Fisheries Research & Management Plan

European Sea Bass (*Dicentrarchus labrax*) in the North of Devon & Severn IFCA's District

Devon & Severn IFCA
Inshore Fisheries and Conservation Authority

NORTH DEVON BIOSPHERE

European Union
European Structural and Investment Funds

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Cover image - European sea bass (*Dicentrarchus labrax*) (Sluijs, 2018, https://commons.wikimedia.org/wiki/File:Zeebaars_met_een_open_bek.jpg).

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Introduction

Background

In 2017, the UK fishing fleet added an estimated £1.53 billion to the UK economy and provided employment to 23,000 people in Great Britain. Globally, the demand for fish is expected to rise but growth in fish catches has stalled, with some regions experiencing declines of up to 35% between 1930–2010, primarily driven by overfishing. The fishing industry is also an integral part of coastal communities' cultural heritage and fishing has been passed down through generations, making the future of the industry an emotive issue.

The North Devon fishing fleet landed just under 1,000 tonnes of documented catch in 2019, with an estimated value of £1.7 million (MMO, 2020a). Much of the commercial fishing effort in the Bristol Channel is potting for shellfish and important trawl fisheries for skates and other demersal species. There are also traditional netting fisheries close to the shore for species such as herring and bass. Although these fisheries have relatively low financial value they carry immense cultural value to the fishers and their communities, being seen as part of their history and way of life (FRMP Interviews, 2020).

UK Government 25 Year Environment Plan

In 2018 the UK Government published a 25 Year Environment Plan (25YEP) with goals and targets for "*improving the environment within a generation and leaving it in a better state than we found it*". These goals and targets include "*ensuring that all fish stocks are recovered to and maintained at levels that can produce their maximum sustainable yield*."

To inform the development and implementation of the 25YEP the Government set up a series of Pioneer projects including a Marine Pioneer in North Devon (see **Figure 1**). The pioneer projects have been created to test innovative ways of managing the environment using a natural capital approach. The intention is that successful measures can be scaled up and applied at a national level.

As part of the Marine Pioneer, Devon and Severn Inshore Fisheries and Conservation Authority (D&S IFCA) and the North Devon Biosphere have produced a series of innovative Fisheries Research Management Plans (FRMPs) for commercially important species in the north of D&S IFCA's District (see **Figure 1**).

Fisheries Research & Management Plans

The FRMPs consider a localised and ecosystem-based fisheries management (EBFM) approach. EBFM is a holistic way of managing fisheries. It accounts for interactions between species, the overall health of the ecosystem and pressures that can affect this such as aggregate dredging, poor water quality and marine developments.

The FRMPs are different from previous work in this area because they take local and historical knowledge into account and include the cultural and heritage value of the fisheries. The plans also account for ecosystem factors that are sometimes overlooked by traditional fisheries management such as the impacts of local marine developments and the relationships marine species have with one another.

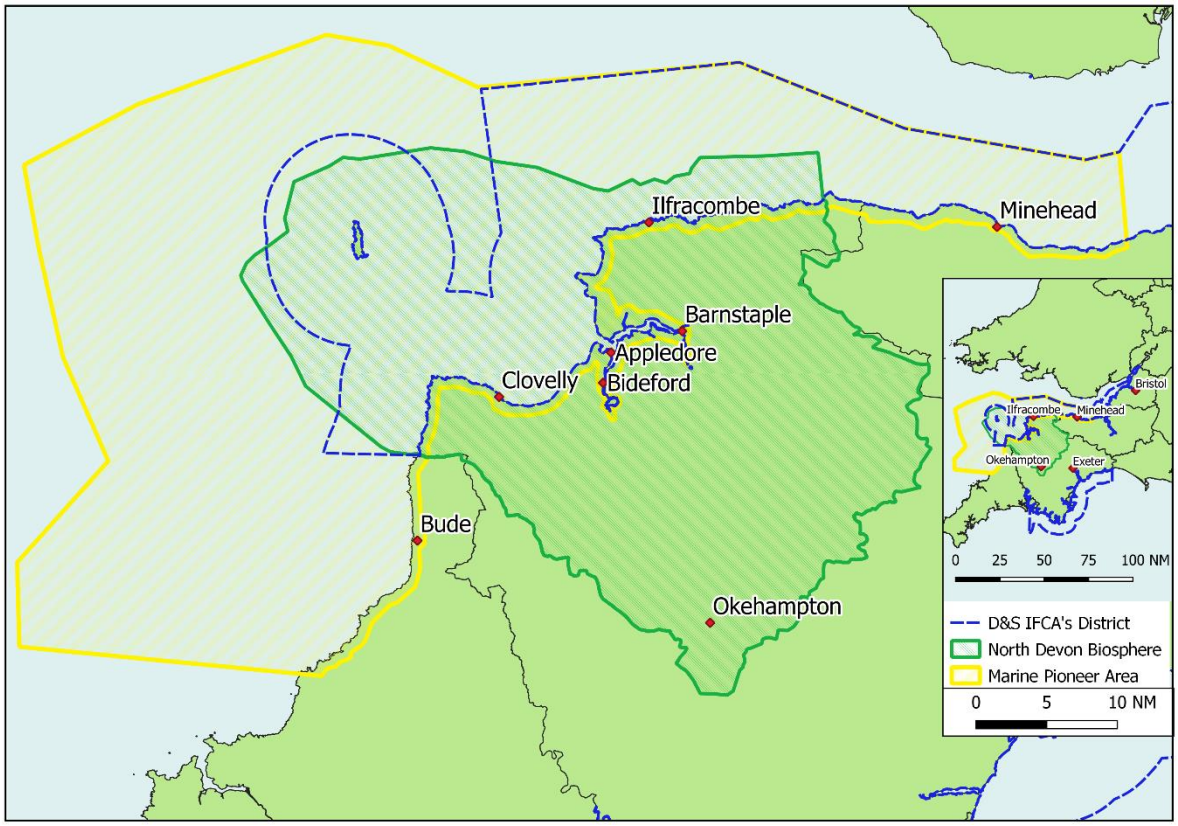

Figure 1 *- The Marine Pioneer area, North Devon Biosphere reserve, and Devon & Severn IFCA District on the North Devon and Somerset coastline*

Methodology

Each FRMP has been developed using existing data and knowledge combined with information gathered through stakeholder engagement. There was a thorough review of the evidence available in academic journals, grey literature, regulator and industry reports and historical sources. Semi-structured interviews were held with 9 fishers who are or have been active in the north of the D&S IFCA's District, and with individuals who have fished in this area in the past and worked within the inshore fishing industry. This included commercial and recreational fishers, charter boat operators and members of the North Devon Fishermen's Association (NDFA).

Each FRMP includes:

- A full ecosystem-based review of the ecology, fisheries, and management for the focal species, which can be used by a range of stakeholders as a comprehensive source of fish and fisheries knowledge.
- An evidence base that can be used to evaluate the impact of human activity on fisheries, fish and habitats. This can also be used to engage with other organisations in the development of national policy and implementation of Fishery Management Plans under the Fisheries Act (2020).
- Identification of current gaps in evidence so that D&S IFCA and other organisations can take a rational and prioritised approach to future research.
- Recommendations for fisheries management, making the case for local, sustainable, ecosystem-based fisheries management where realistic and appropriate.

European Sea Bass

This FRMP focuses on the European sea bass (*Dicentrarchus labrax*), an important commercial species that has been fished in Europe for centuries, and more recently has also been farmed for human consumption (Pickett and Pawson, 1994). Sea bass is also considered as the "*premier sporting fish*" and supports recreational fisheries across its range (Kelley, 1988).

Summary of Recommendations

Drawing on existing data, and knowledge and information gathered through stakeholder interviews, this plan makes a series of recommendations to facilitate the transition to a localised approach to managing sea bass fisheries in the north of the D&S IFCA's District. Recommendations have been grouped into 'research' and 'management'. Many of the recommendations are interconnected and would need to be delivered as a whole for them to be effective.

You can find the details of each recommendation in **PART 1** of this plan.

Research

Establish detailed knowledge of sea bass movements in and around the Bristol Channel to determine the appropriate scale of future management and effectively prevent overexploitation.

Investigate stock structure of sea bass in the Bristol Channel to find out whether distinct local populations exist. This information is needed to determine if local management of sea bass is possible and appropriate.

Involve fishers in the planning of future research to make the most of local expertise and knowledge.

Investigate reported nursery ground off Minehead to determine its importance for sea bass and other species.

Management

Improve integration between fisheries management and marine planning to make sure the exploitation of the marine environment is responsible and sustainable.

Ensure proportionate management of sea bass fisheries. Sea bass are an extremely popular species among both commercial and recreational fishers, and management in the past has led to fishing restrictions within both sectors. It is vital that future management of UK sea bass continues to allow both sectors to fish the species, and that UK bass stocks continue to benefit coastal communities around the UK.

Improve landings data collection for recreational and commercial fishers to gain a clearer picture of how fishing is affecting sea bass stocks locally and on a larger scale.

Improve communication and engagement with fishers to establish stronger fisheries enforcement presence in the north of D&S IFCA's District and combat illegal fishing and non-compliance in the area.

PART 1. RECOMMENDATIONS FOR RESEARCH & MANAGEMENT TO FACILITATE A TRANSITION TO A LOCALISED, ECOSYSTEM BASED APPROACH

*This section outlines the research and management changes that are needed to adopt a local, ecosystem-based approach to sea bass fishery management. The evidence to support the recommendations is outlined in **PART 2** of this plan. The recommendations have been categorised in terms of priority. Many of the high priority recommendations need to be addressed first to make it possible for the others to be carried out in the future. For example, many of the management recommendations can only be actioned once the research gaps have been filled.*

Summary of Current Fishery Status

European sea bass is listed as a species of least concern on the IUCN Red List despite many populations having dramatically decreased in recent decades (Pollard, 2015). The main threats to sea bass in Europe stem from commercial and recreational fishing as well as aquaculture farming, particularly following large expansions of the commercial fishery in the 1980s.

Sea bass is one of the most challenging species for fisheries managers, due to its migratory routes covering large areas and its popularity with both recreational and commercial fishers internationally. There is information available on the use of the Bristol Channel by sea bass but more detail is needed on its movements, range, and distribution within the Channel before any local management methods can be trialled. Engagement with fishers in the Bristol Channel highlighted that local sea bass fishers felt EU bass regulations were not appropriate for the small-scale nature of their fisheries and that even in years where large amounts of sea bass were caught, their fishing was not large-scale enough to put any significant pressure on bass stocks. Management may begin to shift towards a more localised approach after adequate information about local sea bass stocks has been collected, though this shift will not be a quick process.

Research Recommendations

The research recommendations are also available on D&S IFCA's website and will be shared periodically with interested parties to encourage collaborative research between fishers, scientists and managers that is relevant to management and policy.

Establish detailed knowledge of bass movements in and around the Bristol Channel – *High Priority*

Further research is needed to build on existing information of sea bass movements in and out of the Bristol Channel. Understanding where sea bass populations spend their time throughout their life cycles is essential to determine the appropriate scale of future management and effectively prevent overexploitation. A recent study shows young sea bass in the South West spend the majority of their time in the same small inshore areas, though bass are a famously migratory species. It is also known that adult sea bass migrate in and out of the Bristol Channel to areas further offshore in the Celtic Sea and English Channel to breed.

Next steps:

- D&S IFCA will support ongoing research projects gathering information on sea bass such as the Interreg FishINTEL project.

- Future monitoring or research should be designed in collaboration with Cefas and ICES to ensure the data are suitable for input to stock assessments.
- Findings can help inform future Fisheries Management Plans (FMPs), and contribute towards delivery of the ecosystem and scientific evidence objectives of the Fisheries Act 2020.

Investigate stock structure of sea bass in the Bristol Channel – *High Priority*

Sea bass in UK waters are currently assessed as one large stock, but a recent study suggests that assessing fish stocks on this scale might not be appropriate due to true fish population structure being significantly more complicated and localised in nature than previously thought (Hintzen *et al.*, 2015).

Research is needed to investigate whether this is the case for sea bass and if distinct local populations exist in the Bristol Channel. This information is needed to determine if local management of sea bass is possible and appropriate. Recent work carried out with the Marine Pioneer project has shown that there are distinct herring populations in the Bristol Channel (Rees, 2019). This suggests that there may be similar local populations of sea bass in the Bristol Channel and around the UK.

Next steps:

- D&S IFCA and stakeholders/relevant research bodies to explore options for conducting this research in collaboration with local commercial and recreational fishers.
- Future monitoring or research should be designed in collaboration with Cefas and ICES to ensure the data are suitable for input to stock assessments.
- Findings can inform future Fisheries Management Plans (FMPs), and contribute to delivery of the ecosystem and scientific evidence objectives of the Fisheries Act 2020.

Involve fishers in the planning of future research – *High Priority*

Engaging with fishers through the FRMP interviews has been invaluable in investigating local sea bass fisheries and arriving at these recommended next steps for research and management. Local fishing knowledge and fisher engagement should be used as much as possible in future to help direct research and benefit the local fishing industry.

Next steps:

- D&S IFCA is well-placed to facilitate fisher/researcher collaboration and will investigate what is needed to enable this (for example, collaborations will require standardised protocols and terms of reference, including for shared use of vessels and equipment).

Investigate reported nursery grounds off Minehead – *Medium Priority*

A range of both juvenile and large, egg-bearing female fish are regularly caught by netters off Minehead, suggesting the presence of fish nursery grounds nearby. This raises concerns regarding aggregate dredging and coastal development activities in the area and how they may be affecting local fish stocks. Research is needed to determine whether the area is commonly used by juvenile sea bass as a nursery area. If found, the spawning grounds must be mapped thoroughly and the implications of human activity on the habitat need to be incorporated into the management of fisheries and other activities. Past national management measures have included the designation and protection of large numbers of sea bass nursery areas around the UK, similar action may need to be taken if the waters off Minehead prove important to juvenile sea bass populations.

Next steps:

- D&S IFCA will explore collaborative research opportunities with relevant stakeholders to investigate the reported nursery areas near Minehead.
- D&S IFCA will support appropriate investigations of essential fish habitat in undersampled coastal and estuarine areas. This information would inform regional Marine Plans, marine licencing and permitting processes.
- Findings from this research could inform future FMPs and contribute towards delivery of the ecosystem and scientific evidence objectives of the Fisheries Act 2020.

Management Recommendations

Improve integration between fisheries management and marine planning – *High Priority*

In areas beyond the Bristol Channel there is concern that the effects of human activity on marine organisms and environments is not being appropriately considered by planners. Detailed information about marine species and their ecosystems is required to inform environmental impact assessments, Habitats Regulations Assessments, and other licensing and permitting assessments affecting marine developments. There is a strong need to realign and unify aspects of marine spatial planning, licencing, and permitting with fisheries and environmental management so that this information is more accurately and reliably considered in the process. This is particularly true in the Bristol Channel and Severn estuary, where there are high levels of interest for aggregate extraction and renewable energy developments.

Next steps:

- Findings from the recommended research in this FRMP should be incorporated into regional Marine Plans through discussions with D&S IFCA and the MMO.
- This would aid delivery of the Government's 25 YEP and Fisheries Act 2020 objectives, including utilising an ecosystem approach and prioritising sustainability.

Ensure proportionate management of sea bass fisheries – *Medium Priority*

Sea bass is one of the most desired species for both commercial and recreational fishers and the implementation of strict management measures by the European Commission has led to tension between the two groups of fishers. Recreational fishers feel that they are being unfairly restricted by recent management measures, and that they are paying the price for commercial overexploitation. Meanwhile commercial fishers are heavily dependant on the high value of sea bass fisheries and further restrictions can threaten livelihoods and potentially drive fishers out of the industry.

Future management, whether at a local or national scale, needs to reflect the interests of commercial and recreational fishers proportionately, allowing recreational fishers to continue to persue their passion and exercise their right to catch sea bass, while also allowing commercial fishers to fish for bass, protecting their businesses and livelihoods.

Next steps:

- Findings from the research recommended in this FRMP, and research into fisheries impacts, should inform the approaches required to manage distinct fishing activities, inform bass FMPs, and contribute towards delivery of the ecosystem and scientific evidence objectives of the Fisheries Act 2020.

Improve landings data collection for recreational and commercial fishers – *Medium Priority*

Reliable data on fish mortality is essential for the effective management of fisheries. Until recently, national management stated that smaller commercial vessels (<10 metres) were not required by law to declare their landings, but any sales of fish over 30kgs to registered sellers required a sales note. It is unlikely that many sales from the artisanal fisheries in the north of D&S IFCA's District exceed 30kgs in weight so they will have gone unrecorded. Any catches of sea bass by recreational anglers or netters also go undocumented.

Progress has been made regarding the development of the <10 metre vessel catch recording app, and there are similar options for recording catch for recreational fishers (e.g. Cefas Sea Angling Diary), however, more detail is needed, particularly in a local context to properly understand the impacts of fishing on bass populations. One option is to trial monitoring stations with logbooks in popular coastal bass fishing spots and make it mandatory for smaller-scale commercial fishers and recreational fishers to record their sea bass landings.

Next steps:

- The IFCAs are well-placed to facilitate improvements in landings data. The need for additional data should be evaluated with the organisations that would use the information to make stock and distribution assessments (e.g. Cefas/ICES).
- If specific data needs are identified, for example, the mandatory recording of sea bass catch, a pilot study should be undertaken as part of D&S IFCA's Annual Plan.

Improve communication and engagement with fishers to establish stronger fisheries enforcement presence in the north of D&S IFCA's District – *Medium Priority*

There is a strong consensus among fishers in the north of the District that a stronger enforcement presence is needed to help combat non-compliance and illegal fishing in the inshore fishing industry. D&S IFCA has one of the largest districts of any IFCA and is the only IFCA with two separate coastlines to cover and monitor. The limited size of the enforcement team means it is not possible for IFCA officers to maintain a strong presence in every area of the District. Consequently, officers must implement an intelligence-led, risk-based approach to their work that is proportionate to the compliance requirements: officers must prioritise patrols in areas with high numbers of reports of illegal fishing activity, which is typically the south coast of the District.

To enable enforcement officers to focus more of their activities (e.g., patrols) in the north of D&S IFCA's District, there needs to be more comprehensive reporting of illegal activity from those in the area, and improved communication between officers, fishers, and other local stakeholders. Additional external funding to expand research and enforcement capabilities would also improve this situation.

Next steps:

- D&S IFCA will improve collaboration and engagement through activities such as virtual roadshows for ports, sectoral meetings and future FRMP interviews. More information about planned activities is available in the D&S IFCA's Annual Plan and Communications Strategy, accessible via the D&S IFCA website.

PART 2. REVIEW OF EXISTING SCIENTIFIC RESEARCH AND FINDINGS FROM STAKEHOLDER ENGAGEMENT

Species Ecology

European sea bass belong to the family *Moronidae* (the temperate basses) that are typically found in the eastern Atlantic Ocean. They are a slow-growing species with adults commonly growing to lengths of 50 cm, though they can reach lengths of up to a metre and weigh up to 12kg (Pickett and Pawson, 1994). Individuals have a silvery grey colour with dark blue colourings often seen on the back (see **Figure 2**). Juveniles tend to form schools with other young sea bass while adults are less social.

Figure 2 *- The European sea bass (D. labrax) (Pillon, 2012, https://commons.wikimedia.org/wiki/File:Dicentrarchus_labrax_Minorca.jpg [unedited]).*

Geographical Range, Migrations & Habitat

European sea bass form two major populations across their range, the Mediterranean population, and the Atlantic population. Despite the classification of two distinct populations, sea bass geographic distribution is continuous (see **Figure 3**), covering all northern European coasts, including the UK and southern Norway. Their range extends south throughout Europe along the Mediterranean and north African coastlines (IUCN, 2008). Bass can be found along the entirety of the UK coastline, including within the Bristol Channel and the NDMP area. In recent years there have been reports that the range of the bass has been extending northwards (possibly as a result of warming seas and climate change) as sea bass have been observed in areas of the Baltic Sea where they have not been seen historically (Bagdonas *et al.*, 2011). European sea bass has also been recorded in coastal areas of Finland (Koli, 1990), Iceland (Jónsson and Pálsson, 2006), Poland (Więcaszek *et al.*, 2011) and Latvia (Plikss, 2002), however, it is thought that some of these reports are a result of escapees from aquaculture farms, and are not populations included in the natural range of the sea bass.

Figure 3 *- The global distribution of the European sea bass (D. labrax) (Etrusko25, 2020, https://commons.wikimedia.org/wiki/File:Dicentrarchus_labrax_map.png [unedited]).*

Bass are euryhaline (tolerate water across a wide range of salinities) and, though they spend most of their lives in marine, saltwater habitats, also spend large amounts of time in estuaries and lower reaches of rivers as juveniles (Lloris, 2002). Indeed, Nebel *et al*. (2005) found that small numbers of juvenile bass can adapt to freshwater environments, though even in these scenarios will only travel a few kilometres further upstream than the rest of their population. Bass exhibit demersal behaviour in water down to depths of around 100m, but typically remain in shallower water. They can be found over a variety of substrates in the littoral (nearshore) zone as well as near estuaries, rivers and coastal lagoons (Kelley, 1988).

Bass are a famously migratory species, leaving coastal feeding grounds in time to shoal and breed in winter (Mediterranean populations) and spring (Atlantic population) before moving further inshore again before temperatures decline (Pawson *et al.*, 2007). During the first four or five years of their lives they can be found in inshore habitats such as estuaries, however, during their first summer, areas such as shallow creeks, channels, marsh pools, and tributary streams are favoured; *Spartina* marshes are especially favoured in some areas of the UK (Kelley, 1988). The young bass stay in or near their “native” estuary for a minimum of four years before the more wide-ranging behaviours of adolescents are adopted. Once this has happened, the bass may begin to visit other nearby estuaries or coastal ecosystems. During this time a bass will “choose” the coastal area where it will revisit during future spawning seasons in spring and summer months (Pawson, Pickett and Kelley, 1987).

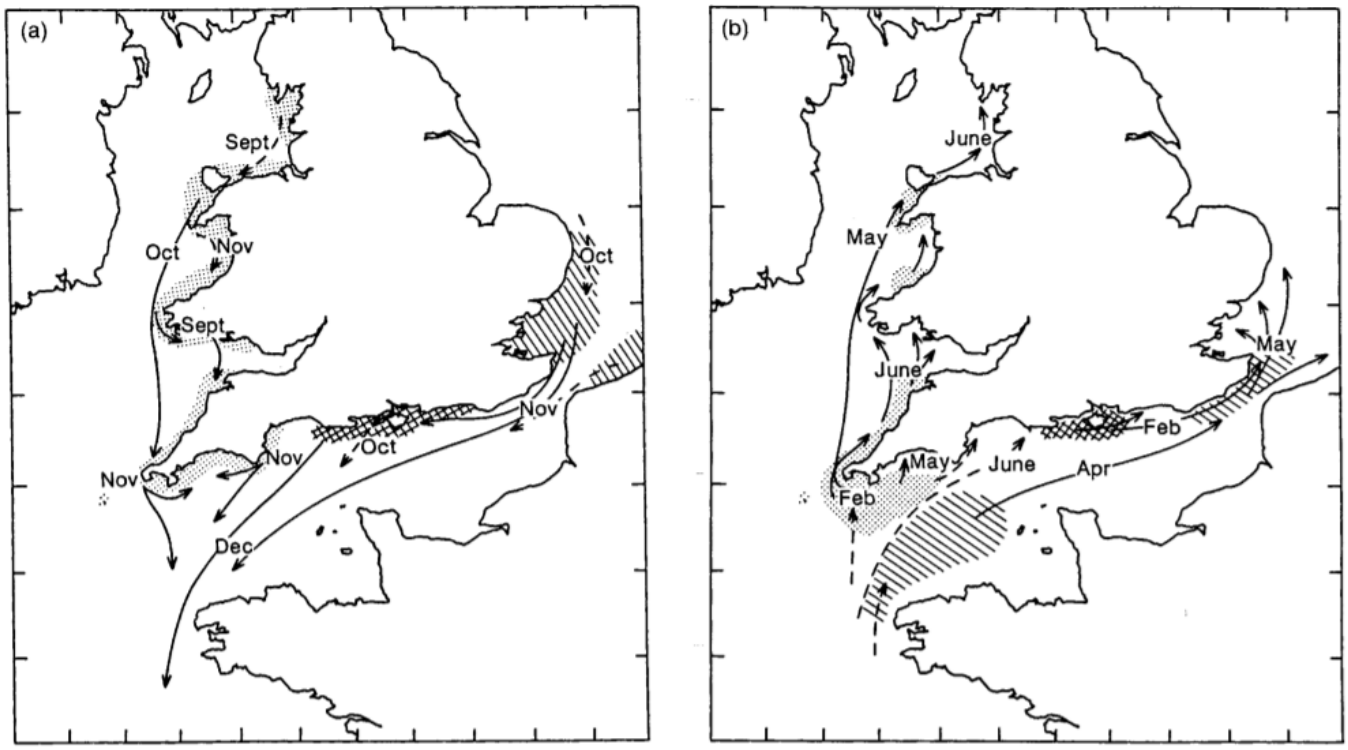

Figure 4 *– Seasonal movements and migrations of adult bass in the three main populations around England and Wales indicated by shaded areas: (a.) Autumn movements from summer feeding areas; (b.) Spring movements from winter spawning areas .(ICES, 2001, http://www.ices.dk/sites/pub/CM%20Doccuments/2001/ACFM/ACFM2501.pdf [unedited])*

Several studies have investigated bass population dynamics and movements in UK waters, including in the Bristol Channel. One such tagging study conducted in the 1980s found that adult bass from around England and Wales migrate offshore to the western English Channel and eastern Celtic Sea to spawn from February to March (see **Figure 4**) (Pawson, Pickett and Kelley, 1987). Once hatched, the hatched larvae from this spawning drift inshore and recruit to estuarine and coastal nursery areas along the south and west coasts of the UK (Reynolds, Lancaster and Pawson, 2003). A separate study from the 1980's found that the inner Bristol Channel and Severn Estuary is an important nursey ground for young-of-the-year sea bass (bass less than one year of age) that begin to move into the estuary in late August and September, reaching peak abundance in September and early November (Claridge and Potter, 1983). These findings have since been reinforced with additional research and there are now multiple nursery grounds for sea bass documented off North Devon (see **Figure 5**). The timing of the arrival of these juvenile fish off North Devon implies they are recruits from spawning stocks in the English Channel and Celtic Sea. Once the sea bass have reached sexual maturity and move out to sea however, they do not always return to their parental stock: there is substantial mixing at this stage throughout large areas of the bass' range (Pawson, Pickett and Kelley, 1987). This means the Bristol Channel indirectly acts an important nursery area for several UK bass spawning stocks, not just those in the English Channel and Celtic Sea.

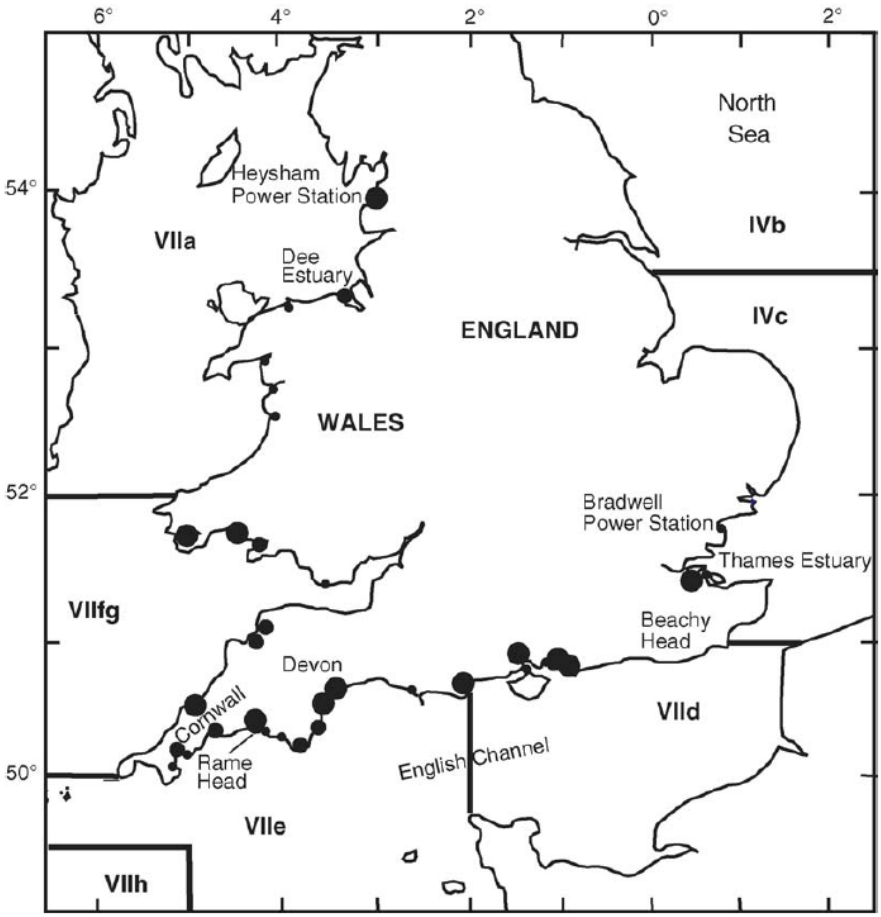

Figure 5 *- Location of 34 bass nursery areas designated by MAFF in 1990 (size of symbol indicates their relative status based on the probable proportional contribution of recruits to the adult bass stock as a whole and the significance of protecting juveniles there in terms of the benefits to local bass fisheries (Pickett et al., 1995, https://www.cefas.co.uk/data-and-publications/publications/search/#/details/12149;f=1;q=An%20appraisal%20of%20the%20UK%20bass%20fishery%20and%20its%20management;h=1;t=An%20appraisal%20of%20the%20UK%20bass%20fishery%20and%20its%20management;j=0;r=;a=1;w=Pickett;p=1 [unedited]).*

Additionally, research has shown that young bass display high site fidelity within their inshore habitats and rarely travel outside these areas in the UK (Green et al., 2012). PhD research in collaboration with D&S IFCA and the University of Plymouth has shown that young sea bass found off North Devon (primarily within the Taw/Torridge estuary, with similar reports from Salcombe Harbour and the Dart estuary in South Devon) show similarly high fidelity and can spend as much as 70 to 80% of their time within a small radius of only a few kilometres (Stamp, 2020) As the bass can live in these habitats for four or five years it means they are extremely vulnerable to local pressures such as overfishing and pollution even before they have matured and have the chance to breed offshore.

During interviews conducted with fishers from North Devon and Somerset, netters from Minehead spoke at length about the large numbers of small, juvenile, and larval fish that could be found in nets just off Minehead (FRMP Interviews, 2020). They are certain the area is used as a breeding ground and nursery area for many species, including bass. There are already two designated and protected bass nursery areas (BNAs) within the English section of the Severn Estuary, and another on the Welsh side (see **Figure 5**), however, the presence of additional, undesignated nursery areas further up the Channel may have significant

implications for the management of bass on a regional level. Indeed, the river Parrett (Somerset) has previously been proposed for designation as a BNA.

Reproduction & Life History

Sea bass have only one spawning event per population per year (Naciri *et al.*, 1999). Mediterranean bass are winter spawners, migrating from inshore feeding grounds to deeper, offshore waters to congregate and spawn from December. Adults from the Atlantic population move offshore in winter before spawning from March to mid-June (Smith, 1990). Temperature is an important cue for the timing and location of bass spawning events, and so is a major factor in bass reproductive dynamics. Sea bass eggs are rarely found in waters cooler than 8.5°C or warmer than 15°C (Pawson, Pickett and Witthames, 2000). Some inshore spawning populations have been recorded (López *et al.*, 2015).

Bass use external fertilisation to reproduce sexually: females lay their eggs before they are fertilised by males whilst in the water. Bass are batch spawners, meaning the females release groups of eggs multiple times during the single annual spawning event (Pickett and Pawson, 1994). During this time, females can produce up to half a million eggs per kilogram of her own bodyweight (Smith, 1990). The eggs are planktonic (meaning they travel via ocean currents, suspended in the water column) and will hatch between four and nine days after fertilisation, depending on temperature. The larvae are only 3mm in length upon hatching but will reach lengths of 10–15mm during this stage of their life cycle (see **Figure 6**). They drift from the open sea towards the coast over the course of two to three months; this is sometimes referred to as the pelagic phase (Cambiè *et al.*, 2015; Beraud *et al.*, 2018). They arrive in slightly more inshore, sheltered, nursery environments such as coastal lagoons and estuaries where they spend the juvenile phase of their life cycle.

Figure 6 *- Larval European sea bass (D. labrax) after 11 (top), 13 (middle) and 15 (bottom) days (Hillewaert, 2012, https://commons.wikimedia.org/wiki/File:Dicentrarchus_labrax_(11d_-_13d_-_15d).jpg [unedited]).*

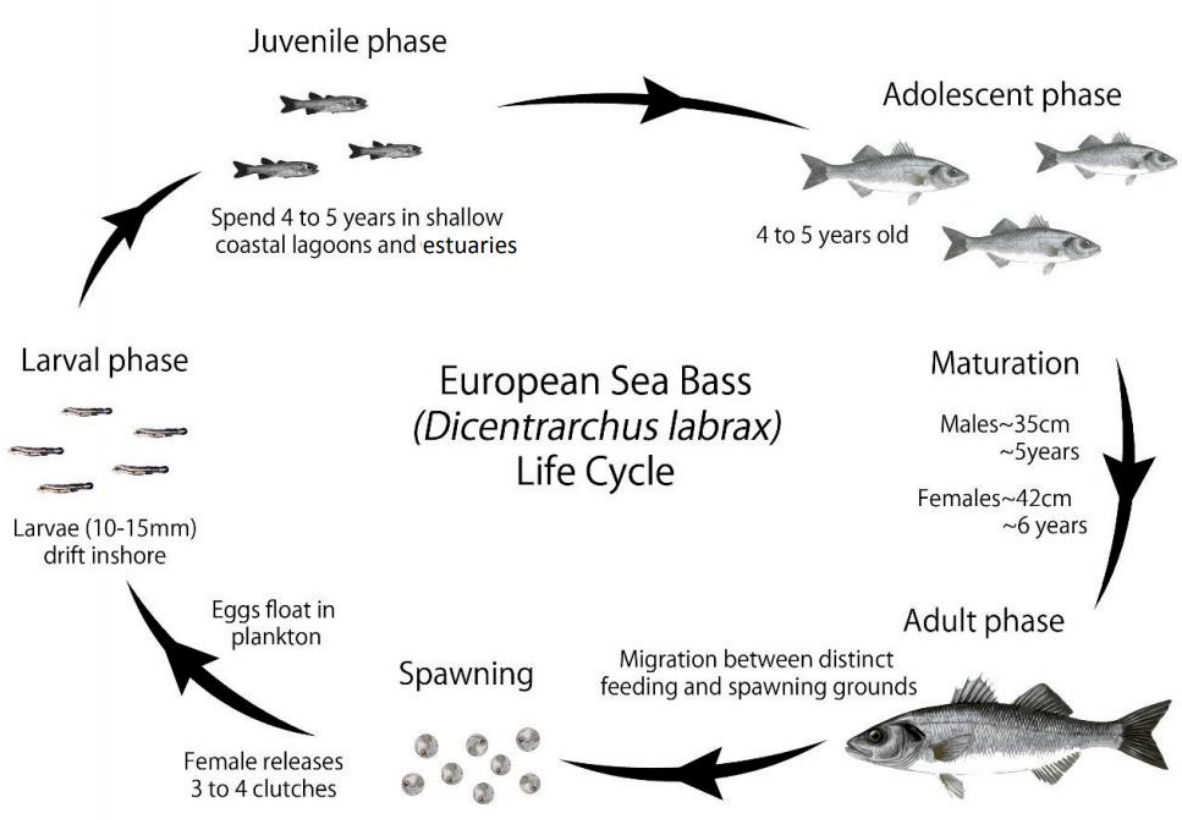

Figure 7 *- Illustration of the European sea bass (D. labrax) life cycle (Carroll, 2014, http://fisheries-conservation.bangor.ac.uk/wales/documents/ThesisCARROLL_ABI_MEP_bass.pdf [unedited]).*

The juvenile phase lasts for four to five years (see **Figure 7**); the bass spend this time feeding and growing in their inshore habitats forming large schools together (Vandeputte, Gagnaire and Allal, 2019). After reaching sexual maturity, adult bass cease their juvenile schooling behaviour, and act less gregariously (Frimodt, 1995). Matured bass will venture offshore, adopt the migratory movements of adults and take part in annual spawning events (Pickett and Pawson, 1994; Pickett, Kelley and Pawson, 2004). Females tend to mature a year later than males and grow to larger sizes. Bass sexual maturity occurs at different ages/ body lengths depending on their sex and population of origin. Atlantic males mature between 30–40cm in length (after four to seven years old), and Atlantic females mature at lengths of 36–46cm (five to eight years old). Meanwhile, Mediterranean male and female bass mature after only two to four and three to five years, respectively (Vázquez and Muñoz-Cueto, 2014). Studies have shown that the amount of time spent exposed to sunlight (photoperiodism) is a major factor in inducing sexual maturity in sea bass (Mañanós, Zanuy and Carrillo, 1997), and light exposure can be manipulated to increase fish yields in bass farms. Sea bass can live up to 30 years and are relatively slow growing, with adults reaching a common size of ~55cm, however, individuals as large as one metre have been caught by recreational fishers (The Fish Society, 2020).

Food Web & Interspecies Interactions

The European sea bass is mostly a night hunter, feeding on shrimp and molluscs, however they have also been observed as schooling predators of crustacea, squid and smaller fish such as herring and sand eels (see **Figure 8**; Vázquez and Muñoz-Cueto, 2014). Due to its

wide distribution across Europe, it is likely that the diet of sea bass varies across the different regions it is found. During their larval stage bass feed on plankton with their diet diversifying as it grows larger and ventures further offshore (Vandeputte, Gagnaire and Allal, 2019). In UK coastal waters, the diet of juvenile and adult sea bass is dominated by crabs of all types, sand eels and smaller crustaceans (prawns/shrimps). Other fish also comprise a substantial proportion of the bass diet, but the species of these fish varies with habitat (Kelley, 1987). Bass sampled in offshore environments were found to favour *clupeids* such as herring, whereas bass in estuarine environments consumed larger proportions of grey mullet and flat fish (Kelley, 1987). Studies on bass in sandy-bottomed habitats in Cornwall showed that, in these environments, sand-eels made up a much larger component of bass diets compared to areas of lower sand-eel abundance (Hester, 1980). This suggests that the European sea bass is an opportunistic predator, and that its diet composition is likely to vary from region to region depending on prey availability. Overall, younger bass feed on invertebrates more often than adults, and feeding on fish rather than invertebrates is more common offshore (Kelley, 1987).

Figure 8 *– Lesser sand eels (Ammodytes tobianus), an important food source for sea bass (D. labrax) in UK waters (Hillewaert, 2013, https://commons.wikimedia.org/wiki/File:Ammodytes_tobianus_(catch).jpg [unedited]).*

Bass are described as “violent,” opportunistic predators and have developed a variety of different hunting techniques to find and catch their prey (Pickett and Pawson, 1994). One such technique is to drive upwards towards the surface at a steep angle, attacking their prey from below. European sea bass are one of the major large predators in continental shelf marine ecosystems, meaning they are rarely predated upon by other organisms (possibly part of their appeal as a recreationally targeted species), though it is likely that younger bass are consumed by other organisms when they are smaller and less formidable (Vázquez and Muñoz-Cueto, 2014). Consequently, heavy exploitations of bass fisheries are unlikely to lead directly to declines of other commercially important species; however, rapid declines of bass may cause changes in ecosystem structure and functions that could indirectly affect a variety of other marine organisms.

Fishery Information & Structure

Sea bass has only been fished on a large, commercial scale since the 1970s; before then it was mostly caught inshore by recreational fishers. Commercial fisheries for bass are more common in the Atlantic and northern parts of its range, and bass aquaculture is more heavily concentrated within the Mediterranean (Vandeputte, Gagnaire and Allal, 2019). Within the Atlantic population of European sea bass, ICES currently describe four main spawning stocks that are exploited by fishers (see **Figure 9**):

- Divisions IVb-c, VIIa & VIId-h, sometimes referred to as the Northern Atlantic stock.
- Divisions VIIIa-b & d, Bay of Biscay.
- Divisions VIIIc & IXa, 'Iberian waters.'
- Divisions VIa & VIIb & j, West Ireland-West Scotland.

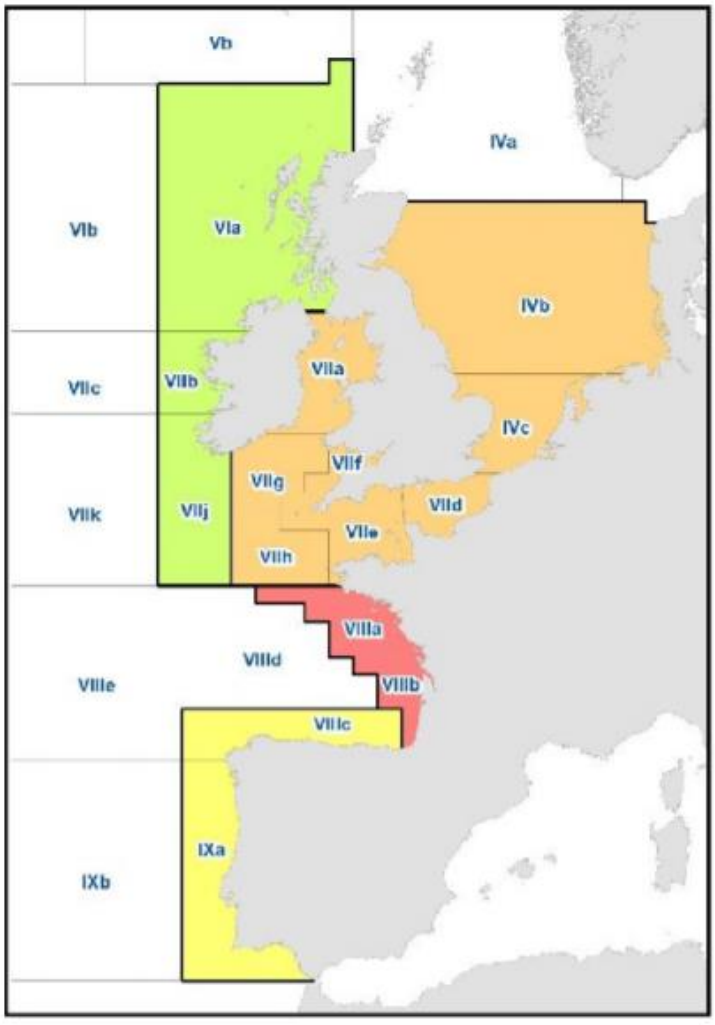

Figure 9 *- The four stocks making up the Atlantic population of European sea bass (D. labrax), as described by ICES (ICES, 2018b, http://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/acom/2018/WGCSE/02_ExSumm_Intro_2018.pdf [unedited]).*

These stocks are exploited by both inshore and offshore fishers, using a range of gear types. Recreational fishers mostly target inshore bass, though charter boat users do venture further offshore to fish for larger, adult bass (Andrews and Pawson, 2013).

Importance & Value of Fishery

European sea bass is an important commercial and recreational species, being exploited by fishing fleets from the UK, France, Spain, Belgium, and the Netherlands (ICES, 2018b). Due to the large commercial and recreational interest in this species from multiple countries, the range of gears used to target it and the different impacts these gears cause, sea bass is politically sensitive at both EU and national levels (Andrews and Pawson, 2013).

On average, European sea bass is the second most expensive commercial species caught in the North East Atlantic. In 2019, the UK fishing fleet landed ~413 tonnes of bass, with a value of over £4.2 million, though annual landings have been as high as 1,000 tonnes in the past (MMO, 2020a). Though this is only a small proportion of the total UK landings value of all species for that year (almost £1 billion), sea bass remains one of the most important commercially caught species in the UK due to its popularity for fish mongers and in restaurants (Blue Marine Foundation, 2014). Part of the appeal of sea bass to commercial fishers is that it is a non-quota species with no allocated total allowable catch (TAC), meaning, historically, the fishery has easy access and availability to new fishers. However, in recent years the fishery has become much more restricted (ICES, 2018b).

Of the ~413 tonnes of sea bass landed in the UK in 2019, 3.1 tonnes were landed in North Devon ports within the NDMP Area, with a value of just below £30,000 (MMO, 2020a). Bass are caught all year round off North Devon (see **Figure 10**) but are only actively targeted during the summer months, given that there are a number of other important, high-value commercial fisheries in operation within the Bristol Channel, the non-quota bass fishery provides a seasonal alternative to fishers to direct effort away from other catch and allow stocks to recover from their fishing efforts. The Bristol Channel trawl fishery for bass has previously sought sustainability certification from the Marine Stewardship Council (MSC), meaning their fishing practices would be monitored and assessed to be non-damaging to the long-term health of the target population and their ecosystem. Certified fisheries such as this can market their fish as MSC standard, providing additional value to their catch. Assessment for certification began in 2009, but was not awarded due to discard and management issues within the fishery (Andrews and Pawson, 2013).

Figure 10 *- Seasonal catch and target species of North Devon fishers (from NDFA, 2020, http://www.northdevonfishermen.co.uk/our-catch [unedited])*

Although thousands of pounds worth of bass are landed within North Devon each year, it is likely that large number fish are potentially being landed and sold without documentation. The majority of the fishing vessels in North Devon are under 10 metres in length and until recently there has been no statutory requirement for fishers using these smaller vessels to declare their catches. Until recently, any landings information was usually collected co-operatively using log sheets and sales notes from ports. In 2005, the UK Government introduced the First-Sale Fish Scheme, which declares that registered buyers must report their purchases of landed fish using sales notes (UK Government, 2020). However, this only applies to individual sales over 30 kilograms in weight, meaning large amounts of bass and other species and may have gone unrecorded if they were sold at a small scale (Masters, 2014). Additionally, MMO landings data do not account for the fish caught by recreational fishers and anglers.

Progress has been made to fill these landings data gaps. Recently the MMO developed and launched the <10 metre vessel catch recording app for use by commercial fishers to aid in mandatory catch data recording, and there are similar options for recording catch for recreational fishers (e.g. Cefas Sea Angling Diary), however, more detail is needed, particularly in a local context to properly understand the impacts of fishing on bass populations.

Figure 11 *- European sea bass caught by recreational angler (Sluijs, 2017, https://commons.wikimedia.org/wiki/File:Peter_van_der_Sluijs_maakte_een_selfie_van_zijn_grote_zeebaars.jpg [unedited]).*

For several decades now, there has been a "rivalry" between recreational and commercial fishers over sea bass due to the popularity of the species within both sectors and their declining numbers in the wild (SOS Campaign, 2018). Sea bass is one of the most popular target species for recreational fishers in both Europe and the UK (Armstrong et al., 2013). The European Anglers Alliance estimates that approximately 2 million sea anglers regularly or occasionally target sea bass in EU waters, with a conservative estimated value to the economy of €100 per bass angler per year (€200 million total per year) (EAA, 2020). In the UK, recreational angling overall is estimated to contribute £1.2 billion to the UK economy per year, supporting over 10,000 full-time jobs across the leisure and tourism industry (MMO, 2020b). Bass is famously one of the most popular species for sea anglers across the UK, including in the South West and North Devon (see **Figure 12** & **Figure 13**). Although the bass caught by these fishers will rarely be sold commercially, they still carry strong non-monetary, cultural and emotional values to those who fish for them, with wild sea bass being described as "priceless and irreplaceable" by some anglers (SOS Campaign, 2018). Sea angling provides physical and mental health benefits to those who practice it, with bass populations directly contributing to this due to its popularity.

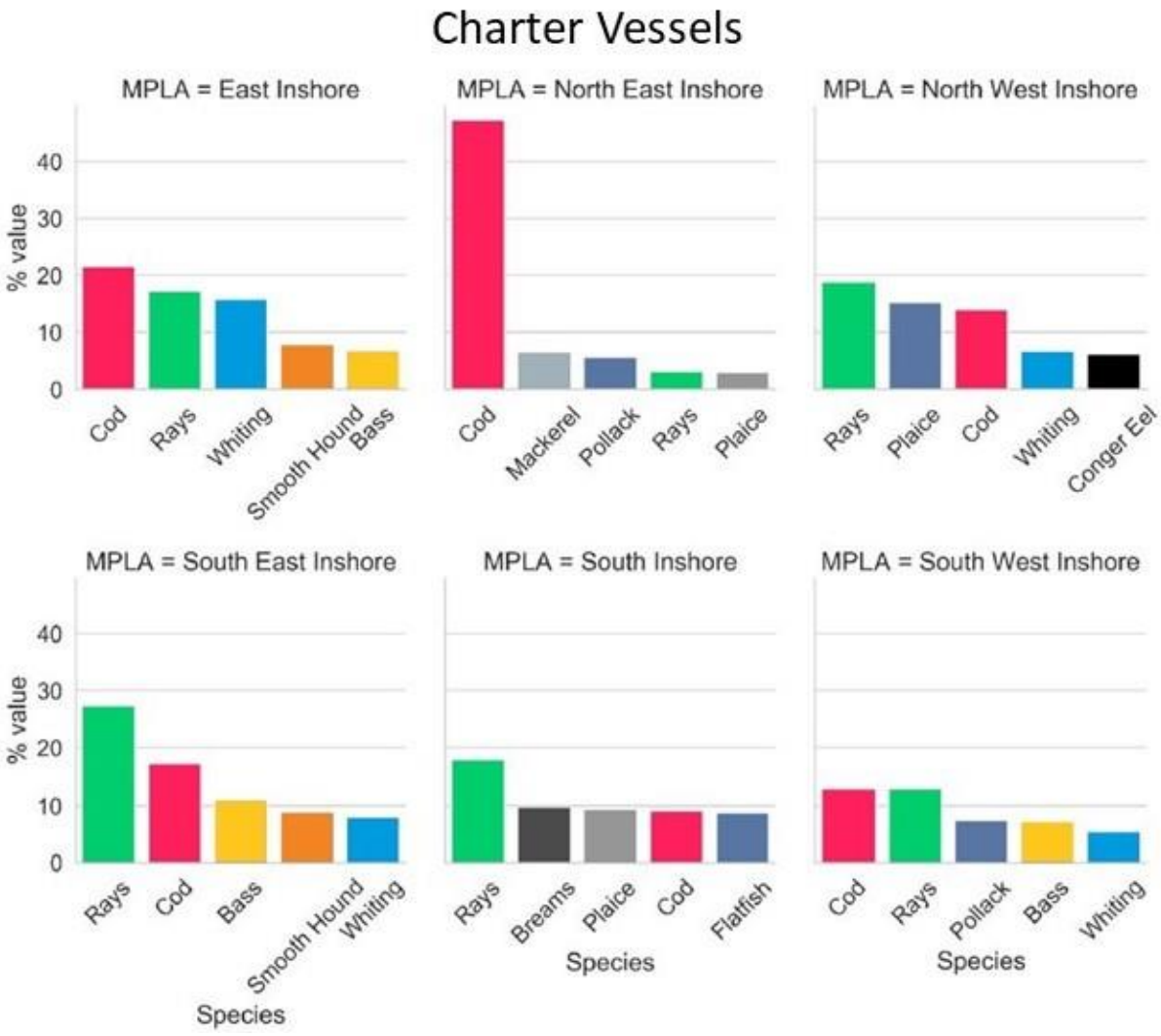

Figure 12 *- Preferred target species of charter vessel users in the UK (MMO, 2020c, https://www.gov.uk/government/publications/mapping-sea-angling-mmo1163 [unedited])*

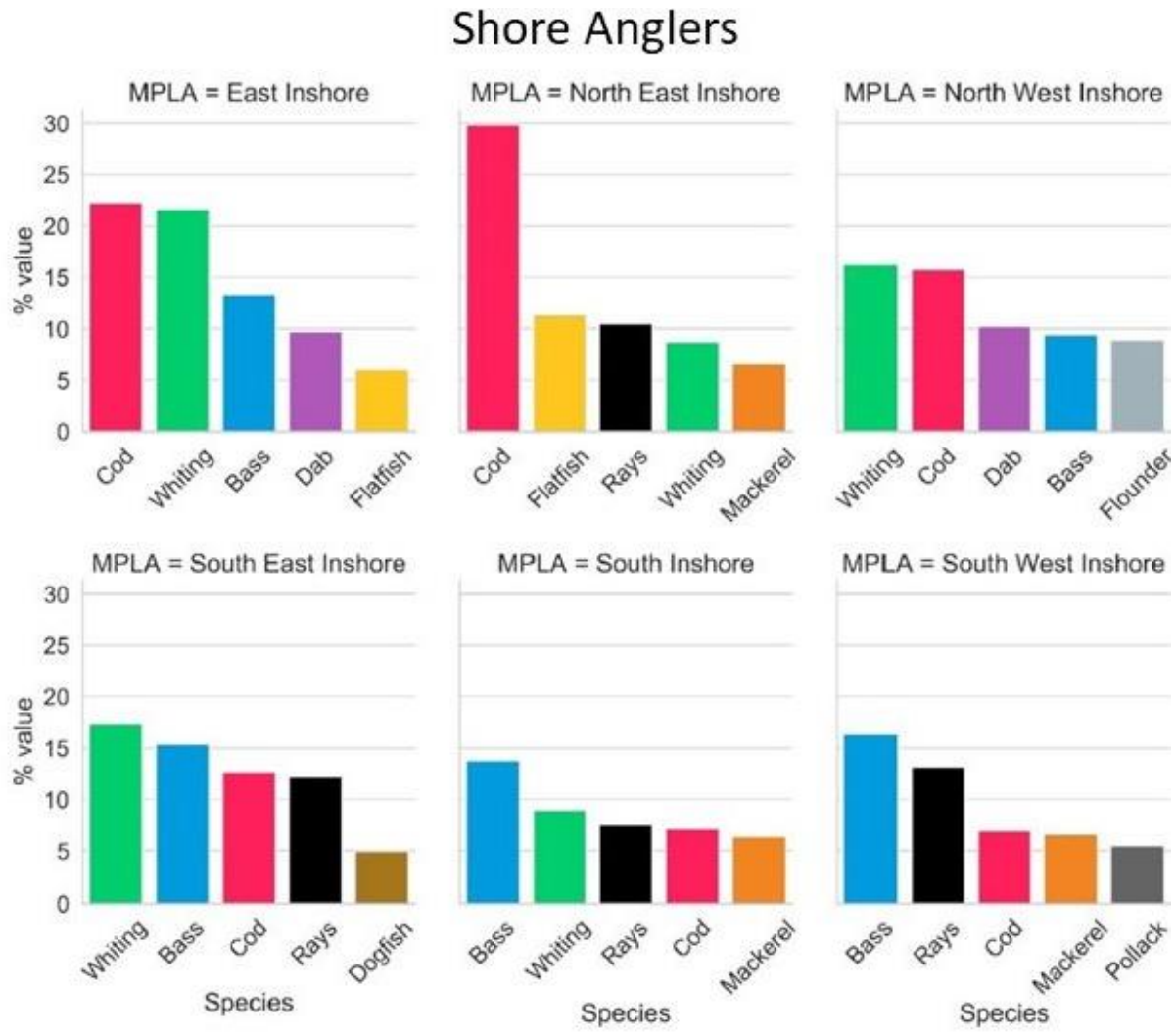

Figure 13 *- Preferred target species of shore anglers within the UK (MMO, 2020c, https://www.gov.uk/government/publications/mapping-sea-angling-mmo1163 [unedited])*

Historical Landings & Changes Over Time

There is evidence for fishing activity in the Bristol Channel and North Devon dating back as far as the Mesolithic era (10,000 BCE to 8,000 BCE), with evidence of lines of stakes thought to be the remains of fish traps being found during excavations around Westward Ho! (Preece, 2008). Due to the regular presence of bass in inshore waters, it is likely that British artisanal fisheries have targeted bass for centuries. There are accounts of bass being fished by hook and line and seine nets from the 1860s in North Devon, though historical landings data are not available (Ibrahim, 2019).

The modern commercial sea bass fishery began to develop in the 1970s (Blue Marine Foundation, 2014); before this time, bass were mainly caught by recreational fishers and a handful of commercial rod and line fishers who targeted bass as a valuable and sought-after table fish. The introduction of “fish finding” sonar as well as monofilament gillnets made species such as bass much easier to catch on a commercial scale (Pawson, Pickett and Smith, 2005). The fishery rapidly developed throughout Europe and, in the 1980s, French mid-water pair trawlers (with British vessels joining the fishery more recently) began targeting adult bass as they moved offshore to spawn in the English Channel and Celtic Sea (Pollard, 2015).

The vulnerability of the inshore juveniles as well as the high prices offered for landed bass caused the fishery to develop rapidly through the 1980s, with international landings fluctuating between one and two thousand tonnes (see **Figure 14**). Commercial landings rose throughout the early 1990s and began to fluctuate after reaching a peak of over 3,000 tonnes in 1996 (ICES, 2019). Landings began to rise again in the early 2000s, with most landings being made from net and line fisheries as well as the English and French pair trawl fisheries. During the development of the fishery, it is thought that bass caught by recreational anglers have comprised a substantial part of the overall landings, with estimates of over 1,000 tonnes being landed in some years throughout the 1980s and 90s (Blue Marine Foundation, 2014).

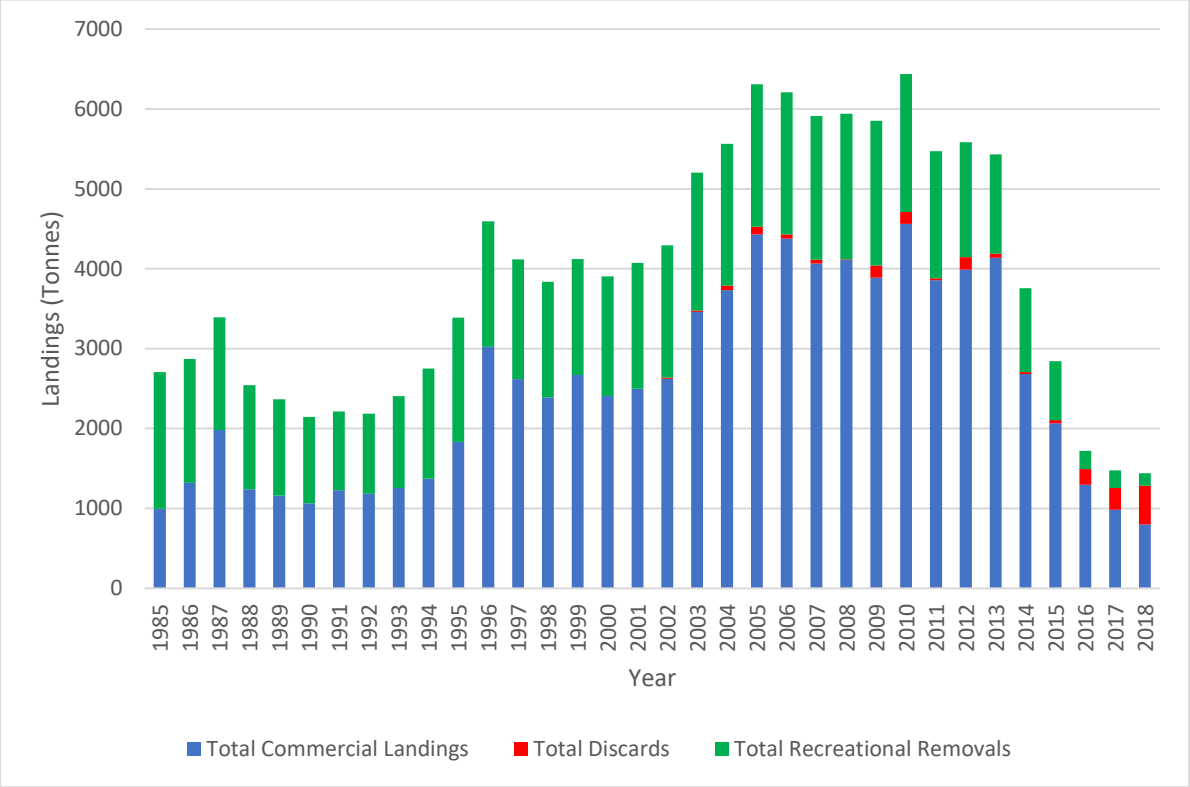

Figure 14 *- International commercial and recreational landings and discards of European sea bass (D. labrax) in the North Atlantic (ICES divisions IVb–c, VIIa, and VIId–h) (ICES, 2020, http://ices.dk/sites/pub/Publication%20Reports/Advice/2020/2020/bss.27.4bc7ad-h.pdf [unedited]).*

Throughout the 1980s, exploitation patterns of sea bass shifted towards younger fish found inshore, as numbers of larger adults being caught offshore began to drop due to overfishing (Pawson, Pickett and Smith, 2005). Towards the late 1980s it was becoming increasingly clear that management measures were required to protect young, inshore bass populations from overfishing; however, this would prove extremely challenging due to the wide range of interests and number of participants in the fishery. Despite this, new management measures affecting recreational and commercial fishers were introduced in 1990 to help lift pressure on inshore bass stocks, leading to increased landings of bass in later years (see **Figure 14**). Landings rose and then began to fluctuate from 2005 with between 4,000 – 4,500 tonnes of bass being landed from the North Atlantic each year (ICES, 2018b). Recreational landings of sea bass had remained at similar levels for decades (between a quarter and half of total landings) until around 2015, when recreational removals declined significantly, most likely as a result of new European Commission management measures designed to protect sea bass stocks.

In more recent years, the spawning stock biomass for the main UK sea bass stock (ICES divisions IVb–c, VIIa, and VIId–h) has been declining and is currently at significantly low levels (ICES, 2019). Landings have shown a similar downwards trend, heightening tensions between the recreational and commercial fishing sectors (British Sea Fishing, 2020). As landings and stocks continued to decline, the EU introduced new emergency management measures in 2015 to try and protect the remaining stock and enhance bass populations.

During engagement with local fishers, both recreational and commercial fishers reported declines in most target species in the Bristol Channel during their time fishing, as long as 50 years for some individuals (FRMP Interviews, 2020; Marine Pioneer Interviews, 2020). Most fishers reported that bass had been abundant in recent years, with 2020 in particular being a "*good year for bass,*" possibly due to a reduction in commercial effort due to the Covid-19 coronavirus pandemic. However, it is not clear if this is in comparison to recent years, or over decades, and the reports may relate to degraded baselines. It is likely that bass populations may have risen slightly recently due to precautionary management, however, the populations may still only be a fraction of the bass once found historically within the Bristol Channel.

Gear Used

In the UK, bass are targeted in different habitats using a range of fishing gears. Generally, the UK bass fisheries can be categorised into three different gear types: (i) nets, (ii) trawls, and (iii) hooks.

Hooks and nets tend to be used in the inshore, coastal fisheries to catch younger bass, whereas trawls are used to catch the larger, adult bass as they travel offshore to aggregate and spawn (Andrews and Pawson, 2013). MMO landings data show that in 2016, 46% of the sea bass landed by the UK fishing fleet was caught using nets, with 37% caught using hooks and the remaining 17% caught in trawls (Williams *et al.*, 2018).

Gill nets (including drift nets) are the most common net types used to catch bass in the UK (see **Figure 15**). A gill net is a single wall of netting, usually deployed anchored to the seabed, that catches fish that swim into it (Seafish, 2020a). Gill nets can be fairly selective when targeting fish: the mesh size of the net dictates which species are more likely to be caught, and they can easily be deployed in different areas to account for local patterns in species abundance (Masters, 2014). In the past, cetacean bycatch has been an issue in gillnet fisheries, however awareness of this problem is now widespread and skippers often fit their nets with acoustic "pingers" to deter cetaceans from getting tangled in the nets, as it is now mandatory in many fisheries (Cosgrove *et al.*, 2007). Although there is minor contact with the sea floor, there is very little habitat damage associated with gill nets as only the foot rope and small anchors touch the seabed, and the gear is not towed at all once placed (Seafish, 2020a).

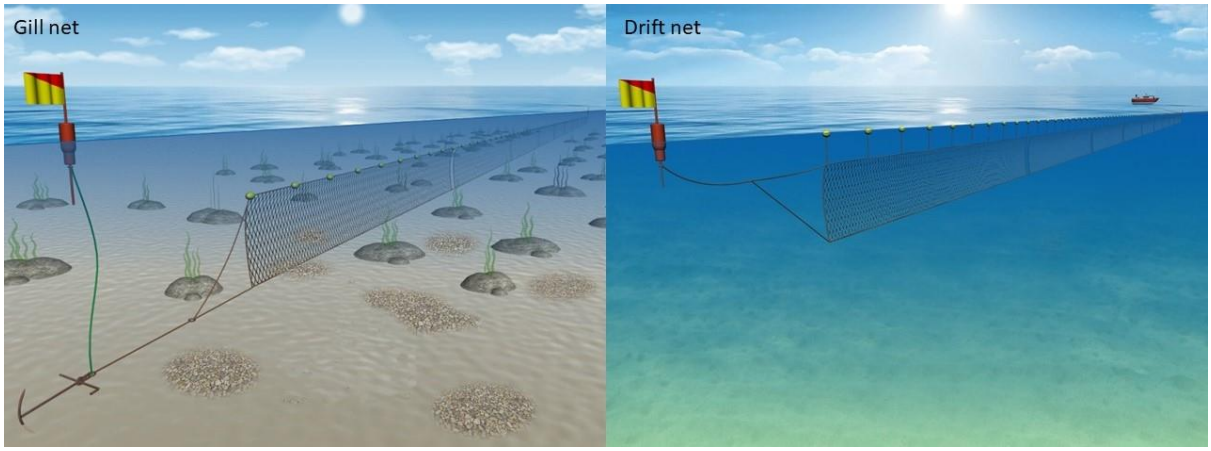

Figure 15 *- Gill (left) and drift netting (right) (Seafish, 2020, https://seafish.org/gear-database/ [unedited]).*

There are various types of gill net, including drift nets (see **Figure 15**). Instead of being anchored to the seabed, drift nets are usually set to catch fish near the surface and so have no contact with the sea floor so cause very little if no damage to the habitats they are deployed above (Masters, 2014).

Another type of net often used to catch bass from the shore is the beach seine (see **Figure 16**). These nets are shot by hand or from a small boat from the shore, extended out to sea in a horseshoe shape and brought back into the beach. They are drawn in from the shore at both ends to catch schooling fish living in coastal shallows (Hahn, Bailey and Ritchie, 2007). This fishing method tends to have little environmental impact due to its small scale. There is contact between the nets and the sea floor, though this leads to beach seines generally being used over sandy substrates, avoiding delicate habitats such as reefs. This fishing method was common in small-scale estuarine fisheries in the UK, though this has largely died out due to declining stocks and management restrictions (Seafish, 2020c).

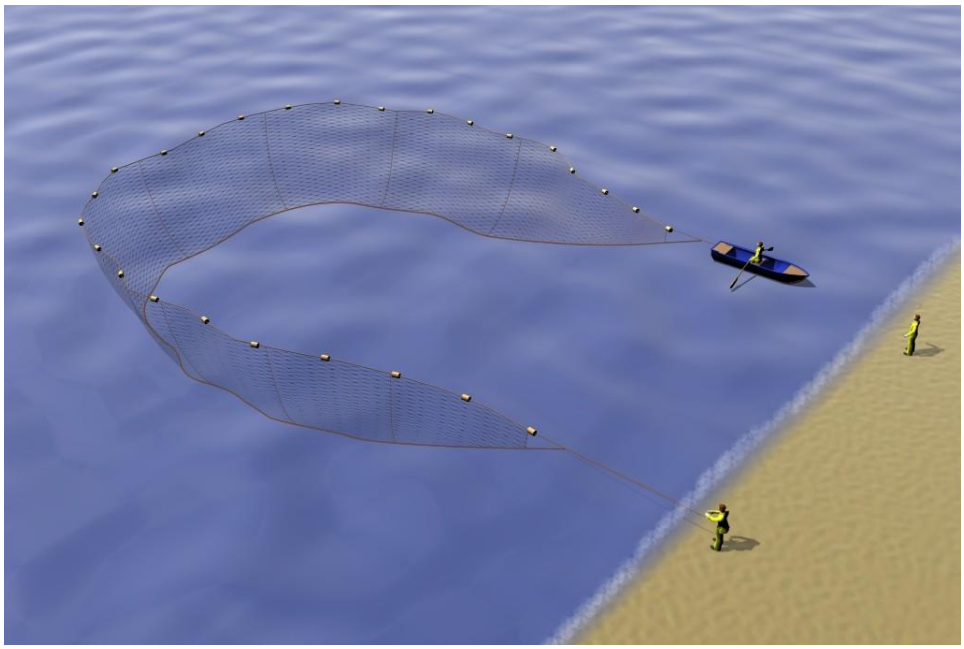

Figure 16 *- Beach seine netting (Seafish, 2020a, https://seafish.org/gear-database/gear/beach-seine/ [unedited]).*

Much of the trawling activity for bass is conducted by English and French pair trawlers in the English Channel (Pawson, Pickett and Smith, 2005), though there are a number of bass trawlers operating off North Devon and in the Bristol Channel (Andrews and Pawson, 2013). Pair trawling requires two boats to tow one trawl between them, targeting pelagic and demersal fish swimming in the water column (see **Figure 17**). Nets can be up to 240 metres wide and 160 metres deep, with the mesh size at the mouth of the trawl sometimes being as deep as 50 metres (Seafish, 2020d).

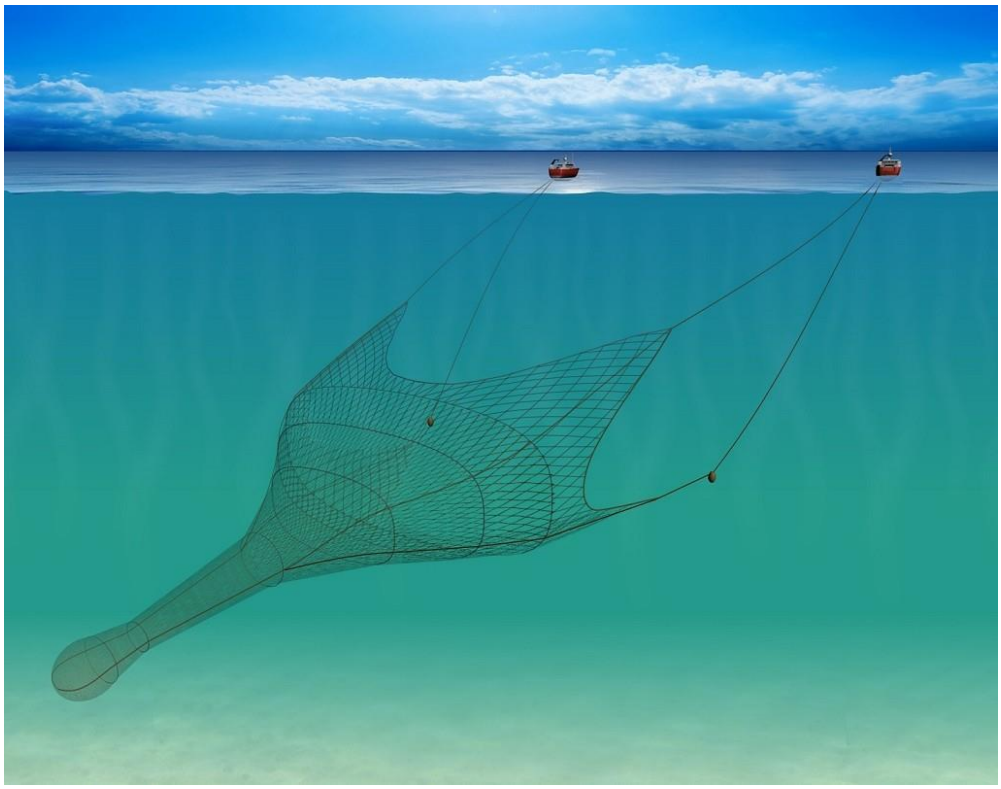

Figure 17 *- Pelagic pair trawl (Seafish, 2020c, https://seafish.org/gear-database/gear/pelagic-pair-trawl/ [unedited]).*

If trawls are towed pelagically there will be little or no contact with the seabed, minimising habitat damage. However, if the gear is towed demersally there will be some significant contact with the seabed, potentially damaging habitats. Because of this, spatial and seasonal restrictions on trawl fisheries are often used by fisheries managers to help protect vulnerable fish stocks and prevent damage to the sea floor. It is important to note that demersal trawling mostly takes place over sand, mud and shingle beds that are already subject to regular disturbance through natural tides and water movement (Seafish, 2020e). However, there is a vast amount of scientific evidence showing regular trawling can be damaging even in these habitats, especially if used for spawning grounds, and that these ecosystems can take years to recover post-disturbance (Hiddink *et al.*, 2017; Sciberras *et al.*, 2018). Studies have shown that different trawl types cause different degrees of damage to the sea floor, and that recovery times vary and can take over five years (Hiddink *et al.*, 2017).

Mesh sizes throughout the trawl can be altered to make fishing more species specific and exclude the capture of undersized fish. Additional equipment on board such as echo sounders and sonar can also be used to distinguish between target species and other fish shoals (Seafish, 2020d). As with other fishing methods, much of the selectivity of this fishing is

dictated by skipper knowledge and experience about where the target species is likely to be at that time of year. Species that undergo seasonal movements and migrations, such as sea bass, can be reliably fished by experienced skippers with knowledge about their annual movements. Previously cetacean bycatch has been seen in some areas; however, protective legislation has been put in place banning fishing methods prone to bycatch such as this (Seafish, 2020d). Gear-based methods to reduce cetacean bycatch in trawls include guiding grids and acoustic deterrents. (De Carlo *et al.*, 2012).

Bass may also be caught on hooks using hand lines or trolling. Trolling involves a vessel towing a line or multiple lines of hooks with natural or artificial bait through the upper layer of the water column (see **Figure 18**). In England, a portion of the inshore fishing fleet use this method to target bass (Seafish, 2020f). Hand lining is possibly the least complex method of fishing, utilising rods (as do recreational anglers), jigs, trolling lines or just a fishing line with baited hooks. Hand liners will land small quantities of fish daily but in pristine condition usually not achievable with other, large-scale fishing methods. Bait selection makes hand lining very species selective, and even if unwanted species are caught, they can be instantly returned to the sea alive, making handlining one of the most environmentally friendly and sustainable fishing methods (Seafish, 2020g).

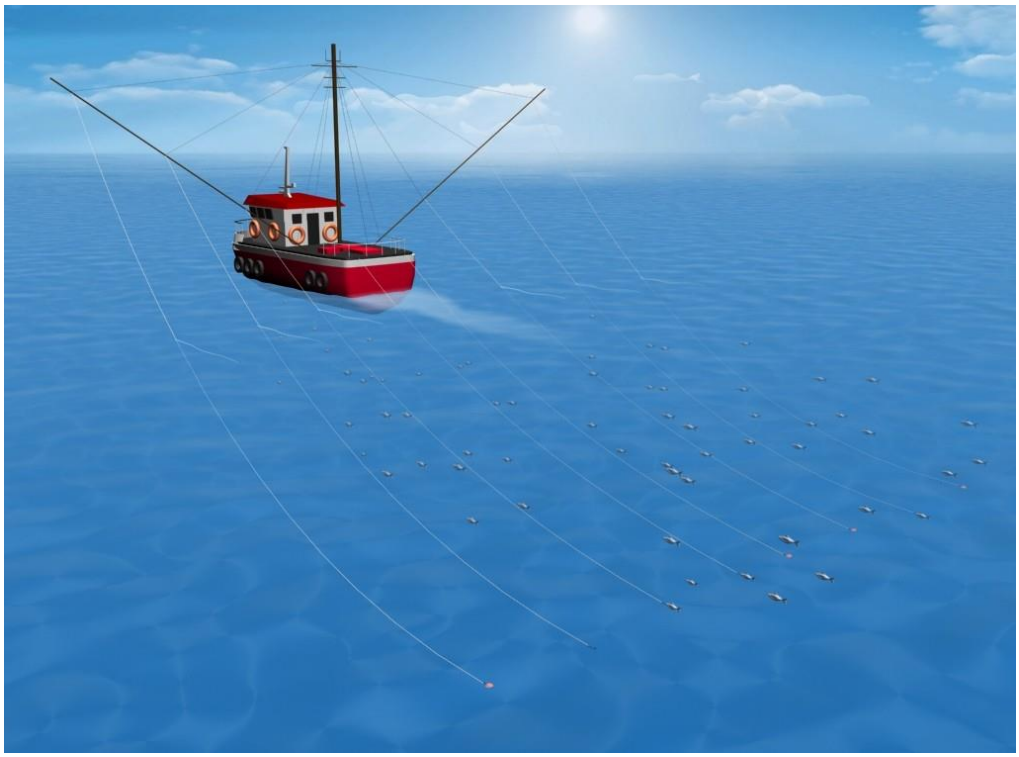

Figure 18 *- A vessel trolling for fish (Seafish, 2020e, https://seafish.org/gear-database/gear/trolling/ [unedited]).*

Due to the increasing importance of food sustainability to the public, the demand for bass caught sustainably by hook and line is increasing. Seafish conducted a preliminary investigation into using lured long lines to catch bass off North Devon using a Clovelly-based vessel (Rush and Caslake, 2009). They found that bass could be successfully caught using this method and a range of lures with minimal environmental impact, with the skipper noting "*this has to be the way we need to go"* when discussing the trial and the future of the bass fishery.

Current Landings & Stock Status

Currently the most important of the four Atlantic bass stocks for UK fisheries is the Northern Atlantic stock (ICES divisions IVb–c, VIIa, and VIId–h, coloured orange in Figure 9). The Northern Atlantic stock has been in rapid decline since 2009 due to combined overfishing and environmental conditions leading to poor recruitment years (see Figure 19). The low spawning stock biomass (SSB) level (below what is known as the MSY Btrigger) has prompted ICES to advise a "cautious approach" to management (ICES, 2020a). This cautious approach is designed to build and maintain a desirable stock size for bass and prevent any further drops in biomass (Degnbol, 2010).

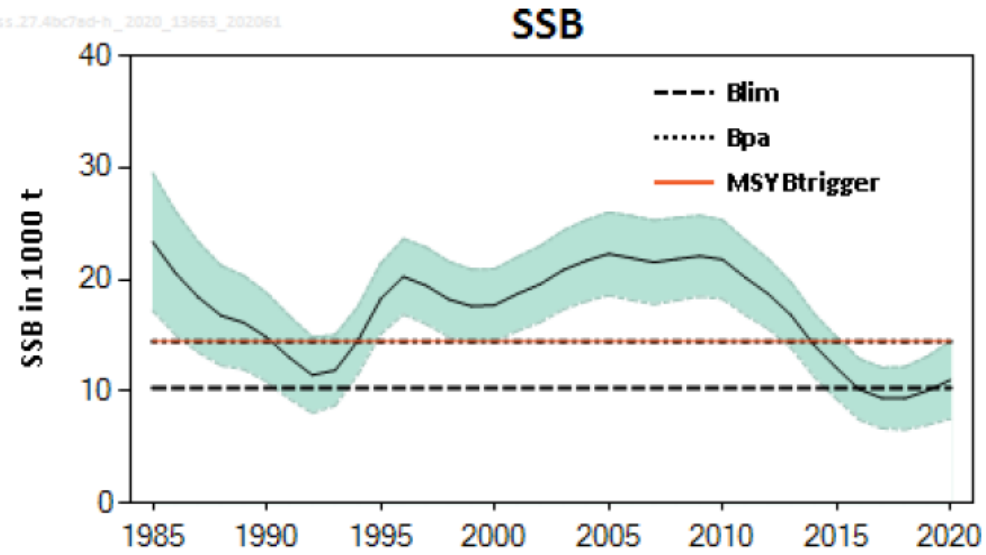

Figure 19 *- Spawning stock biomass of the Northern European sea bass (D. labrax) stock with 95% confidence interval and reference points (ICES, 2020, http://ices.dk/sites/pub/Publication%20Reports/Advice/2020/2020/bss.27.4bc7ad-h.pdf [unedited]).*

Protective legislation put in place since the 1990s has been successful in partially reducing the overall fishing effort directed at the Atlantic stocks of European sea bass, though it remains a highly important commercial fishery (Williams *et al.*, 2018). Current international annual landings from the Northern Atlantic stock (ICES Divisions IVb-c, VIIa & VIId-h) are estimated at ~1,000 tonnes (see **Table 1**). The stock is still commercially exploited by several countries, though the UK is responsible for just under half of all landings. However, France currently catch almost all sea bass landed from the Bay of Biscay stock (ICES Divisions VIIIa-b), making them by far the largest catchers of European sea bass (EUMOFA, 2020).

Table 1 *- Estimated European sea bass (D. labrax) landings from the Atlantic Ocean from 2018 (EUMOFA, 2020, https://www.eumofa.eu/documents/20178/136822/Eumofa_Seabass+Market+study+report_EN.pdf [unedited]).*

Stocks	Divisions 4.b–c, 7.a, and 7.d–h[4] (Northern stock)		Divisions 8.a-b[5] (Southern stock)	
Countries	Commercial landings	Recreational removals[6]	Commercial landings	Recreational removals[7]
BE	18	156	-	720
FR	297		2.204	
NL	165		-	
ES	0		84	
UK	431		-	
IE	-		-	
Total	912	156	2.288	720

There is known uncertainty in the current landings data, particularly regarding those recorded for the UK under-10 metre fleet, as highlighted in the ICES report on the Benchmark Workshop on Sea Bass (ICES, 2018b). When comparing logbook data and the official recorded landings of sea bass, actual landings for the under-10 metre fleet could be as much as three times higher than that officially reported, meaning fishing effort, particularly for the inshore fishing fleet is most likely being underestimated. In 2005, the UK Government introduced the First-Sale Fish Scheme, which declares that registered buyers must report their purchases of landed fish using sales notes (UK Government, 2020). However, this only applies to individual sales over 30 kilograms in weight, meaning large amounts of bass and other species and may go unrecorded if they are sold at a small scale (Masters, 2014). Additionally, MMO landings data do not account for the fish caught by recreational fishers and anglers. More detailed data are needed regarding the true amounts of bass being caught in North Devon and the rest of the UK in order to enable effective management of the fishery.

Current bass mortality due to fishing and current landings are at sustainable levels, but poor recruitment is preventing recovery of the stock, with the SSB fluctuating without trend since 2008 (ICES, 2020a). ICES have advised that the current catch limits should continue to ensure sustainable exploitation of the stock in the long-term. These limits are part of the EU's multiannual plan for western fish stocks and are different to TACs that operate as part of the Common Fisheries Policy (Council of the European Union, 2019). The Bay of Biscay stock has also been heavily fished in recent years, mostly by French trawling vessels. However, it has not experienced as severe declines in bass populations as the northern stock (Biseau, Le Goff and Drogou, 2016). There is little to no data relating to the "Iberian" bass stocks and there has been a moratorium on commercial sea bass fishing in Ireland since 1990, meaning the Irish/Scottish bass stocks are mostly unexploited by commercial fisheries with the exception of a handful of French vessels (ICES, 2018a).

Removals of fish due to recreational fisheries are usually extremely difficult to accurately assess, however, due to its importance to both recreational and commercial fishers, there have been some attempts to investigate and quantify this for European sea bass stocks. Recreational removals were estimated at 156 tonnes for the Northern Atlantic stock and 720 tonnes for the Bay of Biscay stock in 2018 (see **Table 1**); however, in previous years, recreational removals have been estimated to be as high as 440 tonnes for the UK and in the thousands of tonnes for France (EUMOFA, 2020). Recreational catches of sea bass have comprised up to 25% of the total UK catch in the past (Armstrong *et al.*, 2013; Radford *et al.*,

2018). Recreational effort will most likely remain at similar levels through the years; however, removals from bass stocks will be greatly affected by compliance with management measures such as bag limits and netting bans.

UK landings have steadily decreased in the last five years, mirroring the population status of the Northern stock, with landings decreasing by over 250% (see **Figure 20 & Figure 21**).

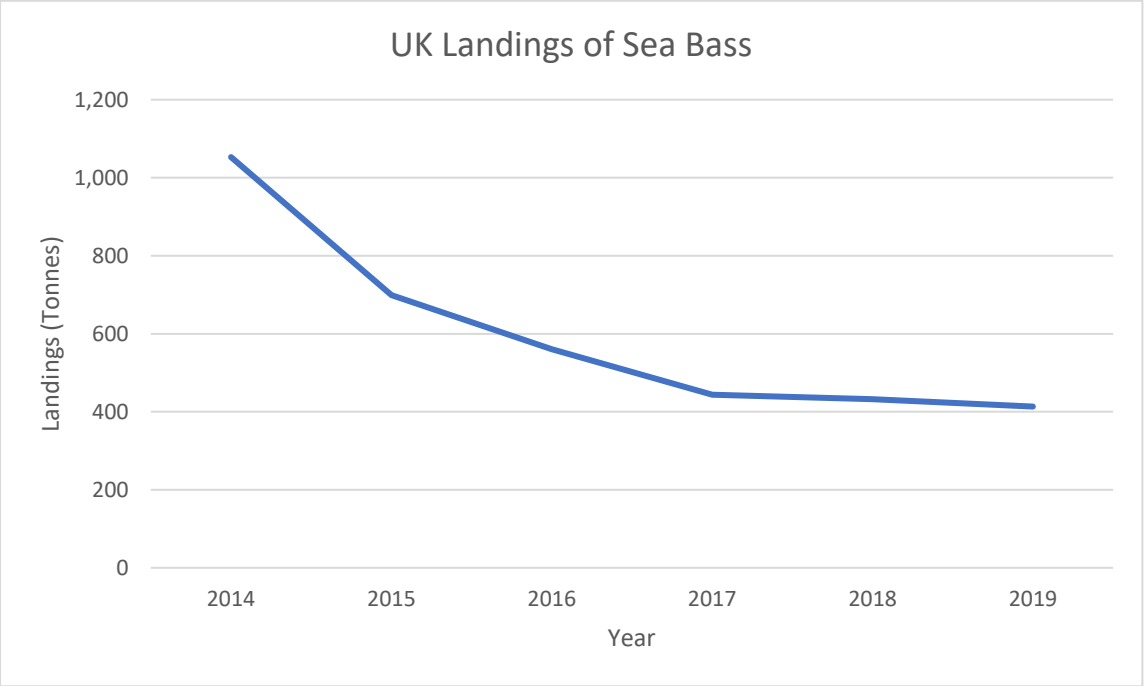

Figure 20 *– Annual landings of European sea bass into UK ports (D. labrax) (MMO, 2020a).*

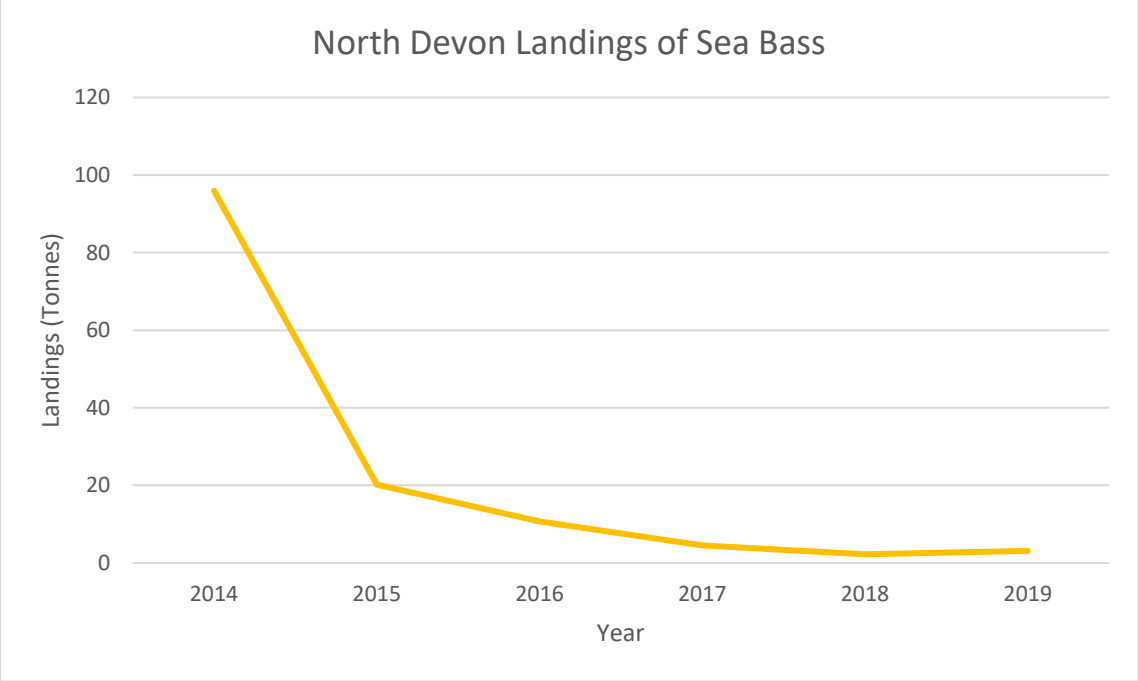

Figure 21 *- Annual landings of European sea bass (D. labrax) into North Devon ports (MMO, 2020a).*

Although the stock size has declined substantially, the drop in landings is thought to be due to precautionary management implemented in 2015 by the European Commission to help

relieve fishing pressure and rebuild the bass stocks (ICES, 2018b). Restrictions are unlikely to be lifted until the stock experiences better recruitment and recovers significantly, assuming sustainable exploitation of the fishery continues. Similar large decreases in bass landings have been observed in North Devon ports, with landings value decreasing by hundreds of thousands of pounds since the 2015 management measures were implemented and the fishery restricted (MMO, 2020a).

Fishery Management

The management measures laid out in the following section have been summarised for the sake of this management plan and were accurate at time of publication. For full details of management regulations, please seek out the original legislation at either the EU-Lex, Legislation.gov or the D&S IFCA websites.

Measures are often reviewed as more evidence becomes available; D&S IFCA recommends checking online for the most up to date bass management measures, including at https://www.devonandsevernifca.gov.uk/Enforcement-Legislation/Bass-Compliance-Direction

European sea bass is managed under the EU Common Fisheries Policy, with regulations and restrictions implemented across all member states (Biseau, Le Goff and Drogou, 2016). In addition to any measures implemented by the EU, many countries have national regulations in place regarding fishing for sea bass. Many of the regulations put in place regarding sea bass have been in place for years, for example, the minimum conservation reference size (MCRS) was changed to 42cm in 2015 and has stayed in place ever since. However, some regulations are changed from year to year depending on stock health, such as the number of fish recreational fishers can keep after catching them (bag limit).

Since the UK's departure from the EU, and the coming into force of the Fisheries Act and related legislation, the British fishing fleet is not subject to EU regulations while operating in British waters, though many of the regulations brought in through the European Commission are still present in UK law (e.g., the landing obligation). The EU-UK Trade and Cooperation Agreement allows the UK to establish its own regulations for fisheries, as provided for by the UK Fisheries Act, and will not be bound to the EU's CFP rules. This ability to deviate from the CFP and establish regulations that can be more responsive and specific to the situation in UK waters has long been an important issue for UK policymakers and the fishing industry.

Marine activities in England are regulated by the Marine Management Organisation (MMO), who are responsible for managing fishing fleets, quotas and fighting illegal, unregulated, and unreported fishing. English inshore and regional fisheries are managed by the Inshore Fisheries and Conservation Authorities (IFCAs); IFCAs are responsible for enforcing national and EU-derived fishing legislation as well as ensuring local fishery exploitation remains sustainable through the implementation of byelaws in their regional districts.

As previously mentioned, sea bass has not previously been subject to a total allowable catch (TAC) or quota; there have been attempts to establish a TAC through the EU in the past – most recently in 2014 – but agreements could not be reached between nations, resulting in sea bass remaining a non-quota species (ICES, 2018b). The regulations for commercial and recreational fishing for bass have a long and complex history (see **Appendices**).

The following section of this FRMP summarises the management measures currently in place:

Management Measures Currently in Place

The measures outlined in this section are correct as of January 2021. Measures are often reviewed as more evidence becomes available; D&S IFCA recommends checking online for the most up to date management measures, including at https://www.devonandsevernifca.gov.uk/Enforcement-Legislation/Bass-Compliance-Direction.

Commercial vessels must be authorised to catch and land sea bass in Northern Europe, this is currently managed by the MMO for UK vessels and authorisations are distributed based on vessels past landings of sea bass (MMO, 2020c). Currently, under EU and UK law (Council of the European Union, 2020), it is prohibited for vessels to catch sea bass in certain areas of

European waters (see **Table 2**), regardless of whether they are authorised to catch sea bass or not.

***Table 2** - Areas fishers are currently prohibited from fishing for sea bass.*

Sea area	International Council for the Exploration of the Sea (ICES) Division
South West Approaches	ICES VIIb, VIIc, VIIj and VIIk
Irish or Celtic Sea	Outside the 12 nautical mile limit of UK waters in ICES VIIg and VIIa

Fishing for sea bass in the areas outlined in **Table 3** is permitted (assuming the vessel has been issued with the correct authorisation), with the exception of a closed season during February and March (Council of the European Union, 2020):

***Table 3** - Areas authorised commercial fishers can target sea bass in January and from April to December.*

Sea area	International Council for the Exploration of the Sea (ICES) Division
North Sea	IVb, IVc
Channel	VIId, VIIe
Celtic Sea	VIIf, VIIg*
Irish Sea	VIIa*
South West Approaches	VIIh

(*Inside UK 12nm limit only)

Within the areas outlined in **Table 3**, there are additional gear and catch restrictions in place to prevent overfishing and allow population recovery (see **Table 4**). In addition to these commercial restrictions, recreational fishers are not permitted to fish for sea bass using fixed nets, and are restricted to catch and release fishing during December, January and February, with a bag limit of two sea bass per fisher per day from March to November (Council of the European Union, 2020).

***Table 4** - Sea bass gear and catch restrictions currently in place.*

	Demersal Trawls	Demersal Seines	Hooks and Lines	Fixed Gillnets Nets	All other gears (including drift nets)	Commercial shore fisheries
Fishery Restrictions	Closed February and March	Closed February and March	Closed February and March	Closed February and March	All bass catches prohibited	All bass catches prohibited
Maximum catch limit	Maximum 5% by weight of all marine organisms per day. Unavoidable by-catch of 520kg per two consecutive calendar months	Maximum 5% by weight of all marine organisms per day. Unavoidable by-catch of 520kg per two consecutive calendar months	5.7 tonnes per year	Unavoidable by-catch of 1.4 tonnes per year	All bass catches prohibited	All bass catches prohibited

Many of the national management measures in place for sea bass reflect EU legislation, such as the current MCRS of 42cm (Council of the European Union, 2015). However, one of the

most significant national management measures for sea bass came with the designation and protection of the 34 bass nursey areas (BNAs) in 1990 (UK Government, 1990), later updated in 1999 (UK Government, 1999). Eight of these BNAs are found within D&S IFCAs District, two of which are in North Devon within the NDMP Area (see **Figure 22**). Under national law it is illegal to fish for any species of fish, including sea bass, using sand eels as bait, by any fishing boat within any part of the River Taw and River Torridge Bass Nursery Areas between 30th April and 1st November (UK Government, 1999).

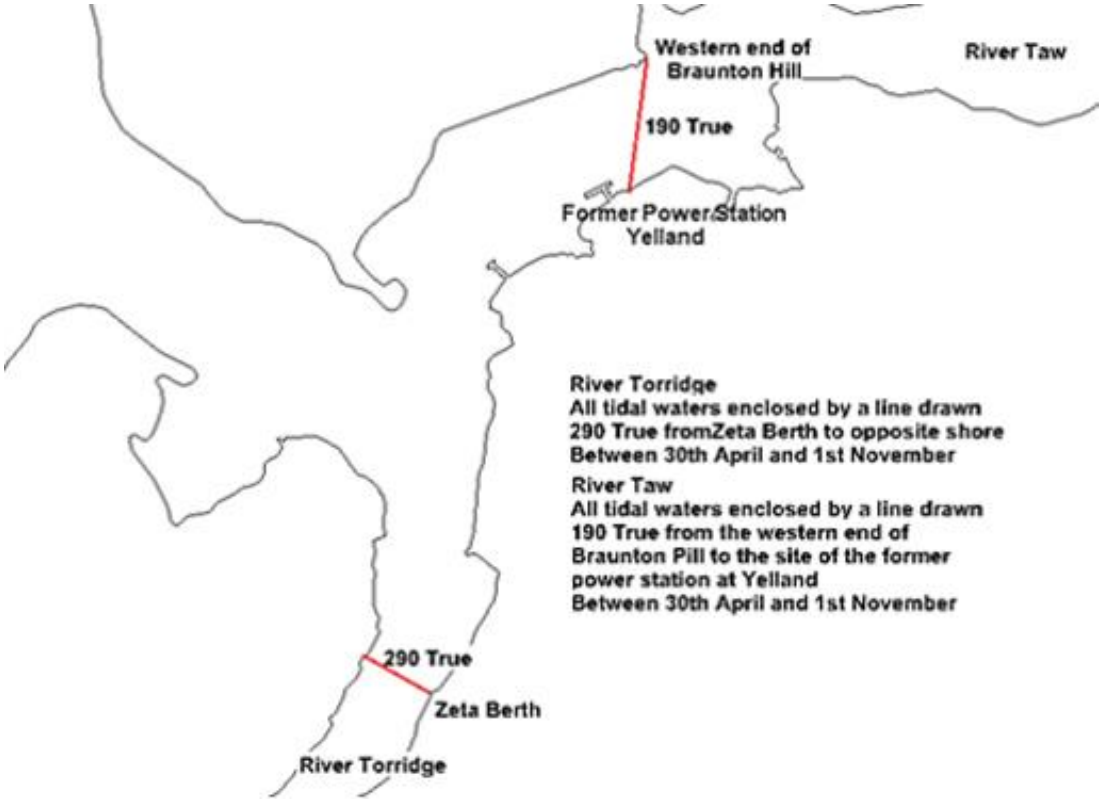

Figure 22 *- Designated bass nursey areas in the Taw-Torridge Estuary (D&S IFCA, 2020, https://www.devonandsevernifca.gov.uk/Enforcement-Legislation/Bass-Compliance-Direction [unedited]).*

During the reformation of the EU's Common Fisheries Policy in 2012, one of the main changes made was to cut down on the amount of discarding (the practice of throwing unwanted catch over the side while at sea). Previously, vessels that caught undersized fish or fish for which they held no quota would discard them before returning to port as landing them would be illegal. The minimum landing size (MLS) system, previously used to define undersized fish, has been replaced with the Minimum Conservation Reference Size (MCRS). Fish below MCRS cannot be sold for direct human consumption (at higher prices), and therefore gives incentive to fishers to catch in-size fish, while also ensuring undersized fish are not wasted or discarded. As of January 2019, all catches of regulated species must be landed, though with some exceptions, one of which is European sea bass. Bass is a non-quota species managed using landings limits, and as such is not subject to the landing obligation (MMO, 2020d), meaning any bass caught in breach of landings limits or without authorisation must be returned to the sea as soon as possible. The aim of this is to reduce unnecessary mortality to stocks, however, many fishers argue that returning caught bass is wasteful, because discarded fish die before or shortly after being put back in the water as opposed to being landed and sold (FRMP Interviews, 2020).

In addition to these EU and national regulations, fishers targeting sea bass within the NDMP Area also have to comply with local IFCA regulations. IFCAs each have a set of byelaws in place regulating the fishing effort and gear in their Districts. Fishers targetting bass in North Devon need to comply with regulations set out in both the Netting Permit Byelaw and Mobile Fishing Permit Byelaw established by D&S IFCA, most recently revised in 2018. These byelaws regulate inshore fishing throughout the District by placing catch, gear, temporal and spatial restrictions on fishers (outlined in **Table 5**) to manage fisheries effectively and sustainably. As well as these gear-specific byelaws, D&S IFCA has additional byelaws in place that were inherited from Devon Sea Fisheries and the Environment agency, described in the IFCA 'byelaw booklet.'

Available at: https://www.devonandsevernifca.gov.uk/Enforcement-Legislation/D-S-IFCA-Byelaw-Book-and-Minimum-Conservation-Reference-Size-List

***Table 5** - Fishing restrictions currently in place affecting European sea bass fisheries as part of D&S IFCA byelaws.*

Regulation Type	Gear	Restrictions	Permit Byelaws
Catch	All	Minimum size of sea bass of 42cm (tip of snout to tail), in line with EU and national legislation	Netting, Mobile Fishing and Potting
Gear	Netting	Nets must be marked with floating markers displaying port, vessel and permit details as well as fixed with tags when required by the authority	Netting
		Nets with mesh sizes between 71 and 89mm are prohibited	Netting
	Seine netting	When using authorised seine nets, permit holders must remain with the net for the full time of deployment as well as deploy and haul the net in one continuous action	Netting
	Drift netting	When using authorised drift nets, permit holders must remain within 100 metres of the net for the full time of deployment	Netting
	-	The storing of crabs, lobsters, scallops, or bass in containers within the sea or estuaries is prohibited	Netting
Spatial	Netting	In the North Devon estuaries (defined in Annex 2), fishers are not permitted to use any nets other than seine and providing that they are no longer than 20 metres in length, all species other than sand eel are returned to the water and that the mesh size is no greater than 20mm	Netting, Netting Annex 2
	Netting	Only a single net, no longer than 25 metres may be used by recreational permit holders in the seaward areas defined in Annex 2	Netting, Netting Annex 2
	Netting	In the Annex 3 coastal areas, use of a net is only authorised when the headline of the fixed net is set at least 3 metres below the water's surface, and if the net used is a drift or seine net	Netting, Netting Annex 3

	Netting	In the areas off Lundy Island (defined in Annex 4) no netting of any kind is authorised	Netting, Netting Annex 4
	Netting	The use of fixed nets is prohibited in the Somerset areas (defined in Annex 5) unless in accordance with temporal restrictions in the netting byelaw	Netting, Netting Annex 5
	Demersal mobile gear	In the Lundy SAC and MCZ (defined in Annex 1) the use of demersal fishing gear is prohibited except for the authorised use of demersal trawl gear in the areas outlined in Annex 1a and the authorised use of demersal scallop gear in the areas defined in Annex 1b	Mobile Fishing, Mobile Fishing Annex 1, 1a and 1b
	Demersal mobile gear	In the Severn Estuary SAC (defined in Annex 6) the use of demersal mobile fishing gear is prohibited	Mobile Fishing, Mobile Fishing Annex 6
Temporal	Fixed nets	The use of fixed nets is authorised in the Somerset areas (defined in Annex 5) between 30th September and 1st April	Netting, Netting Annex 5

Many of the restrictions laid out in Devon & Severn IFCAs netting permit byelaw were previously in place as part of older byelaws, however some were implemented to support the National Salmon and Sea Trout Protection Byelaws. For example, the netting bans in the certain estuaries across the District were implemented to protect migrating populations of salmon and sea trout (Environment Agency, 2018), however these regulations affect other netting fisheries in the area such as bass and herring.

The IFCAs are also responsible for managing recreational fisheries within their Districts, meaning recreational netting for bass in the Bristol Channel is regulated by Devon & Severn IFCA's Netting Permit Byelaw and the Byelaw Booklet. As part of these regulations, the Netting Permit Byelaw states that recreational netters may only use nets no greater than 25 metres in length when catching fish in the IFCA District. There are also additional restrictions on netting fisheries (commercial and recreational) in estuaries within the District, meaning that only short seine nets (20 metres or less) can be used to catch sand eels within designated estuarine areas, with all other species caught being immediately returned to the sea. There are several of these designated areas along the north coast of the IFCA District, including a large area of the upper Severn Estuary (see **Figure 23**).

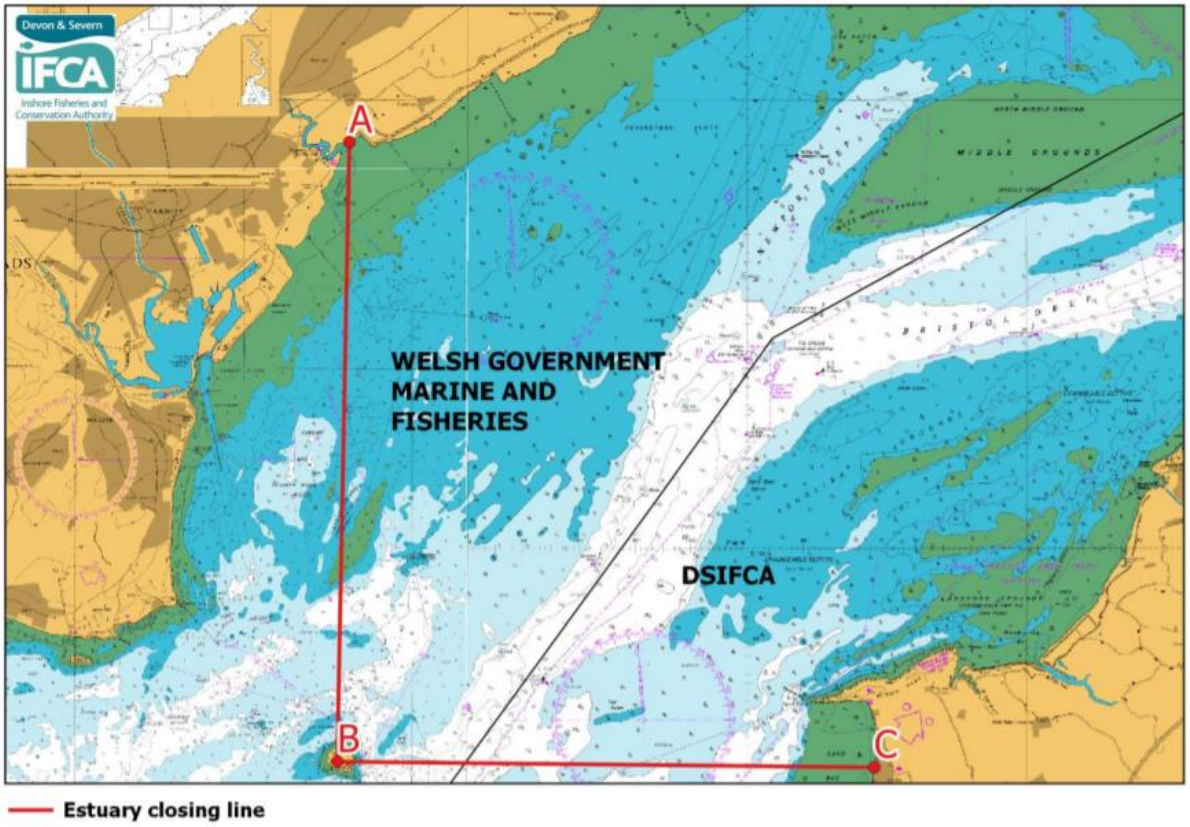

Figure 23 *- Chart of Severn Estuary closing line from Annex 2 of D&S IFCA Netting Permit Byelaw, permit holders may only use a seine net, no longer than 20 metres, to catch only sand eels within the shown area (Devon & Severn IFCA, 2020b, https://www.devonandsevernifca.gov.uk/Enforcement-Legislation/Current-Permit-Byelaws-Permit-Conditions [unedited]).*

Risks & Threats

Conservation Status

At present, European sea bass is listed as a species of least concern on the IUCN Red List, despite their populations having decreased dramatically in recent decades (Pollard, 2015). The main threats to sea bass in Europe stem from commercial and recreational fishing as well as aquaculture farming, particularly following large expansions of commercial fisheries in the 1980s. The recent stock declines are thought to be a result of both overfishing and consecutive years of poor recruitment. Management measures brought in to protect decreasing bass populations has restricted the catch of both commercial and recreational fishers, causing a lot of backlash, particularly with the recreational fishing sector.

Threats to Species & Ecosystem

Overfishing

Historically the greatest threat to European sea bass populations has been overfishing, perhaps enabled by ineffective management. The absence of a TAC limit for sea bass led to increased fishing pressure on the stock as fishers without quota for other species shifted their efforts to the sea bass fishery. Many small-scale fishers have difficulty acquiring quota for commercially important species and so are faced with either leaving the industry or focusing their effort on non-quota species, such as sea bass (Williams *et al.*, 2018). It is likely the inability of EU member states to agree on a TAC for sea bass was a key contributing factor to the stock declines from 2010 onwards, as it prevented more effective management in the years before emergency measures were needed in 2015. Prior to these emergency management measures, the established minimum landing size (MLS) allowed capture of immature bass that were unable to breed (recruitment overfishing), and heavy fishing of the spawning stocks during winter breeding aggregations was unmanaged (ICES, 2018b). During the decline of the North Atlantic stock, scientific advice from ICES was consistently ignored by policy makers, resulting in the need for more stringent measures each year as the stock declined until 2015 (Williams *et al.*, 2018). However, since the establishment of recent management measures, ICES surveys indicate that the Northern Atlantic sea bass stock is currently being exploited at sustainable levels (ICES, 2020a). It is essential that fishing effort does not rise above sustainable levels in the future, especially while the stock continues to remain at low levels due to several consecutive years of poor recruitment (ICES, 2020a).

In addition to commercial fishing fleets, bass is heavily sought after by recreational fishers, with 26% of all bass fishing mortality in ICES Divisions IV – VII being from recreational fishers (Radford *et al.*, 2018). These recreational fishers utilise a variety of gear types, meaning bass may be vulnerable to overfishing in a variety of habitats throughout its lifecycle. In order to effectively manage bass stocks, future management will need to continue to regulate both commercial and recreational fisheries, as both are significant sources of bass mortality.

Demersal Fishing

Demersal and pelagic trawls are among the most common methods of fishing for bass. Demersal trawls can be damaging to some marine environments, particularly when the area is trawled often (Jennings et al., 2002). Contact between the trawls and the seabed can damage benthic habitats, reduce the abundance of target and non-target species and truncate age and size distributions (Kaiser et al., 2006; Jorgensen et al., 2007). A vast amount of

research has shown that trawling can greatly alter the dynamics of ecosystems, for example, by reducing the abundance of large predators, trawling can indirectly increase the abundance of small and fast-growing species that can recover quickly from disturbance (Tillin et al., 2006). Trawling can also increase the availability of organic matter (in the form of more dead or injured animals) to scavengers and bottom feeders and decrease the feeding efficiency of filter feeders by resuspending sediment from the sea floor (Bradshaw, Collins and Brand, 2003; Howarth et al., 2018). Management often restricts demersal trawling to locations away from sensitive areas with rich benthic communities to prevent long-term damage to these ecosystems, however, there are areas such as sand, mud, and shingle beds where trawling regularly takes place. Though these areas may be seen as more resilient to demersal activity as they are subject to regular seabed disturbance through natural water movements, continuous trawling can still be highly damaging to these ecosystems and their communities, especially if the disturbances brought about by fishing outweigh those from natural processes (Diesing, Stephens and Aldridge, 2013).

Bycatch & Discards

As with many fisheries, there are potential issues regarding bycatch and discards when fishing for bass. Discards are the portion of catch that are not retained on board for landings upon returning to port and are instead returned to the sea. Discards can be made up of the target species as well as bycatch meaning both bass populations and those of other marine species are affected by the bass fishery. Fish are discarded when they are unmarketable, below MCRS, or are species which fishers are not authorised to land (Wade *et al.*, 2009). For example, as a non-quota species, bass are exempt from the landing obligation; therefore, fishers that catch bass without authorisation from the MMO must return it to the sea regardless of what condition the fish are in (MMO, 2020d). The health and survival of fish discarded back to the sea varies greatly based on what fishing gear was used to catch them, for example, hook and line fisheries can return unwanted fish back to the sea immediately after capture with relatively little injury, which is one of the reasons these fisheries are so sustainable (Rush and Caslake, 2009). Conversely, fish caught in demersal trawls can often be severely injured or killed during the trawl, meaning mostly dead fish are returned to the sea, adding additional mortality to the stock. ICES accounts for discards in its analysis of fishing effort for bass, however, discards are rarely reported on an official level and as such, are extremely difficult to accurately quantify (Kelleher, 2005). Currently discards are thought to make up close to a third of all bass fishing mortality, with 481 tonnes being discarded in 2019, compared to 801 tonnes of bass landed by commercial fishers in the Northeast Atlantic (ICES, 2020a).

A number of species are regularly caught as bycatch in bass trawls within the Bristol Channel. Data from a Defra funded fisheries programme (Andrews and Pawson, 2013) found 25 other commercial species regularly caught alongside bass in trawls, including the lesser spotted dogfish (*Scyliorhynus canicula*, 42% of landed bycatch weight), plaice (*Pleuronectes platessa*, 23%), small-eyed ray (*Raja microocellata*, 10%) and thornback ray (*Raja clavata*, 6%). Currently, ray stocks within the Bristol Channel are stable or increasing, so bycatch from bass fisheries is unlikely to be having a significant impact on populations (ICES, 2018c). Plaice stocks within the Bristol Channel are also at healthy levels and being fished sustainably, however are subject to high levels of discards (Andrews and Pawson, 2013). In the past, high discards of plaice, coupled with low stock levels has prevented the Bristol Channel trawl fishery from being certified as sustainable by the MSC in 2009, however, plaice stocks have increased substantially since then (ICES, 2020b). Lesser spotted dogfish are often used as

bait in fisheries though are not highly prized or sought after by fishers. Populations and ranges are thought to be increasing in the South West of England despite often being caught as bycatch in other fisheries (ICES, 2018c). Aside from the 25 commercial species caught as bycatch in bass trawls there are a large number of non-commercial species that are also caught and subsequently discarded (Andrews and Pawson, 2013).

Marine Development & Resource Extraction

The Severn Estuary and Bristol Channel are the focus of several plans for marine development and resource extraction, each representing a number of pressures on fish populations. Dredging for marine aggregates can alter the structure of soft sediment habitats, affecting the organisms found within these environments. Declines in many different organisms, particularly within benthic communities, in or around dredged areas has been well documented (Thrush and Dayton, 2002). Dredging results in an increase in suspended sediment in the water column, this affects processes requiring vision such as foraging, hunting and predator avoidance, which are key to survival for fish populations (Harvey *et al.*, 2017). Increases in suspended sediment can also cause physiological impacts on fish such as gill impairment, leading to decreases in respiration rates and increases in disease, and impacting chemoreception. Dredging can also impact the ability of larval fish to detect suitable habitats for settlement and even smother benthic eggs and larvae post-settlement, negatively impacting recruitment survival (Wenger *et al.*, 2017). Bass eggs and larvae are pelagic and drift inshore, usually hatching before they reach coastal waters. Sediment adhesion caused by aggregate extraction and other developments can cause them to sink, affecting settlement and therefore recruitment to the overall stock as well as affect the young bass that spend large portions of their lives in inshore nursery areas, commonly near estuaries (Reynolds, Lancaster and Pawson, 2003). Currently there are seven aggregate dredging licenses operating within the Severn Estuary and Bristol Channel, removing ~2.7 million tonnes of marine aggregate each year, with two more applications pending approval (The Crown Estate, 2020) (see **Figure 24**).

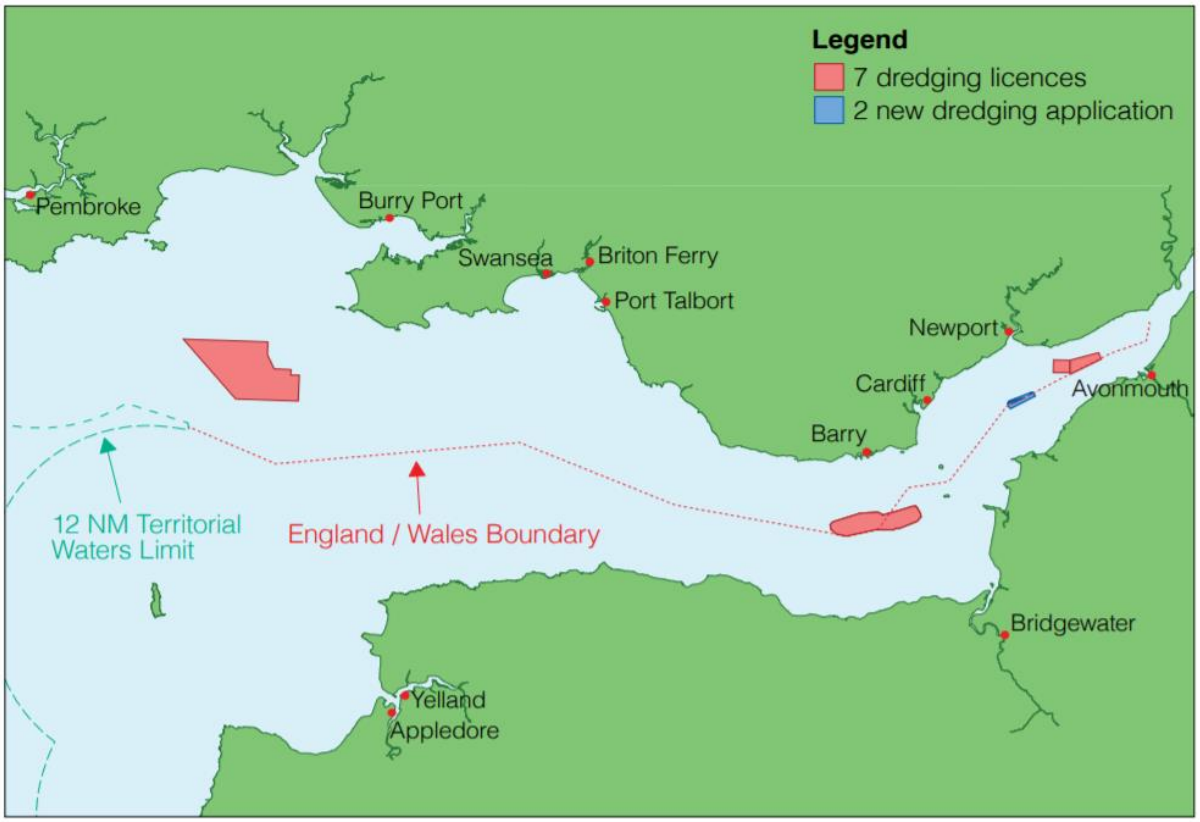

Figure 24 *- Active and potential aggregate extraction sites within the Bristol Channel (The Crown Estate, 2020, https://www.thecrownestate.co.uk/media/3634/2020-capability-portfolio-report.pdf [unedited]).*

The Severn Estuary is designated as a European Marine Site (EMS), with several large cities and industrial areas surrounding it. There are currently several existing or planned development projects within the EMS in various stages of development that could potentially negatively impact marine species and ecosystems. The presence of bass nursery areas in the Bristol Channel, and the possibility of further fish nursery grounds near Minehead, adds to these concerns due to their close proximity to Hinkley Point Nuclear Power Station. Hinkley Point C (HPC) is an ongoing project to construct a 3,200 MWe nuclear power station next to Hinkley Point A (decommissioned) and Hinkley Point B nuclear power stations in Somerset. This project includes plans to abstract 132 cumecs of water directly from the Severn Estuary (over 11 million cubic metres per day) in order to cool the two reactors at HPC. The extraction of this quantity of water, from intake heads situated on the seabed 3.3 km offshore, has raised significant concerns regarding impacts on the marine environment, including the assemblage of fish species (Devon & Severn IFCA, 2018, 2019, 2020c; Environment Agency, 2020b). The various permits and licences necessary for HPC to extract large quantities of cooling water from the Severn Estuary were conditionally granted in 2013 on the understanding that three mitigation measures would be implemented to reduce any impacts on the fish assemblage. The developers have sought to remove the requirement to install Acoustic Fish Deterrents (AFDs), which were the central part of the three mitigation measures. The Environment Agency have estimated that, without the AFD, the cooling water system of HPC would be responsible for 3% annual losses from the ICES VIIf bass population (Environment Agency, 2020a). This is a significant fish kill, particularly given the importance of surrounding areas for young bass, and that adjacent ICES bass stocks are at increased risk of fishing pressures and currently have a reduced reproductive capacity (ICES, 2020a).

The fish assemblage, including bass, is protected in the Severn Estuary as part of the Severn Estuary SAC and Ramsar site. It is only on this basis that the effects of HPC and other marine developments on fish can be considered in a regulatory and licencing context. In turn, this highlights the regulatory gaps for fish protection in other locations (e.g., the rest of the Bristol Channel) that do not fall within designated sites, or that fall within designated sites that do not include designations for fish or the fish assemblage.

Due in part to its funnel-like shape, the Severn Estuary has one of the largest tidal ranges in the world, around 14 metres (Xia, Falconer and Lin, 2010). There is increasing interest in harnessing this large tidal range for tidal power projects, especially after the Government's commitment to increase the usage of renewable energy sources. Although there is a strong desire and environmental justification to shift away from the usage of fossil fuels, tidal power developments can be damaging to marine life and their habitats. In 2013, plans for a tidal barrage across the mouth of the Severn were rejected by MPs due to several economic and environmental problems (Harvey, 2013). Among these were concerns of fish mortality when passing through turbines, delays or prevention of reproduction/migrations and loss of habitat (House of Commons Energy & Climate Change Committee, 2013). Since then, smaller scale tidal lagoon projects have been proposed in the Severn Estuary, such as the Swansea, Cardiff, and Newport tidal lagoon projects, however, these projects still carry similar threats to marine populations on a more localised scale. Though some tidal energy proposals focus on Welsh waters of the Severn Estuary and Bristol Channel, these waters form part of a large and connected ecosystem. The movement of these waters and the fish within them transcends administrative boundaries; consequently, effects of tidal energy developments have the potential to impact ecosystems within the jurisdiction of D&S IFCA.

In addition to tidal energy generation, interest in offshore wind farms for energy generation has increased greatly in the last two decades, particularly in the Bristol Channel. In 2007, proposals were set out for the development of a 240 turbine offshore windfarm just off the island of Lundy (Quilter, 2013). However, the project met considerable resistance due to environmental concerns and the plans were eventually scrapped due to "technical and financial reasons". The development of offshore wind farms can trigger a variety of potentially damaging effects to marine life (Hiscock, Tyler-Walters and Jones, 2002). Damage to the seabed and benthic communities can be partly mitigated through the use of floating turbines, however, these farms can still negatively impact wildlife, particularly birds and marine mammals (Bailey, Brookes and Thompson, 2014; Bergström et al., 2014). Despite this, the development of offshore wind farms is expected to increase with some experts stating that the development of a wind farm within the Bristol Channel is most likely inevitable, e.g. project Erebus off south Wales (Cooper, 2019; BBC, 2020).

Climate Change

After overfishing, one of the most pressing threats to marine life and the fishing industry is climate change (Stewart and Wentworth, 2019). Climate change is predicted to affect the oceans in many ways, including warming waters, changes in oscillations and currents, increases in dissolved carbon dioxide concentrations and rising sea levels (Petitgas *et al.*, 2013; Stewart and Wentworth, 2019). Changes in water temperature are expected to dramatically affect many fish species, especially those whose biology and reproductive activities are dependent on temperature and climate, including bass (Pawson, 1992). For example, several environmental factors affect the development and abundance of young sea bass, such as water salinity, temperature, and oceanographic conditions (Anastasiadi, Díaz

and Piferrer, 2017; Bento et al., 2016). Water temperature is extremely important to the life histories of sea bass, influencing factors such as growth and development, as well as acting as a direct stressor affecting the survival of juvenile bass in their inshore nursery areas (Beraud *et al.*, 2018). Additionally, the sea temperature helps define the spawning area for adults, and so will influence the location of egg and larvae release, with poorer recruitment occurring being correlated with colder years (ICES, 2012). Temperature-sensitive species such as sea bass are of concern under future climate change, particularly when the stock is already in poor health, as is the case with sea bass in the North Atlantic.

Studies predicting the potential impacts of climate change on the health and populations of fish species have yielded a range of different results, with scientists now choosing to investigate the impacts on individual species rather than generalising (Crespel *et al.*, 2017). Results from such studies on sea bass are suggesting that despite being a very temperature-sensitive species, some aspects of the sea bass life cycle may demonstrate a strong resilience to the changing environmental conditions associated with climate change. Pope *et al*. (2014) investigated the effects of increased ocean temperature and acidity on sea bass larvae and found that although minor morphological and developmental differences are observed with increased temperature and acidity, European sea bass are highly resilient to climate change during the early stages of their life cycle. However, a separate study focusing on the genetic effects of climate change related environmental conditions found that the predicted temperature rises could cause changes in important physical and physiological traits of sea bass, such as stress response and muscle and organ formation (Anastasiadi, Díaz and Piferrer, 2017). Even minor changes such as these could greatly alter future stock recruitment success and lead to major changes in sea bass population biology. One of the long-term consequences of climate change will be shifts in temperature patterns in our oceans, so in addition to potentially altering the biology of fish species, there may be some major changes in the ranges and distributions of many fish species, with some changes already observable today (Roessig *et al.*, 2004; Comte *et al.*, 2013). This may not substantially influence commercial sea bass fisheries, as modern fishing technology allows some vessels to follow fish stocks further offshore; however, this may be devastating for recreational fishers and for smaller-scale, inshore commercial fisheries that are reliant on non-quota species such as bass, but are less able to track their distribution shifts.

In addition to warming waters, the increasing frequency of hypoxic (very low oxygen) ocean “dead zones” has been attributed to climate change and the runoff of fertilisers into rivers (Diaz and Rosenberg, 2008). Dead zones have significant consequences for the functioning of marine ecosystems and the services they provide to society, including fisheries production, water filtration, and nutrient cycling (Altieri and Gedan, 2015). Fertiliser used on farmland will often run off into rivers and be transported downstream to estuaries. The increase in nutrients such as phosphorus and nitrogen in these environments (known as eutrophication) can cause blooms of marine algae (Joyce, 2000). As the algae dies, it sinks to the bottom, where oxygen in the water is consumed by microbes as part of the decomposition process, lowering the oxygen concentrations in the water. Stratification, or layering, of the water column prevents mixing between these low-oxygen waters and surface waters. Stratification is linked to temperature and salinity concentration gradients in the water and is projected to increase due to warming waters, particularly in more northerly latitudes (Keeling, Körtzinger and Gruber, 2010). This process continues until the area has been transformed into an oxygen-deficient or oxygen-free zone, devastating marine life in the area, particularly within benthic communities (Diaz and Rosenberg, 2008). Dead zones are common across much of the range of sea bass

(see **Figure 25**). Changes in EU legislation regarding fertiliser usage has led to improvements in oxygen conditions in the North Sea, though hypoxic zones are still present throughout areas of Europe (Townhill *et al.*, 2017).

Hypoxic dead zones pose a threat to all nearby inshore marine life, but are potentially devastating for fish species such as bass that use inshore and estuarine habitats as nurseries, as these are the areas where dead zones are most likely to occur (Altieri and Gedan, 2015). Increases in the frequency of dead zones in or near bass nursery areas could cause further damage to the reproductive output of populations and hinder recovery of damaged stocks. Fish exposed to hypoxic environments at a young age show reduced growth rates later in life and consume less food than those not exposed to these conditions (Thetmeyer *et al.*, 1999; Zambonino-Infante *et al.*, 2017). Even if the bass themselves do not spend a lot of time within these zones, they could be indirectly affected through damage to their ecosystems and prey, placing further pressure on the already lowered stocks.

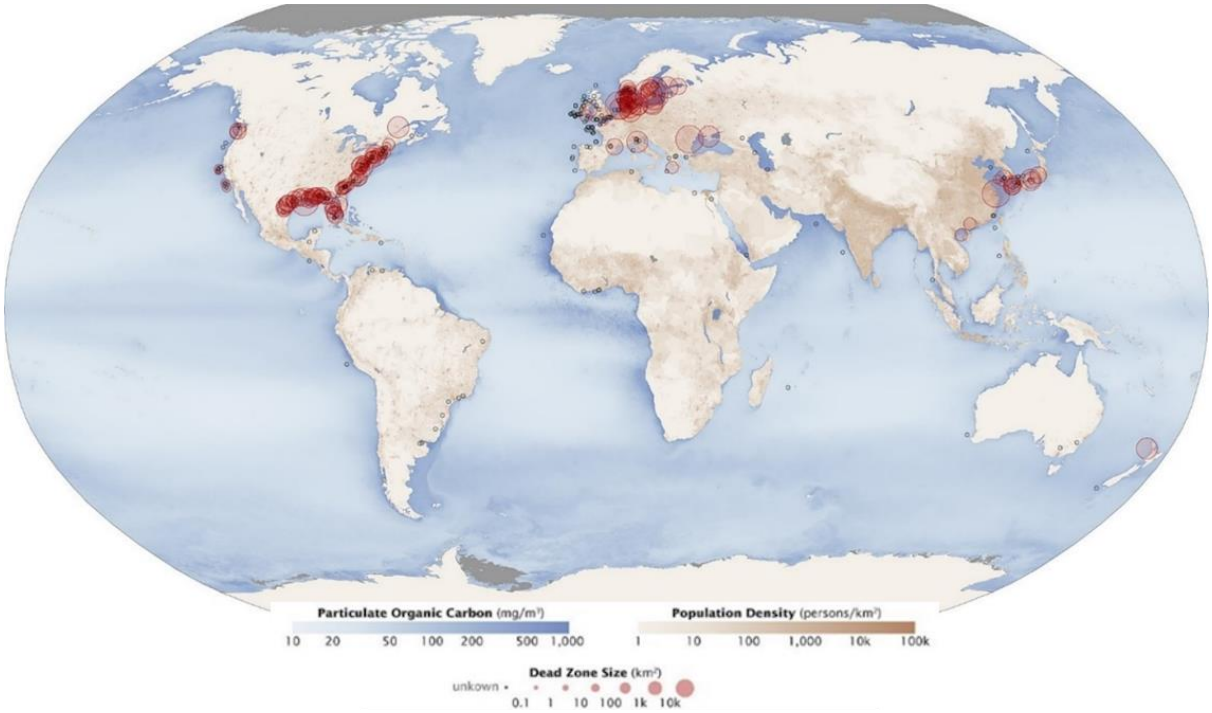

Figure 25 *- Locations of hypoxic and anoxic dead zones. Red circles on this map show the location and size of many of our planet's dead zones. Black dots show where dead zones have been observed, but their size is unknown (Allen, 2010, https://commons.wikimedia.org/wiki/File:Aquatic_Dead_Zones.jpg [unedited]).*

Climate Change: Coastal Squeeze & Flooding

With sea levels across the world rising due to climate change, a phenomenon known as coastal squeeze is an increasing concern to conservationists. As sea level slowly rises, the sea encroaches upon coastal areas causing terrestrial erosion and loss of habitat. In the marine environment, ecosystems and organisms with preferred depth ranges "migrate" towards the shore to maintain their positions relative to the water level (Torio and Chmura, 2013). However, to combat rising seas, humans have installed flood defence systems such as sea walls and groynes to protect coastal areas from the rising water. Barrier defences such as sea walls prevent coastal marine life from migrating to maintain their position in preferred habitats, and thus reduce the availability of coastal habitat (Pontee, 2013). This is a very slow

process but poses a significant threat to coastal ecosystems, particularly for benthic organisms.

Figure 26 *- Flood defence sea wall on Chesil Cove Beach, Dorset (BennH, 2014, https://commons.wikimedia.org/wiki/File:Chesil_Cove_flood_defences.png [unedited]).*

As weather patterns get more extreme and less predictable due to the effects of climate change, the potential for flooding within the Bristol Channel increases. There are many major cities and built-up areas surrounding the Severn that are at risk of flooding, with flood defences installed in such areas. The effects of coastal squeeze will be most severe in these developed and defended areas compared to the more rural coastal zones of the estuary, as the lack of flood defences and developments allow marine communities to retreat inland as the sea rises. In addition to causing coastal squeeze, there is concern that the construction of new flood defence installations could be damaging to fish populations within the Severn Estuary.

Threats to Fishery & Industry

As a non-quota species, sea bass fisheries were traditionally extremely important to inshore fishers in the Bristol Channel, as they provided a valuable, seasonal, alternative catch during the summer months so that fishing pressure could be shifted away from other commercial species. During interviews, inshore fishers who operate within the Bristol Channel spoke about the seasonal nature of their fishing in the past and described how they would target a fishery for a few months of the year, before then moving on to another fishery every few months throughout the year (FRMP Interviews, 2020). Fishing this way would allow fishers to land a variety of commercially important species through the year while making sure that no single fishery was subjected to high levels of fishing pressure for extended periods of time. However, over the past twenty years, the introduction of more and more restrictive management has resulted in many inshore fisheries either closing or becoming unviable, leaving fishers with fewer options of fisheries to target throughout the year. This results in more vessels targeting viable stocks for longer throughout the year, which increases the likelihood of unsustainable fishing and further restrictive management measures being implemented in the future (FRMP Interviews, 2020). This cycle has led to a situation in which many fishers are frustrated with

having their current fisheries restricted, without management lifting restrictions on other species to provide them with alternative catch and ease pressure on stocks. This combined with heavy offshore fishing pressure declining stocks, difficulty acquiring crew and quotas and a variety of other issues has led many inshore fishers to believe the inshore fishing industry as a whole will soon die out. Several fishers interviewed stated that the only reason they are still involved in the industry is due to their love of the sea and the importance their fishing has to them. Those fishers in the Bristol Channel who are still authorised to catch bass commercially have stressed the importance of their bass authorisations to them, both as a means of income and as a matter of personal importance. Inshore bass fisheries in the Bristol Channel date back centuries and many commercial and recreational fishers see bass fishing as part of their way of life and culture (FRMP Interviews, 2020).

One of the major issues inshore fishers have with management is that they feel fisheries and fish stocks are not assessed or considered at the correct scale (FRMP Interviews, 2020). Several of the fishers interviewed as part of this project objected to the bass fishing bans implemented as part of the emergency measures in 2015, with some describing it as "*a complete and total disgrace*" (FRMP Interviews, 2020). They argued that most of their fishing was small-scale and low impact, and that the dramatic population fluctuations that led to the new management measures were not seen in the Bristol Channel. It is not clear if this is the case, however, there is a growing body of evidence suggesting that fish population and stock structure is much more localised and complex than previously thought (Kerr *et al.*, 2017). For example, research is now showing that cod populations on both sides of the Atlantic are in fact far more complex and localised than previously thought by both scientists and fisheries managers (Kerr *et al.*, 2014; Dahle *et al.*, 2018). Similar findings regarding herring populations within the Bristol Channel have been found through work conducted as part of the Marine Pioneer (Clarke, 2020). With findings like these becoming more and more common, there is a strong need to focus research on identifying distinct, localised populations of fish to ensure commercially important fish species, such as bass, are managed appropriately.

Another issue raised by almost all interviewed fishers was illegal, unregulated, and unreported fishing occurring in the Bristol Channel, particularly with unauthorised netting for sea bass (FRMP Interviews, 2020). Many mentioned instances of illegally large nets being used and being left to soak for days at a time, against IFCA byelaws. This is not a problem isolated to bass fisheries, with one fisherman commenting "*there is a lot of fishing going on up here you don't know about…*" when discussing illegal fishing in North Devon and Somerset. Similar activities are suspected to take place within recreational fisheries also, it is thought that the bag limits introduced as part of the European Union bass management measures just encourage some anglers to catch and retain many large fish, and then select the largest to take home for their bag limit allowance, while discarding the rest. Activities such as this can be damaging to local fish populations and undermine the sustainable fishing efforts of other fishers following regulations in the same area. Several commercial fishers stated that there was a need for a larger IFCA enforcement presence to combat illegal fishing and ensure compliance with fishing regulations. D&S IFCA is seeking to rectify this, including by improving collaboration and engagement through activities such as virtual roadshows for ports, sectoral meetings and future FRMP interviews. It is hoped that this will improve stakeholder engagement with D&S IFCA's intelligence-led, risk-based approach to enforcement and compliance work, which is prioritised to areas with high numbers of reports of illegal fishing activity. More information about planned engagement activities is available in the D&S IFCA's Annual Plan and Communications Strategy, accessible via D&S IFCA's website.

Bibliography

Allen, R. S. & J. 2010. Aquatic Dead Zones. https://commons.wikimedia.org/wiki/File:Aquatic_Dead_Zones.jpg (Accessed 4 September 2020).

Altieri, A. H., and Gedan, K. B. 2015. Climate change and dead zones. Global change biology, 21: 1395–1406. Wiley Online Library.

Anastasiadi, D., Díaz, N., and Piferrer, F. 2017. Small ocean temperature increases elicit stage-dependent changes in DNA methylation and gene expression in a fish, the European sea bass. Scientific Reports, 7: 12401. Nature Publishing Group.

Andrews, J., and Pawson, M. 2013. Bristol Channel Bass Trawl Fishery. MSC Assessment Report, 82061. Marine Stewardship Council.

Armstrong, M., Brown, A., Hargreaves, J., Hyder, K., Pilgrim-Morrison, S., Munday, M., Proctor, S., *et al.* 2013. Sea Angling 2012–a Survey of Recreational Sea Angling Activity and Economic Value in England. London, UK.

Bagdonas, K., Nika, N., Bristow, G., Jankauskiene, R., Salyte, A., and Kontautas, A. 2011. Short communication First record of *Dicentrarchus labrax* (Linnaeus, 1758) from the southeastern Baltic Sea (Lithuania). J. Appl. Ichthyol, 1. Citeseer.

Bailey, H., Brookes, K. L., and Thompson, P. M. 2014. Assessing environmental impacts of offshore wind farms: lessons learned and recommendations for the future. Aquatic Biosystems, 10: 8.

BBC. 2020, November 12. Erebus floating windfarm planned off Pembrokeshire coast. BBC News. https://www.bbc.com/news/uk-wales-54920523 (Accessed 7 January 2021).

BennH. 2014. English: Chesil Cove flood defences the Isle of Portland. https://commons.wikimedia.org/wiki/File:Chesil_Cove_flood_defences.png (Accessed 24 November 2020).

Bento, E. G., Grilo, T. F., Nyitrai, D., Dolbeth, M., Pardal, M. Â., and Martinho, F. 2016. Climate influence on juvenile European sea bass (*Dicentrarchus labrax*, L.) populations in an estuarine nursery: A decadal overview. Marine Environmental Research, 122: 93–104.

Beraud, C., van der Molen, J., Armstrong, M., Hunter, E., Fonseca, L., and Hyder, K. 2018. The influence of oceanographic conditions and larval behaviour on settlement success—the European sea bass *Dicentrarchus labrax* (L.). ICES Journal of Marine Science, 75: 455–470. Oxford University Press.

Bergström, L., Kautsky, L., Malm, T., Rosenberg, R., Wahlberg, M., Capetillo, N. Å., and Wilhelmsson, D. 2014. Effects of offshore wind farms on marine wildlife—a generalized impact assessment. Environmental Research Letters, 9: 034012. IOP Publishing.

Biseau, A., Le Goff, R., and Drogou, M. 2016, January 14. European sea bass stocks and management measures within the European Union. Publications Office of the European Union. http://op.europa.eu/en/publication-detail/-/publication/e365b910-7ed0-11e5-b8b7-01aa75ed71a1 (Accessed 19 August 2020).

Blue Marine Foundation. 2014. Defining the Economic and Environmental Values of Sea Bass. Final Report, GB2016. Blue Marine Foundation. https://cornishfed.weebly.com/uploads/1/2/7/9/12797807/gb2016_final_report.pdf.

Bradshaw, C., Collins, P., and Brand, A. R. 2003. To what extent does upright sessile epifauna affect benthic biodiversity and community composition? Marine Biology, 143: 783–791. Springer.

British Sea Fishing. 2020. Europe's Bass on Edge of Collapse? | Britishseafishing.co.uk. https://britishseafishing.co.uk/europes-bass-a-species-on-the-edge-of-collapse/ (Accessed 10 September 2020).

Cambiè, G., Kaiser, M. J., Hiddink, J. G., Salomonsen, H., Pantin, J. R., and McCarthy, I. 2015. Population dynamics of the European sea bass (*Dicentrarchus labrax*) in Welsh waters and management implications. Fisheries & Conservation report.

Cardia, F., and Lovatelli, A. 2007. A review of cage aquaculture: Mediterranean Sea. FAO Fisheries Technical Paper, 498: 159. FOOD AND AGRICULTURE ORGANIZATION.

Carroll, A. 2014. Population dynamics of the European sea bass (*Dicentrarchus labrax*) in Welsh waters. MSc Marine Environmental Protection Thesis, Bangor University.

Claridge, P. N., and Potter, I. C. 1983. Movements, abundance, age composition and growth of bass, *Dicentrarchus labrax*, in the Severn Estuary and inner Bristol Channel. Journal of the Marine Biological Association of the United Kingdom, 63: 871–879. Cambridge University Press.

Clarke, D. 2020, November 13. Discussions on herring stock structure within the Bristol Channel and the findings of herring genetics research.

Comte, L., Buisson, L., Daufresne, M., and Grenouillet, G. 2013. Climate-induced changes in the distribution of freshwater fish: observed and predicted trends. Freshwater Biology, 58: 625–639. Wiley Online Library.

Cooper, J. 2019, March 14. Plans for HUGE Devon offshore wind farm are 'back on the table'. DevonLive. https://www.devonlive.com/news/devon-news/plans-huge-offshore-wind-farm-2641870 (Accessed 24 November 2020).

Cosgrove, R., Browne, D., Rihan, D., O'Shea, T., Robson, S., and BIM, N. G. 2007. Assessment of maximum effective spacing for acoustic deterrents deployed in gill net fisheries in the Celtic Sea. Final report. BIM, Irish Sea Fisheries Board.

Council of the European Union. 2015. Commission Implementing Regulation (EU) 2015/1316 of 30 July 2015 derogating from Council Regulation (EC) No 850/98, as regards the minimum conservation reference size for sea bass (*Dicentrarchus labrax*). 32015R1316. http://data.europa.eu/eli/reg_impl/2015/1316/oj/eng (Accessed 29 January 2021).

Council of the European Union. 2019. Regulation (EU) 2019/472 of the European Parliament and of the Council of 19 March 2019 establishing a multiannual plan for stocks fished in the Western Waters and adjacent waters, and for fisheries exploiting those stocks, amending Regulations (EU) 2016/1139 and (EU) 2018/973, and repealing Council Regulations (EC) No 811/2004, (EC) No 2166/2005, (EC) No 388/2006, (EC) No 509/2007 and (EC) No 1300/2008. 32019R0472. http://data.europa.eu/eli/reg/2019/472/oj/eng (Accessed 10 September 2020).

Council of the European Union. 2020. Council Regulation (EU) 2020/123 of 27 January 2020 fixing for 2020 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32020R0123&from=EN (Accessed 19 August 2020).

Crespel, A., Zambonino-Infante, J.-L., Mazurais, D., Koumoundouros, G., Fragkoulis, S., Quazuguel, P., Huelvan, C., *et al.* 2017. The development of contemporary European sea bass larvae (*Dicentrarchus labrax*) is not affected by projected ocean acidification scenarios. Marine Biology, 164: 155.

Dahle, G., Quintela, M., Johansen, T., Westgaard, J.-I., Besnier, F., Aglen, A., Jørstad, K. E., *et al.* 2018. Analysis of coastal cod (Gadus morhua L.) sampled on spawning sites reveals a genetic gradient throughout Norway's coastline. BMC genetics, 19: 1–17. Springer.

De Carlo, F., Virgili, M., Lucchetti, A., Fortuna, C. M., and Sala, A. 2012. INTERACTIONS BETWEEN BOTTLENOSE DOLPHIN AND MIDWATER PAIR TRAWLS: EFFECT OF PINGERS ON DOLPHIN BEHAVIOUR/INTERAZIONI TRA TURSIOPI E RETI DA TRAINO SEMI-PELAGICHE" VOLANTI A COPPIA": EFFETTO DEI PINGERS SUL COMPORTAMENTO DEI DELFINI. Biologia Marina Mediterranea, 19: 206. Societa Italiana di Biologia Marina.

Degnbol, P. 2010. Maximum Sustainable Yield. Santander, Spain. http://www.nwwac.org/_fileupload/Image/MSY_Sostenibilidad_Pesquera_Ecosistemas_Marinos_POUL_DEGNBOL.pdf.

Devon & Severn IFCA. 2018. Devon and Severn IFCA Response to the Consultation on the Siting Criteria and Process for a New National Policy Statement for Nuclear Power with

Single Reactor Capacity Over 1 Gigawatt Beyond 2025.
Devon & Severn IFCA. 2019. D&S IFCA Response to the Environment Agency Consultation Regarding the EDF Energy Proposal to Remove the Requirement for Acoustic Fish Deterrents at Hinkley Point C.
Devon & Severn IFCA. 2020a. Bass Compliance Direction. https://www.devonandsevernifca.gov.uk/Enforcement-Legislation/Bass-Compliance-Direction (Accessed 3 September 2020).
Devon & Severn IFCA. 2020b. Netting Permit Byelaw (Annexes 1-5). https://www.devonandsevernifca.gov.uk/Resource-library/E-Legislation-and-management-relevant-to-functions/Current-Permit-Byelaws-Permit-Conditions (Accessed 28 October 2020).
Devon & Severn IFCA. 2020c. Devon and Severn Inshore Fisheries and Conservation Authority's Representation on NNB Generation Company (HPC) Limited Environmental Permit Appeal.
Devon & Severn IFCA. 2020d, February 12. TWAO proposal: Bridgwater Tidal Barrier ACL/SZC/005182.0001.
Diaz, R. J., and Rosenberg, R. 2008. Spreading dead zones and consequences for marine ecosystems. science, 321: 926–929. American Association for the Advancement of Science.
Diesing, M., Stephens, D., and Aldridge, J. 2013. A proposed method for assessing the extent of the seabed significantly affected by demersal fishing in the Greater North Sea. ICES Journal of Marine Science, 70: 1085–1096. Oxford Academic.
EAA. 2020. Bass Stock Recovery Position Paper. European Anglers Alliance. https://www.eaa-europe.org/files/eaa-bass-a3_6354.pdf.
Environment Agency. 2018. National Salmon and Sea Trout Protection Byelaws.
Environment Agency. 2020a. Hinkley Point C Permit Variation: Summary Technical Brief - Summary of Quantitative Impact Assessment Results. Technical Brief: TB020. National Permitting Service, Environment Agency. https://consult.environment-agency.gov.uk/psc/ta5-1ud-nnb-generation-company-hpc-limited-2/supporting_documents/EA19%20%20TB020%20%20Summary%20of%20QIA%20Results%20%20Draft06.pdf.
Environment Agency. 2020b. Appropriate assessment of the application to vary the water discharge activity permit for Hinkley Point C. The Environment Agency. https://consult.environment-agency.gov.uk/psc/ta5-1ud-nnb-generation-company-hpc-limited-2/supporting_documents/EA7%20%20Environment%20Agencys%20Appropriate%20Assessment%20finalNovember%202020.pdf.
Etrusko25. 2020. English: *Dicentrarchus labrax* distribution map. https://commons.wikimedia.org/wiki/File:Dicentrarchus_labrax_map.png (Accessed 12 August 2020).
EUMOFA. 2020. COMMERCIAL AND RECREATIONAL FISHERIES FOR WILD SEABASS IN THE ATLANTIC - Economic and Market Study. European Union, Luxembourg. https://www.eumofa.eu/documents/20178/136822/Eumofa_Seabass+Market+study+report_EN.pdf (Accessed 18 August 2018).
FAO. 2019. FAO YEARBOOK FISHERY AND AQUACULTURE STATISTICS 2017 (ENGLISH/FRENCH/SPANISH EDITION). FOOD & AGRICULTURE ORG, S.l.
FAO. 2020. FAO Fisheries & Aquaculture - Cultured Aquatic Species Information Programme - *Dicentrarchus labrax* (Linnaeus, 1758). http://www.fao.org/fishery/culturedspecies/Dicentrarchus_labrax/en#tcNA0050 (Accessed 18 May 2020).
Frimodt, C. 1995. Multilingual illustrated guide to the world's commercial coldwater fish. Fishing News Books Ltd.,.
FRMP Interviews. 2020. Fisheries Research & Management Plans Engagement Interviews.
Green, B. C., Smith, D. J., Grey, J., and Underwood, G. J. 2012. High site fidelity and low site connectivity in temperate salt marsh fish populations: a stable isotope approach. Oecologia, 168: 245–255. Springer.
Gudmundsson, E., and Roheim, C. 2000. Ecolabeling Seafood for Sustainable Production: Implications for Fisheries Management. Marine Resource Economics, 15.
Haffray, P., Tsigenopoulos, C. S., Bonhomme, F., Chatain, B., Magoulas, A., Rye, M., Triantafyllidis, A., *et al.* 2007. Genetic effects of domestication, culture and

breeding of fish and shellfish, and their impacts on wild populations. European sea bass-*Dicentrarchus labrax*. p 40-46. Genetic impact of aquaculture activities on native populations. Genimpact final scientific report (EU contract n. RICA-CT-2005-022802). http://genimpact. imr. no.

Hahn, P. K., Bailey, R. E., and Ritchie, A. 2007. Beach seining. Salmonid field protocols handbook: 1267.

Harvey, E., Wenger, A., Saunders, B., Newman, S., Wilson, S., Travers, M., Browne, N., *et al.* 2017. Effects of dredging-related pressures on critical ecological processes for finfish: a review and possible management strategies. Report of Theme.

Harvey, F. 2013, September 18. UK government rejects current Severn barrage plans. The Guardian. Online. http://www.theguardian.com/environment/2013/sep/18/severn-estuary-tidal-barrage (Accessed 24 November 2020).

Hester, N. 1980. Some aspects of surf angling for bass in Cornwall. Magazine of the Bass Anglers' Sport-Fishing Society, 24.

Hiddink, J. G., Jennings, S., Sciberras, M., Szostek, C. L., Hughes, K. M., Ellis, N., Rijnsdorp, A. D., *et al.* 2017. Global analysis of depletion and recovery of seabed biota after bottom trawling disturbance. Proceedings of the National Academy of Sciences, 114: 8301–8306. National Academy of Sciences.

Hillewaert, H. 2012. *Dicentrarchus labrax* (Linnaeus, 1758). https://commons.wikimedia.org/wiki/File:Dicentrarchus_labrax_(11d_-_13d_-_15d).jpg (Accessed 13 August 2020).

Hillewaert, H. 2013. *Ammodytes tobianus* Linnaeus, 1758. https://commons.wikimedia.org/wiki/File:Ammodytes_tobianus_(catch).jpg (Accessed 13 August 2020).

Hintzen, N. T., Roel, B., Benden, D., Clarke, M., Egan, A., Nash, R. D. M., Rohlf, N., *et al.* 2015. Managing a complex population structure: exploring the importance of information from fisheries-independent sources. ICES Journal of Marine Science, 72: 528–542.

Hiscock, K., Tyler-Walters, H., and Jones, H. 2002. High level environmental screening study for offshore wind farm developments–marine habitats and species project. The Department of Trade and Industry New & Renewable Energy Programme, Plymoth Marine Laboratory.

House of Commons Energy & Climate Change Committee. 2013. A Severn Barrage?: Government Response to the Committee's Second Report of Session 2013–14. House of Commons London: The Stationery Office Limited. https://publications.parliament.uk/pa/cm201314/cmselect/cmenergy/622/622.pdf.

Howarth, L. M., Waggitt, J. J., Bolam, S. G., Eggleton, J., Somerfield, P. J., and Hiddink, J. G. 2018. Effects of bottom trawling and primary production on the composition of biological traits in benthic assemblages. Marine Ecology Progress Series, 602: 31–48.

Ibrahim, M. 2019. Once upon a time in North Devon: Historical perspectives reveal multiple dimensions of change in North Devon fishing communities. University of Exeter, Exeter. 45 pp.

ICES. 2001. Report on the Study Group on Sea bass. ICES CM 2001/ACFM:25. International Council for Exploration of the Sea, Advisory Committee on Fishery Management.

ICES. 2012. Report of the Working Group on Assessment of New MoU Species (WGNEW). ICES CM 2013/ACOM: 21. International Council for Exploration of the Sea, ICES HQ, Copenhagen, Denmark. http://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/acom/2013/WGNEW/WGNEW%20report%20160513.pdf.

ICES. 2018a. Report of the Working Group on Celtic Seas Ecoregion (WGCSE). International Council for Exploration of the Sea, Copenhagen. http://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/acom/2018/WGCSE/02_ExSumm_Intro_2018.pdf (Accessed 19 August 2020).

ICES. 2018b. Report of the Benchmark Workshop on Sea Bass (WKBASS): 287.

ICES. 2018c. Report of the Working Group on Elasmobranch Fishes (WGEF). ICES CM 2018/ACOM:16. Lisbon, Portugal. http://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/acom/2018/WGEF/01%20WGEF%20Report%202018.pdf.

ICES. 2019. Sea bass (*Dicentrarchus labrax*) in divisions 4.b-c, 7.a, and 7.d-h (central and southern North Sea, Irish Sea, English Channel, Bristol Channel, and Celtic Sea). ICES. http://www.ices.dk/sites/pub/Publication Reports/Forms/DispForm.aspx?ID=35852 (Accessed 17 August 2020).

ICES. 2020a. Sea bass (*Dicentrarchus labrax)* in divisions 4.b?c, 7.a, and 7.d?h (central and southern North Sea, Irish Sea, English Channel, Bristol Channel, and Celtic Sea). ICES. http://www.ices.dk/sites/pub/Publication Reports/Forms/DispForm.aspx?ID=36784 (Accessed 19 August 2020).

ICES. 2020b. Plaice (*Pleuronectes platessa*) in divisions 7.f and 7.g (Bristol Channel, Celtic Sea). ICES. http://www.ices.dk/sites/pub/Publication Reports/Forms/DispForm.aspx?ID=36798 (Accessed 14 September 2020).

IUCN. 2008, January 1. *Dicentrarchus labrax*: Freyhof, J. & Kottelat, M.: The IUCN Red List of Threatened Species 2008: e.T135606A4159287. International Union for Conservation of Nature. http://www.iucnredlist.org/details/135606/0 (Accessed 30 April 2020).

Jennings, S., Nicholson, M. D., Dinmore, T. A., and Lancaster, J. E. 2002. Effects of chronic trawling disturbance on the production of infaunal communities. Marine Ecology Progress Series, 243: 251–260.

Jónsson, G., and Pálsson, J. 2006. Íslenskir fiskar (Icelandic fishes). Vaka-Helgafel, Reykjavik, Iceland.

Jorgensen, C., Enberg, K., Dunlop, E. S., Arlinghaus, R., Boukal, D. S., Brander, K., Ernande, B., *et al.* 2007. Ecology-Managing evolving fish stocks. Science, 318: 1247–1248. Science AAAS.

Joyce, S. 2000. The dead zones: oxygen-starved coastal waters. Environmental Health Perspectives, 108: A120–A125.

Kaiser, M. J., Clarke, K. R., Hinz, H., Austen, M. C., Somerfield, P. J., and Karakassis, I. 2006. Global analysis of response and recovery of benthic biota to fishing. Marine Ecology Progress Series, 311: 1–14.

Kaiser, M. J., and Edwards-Jones, G. 2006. The Role of Ecolabeling in Fisheries Management and Conservation. Conservation Biology, 20: 392–398.

Keeling, R. F., Körtzinger, A., and Gruber, N. 2010. Ocean Deoxygenation in a Warming World. Ann. Rev. Mar. Sci.

Kelleher, K. 2005. Discards in the world's marine fisheries: an update. Food & Agriculture Org.

Kelley, D. F. 1987. Food of bass in UK waters. Journal of the Marine Biological Association of the United Kingdom, 67: 275–286. Cambridge University Press.

Kelley, D. F. 1988. The importance of estuaries for sea-bass, *Dicentrarchus labrax* (L.). Journal of Fish Biology, 33: 25–33. Wiley Online Library.

Kerr, L. A., Cadrin, S. X., and Kovach, A. I. 2014. Consequences of a mismatch between biological and management units on our perception of Atlantic cod off New England. ICES Journal of Marine Science, 71: 1366–1381. Oxford University Press.

Kerr, L. A., Hintzen, N. T., Cadrin, S. X., Clausen, L. W., Dickey-Collas, M., Goethel, D. R., Hatfield, E. M., *et al.* 2017. Lessons learned from practical approaches to reconcile mismatches between biological population structure and stock units of marine fish. ICES Journal of Marine Science, 74: 1708–1722. Oxford University Press.

Koli, L. 1990. Suomen kalat.[Fishes of Finland]. Werner Söderström Osakeyhtiö. Helsinki, 357.

Lloris, D. 2002. A world overview of species of interest to fisheries. Chapter: *Dicentrarchus labrax*. FIGIS Species Fact Sheets. Species Identification and Data Programme-SIDP. FAO-FIGIS, 3.

López, R., De Pontual, H., Bertignac, M., and Mahévas, S. 2015. What can exploratory modelling tell us about the ecobiology of European sea bass (*Dicentrarchus labrax*): A comprehensive overview. Aquatic Living Resources, 28.

Mañanós, E. L., Zanuy, S., and Carrillo, M. 1997. Photoperiodic manipulations of the reproductive cycle of sea bass (*Dicentrarchus labrax*) and their effects on gonadal development, and plasma 17ß-estradiol and vitellogenin levels. Fish Physiology and Biochemistry, 16: 211–222.

Marine Pioneer Interviews. 2020. Marine Pioneer & Blue Marine Foundation Engagement Interviews.

Masters, J. 2014. Report on the Current State of Driftnet Fisheries in the UK. SeaFish.
MMO. 2020a. UK and Foreign Vessels Landings by UK Port and UK Vessel Landings Abroad: 2014 to 2019. Marine Management Organisation, London.
MMO. 2020b. Mapping Sea Angling in English Waters. MMO1163. MMO.
MMO. 2020c. Bass Fishing Guidance 2020. https://www.gov.uk/government/publications/bass-industry-guidance-2020/bass-fishing-guidance-2020 (Accessed 19 August 2020).
MMO. 2020d. Landing obligation general requirements 2020. https://www.gov.uk/government/publications/technical-conservation-and-landing-obligation-rules-and-regulations-2020/landing-obligation-general-requirements-2020 (Accessed 3 September 2020).
Naciri, M., Lemaire, C., Borsa, P., and Bonhomme, F. 1999. Genetic study of the Atlantic/Mediterranean transition in sea bass (*Dicentrarchus labrax*). Journal of Heredity, 90: 591–596. Oxford University Press.
NDFA. 2019. Our Catch - North Devon Fishermen's Association. http://www.northdevonfishermen.co.uk/our-catch (Accessed 7 July 2020).
Nebel, C., Romestand, B., Nègre-Sadargues, G., Grousset, E., Aujoulat, F., Bacal, J., Bonhomme, F., *et al.* 2005. Differential freshwater adaptation in juvenile sea-bass *Dicentrarchus labrax*: involvement of gills and urinary system. Journal of Experimental Biology, 208: 3859–3871. The Company of Biologists Ltd.
Pawson, M. G., Pickett, G. D., and Kelley, D. F. 1987. The distribution and migrations of bass, *Dicentrarchus labrax* L., in waters around England and Wales as shown by tagging. Journal of the Marine Biological Association of the United Kingdom, 67: 183–217. Cambridge University Press.
Pawson, M. G. 1992. Climatic influences on the spawning success, growth and recruitment of bass (*Dicentrarchus labrax* L.) in British waters. *In* ICES Marine Science Symposia, pp. 388–392.
Pawson, M. G., Pickett, G. D., and Witthames, P. R. 2000. The influence of temperature on the onset of first maturity in sea bass. Journal of Fish Biology, 56: 319–327. Wiley Online Library.
Pawson, M. G., Pickett, G. D., and Smith, M. T. 2005. The role of technical measures in the recovery of the UK sea bass (*Dicentrarchus labrax*) fishery 1980–2002. Fisheries research, 76: 91–105. Elsevier.
Pawson, M. G., Pickett, G. D., Leballeur, J., Brown, M., and Fritsch, M. 2007. Migrations, fishery interactions, and management units of sea bass (*Dicentrarchus labrax*) in Northwest Europe. ICES Journal of Marine Science, 64: 332–345.
Petitgas, P., Rijnsdorp, A. D., Dickey-Collas, M., Engelhard, G. H., Peck, M. A., Pinnegar, J. K., Drinkwater, K., *et al.* 2013. Impacts of climate change on the complex life cycles of fish. Fisheries Oceanography, 22: 121–139.
Pickett, G. D., and Pawson, M. G. 1994. Sea Bass: Biology. Springer Science & Business Media.
Pickett, G. D., Eaton, D. R., Cunningham, S., Dunn, M. R., Potten, S. D., and Whitmarsh, D. 1995. An appraisal of the UK bass fishery and its management. Citeseer.
Pickett, G. D., Kelley, D. F., and Pawson, M. G. 2004. The patterns of recruitment of sea bass, *Dicentrarchus labrax* L. from nursery areas in England and Wales and implications for fisheries management. Fisheries Research, 68: 329–342. Elsevier.
Pillon, R. 2012. English: *Dicentrarchus labrax* photographed in Minorca, Spain. https://commons.wikimedia.org/wiki/File:Dicentrarchus_labrax_Minorca.jpg (Accessed 12 August 2020).
Plikss, M. 2002. Fish of Latvia. World wide web electronic publication [latvijas. daba. lv/scripts/db/saraksti/saraksti. cgi.
Pollard, D. 2015, January 12. IUCN Red List of Threatened Species: European Seabass. https://www.iucnredlist.org/en (Accessed 13 May 2020).
Ponte, S. 2012. The Marine Stewardship Council (MSC) and the Making of a Market for 'Sustainable Fish'. Journal of Agrarian Change, 12: 300–315.
Pontee, N. 2013. Defining coastal squeeze: A discussion. Ocean & coastal management, 84: 204–207. Elsevier.

Pope, E. C., Ellis, R. P., Scolamacchia, M., Scolding, J. W. S., Keay, A., Chingombe, P., Shields, R. J., *et al.* 2014. European sea bass, *Dicentrarchus labrax*, in a changing ocean. Biogeosciences, 11: 2519–2530. Copernicus GmbH.

Preece, C. 2008. A Field Guide to the Archaeology of the Taw and Torridge Estuaries. Edward Gaskell.

Quilter, J. 2013, November 29. Analysis: Why did RWE decide to drop Atlantic Array? Wind Power Monthly. http://www.windpowermonthly.com/article/1223085/analysis-why-rwe-decide-drop-atlantic-array?utm_source=website&utm_medium=social (Accessed 24 November 2020).

Radford, Z., Hyder, K., Zarauz, L., Mugerza, E., Ferter, K., Prellezo, R., Strehlow, H. V., *et al.* 2018. The impact of marine recreational fishing on key fish stocks in European waters. PLoS One, 13: e0201666. Public Library of Science San Francisco, CA USA.

Rees, A. 2019. Studying Silver Darlings in the Bristol Channel - Bristol Channel Herring Project Update. North Devon Marine Pioneer. www.northdevonbiosphere.org.uk.

Reynolds, W. J., Lancaster, J. E., and Pawson, M. G. 2003. Patterns of spawning and recruitment of sea bass to Bristol Channel nurseries in relation to the 1996'Sea Empress' oil spill. Marine Biological Association of the United Kingdom. Journal of the Marine Biological Association of the United Kingdom, 83: 1163. Cambridge University Press.

Roessig, J. M., Woodley, C. M., Cech, J. J., and Hansen, L. J. 2004. Effects of global climate change on marine and estuarine fishes and fisheries. Reviews in fish biology and fisheries, 14: 251–275. Springer.

Rush, S., and Caslake, R. 2009. Bass Lured Long Lines. ISBN 978-1-906634-08-7. Seafish.

Sciberras, M., Hiddink, J. G., Jennings, S., Szostek, C. L., Hughes, K. M., Kneafsey, B., Clarke, L. J., *et al.* 2018. Response of benthic fauna to experimental bottom fishing: A global meta-analysis. Fish and Fisheries, 19: 698–715.

Seafish. 2020a. Gill Nets. https://seafish.org/gear-database/gear/gill-nets/ (Accessed 17 August 2020).

Seafish. 2020b. Seafish. https://seafish.org/ (Accessed 30 June 2020).

Seafish. 2020c. Beach Seine. https://seafish.org/gear-database/gear/beach-seine/ (Accessed 18 August 2020).

Seafish. 2020d. Pelagic Trawl. https://seafish.org/gear-database/gear/pelagic-trawl/ (Accessed 30 June 2020).

Seafish. 2020e. Demersal Trawl – General. https://seafish.org/gear-database/gear/demersal-trawl-general/ (Accessed 16 July 2020).

Seafish. 2020f. Trolling. https://seafish.org/gear-database/gear/trolling/ (Accessed 18 August 2020).

Seafish. 2020g. Hand Lines. https://seafish.org/gear-database/gear/hand-line/ (Accessed 18 August 2020).

Sluijs, P. van der. 2017. English: Peter van der Sluijs made a selfie of his great sea bass caught with the fishing rod. https://commons.wikimedia.org/wiki/File:Peter_van_der_Sluijs_maakte_een_selfie_van_zijn_grote_zeebaars.jpg (Accessed 17 August 2020).

Sluijs, P. van der. 2018. English: Seabass with open mouth. https://commons.wikimedia.org/wiki/File:Zeebaars_met_een_open_bek.jpg (Accessed 12 August 2020).

Smith, C. L. 1990. Moronidae. Check-list of the fishes of the eastern tropical Atlantic (CLOFETA), 2: 692–694.

SOS Campaign. 2018, November 24. Save Our Sea Bass Campaign Group. https://www.boat-angling.co.uk/2018/11/24/save-sea-bass-campaign-group/ (Accessed 17 August 2020).

Stamp, T. 2020. The Ecology and Distribution of European Bass (*Dicentrarchus labrax*) in Inshore and Coastal Waters of the UK. University of Plymouth.

Stewart, J., and Wentworth, J. 2019. Climate Change & Fisheries. Parliamentary Office of Science & Technology. https://post.parliament.uk/research-briefings/post-pn-0604/.

The Crown Estate. 2020. Marine Aggregates Capability & Portfolio 2020. The Crown Estate. https://www.thecrownestate.co.uk/media/3634/2020-capability-portfolio-report.pdf.

The Fish Society. 2020. SEA BASS. https://www.thefishsociety.co.uk/fishopedia/sea-bass (Accessed 30 April 2020).

Thetmeyer, H., Waller, U., Black, K. D., Inselmann, S., and Rosenthal, H. 1999. Growth of European sea bass (*Dicentrarchus labrax* L.) under hypoxic and oscillating oxygen conditions. Aquaculture, 174: 355–367.

Thrush, S. F., and Dayton, P. K. 2002. Disturbance to marine benthic habitats by trawling and dredging: implications for marine biodiversity. Annual Review of Ecology and Systematics, 33: 449–473. Annual Reviews 4139 El Camino Way, PO Box 10139, Palo Alto, CA 94303-0139, USA.

Tillin, H. M., Hiddink, J. G., Jennings, S., and Kaiser, M. J. 2006. Chronic bottom trawling alters the functional composition of benthic invertebrate communities on a sea-basin scale. Marine Ecology Progress Series, 318: 31–45.

Torio, D. D., and Chmura, G. L. 2013. Assessing coastal squeeze of tidal wetlands. Journal of Coastal Research, 29: 1049–1061. The Coastal Education and Research Foundation.

Townhill, B., van der Molen, J., Metcalfe, J., Simpson, S., Farcas, A., and Pinnegar, J. 2017. Consequences of climate-induced low oxygen conditions for commercially important fish. Marine Ecology Progress Series, 580.

UK Government. 1990. The Bass (Specified Areas) (Prohibition of Fishing) Order 1990. No. 1156. Queen's Printer of Acts of Parliament. https://www.legislation.gov.uk/uksi/1990/1156/contents/made (Accessed 3 September 2020).

UK Government. 1999. The Bass (Specified Areas) (Prohibition of Fishing) (Variation) Order 1999. No. 75. Queen's Printer of Acts of Parliament. https://www.legislation.gov.uk/uksi/1999/75/made (Accessed 3 September 2020).

UK Government. 2020. Fishing data collection, coverage, processing and revisions - GOV.UK. https://www.gov.uk/guidance/fishing-activity-and-landings-data-collection-and-processing (Accessed 30 June 2020).

Vandeputte, M., Gagnaire, P.-A., and Allal, F. 2019. The European sea bass: a key marine fish model in the wild and in aquaculture. Animal genetics, 50: 195–206. Wiley Online Library.

Vázquez, F. J. S., and Muñoz-Cueto, J. A. 2014. Biology of European sea bass. CRC press.

Wade, O., Revill, A. S., Grant, A., and Sharp, M. 2009. Reducing the discards of finfish and benthic invertebrates of UK beam trawlers. Fisheries research, 97: 140–147. Elsevier.

Wenger, A. S., Harvey, E., Wilson, S., Rawson, C., Newman, S. J., Clarke, D., Saunders, B. J., *et al.* 2017. A critical analysis of the direct effects of dredging on fish. Fish and Fisheries, 18: 967–985. Wiley Online Library.

Więcaszek, B., Sobecka, E., Dudko, S., and Keszka, S. 2011. New and 'visiting'fish species collected off the western coast of Poland (Baltic Sea) in 2007–2008 with a description of their parasite fauna. Oceanologia, 53: 163–179. Elsevier.

Williams, C., Carpenter, G., Clark, R., and O'Leary, B. 2018. Who gets to fish for sea bass? Using social, economic, and environmental criteria to determine access to the English sea bass fishery. Marine Policy.

Xia, J., Falconer, R. A., and Lin, B. 2010. Impact of different tidal renewable energy projects on the hydrodynamic processes in the Severn Estuary, UK. Ocean Modelling, 32: 86–104.

Zambonino-Infante, J. L., Mazurais, D., Dubuc, A., Quéau, P., Vanderplancke, G., Servili, A., Cahu, C., *et al.* 2017. An early life hypoxia event has a long-term impact on protein digestion and growth in juvenile European sea bass. Journal of Experimental Biology, 220: 1846–1851. The Company of Biologists Ltd.

Appendices

European Sea Bass Aquaculture

Sea bass is one of the most heavily captively farmed fish species in Europe, with aquaculture yields dwarfing the combined landings of recreational and commercial fisheries (Vandeputte, Gagnaire and Allal, 2019). Sea bass was the first non-salmonid species to be commercially farmed in Europe; production is centred around southern Europe and some north African countries, with the bulk of fish being produced in Greece and Turkey (FAO, 2020). Aquaculture for sea bass began in the 1980s and rapidly grew over the next few decades to reach yields of close to 200,000 tonnes a year (see **Figure 27**).

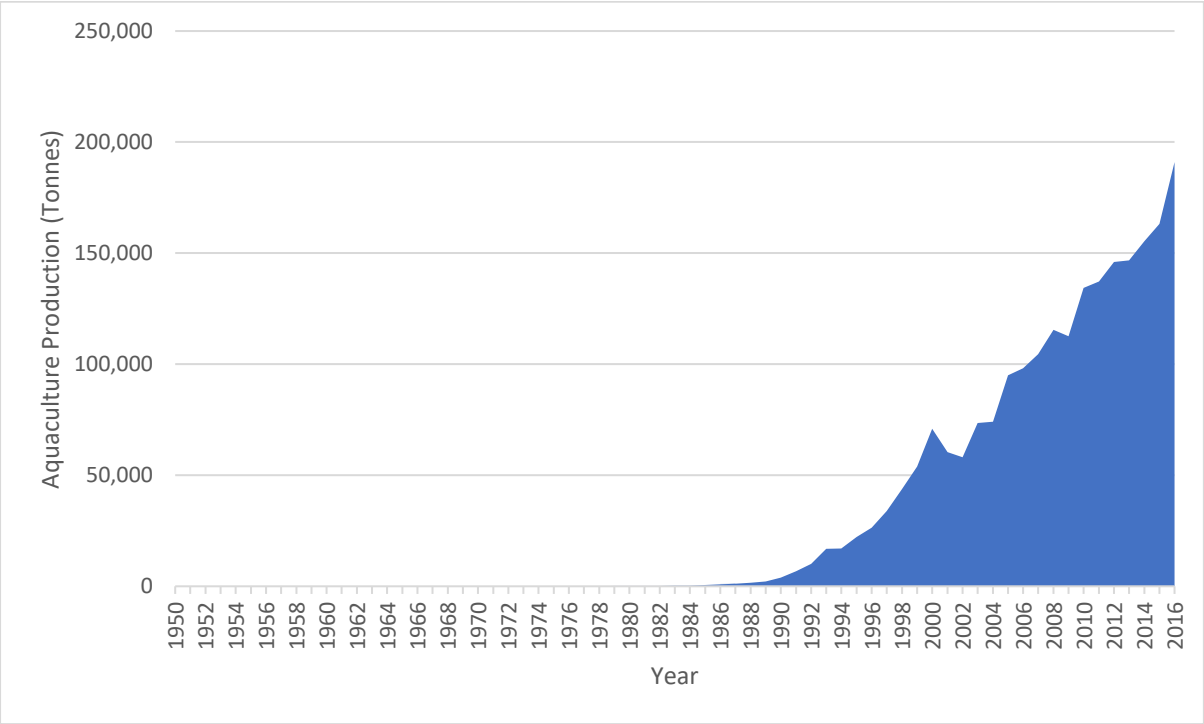

Figure 27 *- Global sea bass farming production.*

The farming of sea bass can be damaging to wild populations and their ecosystems (Vandeputte, Gagnaire and Allal, 2019). At present, approximately 96% (165,915 tonnes) of all farmed European sea bass production comes from captive farming with the remaining 4% (6,919 tonnes) being landed from fisheries (FAO, 2019). However, following the recent closure of a site in Wales, there are currently no active sea bass farms in the UK. Captive bass are farmed in open net pens which allow leaking of nutrients and other organic matters that can lead to chemical changes in the nearby environment (Cardia and Lovatelli, 2007). Many chemicals are used during fish production which also leaks into the surrounding ecosystem. Another form of pollution originating from bass farming is genetic pollution. This occurs when captive fish escape their pens and join wild populations of bass (Haffray *et al.*, 2007). Though this is not immediately threatening to the wild populations, there are risks relating to introduction of disease/parasites to wild populations as well as potential consequences to population genetics following long-term mixing of captive and wild populations, including the spread of genetic variants that are poorly adapted to local conditions.

Timeline of European Sea Bass Management Measures

Table 6 *- Past management measures for European sea bass (D. labrax) at EU, National and Regional level. Unless specified all measures here refer specifically to European sea bass.*

Year of Implementation	Management Body	Management Measures	Areas Affected	Reasons for Implementation	Reference
1986	European Commission	Minimum landing size (MLS) of 32cm	EU member states	Declining stocks of throughout the 1980s	Council Regulation (EEC) No 3094/86
1990	Irish Government Legislation	Moratorium on commercial fishing by Irish vessels	ICES Divisions VI & VII	Declining stocks throughout the 1980s in Irish waters	S.I. No. 128/1990 - Bass (Conservation of Stocks) Order, 1990
1990	European Commission	MLS increase to 36cm	EU member states	Declining stocks throughout the 1980s	Council Regulation (EEC) No 4056/89
1990	UK Government Legislation	Prohibition on enmeshing (gill) nets with mesh size between 65 and 89mm	ICES Divisions IV, VI, VIIa, VIId-h	Declining stocks throughout the 1980s	The Sea Fish (Specified Sea Area) (Regulation of Nets and Prohibition of Fishing Methods) Order 1989
	UK Government Legislation	Banned fishing in 34 designated nursery areas during spawning season	Various nursery areas across the UK	Aimed to prevent catching of immature fish before they have had a chance to breed	The Bass (Specified Areas) (Prohibition of Fishing) Order 1990
1999	UK Government Legislation	Three additional nursey areas added to legislation for closure to fishing during spawning as well as ban on using sand eels for bait	Various nursery areas across the UK	Aimed to prevent catching of immature fish before they have had a chance to breed	The Bass (Specified Areas) (Prohibition of Fishing) (Variation) Order 1999
2014	Devon & Severn IFCA	Use of mobile gear is restricted in certain estuaries and MPAs throughout the District	Various locations throughout District, including the rivers Taw and Torridge in North Devon	Aimed to protect vulnerable fish populations and key habitats	Devon and Severn IFCA Mobile Fishing Gear Permit Byelaw

2015	European Commission	Temporary pelagic trawling ban during spawning season	ICES Divisions IV, VI, VIIa, VIId-h	Huge declines in stocks prior to implementation	Commission Implementing Regulation (EU) 2015/111
		Three fish daily bag limit	EU member states	Large amount fishing mortality from recreational fisheries	Council Regulation (EU) 2015/523
		MCRS increase to 42cm	EU member states	Aimed to protect stocks and allow fish to reproduce before being caught	Commission Implementing Regulation (EU) 2015/1316
		Gear and catch limits	ICES Divisions IVb-c, VIId-f & h ICES Divisions VIIa & g (within 12 nautical miles of UK)	Huge declines in stocks prior to implementation	Council Regulation (EU) 2015/960
		Ban on all EU commercial fishing	ICES Divisions VIIa-c, g, j & k (outside 12 nautical miles of UK)	Stocks continuing to decline despite Irish national ban on sea bass fishing	Council Regulation (EU) 2015/960
2016	European Commission	Temporary pelagic trawling ban during bass spawning season	ICES Divisions IVb-c, VIId-f & h	Stocks still decreasing despite emergency measures in 2015	Council Regulation (EU) 2016/72
		Continued ban on all EU commercial fishing outside of allocated times	ICES Divisions VIIa-c, g, j & k (outside 12 nautical miles of UK)	Stocks continuing to decline despite Irish national fishing ban	Council Regulation (EU) 2016/72
		Gear and catch limits	ICES Divisions IVb-c, VIId-f & h ICES Divisions VIIa & g (within 12 nautical miles of UK)	Aims to relieve fishing pressure on stocks	Council Regulation (EU) 2016/72
2017	European Commission	Catch and release from 1st January till 30th June	ICES Divisions IVb-c, VIIa and from VIId-h (one fish		Council Regulation (EU) 2017/127

		One fish daily bag limit between 1st July and 31st September	daily bag limit year-round in Divisions VIIj and VIIk)	Stocks still decreasing despite emergency measures in 2015	
		Ban on commercial fishing from the shore	ICES Divisions IVb-c, VIId-f & h VIIa & g (within 12 nautical miles of UK)	Aims to protect inshore populations of immature fish	Council Regulation (EU) 2017/127
		Gear and catch limits	ICES Divisions IVb-c, VIId-f & h	Stocks still decreasing despite emergency measures in 2015	Council Regulation (EU) 2017/127
		Continued ban on all EU commercial fishing outside of allocated times	ICES Divisions VIIa-c, g, j & k (outside 12 nautical miles of UK)	Stocks continuing to decline despite Irish national ban	Council Regulation (EU) 2017/127
		Authorisation needed for commercial sea bass fishing	EU member states	Aimed to limit additional fishing effort	Council Regulation (EU) 2017/127
2018	European Commission	Catch and release	ICES Divisions IVb-c, VIIa and from VIId-h	Stocks still decreasing despite emergency measures in 2015	Council Regulation 2018/120
		Continued ban on all EU commercial fishing outside of allocated times	ICES Divisions VIIa-c, g, j & k (outside 12 nautical miles of UK)	Stocks continuing to decline despite Irish national ban on sea bass fishing	Council Regulation 2018/120
		Gear and catch limits	ICES Divisions IVb-c, VIId-f & h	Stocks still decreasing despite emergency measures in 2015	Council Regulation 2018/120
		Ban on commercial fishing from the shore	ICES Divisions IVb-c, VIId-f & h VIIa & g (within 12 nautical miles of UK)	Aims to protect inshore populations of immature fish	Council Regulation 2018/120
		Authorisation needed for commercial sea bass fishing	EU member states	Aimed to limit additional fishing effort	Council Regulation 2018/120

2018	Devon & Severn IFCA	Netters are not authorised to use nets with mesh sizes between 71 and 89mm	Devon & Severn IFCA District	Aimed to protect vulnerable fish populations and key habitats	Devon and Severn IFCA Netting Permit Byelaw
		Netting restrictions within specified estuaries and coastal habitats, including Lundy MPA	Various locations throughout District, including the rivers Taw and Torridge in North Devon		Devon and Severn IFCA Netting Permit Byelaw
		Using sand eels as bait when fishing for bass is prohibited			Devon and Severn IFCA Netting Permit Byelaw
2019	European Commission	Catch and release from 1st January to 31st March and 1st November to 31st December	ICES Divisions IVb-c, VIa and VIId-k	Stocks still decreasing despite emergency measures in 2015	Council Regulation (EU) 2019/124
		One fish daily bag limit between 1st April and 31st October			
		Continued ban on all EU commercial fishing outside of allocated times	ICES Divisions VIIa-c, g, j & k (outside 12 nautical miles of UK)	Stocks continuing to decline despite Irish national ban on sea bass fishing	Council Regulation (EU) 2019/124
		Gear and catch limits including ban on fishing during February and March	ICES Divisions IVb-c, VIId-f & h	Stocks still decreasing despite emergency measures in 2015	Council Regulation (EU) 2019/124
		Ban on commercial fishing from the shore	ICES Divisions IVb-c, VIId-f & h VIIa & g (within 12 nautical miles of UK)	Aims to protect inshore populations of immature fish	Council Regulation (EU) 2019/124
		Authorisation needed for commercial sea bass fishing	EU member states	Aimed to limit additional fishing effort	Council Regulation (EU) 2019/124
2020	European Commission	Catch and release from 1st January to 29th February and 1st November to 31st December	ICES Divisions IVb-c, VIa and VIId-k	Stocks still decreasing despite emergency measures in 2015	Council Regulation (EU) 2020/123
		Two fish daily bag limit between 1st April and 31st October			

	Continued ban on all EU commercial fishing outside of allocated times	ICES Divisions VIIa-c, g, j & k (outside 12 nautical miles of UK)	Stocks continuing to decline despite Irish national ban on sea bass fishing	Council Regulation (EU) 2020/123
	Gear and catch limits including ban on fishing during February and March	ICES Divisions IVb-c, VIId-f & h	Stocks still decreasing despite emergency measures in 2015	Council Regulation (EU) 2020/123
	Authorisation needed for commercial sea bass fishing	EU member states	Aimed to limit additional fishing effort	Council Regulation (EU) 2020/123
	Fixed netting ban	ICES Divisions IVb-c, VIa & VIId-k	Stocks remaining low	Council Regulation (EU) 2020/123
	Ban on commercial fishing from the shore	ICES Divisions IVb-c, VIId-f & h VIIa & g (within 12 nautical miles of UK)	Aims to protect inshore populations of immature fish	Council Regulation (EU) 2020/123

Key:	
	Commercial
	Recreational
	Both

Sustainability Ecolabels

The concept of sustainably sourced seafood has slowly been receiving more attention from consumers recently. More than ever, people are showing concern over the environmental implications of their actions, including where and how their food is sourced (Kaiser and Edwards-Jones, 2006). One way to encourage the sustainability of commercial fisheries, as well as the purchasing of sustainably sources products, is through the use of ecolabels. In essence, these are labels or marks found on seafood products that assure consumers the seafood in question has been caught in accordance with certain principles or practices, namely the fishery being formally assessed and found to be non-damaging to non-target marine species and habitats (Gudmundsson and Roheim, 2000). These ecolabelled products are usually sold at a higher price than similar non-labelled products. In principle, this price premium serves to recompense producers for the extra effort required to uphold the ecolabel standards during production as well as serve as an incentive to continue to uphold these standards and practices (Kaiser and Edwards-Jones, 2006).

The most well-known ecolabel within the seafood industry is the MSC, who have been assessing and certifying fisheries on their sustainability since 1997, allowing their catch to carry the MSC ecolabel and be sold as sustainably sourced (Ponte, 2012). As previously mentioned, the Bristol Channel bass trawl fishery previously sought sustainability accreditation from the MSC, with the assessment beginning in 2010. The assessment was completed in February 2011 and found that there were several weaknesses in the fishery preventing it from achieving MSC sustainable status (Andrews and Pawson, 2013). Chief among these was a lack of up-to-date stock assessment information, and the issue of discards of undersized bass and non-target species, particularly plaice seen within the fishery. In addition, the report found that the overall management regime for sea bass lacked formal objectives and harvest control rules that would allow for effective management of an inshore fishery. Notably, habitat damage and disturbance were not highlighted as a weakness of the trawl fishery, this is due to most of the bass fishery operating over sandy and muddy bottomed areas, where trawling is least destructive to demersal ecosystems.