Devon and Severn IFCA
Mariculture Strategy
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Introduction

Devon & Severn IFCA (D&S IFCA) is an organisation which will lead, champion, and manage a sustainable marine environment and inshore fisheries by successfully securing the right balance between social, environmental and economic benefits to ensure healthy seas, sustainable fisheries and a viable industry. In this context, and as set out in D&S IFCA's 2019–20 Annual Plan, D&S IFCA have developed this Mariculture Strategy to "*…highlight core areas where the IFCA may have the opportunity to work with the mariculture sector to evaluate and advance mariculture opportunities and provide information to those interested in entering this sector*".

Mariculture, within the context of this Strategy report, is defined as: 'The cultivation of fish or other marine life within the marine environment', and therefore excludes cultivation of freshwater species, and cultivation in terrestrial facilities, which are beyond D&S IFCA's remit. The specific aims of the strategy are set out in the 'Future Mariculture Opportunities and Development' section, which follows key information on the current state of mariculture, and a review of factors influencing mariculture in D&S IFCA's District. This strategy has been developed through discussions with relevant parties, including current industry members and prospective mariculturists, and by reviewing the relevant literature including regional, national and international aquaculture strategies and plans.

National Context

There is increasing interest, at local to international levels, in sustainable mariculture as a source of revenue and high-quality resources. Despite the potential for growth in aquaculture, a 2012 Defra initiative to stimulate the sector through an English Aquaculture Strategy was stalled. However, the Aquaculture Leadership Group of the Seafood 2040 initiative has revitalised this scheme and aims to publish an English Aquaculture Strategy by September 2020 (Seafish 2040 Annual report, 2019). Seafood 2040 have also published a Strategic Framework to support a flourishing aquaculture sector at the national level, which encompasses the Strategy's vision for investment and expansion of aquaculture. Similarly, Defra's 2015 Multiannual National Plan details how the UK Government will encourage sustainable growth in the sector through coordinated spatial planning (Defra, 2015).

The Multiannual National Plan highlights that the Marine Policy Statement is facilitating the formulation of Marine Plans (by the Marine Management Organisation) to ensure that marine resources are used in a sustainable way in line with the high level marine objectives (Defra, 2015). These Marine Plans, including the South and South West Marine Plan, actively incorporate aquaculture production areas, with the aim of recognising aquaculture's place in supporting food security and livelihoods. In particular, mariculture has the potential to deliver social and economic growth in coastal communities.

However, the suitability of local areas for mariculture is variable and depends on a range of factors. In this context, regional strategies are increasingly in development. For example, the Dorset Marine Aquaculture Strategy aims to highlight local opportunities to investors and prospective aquaculture stakeholders in Dorset. It will convey the information using a purpose designed website containing signposting information and maps containing high resolution spatial surveys of habitat distribution, nutrient outflows, and subsequent suitability of differing spatial zones for specific forms of aquaculture. These data were collected on contract by Cefas. D&S IFCA recognises the importance of having such a strategy in terms of (a) an ability to benefit from upcoming aquaculture developments at a national scale, and (b) promoting regional development of mariculture within the District. Mariculture is especially relevant to the D&S IFCA District, which has the second longest coastline and largest sea area of any IFCA District. This strategy will be a vital means to promote and develop sustainable mariculture businesses within the District. Such a strategy will be the first of its kind produced by an IFCA. It considers the options for intertidal, inshore and offshore cultivation, highlights examples of these within the District, and outlines limitations and opportunities that may arise.

Current Status of Aquaculture and Mariculture

World Aquaculture

In 2017, global aquaculture production of animals and plants was 111 million tonnes. This had an estimated value of $238 billion at first sale, having more than doubled in the ten years since 2008. European production equated to 3.08 million tonnes of production worth $14.45 billion. By comparison, 2017 global capture fisheries production at first sale was valued at $145 billion from 92.5 million tonnes of catch. Only 30.6 million tonnes (17.7%) of global aquaculture production was from in the marine environment (FAO 2018, FAO 2019).

UK Aquaculture

UK aquaculture production escalated in the 1980s, leaping from 200 tonnes in 1979 to 50,040 tonnes in 1990 (World Bank 2020). In 2017 total UK aquaculture production totalled 227,434 tonnes worth approximately £1.1 billion. This was primarily dominated by the Scottish aquaculture sector which accounted for approximately £1 billion in revenue and 90% of production, the majority of which stemmed from salmon mariculture.

UK shellfish mariculture production in 2017 totalled around 18,000 tonnes worth a total £27 million. This increased in 2018 to around 21,000 tonnes worth £28.3 million. Despite this increase it is important to note that production and value of shellfish within the UK has fluctuated considerably over time, in 2013 the UK shellfish industry was worth £48 million with shellfish production approximated at around 26,000 tonnes.

The main shellfish species produced by sustainable mariculture in the UK are mussels (*Mytilus spp*.). In 2018 alone over 14,247 tonnes worth almost £16 million were produced. Pacific oyster *Magallana gigas* (formerly *Crassostrea gigas*) was the next most cultivated species with 2,220 tonnes produced worth almost £7 million. European oysters *Ostrea edulis* and Atlantic scallops *Pecten maximus* make up most of the rest of UK sustainable shellfish production (24 tonnes worth £172,756) *(pers. comm.,* Cefas; February 2020).

English shellfish production accounts for 16.8% of the UK total shellfish production at 2,764 tonnes worth an estimated £23 million. England produces 12.6% of the total UK harvested mussels, with 1793 tonnes produced in 2018. England also produces 43.4% of the total Pacific oyster production at 964 tonnes. The most (48%) of the UK's mussels are produced in Scotland and 40% of Pacific oyster production is in Northern Ireland. Native oyster production comes in at only 26 tonnes, with 7.5 tonnes produced in England.

Current Devon Aquaculture

The approximate spatial distribution of all mariculture in the D&S IFCA's District is shown in Figure 1, correct as of February 2020. Due to the nature of mariculture development this map may change considerably over time as businesses grow, cease trading or new mariculture developments arise. Shellfish production currently occurs primarily on the South Devon coast, in and around the mouths of estuaries and within large bays, notably Lyme Bay and Torbay. Methods of cultivation can vary considerably, even for the same species, based on personal preferences, and on the oceanographic and environmental characteristics of the site.

Currently, blue mussels and Pacific oysters are the only mariculture species being actively farmed and harvested within the D&S IFCA's District, although scallop ranching is being developed within Torbay (Figure 1). In 2018, production of both mussels and Pacific oysters in the District was valued at around £1.04 million. Of the total production 619 tonnes were mussels with an estimated value of almost £1,200 per tonne. Pacific oyster production in the District during 2018 totalled 123.9 tonnes with an estimated value of £2,500 per tonne. Production figures and estimated production values for the UK and D&S IFCA District were obtained from Cefas *(pers comm*, Cefas; February 2020). Value estimates were based on the annual regional average price per tonne of product at first sale.

Mussel production in the District accounts for 35% of English mussel production, and 4.3% of the UK total (Cefas, 2020). The Offshore Mussel farm in Lyme Bay (see Figure 1) is the largest rope-grown mussel farm in the UK, projected production at full capacity is an approximately 10,000 tonnes per year (Offshore Shellfish Ltd. 2020). Other methods of mussel cultivation include harvesting from subtidal beds using elevator harvesters, followed by re-laying of seed mussel (Exe Estuary). Re-laying of seed and dredging on subtidal beds (Teign). Intertidal harvesting by hand and seed collection is permitted in the Taw-Torridge on the public beds but is currently limited to 500kg total per month.

In 2018, Pacific oyster production primarily occurs in estuaries on trestles, on the foreshore in bags or using the PARC system. Seed is typically imported rather than wild-gathered for these methods. Sites can be found within the Avon, Dart, Yealm and Exe (Figure 1). Oysters in the Teign are gathered on the intertidal, and then re-laid on trestles in classified waters for growth and subsequent harvesting. Oysters are farmed on the north coast of the District in Porlock Bay and within the Taw-Torridge estuary on trestles. Current regulation and management of mariculture within the District includes two Regulating Orders: the 2001 Waddeton Regulating Order and the 1996 Teign Regulating Order. Regulating Orders enable the holder to regulate fishing, dredging or otherwise taking of shellfish within the specified area. The 2001 Waddeton Regulating Order is held by D&S IFCA, with plots leased to shellfishers for the production of a range of shellfish species. In addition to Regulating Orders, particularly offshore, land can be leased from The Crown Estate for the construction of installations such as mussel farms. Within estuaries, land may be privately owned by individual estate owners and leased for the cultivation of shellfish.

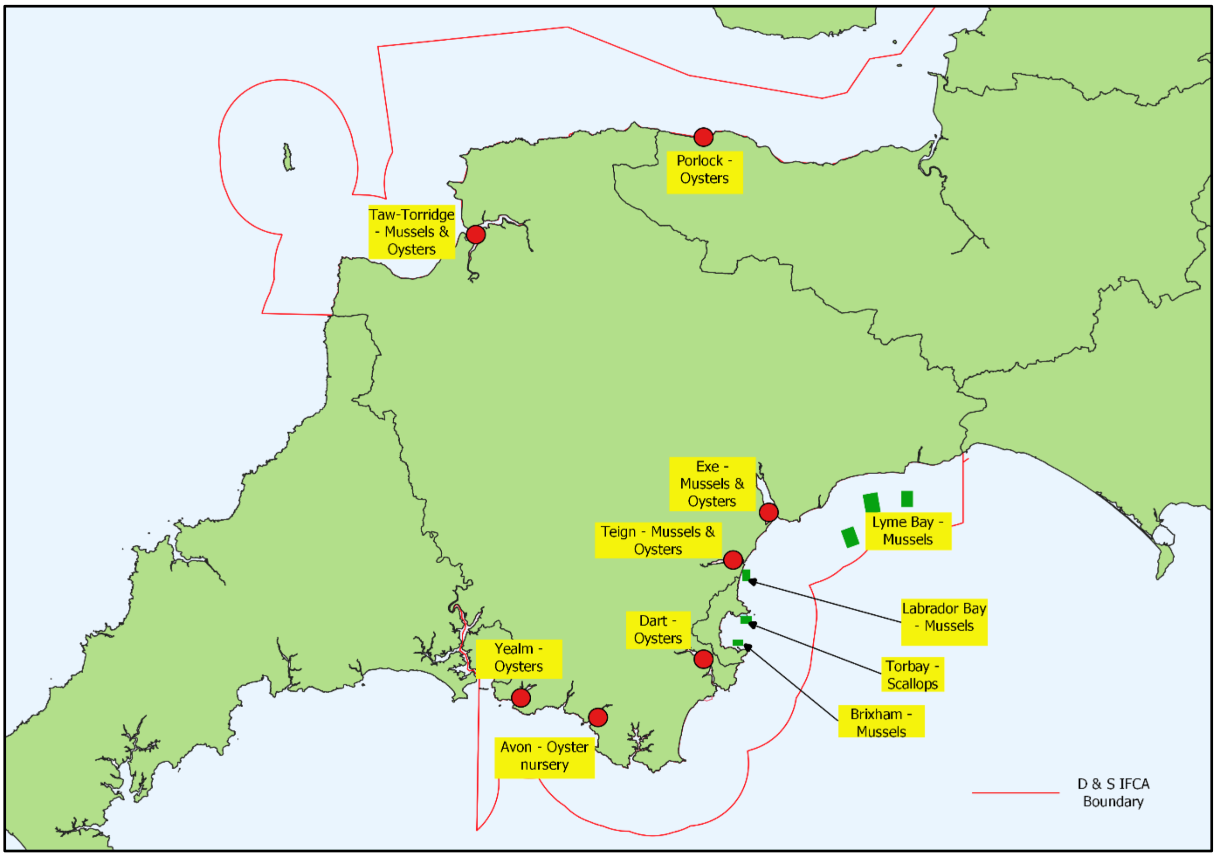

Figure 1: Locations of current mariculture production areas within Devon and Severn IFCA's District.

Factors Influencing Mariculture in the D&S IFCA's District

As part of the development of the Mariculture Strategy D&S IFCA consulted with ten key mariculture stakeholders within its District, and attended multiple conferences and symposiums relevant to the current state of regional UK aquaculture. This highlighted both current opportunities and issues facing the mariculture sector. Due to the diverse nature of mariculture farming the challenges faced by the industry are usually site- and species-specific. Estuarine and offshore mariculture will face differing challenges, as will, for example, shellfish mariculture versus macroalgal mariculture. Similarly, different forms of aquaculture will have differing ecological and physical impacts on their surrounding environment both positive and negative. Therefore, highlighting specific issues and synergies relative to both the nature and spatial location of any current and proposed mariculture within the D&S IFCA's District is vital to proposal of strategies aimed at facilitating the industry's future growth and development within the District.

Water Quality

Water quality may be the most important issue for all shellfish mariculturists within the District. Shellfish production can be negatively impacted, sometimes for significant periods of time, if high amounts of *Escherichia coli* register during official live bivalve mollusc (LBM) sanitary tests. *E. coli* is the proxy used for microbial contamination of shellfish. The relevant local authority, on behalf of the Food Standards Agency (FSA) and in conjunction with Cefas, carries out these tests on classified shellfish harvesting areas monthly in the UK, and prior to classifying new shellfish harvesting sites. FSA sanitary surveys also assess the area or catchment that may impact the shellfish harvesting sites, and are a detailed source of environmental data relevant to the growth and classification of bivalve molluscs.

Shellfish harvesting sites are classified A, B, C or prohibited (closed to harvesting/ production), based on the levels of *E. coli* detected in shellfish flesh. The classification process is described here: www.food.gov.uk/business-guidance/shellfish-classification. In summary, the classification determines the level of treatment required before shellfish can be harvested for direct human consumption. All shellfish to be harvested must undergo a purification process, called depuration, unless from Class A beds. If tests of LBMs from a classified site show consistently high *E. coli* concentrations, then the site may be downgraded. Even for one-off exceptionally poor results, the site will be temporarily closed until *E.coli* levels have returned to the appropriate levels. The results of all active and historically farmed classified beds can be found at: https://cefas.cefastest.co.uk/cefas-data-hub/food-safety/classification-and-microbiological-monitoring/england-and-wales-classification-and-monitoring/shellfish-monitoring-results/.

Poor water quality leading to high *E. coli* readings within LBM flesh samples is influenced by several compounding factors, which primarily stem from agricultural run-off, discharge from effluent pipes, overflow drains, and from storm discharges from sewerage treatment works. However poor results can also be elevated by other factors such as natural variability, and isolated pollution incidents (Quilliam *et al*. 2011). There is evidence that improving water quality by reducing nutrient loads has a positive correlation with decreasing *E. coli* concentrations within LBMs (Quilliam *et al*. 2011).

LBMs like mussels are adept at filtering large volumes of water and in so doing purify the estuarine or coastal waters. However, this filtration processes may lead to the bioaccumulation of trace elements such as heavy metals and other anthropogenically-sourced toxins. In industrialised or developed areas these toxins may enter the water in increased quantities (Ruiz *et al*. 2011). Therefore, situating shellfish mariculture sites away from such sources, and monitoring development near existing mariculture sites is vital for both food safety and business viability (Ruiz *et al*. 2011).

Harmful Algal Blooms

Harmful Algal Blooms (HABs) are large aggregations of toxin-producing microalgae. There are several types of HABs and can be found in both fresh and saltwater forming large 'mats' or 'slicks' on the surface of the water, although they may not always be visible. Bivalves consume high concentrations of microalgae and, in the presence of HABs, can bioaccumulate high toxin concentrations. Human consumption of LBMs with high toxin loads can be potentially fatal (Anderson *et al*., 2002; Townhill *et al*., 2018). HABs can therefore have significant impacts on shellfish production, as the sale of affected shellfish is prohibited until toxins within the flesh return to safe levels. Although these blooms occur naturally within the marine environment, poor water quality (high anthropogenic nutrient loads) and high temperatures can increase their frequency and magnitude.

Despite the potential high impact to the shellfish industry, D&S IFCA's District stakeholders expressed little concern about HABs. This is due to independent testing they conduct on their product before sale, and lower occurrences of blooms in the summer months than in previous years when water quality was less well-regulated. Although this work is still in its infancy, early warning systems may be able to alert marine users–including mariculturists–of impending blooms. This is increasingly important as ocean temperatures rise and blooms become more frequent (Townhill *et al*., 2018). EUROHAB is just one such alert system which focuses on detecting blooms in the French-English Channel. More information can be found on their website: www.s3eurohab.eu.

Spatial Conflict

Spatial conflict issues may affect both shellfish mariculture and macroalgal mariculture development within the District. Fishers operating towed gear may see mariculture developments adjacent to or near their trawling grounds as a threat to their business and way of life. Many demersal gear fishers have historic, community and economic ties to their trawling grounds and worry that mariculture could displace them over time. Much of the inshore waters in the D&S IFCA's District are closed to demersal fishing gear (43% in the southern part of the District) and therefore there is a strong desire by the mobile gear fleet to maintain the open areas to allow their activity to continue. This concern has led to strong opposition of both current and future mariculture developments within the District. Previous action has been taken to facilitate dialogue between the sectors, but working solutions are yet to be identified. Offshore mariculture sites within the District have previously been subject to damage from towed gear vessels trawling through static infrastructure.

There are positive interactions with static gear fishermen and offshore mariculturists. The nature of static gear allows for deployment of pots amongst fixed mariculture infrastructure. Anecdotally, pot fishers have been noted to fish more heavily around and amongst the rope-grown mussel beds in Lyme bay, possibly due to perceived aggregations of commercial species. Estuarine mariculture has generally negligible spatial conflicts with other fisheries users in D&S IFCA's District. Interaction with mobile gear is mitigated as it is not permitted within estuaries in D&S IFCA's District, and positive interactions have been noted between anglers who cite fixed gear, such as oyster trestles, as favourable locations to catch fish. Conflict can arise when intertidal private beds become exposed. It is difficult to display signage and warnings on these beds due to their position and the nature of the marine environment, and members of the public may engage in hand gathering activities on these private beds without necessarily understanding they are privately leased mariculture sites. This is a continual point of contention for some of the District's shell fishermen.

An issue of growing concern to local mariculturists within the District is the current negative perception of wild Pacific oysters. Pacific oysters are a non-native species first grown in the UK in the 1890s (Humphreys *et al.*, 2014). In 1960s the then Ministry of Agriculture, Food and Fisheries encouraged the development of Pacific oyster production to allow for diversification after the decline in native oyster populations. There is a growing anti-Pacific oyster lobby due to their perceived threat as an invasive species. Mariculture of Pacific oyster relies on obtaining seed from hatcheries. The seed are either diploid (two sets of chromosome and fertile) or triploid (treated to become sterile). Diploid oysters were initially farmed but the industry have moved to triploid oysters, which are believed not to spawn in UK waters (limiting their invasive potential) and to have a better meat yield. However, under some circumstances (including abnormally warm conditions, and with an ageing stock), triploid oysters are known to revert back to the diploid state and therefore are no longer sterile Herbert *et al.*, (2016). The two are morphologically similar and not easy to distinguish (Nell 2002). Mariculturists are concerned that current efforts by environmental groups to remove wild, invasive Pacific oysters are not only unscientific and ineffective, but could indirectly result in farmed stock being targeted. Defra announced in late 2019 at Seafood 2040 that they have established a Pacific oyster policy focus group with input from Natural England and Cefas that would be investigating the positive and negative impacts associated with Pacific oysters over the coming years, as well as defining their overall policy on farming Pacific oysters (Seafood 2040 Annual Report, 2019). This should provide clarity as to the true extent and nature of any ecological impacts presented by Pacific oysters and the regulatory framework in which they will be managed (Defra 2019).

Disease and Parasites

Diseases and parasites do not currently present a significant risk to the District's mariculturists. Due to shellfisheries current standard operating practices, such as operating with sustainable stocking densities, disease instances are largely prevented. Parasites have affected shellfish enterprises within the District before, notably high cockle mortalities in the Exe in 2011 due to infections of *Minchinia spp.* and *Himasthla spp.,* both of which cause 'gaping' in cockles. These infections closed the fishery before it had a chance to be properly establish (Davies & Blundell 2019).

Native oyster farming, though carried out in Cornwall IFCA and Southern IFCAs' Districts, does not currently occur within D&S IFCA's District. Local mariculturists would like to farm native oysters due to their high value: English native oysters in 2018 sold at £3,500/tonne compared to £2,500/tonne for Pacific oysters (Cefas *pers. comm.,* 2020). However, local mariculturists believe that native oysters are less resilient to adverse conditions and are subject to higher mortality rates than Pacific oysters. This perceived unreliability makes them a potentially high-risk investment. There is evidence in the literature that because native oysters tolerate a narrower environmental niche than pacific oysters and are therefore more vulnerable to suffering higher mortalities when environmental conditions become unfavourable over extended periods of time (Laing *et al*., 2006). It is worth noting that despite this, native oysters are being successfully farmed in several sites in the south of England. Current Sites within the Fal estuary and within Portsmouth Harbour provide two profitable examples (Cefas 2020) .). There is also a strong regional and national drive, through organisations like the Native Oyster Restoration Alliance (NORA), to promote the recovery of native oysters, both as a food source and for their role in habitat creation. Drivers like NORA may well be a pathway for facilitating native oyster mariculture within the District, through either funding or support (Pogoda *et al*., 2019). Other A significant limiting factorfor native oyster production is the restriction placed on the movement of native oysters from areas where the oyster disease *Bonamia* has been detected. The area between Start Point and Portland Bill is one of the few areas along the south coast of England that is free from *Bonamia* so movement into this area is restricted.

Another area of concern for many Pacific oyster farmers is the Oyster Herpes Virus (OsHV-1). Oyster herpes virus is a virulent disease affecting both juvenile and adult native and pacific oysters. The virus is most prevalent when water temperatures exceed 16 C (Renault *et al.,* 2014), and is associated with high mortality rates. The main prevention method is to restrict movement from infected areas to non-infected area (Arzul *et al.,* 2001). Cefas monitors areas for the virus should unexpected high mortalities be observed.

Norovirus presents another challenge to the industry, particularly for cultivators of Pacific oysters. Detected occurrence of norovirus within shellfish flesh following a reported human illness can cause the temporary closure of a bed and reduce demand for the product. Testing for norovirus is not yet fully regulated for Pacific oysters, and current tests are regarded as unreliable indicators for potential danger to human health (Lowther et al., 2019). Recent research commissioned by the FSA highlighted that of reported incidents levels of norovirus within oysters has a negligible impact on transmission to humans getting sick, and that poor food hygiene and latent immunity was more significant for the transmission and effective contamination by the virus. This research also noted that norovirus levels were higher in foods like lettuce than oysters (Cook *et al.,* 2019., Lowther *et al.,* 2019).

Sedimentation

Sedimentation can adversely affect some types of mariculture, particularly benthic shellfish farming. High sediment loads over extended durations can smother and kill benthic shellfish species like mussels and Pacific oyster (Karel 1999, Mainwaring *et al.,* 2014, Hutchison *et al*., 2016). For estuarine oyster famers this sedimentation can be avoided by suspending their product above the benthos, using trestles and bags. Offshore mussel fishermen routinely suspend their product above the seabed, so are unaffected by sedimentation. By contrast, cultivated subtidal mussels are more at risk to sedimentation. Some stakeholders believe that disposal of material from aggregate dredging in the vicinity of shellfish production areas has caused considerable mortalities to their stock.

Dredging in many of the District's estuaries historically occurred due to their use as ports and areas of active industry. In many of the Districts estuaries these industries have declined, so dredging activities became unnecessary and were discontinued. Some mariculturists have suggested that shellfish populations were larger and denser prior to the cessation of dredging.

Ecosystem Effects

Some forms of mariculture, when managed responsibly, have a positive effect on the surrounding ecosystems (Neori *et al*., 2007). Current research suggests that offshore mussel farms within the District have the potential to be nursery grounds for a plethora of species and create areas of increased biodiversity (Sheehan *et al*., 2019). Algal farms are less studied but are potentially able to provide similar secondary ecosystem functions to that of rope grown bivalves (McHugh, 2003; Peteiro, 2018).

Gamete dispersal from farmed species, such as mussels and other shellfish can help restock public beds by increasing the available abundance of viable larvae within the water column. Gamete dispersal from Pacific oysters farmed via mariculture should not contribute to the perceived spread of wild Pacific oysters due to the use of infertile triploid stock (Nell, 2002). However, there are some concerns surrounding the potential for reversion of these oysters to the fertile diploid state (Herbert *et al.,* 2016).

Mixing of gametes between differing species of blue mussel can occur. This is pertinent to the south west as there is mixing and hybridisation of two separate species of blue mussel: the native *Mytilus edulis* and non-native *M. galloprovincialis*. For the majority of England *M. edulis i*s the dominant species with low to negligible spatial competition with other blue mussel species*.* In the southwest *M. galloprovincialis* is also established. *M. edulis* and *M. galloprovincialis*, both occupy similar environmental niches and can hybridise with one another to produce viable offspring. These hybrids have only been found in areas of high aquaculture activity where the two species mix (Michalek *et al*., 2016).

The impacts of hybridisation of differing mussel species even within UK waters can be negative. For example, *M. trossulus* is a non-native species of mussel present in parts of in Scotland that is currently having a negative economic impact on local shellfish farms due to hybridisation with stock mussels. Unlike *M. edulis, M. trossulus* have very thin and brittle shells making them unsuitable for commercial sale. They have manged to successfully hybridise with other *Mytilus* species producing offspring with the same traits. The difficulty in being able to tell either species apart means that maricultrists may unknowingly produce large volumes of the unsellable *M. trossulus* alongside *M. edulis* (Michalek *et al*., 2016).

If overstocked or incorrectly situated, shellfish farms can have adverse implications for the surrounding ecosystem, which include increased nutrification and changes to the local benthic communities and hydrodynamic regime. Such effects are typically limited to more sheltered sites with limited mixing where the build-up of nitrates in the water column from associated faeces can lead to HABs and anoxic conditions. In turn, these impacts can cause high mortality of stock (Troell *et al*., 2003, Liu et al., 2019). D&S IFCA is unaware of any such event having ever occurred within the district.

Ecosystem Services

Mariculture within D&S IFCA's District could provide ecosystem services in addition to a sustainable food resource. Ecosystem services can be defined as the benefits provided by ecosystems that contribute directly or indirectly to human survival and wellbeing. Early research has highlighted that commercial species like edible crab can be found on the mussel ropes within Lyme bay (Sheehan et al., 2019) and there is anecdotal evidence provided by Devon seas anglers and mariculturists that some fish species highly regarded by anglers aggregate around oyster trestles. Mussel and oyster mariculture can sequester and fix large amounts of dissolved carbon from the water column: Ahmed et al. (2016) estimated that 16.1 million tons of molluscs could sequester between 0.97–1.93 million tonnes of blue carbon annually. Macroalgal farming has similar potential to sequester carbon, and could provide additional benefits in terms of reducing fossil fuel consumption if converted to biofuels (Chung et al., 2011). The sequestration potential for both shellfish and algae are therefore highly relevant towards contributing towards the current global and national drive towards a more carbon neutral global society. Offshore installations like Rope grown mussel farms also have the potential to provide costal defence services, absorbing wave action energy, which could have potential ramifications for decreased costal erosion (Plew et al., 2005).

Social and Economic Factors

Coastal fishing communities have suffered economically due to significant declines in the capture fishing industry and increases in fuel prices (Pinder 2003, Abernethy *et al*., 2010). Mariculture can provide both employment and an important cultural link to the sea for former fishers who wish to retain their way of life, diversify into more artisanal fisheries or provide additional employment to fishers who wish to supplement their income (Reed *et al*., 2013). Mariculture can also support jobs indirectly in supply chains. Importantly, mariculture also helps improve national resource security through the creation of sustainable food and other products (biofuel from algae for example). Britain's departure from the EU is a cause of concern to some mariculturists within the District as it could potentially impact their trade, access to European markets and matching of European regulations for imports. This is particularly pertinent to the shellfish industry where product, due to its short shelf life, requires rapid transport between supplier and consumer.

Future Mariculture Opportunities and Development

Despite the potential limitations facing the mariculture industry at a national and regional level, as highlighted above, there are key opportunities for improvement. This strategy represents the first steps in a long journey in developing the sustainable mariculture industry in the D&S IFCA's District therefor the strategy will be reviewed regularly to reflect the progress made. The opportunities highlighted below have not had full feasibility studies, and may require different permissions and licensing, infrastructure development and continued stakeholder engagement. Overall, successful future development of sustainable mariculture will require close collaboration between stakeholders across the supply chain, as well as scientists and regulators.

Management and Development

Aims:

To improve mariculture opportunities within D&S IFCA's District, within D&S IFCA's obligations under Section 153 (2) of the Marine and Coastal Access Act (2009) to:

- Seek to balance the social and economic benefits of exploiting the sea fisheries resources of the District with the need to protect, or promote the recovery of, the marine environment.
- Take any other steps which in the authority's opinion are necessary or expedient for the purpose of making a contribution to the achievement of sustainable development.
- Seek to ensure that the exploitation of sea fisheries resources is carried out in a sustainable way.
- Seek to balance the different needs of persons engaged in the exploitation of sea fisheries resources in the District.

Actions:

Resource development

- Provide up to date maps of all current mariculture fixtures within the District.
- Highlight, through the production of maps, spatial zones where the existing use is low and the potential for future mariculture developments may exist.
- Continue collecting up to date statistics on mariculture production within the District
- Create an online resource library of useful web-links and documents available for potential mariculturists.

Activity management

- To consider appropriate licensing, permitting and management for expansion and creation of mariculture sites, and sustainable exploitation of sea fisheries resources.
- Manage plots within the Waddeton Order on the Dart to allow for shellfishers to trial mariculture or diversify from other fishing activities.
- Consider the future use of the Waddeton Order area for shellfisheries.
- To continue to engage with the National Aquaculture Commons Issues Group to help open potential niche markets to D&S IFCA mariculturists.

Product safety and water quality

- Work with agencies that are involved with projects that seek improvements to upstream management of agriculture and waste water discharges.
- Liaise with the relevant governmental and non-governmental bodies involved with the regulation of water quality to aid reporting of incidents of poor water quality that have affected shellfish businesses and production.
- Support the consideration of alternative testing procedure to improve food safety whilst reducing the current limitations on shellfish productions.
- Continue liaising with HAB sensing organisations like EUROHAB to address and quantify the impact of HABs on the District's mariculture.

Engagement

Aims:

- To understand the needs and requirements of current and prospective mariculturists in D&S IFCA's District so that they can be successfully included in D&S IFCA's planning and decision-making processes.
- To improve the D&S IFCA's knowledge of mariculture and potential for future developments.
- To ensure that D&S IFCA is recognised and heard within the District's mariculture community.

Actions:

- Continue dialogue with both current and prospective mariculturists within the District in order to keep abreast of potential areas of issue and improvement.
- Publicise online resources beneficial for existing and future mariculturists.
- Publish news items and relevant literature online to help keep mariculturists ahead and informed of relevant mariculture news.
- Help to disseminate information about biosecurity measures in mariculture sites, including Defra's upcoming review on Pacific oyster impacts.
- Continue dialogue with mariculturists and other users of the sea that may operate near to mariculture sites, using D&S IFCA's published maps of new and existing mariculture sites to help reduce spatial conflict.
- Use D&S IFCA's published maps and other relevant literature resources as a basis for preventing unwarranted interference by those involved in projects to remove or eradicate Pacific oysters from areas in some estuaries which are classified for mariculture.
- Engage with regulators such as Cefas, FSA, EHO and SAGB to provide a conduit on issues and advances in mariculture to mariculturists in the District.

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