving the EU). Exports of bivalve molluscs to the EU must be harvested from areas with the cleanest water classification or be purified (depurated) prior to export. This restriction did not apply to the UK when it was a Member State.[1]

1.1.3 The policy and regulatory environment

Operators face a multitude of regulations that are implemented by a myriad of government agencies, as well as the various other challenges highlighted in this document. UK shellfish farming is subject to extensive regulation but lacks effective support and coherent policy from the UK government and in most of the devolved nations. As a result, the huge economic potential offered by shellfish farming and its environmental benefits are not being realised.

Aquaculture is included within fisheries in the UK Fisheries Act, with the need to meet various sustainability objectives. The Joint Fisheries Statement also makes a brief and vaguely supportive reference to aquaculture: *…the fisheries policy authorities support balanced, industry-led, sustainable growth of each aquaculture sub-sector based on the best available science relating to that sub-sector, and related industries which are diverse, economically viable and contribute to food security whilst also contributing to the ecosystem, climate change and sustainability objectives…any development and expansion of any part of the aquaculture sector will be undertaken using the best available evidence, in line with the relevant regulations and strategic management frameworks, such as marine planning, and within environmental limits.*

It is for the devolved governments to specify how this development and expansion will occur. Scotland is the only part of the UK with up-to-date legislation and a recent, comprehensive policy and vision for sector growth[2]. In 2022 Scotland established an aquaculture strategic advisory group to advise ministers[3] - the rest of the UK is left without any strategic direction. Previous industry attempts to develop the sector have been met with government apathy, while operators face over-regulation additional barriers caused by Brexit and worsening water quality.

[1] House of Commons (2023) https://researchbriefings.files.parliament.uk/documents/CDP-2023-0066/CDP-2023-0066.pdf
[2] Aquaculture and Fisheries (Scotland) Act 2013 and a Vision for Sustainable Aquaculture (2023).
[3] https://www.gov.scot/news/first-meeting-of-the-scottish-aquaculture-council/

The English Aquaculture Strategy set out an ambitious growth plan, but was part of a wider Seafood 2040 initiative that was not progressed. Defra refers to the strategy in relation to some of its actions, but this piecemeal approach to implementation will not deliver the step change needed for sector development.

In Northern Ireland DAERA is to introduce new legislation to finally replace the 1966 Fisheries Act (Northern Ireland). This is certainly an opportunity to create a simpler and more streamlined process via a single marine licence in future years. Right now, aquaculture policy is absent, and operators are hindered by multiple layers of regulation with very limited practical support from government.

The Wales Marine and Fisheries Strategic Action plan (2013) targeted a doubling of aquaculture production from 8,000 to 16,000 tonnes by 2020. Neither were achieved and aquaculture production has substantially decreased as rather than supporting the sector, government agencies held up the renewal of seabed several orders that have lapsed, despite the industry starting the process many years in advance. This is an example of headline-grabbing targets not being realised due to a lack of government support. Contrast this with development seen in the shellfish industry of countries such as France, Ireland and New Zealand over the same period, which show resilience in the face of many of the same operational challenges and market pressures as the UK sector.

As a low carbon, high value and environmentally beneficial food production sector, the UK government should actively drive the growth of the UK shellfish sector.

1.1.4 Strengths and weaknesses of the shellfish farming sector in England, Wales and Northern Ireland

The table below summaries the strengths and weaknesses of the shellfish farming sector.

Strengths	Weaknesses
• Extensive suitable waters and habitats for the farming of shellfish. • Accumulation of knowledge and expertise across the sector that makes it world-class. The FAO reference centre for disease is located in England. We have healthy animals that are safe to eat. • High levels of collaboration between science, academia and industry in shellfish research. • UK government policy shift towards the farming of low-trophic species, inc. shellfish. • Comparative advantages in terms of disease status and control.	• A lack of policy initiatives to include shellfish in UK food security and export. • Insufficient shellfish hatchery capacity in the UK (e.g. majority of oyster juveniles are imported from France). • Ageing water treatment infrastructure impacts shellfish water quality classification and therefore the costs of producing safe shellfish. • Post-Brexit trade rules and processes over-complicate and restrict shellfish exports to the EU. • Over-precautionary and unrealistic policy on the use of Pacific oysters in aquaculture. • Limited security of tenure for shellfish farmers.

1.2 Opportunities for – and challenges to – growing farmed shellfish production

1.2.1 Potential for growing farmed shellfish production and associated ecosystem services

The English Aquaculture Strategy (EAS 2021 – 2040) envisages a substantial increase in English rope-grown mussels from around 717 t in 2018 to around 25,000 t in 2040, mostly in new offshore locations (see Figure 2 in **Appendix A**). Building on the pioneering work by Offshore Shellfish Ltd (OSL) in South Devon, the development of larger farms using vertical ropes in cooler, cleaner offshore waters (5 – 15 nautical miles offshore) is expected to offer the greatest opportunity for growth. The traditional bottom culture of mussels was projected to increase at a much slower rate from the current 1,076 t to just over 5,000 t. This method has driven mussel production in Wales and Northern Ireland and with improved coastal water quality and the reinstatement of productive areas, future production could be much higher.

Growth in Pacific oyster production is also foreseen from around 1,000 t to 5,000 t, but this was dependent upon the development of a more pragmatic government policy towards this established aquaculture species. There are also minor increases in scallops (775 t), native oysters (37 t), clams (60 t) and lobsters (50 t). Although 2040 is some way off, progress has been slow, in part due to the Covid pandemic, but mainly due to continued drag from unsupportive government development policy and the consequences of Brexit on EU trade.

A recent 'Wales Supply Chain Task and Finish Group' initiative by Seafish also looks at revitalizing the Welsh once dynamic mussel farming industry, both as a food production sector and as a means of generating ecosystem services. The main approach is to facilitate the development of offshore mussel farming through the identification and approval of suitable areas for development, simplifying regulation where possible, building social licence to operate aquaculture and capitalising on the ecosystem services with the potential monetisation of these benefits. With political will, there is also the potential to re-introduce bottom-grown mussel farming to former locations like the Menai Straits with its ideal tidal conditions and water flow.

1.2.2 Exploring the opportunities for growing farmed shellfish production

There is considerable potential to grow shellfish production in UK waters, meeting multiple UK policy objectives for food security, trade and environmental gain. The main opportunities are:

1. **UK waters are ideally located in terms of planktonic food and temperature, to produce good growth rates of mussels, oysters, scallop, clams** and other shellfish species. Climate change is creating a comparative advantage for UK production whilst introducing extra challenges in terms of viruses etc.
2. **An established large scale export market already exists in EU**, although Brexit has raised several barriers that unnecessarily constrain UK shellfish exporters.
3. **There is room for market growth in the UK**. Currently consumption is low and there is plenty of potential to grow this home market, thus reducing dependence on other, imported seafood.
4. Shellfish are low in the food chain, naturally feeding on plankton and thus **a very efficient way of producing healthy, low-carbon marine protein**.
5. In addition to increasing food production, **shellfish farming generates significant and proven environmental services** including utilising excessive nutrients, sequestering carbon and providing both the space and habitat for biodiversity conservation.

1.2.3 The main challenges to maintaining and growing farmed shellfish production

Despite the considerable potential to expand the role of shellfish farming in food production and ecosystem management, there are many technical, socio-economic and in particular, regulatory challenges to growing shellfish production. These are outlined below but are examined in more detail in **Section 2**.

1. The **limited engagement by – and support from - successive governments** in sustaining or growing shellfish aquaculture businesses. If this part of the blue economy is to grow, it needs active support and encouragement.
2. There is **limited understanding of - and a lack of technical expertise in low trophic aquaculture such as shellfish farming - within some public agencies and regulating authorities**. Whilst there is an excellent knowledge base in agencies such as CEFAS, others such as local NE offices who are regulating are deficient. As discussed in the next section, this tends to result in unnecessarily restrictive permitting and regulation.
3. Brexit – through a combination of punitive and ill-informed actions - has caused **loss and huge damage to the UK's shellfish export market**, especially for mussels which were previously a major UK seafood export to the EU.
4. The well-publicised **issues around coastal and estuarine water quality continues to reduce consumer confidence in UK shellfish**.
5. **The UK has lost the culture of eating shellfish** over several generations, so consumption rates are low and knowledge of shellfish and how to prepare them is generally poor.
6. The demise of specialist fishmongers means that shellfish are now mainly available only through multiple retailers. The downside is that the **economic returns to shellfish farmers have remained static** whilst costs throughout the value chain have increased, with negative consequences for both producers, the overall market and affordability to the consumer.
7. **England and Wales compete in the marketplace for live sales with Scottish producers** that are much better supported with grant aid and subsidies for infrastructure, transport and marketing by Scottish government (Seafood Scotland), local government (Shetland Council, HIE) and Crown Estate Scotland.
8. Despite our extensive coast, **there is increasing competition and restrictions on the sea space available for shellfish farms**. It is important that marine spatial planning understands the potential for shellfish farms to provide spatial habitat protection, water quality improvement and low-carbon food production in a single operation.
9. As a result of an increasingly crowded coast, supporting infrastructure such as landing areas, berthing and shoreside space is increasingly being taken over by recreational and other interests, **reducing access for shellfish farming interests**.

Overall shellfish farming has the potential to contribute directly to the UK's net zero ambition by providing low carbon, low trophic food production that contributes to biodiversity and environmental gains, unlike any other form of farming in the UK. However, this potential is being stymied by a combination of poor government policy, the fallout from Brexit poor water quality and the increasingly apparent impacts of climate change.

1.2.4 Opportunities and threats to the shellfish farming sector in England, Wales and Northern Ireland

Opportunities	Threats
• The current government's 'growth agenda' extends as far as shellfish aquaculture. • Further development of offshore, rope-grown shellfish, especially mussels. • Developing products from farmed shellfish for both food and non-food use. • Adapting to climate change e.g. utilising productive naturalised species such as the Pacific oyster and the Mediterranean mussel (*M. galloprovincialis*) as our sea temperature profile changes. • Including farmed shellfish into integrated multi-trophic aquaculture (IMTA) and co-locating with offshore wind farming. • Shellfish farms a valued contributor to improving sea water quality and biodiversity.	• Continued water pollution fails to improve shellfish water classification and discourages the public from eating shellfish. • UK fisheries policy fails to adapt to the reality of climate change e.g. the inevitable increase and spread of wild Pacific oyster populations. • Continued lack of a policy specific for aquaculture development. • Shellfish farming is squeezed out of the marine space by offshore wind, environmental conservation and other spatial demands. • Climate change could affect shellfish farming through a combination of seawater temperature rise and over the longer-term, ocean acidification.

1.2.5 How other countries are doing it better

The key difference between the UK and those countries with more successful shellfish production is that the latter recognise shellfish aquaculture as a valuable industry that is supported by their governments. The key support elements include dedication of marine space, maintenance of good water quality, provision of physical infrastructure and having a functional and supportive legislation.

France, **Italy** and **Spain** have large shellfish production industries which are supported by strong domestic consumption and shellfish are part of the everyday diet. This means that the average shellfish consumer is sophisticated in their buying habits and understand and demand good quality. Shellfish consumption is a part of their culture and that generates public support, social license and pride in the industry which in turn drives governments to enable and support shellfish production.

New Zealand, **Chile, Ireland**, **Denmark** and **Holland** have some domestic consumption, but their large-scale industries depend mostly on exports. Governments in those countries recognise the positive net export value of shellfish production and provide the support to enable those industries:

- New Zealand and Chile focus on frozen product which is sold globally. New Zealand has a high level of mechanisation and innovation to minimise production costs while Chile has low labour costs to achieve the same.
- Ireland, Denmark and Holland focus on live sales to neighbouring countries. Ireland and Denmark also have some frozen production sold at the lower end of the price bands.

There are some geographical coastal advantages for the countries listed above that help production levels. We also have a large coastline, but it is often unusable because of pollution or because the necessary space is reserved for other purposes. The Marine Plans attempt to address this by identifying suitable aquaculture sites, but it was not done with a full understanding of what the industry needs.

2. Key areas to achieve growth

2.1 Improved and proportionate governance and regulation

2.1.1 Reducing the administrative burden of obtaining permission to farm shellfish

Obtaining the various permissions required to grow shellfish is a perennial challenge for new and established farmers. Devolved powers mean that the arrangements differ around the UK, but in all nations the sector suffer from lengthy procedures and uncertain outcomes. Scotland recognised this was a major brake on sector development (except in Shetland which already had specific licensing powers) and has taken steps to address this through an independent licensing review leading to a streamlined process.

In reality, many practical barriers to shellfish development will remain without government actions that actively promoting growth of the sector.

The Crown Estate (TCE) is currently reviewing its approach to licensing and fees of all tenants, including aquaculture producers. TCE is benefitting from the very large revenue streams resulting from development projects in the UK EEZ, most notably offshore wind. This provides an opportunity to provide incentives for shellfish development, including the potential it offers as mitigation for larger-scale developments, e.g. incentivising co-location.

TCE also states the need to support developments providing environmental and social value to local communities, which shellfish aquaculture clearly does. TCE should recognise shellfish aquaculture as being restorative, ensuring that it is included in its natural capital policies and that it contributes to TCE's own Ambition for Nature Recovery.

2.1.2 Improving coastal water quality and its management

Water quality has been an issue for the shellfish industry since the 1970s. The then EEC's Shellfish Waters Directive (1979) and its successors[4] were aimed at protecting shellfish harvesting waters from pollution and keeping our shellfish high quality for consumption. The government of the time delayed implementing this legislation whilst they privatised the water industry in England, thus putting the costs of updating our water systems onto private companies, and the shellfish industry has been dealing with the consequences of those actions since then, including the regular discharge of untreated wastewater which until recently was largely unmonitored and is still essentially uncontrolled.

Water quality has always been a huge issue for shellfish farmers. Our European neighbours all have cleaner water, and a much higher percentage of Class A waters where harvested bivalves can be sold without further treatment (called depuration). After leaving the EU common market the historic trade in shellfish harvested from UK Class B waters was halted. Our poor water quality has become catastrophic for the shellfish industry. The shellfish industry has been the main victim of this. Cultured shellfish do not contribute to pollution but help to clean the water simply by being there. Yet there is scant protection and certainly no application of the polluter pays principle. Shellfish businesses have to bear the cost of pollution, either in increased depuration costs, or on restrictions on harvesting. Despite this the government only aspires to "no deterioration" this means that the target for shellfish waters is to achieve Class B status, which is currently the absolute minimum requirement for viable production.

[4] EU Shellfish Waters Directive (2006) was repealed in 2013 and all responsibility for legislative protection of shellfish waters was subsumed into the Water Framework Directive (WFD).

The industry (and our coastal communities) aspires to Class A waters around all our shores.

2.1.3 Increasing access to EU and other markets after Brexit

Before Brexit 89% of shellfish worth some £15-18 million landed into the UK was exported, the vast majority to the EU. The only paperwork required was a simple and cheap movement document. Following our relegation to third country status, live molluscs (e.g. mussels, oysters, cockles and clams) must come from Class A shellfish waters or be depurated before export. This is a first major barrier because as most UK shellfish waters are Class B (not because they are less clean, they are simply classified under different protocols) and sufficient domestic depuration facilities don't exist whereas continental EU buyers prefer to depurate their mussel purchase and are equipped at scale to do so.

The second new barrier is the paperwork, cost and uncertainty associated with shipping a live, highly perishable product over the new bureaucratic 'fence' that now lies across the Channel. One major mussel exporter has charted the issues they now face - shown in **Box 1** below - which are largely unnecessary and purely a product of a badly designed post-Brexit agreement.

We need a pragmatic, common sense approach to the export of live shellfish with the EU. The UK needs the market, and the EU needs the product. There are no new biosecurity or human health issues that have suddenly arisen since Brexit and most large EU buyers prefer to depurate at their own facilities. The UK Government is urged to reach agreement with their EU partners on a more rational approach to export and simplifying the certification systems for more efficient verification and lower costs.

2.1.4 A realistic approach to Pacific oysters

Pacific oysters (*Magallana gigas*) are the most common oyster species farmed both in the UK and the rest of Europe (where it is the second most valuable aquaculture species after mussels). The species was introduced into the UK as early as the 19th century but was encouraged by the UK government during the 1950s and 1960s to replace the stocks of native oysters that had collapsed from overfishing and disease. Pacific oysters are the only species of oyster that can be generally cultivated in Europe as natives simply do not survive, a situation that will be exacerbated as sea water temperatures continue to rise. This species is now found around the south coasts of England and Wales, and it is widely accepted that there is no way to remove the species once there or to prevent its gradual spread northwards as the seas continue to warm. In the EU, Pacific oysters are now considered naturalised and there are increasing arguments that the ecological benefits of allowing the largely unchecked spread of this species outweigh the costs of removing it (Hansen *et al*, 2023)[5].

DEFRA has recently produced a policy, but this has made the situation even more unclear and essentially leaves the decision on cultivating Pacific oysters to delegated bodies. This creates confusion with no certainty for new entrants to the industry and unworkable conditions for existing farmers. To restrict the industry in this way is unwarranted. There is no reason for the UK to restrict the operation and expansion of the industry given that current EU member states do not use the European legislation in this way, and many of them consider the species ordinarily resident and completely acceptable to farm in Natura 2000 sites. It would be timely for DEFRA to conclude that Pacific oysters are ordinarily resident and fully compatible with nature conservation sites as is the case in France. There are many advantages that shellfish aquaculture has to offer our country in terms of a healthy source of protein, carbon and nitrogen capture, employment in coastal communities and food security.

[5] Hansen, B., P. Dolmer & B. Vismann (2023). Too late for regulatory management on Pacific oysters in European coastal waters?, *Journal of Sea Research*, Vol. 191, 2023, https://doi.org/10.1016/j.seares.2022.102331

Box 1: Paperwork, costs and risks associated with exporting mussels to the EU

Process	Paperwork and costs	Risks
Preparing assignment	• Receive order and book transport. • Confirm registered number of lorry and trailer. • Request Export Health Certificate (EHC) from Defra. • Complete food business operator section of EHC • Send EHC to vet for completion of their section. **Cost £200.** EHC consists of 14 pages with 32 stamps and signatures plus sections to be scored out on each page. • Organic certificate of inspection completed and sent to TRACES electronically. **Cost £40.** • Commercial invoice completed & packing list completed • Email paperwork in advance to customs agents in UK and Boulogne-Sur-Mer. • T1 sent to transport export company. T1 permits the lorry to leave UK and travel from Calais to B-S-M. **Cost £65.**	Limited availability of chilled transport to EU post Brexit. Several companies have stopped chilled fish transport to EU and transport costs have gone up by approximately **£4-500 per load due** to difficulty of obtaining onward loads or backloads and delays at customs. Minor mistakes such as a stamp or signature being slightly outside designated box have resulted in loads being refused entry to EU and sent back to UK.
Transport in UK	• Mussel harvest completed and loaded onto lorry. • Vet inspection of load, documentation, trailer registration and seal number code • EHC plus movement documents detailing species, harvest area, weights, organic status, water classification, filled out by landing vessel and passed to lorry. • Lorry sealed and seal number recorded. **Seal £1.** • CMR[6] transport document filled out to cover international transport insurance. • Lorry dispatched to Dover. • Lorry cleared at Dover	
Transport in the EU	• Lorry arrives Calais and diverted to B-S-M under T1 certificate where load cleared for entry to EU. • Load cleared and continue to Yerseke for unloading.	To be cleared it may be a simple check of the lorry trailer seal or could be a complete unloading and vet inspection of 20t of mussels. Delays at this stage are frequent and may take several hours. This can result in driver hours being exceeded so new driver or rest period is needed. Delays result in loss of condition of live mussels and loss of weight.

[6] Convention on the Contract for the International Carriage of Goods by Road

2.1.5 Proportionate and reasonable environmental and social assessment

Environmental impact assessment (EIA) is required by major development in the UK. The requirements in England and Wales are under the Marine Works (Environmental Impact Assessment) (Amendment) Regulations 2017, and in Northern Ireland under the Planning (Environmental Impact Assessment) Regulations (Northern Ireland) (1999). All these are transposed from the EU EIA Directive 2014/52/EU (amending Directive 2011/92/EU). Essentially shellfish farming is exempt from requiring an EIA, as only intensive finfish farming requires an EIA. This makes sense, as shellfish aquaculture is unfed, thus avoiding many of the environmental issues of finfish farming and proven to be environmentally beneficial.

In addition to the EIA regulations mentioned above, if the site is in or near a European Marine Site, the MMO is required to consider whether if there are any Likely Significant Effects (LSE) on these sites and if so, an appropriate assessment is required to ensure these is no adverse effect on the integrity of the site. If the site is in or near a Marine Conservation Zone, then the project proponent is required to prove that the benefit to the public of their activities is greater than the risk of damage to the environment and demonstrate how they will mitigate the damage.

On paper the system is sensible and pragmatic and generally works well for traditional small-scale, culture operations. When establishing a shellfish farm, ensuring the appropriate siting and scale of the farm to suit local environmental conditions is a key requirement for commercial success. However, when aquaculture is scaled up, or innovative culture techniques are proposed, the weaknesses of the system are exposed. For instance, when the UK's first offshore mussel farm was developed off the southern coast of Devon, the then English Nature (now Natural England) insisted it was an 'intensive fish farm' and required a detailed EIA, despite having a final stocking density of less than 0.1 kg mussels per cubic metre[7]. After a protracted period of discussion and prevarication, it was agreed that the project establish a baseline environmental study and conduct annual monitoring which to date has cost the company over £600,000. Recent results from this and other independent studies show that not only after seven years of operation there was no statistically significant change to sediment organic matter, but that the mussel farm has had a positive impact on the sediment community and associated biodiversity directly beneath the farm and its surrounding areas (Mascorda-Cabre et al, 2024[8]).

The main issue is that when faced with a large, novel project like Offshore Shellfish Ltd (OSL), the regulatory response is obstructive, mainly due to an institutional unwillingness to take planning decisions without extensive, over-whelming evidence that the project is environmentally benign. Whilst a precautionary approach is understandable, it needs to be manifested in a constructive approach (e.g. adaptive and reviewable plans) instead of the current 'all or nothing for ever' licensing that requires extensive environmental assessment and new evidence, often gathered through expensive surveys. Without an intelligent and proportional decision-making process, the blue economy growth ambitions of the industry – and indeed the government – cannot be realised. In particular, brave and ambitious investment in moving shellfish aquaculture into deeper, cleaner and less contested offshore waters needs to be encouraged rather than discouraged. This requires a change in approach from regulators to support sustainable development through adaptive management and informed decision making. It is important that policy encourages staff to do this, and they are provided with the knowledge and capability to make these decisions on the basis of good quality available information, without resorting to continuously

[7] Trout farm stocking densities vary from 20 – 40 kg / m^3

[8] Mascorda-Cabre, L., P. Hosegood, M. Attrill & E. Sheehan 92024). Assessing benthic recovery below the United Kingdom's first large-scale, offshore, longline mussel farm, *Aquaculture Research*, 2024, 1393014, 15 pages, 2024. https://doi.org/10.1155/2024/1393014

seeking more information to delay decisions. The recently announced 'Corry Review'[9] to ensure that Defra's "regulation is driving economic growth while protecting the environment" is welcomed as it seems to be designed to address this very issue.

A second issue is on definitions. New, clearer and pro-growth definitions for EIAs and other regulatory purposes that reflect the likely development of marine aquaculture e.g. extensive, unfed and low trophic level faring of shellfish and marine algae are urgently needed to remove barriers to the sustainable development of marine aquaculture. In addition, the interpretation of thresholds such as "likely significant effects" also need clarification and further thinking to ensure that they are applied intelligently and proportionally.

Related to this is the social licence to operate shellfish farming, both in inshore and offshore waters. In contrast to the other side of the English Channel, where traditional shellfish farming is celebrated as part of the local heritage, there is still opposition to its presence on our shores. Therefore regulators, local councils and local community groups should be encouraged to adopt the approach of a cohesive blue economy approach of both balancing and integrating economic, cultural and environmental interests within sustainable development of our coastal areas. For this reason, larger-scale shellfish farms – which are likely to become more integrated with other forms of aquaculture e.g. seaweed and other maritime economic activities including capture fisheries and offshore wind farming - should be encouraged and facilitated to move offshore and provided both the space and the social licence to operate away from land.

2.2 Innovative and sustainable shellfish production

2.2.1 Improving seed supply - the need for more oyster hatcheries and mussel spat collection

There are differences in the way seed (young molluscs) are obtained for shellfish aquaculture. Mussel seed ('spat') is harvested naturally from the wild, but because Pacific oysters are traditionally not naturally found in UK waters, it is necessary to breed them to produce the seed. Two types of oyster seed are produced, *diploid* which grows into adults capable of breeding themselves and *triploid* which produces overwhelmingly sterile adults. One effective technology for producing 'natural' triploids has been developed in the USA and licensed through Government support in rival producers in France (via the French Research Institute for the Exploitation of the Sea [IFREMER], which also serves Channel Island producers) and in Ireland (via Bord Iascaigh Mhara [BIM]) but is yet to be licensed in mainland Britain, putting UK producers at a considerable commercial disadvantage.

It is therefore necessary to have oyster hatcheries to produce the young stock and here lies the problem. Due largely to policy restrictions, our production of Pacific oyster is too low to support investment into hatcheries and so our seed availability is variable, particularly for triploid stock which is increasingly being mandated because of the highly precautionary Defra policy. In contrast, due to the pro-growth policies in France the production of Pacific oysters - and the number of hatcheries to supply them – has grown and production is expected to rise to from 80,000 to 200,000 t per annum by 2050[10]. As a result, most UK produced oysters are from seed imported from France, but due to biosecurity and other reasons, this is far from ideal and a national hatchery capacity to meet sector aspirations is essential to permit growth. The UK has comparative advantage as an island nation in terms of disease control (Hambrey & Evans,

[9] https://www.gov.uk/government/news/dan-corry-appointed-to-lead-defra-regulation-review

[10] Comité National de la Conchyliculture (2022). French shellfish farming - Situation 2022, perspectives 2050, Workshop -HZ University of Applied Sciences - 16/03/2022

2016[11]), and parts of England remain clear of diseases such as *Bonamia* and OsHV-1 µvar (oyster herpes virus), a status that will require to be continued following EU-Exit with effective import controls.

There is also the potential to rear other shellfish species, such as other bivalve molluscs e.g. clams and scallops, non-mollusc species such as sea urchins and shrimp, and potentially even cephalopods such as squid and octopus which are all high value species that can find niche markets in the UK and abroad. Again, there is an unwillingness to invest in hatchery technology for these species unless there is more government support in permitting grow-out areas as well as facilitating live shellfish exports.

For mussels, the dependence on wild seed harvested from the wild creates an uncertainty and so a business risk, particularly for the bottom-grown mussel sector that would traditionally collect seed from wild beds for relaying. Recent years has seen fewer wild seed resources being identified for harvesting and with concerns around the (public) cost of surveys and the environmental impact of dredging operations, industry and regulators agree that the future is in rope-based spat collection systems. But again, this positive change for the industry and the environment needs to be supported with timely licencing and adequate funding as has been demonstrated in Scotland.

2.2.2 Promoting offshore shellfish production

The inter-tidal and shallow sub-tidal areas out to three or six nautical miles offshore are some of the most congested and sensitive in the UK. As with most aquaculture development worldwide, there are good reasons to move to the less busy, cleaner and deeper water offshore. OSL, England's single offshore mussel farm so far, has proven that offshore mussel farming is both possible and highly productive, with faster growth rates and higher meat yields than found in inshore waters. The greater distance from the shore generally provides water with more stable conditions of temperature, salinity and low turbidity, which contributes to faster growth rates. In some regions planktonic food resources may decrease slightly with distance from shore but the larger space resource, lower density of crop and better water flow counteracts that effect. This move offshore is not without its own challenges and risks. In particular, offshore aquaculture is more difficult and expensive to service due to its distance from shore and may be vulnerable to storms (becoming more frequent and severe with climate change) and collision damage. As a result, it is only really viable at larger scales.

The basic principle for building an offshore farm begins with careful site selection. The farm needs to be designed to suit the needs of the market and the natural conditions at the chosen site. Equipment must be robust, simple, reparable and replaceable. Weather conditions encountered offshore will require a vessel large enough to provide a stable platform. Large vessels are expensive, so their use needs to be maximised to be economic. This therefore requires the farm to be large scale to provide a crop big enough to keep the vessel(s) fully employed. Finding suitable finance for a large offshore farm is challenging due to high initial costs, slow returns and poor security of export markets. Crew for operating offshore farms are hard to find and it is difficult to compete with wind farms and fishing vessels for crew.

If the farm is laid out and designed to survive extreme weather conditions, then the greatest effect the weather will have would be restriction of access to the farm and unpredictable harvest patterns leading to erratic delivery to customers. In an ideal world a degree of redundancy and protection against customer disappointment would be provided by having multiple offshore farms located in different weather patterns working cooperatively to ensure deliveries to the customer.

[11] Hambrey, J & S. Evans (2016). Aquaculture in England, Wales and Northern Ireland: An Analysis of the Economic Contribution and Value of the Major Sub-Sectors and the Most Important Farmed Species. Final Report to Seafish. September 2016. 162 pp. https://www.seafish.org/media/publications/FINALISED_Aquaculture_in_EWNI_FINALISED__-_Sept_2016.pdf

2.2.3 Maximising the synergies across Integrated, Multi-Trophic Aquaculture (IMTA)

Integrated multi-trophic aquaculture (IMTA) – the farming of multiple aquatic species with different positions on the food web - is viewed by many policy makers as the holy grail of aquaculture. A well-designed IMTA system may be used to reduce the overall environmental impact e.g. through one crop assimilating the nutrients form another crop, and in many cases provide net ecosystem benefits. In reality, there are few such systems operational in UK marine waters, although one is being developed off the north Devon coast, where shellfish maybe integrated into a seaweed farming operation.

Shellfish – which are considered an organic 'extractive' species that are suspension feeders, filtering dissolved and particulate organic matter from the cultivation environment - can provide additional nutrients for seaweeds. The main barriers to IMTA uptake are the lack of proven commercial models that compensate for the extra investment needed to support the cultivation of multiple species. The Scottish Association for Marine Science (SAMS) operates an IMTA test site for various kelp and oyster species and the rest of the UK should be encouraged to conduct similar research and develop viable models which can work in the different environments around our coastlines.

2.2.4 Adapting to climate change

Climate change is already having an impact on aquaculture in the UK (Collins et al, 2020[12]), with the rapidly increasing establishment of Pacific oysters as sea temperatures rise being a prime example. Overtime the effects of climate change will become more profound and may include more extreme storm events (that can damage shellfish farms, increased suspended solid levels and increase the frequency of freshwater and storm spillover sewage events in coastal waters), changes in natural spat distribution and availability (important for mussel farming) and potentially increasing ocean acidification that is particularly detrimental to shellfish, in particular larval stages.

Although climate change will be challenging, it is possible to adapt and even benefit from some aspects, such as sea water temperature increases e.g. both the native[13] and Pacific oysters may increase in abundance and range. The blue mussel (*Mytilus edulis*) growth in south of England may be affected by high summer temperatures, but there is the potential to move to the more temperature tolerant Mediterranean mussel (*M. galloprovincialis*) over time.

2.3 Integrating shellfish farming into the wider blue economy

2.3.1 Improved supporting infrastructure

One of the main challenges to growth noted in **Section 1.2.3** was the increasing competition – and cost of – supporting infrastructure, especially as shellfish aquaculture moves offshore and scales up as envisaged. The farmed shellfish value chain needs investment in landing and vessel support facilities, the chill / cold chain and good transport links.

Depuration: there are no large-scale depuration systems in England and building one would be very expensive when it needs to be close to clean seawater as coastal space in England is expensive and planning permission difficult to come by.

[12] Collins, C., Bresnan, E., Brown, L., Falconer, L., Guilder, J., Jones, L., Kennerley, A., Malham, S., Murray A. and Stanley, M. (2020). Impacts of climate change on aquaculture. MCCIP Science Review 2020, 482–520. doi: 10.14465/2020.arc21.aqu

[13] Settlement and growth of larvae requires temperatures greater than 15–20°C with optimal temperatures of 25–30°C (Robert et al., 2017).

Handling and preservation: live shellfish are a valuable and highly perishable product that have to be handled carefully with the minimum of temperature and physical shock. They are bulky, and where high volumes are involved, require heavy quayside lifting gear. Chilled and cold storage is scarce with high costs and there is competition with fishing industry for available space. Landing berths need to be clean, available and affordable, all of which are being increasingly a challenge.

Transport: onward transport also needs to be chilled, and live shellfish must be separated from other goods to prevent cross contamination. Handling of live shellfish during transport is often poor, particularly for multi drop and small volumes by untrained drivers. There is very limited interest in large export volumes from the transport companies and costs can be high, particularly when delays at crossings, border posts and on our crowded road system affect driver hours and the ability to pick up back loads. Road systems into and out of many of our coastal ports are congested, particularly in holiday seasons.

2.3.2 Improving cooperation and coexistence with other marine economic activities

In recent years it has been recognised we are 'better together' and that threatened industries such as shellfish farming – and indeed capture fisheries – need to recognise their common needs and synergies to survive and grow. This starts at the policy level, recognising the socio-economic value of seafood SMEs to coastal economies, as well as for regional development strategies that need to balance food production, offshore energy generation and environmental conservation with wider societal needs in the diverse coastal areas of England, Wales and Northern Ireland.

The co-location and co-existence of shellfish farming with other maritime economic activities is key to ensuring its place in future spatial planning, as well as potentially easing permitting and other steps in establishing new production sites. As co-location is not the easy option and shellfish farming is likely the smaller partner in developments, we need licensing policy that incentivises co-location.

Integration should also include aspects such as research and development. Aquaculture needs to be represented in blue economy innovation hubs and seafood development initiatives that can support the landing and processing of seafood products from both wild and farmed sources as well as further down the value chain for both domestic and export destinations.

2.4 Add value to shellfish products

2.4.1 Increasing domestic consumption of UK farmed shellfish

Mussels and oysters are healthy, nutritious and low-carbon foods, but domestic consumption remains limited compared to other European countries: only 15% of the UK population currently buys mussels at least once a year.

Shellfish can prove challenging to many UK consumers. More campaigns are needed to address the misconceptions of UK consumers, highlighting the positive messages around nutrition, low carbon and convenience. Health is the most cited reason for increasing seafood consumption and price the main reason given for reduced consumption – both should be addressed in promotional campaigns.

UK consumers are most likely to eat mussels in a restaurant, which account for 60% of portions consumed. Retail added-value convenience products for mussels are growing in popularity, including frozen products. 'Cooked Mussels in Sauce' sold in grocery stores totalled 7.3m units in 2021 and accounted for 58% of packets sold with Aldi and Lidl together accounting for more than one third of sales. Buyers over 45 years of age total almost 75% of buyers, highlighting that more effort is needed to make UK shellfish appeal to younger consumers.

In the UK, 33% of the population are 'Eco Actives' and consumer awareness of ethical sourcing continues to grow.[14] Most UK mussel and oyster production is already MSC or ASC certified showing the sustainability and high environmental standards of our shellfish farms. The positive environmental message around UK shellfish needs to be promoted and challenges to increase consumption addressed.

While we want to increase domestic consumption, sector growth at the scale envisaged will inevitably rely on export markets. UK trade negotiations need to support UK shellfish exports, effectively removing the barriers that Brexit introduced for shellfish exporters. Currently there is a lack of visibility of UK production in those export markets as UK production is supplied to major European buyers who then depurate and sell under their own label.

2.4.2 Developing new markets for UK farmed shellfish

Existing domestic markets will grow with the awareness-raising proposed above. They could grow substantially if new domestic markets are developed through:

- Inclusion of UK shellfish in more value-added products.
- Development of added-value products based on shellfish

There is also great potential for UK shellfish in non-food products and supplements. This requires product innovation and sufficient scale of production to develop and maintain supplies to new markets. Potential market opportunities are evident in alternative markets such as:

1. Human health particularly from derivatives of mussel oil
2. Pet health/pet food ingredient
3. Plant and soil health

Mussel oil now accounts for 12% of the mussel export market for New Zealand and contributed NZ$51m in 2020 (£25.9m). Developing bioactive products will rely on bioprocessing capabilities being accessible.

Mussel meal could provide a more sustainable and low-carbon alternative to fishmeal. Global markets are mainly supplied by industrial fisheries in South America and West Africa and fish meal is the main source of GHG emissions in aquaculture production. Even plant-based alternatives such as soy require a huge amount of land and irrigation that could be used for growing human food[15]. A more local, low-carbon supply of protein would help European aquaculture reduce its carbon footprint.

Developing the shellfish industry at scale and ensuring carbon is stored in the shells, would involve the development of markets for meat that are beyond the current in-shell delicacy we are familiar with.

[14] https://www.thegrocer.co.uk/promotional-features/interest-from-consumers-in-responsibly-sourced-seafood-is-growing/689487.article

[15] it takes an area of farmland 7 times the size of the European Union to produce feed for the livestock animals of Europe.

2.5 Realising the potential of ecosystem services from shellfish farming

Ecosystem services are essential for shellfish aquaculture, but uniquely for food production systems, shellfish culture itself improves water quality by filtering water, absorbing algae, nutrients and carbon in the process. The sector's contribution to marine conservation and habitat restoration are not fully realised and should be valued as part of the industry.

2.5.1 Monetising the ecosystem services provided by shellfish farming

Expanding the sector will have a considerable positive impact on the marine environment and society. Shellfish farms remove nutrients, resulting in cost-savings for land-based wastewater treatment. For example, Northern Ireland Water has calculated that without the nutrient removal by mussel production in Belfast Lough, they would have to spend £50million to build bigger treatment plants that would cost an extra £1.5 million a year to run.

In England, bivalve harvest-related bio-extraction alone could offset 2.5% of industrial effluents, while in Northern Ireland, it could more than compensate for industrial nitrogen sources. This signifies a tangible improvement in water quality, adding to the existing suite of ecosystem services from bivalves and benefits derived from the food and by-product industry (Seafish, 2024). The cost savings from nitrogen removal by shellfish culture alone is estimated at £7 million for 2019 production levels. With the sector growth proposed in this vision, this value would be many times greater. The value of all ecosystem services provided by shellfish culture is more valuable than the farmgate value of production.

The Baltic Blue Growth project led municipalities in several countries to appreciate that mussel farms offer a dual benefit to their regions mussels: as a business opportunity and a positive environmental effect. It also explored the potential for Green Finance to support sector growth.

There is an urgent need for economic incentives to support the UK shellfish sector and facilitate investment in production expansion. The Shell-volution project in Shetland has received substantial funding to increase Scottish production by 10,000 t. There is opportunity for similar scales of growth by supporting projects in England (OSL), Wales (Menai) and Northern Ireland (Belfast Lough).

Many UK land-based farms would not survive without receiving subsidies and many of these have now evolved into stewardship payments. Payment for marine ecosystem services should be considered no differently from those paid to terrestrial farmers.

Before monetisation of ecosystem services is possible, evidence of those services must be collected and suitable metrics developed to assess them. The value of N absorption by NI water and Seafish mentioned above are a good start. The value and importance of the various services will vary according to location but could be wide ranging and include nutrient reduction and carbon sequestration plus provision of food, habitat, shelter and nursery areas of many commercial wild caught fish and shellfish.

Payments for enhancement, regeneration and protection of biodiversity are well developed for terrestrial farms and marine farms should be classed similarly.

2.5.2 Contributing to carbon targets with off-setting

Shellfish absorb carbon dioxide, storing it in the shell and meat and contributing to sediment storage through bio-deposition. Carbon sequestration by shellfish farming is cost-effective and energy efficient, enabling the long-term stable storage of carbon if the use of shell is properly managed.

Organic carbon sequestration has been proposed as a possible regulating service, but it is not yet clear whether bivalves are a carbon source or sink because the shell formation process is a net producer of CO_2 (Fodrie et al., 2017). Feng et al (2023)[16], factored this into their assessment of the overall carbon budget for shellfish farming and found that shellfish farming is a net absorber of carbon and so could be used for carbon sequestration. They estimated that the carbon sequestration efficiency and intensity of cultivated shellfish may be much higher than those of artificial forests.

The long-term carbon sequestration potential of bivalve shells is expounded in 'A Shellfish Manifesto for Sequestering Atmospheric Carbon in Quantity'[17], which suggests that the shellfish industry should be expanded at scale primarily for this function.

Shellfish farming presents multiple wins: carbon sequestration, other ecosystem benefits and high-quality food provision.

2.5.3 Making shellfish part of the UK's Green Finance Strategy

Ecosystem services benefit the UK coastal environment, and we should reward shellfish producers for enabling these benefits through schemes that pay for these ecosystem services. Schemes are already in operation in the US that value the removal of nitrogen, phosphorous and suspended sediment by harvested shellfish.

We need to further quantify the provision of various benefits by harvested shellfish – beyond just nutrient removal - including the evident biodiversity benefits of shellfish aquaculture sites. An expansion of shellfish production sites would make a significant contribution to UK marine conservation efforts, e.g. as Other Effective Area-based Conservation Measures (OECM) and help the UK to meet its international commitments, including the Convention on Biodiversity to protect 30% of land and sea areas by 2030.

The UK government's Green Finance Strategy recognises natural blue carbon habitats, but does not currently recognise the potential for shellfish production in providing the same ecosystem services. The UK Nature Impact Fund already supports nature-positive businesses in terrestrial environments - this should be expanded to the marine environment and the blue economy.

For UK shellfish production to capitalise on this, we need to understand the information and assurances needed by UK green finance to recognise the natural capital value of shellfish production. Shellfish farmers have made major commitments to scientific research and long-term monitoring to evidence the environmental benefits provided by their production[18]. This needs to be communicated to government and green financers so that sector growth is supported for the ecosystem services it provides.

[16] https://www.sciencedirect.com/science/article/abs/pii/S1364032122008991#:~:text=Actually%2C%20mariculture%20in%20coastal%20areas,oceans%20%5B14%2C15%5D.

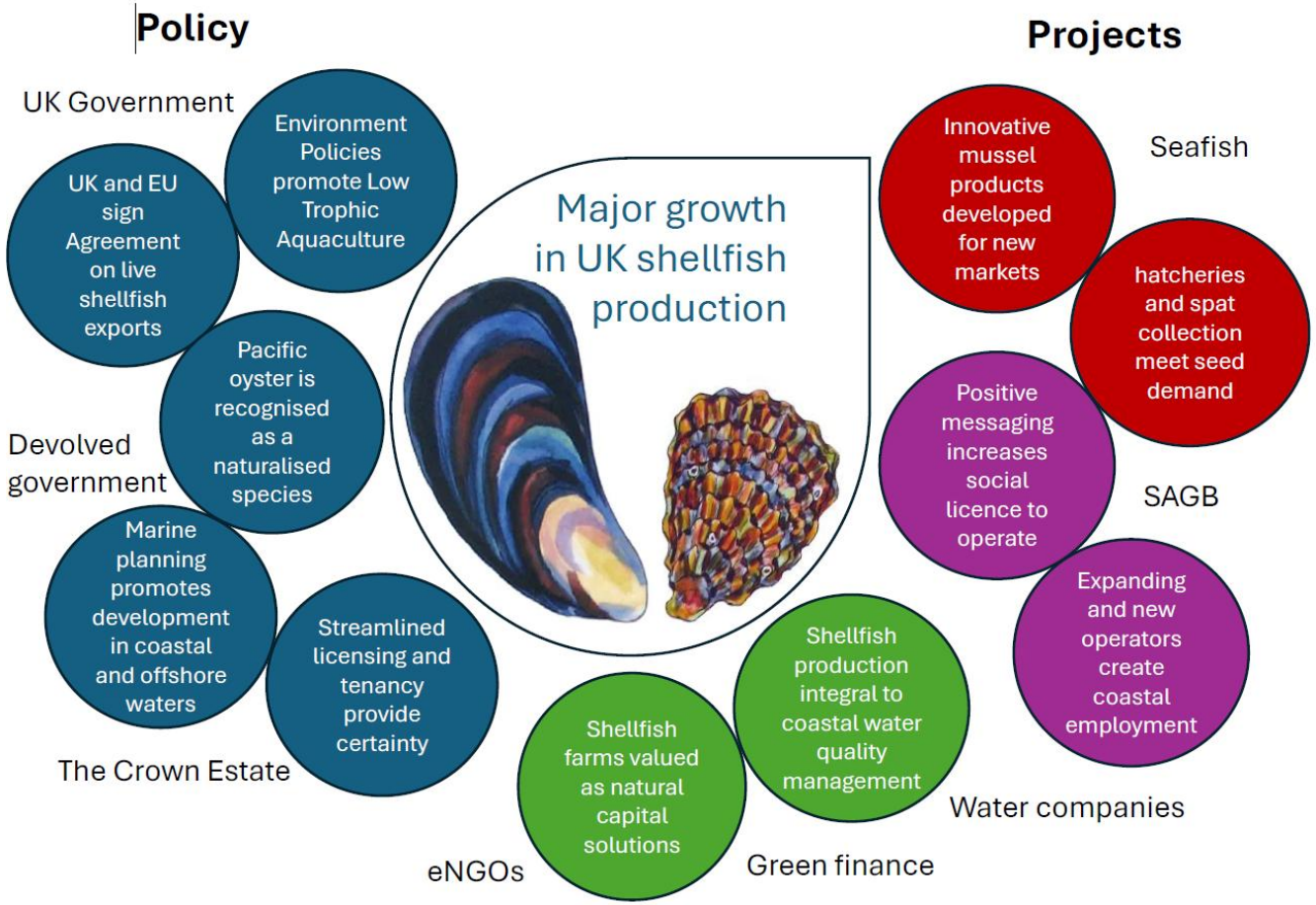
[17] Moore D (2023) A Shellfish Manifesto for Sequestering Atmospheric Carbon in Quantity . Environ Sci Ecol: Curr Res 4: 1083

[18] For example, Ecosystem Benefits of UK Oyster Sites (2024) and the Ropes to Reefs project (2023)

3. Roadmap

3.1 Policy and project actions

Major growth in shellfish production (and with it multiple economic, environmental and social benefits) will require support from UK and devolved government, The Crown Estate and several other key stakeholders. The following key policies and industry projects are needed:



3.2 Actions needed to reach the PotentShell

What action is needed?	Who is responsible?	SAGB role	Potential role of The Crown Estate
1. Enabling governance and regulation			The Crown Estate recognises the **substantial environmental and social value** of shellfish aquaculture for local communities with: A. Include aquaculture in **policy, strategy and position statements**, recognising that shellfish aquaculture is restorative and contributes to TCE's ambition for Nature Recovery. B. Support and fund a "**Voice for aquaculture" role** to drive the development of priority large-scale shellfish projects in England, Wales and Northern Ireland. C. Seek positive outcomes for shellfish production in **discussions with decision-makers** (Defra, APPG, etc.) on EU trade, licensing and water quality, etc. See above
Develop a **standalone aquaculture policy**: encourage government to develop a long-term policy for UK aquaculture that recognises its role on food security and environmental protection.	Defra, MMO, WG & DAERA. Natural England	Lead on policy and licensing co-design with industry.	
Streamline permissions and licensing: simplified processes, localised powers and integrated systems. Including appropriate environmental assessment and monitoring.	Defra / WG / DAERA The Crown Estate, other landowners, MMO, IFCAs, NE	Collate evidence to inform decision-makers	
Improve coastal water quality: investment in sewage treatment and watershed management. Gov. policy implements polluter pays principle. Ensure Classification is fit for purpose, protecting public health and delivering industry confidence	Water companies, OFWAT, FSA, EA etc,	Liaise with Water Companies and other stakeholders, promoting the role of shellfish culture.	
Simplify exports, esp. to the EU: political agreements over depuration and simplified, integrated and cheaper online certification.	Defra, Home Office, APHA		
Pragmatic policy on the use of Pacific oysters: clear, pragmatic and forward-looking policy and guidance.	Defra, Cefas, Natural England, NRW		
2. Increase innovative, sustainable shellfish production			
Installing mussel **spat collection** systems. Developing domestic oyster **hatchery** capacity Incentivised **co-existence** with other offshore sectors	MMO (funding), Cefas, industry, JNCC, NE, NRW, IFCAs et	Supporting role, sharing information and good practice with current and potential shellfish producers.	
Support **climate change adaptation** and **IMTA** solutions: identify climate resilient and viable production systems, species and markets.	MMO (funding), Cefas, industry, EMPA, AAC		
3. Integrate shellfish farming into the blue economy			
Improve **supporting infrastructure**: investment into landing and vessel support facilities, the chill / cold chain and good transport links.	MMO (funding), local government, industry.	Engaging with and representing industry.	
Improve **cooperation and coexistence** with other marine economic activities: develop co-location of shellfish aquaculture with other marine economic activities to maximise use of space.	MMO (marine planning), local government, maritime clusters, IFCAs		
4. Diversify and add value to shellfish products			
Increase domestic consumption of UK farmed shellfish: **increase awareness and attractiveness** of UK farmed shellfish products, especially by younger people.	Seafish, retailers, industry.	Promotions, media engagement	

What action is needed?	Who is responsible?	SAGB role	Potential role of The Crown Estate
Develop **new markets** for UK farmed shellfish: increase the diversity of farmed shellfish products, in **food, supplement and non-food markets**.	Seafish, processors, industry.		
5. Realise the value from ecosystem services			
Evidence and **promote ecosystem services** provided by farmed shellfish: wider recognition of ecosystem services (e.g. nutrient removal & water quality improvement) of shellfish aquaculture.	Cefas, industry, academia, EMPA, AAC	Supporting role, sharing evidence and good practice with policy makers and stakeholders in green finance.	
Contribute to **carbon targets and off-setting**: develop approaches for the long-term sequestration of carbon by shellfish.	Cefas, industry, academia, EMPA, AAC.		
Make shellfish part of the UK's **Green Finance Strategy**: seek inclusion of farmed shellfish production as a key sector in green / blue finance initiatives.	UKIB, Green Technical Advisory Group (GTAG), Land, Nature, and Adapted Systems Advisory Group (LNAS)		

4.1 Conclusion

This document has discussed the huge potential which exists for growth in the shellfish aquaculture industry. If the political landscape were more favourable to the industry, it is completely reasonable to expect that England, Wales and Northern Ireland could increase their production of farmed shellfish by 400% in the next 10 years. It is likely this would be predominantly achieved by replicating the 'Shetland model' (support to innovate and increase production by 10,000 tonnes) in 3 regions and it is reasonable for industry to expect the same level of governmental support seen in the Shetland area for these aquaculture hubs.

In the UK within the shellfish aquaculture industry, we have plenty of ambition for growth, with skills in the workforce, innovation and partnership working with academia readily available. Alongside that we have a fabulous, eminently suitable coastline, advantages in terms of absence of diseases and the controls in place to maintain this. Climate change is also giving the UK an advantage over our European neighbours, offering near perfect conditions for the cultivation of shellfish. This points to the UK being in pole position to benefit from an expansion in this sector

Nutritionally shellfish provide protein, vitamins and minerals, are low in fat and a wonderful source of the Omega-3 fatty acids. The protein from shellfish is of high quality, containing many essential amino acids and are very digestible for people of all ages. As shellfish are generally less than 5% fat they contain fewer calories than other protein sources. They are loaded with vitamins and minerals with vitamins A, E and the Bs being particularly plentiful and they are a great source of copper, iodine, zinc, iron selenium and potassium. Shellfish are also good sources of long chain Omega-3 fatty acids.

Shellfish Aquaculture is beneficial to the environment. No artificial feedstuffs are used, as the shellfish receive all their feed direct from the sea waters in which they are grown, and no veterinary medicines are ever used. The benefit of Shellfish production is a significant contrast to other, more harmful, methods of protein production. The shellfish act as a carbon, nitrogen and phosphorous sink as they use the carbon to make their shells and being filter feeders, reduce the nutrient loading in the water and the possibility of harmful algal blooms. In addition, aquaculture operations act as a nursery ground for other species and also provide a valuable food source for wild birds.

The problems with legislation, water quality and more recently Brexit exports have meant that shellfish aquaculture is struggling to survive in England, Wales and Northern Ireland and will, without serious and targeted interventions in these areas, likely be reduced to a few hobby businesses over the next generation.

The sector needs a regulatory landscape in which it can flourish and grow. Such a landscape can only be delivered by government and their agencies. In the UK our regulators are taking a different approach to that of other European countries. We need to recognise the benefits of aquaculture products and the businesses that produce them and provide high quality employment around the coastline and support them accordingly.

With governmental support, the shellfish aquaculture industry in England Wales and Northern Ireland could have huge growth with all the advantages to the environment, coastal employment, population health, food security and wealth generation that would ensue.

The UK is geographically located in a sweet spot for shellfish aquaculture in some of the most productive waters anywhere. This means that we have an unexploited natural resource that could not only gain jobs and economic value but would also gain all the spinoff benefits of environmental services, improved wild fisheries, cleaner coastline.

Now is the time for all to act to achieve the PotentShell.

Appendix A: Additional figures

Table 1: farmed shellfish production by country and species in tonnes (2008 - 2022)

Country / Species	Year														
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
England	**4,709**	**6,705**	**4,001**	**3,681**	**6,915**	**7,648**	**2,224**	**5,985**	**2,064**	**7,675**	**7,316**	**4,181**	**6,929**	**7,403**	**5,165**
Sea mussels	4,054	3,800	3,233	3,127	5,966	4,149	1,179	1,889	1,072	1,507	1,793	2,944	2,674	2,351	2,655
European flat oyster	44	54	89	86	86	29	9	8	7	11	8	11	19	11	7
Pacific cupped oyster	591	811	646	447	850	953	1,012	1,036	979	913	1,064	1,220	683	1,147	1,020
Great Atlantic scallop	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Queen scallop	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common edible cockle	10	2,027	7	6	0	2,504	5	3,045	1	5,223	4,440	0	3,531	3,886	1,476
Manila clam	5	9	15	5	5	11	4	6	3	20	11	7	21	1	1
Hard clam	5	4	12	10	9	1	15	2	1	1	0	0	1	6	6
Marine mollusc (other)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Whiteleg shrimp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern Ireland	**16,726**	**8,452**	**11,081**	**7,716**	**4,920**	**3,464**	**3,240**	**3,529**	**3,438**	**5,831**	**2,969**	**1,747**	**1,547**	**2,696**	**3,532**
Sea mussels	16,566	8,015	10,820	7,665	4,783	3,324	2,866	2,959	2,551	4,919	2,060	695	674	1,277	2,340
European flat oyster	0	127	0	0	0	0	0	0	0	0	0	0	0	0	0
Pacific cupped oyster	160	309	260	50	137	138	372	568	887	912	909	1,052	872	1,419	1,192
Great Atlantic scallop	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Queen scallop	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common edible cockle	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manila clam	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Hard clam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Marine mollusc (other)	0	0	0	0	0	2	2	2	0	0	0	0	0	0	0
Whiteleg shrimp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wales	**10,978**	**13,816**	**8,963**	**8,376**	**8,999**	**8,344**	**7,945**	**7,129**	**3,346**	**1,545**	**3,545**	**2,946**	**54**	**27**	**30**
Sea mussels	10,971	13,812	8,960	8,370	8,996	8,340	7,940	7,117	3,330	1,520	3,520	2,926	48	5	5
European flat oyster	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pacific cupped oyster	7	4	3	6	3	4	5	12	16	25	25	20	6	22	25
Great Atlantic scallop	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Queen scallop	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common edible cockle	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manila clam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hard clam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Marine mollusc (other)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Whiteleg shrimp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	**32,413**	**28,973**	**24,045**	**19,773**	**20,834**	**19,456**	**13,409**	**16,643**	**8,848**	**15,052**	**13,830**	**8,874**	**8,529**	**10,126**	**8,727**

Source: Cefas (unpublished data)

Figure 2: Growth aspirations for shellfish farming in England according to the English Aquaculture Strategy (2021- 2040)

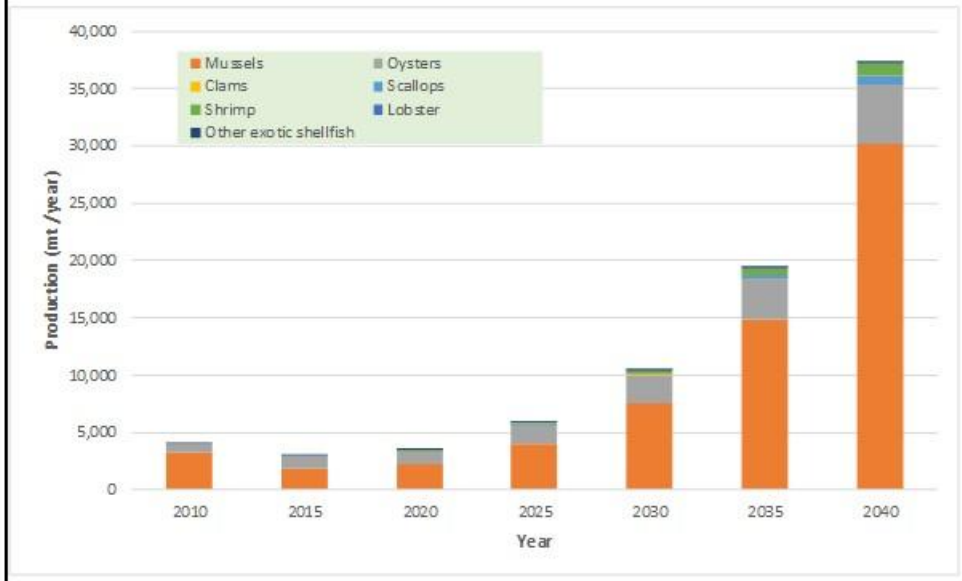
Shellfish

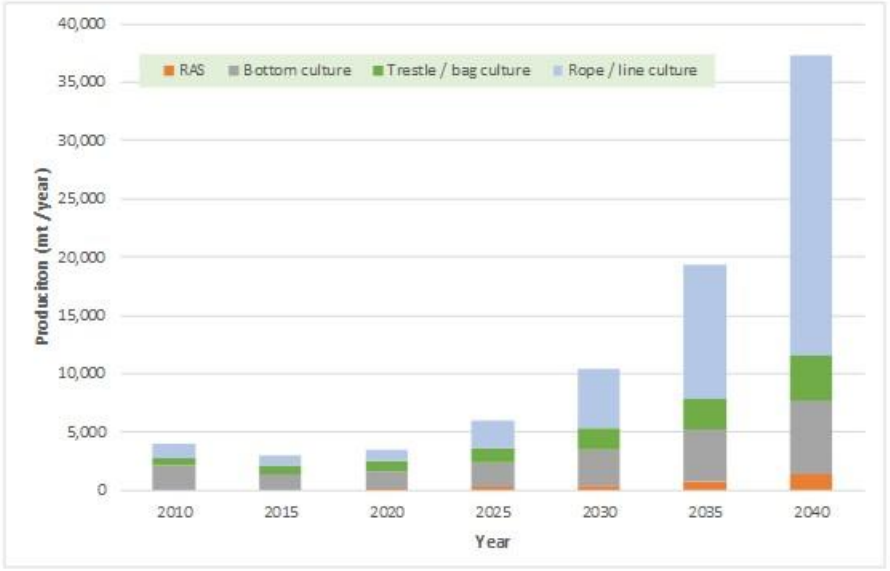
A. By species

Species	2010	2015	2020	2025	2030	2035	2040
Mussels	3,233	1,909	2,233	4,003	7,529	14,803	30,197
Oysters	735	1,034	1,123	1,675	2,429	3,528	5,141
Clams	0	0	21	27	34	44	56
Scallops	0	0	20	69	155	346	776
Shrimp	0	0	100	180	325	585	1,055
Lobster	0	0	2	4	10	22	50
Other exotic shellfish	27	8	12	12	12	12	12
Grand Total	**3,994**	**2,951**	**3,511**	**5,971**	**10,493**	**19,341**	**37,285**

B. By system

System type	2010	2015	2020	2025	2030	2035	2040
RAS	0	0	100	243	439	791	1,425
Bottom culture	2,184	1,366	1,497	2,143	3,069	4,397	6,304
Trestle / bag culture	517	821	902	1,293	1,854	2,660	3,815
Rope / line culture	1,293	764	1,012	2,291	5,132	11,493	25,742
Grand Total	**3,994**	**2,951**	**3,511**	**5,971**	**10,493**	**19,341**	**37,285**





Shellfish
Association of Great Britain