Devon & Severn IFCA
Inshore Fisheries and Conservation Authority

# Razor Clam Dredge Fishery

## Research and Evidence Review

30th October 2026

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# 1. Introduction

At the Full Authority meeting held on 18th June 2026, the Officers' Monitoring and Control Plan (M&CP) for the razor clam fishery was discussed. Some Members raised concerns regarding aspects of the M&CP and Natural England, as the UK Government's Statutory Nature Conservation Body, provided advice on the contents of the M&CP. Natural England recommended that, if the fishery is progressed, it is done so under a clearly defined, precautionary management framework with monitoring, adaptive management, and safeguards to ensure alignment with wider environmental objectives.

This Research and Evidence Review has been undertaken to answer the concerns of some Authority Members and fill in the evidence gaps so that Natural England's recommendations on the M&CP can be met. As the fishery has been agreed subject to the M&CP, no economic or social data have been included in this Research and Evidence Review nor in the M&CP.

Each section of this document relates to Natural England's recommendations. A review of literature has been undertaken, evidence has been gathered and research has been carried out by D&S IFCA Officers to fill evidence gaps to give Members and stakeholders a better understanding of the fishery and provide evidence to support D&S IFCA's use of the precautionary principle approach to achieve adaptive management. Adaptive management acknowledges the high levels of uncertainty in natural systems and the difficulties of making decisions based on this uncertainty. It relies on the application of the ecosystem and adaptive precautionary approach. It provides a framework for a flexible and pragmatic approach to marine management, allowing sustainable development whilst adapting management and policies to respond to new evidence.

Agenda Item 14 presented to the Full Authority on 18th June 2026 contained the initial draft of the M&CP. This draft M&CP highlighted uncertainties that were present at that stage. This review of evidence and the research undertaken eliminates many of those uncertainties which has helped inform a further developed M&CP for Authority Members to consider.

# 2. Location of the Razor Clam Fishery

Within Natural England's advice there were several recommendations that relate to the location of the razor clam fishery. This section considers Natural England's advice regarding the location of the fishery and endeavours to remove the uncertainties that previously existed in relation to baseline information on the fishery location. Natural England raised the following points in relation to location of the fishery and the habitat over which the fishery will take place:

- *Limitation of area(s) open to this fishery within the wider shellfish classification area: start small and expand from there if the fishery proves sustainable over time.*

- *Limit areas open to the fishery to areas that are already open to (and fished by) other towed gear (e.g. using iVMS tracks to define these areas).*
- *Exclude sensitive habitat types from areas open to the fishery e.g. sensitive habitats like sandstone reef. Areas open to the fishery should be higher energy, more mobile sandy habitats with the highest potential for recovery*

## 2.1 Razor Clam Habitat Preference

When considering the location of a razor clam fishery it is important to consider the distribution and habitat preference of razor clams. Aitken et al (2018) describe that all *Ensis* species are found in sandy sediments from the lower shore to shallow sublittoral to a depth of 60m. The Marine Life Information Network (MarLIN) describes that sheltered lower shore and shallow sublittoral sediments of sand or muddy fine sand in fully marine conditions support population of razor clam *Ensis siliqua*. MarLIN also describes the depth preference as lower intertidal shore down to shallow sublittoral depths of about 5 to 30m. *Ensis spp*. inhabit sandy substrates from the intertidal to depths generally described as approximately 40 m (e.g., Holme, 1954; Pyke, 2002, Tuck et al., 2000). Muir (2003) observed that a substantial depth of sand is required for an area to be suitable for razor clams, noting that *Ensis* spp. were not present where the sand depth was less than 30 cm or where there was overlying stones. *Ensis siliqua* are found in clean fine sands (Holme, 1951; Muir, 2003) and are most tolerant of wave exposure (Holme, 1954).

## 2.2 Razor Clam Classification Process

Figure 1 is the chart included in a paper to the B&PSC on 26th February 2026 (Agenda Item 8 Figure 2) and shows the potential area to be considered for shellfish classification by the Food Standards Agency (FSA) and Food Health Inspectorate (FHI). The removal of razor clams from the sea requires classification under EU Regulation 627/2019. Classifying shellfish harvesting areas requires a formal application to the FSA, a mandatory sanitary survey to identify pollution sources, and 10+ samples taken weekly for a provisional classification (or 3 years' data for seasonal. Harvesters must register with the local council Environmental Health Office. The area classified is then monitored monthly to ensure the shellfish meet the classification given which in turn ensures that shellfish are safe to eat. Figure 1 shows an arbitrary line drawn along the coast to allow the FSA/FHI and Cefas considered where classification zones representative monitoring points should be located

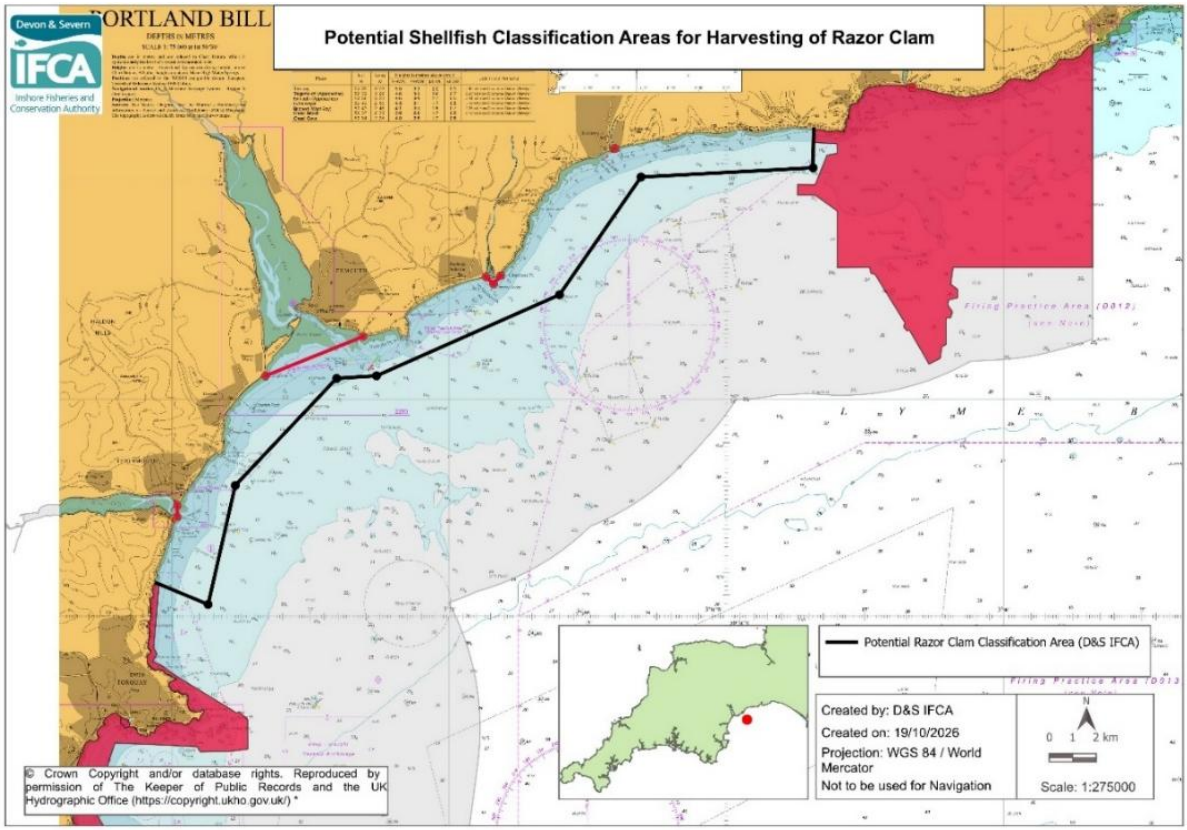



*Figure 1 Potential Shellfish Classification Areas for Harvesting Razor Clams*

Since the B&PSC meetings in February and June 2026 and the Full Authority meeting in June 2026, the FSA and FHI have considered the areas where the harvesting of razor clams can take place and liaised with the local council's Environmental Health Officers.

Figure 2 shows the areas initially proposed by the FSA/FHI for razor clam harvesting in July 2026. These will be subject to slight changes. The hatched areas within this chart are areas for oyster relaying only and are likely to exclude the harvesting of razor clams, although this is still in discussion. As mentioned in previous Authority papers the areas to be classified are smaller than the area in Figure 1 in this document.

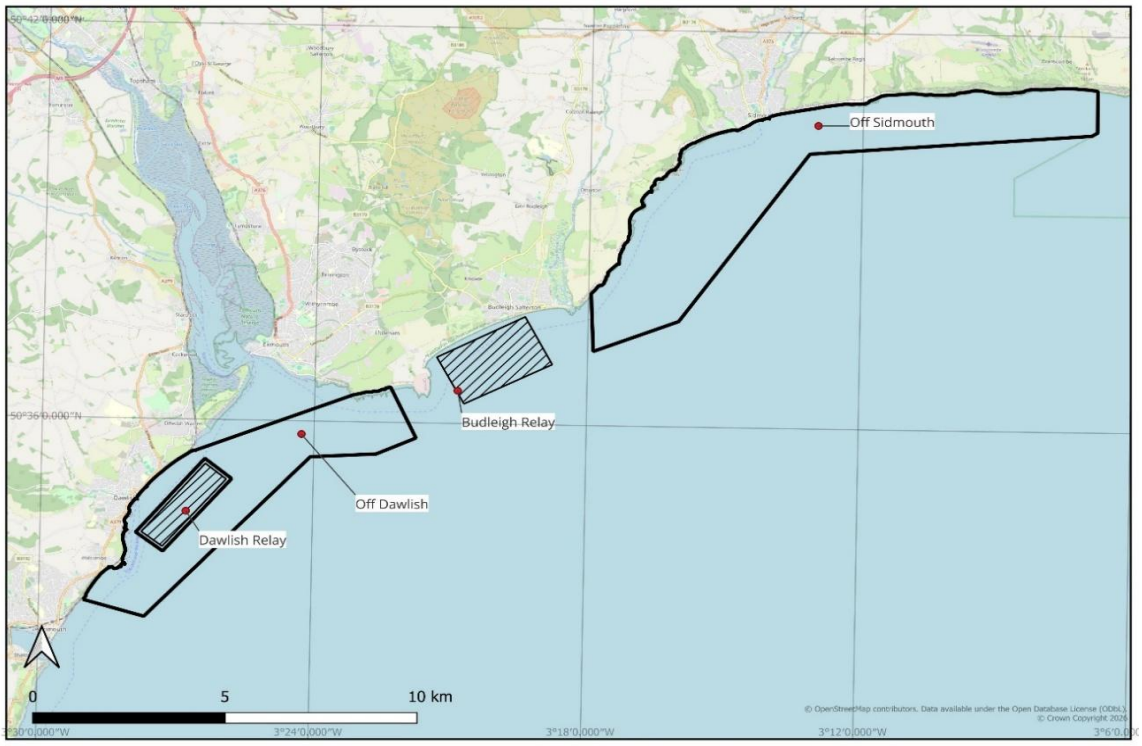



*Figure 2 FSA/ FHI initially Proposed Classification Area for Razor Clam Harvesting – July 2026*

## 2.3 Potential Fishery Areas

Initially three potential areas were considered for the proposed razor clam fishery. These are shown in Figure 3 together within the preliminary FSA proposed classification areas.

Officers have reviewed evidence to help inform the location of smaller razor clam fishery areas within the classification zones as shown in Figure 3. These have included:

- European Marine Observation and Data Network (EMODnet ) kinetic energy at the seabed due to wave action;
- IVMS data for demersal mobile fishing vessels which operated in the D&S IFCA's District in 2024;
- C-Map (a leader in digital marine cartography) charts showing seafloor relief and
- the Marine Strategy Framework Directive's broad scale habitat maps provided in the EMODnet chart viewer.

Officer undertook survey work using an ROV camera system in these three areas which included 31 video tows to help inform the areas where the fishery could potentially take place.

Using the data outlined above, Officers narrowed down the proposed fishery area to an area within Dawlish Bay (Area A). The Area B in Ladram Bay, through ROV video analysis, was found to have harder rocky ground close inshore. The proposed box was moved out from this habitat and further survey work was carried out in the deeper areas. However, the habitat here did not appear to have razor clams present, which was largely determined by the fishermen, who worked with D&S IFCA, undertaking dive surveys in the area. The deeper area of the proposed box was also found to be too deep for the razor clam dredge equipment to operate. Area C in Sandy Bay, whilst being located in a high energy and from video footage having areas of sandy habitat, had, through IVMS analysis, a low level of demersal mobile gear activity. The three minute positional data from the IVMS devices indicated that vessels were leaving or entering the Exe Estuary rather than actively fishing.

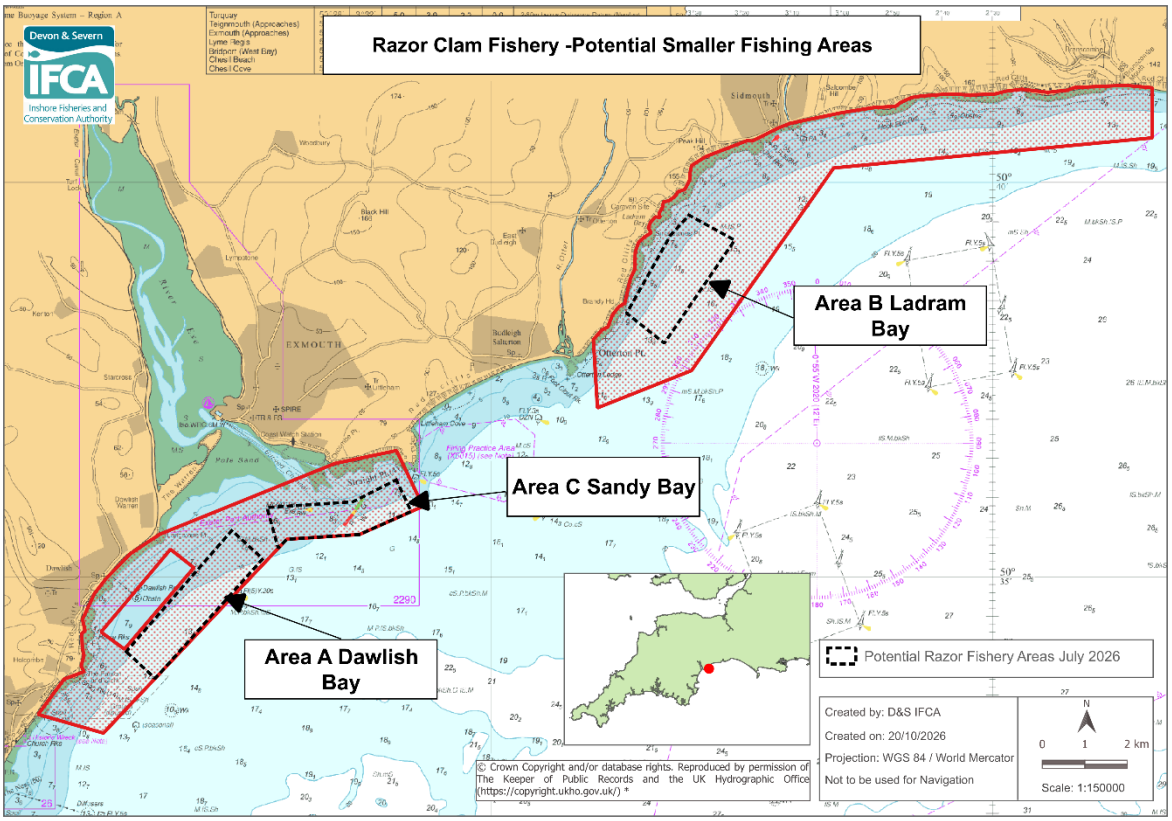



*Figure 2 Three areas within the FSA classification areas that have been considered for the proposed razor clam fishery*

Due to the outputs from this analysis Area C was discounted as it did not meet the criteria of being currently fished by demersal mobile fishing vessels.

Area A in Dawlish Bay, as show in Figure 3, covers an area of 3.62km$^2$. Through the analysis of the data listed above it, in particular the EMODnet kinetic energy at the seabed due to wave action, the southerly part of the proposed Area A was not located in an area that had moderate to high energy on the seabed. Therefore, the potentially area for the fishery was reduced to an area of 1.93km$^2$ in depths of between 7m and 12m and can be seen in Figure 4.

The results of the evidence gathered are discussed in further sections of this review and a report of the ROV and Side Scan Sonar survey work can be viewed in Annex D Agenda Item 8. The results of the survey work are also discussed in the relevant sections of this report. The initial areas B and C and part of area A were not suitable to meet the criteria recommended by Natural England of having existing fishing activity, being moderate to high energy, being of a suitable habitat and, for the fishermen's operation, being of a suitable depth. The initial analysis of the data sources discussed have led to changes in the potential areas and resulted in an initial smaller area for the proposed fishery.

To summarise Areas B Ladram and C Sandy Bay were discounted as they did not fit the criteria for the fishery and Area A at Dawlish was reduced in size.

The Dawlish area shown in Figure 4 meets Natural England's first criterion above which recommends defining the restricted areas within which the fishery could operate. It is important to note that the proposed area for the razor clam fishery is not within a Marine Protected Area (MPA) and therefore the fishery will not impact the designated features of

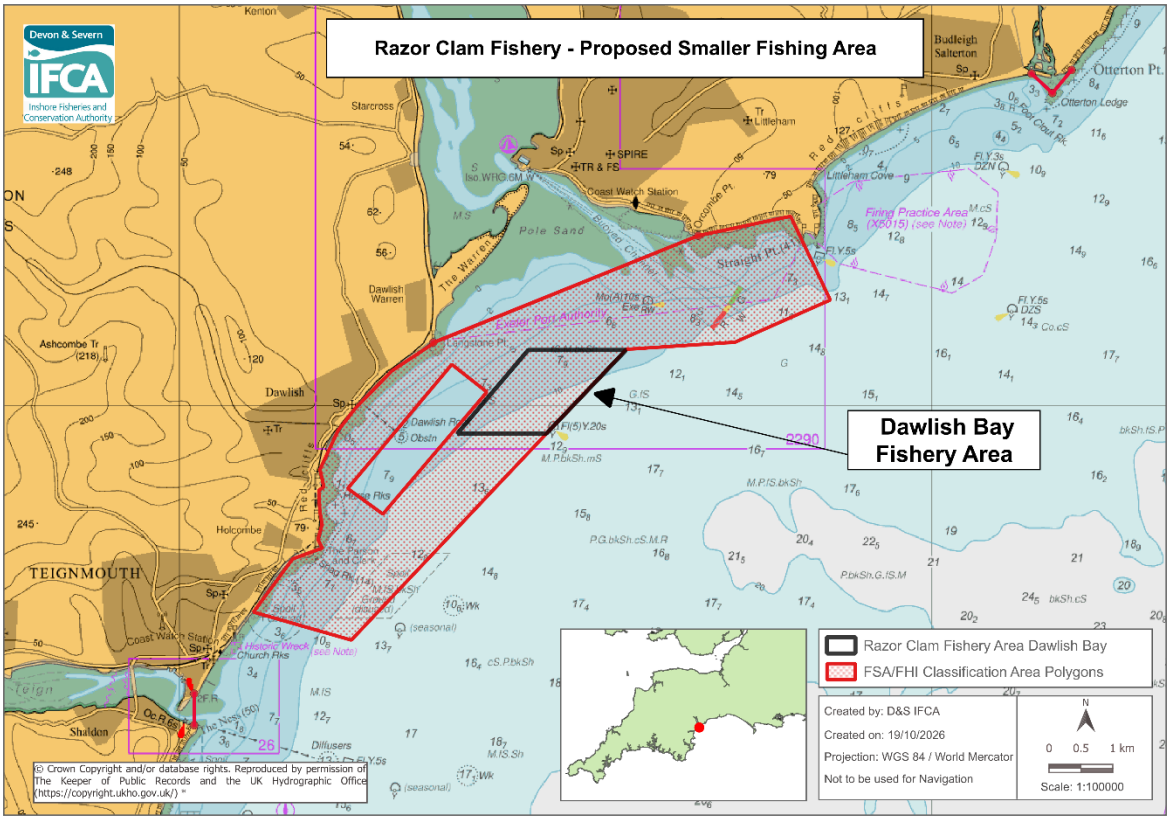



*Figure 4 - Proposed Fishery Area Dawlish Bay*

MPAs. As stated in Natural England's advice the fact that the fishery will not take place in an MPA means that Natural England's statutory duties around MPA protection are not triggered in this case.

## 2.4 Fishing Activity in the Proposed Area of the Fishery

Natural England's advice recommends that the fishery is limited to areas where demersal mobile fishing activity currently takes place. Figure 5 shows the IVMS data from demersal mobile fishing vessels operating in 2024 in the D&S IFCA's District between Budleigh Salterton and Teignmouth and covers the proposed fishery area in Dawlish Bay. The IVMS data were filtered to show vessel speeds of 2 to 4 knots which D&S IFCA uses as a proxy for fishing activity rather than transiting across an area. In the Dawlish Bay area five demersal towed gear vessel operated in 2024. From permit application data four demersal towed gear vessels indicated they operate trawls (otter and beam) and scallop dredges, and one indicated it uses trawls only.

It is clear from the IVMS data that the area proposed for razor clam harvesting is an area where existing mobile fishing takes place.

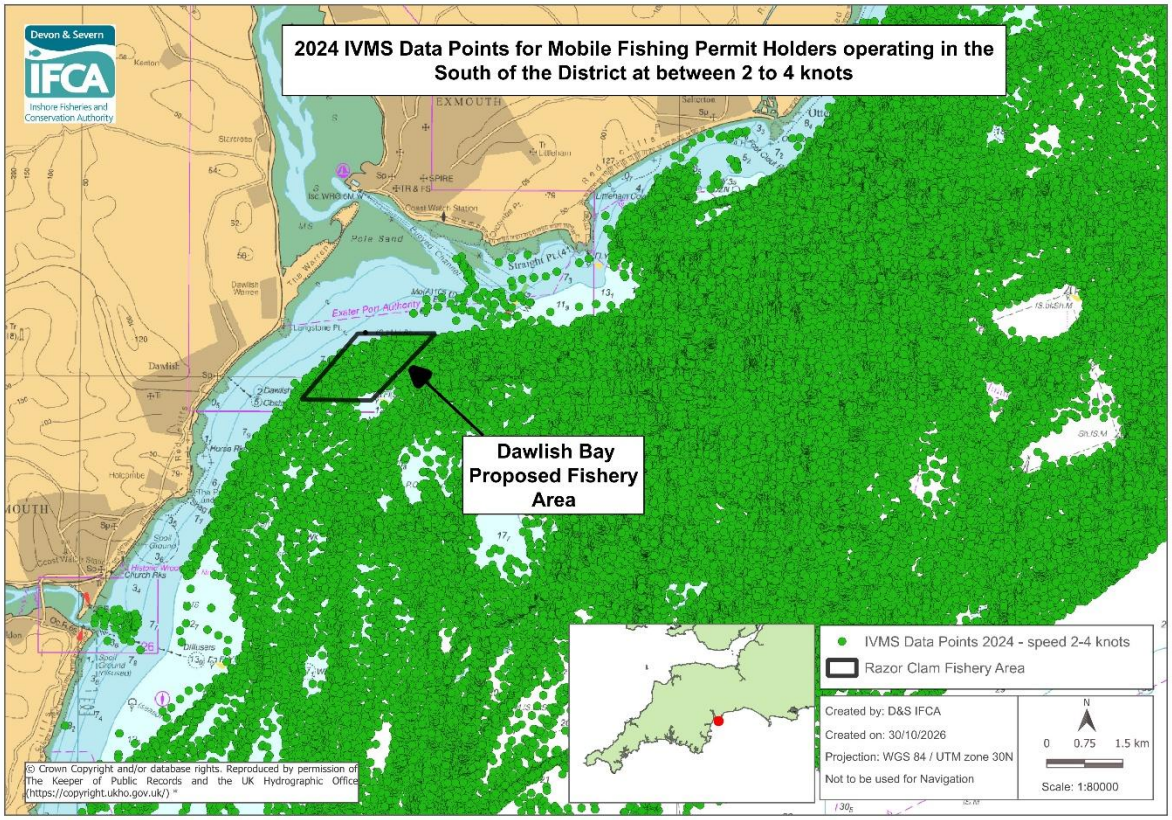



*Figure 5 - 2024 IVMS Data points of Vessels operating in the Dawlish Bay Area*

## 2.5 Wave Energy on the Seabed

Figure 6 shows the kinetic energy at the seabed. The chart has been taken from EMODnet Map Viewer and is based on wave modelled data using wave and current data and particle velocity on the seabed. The chart indicates that the Dawlish Bay fishery area is located within a moderate to high energy area, which would likely result in more mobile

habitats and fulfils Natural England's recommendation on the energy status of the habitats open to the fishery.

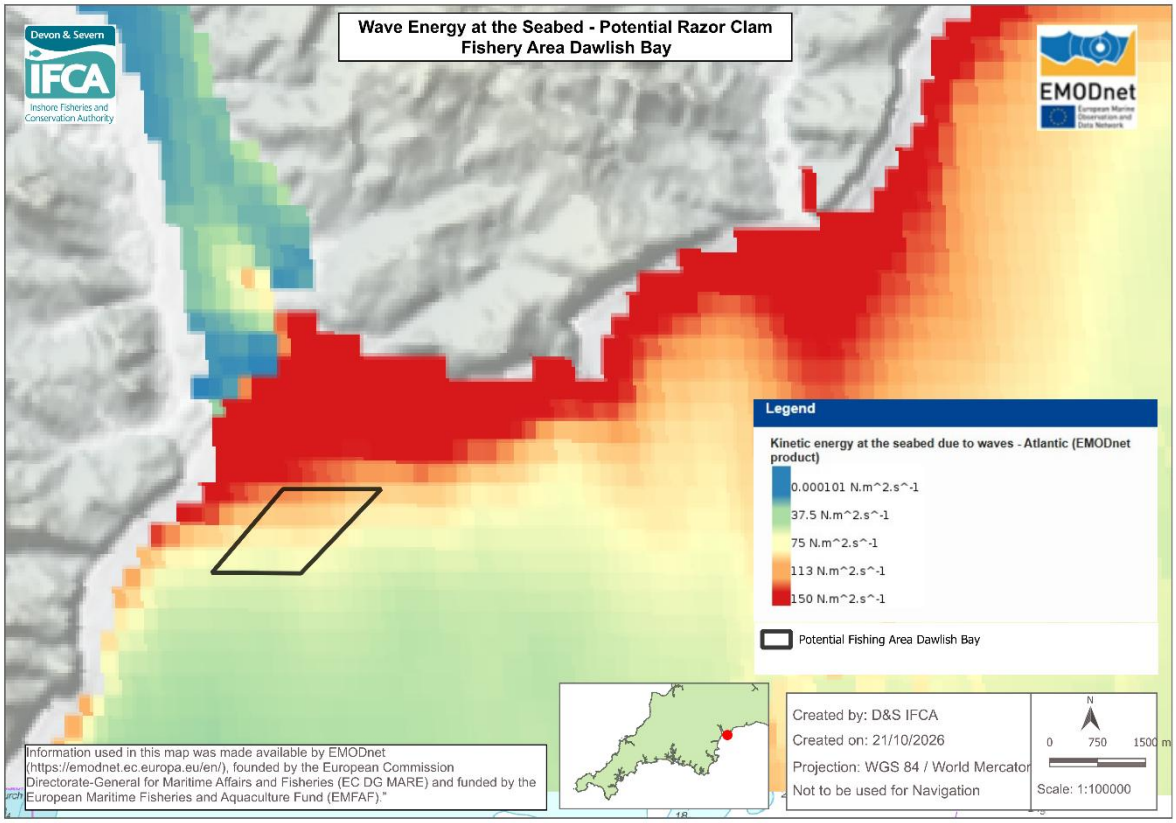



*Figure 6 - EMODnet Chart of the Kinetic Energy on the Seabed due to Waves*

# 3 Habitat Structure and Type

## 3.1 Habitat Structure

Figures 7 shows the C-MAPs of sea floor relief. C-MAP Reveal's shaded floor relief shows 3D-rendered underwater elevation and high-resolution bathymetric imagery. It visually transforms flat seabed data into a clear, colourised topographical view—highlighting reefs, underwater ledges, drop-offs, holes, humps, and shipwrecks with high clarity. This relief chart appears to show a more consistent uniform seabed relief indicating that the area ise away from sandstone reef areas.

Further information on the possible habitat structure on the area of the proposed fishery (and outside of this area) can be gained from the outputs from the side scan sonar survey work, which give an indicative picture of the structure of the habitat. These are discussed in section 3.2.2.

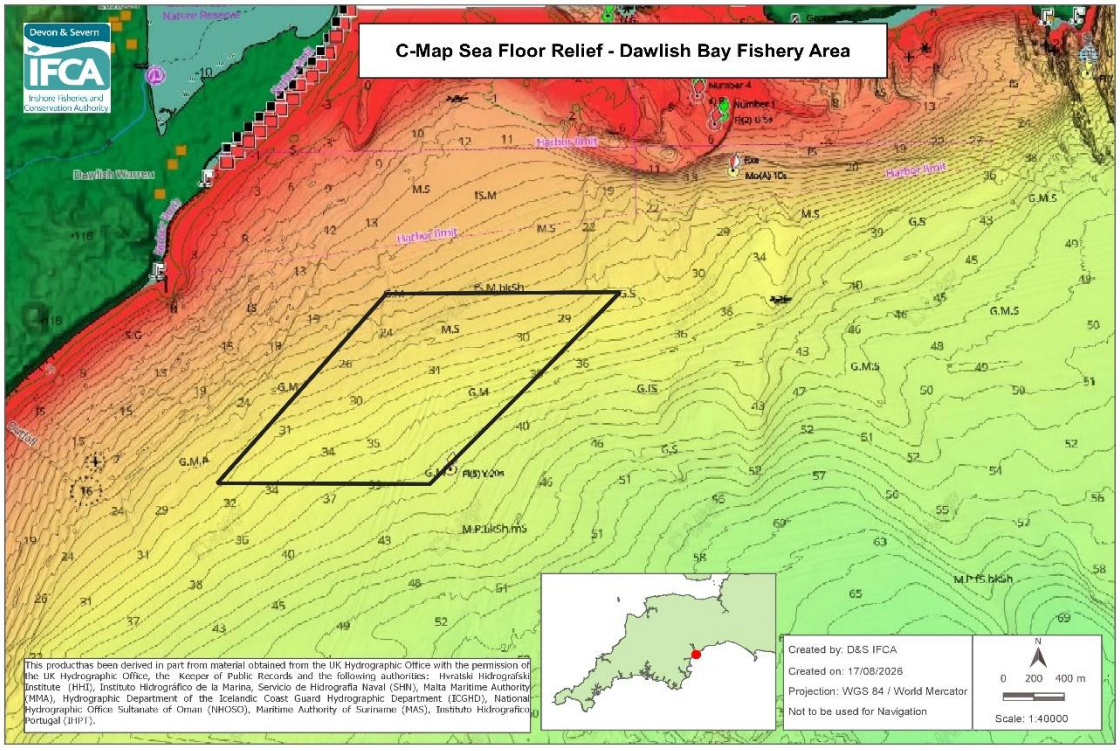



*Figure 7 - C-MAP Chart of the Sea Floor Relief -Dawlish Bay Potential Fishery Area*

## 3.2 Habitat Type

Natural England has recommended in its advice that '*Areas open to the fishery should be higher energy, more mobile sandy habitats with the highest potential for recovery'*. Officers and the fisherman have maintained that due to the habitat preference of *Ensis siliqua* for sandier habitats this will be the type of habitat on which the fishery will take place.

JNCC have defined sandbanks which are slightly covered by sea water all the time (JNCC 1100) (defined for MPAs) as '*The diversity and types of community associated with this habitat are determined particularly by sediment type together with a variety of other physical, chemical and hydrographic factors. These include geographical location (influencing water temperature), the relative exposure of the coast (from wave-exposed open coasts to tide-swept coasts or sheltered inlets and estuaries), the topographical structure of the habitat, and differences in the depth, turbidity and salinity of the surrounding water'*.

### *3.2.1 Modelled Data*

Figure 8 shows the EMODnet chart of EU SeaMap (2025) Marine Strategy Framework Directive's broadscale habitats. These correspond to the EUNIS Classification 2019 Broad Scale Habitat types. These broadscale maps indicate the proposed areas for the

fishery are moderate energy circalittoral sand and mixed sediment. As described, these are broad cale map and do not provide detail of the habitat type.

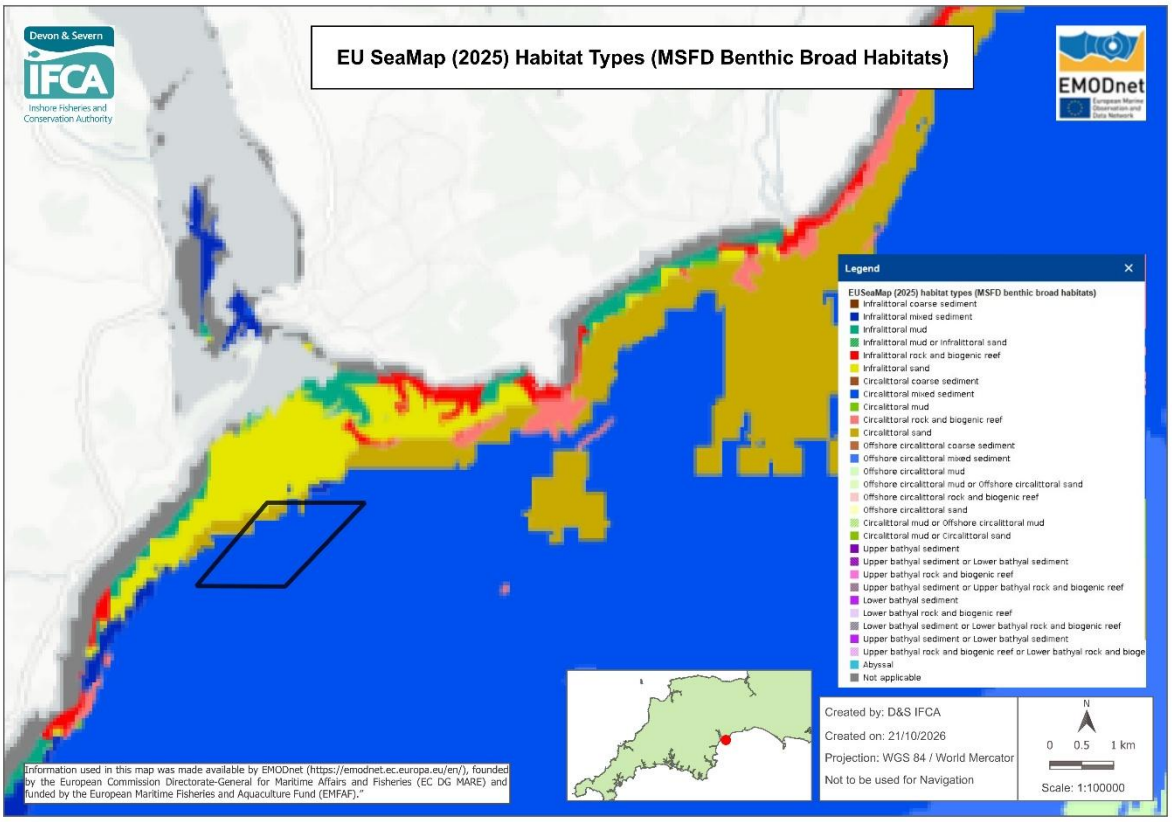



*Figure 8 - EMODnet Chart of the EU SeaMap (2025) MSFD Broadscale Habitats in the Dawlish Bay Area.*

The Side Scan Sonar (SSS) work and ROV underwater video filming undertaken by D&S IFCA Officers has helped to ground truth the type of habitat present in the proposed fishery area. It is important to understand that the evidence gathered from these surveys, in particular, the SSS work, gives an indication of the habitat type. This work is discussed below.

### *3.2.2 D&S IFCA Survey Work*

D&S IFCA Officers undertook underwater camera ROV surveys of the seabed in the three initial areas of interest for the fishery using a Blue ROV2 – R3-RP with four lumen subsea lights and Go Pros attached to the frame on the ROV. This work was undertaken on board a fishing vessel with collaboration and assistance from the fisherman involved in the development of the fishery.

Thirty one ROV transact tows were undertaken across the three areas and ten transacts were undertaken in the area narrowed down in Dawlish Bay. Video footage was analysed by Officers following the North East Atlantic Marine Biological Analytical Quality Control (NMBAQC) Scheme - Epibiota Remote Monitoring from Digital Imagery: Interpretation Guidelines (Turner et al., 2016). These guidelines were developed in conjunction with Joint Nature Conservation Committee (JNCC) which is a Statutory Nature Conversation Body. Further reference was made to Ocean Ecology work who refined the NMBAQC

methodology (and who help produce the NMBAQC guidelines) and who have previously been contracted by D&S IFCA to undertake similar work. These guidelines detail how the video footage should be viewed, how to assess video quality and provides detail on how to analyse the footage. Officers analysed the video tows to broadscale habitat mapping EUNIS level 3.

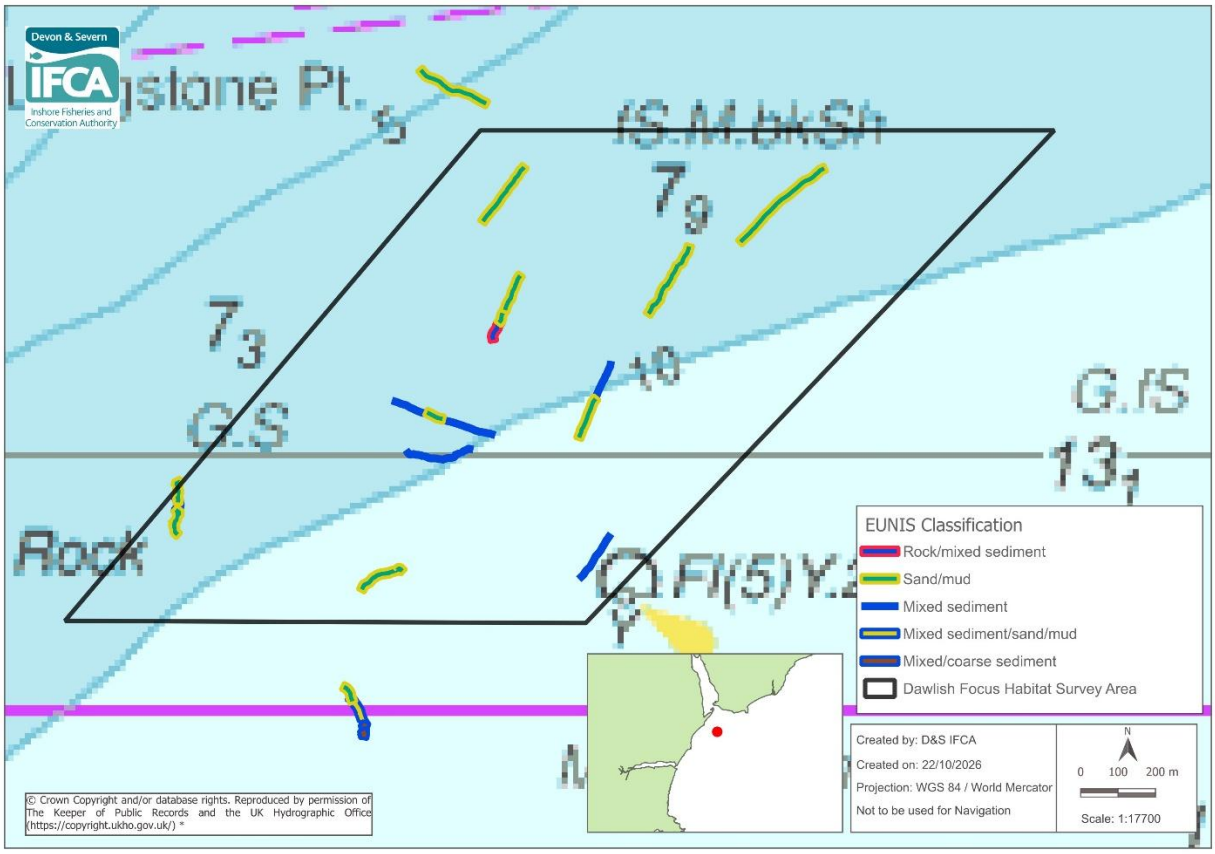



*Figure 9 - Habitat classification of twelve areas surveyed by ROV video in and around the Dawlish focus habitat survey area. In many cases the habitat is a combination/mosaic of different habitat types, so multiple classifications were assigned (as indicated by more than one colour per area). The EUNIS codes for the habitats shown are: A3.2 Moderate energy infralittoral rock; A5.1 Sublittoral coarse sediment; A5.2 Sublittoral sand; A5.3 Sublittoral mud; A5.4 Sublittoral mixed sediment. The northern third of the area appears to be predominated by muddy sand containing burrows. Areas of muddy sand, mixed sediment, rock and coarse sediment is present) in areas further south*

In Figure 9, the muddy sand is depicted as 'sand/mud'; the distinct habitat types 'A5.2 Subtidal Sand' and 'A5.3 Subtidal Mud' are defined largely by the proportion of different-sized sediment grains that are present. These habitat types are difficult to discern from one another without Particle Size Analysis, and the habitat classification guidelines (Turner *et al.,* 2016) state "*It is recommended that video is not used to distinguish between muddy sands and sandy muds as they can appear very similar*". Therefore, these areas of sand/mud determined from the video footage are referred to simply as muddy sand, which also correlates with a broader-scale sediment map produced by the British Geological Society (BGS, 2026), while recognising that the proportion of sand and mud may vary.

The muddy sand is present in ten out of the 12 video tows in the Dawlish area, comprising approximately 62% of the total tow distance. Muddy sand dominates the northern

section of the area. It is important to note that the JNCC guidelines for habitat classification state that brief changes in habitat (lasting less than a 5 m x 5 m area) should be considered as incidental patches and so may not be logged as separate sections. Some areas of muddy sand within the a few tows may have contained small incidental patches of mixed sediment, including some larger particles (e.g. pebbles, cobbles). Mixed sediment (EUNIS A5.4) was present in seven out of 12 tows, comprising approximately 38% of the total tow distance. This includes mixed sediment as a mosaic with rock (one tow, approximately 2% of tow distance) and coarse sediment (two tows, approximately 3% of tow distance).

A D&S IFCA Officer, together with a Cornwall IFCA Officer, undertook the Side Scan Sonar (SSS) survey work on board the fishing vessel using a Tritech SeaKing Towfish. Data were collected at a frequency of 600 kHz. The SSS was deployed from the starboard side of the vessel and then tied off to allow for it to be hauled and deployed by hand, once in place. The SSS was towed at a speed of 3-4 knots into the current. The range was set to 50m for all tows, covering a 100m wide swathe. Survey areas were identified prior to the survey in order to cover priority areas off Exmouth and the Dawlish potential fishery area. Unfortunately, there were some technical difficulties with the SSS equipment, and these together with survey time restraints, meant that not all the seabed within the potential Dawlish Bay Fishery Area was surveyed using the side scan sonar.

Data processing was carried out by Cornwall IFCA. The outputs were GeoTIF files for each survey line, which has geographic positioning information allowing for use in Geographical Information Software (GIS), and analysis was undertaken by Officers from D&S IFCA and Cornwall IFCA to identify and assign signatures to different sediment types. The Cornwall IFCA Officer has a wealth of expertise in undertaken, processing and analysing side scan sonar survey data and D&S IFCA Officers gained inavaluable experience working with Cornwall IFCA.

Figure 10 shows the outputs from the SSS analysis. SSS gives a degree of confidence to be able to assign a habitat to the output signature. Figure 11 shows the SSS outputs for the more focused survey area at Dawlish together with the EUNIS Classification of the ROV tows. For both charts the SSS data colours from a darker output (black) to a light (gold) output. These outputs can be assigned a habitat type. Harder areas tend to appear brighter whilst softer features appear darker. From the SSS data the majority of the areas is muddy sand with some areas appearing to contain coarser, mixed sediments. Both Figure 10 and 11 show the area to the east of the survey box and outside of the survey box to the east to have a lighter uniform consistent signature which, from Cornwall IFCA's expert knowledge, represents sand.

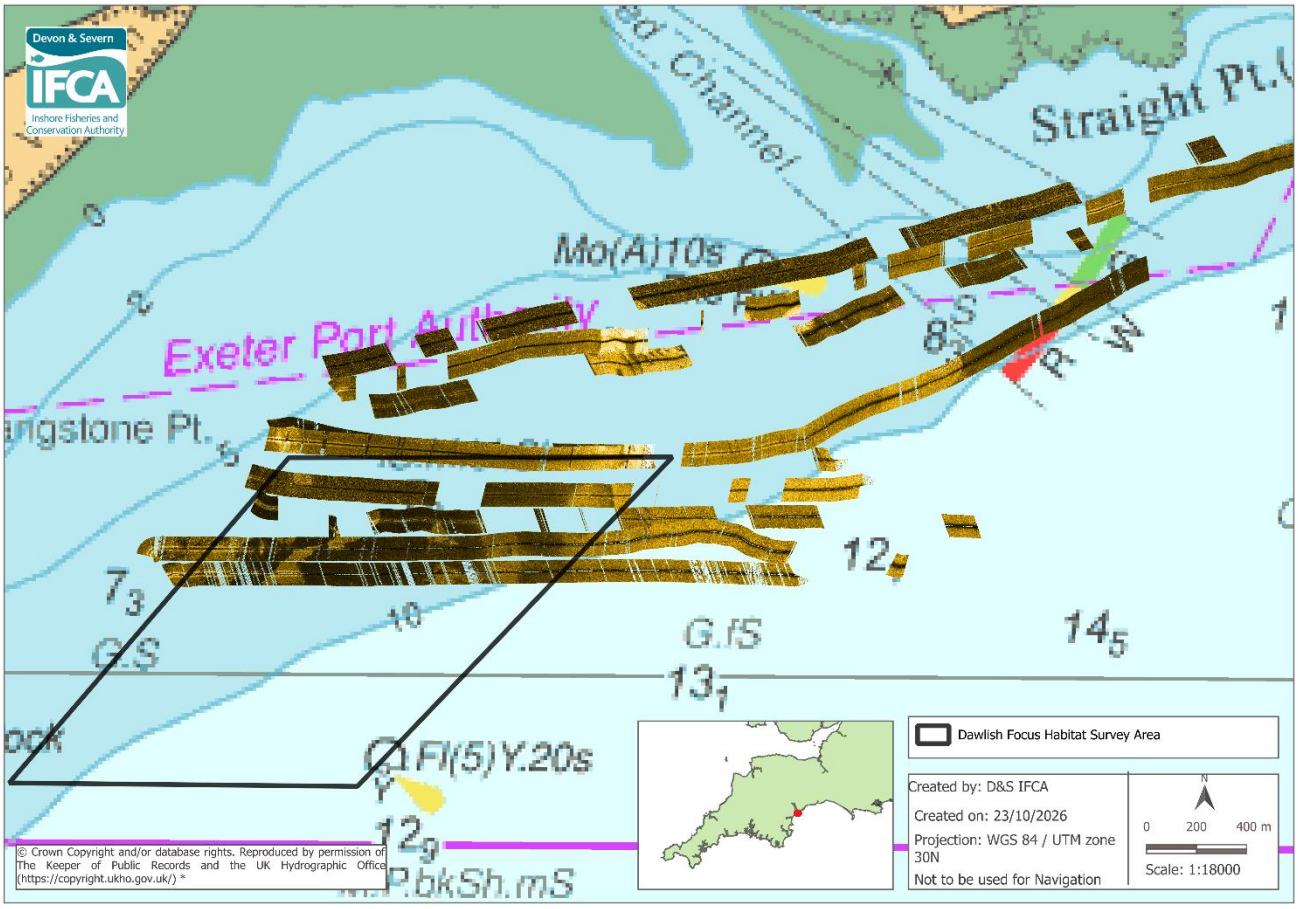



*Figure 10. Side Scan Sonar data (black to gold) gathered from the more extensive survey area. SSS data can be understood as an acoustic photograph of the seafloor, where sound waves replace light. Harder features reflect back a lot of sound, and so appear brighter, while softer features absorb more sound and appear dark. The dark line in the middle of each track is the water column directly beneath the SSS device and does not provide information on the seabed. The signature of the tows in the area outside the survey area to the east can be assigned to a sand habitat.*

The data available from the SSS suggests that the Dawlish habitat survey area is made up of muddy sand with some areas consisting of mixed ground.

There were four ROV video tows which overlapped with the SSS signature in the Dawlish area (Figure 11). Three of these video tows were made up entirely of muddy sand sediments, while one was mostly muddy sand but with a small section of mixed sediment consisting of muddy sand with a gravel, cobble and pebble overlay.

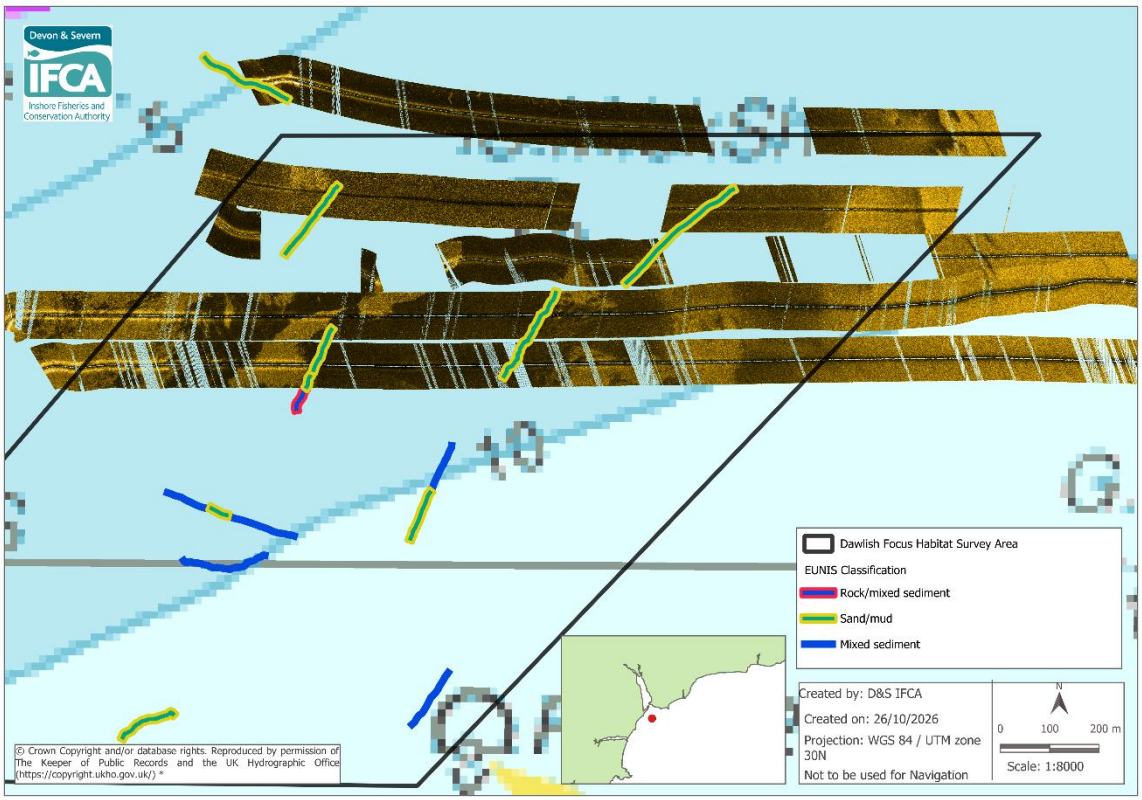



Figure 11 - *Side Scan Sonar data (black to gold) gathered from the northern portion of the Dawlish Focus Habitat Survey Area, overlaid with ROV video transects and habitat classifications. A further three overlaps between the ROV and SSS data were available for comparison in the Sandy Bay area.*

There were also three ROV video tows which overlapped partially with SSS data from the Sandy Bay survey further north. Together with expert guidance from Cornwall IFCA, this information allowed Officers to identify that the darker return in the SSS signature represents muddy sand while the brighter returns to the west generally represented mixed ground and to the east represent sand.

From the SSS and video tows (Figure 11), Officers have a high level of confidence that the darker signature is muddy sands due to the number of video tows which correspond with this signature, and a medium confidence in the mixed sediment areas due to only one short tow overlapping this signature. Confidence in this interpretation is improved due to the expert knowledge provided by Cornwall IFCA.

The results of both these habitat surveys demonstrate that the Dawlish habitat survey area is muddy sand together with some areas of mixed sediment, which includes grain sizes up to pebble and cobble. There is some evidence that the sediment becomes more sand-dominated towards the east of the survey area (based on SSS and Cornwall IFCA's expertise), with potentially more mixed sediment towards the central part of the survey area (based on video tows) and areas of harder ground towards the west (SSS and video tows).

## 3.3 Use of the D&S IFCA Survey Results and Evidence Sources to determine the Fishery Location

The ROV and SSS surveys have provided an understanding of the habitats and have allowed ground truthing to aid decision making on the location of the fishery. From this information, D&S IFCA Officers have revisited the proposed boundary for the razor clam fishery in Dawlish Bay. The set up of the razor clam dredge gear (one vessel towing the other vessel with the airlift system, very slow speed and narrow width) means that it can only operate in areas of sandier habitat. It will not be able to operate in too dense muddy habitats nor over hard substrates (as both will cause it to come to a standstill), and if the substrate is too pebbly this will damage the catch.

From the baseline evidence gathered through the surveys it has become clear that the area for the proposed fishery will need to be changed according to the ground truthed habitat type. The SSS survey helped identify sand sediment to the east of the fishery box both within and outside the survey area. This area to the east outside the box initially was not included in the potential classified harvesting areas but through discussions with the Food Standards Agency, Cefas Shellfish Classification team and Local Authority Environment Health Officers, the proposed shellfish classification area around Dawlish has been extended. The sampling, to establish the shellfish class (for human consumption), is coming to an end and the classification area and shellfish class should be published in the very near future. Figure 12 shows the new classification area in hatched red.

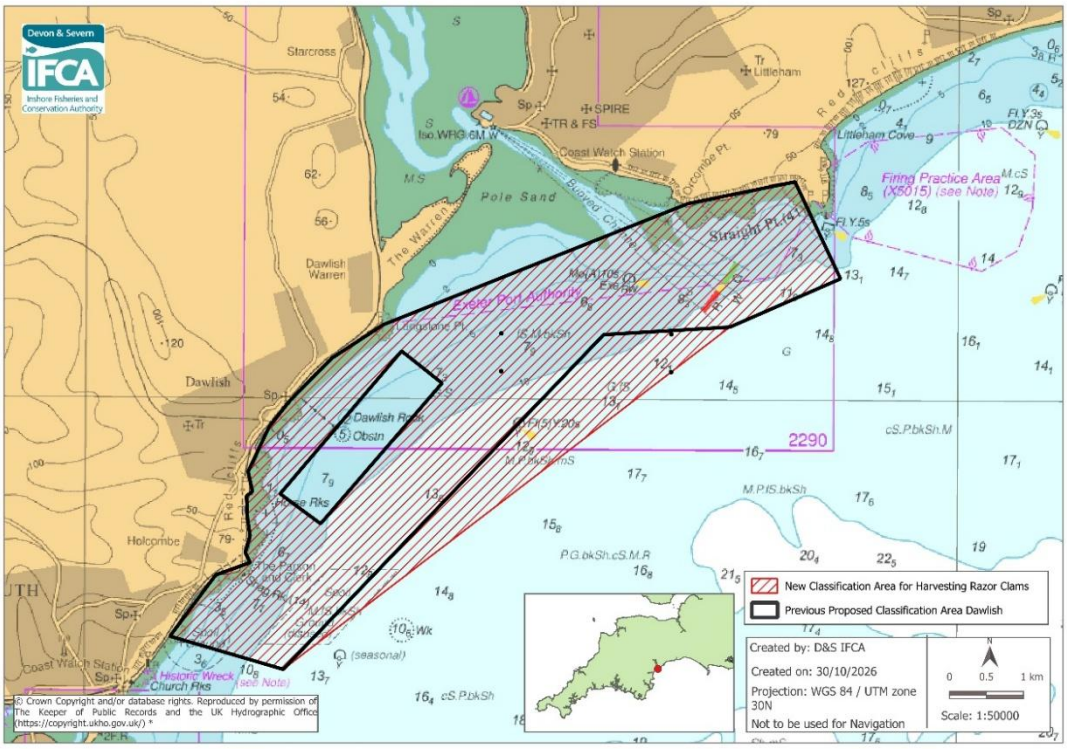



*Figure 12 - New Classification area for Razor Clam Harvesting shown in hatched red*

D&S IFCA Officers have used the evidence and information collated in this report to identify a suitable and appropriate area where the proposed razor clam fishery can take place. This meets the advice provided by Natural England as well as the needs of the fishery. D&S IFCA Officer have met the following Natural England's criteria for the fishery:

- *Limitation of area(s) open to this fishery within the wider shellfish classification area: start small and expand from there if the fishery proves sustainable over time.*
- *Limit areas open to the fishery to areas that are already open to (and fished by) other towed gear (e.g. using iVMS tracks to define these areas).*
- *Exclude sensitive habitat types from areas open to the fishery e.g. sensitive habitats like sandstone reef. Areas open to the fishery should be higher energy, more mobile sandy habitats with the highest potential for recovery*

Considering these criteria and the research results, the new proposed fishery area is shown in Figures 13 to 16, mapped in relation to the habitat type, seabed energy and existing fishing activity. Whilst the area is smaller, and potentiality not large enough to support a viable commercial fishery in the longer term, it is large enough for the fishing activity to begin (under regulation) and be monitored and further assessed in accordance with the Monitoring and Control Plan. It also lies within the extended classification area. The SSS and ROV habitat surveys have shown the suitability of the habitat to be of a sandier nature as advised by Natural England. The three minute IVMS spatial transmissions of demersal mobile fishing vessels (Figure 15) show that the area is used this gear type, as previously described in section 2, and therefore meets the criteria that the fishery takes place in an area already used by demersal towed gear vessels. Figure 16 shows the kinetic energy of waves at the seabed from EMODnet data and clearly shows that the fishery will take place in areas of moderate to higher energy.

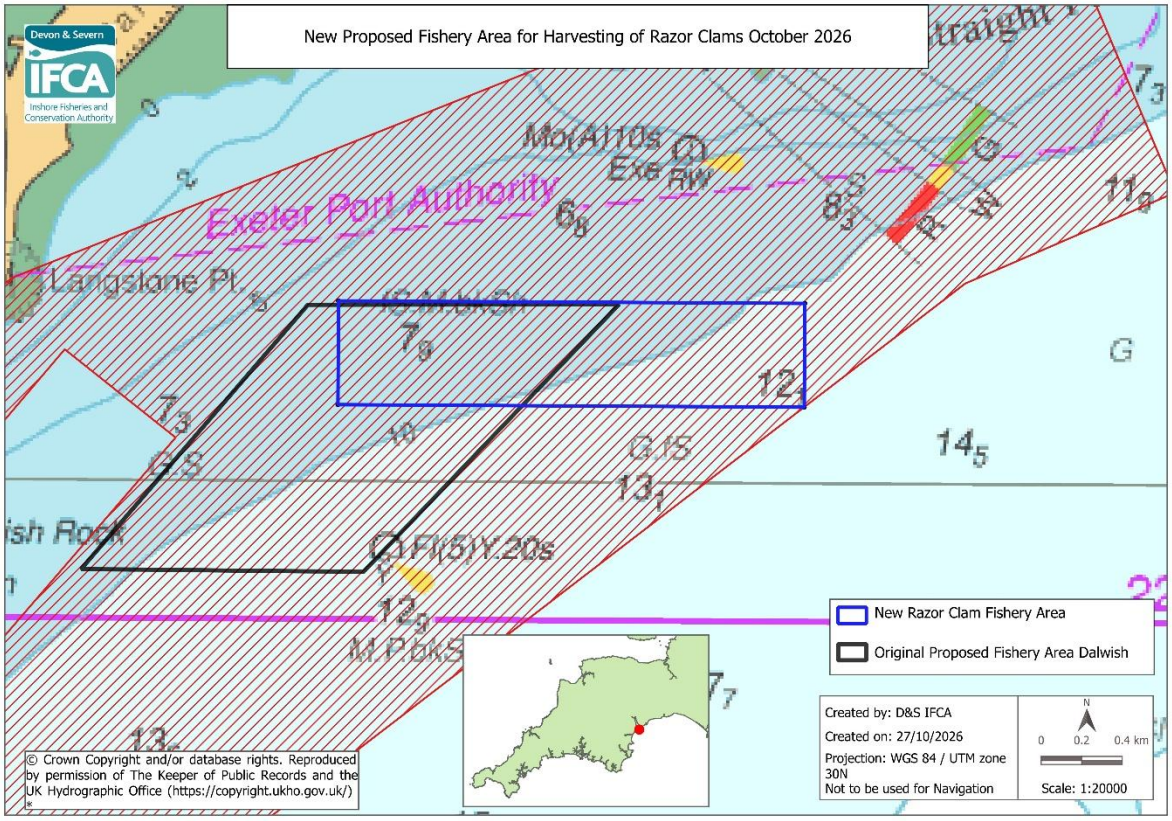



*Figure 13 – New and original proposed razor clam fishery area Dawlish*

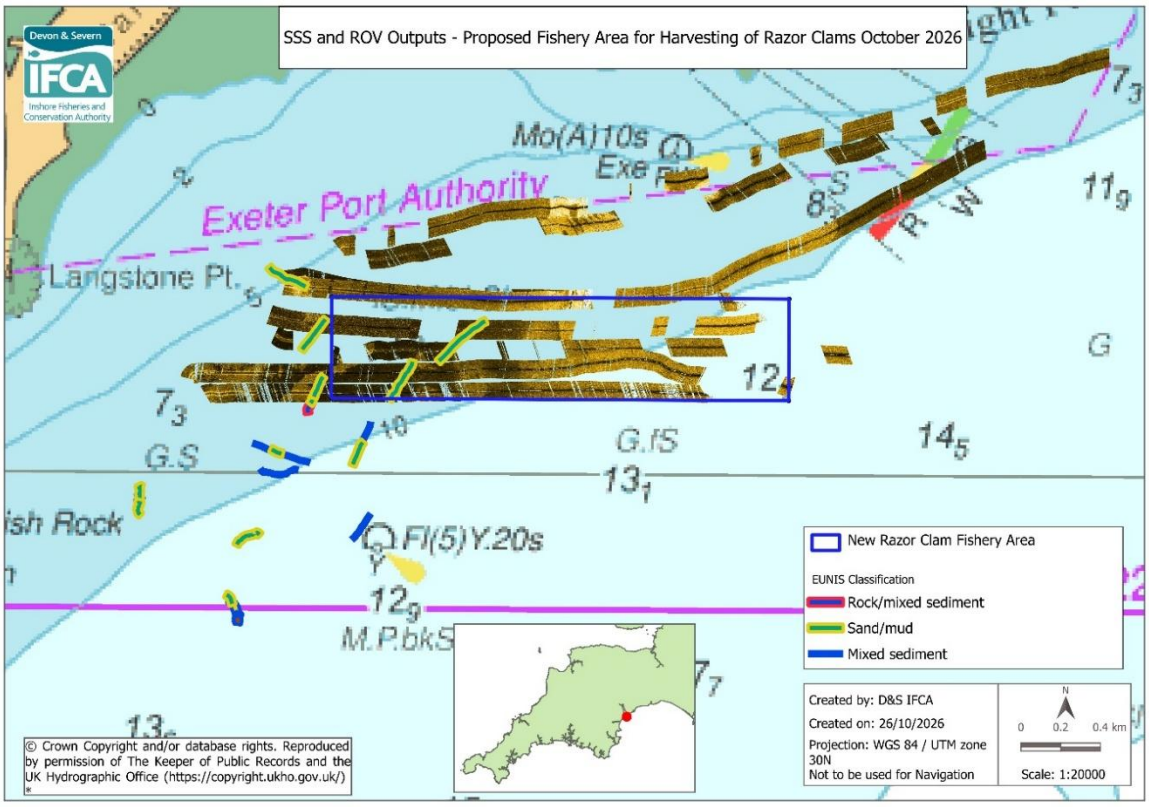



*Figure 14 - SSS and ROV outputs for the new proposed razor clam fishery area*

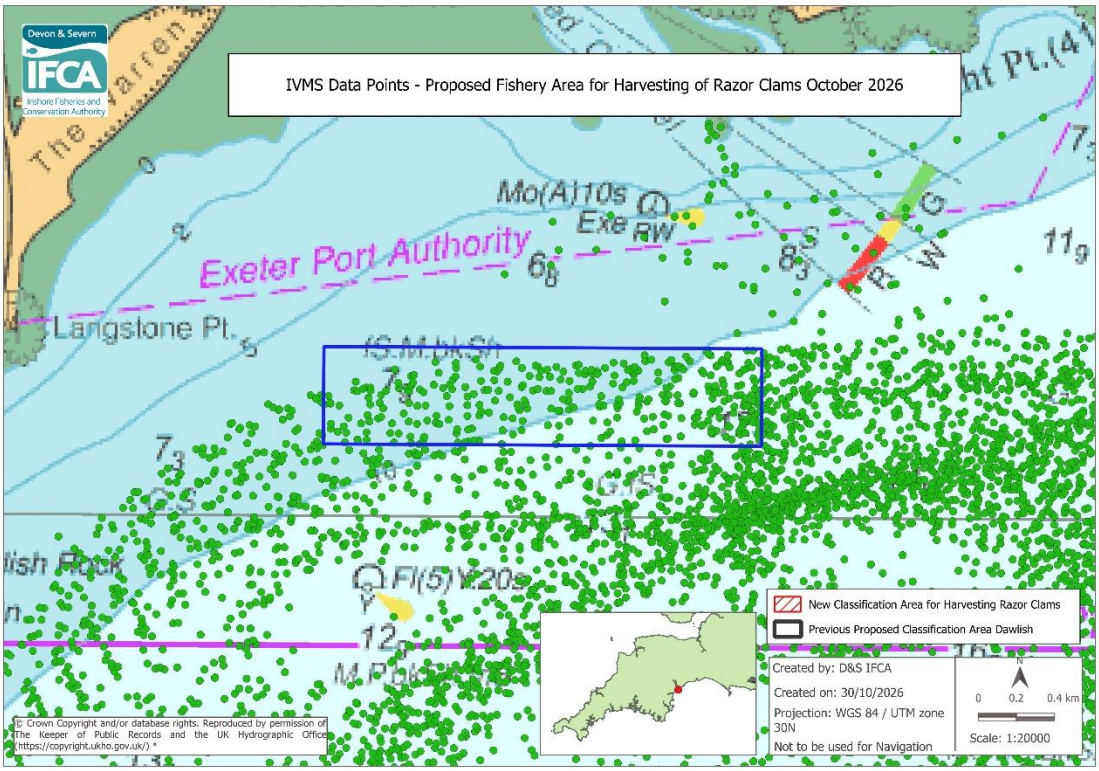



*Figure 15 - IVMS data points in the new proposed razor clam fishery area*

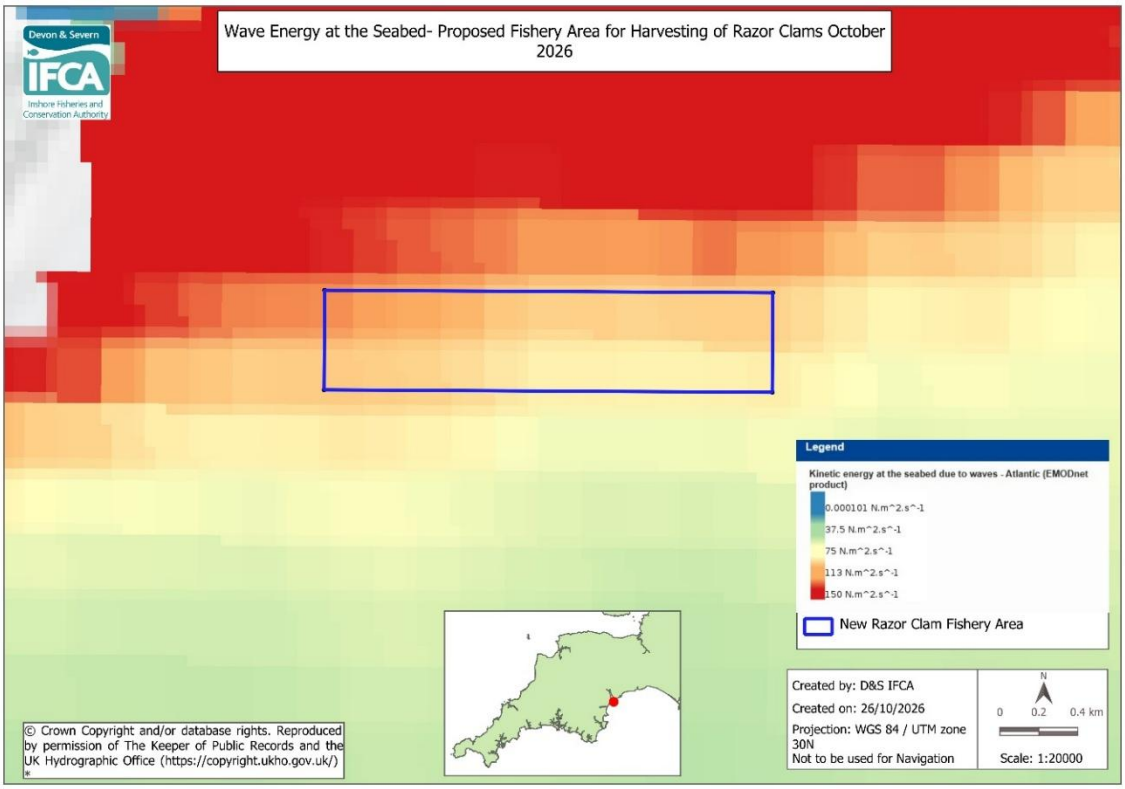



*Figure 16 - Wave energy at the seabed for the new proposed razor clam fishery area*

# 4. Monitoring Catch and Bycatch

This section 4 considers the D&S IFCA Members' concerns and Natural England's advice in relation to effort, catch, bycatch, spawning season, the minimum landing size (now referred to as minimum conservation reference size (MCRS)), reburial of and predation on bycatch returned to the seabed, and disturbance of the seabed by the fishing gear. D&S IFCA Officers have also endeavoured to remove the uncertainties that previously existed.

Natural England raised the following points:

- ***Limiting effort/ catch*** *within the fishery: starting with a more limited, trial fishery with the potential to expand from there should the fishery prove sustainable over time*
- *Investigating and avoiding* ***the spawning season*** *for targeted razor clam species e.g. a requirement for the fishery to cease when spawning is first apparent and resume following recovery of condition after spawning*
- *Increasing the* ***minimum landing size (MLS)*** *– current national Minimum Conservation Reference Size (MCRS) for all Ensis spp. is 100mm. Evidence suggests this is too low for at least some species of razor clam (particularly E. siliqua), and a larger MLS of 140mm plus would be more appropriate. The operator has informed D&S IFCA that they intend to target a market with a minimum landing size of 180mm so it would seem eminently feasible to set a MLS for this fishery at a more sustainable level, above the current national MCRS.*
- *Fragile animals may by damaged by hydraulic/suction gear. Buried animals will be lifted to the surface where they may suffer increased predation. There may be wider impacts from the bycatch (removal) of other organisms.* ***Monitoring of bycatch rates (and species****) during the operation of the fishery will be an important source of information to feed back into the adaptive management of the activity. Where possible, this should include monitoring 'bycatch' of species that are exposed but not lifted onto the boat.*

## 4.1 Limiting Effort/ Monitoring Catch

### *4.1.1 Limiting Effort*

From the analysis of data and evidence as described in sections 2 and 3 above, the fishery will be limited to one smaller proposed location. Other factors that will limit the fishery, within the defined area regulated through the Permit Conditions, are weather and environmental considerations as the vessels involved in the fishery will not be able to operate in adverse conditions. As described in Agenda Item 8 of the B&PSC meeting in February 2026, the fishery involves the use of a 1m wide dredge, which including the airlift systems has a combined weight of 500kg. The operation must be at a slow speed to ensure minimal damage to the razor clams. The slow operation means that any

unsuitable habitat encountered will be avoided and the fisherman will adjust his operation away from these habitats, as this may lead to damage to the equipment and any catch.

### *4.1.2 Monitoring Catch*

Remote Electronic Monitoring (REM) will be used to monitor the substrate, catches and bycatch, and on-board observers will also monitor the substrate, catch and verify REM outputs.

REM is a data collection tool that can be installed on vessels to collect information on fishing activities and catches. A REM system typically consists of sensors and cameras collecting various data (video, GPS etc.), that can then be interpreted to generate information on when and where a vessel is fishing and what it is catching. The set up of the cameras can provide full catch coverage allowing collection of data similar to that usually collected by scientific observers at sea (Rebecca Skirrow, Cefas Blog 2021). Its use has been proven in Scottish fisheries and also documented in research of its use as a potential alternative to on-board observers in small scale fisheries worldwide (Bartholomew et al 2018). The set up of the cameras on the fishing boat taking part in the proposed fishery will allow for determination of the catch, bycatch and sediment type that is brought aboard the vessel by the air lift equipment.

Monitoring of catch can an important part of investigating the sustainability of a fishery if sufficient data ca be generated and there is confidence in that data. Commercial fishing data can provide broad spatial coverage, Catch Per Unit Effort (CPUE) trends and data on size composition. CPUE is an indirect measure of the abundance of the target species. Changes in the CPUE are inferred to signify changes to the target species' true abundance. Due to the small, proposed area for the fishery, determining changes in CPUE may be difficult but the proposed M&CP will demonstrate whether monitoring CPUE is possible.

CPUE can be calculated based on data recorded in logbooks (by the fisher or observer) and is expressed as number or weight of razor clams per fishing hour/day and tow length. These data (particularly location and CPUE) can be used in a statistical model (delta-GLMM) to standardise the data and understand whether there is a change in CPUE over time/an area. D&S IFCA will look to monitor tow-by-tow catch, landings data and IVMS/REM combination for effort data on a regular basis to feed into the modelling to identify changes in CPUE and Landings per Unit Effort (LPUE). Analysis of data will allow comparison of high and low intensity fishing (if identified) and will look to identify changes in CPUE between the different fishing intensities. If an understanding of the CPUE is achieved, Officers will determine if a threshold of declining CPUE can be set. Combining CPUE measures with other indicators e.g. the average length and the proportion of mature individuals change over time which will provide an increase in confidence in the assessment.

With sufficient data on CPUE and location of the fishing activity using REM, the information could also feed into what is known as a 'depletion model'. Such models have been used in geoduck fisheries and scallop fisheries. While the delta-GLMM gives a relative abundance trend over time, the depletion model aims to estimate, after a certain amount of depletion, how much biomass must have been there initially. D&S IFCA Officers will determine the best model to use to identify trends and depletion

Fraser et al., (2018) undertook research on razor clam biology, ecology, stock assessment and exploitation of *Ensis spp* in Wales. In terms of stock assessment, they concluded that recording and analysing fisheries data can support stock assessment and management, with catch rates serving as an indicator of stock status. This approach would not be able to provide accurate population levels which could not be used to for setting a quota but would indicate stock trends. They pointed out that external factors such as weather conditions and gear efficiency/settings can also influence catch rates. They also stated that the use of fisheries derived data for the assessment and management of *Ensis* spp. fisheries is a reactive approach and would rely on relatively quick feedback and analysis of data and would also be appropriate to apply this within a framework of management measures. Such a framework is described in the M&CP and permit conditions.

The type of fishery dependent data that is relevant for monitoring a razor clam fishery was also described (Fraser at al., 2018). Table 1 below highlights data type and methods of collection, which would be applied to the razor clam fishery in the D&S IFCA's District and includes the addition of REM which will also be used to monitor the fishery.

*Table 3: Relevant Data Types and Method of Collection*

| Data Source | Data Type | Method of Collection |
|---|---|---|
| Vessel | Type | Permit Application Form |
| | Length | |
| | | |
| Gear | Type | Mobile Fishing Permit Byelaw 2022 Permit Conditions and M&CP |
| | Quantity | |
| Fishing Activity | Location/Spatial | Permit Conditions/ Logsheet/ IVMS/ REM |
| | Habitat type | REM/ Observers at sea |
| | Duration (e.g., time spent towing, number of tows) | Logsheet/ IVMS/REM |
| | Area covered per day | IVMS / REM |
| Catch | Landings | Logsheet/ observers at sea/ shore inspections |
| | Live returns (including reason for return) | Logsheet/ observers at sea/ REM |
| | Bycatch (species/habitat interactions) | Logsheet/ /observers at sea/ REM |
| | Length Frequency | Observers (sea and/or shore)/fisher self-sampling |

## 4.2 The Spawning Season of Razor Clams

Table 2 shows a summary from literature review of the biology of the razor clam *Ensis siliqua*

*Table 2. Overview of the biology and ecology of Ensis siliqua, found in the UK*

| **Parameter** | ***Ensis siliqua*** |
|---|---|
| **Location** | All around the British Isles, absence of records in Southeastern Ireland |
| **Max. length** | 200 mm [1, 2, 3]; 233.8 mm [4];214 mm [6]; 215 mm [8] |
| **Size at maturity** | 100% at 131-140 mm [4] >100 mm [5]; Smallest 118 mm[10], |
| **Age at maturity** | 3-4 years[1]; ≥3-5 years at maturity [4]; ≥3 years [5]; ~4 years [7] |
| **Age at 100 mm (MLS)** | 4-5 years [4]; 2-3 years [5] |
| **Spawning season** | June-August[1]; Majority May- June [4;] Gonads mature July and spent in August [5]; Peak spawning March-July [6]; Mid-May-early August [7]; |
| **Depth preference and range** | Low water and sublittoral-60 m[1] LW-20 m [1, 9] |
| **Habitat /substrate preference** | Clean sand [1]; Clean sand [2]; Sandy habitats/ Fairly fine clean sand [9]; Fine sand [4] |
| **Density (animals/m²)** | 2.63 [4]; In patches exceeding 200 but average 1.5 for the overall bed [7]; Up to 9 [8] |
| **Wave exposure** | Only *Ensis* spp. present on wave exposed beaches but absent from fully exposed beaches [9]; Tolerate moderate wave exposure [4] |

T

*Table - L2iterature Sources:*


- [1] Aitken, A. and Knott, M. (2018). Razor Clams in the North Western IFCA District: is there potential for a sustainable fishery? pp. 52.
- [2] Holme, N.A. (1951). The identification of British species of the genus Ensis Schumacher (Lamellibranchiata). Journal of the Marine Biological Association of the United Kingdom, 29: 639-4.
- [3] Coates, P. J. (1999). A report to South Wales Sea Fisheries Committee to determine applications under byelaw 40 to take razor fish and other bivalve shellfish using vessel towed hydraulic (water jet injection) dredges. pp. 55.
- [4] Muir, S.D. (2003). The biology of razor clams (Ensis spp.) and their emergent fishery on the West coast of Scotland. PhD thesis, University of London. pp. 280.
- [5] Henderson, S.M. and Richardson, C.A. (1994). A comparison of the age, growth rate and burrowing behaviour of the razor clams, Ensis siliqua and E. ensis. Journal of the Marine Biological Association of the United Kingdom, 74(4): 939-954.

- [6] Cross, M.E., O'Riordan, R.M., and Culloty, S.C. (2014). The reproductive biology of the exploited razor clam, Ensis siliqua, in the Irish Sea. Fisheries research, 150: 11-17.
- [7] Fahy, E. and Gaffney, J. (2001). Growth statistics of an exploited razor clam (*Ensis siliqua*) bed at Gormanstown, Co Meath, Ireland. Hydrobiologia, 465: 139-151.
- [8] Trundle, C. (2004). Report to South Wales Sea Fisheries Committee on trials of a vessel towed hydraulic dredge in Carmarthen Bay. pp. 21.
- [9] Holme, N.A. (1954). The ecology of British species of Ensis. Journal of the Marine Biological Association of the United Kingdom, 33(1): 145-172.
- [10] Muir, S.D. and Moore, P.G. (2003). Too close a shave for razor clams. *Shellfish News*, **15**: 7-9.

Various studies have been undertaken on the breeding and spawning of *Ensis spp*. Table 2 shows the range of *Ensis siliqua* spawning periods which have been identified from the different research studies. Henderson and Richardson, (1994) studied the breeding and spawning of *Ensis spp* and found that these occur annually with gonad development in both sexes during the winter months and spawning during the spring/summer followed by a sexual rest period. Similar studies in North Wales on *E. ensis*, indicated a spawning period around July with individuals found to have spawned in August. In Scotland, *E. siliqua* has been recorded spawning from March to July (Hauton, 2002).

The evidence gathered from the literature reviews undertaken, indicates that the spawning period varies depending in the location and water temperature and can be anytime time between March and August. Many of the studies listed above have been undertaken in Irish, Welsh and Scottish waters. Studies on spawning within a larval rearing and spat production aquaculture of *Ensis spp* indicate that spawning is impacted by water temperature with higher temperatures bringing on spawning. It is important to assess the spawning period of *Ensis siliqua* in South Devon waters, and Officers are proposing that research will be undertaken in 2027 to investigate it. A project proposal has been submitted to the University of Plymouth's MSc in Marine Conservation for an MSC student to join the team and aid the research.

## 4.3 Minimum Conservation Reference Size (MCRS)

Table 2 also shows the size at sexual maturity which is a key parameter in the setting of an MCRS. Research has shown that the size of sexual maturity of *Ensis siliqua,* where 100% are sexually mature, is between 131 to 140mm (Muir, 2003). Henderson and Richardson (1994) compared the age, growth rate and burrowing behaviour of *Ensis spp* and found in their study that the razor clams were at least three years old and over 100mm before they spawned.

For many species the size of sexual maturity which is used to inform size limits is based on 50% of the population having reached sexual maturity. This is known as the $L_{50}$ – a specific measurement where half the population reaches reproductive capability. The size at which *Ensis siliqua* reach sexual maturity ($L_{50}$) varies significantly by latitude and local water temperatures. In Portugal the $L_{50}$ of *Ensis siliqua* was found to be approximately 60 mm to 100 mm (Gaspar and Monteiro 1998). Studies for Welsh and Irish populations estimate age of maturity to be at least three or even four years (Henderson and Richardson 1994, Fahy and Gaffney 2001). This corresponds to the

current EU minimum landing size of 100 mm although there is a suggestion that maturity may not occur until greater lengths (i.e. 120 mm) (Fahy and Gaffney 2001). From the survey undertaken using the razor clam airlift dredge in Lantic Bay in Cornwall IFCA's (CIFCA) District all razor clams caught were measured and the majority of which were found to be over 140mm in length (Figure 16).

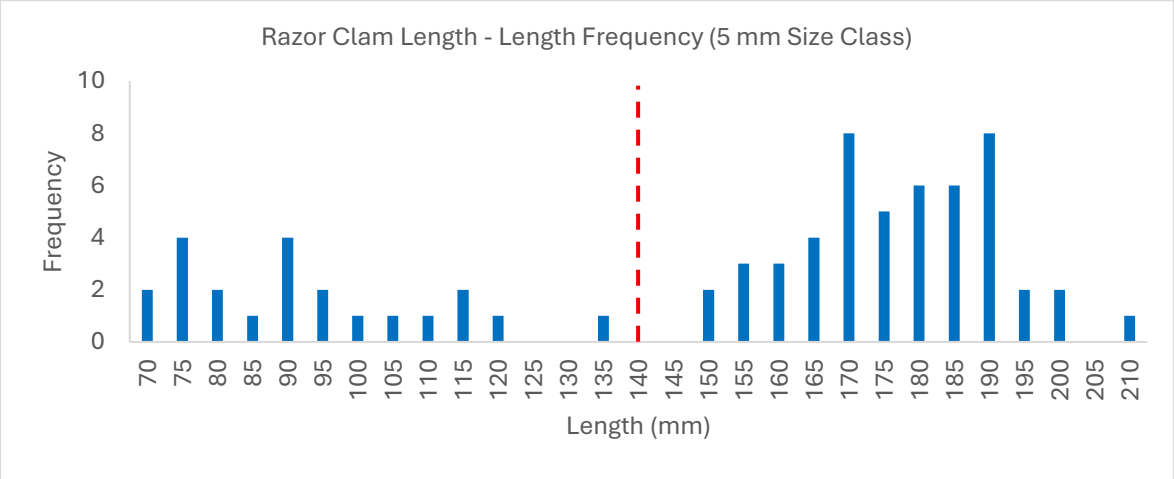



*Figure 16 - Length Frequency Distribution of Razor Clam surveyed in a trial in CIFCA's District*

In the literature reviews of previously undertaken studies the $L_{100}$ where 100% of the population is sexual mature is 140mm. The fisherman proposed a MCRS of 140mm or more. Natural England has recommended an MCRS of 140mm. D&S IFCA Officers support an MCRS of 140mm which will be included in the M&CP.

As previously mentioned in Section 4.2 the research proposed to understand the spawning season could also help identify the size of sexual maturity of *Ensis siliqua* in the proposed fishery areas.

## 4.4 Bycatch Monitoring

### *4.4.1 Bycatch Impacts and Damage Rates*

The monitoring of bycatch will take place through the use of REM and observer surveys. The use and effectiveness of REM to monitor the fishery is a prerequisite of the fishery taking place. REM has been used in trials on mobile fishing vessels in the D&S IFCA's District has been found to be very useful in monitoring the fishery.

REM (which includes an array of cameras) will be used to monitor catch and vessel position and help determine levels of bycatch. On board observers and surveys will assist to gather data and information. Natural England, in its formal advice to D&S IFCA, welcomes the proposal for requiring REM. Catch and bycatch monitoring will be important to analyse any impacts of the fishery.

Studies summarised in Murray et al, (2014) indicate that hydraulic dredging can remove up to 90 % of the target species from the seabed (Hauton et al. 2003), however, there can be high levels of bycatch associated with this method. Whilst in some parts of Scotland over 70 % of the catch are *Ensis* species (Tuck et al 2000), in the Clyde it can be far lower

(25 %, Hauton et al. 2003) due to the high abundance of the burrowing urchin *Echinocardium cordatum*. Hauton et al (2003) in their study of the impact of hydraulic blade dredging on the megafauna in the Clyde Sea area investigate the damage caused to the target species and the discard collected by the dredge as well as the fauna dislodged by the dredge but left exposed at the surface of the seabed was quantified. The dredge contents and the dislodged fauna were dominated by a bycatch of the burrowing heart urchin *Echinocardium cordatum*, approximately 60–70% of which survived the fishing process intact. The high survival rate of *E. cordatum* was considered to be a function of the slow towing speed of the dredge in combination with the water used to fluidise the sand, which would have pushed many of the urchins away from the blade of the dredge.

Tuck et al., (2000) studied the impact of water jet dredging for razor clams, *Ensis* spp., in a shallow sandy subtidal environment. They found that the majority of the studied infaunal community is adapted morphologically and behaviourally to a dynamic environment, and other than initial removal through dispersal, is not greatly affected by the dredge at the site studied. Species that are likely to be affected (e.g. the heart urchin *Echinocarium cordatum,* ocean quahog *Arctica islandica* and other large bivalves) were very rare in infaunal samples, but present in dredge catches, where damage was noted, and ranged on average from 10 to 28% of individuals. The small-bodied bivalve species retained in the dredge were not damaged, but the three larger-sized species of bivalves (otter shell *Lutraria lutraria*, ocean quahog and blunt gaper *Mya truncata*) were vulnerable to damage (10–20%). A number of crustacean (mostly crab) species, and on rare occasions, two fish species, were also retained in the dredge, but were not damaged. They also found various polychaete worms in some if the dredge samples of which the majority were undamaged.

From the razor clam trials undertaken by CIFCA in Lantic Bay in 2025 the bycatch consisted of the heart urchin *Echinocardium cordatum,* the masked crab *Corystes cassivelaunus,* the peanut worm *Golfingia spp.* and the otter shell *Lutraria lutraria*.

D&S IFCA Officers propose, as part of the M&CP, to monitor the bycatch of species from the fishing activity and monitor damage rates. Similar to the CPUE monitoring the data collected for bycatch monitoring will include bycatch data per tow from at-sea observers, REM, return forms and IVMS/REM combination for effort data. The IVMS data will help to quantify a gradient of fishing intensity which will collected from commencement of the fishery. Once an understanding of the bycatch is achieved, Officers will consider a threshold of a declining bycatch CPUE.

### *4.4.2 Reburial of and Predation on Bycatch Returned to the Seabed*

Natural England and Members raised concerns regarding the potential for increased predation to those undersize razor clams and other macrofauna that are either lifted to the surface of the seabed (and not removed through the airlift system) and those returned to the seabed after removal.

Fraser et al (2018) investigated razor clam biology, stock assessment and exploitation. They described the burrowing behaviour of razor clams using a large "foot" to burrow and to anchor themselves in the sediment. When disturbed, they are capable of rapidly digging to depths in excess of 1 m or of emerging out of their burrows. *Ensis magnus* has been observed to also "swim" horizontally along the bottom of the seabed by flicking the foot and jetting water out of the pedal opening to move forward 3 to 5 m at a time (Pyke, 2002). It has been suggested that this swimming behaviour allows *Ensis* spp. to migrate to more favourable substrate and growing conditions and may be responsible for the replenishment of exploited subtidal beds (Fahy and Gaffney, 2001). The burrowing behaviour of *E. siliqua* and *E. ensis* is described in detail in Henderson and Richardson (1994). *Ensis siliqua* first probes its foot into the sediment to obtain a good anchorage before pulling itself vertically upright and then burrowing down into the sediment. Diver observations of the spouts of sediment and water ejected from the siphons of burrowing razor clams have shown *E. magnus* to be more sensitive than *E. siliqua* in taking immediate evasive burrowing behaviour following human disturbance (Muir, 2003).

In studies of the razor clam fishery, when exposed individuals of other bycatch species that are either discarded or left in the dredge track are susceptible to predation by scavenging fauna such as crabs, *Ensis spp* that have been left behind by a dredge either re-bury or move outside of the dredge track (Bailey et al., 1998). The majority of individuals (85 – 90%) begin to re-bury soon after being exposed and it has been suggested the fluidisation of sand aids in faster reburial (Hauton et al., 2003). Only a few clams were still unable to rebury after three hours. Approximately 85% of razor clams retained the ability to rapidly rebury into both undredged and dredged sand, as did the majority of those heart urchins *Echinocardium cordatum* which did not suffer aerial exposure. However, they found that *E. cordatum* were slow to rebury after experiencing aerial exposure which could result in some predation by scavenger species.

Hauton et al (2003) went on to describe that the heart urchin does not have a muscular foot similar to that of bivalves which meant that this species could be displaced more readily without sustaining damage. As described earlier the slow towing speed of the hydraulic dredge contributed to very low abundance of mobile species within the dredge hauls. In particular, the study found that decapod crustaceans and fish were seen to move away from the path of the dredge long before they were washed into the collecting box of that type of dredge. Haunton et al (2003) study demonstrated that even razor clams which have been brought to the surface in the dredge collecting box retain an ability to rebury rapidly. Reburial capability was not impeded by the fluidised sand of a fresh dredge track, which indicated that the bivalves were still able to use their pedal muscles to create an effective anchor in the sediment and the fluidised sand offered less physical resistance to penetration by both the pedal muscle and the shell of the razor clams. Haunton et al (2003) modelled the reburial behaviour *Ensis* spp and found that the reburial would occur within a short time (between one and 30 min) and would not be impeded if the animal were to land back onto the fluidised sand of a fresh dredge track. They concluded that the undersized razor clams, once successfully reburied, would be able to continue growing and so contribute toward the maintenance of *Ensis* spp.

populations at the site studied. Diver observations within the Dawlish area in South Devon (pers. Comms.) have seen rapid reburial of razor clams after disturbance.

The literature review has provided evidence that reburial of *Ensis spp* occurs in a short period of time after exposure and this should allay the concerns raised by D&S IFCA Members. Many other species can move away from the dredge operation although a few species e.g. *Echinocardium* maybe be impacted by predation as their reburial time is longer.

# 5. Habitat Impacts

## 5.1 Physical Seabed Disturbance

At the Authority meeting in June 2026, Members raised concerns regarding the disturbance of the seabed and sediment plumes. The action of mechanical and hydraulic shellfish dredges will physically disrupt benthic substrates. Harvesting may suspend sediment, increase turbidity, alter substrate composition, and cause sediment plumes. Dredges may leave behind tracks of varying depths and widths along the bottom that may persist until sediments are restored by natural processes.

Research into the impacts of razor clam dredging has been undertaken in several areas around the UK Studies show that the persistence of dredge tracks varies, although trenches and tracks generally dissipate quickly after harvesting. During dredging, heavier material and resuspended sediment can fall from the back of the dredge and partially backfill trenches (Tarnowski, 2006). Recovery is highly site-specific and closely linked to sediment type. For example, tracks on sandy seabeds may diminish within 24 hours (Gaspar et al., 1998, 2003), while others may remain as shallow depressions (Meyer et al., 1981), deeper marks lasting several days (Gaspar et al., 2003), or features persisting for weeks (Manning and Dunnington, 1955). Erosion and wave action can reduce the depth and width of dredge tracks within a month (Hauton et al., 2003a).

Most studies have examined the impact of batch dredges, which differ from the proposed airlift dredge design, although both systems involve a blade that penetrates the sediment to a comparable depth. Tuck et al. (2000) investigated the effects of water-jet dredging for *Ensis* spp. on the seabed and benthic community in a shallow subtidal sand environment in the Outer Hebrides. A batch dredge was used in this study which penetrated to 30 cm and the blade was 32.5cm and had a collection cage with skids alongside the catch making the footprint wider. They reported immediate physical effects, including visible trenches left by the dredge. The authors deployed divers to observe the impacts of the dredge directly after the operation. The track immediately behind the dredge had distinct vertical walls and a depth similar to that of the dredge blade. The substrate in the bottom of the track was in extreme suspension not unlike ‘quicksand’. However, once the dredge was hauled and the divers returned to the start of the track, it was immediately obvious that the vertical side walls had collapsed and the cross sectional form of the track was more like a flat-bottomed ‘V’ shape. The average

dimensions of the tracks showed the surface width to be 1.2m and where the blade was in operation was 0.5m wide and 15cm deep. These trenches had begun to infill after five days and were no longer visible after 11 weeks, although sediment within some dredge tracks remained fluidised beyond this period. Dissipation of dredge tracks can be depth dependent as well as tide and current dependent. In the Tuck et al (2000) study described above, the site was shallow being between 3 to 5m in depth and a tidal range of 2.5m to 4m and tidal streams in excess of 3knots. In the proposed fishing area in Dawlish Bay outside of the Exe Estuary the depth is 7 to 12m in depth, with a spring tide reach up to 4.5m, and ebb tidal speeds across Pole Sands at the mouth of the estuary and Dawlish Warren reaching 4.5 to 5 knots and therefore experience considerable tidal action.

Constantino at al., (2009) studied the impacts of a clam dredge in 6m and 18m in an area closed to demersal towed gear along the south coast of Portugal. The dredge itself was 80kg and comprised of a metal frame with a toothed lower bar with teeth of 20cm in length, a dredge spread of 0.64m and a box to retain the catch. The passage of the dredge on the bottom produced a slightly depressed track, about 30 cm wide and 10 cm depth, where the sedimentary structures were disrupted. The authors found that the clam dredge tracks were no longer distinguishable after 24-hours at 6 m depth but remained visible for 13 days at a depth of 18 m. At 18 m depth, 1 day after dredging, a slight increase in grain size was detected within the dredged area. This result might be related to the subsequent infilling of the dredge tracks by coarse particles that were dislodged to the sides of the trench during dredging (Constantino et al. 2009). The authors suggested that the significant recovery observed from 5 days to 13 days after dredging at 18m could be related to an increase in bottom energy levels partially represented in the data and could explain the relative increase in the finer sand fractions. The study found that were there were higher energy events on the seabed after 13 days which may have masked the sedimentary perturbation induced by the dredging activities.

Beimann et al (2022) described that traditional demersal trawling is widely acknowledged as one of the most intense forms of widespread benthic disturbance, resuspending extensive plumes of sediments and dissolved nutrients and the amount of drag of the gear determine that height and concentrations of resuspended sediments. Their results showed the mobilisation of sediment into the water column behind towed gears is a hydrodynamic process driven by turbulent shearing and the pressure drop in the gears wake and that it is not influenced by the pressure force the gear exerts on the seabed.

O'Neill et al (2011) measured the quality of sediment mobilised by trawl components and found that for a given sediment a relationship was demonstrated between the drag of the gear element and the mass of sediment mobilised behind it. The authors demonstrated that the mass of sediment entrained by a gear component is directly related to the hydrodynamic drag of the component and the type of sediment over which it is towed. The authors showed, on four different sediments, that the greater the trawl drag and the finer the sediment, the greater the amount of sediment remobilised.

Hauton et al (2003) undertook an experimental study of the ecological impacts of hydraulic bivalve dredging on maerl. Maerl is a sensitive habitat and it not a habitat over which the proposed fishery will take place. The study involved a batch dredge with a collection box which is different from the hydraulic air lift dredge system to be used in D&S IFCA's District. In their study, the authors found that hydraulic dredging altered sediment structure to depth of at least 9 cm. A single dredge tow significantly reduced the gravel component and increased the degree of sediment sorting. On a fishery scale, repeated dredge hauls would be expected to alter the physical nature of the sediment, producing a more sorted, unconsolidated, sandier habitat.

## 5.2 Sediment Plume Impacts

Bottom trawling plumes in the Baltic Sea have been investigated by Correll et al (2023). Bottom sediment is suspended by direct contact of the trawling gear with the seabed as well as by turbulence created around the gear. Sediment suspension can be quite substantial, particularly on fine-grained seabeds, with local turbidity in the bottom water reaching many hundred mg per L and increasing natural turbidity by orders of magnitude. The sediment plume can be transported up to 3km away from the trawl track.

In the Hauton et al (2003) experimental study of the ecological impacts of a hydraulic bivalve batch dredging on maerl, the results indicated that the batch dredge did create large cloud of sediment either side of the dredge track which settled out and blanketed the seabed to a distance of 8m either side of the dredge track. They found that sediment settled within one hour and the track was eroded within one month and the depth and width was reduced due to wave action.

Disturbance of seabed sediments can increase turbidity as fine-grained material is resuspended into the water column (Maier et al., 1998). Where sediment is resuspended at high concentrations, or where exposure is prolonged, effects on marine organisms can be more severe. Sediment resuspension can reduce the survival of bivalves and fish through gill clogging, or by inhibiting movement and burrowing activity (Dorsey and Pederson, 1998). Small organisms and immobile species may also be vulnerable to smothering as suspended sediment settles (Manning, 1957).

However, many species found in shallow coastal waters where harvesting occurs are expected to tolerate extended periods of turbidity (Gaspar and Chícharo, 2007). Studies of mechanical clam harvesting in South Carolina creeks found no significant short-term effect of elevated turbidity on bottom-dwelling invertebrate and finfish assemblages (Maier et al., 1998). Wilber and Clarke (2001) reviewed the acute effects of suspended sediment exposure on fish and shellfish associated with navigational dredging. Laboratory bioassays exposed target organisms to increasing concentrations and durations of suspended sediment until responses were observed. Survival varied with dosage, ranging from no effect to complete mortality. For example, after a two-day exposure to a relatively high sediment concentration of about 10,000 mg/l, effects on

larval bivalves ranged from sublethal responses to 75% mortality. As the degree of sediment resuspension is related to both the duration and magnitude of dredging activity, short-term, intermittent shellfish harvesting will have a lower effect than navigational dredging. Mercaldo-Allen and Goldberg (2011) reviewed several studies on the effects of shellfish dredging on adjacent undredged areas and summarised by suggesting that in general, harvesting impacts are limited to the directly disturbed area.

Due to the slow moving speed of the hydraulic air lift dredge and its small 1m width, it is likely that any sediment plume will settle quite quickly and with a minimal range compared to natural disturbance, such as storms, and is likely to be less than the plumes caused by existing demersal fisheries (scallop dredges and trawls) that operate in the area, due to the smaller area over which the razor dredge will operate, and its slow operating speed.

The evidence provided here suggests that the activity will not create a significant risk of sediment plume and drift compared to other demersal towed fishing gear, and the proposed fishery areas authorised through the permit conditions will not be near to MPAs, and therefore no impact to designated features of the sites.

## 5.3 Biological Habitat Impacts

The study carried out by Tuck et al. (2000) concluded that most of the infaunal community at the shallow subtidal sand environment site studied was morphologically and behaviourally adapted to a dynamic environment and, aside from initial displacement, was not greatly affected by dredging at the site studied. Epifauna were scarce and largely unaffected, although scavenging species were attracted to dredge tracks. The authors also noted that, based on this and previous studies, the biological impacts of hydraulic and suction dredging appeared broadly similar, although suction dredging may have a greater physical effect due to larger trenches. Tuck et al (2000) concluded that habitats accustomed to disturbance may experience no change in diversity after dredging. In shallow, sandy, subtidal habitat near Scotland, mechanical harvesting of razor clams resulted in no apparent impact on species diversity.

Hall et al. (1990) observed infaunal community response to hydraulic dredging in 7m depths of a Scottish sea loch 40 days after fishing. They recorded an initial reduction in the abundance of a significant proportion of species; however, after 40 days no effects of fishing could be detected both in species abundance and through visible signs on the sea floor. The study was subject to strong winds which was likely to play a role in sediment disturbance and effect dilution. However, they summarised saying that given the restricted depth at which fishing is possible at present, hydraulic dredging is unlikely to have persistent effects on most of the infaunal community in most habitats.

Mercaldo-Allen and Golberg (2011) concluded that the ecological effects of hydraulic escalator dredging are often limited by the resilience of target species and the dynamic conditions of inshore coastal ecosystems where harvesting occurs. Hard-shelled

bivalves generally recover well from harvesting impacts, and benthic communities exposed to long-standing shellfishing activity can recover quickly after disturbance (Tarnowski, 2006). In high-energy environments, where communities are adapted to frequent disturbance, physical and biological characteristics may help buffer the effects of dredging. This may explain why morphological and sedimentary impacts can disappear rapidly after harvesting (Constantino et al, 2009).

Elliot et al (1998), described the characteristics of subtidal mobile sandbanks. The biodiversity of these sedimentary biotope complexes is influenced by habitat stability and sediment type. In particular the complexity of the substratum will determine the number of available niches and hence the diversity of the community. High energy areas such as exposed sandflats and subtidal mobile sandbanks are characterised by a low diversity. The sediment in a mobile sandbank system may range from fine to coarse clean sands, and the density of individuals and species richness is often highest in the coarsest grade, mainly due to large numbers of interstitial polychaetes (Vanosmael et al, 1982). Elliot et al., (1998) stated that

> *'by their nature, the mobile sediments of subtidal sandbanks and their infauna may be more resistant to the sediment disturbance caused by commercial fishing, especially trawling. However, the recovery from the removal of biota, both the target species, often the predators (fishes and macro-crustaceans), and other species, is less well known both for subtidal sandbanks and intertidal flats'*

Some studies which documented an initial decline in species abundance and biomass, also observed rapid benthic community recovery. For example, declines in benthic organisms immediately after dredging were of short duration on subtidal clam beds in Washington State (Goodwin and Shaul 1980). Experimental water jet dredging in Scotland caused an immediate decline in species number, biomass, and number of individuals within the dredge track but this was no longer significant after five days (Tuck et al. 2000). These researchers also found that, water jet dredging decreased polychaete populations while amphipod numbers increased.

As previously described, Constantino at all, (2009) studied the impacts of a clam dredge in 6m and 18m in an area closed to demersal towed gear along the south coast of Portugal. For both depths, impacts on the benthic environment were very low resulting in high recovery rates. However, the study found that at shallower depths communities demonstrated a faster recovery. No clear impacts were observed for the shallower area either considering univariate and multivariate methods and macro and meiofaunal data. Despite the lack of clear differences between control and dredged areas, a general decrease in abundance of the most abundant taxa was observed after dredging. The results of this study clearly demonstrated that in 18 m depth, clam dredging causes an immediate effect on the meiobenthic and macrobenthic communities. Considering macrofauna, all biological variables showed a decrease immediately after dredging, probably due to the removal of target and non-target species by the gear and/or spatial redistribution of macrobenthic fauna in the dredged area.

Fahy and Carroll (2007) found that hydraulic clam dredging can alter ambient community structure when target species decline and are replaced by opportunistic colonists. Goodwin and Shaul 1980 stated that many benthic animals will not reestablish in a dredged area until sediment stability has returned. However, Peterson et al (1987) shellfish dredging does not always measurably alter density or species composition among small benthic macroinvertebrates because of their short life spans and capacity for rapid recolonization. DeGrave and Whitaker 1999 found that enhanced diversity in dredged areas may be due to mobilization of resources and the creation of spatial patchiness, factors which may promote recolonization by a new suite of species. Small scale disturbances caused by dredging can create a spatial and temporal mosaic of successional states which can enhance community diversity (Tarnowski 2006). Collie et al. (2005) concluded that dredge disturbance can prevent any one species from becoming dominant, resulting in a more diverse biological community.

This section has demonstrated the wide range of studies undertaken on the impacts of a range of shellfish dredging, in particular hydraulic dredging, on habitats. In general studies found that habitats accustomed to high energy and disturbance were found to experience little change in diversity after dredging and communities are adapted to help buffer the impacts of dredging. Studies also found that at shallower depths hydraulic dredging is unlikely to have persistent effects on most of the infaunal community in most habitats. However, some studies did see an impact on species abundance and biomass especially immediately after dredging but that benthic communities quickly recovered, particular true in shallower depths. Reestablishment of benthic species may be dependent on the return of sediment stability after dredging and some studies found an increase in biodiversity after dredge disturbance.

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