Fisheries Research & Management Plan

Common Whelk (*Buccinum undatum*) 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 – Live common whelk, *Buccinum undatum* (MertildaA, 2019, https://commons.wikimedia.org/wiki/File:Live_common_whelk.jpg [unedited]).

Contents

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, 2020). 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 are low in 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 and 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 the 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 use a localised and ecosystem-based fisheries management (EBFM) approach. EBFM is a holistic way of managing fisheries. It takes into account 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.

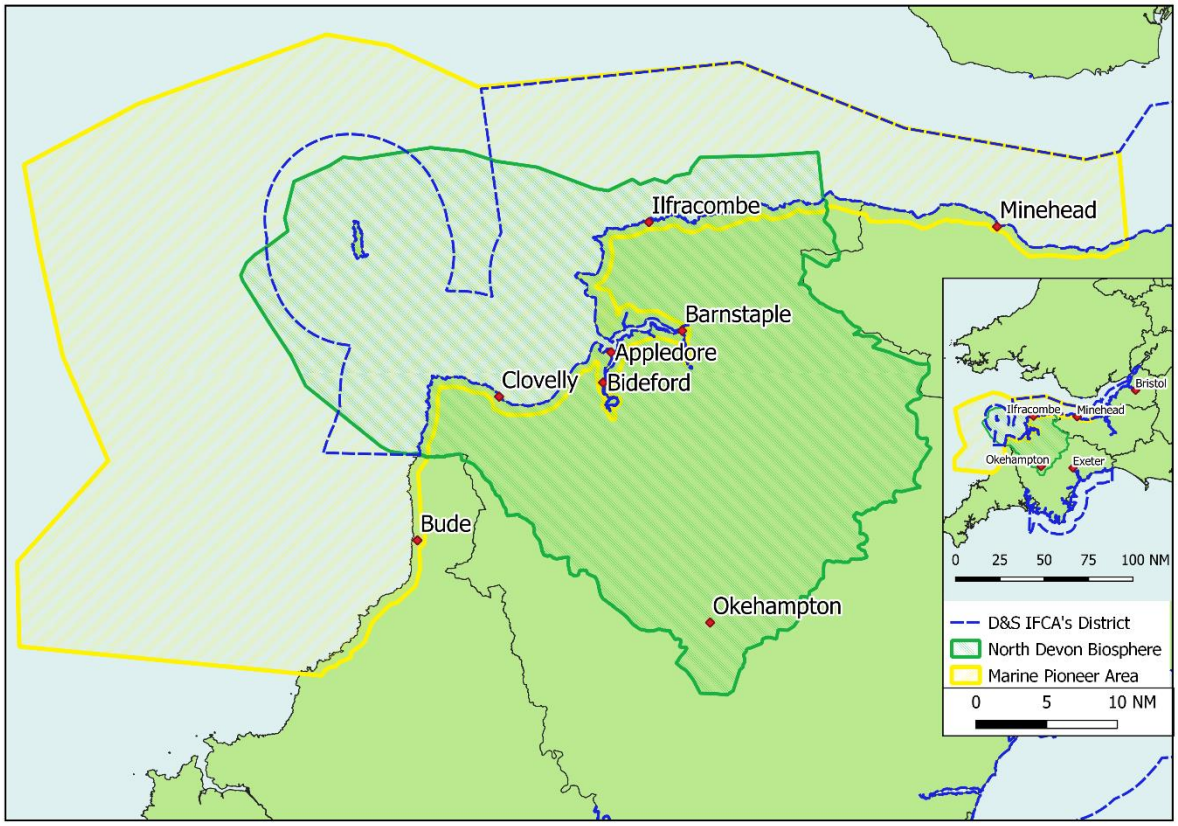

Figure 1 *- The Marine Pioneer area, North Devon Biosphere reserve, and Devon & Severn IFCA District on the North Devon and Somerset coastline.*

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.

Common Whelk

Whelk fisheries have been in place for centuries across the North Atlantic and have expanded rapidly over the course of the past few decades. Whelk is caught for human consumption and for use as bait in other fisheries (Magnúsdóttir, 2010). The growing demand for whelk in Asian markets has led to a dramatic increase in fishing effort in recent years across northern Europe and whelk is now one of the most important fisheries for the UK fleet (Lawler, 2013; McIntyre, Lawler and Masefield, 2015). This FRMP focuses on the common whelk (*Buccinum undatum*).

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 whelk 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 whelk stock structure to better understand whelk populations and feed this information into management.

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

Investigate sizes of maturity for Bristol Channel whelk populations to build on previous work by D&S IFCA and ensure the new regional MCRS is effectively preventing overexploitation of whelk stocks.

Investigate impact of climate change on whelk populations to understand how populations may change in the future and how this will affect fisheries.

Management

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

Trial limits on days at sea and potting for the Bristol Channel whelk fishery to test the viability of different methods to limit fishing effort to help keep whelk exploitation sustainable.

Implement appropriate regional MCRSs across UK and Europe to protect fished whelk stocks from overexploitation.

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 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 whelk 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

There is cause for concern with whelk fisheries because of increasing levels of exploitation driven by the growing demand from Asia and a lack of fisheries regulation. Further management measures are needed to regulate UK whelk fisheries and ensure they remain sustainable. Before the appropriate measures can be identified and introduced, information about whelk populations and life histories at both local and national levels must be gathered. In the meantime, fishing effort needs to be regulated to prevent overexploitation. Some IFCA districts have put in place additional management measures such as potting limits and gear restrictions to regulate fishing effort for whelk (Eastern IFCA, 2020), but there are still many unregulated fisheries across the UK. Fishers in North Devon are concerned about the sustainability of the whelk fisheries in the Bristol Channel because of its rapid development, and would support additional management measures to safeguard it for the future (Marine Pioneer Interviews, 2020).

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 whelk stock structure – *High Priority*

Whelk stocks need to be identified and clearly defined so that fisheries managers are able to assess and monitor them and create an effective management plan. There isn't currently enough information on the stock structure of whelk at a regional nor European level and this is preventing further management measures being developed to protect the sustainability of fisheries. Assessing and monitoring whelk stocks should be simpler than finfish as they have low mobility and populations remain relatively fixed over long periods of time.

Impriving knowledge in this area can also be extremely beneficial to the fishing industry. The whelk fishery in Normandy, France has received MSC certification after management was improved through having detailed information on the local whelk populations. Having a sustainability ecolabel can improve the market and add value to a fishery (see **Sustainability Ecolabels**).

Next steps:

- IFCAs and other researchers should collaborate with fishers to build on existing whelk research and begin local- to regional-scale investigations of whelk stock structure.

- Collaborative projects could be developed and communicated through the Shellfish Industry Advisory Group (SIAG) and the IFCA Whelk Working Group
- Any future monitoring or research should be designed in collaboration with appropriate organisations (e.g. MMO, Cefas, Defra and ICES) to ensure the data is suitable for input to larger scale stock assessments and Fisheries Management Plans (FMPs) when appropriate.

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

Engaging with fishers through the FRMP interviews has been invaluable in investigating local whelk 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 make this standard practice (for example, collaborations will require standardised protocols and terms of reference, including for shared use of vessels and research equipment).

Investigate sizes of maturity for Bristol Channel whelk populations – *Medium Priority*

Identifying the size of maturity (SOM) of whelk populations is needed to determine whether the current minimum conservation reference size (MCRS) measures are protecting the stocks from overexploitation. Existing research shows that the SOM varies between different whelk populations, this includes populations that are located in close proximity to one another. Previous research carried out by D&S IFCA has documented the SOM of whelk in the Bristol Channel near Ilfracombe, but this work needs to be expanded to document the SOM of whelk in the different regions of the Channel. Identifying whelk with different SOM will also help inform management about the distinct local stocks present in the Bristol Channel.

Next steps:

- Build on the body of evidence for a more appropriate MCRS for whelk across the UK by iteratively investigating SOM for different whelk populations on a smaller scale (e.g. in the Bristol Channel). This research could be a collaboration between IFCAs, fishers, other researchers, and higher management such as the MMO or Defra.
- Projects can be developed and communicated through the Whelk Working Groups and be used to inform FMPs by Defra and the MMO. This work would also support delivery of the sustainability objective of the Fisheries Act 2020 and feed into discussions with Cefas and ICES on how to best assess whelk stocks.

Investigate impact of climate change on whelk populations – *Low Priority*

Further research is needed to investigate the impact of climate change on whelk populations. It is likely that climate change will cause major changes in the distributions of whelk because of their low mobility and high sensitivity to temperature. Gathering information on the possible effects of climate change on whelk and feeding this into management will better protect stocks while also help the fishing industry to adapt to our changing seas.

Next steps:

- There are opportunities for researchers to explore the viability and distribution of future fisheries under scenarios of stock health, climate change and management approaches.
- Research collaborations with fishers can be facilitated by the IFCAs and Whelk Working Groups.
- This research would help inform stock assessments and sustainable fisheries management and FMPs, and contribute to delivery of the scientific evidence, climate change, sustainability and ecosystem 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 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 these are 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.

Trial limits on days at sea and potting for the Bristol Channel whelk fishery – *Medium Priority*

Engagement with whelk fishers in the Bristol Channel have shown there is a clear consensus for introducing limitations on the fishing effort to help prevent whelk overexploitation (FRMP

Interviews, 2020). Days at sea and potting limits were both raised by the fishers as potential management measures for the whelk fishery. These measures were preferred to further increases in MCRS as there have already been two recent increases in the MCRS of whelk within D&S IFCA's District. Limits to days at sea and potting should be trialled to see which is the most appropriate approach for the sustainability of the fishery and safety of the fishers.

Days at sea – limiting the number of days a year that fishers can fish for whelk could allow stocks to recover while other species are fished. Some of the fishers interviewed as part of this project are supportive of a return to traditional seasonal inshore fisheries where species are only targeted for several months out of the year and are left to recover while other species are fished. Our interviews with fishers did raise concern that limiting days at sea may drive fishers to operate in dangerous weather conditions to utilise all of their allocated days at sea and not leave them unused (FRMP Interviews, 2020).

Potting – a potting limitations trial across a fixed area would allow for regulation of fishing effort while avoiding the possibility of fishers being forced to operate in dangerous conditions. It would also provide an opportunity to quantify the whelk fishing effort and more accurately assess the size of local populations. This information could be used alongside landings data to predict the health of stocks. Fishers from the FRMP interviews were open to trailing a whelk potting limit within a defined area to test if the measure is viable and appropriate for the Bristol Channel.

Next steps:

- Trials of effort limitations for whelk fishing require careful planning and collaboration between Defra, IFCAs, fishers and most likely NGOs/ public bodies aiming to help the fishing industry such as the Blue Marine Foundation.
- Trialling the viability of effort limitations can feed into future whelk fisheries management and contribute to the delivery of the evidence and sustainability objectives of the Fisheries Act 2020.

Implement appropriate regional MCRSs across UK and Europe – *Medium Priority*

It is vital to assess the SOM of exploited whelk populations on a local level and implement appropriate MCRSs to prevent overexploitation. There is a large amount of scientific research that demonstrates significant regional differences in SOM for whelk populations (see research recommendation on SOM above) and many sampled populations matured at larger sizes than the EU MCRS of 45mm (Haig et al., 2015b; Lawler, 2013; McIntyre, Lawler and Masefield, 2015; MRAG, 2018). There have been a small number of regional increases in the MCRS of whelk in the UK and Europe but whelk populations across large regions of the UK and Europe remain vulnerable to overexploitation. The MCRS for whelk in North Devon has been increased recently but this may need to be reviewed if different stocks of whelk with different SOM are identified in the region.

Next steps:

- Next steps for this recommendation will partially depend on the findings of the recommended research. Management can stay informed on research and the best course of action through expert groups such as the Whelk Working Groups.
- It may be necessary to extend management measures out past the six nautical mile boundary in areas where high levels of whelk fishing occur to protect offshore populations from overfishing. This would ensure that the inshore fishing fleet are not disadvantaged by a difference in management measures and would contribute to the delivery of the sustainability objective of the Fisheries Act 2020.

Improve communication and engagement with fishers and local stakeholders 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

The common whelk (*Buccinum undatum*), sometimes referred to as the waved whelk, is a large, carnivorous marine gastropod found in coastal waters throughout the North Atlantic Ocean. The common whelk is a very important commercial species, particularly in the UK where it is abundant along most coastlines (Hayward and Ryland, 2017).

Figure 2 *- Common whelk (B. undatum) with siphon extended (Picton, 2018, https://commons.wikimedia.org/wiki/File:Buccinum_undatum2.jpg [unedited]).*

Whelks belong to the family *Buccinidae*, also known as the “true whelks” (Fretter and Graham, 1962). Although there are hundreds of different marine gastropod species, the common whelk is easily identified due to its white and black speckled body colouration and large size (see **Figure 2**). Its shell is yellowish brown in colour and has seven or eight whorls with spiralled ridges. Common whelks are the largest sea snails found in UK waters, with their shells reaching up to 10cm in length and 6cm in width (MarLIN, 2020).

Geographical Range, Migrations & Habitat

B. undatum is most commonly found just below the tidal zone, around 50 metres in depth, however, populations occurring at depths of up to 1,200 metres are not uncommon (Weetman *et al.*, 2006). Whelks do not tend to group closely together in their habitat: whelk density tends to be only one whelk per square metre, though some regions are more densely populated than others, such as the Gulf of St. Lawrence in Canada, which is occupied at a density of up to 1.8 whelks per metre^2 (Magnúsdóttir, 2010).

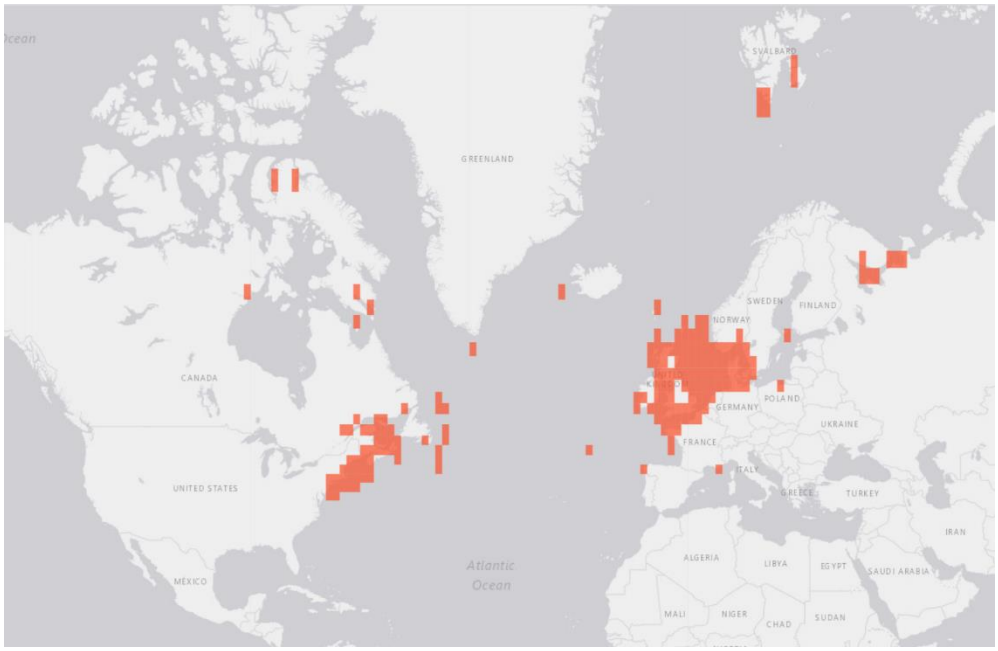

Figure 3 *- Global distribution of the common whelk (B. undatum) (OBIS, 2017, https://obis.org/taxon/138878 [unedited]).*

The common whelk is abundantly distributed across the Atlantic continental shelf and occurs in densities able to support local fisheries in Europe and North America (Emmerson *et al.*, 2020). Whelk populations can be found on both sides of the Atlantic Ocean (see **Figure 3**), also occurring in the Greenland and Norwegian seas (Golikov, 1968). Its European range includes the entire UK coastline (see **Figure 4**), the northern coasts of France, Germany and much of northern Europe (Heude-Berthelin *et al.*, 2011). Populations have been studied off the southern coast of Svalbard and some regions in the White Sea of eastern Russia (Kusnetsov, 1963). There are also reports of common whelks observed in areas of north eastern Spain (Magnúsdóttir, 2010). On the eastern coast of North America, the common whelk can be found as far south as New Jersey and its range extends up to Labrador, with further reports from areas in far northern Canada (Gendron, 1992).

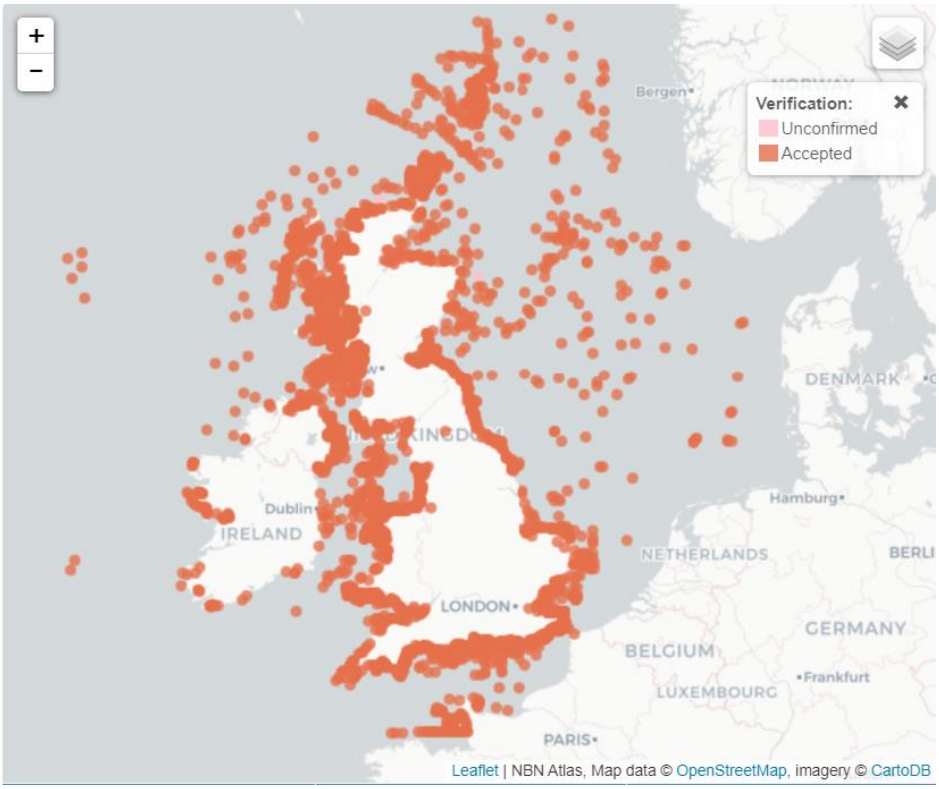

Figure 4 *- Distribution of the common whelk (B. undatum) throughout UK waters (NBN Atlas, 2020, https://species.nbnatlas.org/species/NBNSYS0000174225 [unedited]).*

Common whelks can thrive on a range of substrates, including mud, sand, gravel and rocks. Whilst dwelling in soft substrates such as sandy bottomed areas, whelks will spend most of their time (up to 75%) buried unless engaging in feeding or mating activities (Himmelman, 1988). They are not well adapted to intertidal life due to an intolerance for low salinities and if exposed to air, whelks may abandon and crawl from their shells, risking desiccation (Hallers-Tjabbes *et al.*, 1996). The common whelk may prefer colder temperatures and cannot survive in environments above 29°C (Hallers-Tjabbes *et al.*, 1996), because of this, it is possible that the distribution of whelk populations may change and shift northwards in the coming decades as a result of climate change.

Reproduction & Life History

Unlike many other species of marine gastropod, the common whelk has two distinct sexes. Males are easily distinguished by their large, muscular penis which is found folded back within the mantle cavity (Kideys, Nash and Hartnoll, 1993). The common whelk typically displays distinct seasonality in relation to breeding periods, which has been seen to vary greatly between different geographic populations (Haig *et al.*, 2015a). In the UK and Europe, whelk copulation begins from autumn and lasts until mid-winter, with egg-laying beginning soon after; between November and January (French, 2011; Lawler, 2013). This varies with geographical location however, with copulation and the resulting egg laying occurring from mid-May to the end of August in Canada (Himmelman and Hamel, 1993; Magnúsdóttir, 2010). It has been proposed that this variation in breeding season is due to a difference in sea temperatures between North America and Europe, and that the common whelk may find the slightly warmer waters of Europe unfavourable for embryonic development if it too were to spawn in the summer (Martel *et al.*, 1986a).

Before being deposited, large groups of eggs (between 100 and 2,200 individual eggs) are coated in mucus together to form egg capsules within females (Fretter and Graham, 1962). These capsules are then laid on either solid benthic substrates or floating objects (see), forming large egg masses that multiple females often contribute to (Martel, 1985). Periods of whelk egg laying can be extended as females are able to store sperm for up to eight weeks after copulation, allowing them to wait for optimum environmental conditions before spawning to maximise the chances of offspring survival (Martel, Larrivée and Himmelman, 1986). Of the hundreds and sometimes thousands of eggs per capsule, only ~10 will survive and undergo full development, the rest providing nutrition to these few whelk that will survive or to predators (Magnúsdóttir, 2010).

Figure 5 *- A female common whelk (B. undatum) depositing its egg capsules on rock (Pembrokeshire Coastal Photography, 2014, https://www.pemcoastphotos.com/photo_7430736.html [unedited]).*

Unlike many other marine organisms, the common whelk lacks a planktonic larval phase in its life cycle and rarely migrates between populations. This creates distinct, closed populations with low genetic diversity (Haig *et al.*, 2015b). These regional populations show key characteristic differences in their life histories such as differences in size and age of maturity, growth rates and variations in breeding seasons (Kideys, Nash and Hartnoll, 1993).

For example, previous studies in the UK have shown that the size of maturity (SOM) of common whelk populations across England and Wales can vary from shell heights of 45.2mm up to 85mm (Bell and Walker, 1998; Stephenson, 2019). Further work within UK waters has found that neither males or females mature at consistently larger or smaller sizes than the other (McIntyre, Lawler and Masefield, 2015). Similar results to this are seen for whelk populations in Sweden, however male whelks mature at smaller sizes than females along the

Brittany coast of France and some areas of the English Channel (Valentinsson *et al.*, 1999; Heude-Berthelin *et al.*, 2011). Samples taken in fishing grounds off of Lundy within the NDMP area showed that both male and female whelks in North Devon are becoming sexually mature upon reaching shell heights of 75.5 – 77.5mm (McIntyre, Lawler and Masefield, 2015; Stephenson, 2019). However, as previously mentioned, these life history traits vary between regional populations, so it is likely that this SOM will not apply to all whelk populations along the North Devon coast. Although differences in life histories are often observed between populations, most whelks have been observed to have a lifespan of up to ten years, however it is thought that they are more likely to live to a higher age (Hallers-Tjabbes *et al.*, 1996).

Food Web & Interspecies Interactions

The common whelk is a predator and opportunistic scavenger (French, 2011). Predatory behaviour is very rarely observed in the wild, though whelks are capable of relatively rapid movement and have specific feeding techniques for live prey such as bivalve molluscs (Nielsen, 1974; Himmelman, 1988). Observations and stomach contents analysis have shown that whelk food sources include polychaete worms, echinoderms, small crustaceans, fish eggs and bivalve molluscs, in addition to larger dead marine organisms such as fish and crustaceans (Nielsen, 1974; Taylor, 1978; Himmelman and Hamel, 1993). The relative contribution of each food source to whelk diets may vary regionally and between habitat types (Magnúsdóttir, 2010). Whelk use a sensory organ called a siphon to detect and locate food sources on the seafloor based on their chemical traces in the water (see **Figure 6**); this ability is exploited in whelk fisheries, in which fishers use dead bait in pots to attract whelks (Haig *et al.*, 2015b).

***Figure 6** - A common whelk (B. undulatum) with siphon extending from the top of the head (Picton, 2014, https://commons.wikimedia.org/wiki/File:Buccinum_undatum1.jpg [unedited]).*

Common whelks are also a food source for a variety of larger marine organisms including cod, dogfish, skate and lobsters (Hallers-Tjabbes *et al.*, 1996). Species of crabs have also been recorded to crack open the shells of whelk and feed on them within the pot traps of fishermen (Crouch, 1967).

Fishery Information & Structure

Due to the abundance of the common whelk in all UK coastal waters (Lawler, 2013), local artisanal fisheries for whelk have existed across the UK for over 100 years, including within the Bristol Channel (Ellis, Rogers and Freeman, 2000). Modern, commercial fisheries have been in operation in the South West of England since the 1940s, since then, popularity and fishing effort has been increasing, with over £25 million worth of whelk being landed by the UK fishing fleet in 2019 (MMO, 2020).

Figure 7 *- Whelk pots waiting for IFCA inspection (K&E IFCA, 2020, https://www.kentandessex-ifca.gov.uk/i-want-to/fish-for-whelks/ [unedited]).*

Importance & Value of Fishery

Rising overseas demand has led to whelk becoming one of the most important commercial shellfish fisheries for the UK fishing fleet after *Nephrops*, scallop, crab and lobster, with landings and value increasing steadily over the past decade and several valuable whelk fisheries emerging across the UK (Lawler, 2013). Whelk landings have fluctuated slightly in recent years; however, their value has steadily increased during this time (MMO, 2020). In 2014, just over 20,000 tonnes of whelk were landed by the UK fishing fleet with a value of £16.4 million. However, the same weight of whelk was landed in 2019 but were valued at over £25 million.

Whelk is a non-quota species, meaning they are not subject to any total allowable catch (TAC) regulations under the European Common Fisheries Policy. Nationally, there are no management measures in place dictating how much whelk can be landed each year by fishers in the UK (MRAG, 2018). Because of this, compared to other fisheries, entry into the UK whelk

fishery remains non-restricted, with little investment needed to buy potting traps (Haig *et al.*, 2015b). Valuable non-quota fisheries such as whelk are of particular importance to the inshore fishing fleet due to their localised nature and the opportunity of a seasonal alternative catch to lobster and crab they offer (McIntyre, Lawler and Masefield, 2015). Whelk fisheries can therefore contribute as major income for local regions as displacement fisheries, as vessels shift their fishing effort from more regulated fisheries across to the less regulated whelk fisheries (Haig *et al.*, 2015b).

A small portion of the whelk caught in British waters is consumed in the UK or used for bait in other fisheries, however the majority of the catch is now exported to European or Asian markets, chiefly South Korea (Fahy *et al.*, 2000). In February 2019, the BBC reported that of the 10,000 tonnes of whelk caught in the Bristol Channel each year, almost all are exported to Asia with almost no interest in them from UK markets and that fishermen "*can't give them away*" to locals (Prior, 2019). These whelks are loaded onto factory ships that cook and freeze them while en route to South Korea. The exportation of whelk adds immense value to the fishery, current UK landings of whelk sit around £20 million per year, however, whelk exports from the UK are valued at £40 million per year (Webster and Silcock, 2018). This added value does not transfer directly to the fishermen, but rather supports additional businesses within the trade and transport industries that organise and oversee the export of whelks to Asian markets. Because of this, the whelk fisheries within the UK represent important international trade relationships both within and outside the European Union (see **Figure 8**). Collapses in UK whelk stocks would lead to losses in income for the UK fishers as well as the transportation companies across Europe and Asia that rely on business from the whelk fisheries.

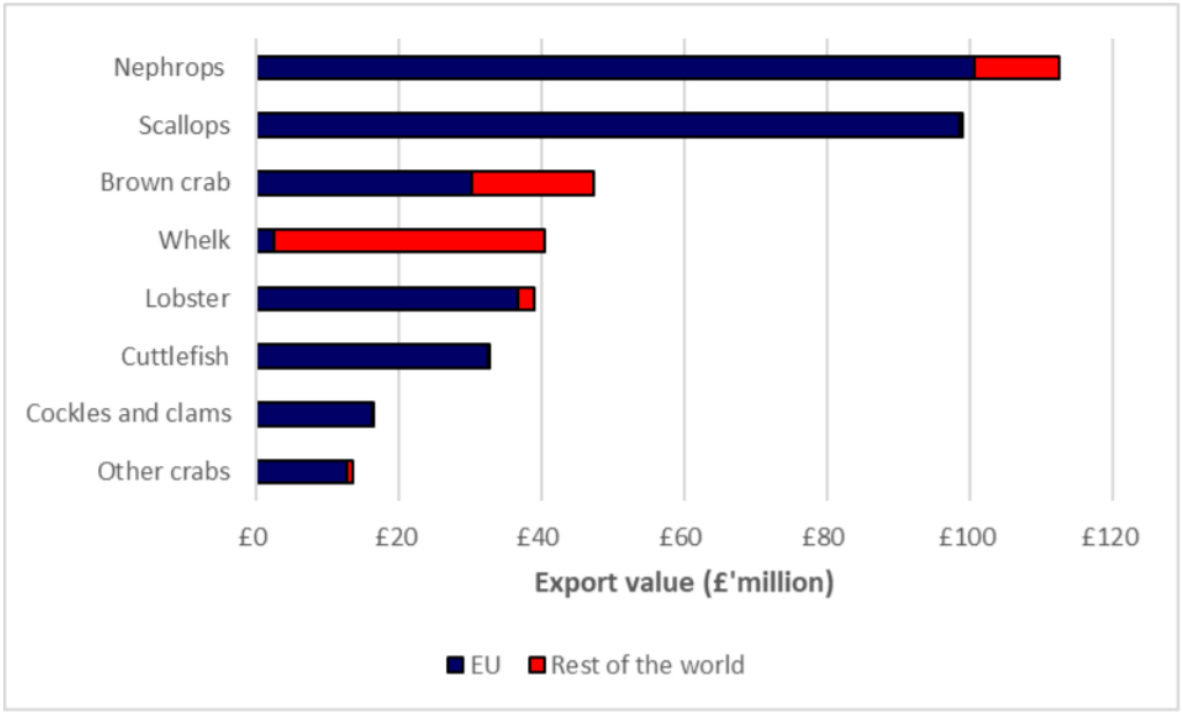

Figure 8 *- Export values within the European Union and to the rest of the world for UK shellfish fisheries (Webster and Silcock, 2018, https://www.seafish.org/media/1814149/clg_nov2018_cumulus.pdf [unedited]).*

Whelk fisheries are in operation all around the UK, including the Northern and Southern coasts of Devon. MMO landings statistics from the last decade show that total landings by the English whelk fishing fleet are highest at ports within the Southern, Sussex, and Devon & Severn IFCA

districts (see **Figure 9**). Of the £25 million worth of whelk landed in the UK in 2019, almost £300,000 worth was landed in Ilfracombe (the largest port within the NDMP area), showing the importance of the whelk fishery to North Devon fishers (MMO, 2020). Fishermen from North Devon, particularly Ilfracombe, have stressed the importance and essential nature of the whelk fishery to their income as it allows them to focus their fishing efforts away from lobster and crab fisheries for part of the year, easing fishing pressure on stocks to help keep future landings high (FRMP Interviews, 2020). The whelk fishery may also carry high non-monetary values in North Devon, such as cultural and heritage values. In many areas of the country, including North Devon, whelk fisheries have been operating for decades and many of the fishermen working these fisheries see them as a way of life, rather than just as a source of income (FRMP Interviews, 2020; Marine Pioneer Interviews, 2020).

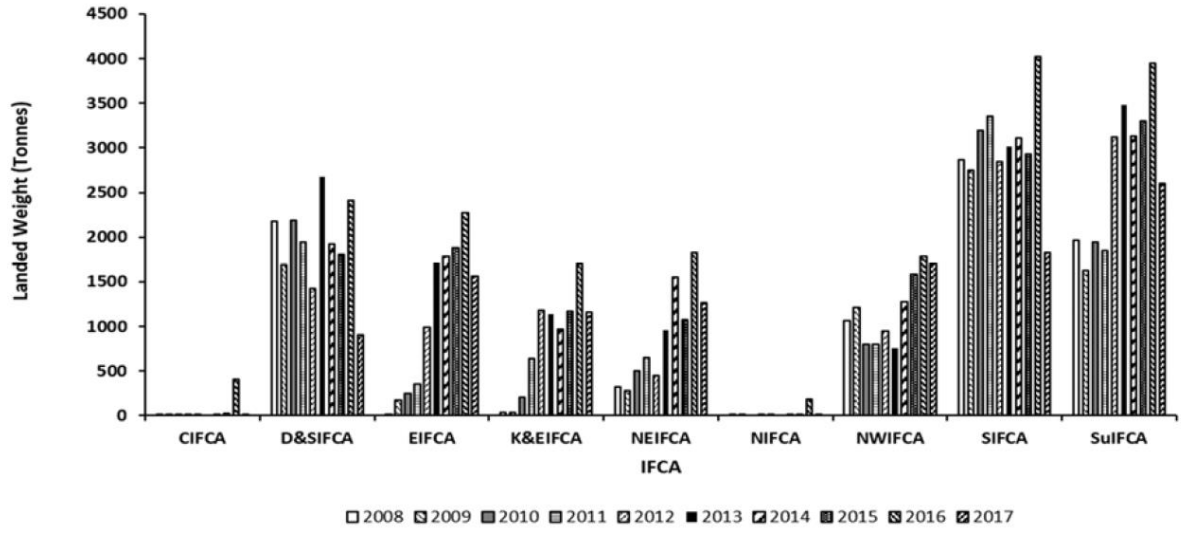

Figure 9 *- Total annual landings (tonnes) of common whelk (B. undatum) in each IFCA district from 2008 to 2017 by UK fishing fleet (MRAG, 2018, https://www.bluemarinefoundation.com/wp-content/uploads/2019/05/MRAG_Final_Whelk_Report.pdf [unedited]).*

Recreational potting and hand gathering for shellfish are popular activities in the UK (Devon & Severn IFCA, 2019b). Recreational potters mostly target lobster and crab and rarely use the specialised pots needed to catch whelk, because of this it is thought that recreational potters have little impact on whelk stocks. It is also unlikely that whelks are taken by coastal hand-gatherers, as common whelks rarely venture into the intertidal zone where these gatherers operate (MRAG, 2018).

Historical Landings & Changes Over Time

The UK whelk fishery has grown substantially in the past century, with landings quadrupling since the early 1900s (Emmerson *et al.*, 2018). During its origins, the whelk fishery was mostly artisanal and patchy in its distribution, with annual landings for England and Wales being in the region of ~4,500 tonnes annually (Dakin, 1912). Fisheries remained stable throughout most of the 20th century until the 1960s and 70s where increasing demand for whelk from overseas markets drove large expansions in whelk fisheries over the next few decades (Fahy, Yalloway and Gleeson, 1995). The increase in popularity of common whelk fishing may also have been a result of depletions in the stocks of Pacific Ocean whelk species (Fahy *et al.*, 2005).

By the 1970s, there were several large-scale whelk fisheries operating across the UK and Europe (MRAG, 2018). Though during the late 20th century there were several significant whelk stock collapses. Declines in catch in the Dutch Wadden Sea whelk fishery had been observed since the 1930s, these declines were thought to be due to overfishing and lethal shell damage to whelks from the dredge fishing gear used by Dutch fishermen (Cadee *et al.*, 1995). Landings were so poor that in the late 1970s the fishery ended. Surveys performed since then have shown that whelks are now locally extinct in coastal areas where they were historically fished in the Wadden and North Seas (Hallers-Tjabbes *et al.*, 1996). The South Irish Sea whelk fishery expanded from 56 tonnes landed in 1990 to 6,575 tonnes in 1996 in response to the rising demand for whelks in South Korea. Over the 1990s annual landings fluctuated around three to four thousand tonnes, however, whelk stocks collapsed in 2004 (Fahy *et al.*, 2000). Investigations found that a large increase in fishing effort in 2003 (a 42% increase in effort from the year before) following a substantial recruitment the year before was the reason behind the 2004 stock collapse (Fahy *et al.*, 2005).

Despite historic crashes in whelk fisheries, it is clear that viable fisheries remain in the UK. There has been a steady increase in landings in the UK throughout the early 21st century, in the decade from 2003 to 2013, UK whelk landings more than doubled from ~8,000 tonnes to 19,000 tonnes (MRAG, 2018). This increase has mainly been attributed to rising demands from Asian markets such as South Korea. This is a prime example of the “fishing down the food web” concept (Pauly and Palomares, 2005), as we can see a clear shift in fishing effort to lower trophic levels and filter feeding species compared to the species targeted in historic fisheries data (Wordley, 2019).

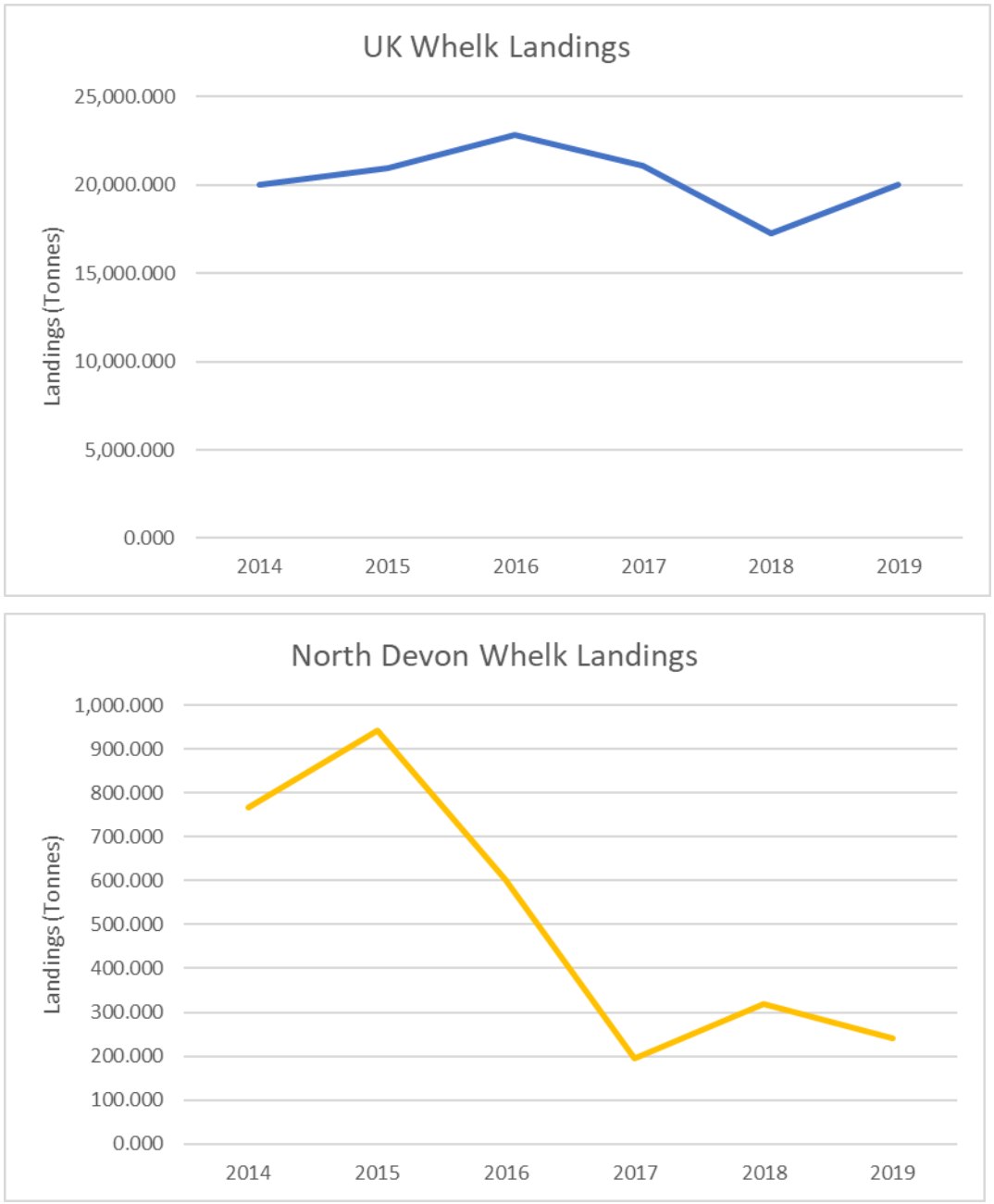

Figure 10 *- Annual UK (top) and North Devon (bottom) landings of whelk from 2014 to 2019 (MMO, 2020).*

Landings in more recent years from the UK fishing fleet have remained relatively steady at 20,000 tonnes per year (see **Figure 10**), though the value of whelk has increased greatly during this time, from approximately £800 per tonne in 2014 to over £1,200 per tonne today (MRAG, 2018; MMO, 2020). This consistency in landings has not been observed in North Devon however, where landings have dropped dramatically in the space of just five years. It is not evident if this drop is a result of overfishing or other factors such as changes in environmental conditions. This drop in landings is worrying for North Devon fishers, as whelk provide a large proportion of income to fishermen here, particularly in Ilfracombe. Whelk also acts as a much-needed alternative catch to species normally targeted such as lobster and crab (FRMP Interviews, 2020).

Gear Used

Whelks in the UK are almost exclusively caught using a specialised type of potting gear. These pots are essentially plastic drums, weighted at the bottom with concrete so that they remain upright when set on the sea floor. Bait, usually dogfish or brown crab, is placed inside the drum and the pots are set attached to one another in strings on the seabed (Seafish, 2020). Pots are hauled up at intervals (usually one to three days), rebaited and then set down again. Many modern pots have entrances formed of netting with a hole set in the middle. This design allows easy access to the bait for whelks but makes escape afterwards almost impossible (see **Figure 11**).

Figure 11 *- Whelk pot (Seafish, 2015, https://seafish.assetbank-server.com/assetbank-seafish/action/viewAsset?id=4841 [unedited])*

A small proportion of whelk landings in the UK are taken as bycatch in other potting fisheries such as lobster and crab (FRMP Interviews, 2020). In the past, non-potting whelk fisheries have been in operation in different regions of the Atlantic. For example, the Dutch Wadden Sea whelk fishery operated using specialised dredges that would scoop up whelk directly from the seafloor (De Vooys and van der Meer, 2010). However, investigations have now shown this gear to be highly destructive to whelk and it is now thought that damage caused to whelk shells by these dredges is one of the reasons whelk have since disappeared from the Wadden Sea (Cadee *et al.*, 1995). Currently these dredges are not in use in the UK, though whelk dredge fisheries may be in operation in some areas of North America (Bruce, 2009).

Environmental impacts from whelk potting is generally very low. The weighted pots mean there is a slight possibility of abrasion on the seabed, however, this will be restricted to areas with strong tides and bad weather (Seafish, 2020). The design of the pots all but abolishes the risk

of bycatch, the netting allows most species of fish and shellfish to easily escape and any fish that do remain trapped can be returned to the sea alive once the gear is hauled. Bycatch usually consists of starfish and various crab species which are caught alive and undamaged, however, there are anecdotal reports of leatherback turtles becoming entangled in pot lines (MCS, 2020). During an interview with the BBC, one Bristol Channel whelk fishermen stated "*You can't get more sustainable than whelks. There's an abundant stock of them in the Bristol Channel and the pots cause virtually no harm to the seabed"* (Prior, 2019).

Current Stock Status

Unlike many other commercial fish species, whelk in the UK have never been assessed as a stock due to a lack of suitable data and therefore little is known regarding their population status (Emmerson *et al.*, 2018). This lack of stock or abundance data means predicting and preventing overexploitation is extremely difficult and often not possible until stocks have already collapsed, as was the case in the Wadden and North Seas (Hallers-Tjabbes *et al.*, 1996). This uncertainty of the health of whelk stocks has prevented the implementation of a TAC across Europe and the UK, meaning more effective management of whelk has not been possible (McIntyre, Lawler and Masefield, 2015). However, Eastern IFCA has recently made an effort to better understand the health of their whelk stocks. In 2016, Eastern IFCA introduced a new permit specifically for vessels targeting whelk in their district. This permit requires recreational and commercial fishermen to submit monthly reports of their landings, the number of whelk pots used as well as soak time (EIFCA, 2020). This information was used to calculate the catch per unit effort in various whelk fisheries across the Eastern IFCA district and has allowed managers to predict the health of whelk populations and highlight areas of potential over exploitation more reliably, helping to prevent stock collapse and safeguarding fisheries.

While it may still be years before whelk are formally assessed across the whole of the UK and the rest of Europe, Eastern IFCA has shown that collection of basic fishing data can be used to calculate catch per unit effort, providing much needed insight into how whelk stocks are being affected by fishing. Due to the low mobility of whelks, and the regional variation in sizes of maturity, IFCAs are in the position to effectively manage local whelk stocks and fisheries, provided they have the correct information to calculate catch per unit effort. Several IFCAs currently issue permits specifically for whelk fishing, though if Eastern IFCA's permit data collection technique was adopted by all IFCAs with substantial whelk fisheries, the effects of fishing on all inshore whelk stocks around England could be investigated. There would of course be limitations to this data and the potential management measures implemented as a result of the findings, however until whelk stocks are formerly assessed on a large scale, this method would provide basic insight into whelk fisheries to inform management.

Fishery Management

The management measures laid out in the following section have been summarised for the sake of this management plan. 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.

Whelk are managed under the EU's Common Fisheries Policy (CFP), however, unlike many of the species that are managed under the EU's CFP, whelk fisheries are not subject to extensive or restrictive management measures. There are currently no TACs or catch restrictions currently in place on a European level, with a 45mm shell height MCRS being the only current form of fishery restriction. Species managed under the CFP are subject to EU fishing regulations applying to all member states and then additional management measures can be applied at a national or regional level within member countries.

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.

The only recent development of commercial whelk fisheries in recent years has meant that there has been little need for restrictive management in the past, leaving fisheries largely open (see **Table 1**).

***Table 1** - Past management measures for the common whelk (B. undatum) at EU, national and regional levels (as of March 2020).*

Year of Implementation	Management Body	Management Measures	Areas Affected	Reasons for Implementation	Reference
1998	European Union	MCRS of 45mm (height of shell)	EU member states	Aimed to prevent overfishing and protect stocks	Council Regulation (EC) No. 850/98
2018	Devon & Severn IFCA	MCRS of 55mm (height of shell)	Devon & Severn IFCA District	Aimed to protect immature stocks	D&S IFCA Potting Permit Byelaw
2020	Devon & Severn IFCA	MCRS of 65mm (height of shell)	Devon & Severn IFCA District	Aimed to better protect stocks	D&S IFCA Potting Permit Byelaw

In addition to enforcing national and EU fishing regulations, IFCAs are also authorised to implement their own regional management measures within their districts under the Marine and Coastal Access Act to safeguard fish stocks and habitats (UK Government, 2009)

Management Measures Currently in Place

There have been no major management changes over whelk fisheries on an EU and national level since the introduction of the MCRS in 1998 (see **Table 1**). However, due to rapid expansion of the fishery in recent years, IFCAs have brought in their own regional management to help safeguard fisheries and protect whelk stocks from overexploitation (see **Table 2**):

Table 2 *- Current IFCA byelaw restrictions applying to whelk fisheries within North Devon.*

Regulation Type	Gear	Restrictions	Byelaws
Catch	Potting	MCRS of 65mm (height of shell) for whelk	Potting Permit Byelaw
Spatial	All gears	In the areas defined in Annex 1 of the Potting Permit Byelaw (Knoll Pins area at Lundy Island), the removal of any sea fish resources is prohibited	Potting Permit Byelaw
	All gears	In the areas defined in Annex 4 of the Potting Permit Byelaw (Lundy Island No Take Zone), fishers are not authorised to remove any sea fisheries resources.	Potting Permit Byelaw
Temporal	Potting	From 1st November 2020 a new MCRS of 65mm (height of shell) shall be in place	Potting Permit Byelaw

As of November 2020, D&S IFCA have increased the MCRS of whelk to 65mm within their district, currently, there are a range of different MCRSs for whelk in place across the UK as well as in other Northern European countries that exploit whelk. For example, 70mm in Wales, 75mm in Shetland, 50mm in Ireland and 45mm in France, Iceland and Sweden (MRAG, 2018). Due to the difference in ages/lengths at maturity geographically with whelk, there is strong demand within the scientific community for whelks to be managed regionally based on these varying biological characteristics of local whelk populations. It is likely that additional measures such as potting limits or catch limits will need to be implemented in the near future to ensure the sustainability of the whelk fishery and the ensure that fishers are still able to shift their effort towards whelk for part of the year to relieve pressure on their other catch.

Risks & Threats

Conservation Status

Whelks are of particular conservation concern due to their fast early-growth, low fecundity, sedentary lifestyle, slow recruitment, and limited genetic mixing between populations (MRAG, 2018), however the common whelk is not currently listed on the International Union for Conservation of Nature's (IUCN) red list. This type of life history and lack of migrations between populations makes whelk susceptible to rapid population declines at a regional level (Shrives, Pickup and Morel, 2015). Following population crashes due to increased harvesting, such as that in the North Sea from the 1970s to the 1990s, and with evidence of increased fishing effort in most areas, concerns are rising regarding the sustainability and exploitation rates of whelk fisheries (McIntyre, Lawler and Masefield, 2015; Haig et al., 2015b). Effective management is essential to maintain ecologically healthy populations and safeguard important commercial fisheries for the future.

Threats to Current Populations & Ecosystem

Overfishing

The greatest threat facing whelk populations currently is increased expansion of whelk fisheries without adequate management and stock knowledge to prevent overfishing. As previously mentioned, studies have shown that whelks sexually mature at different ages and sizes across their range. One study investigated the SOM of whelk at 12 different sites across England, and found that whelk populations mature at varying sizes across the country, between 45 and 101mm, with the majority of whelk sampled maturing above the European Union MCRS (Haig *et al.*, 2015b). These findings suggest the current European Union MCRS of 45mm is currently doing little to protect immature whelk from being caught and landed, which could lead to rapid stock declines in whelk fisheries through recruitment overfishing. In order to combat this, many regional management bodies, including IFCAs have implemented their own MCRS for whelk within their districts to better protect local populations. However despite this, the regionally variable nature of whelk life histories and maturity rates mean that one MCRS might not be effective in protecting all whelk stocks and populations over a large area (McIntyre, Lawler and Masefield, 2015).

Figure 12 *- Seasonal catch and target species of North Devon fishermen (NDFA, 2020, http://www.northdevonfishermen.co.uk/our-catch [unedited).*

In addition to varying regionally, biological characteristics of whelk can be affected by fishing effort. Work by both Martel *et al*. (1986) and Gendron (1992) has linked significant differences in SOM with different levels of fishing effort on whelk stocks, meaning increased shifting of fishing effort from traditional fishing grounds to unexploited areas could further risk the health of some whelk stocks (with the absence of more effective management). Additionally, whelk populations being fished for extended periods of time have been observed to produce fewer large whelk, meaning additional management measures such as pot limits and seasonal/spatial closures may be needed alongside the MCRS to prevent unsustainable pressure on whelk stocks (Morel and Bossy, 2004). As can be seen in **Figure 12**, whelk in the Bristol Channel are fished year-round, though fisheries peak in the winter (FRMP Interviews, 2020), meaning local populations may be subject to biological changes such as these through continuous fishing pressure. In whelk populations around England, positive correlations have been found between depth, temperature and the SOM of whelk, meaning whelk in shallower waters mature and reproduce at younger ages and smaller sizes than those in deeper waters (McIntyre, Lawler and Masefield, 2015). This causes concern for the sustainability of stocks as if fishing pressure moves out from these shallow, inshore areas, the deeper populations of whelk will become overfished more rapidly if an effective MCRS is not in place (Haig *et al.*, 2015b).

Lack of Assessment to Inform Management

Currently whelk stocks are not assessed on a large scale by ICES like most commercially important species, however, data suggests that blanket-style management based on such large assessments would not effectively protect whelk populations from overexploitation. In

order to properly manage and prevent whelk overfishing, more detailed knowledge regarding stock structure and the biological characteristics of whelk is required on a local scale, so that subpopulations can be identified, management areas defined, and the varying SOM can be taken into consideration by regional management and prevent recruitment overfishing. It is also highly important that the levels of whelk biomass in the UK and the rest of Northern Europe be accurately determined so that the health of the whelk stock can be accurately assessed to ensure any future total allowable catches (TACs) set by the European Commission are sustainable.

Bycatch & Discards

With many fisheries, there are concerns over the number of target and non-target fish caught but then discarded back into the sea rather than being landed. In whelk fisheries, specialised whelking pots are almost exclusively used which allow any undersized or unwanted whelk (and other fish) to be returned to the sea immediately after hauling with little to no damage, almost completely removing concerns regarding discards and bycatch for this fishery. In some regions where whelk is fished commercially, there are concerns over the sustainability and management of the bait used. In many fisheries, brown crab (*Cancer pagurus*) and lesser spotted dogfish *(Scyliorhins canicula*) are used (NW IFCA, 2020). There are concerns that these species could be caught and used directly as bait, thus avoiding any documentation as they were not officially landed. This is of particular concern for the brown crab, as this is a very commercially important species. It may be the case that undersized crab are being caught and used as bait, undermining sustainability efforts in the brown crab fishery (MRAG, 2018).

Pollutants & Imposex

In the past, pollution and contamination from tributyltin (TBT) has caused concern for the health of whelk populations (Waite *et al.*, 1991). TBT compounds were regularly used as biocides in anti-fouling paints for boat hulls and have been observed to cause environmental harm after leaking into the water column. The first cases of TBT harm on marine life came in the 1980s when TBT from antifoulants used on small boats in France caused abnormal growth and reproductive failure in cultivated oysters on the French coast (Alzieu, 1991). TBT can cause a condition known as imposex in marine gastropods, this is where females of the species will begin development of male reproductive organs, which will superimpose themselves on and within the female genitalia, potentially leading to infertility for the affected females (Ten Hallers-Tjabbes, Kemp and Boon, 1994). Imposex has been documented in a range of gastropod species, lowering the reproductive output of affected populations and has even been seen to cause local extinction in populations of dog whelks (*Nucella lapillus*). A sampling study conducted in 1997 found cases of imposex in common whelks from North Sea, English Channel, Clyde Sea, Svalbard and some areas of the west coast of Ireland (Nicholson and Evans, 1997). These were most likely the result of TBT runoff from boat hulls as cases were more severe in the areas of higher shipping traffic. It was thought that this was a relatively recent phenomenon as no cases of imposex were seen in whelk samples from the North Sea taken during in 1970. Although quite widespread, it was thought that imposex was not having a significant effect on the reproductive output of whelk populations as whelk populations had supported large commercial fisheries both during and since this study. The use of TBT on vessels under 25 metres in length was banned in the UK in 1987, and banned completely throughout Europe by the European Union in 2008 (Rodríguez *et al.*, 2009), meaning this is no longer considered a major threat to whelk stocks today.

Destructive Fishing Gear

As mentioned previously, large declines in whelk populations have been observed in areas of the North Sea. This decline was due to imposex caused by TBT pollutants and heavy damage/injury to whelk through destructive fishing gear. Studies have shown that both beam trawl and dredging fisheries can cause serious injury and shell damage in common whelk populations and increase mortality (Bergman and Hup, 1992; Cadee *et al.*, 1995). When comparing the health of whelks caught using baited pot traps and beam trawls, cases of high shell damage can be seen much more frequently in the whelks caught using trawls (Mensink *et al.*, 2000). Whelk survival following capture with these gears was investigated and it was found that only 40% of the whelk caught in beam trawls survived within a six-week period, compared to 95% of those caught using baited pots (Mensink *et al.*, 2000). Additionally, most whelks caught in this study showed signs of previous shell damage that had been fully or partially repaired. With demersal trawl fisheries, large amounts of marine organisms are damaged by trawls but not caught up in the nets and are therefore left damaged on the sea floor (Camphuysen *et al.*, 1995). Whelk damaged by fishing gear that are not removed from the sea are at higher risk to predators and scavengers as their protective shell is compromised, affecting mortality within whelk populations where fishing gear such as beam trawls are used.

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, resulting in an increase in suspended sediment in the water column, affecting processes requiring vision such as foraging, hunting and predator avoidance, which are key to survival for many marine organisms (Harvey *et al.*, 2017). Declines in many different organisms, particularly within benthic communities, in or around dredged areas has been well documented (Thrush and Dayton, 2002). As benthic organisms, whelk spend their entire lives on the seabed and also attach their eggs to benthic substrates after breeding, this suggests whelk populations may be susceptible to anthropogenic activities affecting the seabed such as dredging or coastal development, however, there has been very little research focusing on how this can impact whelk specifically. 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 (see **Figure 13**; The Crown Estate, 2020).

Figure 13 *- 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).*

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 several commercially important species, including whelk, in the Bristol Channel add 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, 2019a, 2020a; 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 result in significant losses to local fish populations (Environment Agency, 2020a). Though water intake systems such as these will not impact or harm whelk directly, they will alter community and ecosystem dynamics in the area, which in turn could be harmful to whelk populations.

The fish assemblage 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 marine organisms can be considered in a regulatory and licencing context. In turn, this highlights the regulatory gaps for marine organism 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 marine animals 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 organisms 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 whelk (Heude-Berthelin *et al.*, 2011). Common whelks are a very temperature-sensitive species, not being able to survive in waters above 29°C, meaning changes in water temperatures across Northern Europe due to

climate change will most likely alter the distribution of whelk populations and possibly cause local extinctions in some areas, disrupting local fisheries. Temperature has also been seen to affect SOM in whelk populations (MRAG, 2018), meaning climate change could further alter the reproductive output of whelk populations. Another major effect of climate change is increasing ocean acidity as a result of more carbon dioxide in the atmosphere (Hoegh-Guldberg *et al.*, 2007). Acidification is expected to be particularly damaging to shelled marine organisms as conditions with increased acidity hinder the calcification and growth of shells, preventing shell repair for organisms such as whelk (Gazeau *et al.*, 2007). As previously mentioned, whelks with damaged shells are more vulnerable to consumption by predators and scavengers, meaning ocean acidification could indirectly damage whelk stocks.

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 already present within the range of the common whelk (see **Figure 14**), and increased frequencies could be devastating to local populations due to their low mobility, posing a high risk of local extinction. 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).

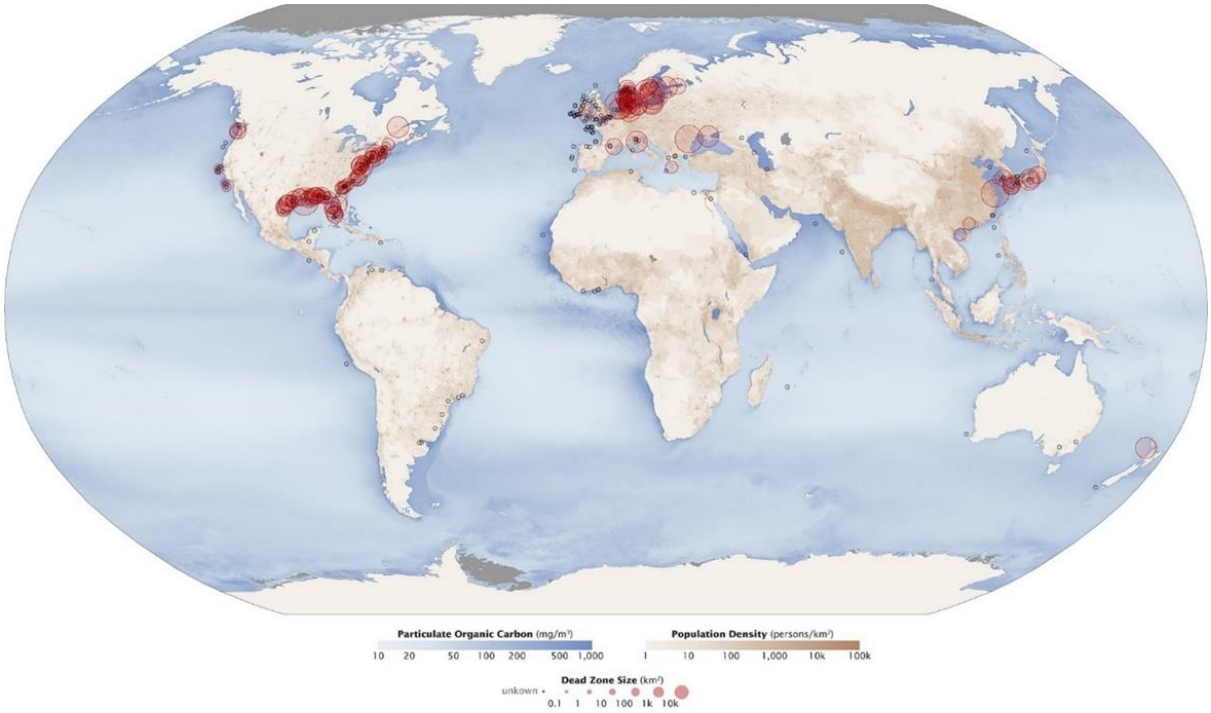

Figure 14 *- Locations of hypoxic and anoxic dead zones. Red circles on this map show the location and size of many of our planet's dead zones. Black dots show where dead zones have been observed, but their size is unknown (Allen, 2010, https://commons.wikimedia.org/wiki/File:Aquatic_Dead_Zones.jpg [unedited]).*

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 15 *- 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. For example, the planned construction of the new Bridgwater flood defence barrier on the river Parrett (which feeds into the Severn Estuary) will involve extensive construction work on and around the river, and local authorities have raised concerns that the potential impacts of such projects on local marine populations are not being properly addressed and mitigated during planning (Devon & Severn IFCA, 2020b).

Threats to Fishery & Industry

As a non-quota species, whelk fisheries are extremely important to inshore fishers in the Bristol Channel, providing a seasonal, alternative catch during the winter months so that fishing pressure can 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 fishermen with less 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 fishermen 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 causing stocks to decline, difficulty acquiring crew and quotas and a variety of other issues has led many inshore fishermen to believe the inshore fishing industry as a whole will soon die out. Several fishermen interviewed stated that the only reason they are still involved in the industry is due to their love of the sea and the importance fishing has to them. Inshore fisheries in the Bristol Channel date back centuries and many commercial fishermen see their fishing as part of their way of life and culture (FRMP Interviews, 2020).

While discussing the whelk fishery, most fishermen interviewed expressed concerns that overexploitation due to recent increases in fishing effort was threatening the future of whelk fisheries in the Bristol Channel and that the current levels of exploitation were not sustainable. Despite this, fishermen noted that currently most stocks seem to be stable, though there are some declines starting to be noticed due to overexploitation (FRMP Interviews, 2020). Overall, fishers seemed happy with the regional increases in MCRS for whelk implemented by D&S IFCA, however, IFCA Districts only extend out to six nautical miles, meaning in these offshore waters, the MCRS of whelk remains at the EU's 45mm regulation. Fishermen spoke on how this difference in regulations results in whelk populations outside the IFCA District being subject to higher levels of fishing effort and overexploitation. There are concerns that die to the low mobility of whelk populations, heavy fishing in these offshore areas may result in local extinctions and loss of fishing grounds for whelk (FRMP Interviews, 2020). Despite the recent increase of the whelk MCRS within the D&S IFCA District, there is a strong consensus between fishermen in the Bristol Channel that some form of restriction needs to be put in place to limit whelk fishing effort. The two potential management measures raised most by fishers during interviews was a potting limit trial or a limit to days at sea when fishing whelk (FRMP Interviews, 2020; Marine Pioneer Interviews, 2020).

One issue seen in most inshore fishing areas is that of illegal, unreported, and unregulated fishing. This issue was raised by almost all fishermen during interviews as part of this project, 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 (FRMP Interviews, 2020). This problem is thought to be most common within netting fisheries, though it is likely to occur to some degree in most fisheries. There was a strong consensus between commercial and recreational fishermen that there was a need for a stronger enforcement presence from D&S IFCA to discourage illegal fishing and ensure fishing regulations are followed by both commercial and recreational fishers (FRMP Interviews, 2020). The large size of D&S IFCA's District, and a small enforcement team made up of only four officers, means patrols are limited to areas with higher numbers of reports of illegal fishing, which is primarily the south coast. Engagement with fishers from the north of the District has highlighted a sense of mistrust towards the IFCA from the inshore fishing industry and shown some fishers have no confidence in the IFCA, which may contribute to illegal fishing activity remaining unreported (FRMP Interviews, 2020). It is important to work to rebuild this trust and engage with fishers as much as possible, including to encourage the reporting of illegal activity.

D&S IFCA is seeking to rectify this, including the improvement of collaboration and engagement through activities such as virtual roadshows for ports, sectoral meetings and

future FRMP interviews. More information about planned engagement activities is available in the D&S IFCA's Annual Plan and Communications Strategy, accessible via the D&S IFCA website. 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.

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Appendices

Whelk Reproduction

Whelk reproduction is controlled and regulated through the release of pheromones by females, which attract males and induce copulation (Martel, Larrivée and Himmelman, 1986). Males produce two different types of sperm for use in copulation, the first is called euspermatozoa, this is the viable sperm that binds with the egg in the female reproductive tract, acting as functional gametes. The second type are called paraspermatozoa, these only act in a supporting role to the euspermatozoa by using their multiple, external tails to help control and assist in movement as well as providing euspermatozoa with nutrients (Heude-Berthelin *et al.*, 2011). Common whelk fertilisation occurs internally, sperm is deposited by the male and is first stored in the bursa copulatrix until the eggs are ready to be fertilised (Kideys, Nash and Hartnoll, 1993). The sperm is then transferred through the capsule gland to a structure called the seminal receptacle. They are kept here until the oocytes (eggs) pass through the albumen and capsule gland where the actual fertilisation takes place (Martel *et al.*, 1986a).

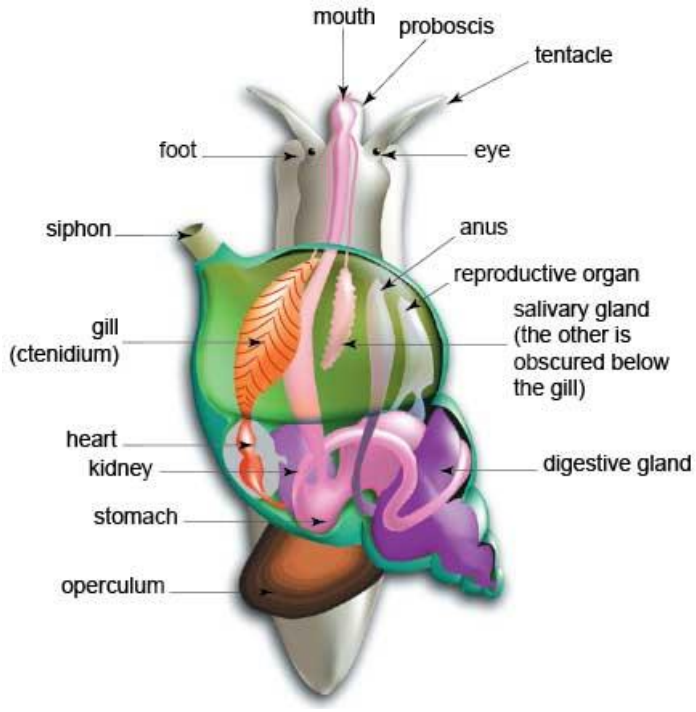

Figure 16 *– Basic marine gastropod anatomy (BGS, 2020, https://www.bgs.ac.uk/discovering-geology/fossils-and-geological-time/gastropods/ [unedited]).*

The fertilised eggs are passed through the oviduct and then large groups of eggs (between 100 and 2,200 individual eggs) are coated in mucus together to form egg capsules (Fretter and Graham, 1962). These capsules are then laid on either solid benthic substrates or floating objects, forming large egg masses that multiple females often contribute to (Martel, 1985). Periods of whelk egg laying can be extended as females are able to store sperm for up to eight weeks after copulation, allowing them to wait for optimum environmental conditions before spawning to maximise the chances of offspring survival (Martel, Larrivée and Himmelman, 1986). Of the hundreds and sometimes thousands of eggs per capsule, only ~10 will survive and undergo full development, the rest providing nutrition to these few whelk that will survive or to predators (Magnúsdóttir, 2010). The whelk offspring go through the trochophora and veliger (larval) life stages while still in their eggs capsules before hatching as

tiny, but fully developed whelks after three to five months in the UK, but five to eight months in Canada (Martel *et al.*, 1986a; Magnúsdóttir, 2010).

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 ecolabeled products are usually sold at a higher price than similar non-labeled 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). Currently, the only MSC certified whelk fishery is the Basse-Normandie Granville Bay whelk fishery, which achieved sustainable certification in 2017 (Gascoigne, Sieben and des Clers, 2017). This fishery was able to achieve MSC certification through the use of harvesting control plans to manage effort in the whelk fishery, clearly defining the whelk stock in the area and through the use of low impact fishing gear. There is also a large amount of scientific research on whelk populations in Granville Bay providing information on the life history of local common whelk populations and a biological framework for management to help ensure sustainable exploitation.

Whelk fisheries in the Bristol Channel use the same whelk pots as the Granville Bay fishery, meaning they too are low impact in terms of bycatch, habitat disturbance and the ability to avoid high mortality while discarding unwanted whelks. However, compared to whelk populations in Granville Bay, there is a lack of scientific knowledge regarding the structure and life histories of Bristol Channel whelk populations with no defined stocks to be assessed. In order for an effective management plan for whelk fisheries to be implemented, whelk stocks in the Bristol Channel need to be clearly defined and detailed information on their life histories and maturation sizes collected to ensure future exploitation is sustainable. Once gaps in knowledge have been filled and management plans created, whelk fisheries have much potential to be assessed and certified as sustainable due to the low levels of habitat disturbance and bycatch associated with them.