Document Control

Title	**South of Portland MCZ – Part B Fisheries Assessment – Bottom Towed Fishing Gear**
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Southern IFCA	TAC Chair	16/07/2020	Signed off to sent to Natural England
Natural England	Richard Morgan	28/08/2020	16/10/2020 To review conclusion rationale.

Southern Inshore Fisheries and Conservation Authority (IFCA)

Marine Conservation Zone Fisheries Assessment (Part B)

Marine Conservation Zone: **South of Portland**

Feature: **High energy circalittoral rock, moderate energy circalittoral rock, subtidal sand, subtidal mixed sediments, subtidal coarse sediments**

Broad Gear Type: **Bottom Towed Fishing Gear**

Gear type(s) Assessed: **Beam trawl / Light Otter Trawl and Dredging (scallops)**

Technical summary

As part of the MCZ assessment process for the tranche 3 South of Portland MCZ, it was identified that trawling (specifically light otter trawl beam trawl) and scallop dredging and its potential impacts require an in-depth assessment. Currently no trawling or dredging activity is known to occur in the site due to its dynamic and morphological characteristics. However, both activities occur in the bays either side and have historically occur to the east and west of the site.

The potential pressures likely to be exerted by the activity upon designated features were identified as abrasion, disturbance and penetration of the seabed below and on the surface of the seabed, the removal of target and non-target species, smothering and siltation rate changes and changes in suspended solids. Scientific literature shows that whilst trawling and scallop dredging have the potential to cause physical and biological disturbance, the extent and severity of impact largely depends on site-specific factors including sediment type, fishing intensity and physical regime. As such, the level of impact can largely vary between studies conducted in 'similar' habitat types.

When considering absence of trawling and scallop dredging within South of Portland MCZ, in combination with other evidence (scientific literature, sightings data, feature mapping) and site-specific factors it was concluded the activity is not likely to pose a significant risk to subtidal coarse sediment, subtidal mixed sediments and subtidal sands. Currently bottom towed fishing gear does not occur in the site, these sediment habitats are considered to have a low sensitivity to the fishing activity pressures from a single pass of fishing gear and they are exposed to high levels of natural disturbance. As such, it is believed the activity will not hinder the achievement of the designated features general management approaches and that it is compatible with the site's conservation objectives. Existing management measures are therefore considered sufficient to ensure that trawling and scallop dredging remains consistent with the conservative objectives for these features.

When considering absence of trawling and scallop dredging within South of Portland MCZ, in combination with other evidence (scientific literature, sightings data, feature mapping) and site-specific factors it was concluded the activity was likely to pose a significant risk to high and moderate energy circalittoral rock. These rock habitats are considered to have a medium to high sensitivity to the fishing activity pressures from a single pass of fishing gear and recovery times for associated fauna can be long (3-20 years). As such, it is believed the activity could hinder the achievement of the designated features general management approaches.

Therefore, additional management measure will need to be introduced to fully protect the rock features from trawling and scallop dredging activities. When this additional management is considered it is concluded that the activities will be managed in a way which is compatible with the site's conservation objectives. Existing and proposed management measures will therefore be considered sufficient to ensure that trawling and scallop dredging will remain consistent with the conservative objectives of the site. Fishing effort will continue to be monitored.

Contents

1 Introduction

1.1 Need for an MCZ assessment

This assessment has been undertaken by Southern IFCA in order to document and determine whether management measures are required to achieve the conservation objectives of Chesil Beach and Stennis Ledges Marine Conservation Zone (MCZ). Southern IFCA has duties under section 154 of the Marine and Coastal Access Act 2009 which states;

154 Protection of marine conservation zones

(1) The authority for an IFC district must seek to ensure that the conservation objectives of any MCZ in the district are furthered.

(2) Nothing in section 153(2) is to affect the performance of the duty imposed by this section.

(3) In this section—

(a) "MCZ" means a marine conservation zone designated by an order under section 116;

(b) the reference to the conservation objectives of an MCZ is a reference to the conservation objectives stated for the MCZ under section 117(2)(b).

Section 125 of the 2009 Act also requires that public bodies (which includes the IFCA) exercise its functions in a manner to best further (or, if not possible, least hinder) the conservation objectives for MCZs. The MCZ assessment process complements Southern IFCA's assessment of commercial fishing activities in European Marine Sites (EMS) – designated to protect habitats and species in line with the EU Habitats Directive and Birds Directive. To bring fisheries in line with other activities, the Department for Environment, Food and Rural Affairs (DEFRA) announced on the 14th August 2012 the revised approach to manage fishing activities within EMSs. This change in approach promotes sustainable fisheries while conserving the marine environment and resources, securing a sustainable future for both.

1.2 Documents reviewed to inform this assessment

- Reference list (Section 7)
- Defra's matrix of fisheries gear types and European Marine Site protected features[1]
- Site map(s) – feature location and extent (Annex 1)
- Map of bathymetry in the South of Portland MCZ (Annex 2)
- Fishing activity data (map(s), etc) (Annex 3)
- Natural England's Advice on Operations for Chesil Beach and Stennis Ledges MCZ (Annex 4)
- Natural England's Supplementary Advice on Conservation Objectives Chesil Beach and Stennis Ledges MCZ[2]
- Natural England's Advice on Operations for The Needles MCZ (Annex 4)
- Natural England's Supplementary Advice on Conservation Objectives for the Needles MCZ[3]
- Fisheries Impact Evidence Database (FIED)

2 Information about the MCZ

2.1 Overview and designated features

The South of Portland MCZ is an inshore site located off of Portland Bill in Dorset. The site covers an area of 1km^2. The site was designated in May 2019 and protects a number of rare and important habitats including circalittoral rock and subtidal sediments. In addition, the site protects a geological feature, the 'Portland Deep' an enclosed rock basin which reaches depth of of 105m.

A summary of the site's designated features is provided in Table 1, together with the recommended General Management Approach (GMA) for each feature. The GMA required for a feature in a MCZ will either be for it to be maintained in favourable condition (if it is currently in this state), or for it to be recovered to favourable condition (if it is currently in a damaged state) and then to be maintained in favourable condition.

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1 https://www.gov.uk/government/publications/fisheries-in-european-marine-sites-matrix

2 https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UKMCZ0004&SiteName=chesil&SiteNameDisplay=Chesil+Beach+and+Stennis+Ledges+MCZ&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=,0

3 https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UKMCZ0040&SiteName=needles&SiteNameDisplay=The+Needles+MCZ&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=

Table 1. Designated features and general management approach

Designated feature	General Management Approach
Portland Deep Geological feature	Maintain in favourable condition
Subtidal Sand	
High energy circalittoral rock	Recover to favourable condition
Moderate energy circalittoral rock	
Subtidal coarse sediment	
Subtidal mixed sediments	

Please refer to Annex 1 for site feature maps of broad-scale habitats.

2.2 Conservation Objectives

The site's conservation objectives apply to the Marine Conservation Zone and the individual species and/or habitat for which the site has been designated (the "Designated features" listed below).

The conservation objective of each of the zones is that the protected habitats:

1. are maintained in favourable condition if they are already in favourable condition
2. be brought into favourable condition if they are not already in favourable condition

For each protected feature, favourable condition means that, within a zone:

1. its extent is stable or increasing
2. its structure and functions, its quality, and the composition of its characteristic biological communities (including diversity and abundance of species forming part or inhabiting the habitat) are sufficient to ensure that its condition remains healthy and does not deteriorate

Any temporary deterioration in condition is to be disregarded if the habitat is sufficiently healthy and resilient to enable its recovery.

For each species of marine fauna, favourable condition means that the population within a zone is supported in numbers which enable it to thrive, by maintaining:

1. the quality and quantity of its habitat
2. the number, age and sex ratio of its population. Any temporary reduction of numbers of a species is to be disregarded if the population is sufficiently thriving and resilient to enable its recovery.

Any alteration to a feature brought about entirely by natural processes is to be disregarded when determining whether a protected feature is in favourable condition.

3 MCZ assessment process

3.1 Overview of the assessment process

The assessment of commercial fishing activities within the Studland MCZ will be undertaken using a staged process, akin to that proposed by the Marine Management Organisation (MMO)[4], for marine license applications. The assessment process comprises of an initial screening stage to establish whether an activity occurs or is anticipated to occur/has the potential to occur within the site. Activities which are not screened out are subject to a simple 'part A' assessment, akin to the Test of Likely Significant Effect required by article 6(3) of the Habitats Directive. The aim of this assessment is to identify pressures capable of significantly affecting designated features or their related processes. Fishing activities and their associated pressures which are not screened out in the part A assessment and then subject to a more detailed 'part B' assessment, where assessment is undertaken on a gear type basis. A part B assessment is akin to the Appropriate

4 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/410273/Marine_conservation_zones_and_marine_licensing.pdf

Assessment required by article 6(3) of the Habitats Directive. The aim of this assessment is to determine whether there is a significant risk of the activity hindering the conservation objectives of the MCZ. Within this stage of assessment, 'hinder' is defined as any act that could, either alone or in combination:

- in the case of a conservation objective of 'maintain', increase the likelihood that the current status of a feature would go downwards (e.g. from favourable to degraded) either immediately or in the future (i.e. they would be placed on a downward trend); or

- in the case of a conservation objective of 'recover', decrease the likelihood that the current status of a feature could move upwards (e.g. from degraded to favourable) either immediately or in the future (i.e. they would be placed on a flat or downward trend) (MMO, 2013).

If the part B assessment is unable to conclude that there is no significant risk of an activity hindering the conservation objectives of the MCZ, then the activity may be subject to management and consideration will be given to whether or not the public benefit of the activity outweighs the risk of damage to the environment; and if so, whether the activity is able to deliver measures of equivalent environmental benefit to the damage that is likely to occur to the MCZ.

3.2 Screening and part A assessment

The aim of the screening stage and part A assessment is to determine whether, under section 125 and 154 of MCAA, fishing activities occurring or those which have the potential to occur within the site are compatible with the conservation objectives of the MCZ.

The screening of commercial fishing activities in The South of Portland MCZ was undertaken using broad gear type categories. Sightings data collected by the Southern IFCA, together with officers' knowledge, was used to ascertain whether each activity occurs within the site, or has the potential to occur/is anticipated to occur in the foreseeable future. For these occurring/potentially occurring activities, an assessment of pressures upon MCZ designated features was undertaken using Natural England's Advice on Operations for the Feature (using an alternate designated site as the Conservation Advice for the South of Portland MCZ has not yet been produced.

Activities were screened out for further part B assessment if they satisfied one or more of the following criteria:

1. The activity does not occur within the site, does not have the potential to occur and/or is not anticipated to occur in the foreseeable future.

2. The activity does occur but the pressure(s) does not significantly affect/ interact with the designated feature(s).

3. The activity does occur but the designated feature(s) is not sensitive to the pressure(s) exerted by the activity.

3.2.1 Screening of commercial fishing activities based on pressure-feature interaction

Fishing activities which were identified as occurring, have the potential to occur and/or are anticipated to occur in the foreseeable future within the site were screened with respect to the potential pressures which they may be exert upon designated features (Part A assessment). This screening exercise was undertaken using Natural England's Advice on Operations (Annex 2) and Supplementary Advice for The Needles MCZ and Chesil Beach and Stennis Ledges MCZ. The Advice on Operations provides a broad scale assessment of the sensitivity of designated features to different activity-derived pressures, using nationally available evidence on their resilience (an ability to recover) and resistance (the level of tolerance) to physical, chemical and biological pressures. The assessments of sensitivity to these pressures are measured against a benchmark. It should be noted that these benchmarks are representative of the likely intensity of a pressure caused by typical activities, and do not represent a threshold of an 'acceptable' intensity of a pressure. It is therefore necessary to consider how the level of fishing intensity observed within the MCZ compares with these benchmarks when screening individual activities.

Due to the broad-scale nature of the sensitivity assessments provided in Natural England's Advice on operations, each pressure is assigned a risk profile based upon the likelihood of the pressure occurring and the magnitude of the impact should that pressure occur. These risk profiles have been used, together with site-specific knowledge, to identify those pressures which could significantly affect designated features.

The Natural England Advice on Operations for the MCZs used is provided in Annex 2. The resultant activity pressure-feature interactions which have been screened in for bottom towed fishing gear for the part B assessment are summarised in Table 2, Table 3, Table 4, Table 5 and Table 6 for sensitive designated features. The activity pressure-feature interactions which were screened out in the Part A Assessment are detailed in a standalone document ('Screening and Part A Assessment') for South of Portland MCZ.

Table 2. Summary of fishing pressure-feature screening for High and moderate energy circalittoral rock and dredges. Please note only pressures screened in for the Part B assessment are presented here.

Potential Pressures	**Advice on Operations (Chesil Beach and Stennis Ledges MCZ)**	**Considered in Part B Assessment?**	**Justification**	**Relevant Attributes (effected by identified pressures)**
Abrasion/ disturbance of the substrate on the surface of the seabed	S	Y	This gear type is known to cause abrasion and disturbance to the seabed surface. Further investigation is needed on the magnitude of the pressure, including the spatial scale/intensity of the activity.	Distribution: presence and spatial distribution of biological communities, Structure and function: presence and abundance of key structural and influential species, Structure: species composition of component communities, Structure: physical structure of rocky substrate
Changes in suspended solids (water clarity)	S	Y	This gear is known to cause the resuspension of finer sediments, therefore further assessment is required.	Supporting processes: water quality - turbidity
Penetration and/ or disturbance of the substratum below the surface of the seabed, including abrasion	S	Y	This gear type is known to cause abrasion and disturbance to the seabed and could penetrate the substrate below the surface of the seabed. Further investigation is needed on the magnitude of the pressure, including the spatial scale/intensity of the activity.	Distribution: presence and spatial distribution of biological communities, Structure and function: presence and abundance of key structural and influential species, Structure: species composition of component communities
Removal of non-target species	S	Y	Impacts on the associated community may occur through the removal of epifaunal. There is no site-specific information on the communities associated with this feature as it is newly designated. General information on the site's factsheet indicates that the rocks are exposed to high energy and currents and are dominated by species such as cup corals and anemones, crustaceans, mussels and oysters. Further investigation is needed as to the magnitude of disturbance to associated communities/species.	Distribution: presence and spatial distribution of biological communities, Structure and function: presence and abundance of key structural and influential species, Structure: species composition of component communities

Removal of target species	S	Y	Dredging in the area targets scallops (Pecten maximus). Further, investigation is needed as to the magnitude of disturbance to associated communities/species and location of the activity in relation to the feature.	Distribution: presence and spatial distribution of biological communities
Smothering and siltation rate changes (Light)	S	Y	This gear is known to cause the resuspension of finer sediments, therefore further assessment is required.	Supporting processes: sedimentation rate

Table 3. Summary of fishing pressure-feature screening for High and moderate energy circalittoral rock and demersal trawls. Please note only pressures screened in for the Part B assessment are presented here.

Potential Pressures	Advice on Operations (Chesil Beach and Stennis Ledges MCZ)	Considered in Part B Assessment?	Justification	Relevant Attributes (effected by identified pressures)
Abrasion/ disturbance of the substrate on the surface of the seabed	S	Y	This gear type is known to cause abrasion and disturbance to the seabed surface. Further investigation is needed on the magnitude of the pressure, including the spatial scale/intensity of the activity.	Distribution: presence and spatial distribution of biological communities, Structure and function: presence and abundance of key structural and influential species, Structure: species composition of component communities, Structure: physical structure of rocky substrate
Changes in suspended solids (water clarity)	S	Y	This gear is known to cause the resuspension of finer sediments, therefore further assessment is required.	Supporting processes: water quality - turbidity
Penetration and/ or disturbance of the substratum below the surface of the seabed, including abrasion	S	Y	This gear type is known to cause abrasion and disturbance to the seabed and could penetrate the substrate below the surface of the seabed. Further investigation is needed on the magnitude of the pressure, including the spatial scale/intensity of the activity.	Distribution: presence and spatial distribution of biological communities, Structure and function: presence and abundance of key structural and influential species, Structure: species composition of component communities
Removal of non-target species	S	Y	Impacts on the associated community may occur through the removal of epifaunal. There is no site-specific information on the communities associated with this feature as it is newly designated. General information on the site's factsheet indicates that the rocks are exposed to high energy and currents and are dominated by species such as cup corals and anemones, crustaceans, mussels and	Distribution: presence and spatial distribution of biological communities, Structure and function: presence and abundance of key structural and influential species, Structure: species composition of component communities

			oysters. Further investigation is needed as to the magnitude of disturbance to associated communities/species.	
Smothering and siltation rate changes (Light)	S	Y	This gear is known to cause the resuspension of finer sediments, therefore further assessment is required.	Supporting processes: sedimentation rate

Table 4. Summary of fishing pressure-feature screening for Subtidal coarse sediment and demersal trawls & dredges. Please note only pressures screened in for the Part B assessment are presented here.

Potential Pressures	Advice on Operations (Needles MCZ)	Considered in Part B Assessment?	Justification	Relevant Attributes (effected by identified pressures) (Needles MCZ)
Abrasion/ disturbance of the substrate on the surface of the seabed	S	Y	This gear type is known to cause abrasion and disturbance to the seabed surface. Further investigation is needed on the magnitude of the pressure, including the spatial scale/intensity of the activity.	Distribution: presence and spatial distribution of biological communities, Structure and function: presence and abundance of key structural and influential species, Structure: species composition of component communities
Changes in suspended solids (water clarity)	S	Y	This gear is known to cause the resuspension of finer sediments, therefore further assessment is required.	Supporting processes: water quality - turbidity
Penetration and/ or disturbance of the substratum below the surface of the seabed, including abrasion	S	Y	This gear type is known to cause abrasion and disturbance to the seabed and could penetrate the substrate below the surface of the seabed. Further investigation is needed on the magnitude of the pressure, including the spatial scale/intensity of the activity.	Distribution: presence and spatial distribution of biological communities, Structure and function: presence and abundance of key structural and influential species, Structure: species composition of component communities, Structure: sediment composition and distribution

Removal of non-target species	S	Y	Impacts on the associated community may occur through the removal of epifaunal. There is no site-specific information on the communities associated with this feature as it is newly designated. General information on the site's factsheet indicates that the sediments protect a range of worms including tube and reef-building worms. Further investigation is needed as to the magnitude of disturbance to associated communities/species.	Distribution: presence and spatial distribution of biological communities, Structure and function: presence and abundance of key structural and influential species, Structure: species composition of component communities, Structure: sediment composition and distribution
Smothering and siltation rate changes (Light)	IE	Y	This gear is known to cause the resuspension of finer sediments, therefore further assessment is required.	Structure: sediment composition and distribution

Table 5. Summary of fishing pressure-feature screening for Subtidal mixed sediment and subtidal sand and demersal trawls. Please note only pressures screened in for the Part B assessment are presented here.

Potential Pressures	Advice on operations	Considered in Part B Assessment?	Justification	Relevant Attributes (effected by identified pressures) (Needles MCZ)
Abrasion/ disturbance of the substrate on the surface of the seabed	S	Y	This gear type is known to cause abrasion and disturbance to the seabed surface. Further investigation is needed on the magnitude of the pressure, including the spatial scale/intensity of the activity.	Distribution: presence and spatial distribution of biological communities, Structure and function: presence and abundance of key structural and influential species, Structure: species composition of component communities
Changes in suspended solids (water clarity)	S	Y	This gear is known to cause the resuspension of finer sediments, therefore further assessment is required.	Supporting processes: water quality - turbidity
Penetration and/ or disturbance of the substratum below the surface of the seabed, including abrasion	S	Y	This gear type is known to cause abrasion and disturbance to the seabed and could penetrate the substrate below the surface of the seabed. Further investigation is needed on the magnitude of the pressure, including the spatial scale/intensity of the activity.	Distribution: presence and spatial distribution of biological communities, Structure and function: presence and abundance of key structural and influential species, Structure: species composition of component communities, Structure: sediment composition and distribution

Removal of non-target species	S	Y	Impacts on the associated community may occur through the removal of epifaunal. There is no site-specific information on the communities associated with this feature as it is newly designated. General information on the site's factsheet indicates that the sediments protect a range of worms including tube and reef-building worms. Further investigation is needed as to the magnitude of disturbance to associated communities/species.	Distribution: presence and spatial distribution of biological communities, Structure and function: presence and abundance of key structural and influential species, Structure: species composition of component communities, Structure: sediment composition and distribution
Smothering and siltation rate changes (Light)	S	Y	This gear is known to cause the resuspension of finer sediments, therefore further assessment is required.	Structure: sediment composition and distribution

Table 6. Summary of fishing pressure-feature screening for Subtidal mixed sediment and subtidal sand and dredges. Please note only pressures screened in for the Part B assessment are presented here.

Potential Pressures	Advice on Operations (Needles MCZ)	Considered in Part B Assessment?	Justification	Relevant Attributes (effected by identified pressures) (Needles MCZ)
Abrasion/ disturbance of the substrate on the surface of the seabed	S	Y	This gear type is known to cause abrasion and disturbance to the seabed surface. Further investigation is needed on the magnitude of the pressure, including the spatial scale/intensity of the activity.	Distribution: presence and spatial distribution of biological communities, Structure and function: presence and abundance of key structural and influential species, Structure: species composition of component communities
Changes in suspended solids (water clarity)	S	Y	This gear is known to cause the resuspension of finer sediments, therefore further assessment is required.	Supporting processes: water quality - turbidity
Penetration and/ or disturbance of the substratum below the surface of the seabed, including abrasion	S	Y	This gear type is known to cause abrasion and disturbance to the seabed and could penetrate the substrate below the surface of the seabed. Further investigation is needed on the magnitude of the pressure, including the spatial scale/intensity of the activity.	Distribution: presence and spatial distribution of biological communities, Structure and function: presence and abundance of key structural and influential species, Structure: species composition of component communities, Structure: sediment composition and distribution
Removal of non-target species	S	Y	Impacts on the associated community may occur through the removal of epifaunal. There is no site-specific information on the communities associated with this feature as it is newly designated. General information on the site's factsheet indicates that the sediments protect a range of worms including tube and reef-building worms. Further investigation is needed as to the magnitude of disturbance to associated communities/species.	Distribution: presence and spatial distribution of biological communities, Structure and function: presence and abundance of key structural and influential species, Structure: species composition of component communities, Structure: sediment composition and distribution
Removal of target species	S	Y	Dredging in the area targets scallops (Pecten maximus). Further, investigation is needed as to the magnitude of disturbance to associated communities/species and location of the activity in relation to the feature.	Distribution: presence and spatial distribution of biological communities
Smothering and siltation rate changes (Light)	S	Y	This gear is known to cause the resuspension of finer sediments, therefore further assessment is required.	Structure: sediment composition and distribution

4 Part B Assessment

The aim of the part B assessment is for the IFCA to ensure that that there is no significant risk of a fishing activity hindering the conservation objectives of the MCZ; and to confirm that the authority is able to exercise its functions to further the site's conservation objectives.

In order to adequately assess the potential impacts of an activity upon a designated feature, it is necessary to consider the relevant attributes of that feature that may be affected. Attributes are provided in Natural England's Supplementary Advice on Conservation Objectives (SACOs) and represent the ecological characteristics or requirements of the designated species and habitats within a site. These attributes are considered to be those which best describe the site's ecological integrity and which if safeguarded will enable achievement of the Conservation Objectives. Each attribute has an associated target which identifies the desired state to be achieved; and is either quantified or qualified depending on the available evidence.

4.1 Summary of fisheries

At present no trawling or dredging activity is known to occur within the South or Portland MCZ. Conversations with fisher have revealed that the site is too hard bottomed and deep with fast tidal flows to enable bottom towed fishing gears. However, either side of the site, in Lyme Bay and Weymouth Bay, bottom towed gears are used. In Lyme Bay both trawling and dredging for scallops occur outside of closed areas. In Weymouth bay trawling also occurs.

4.2 Technical gear specifications

There is potential for light otter trawls, beam trawls and scallop dredges to occur on the fringes of the South of Portland MCZ.

4.2.1 Light otter trawl

An otter trawl comprises of following design (see Figure 1). Two shaped panels of netting are laced together at each side to form an elongated funnel shaped bag (Seafish, 2015). The funnel tapers down to a cod-end where fish are collected (Seafish, 2015). The remaining cut edges of the net and net mouth are strengthened by lacing them to ropes to form 'wings' that are used to drive fish into the net (Seafish, 2015). The upper edge of the rope is referred to as the head line, the lower edge is referred to as the foot rope of fishing line and side ropes are known as wing lines (Seafish, 2015). Floats are attached to the headline to hold the net open and the foot rope is weighted to maintain contact with the seabed and prevent damage to the net (Seafish, 2015). The wings of the net are held open by a pair of trawl doors, also known as otter boards, and are attached to the wings by wires, ropes or chains known as bridles and sweeps (Seafish, 2015). The sweep connects the trawl door to top and bottom bridles which are attached to the headline and footrope of the net, respectively (Seafish, 2015). The choice of material used for the sweeps and bridles depends on the size of gear and nature of the seabed, with smaller inshore boats using thin wire and combination rope (Seafish, 2015). The trawl doors, which are made of wood or steel are towed through the water at an angle which causes them to spread apart and open the net in a horizontal direction (Seafish, 2015). The trawl doors are attached to the fishing vessel using wires referred to as trawl warps (Seafish, 2015). The trawl doors must be heavy enough to keep the net on the seabed as it is towed (Seafish, 2015). As the trawl doors are towed along the seabed, they generate a sediment cloud which helps to herd fish towards the mouth of the trawl (Seafish, 2015). The bridles and sweeps continue the herding action of the trawl doors as the trail on the seabed and disturb the sediment, creating a sediment cloud (Seafish, 2015). The length of the sweeps and bridles and distance between the two trawl doors is tuned to the target species (Seafish, 2015). Species such as lemon sole and plaice can be herded into the trawl over long distances and so the length of the sweeps is longer (Seafish, 2015).

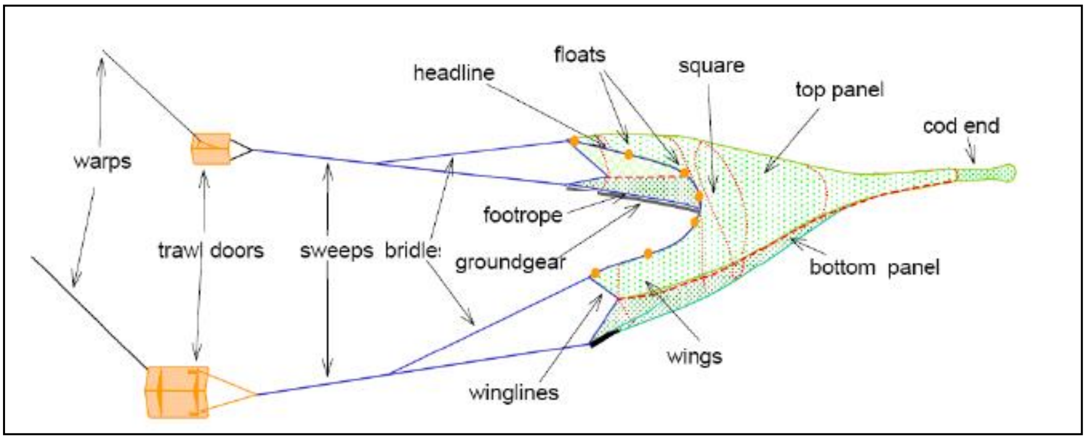


Figure 1. Key components of an otter trawl. Source: www.seafish.org/upload/b2b/file/r_d/BOTTOM%20TRAWL_5a.pdf

The mesh size of the net used varies depending on the type of trawl (Seafish, 2015). In the UK, there has been a move towards an increase in mesh size, particularly in the top panel and wings, in order to improve gear selectivity (Seafish, 2015).

The ground rope will have some form of ground gear attached to protect the netting from damage on the seabed (Seafish, 2015). The ground gear can largely vary. The most basic is where bare fishing line and the netting is laced directly to the rope of combination rope (Seafish, 2015). Chains may also be used and the style of attachment can vary (Seafish, 2015). Ground gear may also include bobbins and rock hoppers which commonly use small and large rubber discs (up to 600 mm) (Seafish, 2015).

The drag of the gear, combined with the floats on the headline, mean the weight of the trawl on the seabed is in the region of 10 to 20% of what it would be in air (Seafish, 2015).

A light otter trawl is one that uses anything less than the definition given for a heavy otter trawl, which include any of the following (MMO, 2014):

- Sheet netting of greater than 4 mm twine thickness
- Rockhoppers or discs of 200 mm or above in diameter
- A chain for the foot/ground line (instead of wire)

Generally, vessels will shoot and haul their gear over the stern of the boat (Seafish, 2015). Restrictions on vessels over 12 metres in length in the Southern IFCA district limits the size of gear that can be used within the district.

There is no typical gear set up used in the Solent and each individual has a different approach (Southern IFCA Committee Member Pers. Comm)[5]. The size and weight of trawl doors used in the Solent varies, however the largest doors likely to be used in the Solent are made of steel and measure approximately 52 x 38 inches, weighing 130 kg each (Southern IFCA Committee Member Pers. Comm). The ground rope used by the vessels ranges between 36 to 60 ft in length and commonly made of 16 mm wire with rubber discs of 4 to 6 inches, spaced 1 inch apart (Southern IFCA Committee Member Pers. Comm). The rubber discs are designed to maintain consistent contact with the seabed. Additional buoyancy may be attached to the ground rope to minimise contact with the seabed (Southern IFCA Committee Member Pers. Comm). The length of the sweeps and bridles is approximately 90 ft (Southern IFCA Committee Member Pers. Comm). Trawls are towed at between 1 and 3.5 knots, depending on the state of the tide. In the Solent, the tow length is dependent on the level of weed and in some areas takes no longer than 10 minutes (Southern IFCA Committee Member Pers. Comm).

4.2.2 Beam trawl

A net is held open by a rigid framework to maintain trawl opening, regardless of towing speed, in addition to supporting the net (Seafish, 2015). The framework consists of a heavy tubular steel beam which is supported by steel beam heads at each end. Each beam head has wide shoes at the base which slide over the seabed

[5] Information was provided by a Southern IFCA Committee Member who has valuable knowledge and experience of the fishery.

(Seafish, 2015). A cone shaped net is towed from the framework, with the head rope attached to the beam and foot rope connected to the base of the shoes (Seafish, 2015). The footrope forms a 'U' shape curve behind the beam as it is towed over the seabed (Seafish, 2015). The beam is towed using a chain bridle which is attached to both shoes and at the centre of the beam; all coming together to form a single trawl warp which leads to the vessel (Seafish, 2015).

There are two types of beam trawl and these are referred to as 'open gear' and 'chain mat gear' (Seafish, 2015). Open gear uses a lighter rig, with a number of chains, known as 'ticklers', which are towed along the seabed across the mouth of the net (Figure 2) (Seafish, 2015). Tickler chains help to disturb fish from a muddy seabed. Open gear is used on clean and soft ground. Chain mat gear on the other hand is used for towing over harder and stonier seabed and if often used by larger vessels (Seafish, 2015). The chain mat gear uses a lattice work of chains which are towed from the back of the beam and attach to the footrope of the net (Figure 3) (Seafish, 2015). Lighter styles of beam, using fewer tickler chains and without a chain mat, are used to target shrimp (Seafish, 2015).

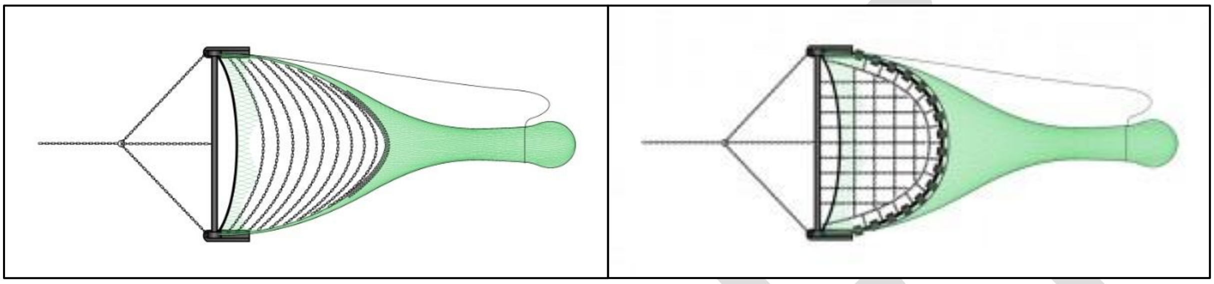


Figure 2. (a) 'Open gear' beam trawl, (b) 'Chain mat gear' beam trawl.

Generally, vessels below 12 metres, like those used in the Southern IFCA district, tow one trawl from the stern of the vessel (Seafish, 2015). The size of the beam towed, and the horsepower of many vessels, can be restricted by the local fishery regulations (Seafish, 2015).

4.2.3 Scallop dredges

Scallop dredges are rigid structures of the following design (see Figure 1). A triangular frame, with a width of up 85 cm in the Southern IFCA district, is attached to a collection bag and chain mesh which sits behind it. The triangular frame is fitted with a toothed bar at the front to dislodge scallops from the seabed and into the collection bag. In the Southern IFCA district, the dredge must be fitted with a spring-loaded tooth bar. The teeth on the bar are approximately 120 mm long; with 20 mm penetrating the seabed (depending on the substrate). The collection bag sits on top on the chain mesh. A number of dredges are attached to and towed behind a spreading bar with a bar usually deployed from each side of the vessel. The length of the bar and number of dredges depends on the size and power of the vessel. In Southern IFCA, the maximum number of dredges which may be towed at any time is twelve. However, the Solent Scallop fishers are typically under 10m, lower horse power vessels, and tow a maximum of 2 dredges of the stern of the vessel, usually one at a time.

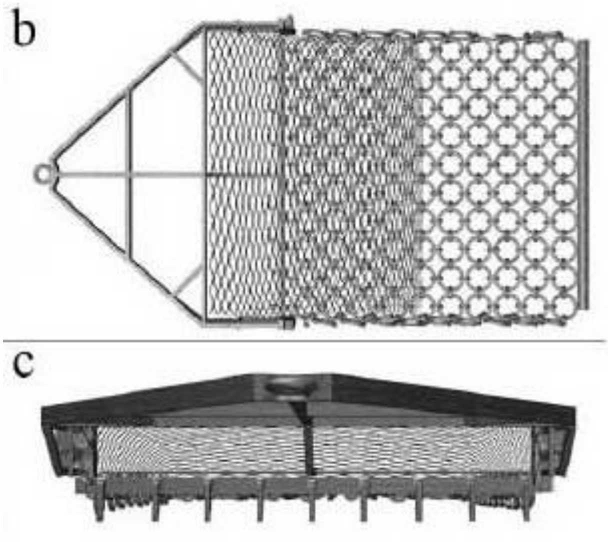


Figure 3.Typical scallop dredge set up used in the UK. (b) Chain mesh and collection bag (top side). (c) Spring-loaded toothed bar. Source: http://www.gov.scot/Publications/2012/10/7781/4

4.3 Fishing effort, scale and co-location of activities

Currently, Bottom Towed Gears are not Used in the South of Portland MCZ. This is due to a number of reasons including the deep depth of the site, the fast-tidal flows/races and the presence of large areas of rock (which is usually avoided by bottom towed gear to prevent snagging).

A map of the broadscale habitats found in the South of Portland MCZ can be found in Annex 1. Sightings data in Annex 3 shows that no sightings of BTFG activities have been made in the site or area over the past three years. Historical sightings data shows that both dredging and trawling have occurred in areas outside of the site to the east and west.

As there is currently no use of bottom towed fishing gear within the site, we cannot co-locate fishing activities. However, trawling usually occurs over subtidal sediments and therefore has the potential to occur in the top north western corner of the site. Scallop dredging can occur over both rock and sediment habitats and therefore has the potential to occur throughout most of the site. It is worth noting that several sections of the site are very deep (including part of the Portland Deep geological feature) (See Annex 2 containing bathymetric map of the site). Fishing is very unlikely to occur in these deep areas as the gear is not towed on a line deep enough for it to reach the seafloor.

4.3.1 Pressures

4.3.2 Abrasion/disturbance of the substrate on the surface of the seabed/ Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion/ Removal of non-target species

Rock Habitats

The environmental impacts of bottom towed fishing gear are complex (Boulcott *et al*., 2014). The extent of disturbance depends on a number of factors including substrate type (Kaiser *et al*., 2002), design and weight of the gear (Boulcott & Howell, 2011) performance of the gear over a particular substrate (Caddy, 1973; Currie and Parry, 1999) and the sensitivity of the benthic community (Currie and Parry, 1996; Bergman *et al*., 1998; Collie *et al*., 2000a; Boulcott *et al*., 2014).

In a meta-analysis of 41 bottom towed impact control studies, only 3 were found to look at reef features, and these focused on biogenic reefs (Hiddink *et al.,* 2020). The meta-analysis revealed that effects of bottom towed gears were strongest on coarse sediments and biogenic structures. Additionally, those effects were worse for impacts caused by dredges rather than trawls (Hiddink *et al.,* 2020). Whole community biomass and numbers were found to be strongly negatively affected by bottom towed gear in benthic habitats and were determined to be the best indicators (Hinddick *et al.,* 2020). However, biomass of individual taxa was not found to be significantly affected (Hiddink *et al.,* 2020).

Dredges

Very few studies have been carried out of the impacts of bottom towed fishing gear over rocky reef habitat. A meta-analysis of 39 fishing impact studies revealed dredging had a more negative impact than trawling (Collie *et al*., 2000b). Potential effects include reductions in habitat structural complexity and subsequent habitat homogenisation, reduction in biodiversity, removal of erect epifaunal species and large sessile species some of which are likely to large, fragile and long-lived and physical damage to fragile structures (Sewell and Hiscock, 2005). Such impacts are caused through direct contact with the seabed.

Cranfield *et al.,* (2003) studied the effect of oyster dredges in the Foveaux Strait, New Zealand, on bryozoan biogenic reefs. Side scan surveys revealed that dredging over the reefs completely removed the biogenic structure and, on the fringes, had damaged the framework structure (Cranfield *et al.,* 2003). The removal of the biogenic structures had exposed associated sediments which were then transported down current, however this sediment supply stopped when dredging ceased due to a lack of oyster stock (Cranfield *et al.,* 2003).

In Lyme Bay, within the southern IFCA district king scallops are typically harvested using mechanical dredges in the past over rocky, boulder and coble reef habitats (Munro & Baldock, 2012). The introduction of a statutory closed area provided the opportunity to measure the effects of scallop dredging over rocky habitats. Three types of area were studied – areas which had been voluntarily closed to fishing before the statutory closure, areas newly closed as a part of the statutory closure, and areas which were open to fishing. In open areas there were significantly fewer taxa when compared to both closed and newly closed areas. In particular the number of branching sponges and cover of sponge crusts were significantly lower in areas open to scallop dredging (Munro & Baldock, 2012). The assemblage composition was also significantly different between open and closed areas (Munro & Baldock, 2012). Open sites were characterised by hydroids, polychaetes and barnacles, whilst the closed sites contained sponges as an important component (Munro & Baldock, 2012).

Trawling

Otter trawl fishing gear has contact with the seabed through ground rope, chains and bobbins, sweeps, doors and any chaffing mats or parts of the net bag (Jones, 1992). Otter door marks are often the most recognisable and commonly observed effects of otter trawls on the seabed (Caddy, 1973; Friedlander *et al*., 1999; Grieve *et al*., 2014). Bridles or sweeps, the cables that connect the trawl doors to the trawl net, can snag on boulders or other obstructions over rough ground (Grieve *et al*., 2014). This contact with the seabed disturbs the benthos and relocates stones and boulders (Gislason 1994).

A number of studies have reported impacts of otter trawling in areas of reef and where corals are present. In an area of mixed substrata at 50 to 100 m depth in north-western Australia, Moran and Stephenson (2000) reported, on each tow of an otter trawl (dimensions unknown), a 15.5% reduction in benthic organisms that stood higher than 20 cm off the seabed, comprised mainly of gorgonians, sponges and soft corals. Van Dolah *et al*. (1987) reported significant decreases in the density of barrel sponges and damage to finger sponges, vase sponges, whip corals, fan corals, stock corals and stony tree corals after a single pass with an otter trawl in a hard-bottom sponge and coral community at 20 m in Grays Reef, Georgia. The otter trawl used had a 40/54 fly net,12.2-m headrope,16.5-m footrope with 30 cm rubber rollers and 15-cm rubber discs and 1.8 x 1.2 m China V-doors. Recovery was reported to occur within one year (Van Dolah *et al*.,1987).

Deep-water trawling has had a clear and significant impact on deep-water coral reefs (200-1300m) and other organisms, including *Lophelia*, in the North Atlantic since the 1980s (Sewell and Hiscock, 2005; Malecha & Heifetz, 2017). Halls-Spencer *et al*. (2002) analysed commercial otter trawl catches taken from the West Ireland continental shelf break and West Norway and reported large amounts of coral bycatch in 5 out of 229 trawls, including pieces up to 1 m^2. ROV video observation revealed sparse living coral, coral rubble and track marks in trawled area. The otter trawls used in the fishery are fitted with rockhopper gear and 900-kilogram trawl doors. A similar study, looking at the same corals in the same area, documented that trawling had caused complete destruction of reef structures, removal and displacement of reefs by the otter boards and trawl nets (Fossa et al., 2002).

The intensity of trawling activity plays a key role in the severity of the effect to reef habitats. Kędra *et al.* (2017) found that high intensity trawled areas had considerably lower taxonomic richness, species numbers and significant differences in epifaunal abundance and biomass. Hydrozoans, bryozoans and annelids were particularly negatively affected; however, gastropods were found only in trawled areas (Kędra *et al.,* 2017). Sponges occurred five times less frequently in trawled areas (Kędra *et al.,* 2017).

Malecha & Heifetz (2017) revisited an experimentally trawled site, ~200m depth, in the Gulf of Alaska, 13 years after the experimental original study. Thirteen years after the trawling average density of large sponges was more than 30% lower and incidence of sponge damage was 59% higher in trawled transects compared to reference areas, indicating the long-term effects of trawl damage to fragile species.

Unfortunately, due to the lack of similarity between areas and habitats in which trawling has been shown to cause adverse effects and those found in the Southern IFCA district, many of the studies examined are of limited relevance.

Sediment Habitats

Abrasion and disturbance are generally related to the direct and physical effects of bottom towed fishing gear. Such effects include the scraping and ploughing of the substrate, scouring and flattening of the seabed, sediment resuspension and changes in the vertical redistribution of sediment layers (Roberts *et al*. 2010).

Otter trawl

Otter trawl fishing gear has contact with the seabed through the ground rope, chains and bobbins, sweeps, doors and any chaffing mats or parts of the net bag (Jones, 1992). Otter boards, or doors, leave distinct tracks on the seafloor ploughing distinct groove or furrows, which can be 0.2-2 metres wide and up to 30 centimetres deep (Jones, 1992; Thrush & Dayton, 2002). The depth of furrows depends on the weight of the board, the angle of attack, towing speed, and the nature of the substrate, being greatest in soft mud (Jones, 1992; Løkkeborg, 2005). The passage of the doors also creates sediment mounds known as berms (Gilkinson *et al*. 1998; Johnson *et al*. 2002). Marks on the seabed caused by other parts of the gear are faint when compared with those caused by trawl doors (Løkkeborg 2005). Ground ropes and weights can scour and flatten the seabed, skimming the surface sediment between the grooves left by the trawl doors (Jones, 1992; Roberts *et al*. 2010; Grieve *et al*., 2014). Spherical footrope bobbins can cause compressed tracks on surficial sediments (Brylinsky *et al*. 1994). In areas of surface roughness i.e. sand waves and ripples, features can be flattened and the habitat smoothed (Kaiser & Spencer, 1996; Tuck *et al*., 1998; Schwinghamer *et al*., 1996; 1998). It has been reported that the bridles do not appear to result in any marks on the seabed (Brylinsky *et al*. 1994).

Experimental flounder trawling, using an 18 m trawl with 200 kg doors and footrope with 29 cm rubber rollers, in the Bay of Fundy revealed that trawl doors made furrows that were 30 – 85 cm wide and up to 5 cm deep in an intertidal area characterised by silty sediments (Brylinsky *et al*. 1994). The same study reported an area of approximately 12% between the outer edges of the doors was visually disturbed (Brylinsky *et al*. 1994). A side-scan survey, used to assess the effects of otter trawl over sand and mud sediments in lower Narragansett Bay, revealed 5 to 10 cm deep tracks from otter trawl doors and 10 to 20 cm high berms in mud bottom channels (DeAlteris *et al*., 1999). No information on the type of gear used was provided in the study. Sediment profile images (SPIs) were used to estimate the physical impacts of experimental trawling using a shrimp otter trawl with a head rope length of 10 m, otter boards measuring 90 x 140 cm and weighing 125 kg each and ground rope of 14 m with 20 kg of lead weight distributed across its length in an area of muddy sediments in the Gullmarfjord (Nilsson & Rosenberg, 2003). Forty-three percentage of the images in trawl area had signs of physical disturbance (Nilsson & Rosenberg, 2003). A crude estimate of the scale of disturbance was made from the images, with an estimated depth of the trawl tracks at approximately 10 cm, and width between 30 and 60 cm (Nilsson & Rosenberg, 2003). It was calculated that one-tenth of the area affected by trawling would be directly affected by ploughing from the otter boards themselves (Nilsson & Rosenberg, 2003).

The gear used by beam trawl is known to penetrate the seabed, leaving tracks and disturbing the surface sediments (Gubbay & Knapman, 1999). Beam trawls flatten seabed features and can also leave trenches in soft sediment (Tuck *et al*., 1998). It is important to point out however that generally speaking beam trawling does not occur in mud habitats as it cannot be used effectively in such habitat types (Kaiser *et al*. 2002). Studies have revealed that the penetration depth of tickler chains on a beam trawl range from a few centimetres to at least 8 cm (Løkkeborg, 2005). Using a light beam trawl, of 700 kg with 15 tickler chains, disturbance was revealed to be restricted to the upper 1 cm in sandy sediments and 3 cm in muddy silt (Bridger, 1972). An average penetration depth of 40 to 70 mm was reported by de Groot *et al*. (1995). Experimental trawling, using a 3.5 tonne 4 m beam trawl with chain matrix, led to the flattening of sand ripples, suspension of fine materials and a reduction in the consolidation of sediments in areas of stable coarse sand and gravel and mobile sand in the eastern Irish sea (Kaiser & Spencer 1996, Kaiser *et al*. 1996, 1998, 1999). In the North Sea, experimental trawling, using a 7000 kg 12 m beam trawl with tickler chains, resulted in the physical penetration of the gear to at least 6 cm in an area of medium hard sandy sediment (Bergman *et al*. 1990; Bergman & Hup, 1992).

4.3.3 Removal of non-target species

Bottom towed fishing gear can result in the mortality of non-target species through direct physical damage inflicted by the passage of the trawl or indirectly through damage, exposure and subsequent predation (Roberts *et al*. 2010). This can lead to long-term changes in the benthic community structure (Jones, 1992), including decreases in biomass, species richness, production, diversity, evenness (as a result of increased dominance) and alterations to species composition and community structure (Tuck *et al*., 1998; Roberts *et al*. 2010). Disturbance from repeated trawling selects for more tolerant species, with communities becoming dominated by smaller-bodied infaunal species with fast life histories, juvenile stages, mobile species and rapid colonists (Engel & Kvitek, 1998; Gubbay & Knapman, 1999; Kaiser *et al*. 2000; Jennings *et al*. 2001; Kaiser *et al*. 2002). In addition, larger individuals may become depleted more than smaller individuals (Jennings *et al*. 2002).

The impacts of fishing activities on benthic communities varies with gear type, habitat and between taxa (Collie *et al*. 2000; Thrush & Dayton, 2002; Kaiser *et al*. 2006). Reported effects are habitat-specific (Roberts *et al*. 2010). A meta-analysis conducted by Kaiser *et al*. (2006) revealed that soft-sediment, especially muddy sands were vulnerable to fishing impacts, with otter trawling and beam trawling all producing a significant immediate impact on this habitat. In mud communities, otter trawling was reported to have a significant negative short-term impact, but positive long-term effect with respect to the mean abundance of benthic taxa (Kaiser *et al*. 2006). A number of studies found no detectable impacts, specifically in relation to different forms of trawling in sand habitats (Van Dolah *et al*., 1991; Kaiser & Spencer, 1996; Kenchington *et al*., 2001; Roberts *et al*., 2010), although this is not true in all cases. Such habitats are likely to be pre-adapted to higher levels of natural disturbance and are characterised by relatively resistant fauna (Kaiser *et al*. 2006).

Otter Trawls

The impact of otter trawls on benthic communities varies between studies, notably between sediment types. In a meta-analysis of experimental fishing impact studies, conducted by Kaiser *et al*. (2006), otter trawling was found to have one of the least negative impacts, compared to other gear and substrata combinations. The initial impact on benthic communities from otter trawl disturbance on mud was estimated to be -29%, -15% on sand and +3% on gravel (Kaiser *et al*., 2006; Hinz *et al*., 2009).

Direct mortality of different megafaunal taxa groups varied after a single sweep with a commercial otter trawl (dimensions unknown) over shallow (30-40 m) sandy areas and deeper (40-50 m) silty sand areas in the southern North Sea (Bergman & van Santbrink, 2000). In areas of silty sand, direct mortality ranged from 0-52% for bivalves, 7% for gastropods, 0-26% for echinoderms, and 3-23% for crustaceans. In areas of sand, direct mortality ranged from 0-21% for bivalves, 12-16% for echinoderms and 19-30% for crustaceans. Experimental otter trawling (dimensions unknown) on the continental shelf of northwest Australia, in an area presumed to be sand, led to an exponential decline in the mean density of macrobenthos with increasing tow numbers (Moran & Stephenson, 2000; Johnson *et al*. 2002). Density was reduced by approximately 50% after four tows and 15% after a single tow (Moran & Stephenson, 2000; Johnson *et al*. 2002). A trawl with 20 cm disks, separated by 30 to 60 cm spacers was used (Johnson *et al*. 2002). No further information on the trawl used is known. The impacts of otter trawling on benthic communities on a sandy bottom in Grand Banks, Newfoundland were studied over a three-year period (Kenchington *et al*., 2001). Three experimental corridors with adjacent reference corridors were established and experimental corridors were trawled 12 times within 5 days for three years using an Engel 145 otter trawl with 1250 kg otter doors, 60 m door spread and 46 cm rockhopper foot gear. Changes in the benthic community were sampled using an epibenthic sledge. The sled is largely used to sample epifauna and some infauna as the sled penetrates to a depth of 2 to 3 cm. Samples collected using the benthic sled revealed a 24% reduction in average biomass in trawled corridors compared to reference corridors. This decrease was caused by reductions in biomass of sand dollars, brittle stars, soft corals, sea urchins and snow crabs. No significant effects were observed for mollusc species. The mean total abundance per grab sample was 25% lower immediately post trawling in one of the three years and declines were demonstrated for 13 taxa primarily made up of polychaetes, which also declined in biomass (Løkkeborg, 2005).

Valentine and Lough (1991) investigated the impact of scallop dredging and trawling on sand and gravel habitats using side scan sonar and a submersible on eastern Georges Bank. The study documented the most obvious signs of disturbance on gravel pavement habitats. Unfished gravel areas (as a result of the presence of large boulders) had more biologically diverse communities with an abundance of epifaunal organisms. In fished areas, the attached epifaunal community was limited. Similarly, Collie *et al*. (1997) investigated the effects of multiple methods of bottom towing fishing gear (otter trawl and scallop dredging) on benthic megafaunal communities in gravel habitat on Georges Bank at depths between 47 to 90 metres. No information on the types of otter trawls used were given. Numerical abundance of organisms, biomass and species diversity were all significantly greater at undisturbed sites, whilst evenness was greater at disturbed sites (Collie *et al*., 1997). Disturbed sites are likely to have greater evenness because disturbance of towed gear prevents one species becoming numerically dominant (Collie *et al*., 1997). Small fragile polychaetes, shrimps and brittle stars were absent or less common at disturbed sites. At undisturbed sites epifauna such as tube-dwelling polychaetes, bushy bryozoans and hydroids provide a complex habitat.

Engel and Kvitek (1998) documented differences between lightly (average of 220 trawl hours per year) and heavily (average of 816 trawl hours per year) otter trawled areas with similar bottom types (gravel, coarse sand, medium-fine sand and silt-clay) off central California. The densities and abundance of all invertebrate epifaunal species were higher in the lightly fished area when compared to the heavily fished area, including significant differences in species of sea pens, sea stars, sea anemones and sea slugs. Opportunistic species including oligochaetes, nematodes, ophiuroids were found in greater densities in the heavily fished area in each year of the study (1994-1996), whilst significantly more polychaete species were reported in lightly fished areas and no significant difference in the number of crustaceans between the two areas. The study concluded that high levels of trawling can lead to a decrease in habitat complexity and biodiversity and lead to subsequent increases in opportunistic species.

Thrush *et al*. (1998) assessed the importance of fishing pressure (by collecting samples along a fishing pressure gradient) in accounting for variation in community composition in an area characterised by varied sediment characteristics (from 1 to 48% mud) in Hauraki Gulf in New Zealand at depths between 17 to 35 metres. In this area, a major fin fishery for snapper (*Chrysophrys auratus*) exists. The typical trawl gear used consists of 480 kg doors, ground rope of 140-150 mm diameter rubber bobbins, steel balls, with a total ground rope mass of 240 kg (not including sweeps and bridles). After accounting for differences in environmental conditions, the study reported 15-20% of the variability in the macrofauna community composition was attributed to fishing. Observations following reduction in fishing pressures included increases in the density of echinoderms, long-lived surface-dwelling organisms, total number of species, individuals and species diversity. Decreased fishing pressure led to significant increases in large epifaunal densities.

Hiddink *et al*. (2006a) conducted an assessment of large-scale impacts of a bottom trawl fishery on benthic production, biomass and species richness in the North Sea, using a size-based approach for assessing trawling impacts on benthic communities. Model development allowed for the effects of habitat parameters on the dynamics of benthic communities and to predict the effects of trawling on species richness. Data used to validate the model was collected from 33 sampling stations in four areas of soft sediment in the North Sea subject to different levels of trawling intensity. The model predicted that benthic community biomass was reduced by 56% and production by 21%. Queirós *et al*. (2006), analysed the biomass, production and size structure of two communities from a muddy sand and a sandy habitat with respect to quantified gradients of trawling disturbance on real fishing grounds in the Dogger Bank (sandy) and Irish Sea (muddy sand). The Dogger Bank is mostly fished by beam trawlers targeting plaice and the Irish Sea is fished by otter trawls targeting Norway lobster. In the muddy sand habitat, chronic trawling was found to have a negative impact on biomass and production of benthic communities, whilst no impact was identified on benthic communities within the sandy habitat. The differences in result for each habitat type are caused by differences in size structure between the two communities that occur in response to an increase in trawling disturbance. Lindholm *et al*. (2013) reported similar results in an area of coarse silt/fine sand at 160-170 m depth with experimental trawling using a small footrope otter trawl (61 ft head rope, 60 ft ground rope, 8 inch and 4 inch discs, 3.5 ft x 4.5 700 lbs ft trawl doors) (Lindholm *et al*., 2013). The study reported no measurable effects of trawling on densities of invertebrates, including sessile and mobile epifauna and infauna. The study area was characterised by a high level of patchiness in both space and time with regards to invertebrate assemblage, particularly with respect to opportunistic species (polychaete worms and brittestars). Densities of sessile and mobile invertebrates were low in the study and varied considerably between plots and study periods, suggesting that the effects on trawling should be considered with background environmental variation in mind.

Beam trawls

Repeated experimental trawling (3 times) with a 7000 kg, 12 m beam trawl with tickler chains led to a significant 40-65 % decrease in the density of starfishes, small heart urchins, tube-dwelling polychaete worms and small crustaceans, although other species, namely worm and mollusc species, did not change and a number increased (Bergman *et al*. 1990; Bergman & Hup, 1992). The study was conducted in the North Sea in an area of medium hard sandy sediments at a depth of 30 m. Bergman and van Santbrink (2000) reported similar mortality levels of 5-40% in gastropods, starfish, crustaceans and annelid worms and a 20-65% mortality of bivalves using a 12 m and 4 m beam trawl with ticklers and a 4 m beam with chain matrix over shallow sandy areas and deep silty sand areas in the North Sea. Direct mortality in a number of infaunal species was higher in silty areas than in sandy areas (Bergman & van Santbrink, 2000). The 12 m beam trawl caused the highest annual fishing mortality (Bergman & van Santbrink, 2000). In an area of stable coarse sand and gravel, experimental trawling (10 to 12 passes) with a 3.5 tonne 4 m beam trawl with chain matrix led to a 54% reduction in the number of infaunal species and 40% reduction in individuals, a decrease in slow moving epifauna and an increase in mobile species (Kaiser & Spencer, 1996, Kaiser *et al*., 1996, 1998, 1999). At the scale and intensity of the study, no changes in densities were detected (Kaiser & Spencer, 1996, Kaiser *et al*., 1996, 1998, 1999). The same experimental treatment was applied to an area characterised by mobile sand ribbons and megaribbons, however no differences in the benthic community were detected (Kaiser & Spencer, 1996b, Kaiser *et al*., 1996b, 1998, 1999). A study on the impacts of chronic beam trawling in central regions of the North Sea reported significant decreases in infaunal biomass and production in a region of muddy sand sediment and depth of 55 to 75 m (Silver Pit) in response to trawling intensity (Jennings *et al*. 2001). The effects of trawling disturbance were not significant on epifauna and in another region, characterised by sand with a depth of 40-65 m (The Hills) and smaller range of trawling intensity, a relationship between infaunal biomass and production could not be established (Jennings *et al*., 2001). Another study, also based in the central North Sea, investigated the impacts of experimental beam trawling (using a 4 m beam trawl with a chain matrix) on meiofauna and reported that meiofauna are more resistant to trawling disturbance than macrofauna and have the potential to withstand chronic trawling impacts (Schratzberger *et al*. 2002).

Size of fauna

Many studies have observed a shift in benthic community structure from one dominated by relatively high biomass species to one dominated by a high abundance of small-sized organisms (Collie *et al*., 2000). The predicted change in shallow water communities, as a result of trawling disturbance, is an increase in r-strategists (i.e. polychaetes) and decrease K-strategist (i.e. molluscs and crustaceans) (Jones, 1992). A shift towards small-sized species has the potential to alter benthic productivity as body mass is negatively correlated with individual production to biomass ratio (Jennings *et al*., 2001; Queirós *et al*., 2006). Overall reductions in benthic productivity have been reported in areas where intense bottom trawling takes place (Jennings *et al*., 2001). Increases in the biomass or production of smaller infauna have been found to be small in relation to losses in overall community biomass and production that occurred as a result of the depletion of larger individuals (Jennings *et al*., 2001). Smaller bodied fauna is incapable of utilising resources that become available as larger fauna are removed from the community (Queirós *et al*., 2006). Under such conditions, resources may be redirected to other parts of the system (Queirós *et al*., 2006). In areas of natural disturbance, the dominance of smaller bodied fauna may be a general adaptation to such a dynamic environment and therefore the community may seem relatively unaffected by trawling (Queirós *et al*., 2006).

Populations of larger, longer-lived species are less resilient to fishing impacts than smaller, short-lived species as they are able to compensate for any increases in mortality (Roberts *et al*., 2010). In addition, lighter animals are often pushed aside by the pressure wave in front of the net (Gilkinson *et al*., 1998; Jennings *et al*., 2001). Larger fauna is mainly affected through direct physical contact with the gear and may be removed from the community (Bergman & van Santbrink, 2000; Queirós *et al*., 2006). Bergman and van Santbrink (2000) revealed a size-dependent trend for some species with respect to direct mortality from a 12 and 4 m beam trawl. In areas of silty sediments, individuals of the bivalve species *Chamelea gallina* above 2 cm were more vulnerable with mortalities ranging between 22-26%, compared to smaller specimens (4-7% mortality). The impact caused by contact with the fishing gear is not comparable to natural disturbance, and mortalities in more mobile and dynamic sediments will not necessarily be lower than in stable sediments (Bergman & van Santbrink, 2000). The impacts on densities of small individuals may however be greater if the larger animals in question live deeper in the sediment, in addition to their potentially more efficient escape possibilities (Bergman & Hup, 1992; Gubbay & Knapman, 1999).

Studies have shown that trawling impacts on meiofuna (animals that pass through a 500 µm mesh sieve but are retained in a 63 µm mesh sieve) are relatively limited (Brylinsky *et al*., 1994; Scratzberger *et al*., 2002). Brylinsky *et al*. (1994) reported reductions in the abundance of nematodes after experimental flounder trawling on the intertidal in the Bay of Fundy, although the rate of recovery was rapid following trawling disturbance. Scratzberger *et al*. (2002) reported no short- to medium- term (1-392 days after experimental trawling) impacts on diversity or biomass of meiofauna from experimental fishing with a 4 m beam trawl in muddy sand in the southern North Sea. Mild effects on community structure were reported at one location however these impacts were minor in relation to seasonal change. The authors suggested that meiofauna are more resistant to beam trawling than macrofauna and they have the potential to withstand the effects of chronic trawling. Their resistance to trawling is thought to be related to their small body size as they are resuspended rather than killed, combined with their short generation cycles which allow populations to withstand elevated mortality.

Faunal groups and species responses

The relative impact of bottom towed fishing gear on benthic organisms is species-specific and largely related to their biological characteristics and physical habitat. The vulnerability of an organism is ultimately related to whether or not it is infaunal or epifaunal, mobile or sessile and soft-bodied or hard-shelled (Mercaldo-Allen & Goldberg, 2011). Fragile fauna (i.e. bivalves and sea cucumbers) have been shown to be particularly vulnerable to trawling damage and disturbance and sedentary and slowing moving species can be significantly lower (Kaiser & Spencer, 1996; Gubbay & Knapman, 1999). Motile groups and infaunal bivalves have shown mixed responses to trawling disturbance, with life history considerations such as habitats requirements and feeding modes likely to play a key role in determining a species response (McConnaughey *et al*., 2000; Johnson *et al*., 2002). In a meta-analysis of experimental fishing impact studies, conducted by Kaiser *et al*. (2006), otter trawling was found to have the greatest impact on suspension feeders in mud habitats, perhaps reflecting the depth of penetration from the otter doors, whilst the response of suspension feeders and deposit feeders to beam trawling was highly variable. The most negative effect on deposit feeders was found in gravel habitats and the most negative effect on suspension feeders was found in sand habitats (Kaiser *et al*., 2006). Suspension feeding bivalves, such as *Corbula gibba*, are largely unable to escape burial of more than 5 cm (Maurer *et al*., 1982) and are also sensitive to high sedimentation rates that may occur following intensive trawling (Howell & Shelton, 1970; Tuck *et al*., 1998). Having said this, larger-sized individuals have been shown to be more resistant to trawling disturbance as they are relatively robust (Bergman & van Santbrink, 2000).

Studies have revealed mixed effects on epifauna (organisms that inhabit the seabed surface). Jennings *et al*., (2001) found that chronic trawling disturbance had no significant effect on epifauna in the North Sea. Similarly, no long-term effects on the number of epifaunal species or individuals were detected by Tuck *et al*. (1998), although a number of species-specific changes in density did occur (increase in *Ophiura* sp. and decreases in *Hippoglossoides platessoides*, *Metridium senile* and *Buccinum undatum*). The lack of long-term effects detected by Tuck *et al*. (1998) is likely to be compounded by the fact that beam trawl gear used was not equipped with a net, as greater effects on epifauna may be expected. The removal of 7 tonnes of epifaunal was reported by Pitcher *et al*. (2000) during experimental trawling, however no significant changes in the density of epifauna were reported (Thrush & Dayton, 2002). Kenchington *et al*. (2001) investigated the impacts of otter trawling on benthic communities on a sandy bottom in Grand Banks, Newfoundland over a three-year period. Changes in the benthic community were sampled using an epibenthic sledge. The sled is largely used to sample epifauna and some infauna as the sled penetrates to a depth of 2 to 3 cm. Samples collected using the benthic sled revealed a 24% reduction in average biomass in trawled corridors compared to reference corridors. Hinz *et al*. (2009) investigated the biological consequences of long-term chronic disturbance caused by the otter trawl *Nephrops norvegicus* (Norway lobster) fishery along a gradient of fishing intensity over a muddy fishing ground in the north-eastern Irish Sea. The study reported reductions in epifaunal abundance of 81% from the lowest trawling effort recorded (1.3 times trawled/year) to the highest (18.2 times trawled/year). Over the same range of trawl intensities, epifaunal species richness decreased by 18%, while no effect was evident for epibenthic biomass.

Epifaunal biomass at high trawling intensity sites was reported to be dominated by *Asterias rubens*, a possible response to elevated food availability in the form of biota killed or damaged by trawling (Hinz *et al*., 2009). Starfish species can respond rapidly to prey availability (Freeman *et al*., 2001) and are known to be resilient from the damaging impacts of trawls (Hinz *et al*., 2009). Similarly, despite lower diversity, a greater dominance of the sea star, *Asterias amurensis*, was reported in heavily fished areas of the eastern Bering Sea (McConnaughey *et al*., 2000). The overall mean abundance of *A. amurensis* was 58.5 kg/ha in the heavily fished, compared with 53.1 kg/ha in the unfished area. In contrast, Bergman and Hup (1992) reported a 43% reduction in the mean density of *A. rubens* after a single beam trawling. Generally speaking, a number of studies have shown to have adverse impacts on echinoderms, including a 0-26% mortality in silty sand and 12-16% mortality in sand as a result of otter trawling in the North Sea (Bergman & van Santbrink, 2000) and a 24% reduction in total biomass of mega-epibenthic species as a result of otter trawling on a sandy bottom in Grand Banks, owing primarily to reductions in sand dollars, brittle stars, soft corals, sea urchins and snow crabs (Kenchington *et al*., 2001). Trawling caused significant damage only to echinoderms, with the highest probability of damage occurring on the sea urchin (10 percent damage) (Kenchington *et al*., 2001). Large and fragile echinoderms particularly suspectible to trawling, include the sea urchins *Brissopsis lyrifera* and *Echinocardium cordatum* (Ball *et al*., 2000), the latter of which has been reported to have a mortality of 10-40% after the single passage of a 4 m and 12 m beam trawl (higher in silty areas than in sandy areas) (Bergman & van Santbrink, 2000). Jennings *et al*. (2001) reported highly significant reductions in the biomass of burrowing sea urchins in response to a chronic beam trawling in the North Sea.

A meta-analysis by Kaiser *et al*. (2006) showed beam trawling in sand to have a greater individual impact on crustaceans, echinoderms and molluscs when compared with annelids, whilst otter trawling in muddy sand appeared to have a greater impact on crustaceans than annelids and molluscs. The single passage of a 4m and 12 m beam trawl in sand and silty sand led to direct mortalities of up to 22% in small-sized bivalves and crustaceans and in megafaunal species up to 68% for bivalves and 49% for crustaceans (Bergman & van Santbrink, 2000). Bivalves such as *Mya truncata*, *Lutraria lararia* and *Nucula nitidosa* showed greater densities in samples taken after trawling compared to those taken prior to trawling. By contrast, Tuck *et al*. (1998) reported a decline in *Nucula nitidosa* and *Corbula gibba* in abundance in the trawled area relative to reference area, with the former species being identified as sensitive. Other mollusc species reported to be sensitive to trawling disturbance includes the tellin shells, *Tellina fabula* (Bergman & Hup, 1992). Jennings *et al*. (2001) reported highly significant reductions in the biomass of bivalves in response to a chronic beam trawling in the North Sea. The physical interaction with trawl doors with the sea bed was simulated in a test tank in order to examine physical disturbance and biological damage (Gilkinson *et al*., 1998). During the simulation, bivalves which were buried in the scour path were displaced to the berm and 58-70% of displaced individuals were completely or partially exposed on the surface. Despite this, of the 42 specimens in the scour path, only two showed major damage, despite being displaced. A number of studies have reported limited impacts of molluscs in general as a result of trawling disturbance (Bergman & Hup, 1992; Prena *et al*., 1999).

Experimental fishing manipulations have shown that the impacts of trawling disturbance on annelids are limited, and in some instance may be positive, particularly with respect to polychaetes Experimental flounder trawling on an intertidal silty habitat in the Bay of Fundy revealed no impact on either the composition or abundance of polychaetes, the majority of which are tube dwelling (Brylinsky *et al*., 1994). Whilst the single passage of a 4 m and 12 m beam trawl on sandy and silty sediment led to direct mortalities of 31% for annelids, principally the tubedwelling polychaete *Pectinaria koreni*, the mortality of many other small annelids observed was negligible (Bergman & van Santbrink, 2000). Ball *et al*. (2000) reported a decrease in abundance in most species following experimental trawling with a Nephrops otter trawl, except for most polychaete species which increased in abundance following trawling. These species included small opportunistic species such as such as *Chaetozone setosa* (52%), *Prionospio fallax* (149%) and *Scolelepis tridentate* (457%) or large scavenges such as *Nephtys incisa* (16%). Tuck *et al*. (1998) reported a consistently higher proportion of polychaetes in the treatment areas, with an increase in the abundance of opportunistic polychaete species belonging to the cirratulid family, *Chaetozone setosa and Caullenella zeflandica*, in response to trawling disturbance. The polychaete, *Pseudopolydora paucibranchiata*, also increased in density, immediately following trawling disturbance (Tuck *et al*., 1998). Other polychaete species however did decline in response to fishing disturbance, including *Scolopolos armiger*, *Nephtys cirrosa* and *Terebellides stroemi* (Tuck *et al*., 1998). *Scolopolos armiger* is thought to be sensitive to burial, whilst *N. cirrosa* and T. *stroemi* are larger bodied and therefore more likely to be adversely affected by trawling disturbance (Tuck *et al*., 1998). Bergman and Hup (1992) found that three-fold trawling had minimal effect on the densities of worm species, except for *Magelona*, *Lanice* and *Spiophanes*, although densities of the former species significantly increased after experimental trawling for larger individuals. Jennings *et al*. (2001; 2002) reported no significant changes in polychaetes in in response to a chronic beam trawling in the North Sea. In contrast to the aforementioned studies, Kaiser *et al*., (1998) studied the effect of beam trawling of megafauna in an area of stable sediments in the north eastern and found a reduction the abundance in the polychaetes *Aphtodita aculeata* and *Nephtys* spp., although these differences were no longer apparent 6 months after trawling.

A number of studies have identified common trends for certain species in response to trawling disturbance. The gastropod *Buccinum undatum* is shown to decline in areas of trawling disturbance (Tuck *et al*., 1998; Kaiser *et al*., 2000), with one study stating the effects of trawling persisted for 6 months into the recovery period (Tuck *et al*., 1998). Similarly, *Echinocarodium cordatum* has been identified as a fragile and highly vulnerable to trawling disturbance (Bergman & Hup, 1992; Bergman & van Santbrink, 2000), showing declines of 40 to 60% in density in one study (Bergman & Hup, 1992). Similar reductions were shown by the polychaete *Lanice conchilega* (Bergman & Hup, 1992), a species of polychaete which is highly incapable of movement in response to disturbance and therefore take a significant period of time to recolonise disturbed habitats (Goss-Custard, 1977). Other species that have been reported to exhibit adverse effects of trawling include the polychaete species *Nephtys* (Kaiser *et al*., 1998; Tuck *et al*., 1998) and *Magelona* (Bergman & Hup, 1992; Kaiser *et al*., 2000) and the emergent soft coral *Alcyonium digitatum* (Kaiser *et al*., 1998; 2000; Depestele *et al*., 2012). By contrast, the brittle star, *Ophiura* sp., has been reported to increase or remain constant in response to trawling disturbance (Tuck *et al*., 1998; Gubbay & Knapman, 1999; Kaiser *et al*., 2000; Callaway *et al*., 2007).

4.3.4 Removal of Target Species

The king scallop (*Pecten maximus*) can be found throughout most of the inshore waters of the English Channel (Le Goff *et al.,* 2017). Throughout the Southern IFCA district both in the east around the Isle of Wight and the West in Lyme Bay the king scallop is harvested and landed as an important commercial species (Le Goff *et al.,* 2017). *Pecten maximus* contribute 6-20% of the total catch weight in scallop dredges in the English Channel, with shell and rock making up the majority of the catch (Szostek *et al.,* 2017; Jenkins *et al.,* 2001). Of the live biomass caught within the dredge the king scallop accounts for, on average, 81%, indicating the fishing method is relatively selective (range 55-83%) (Szostek *et al.,* 2017).

The average efficiency of dredges 1.2m wide, with 12 teeth and bag belly rings of 83mm diameter was studied by Chapman *et al.* (1977). The dredge efficiency of standard dredges in Scotland showed large variations from 0 to 35.7% capture efficiency (Chapman *et al.,* 1977). The average efficiency for all scallop sizes was around 20%, but slightly higher for larger scallops. Only 3.3 % of scallops smaller than 80mm were caught. The overall efficiency of a spring-loaded dredge varied from 2.5 to 37.5 %, at an average of around 13 % (Chapman *et al.,* 1977). 4.3% of scallops left behind in a dredge track showed mortality, compared to 2.6 % in an unfished control group. Mortality occurred mostly in those individuals which were severely damaged. Only 5% or less of those scallops within the dredge track and dredge catch showed sever damage (Chapman *et al.,* 1977).

In a Newhaven style scallop dredge, of those scallops which are brought to the surface within the dredge between 5 and 6% have died (Shephard *et al.,* 2009). Of those scallops which are undersized and returned to sea, it is generally considered that unless badly damaged these scallops survive (Howell and Frazer 1984).

On the seabed only 15% of scallops disturbed by a dredge remain recessed within the sediment (Jenkins *et al.,* 2001). Of all the scallops both brought up within the dredge and those which remain in the dredge track more than 90% show very little damage (Jenkins *et al.,* 2001).

However, in the lab, experimental simulations of dredging have caused a significant increase in scallop (*P. maximus*) time taken to respond to a predator stimulus and the adduction number of the response (Jenkins and Brand, 2001). Larger scallops take longer to respond than smaller individuals. After 1 hour's recovery time, scallops showed a similar response indicating recovery from dredging takes more than 1 hour (Jenkins and Brand 2001).

Bremec *et al.* (2004) studied the survival of the Patagonian scallop (*Zygochlamys patagonica*) after exposure to 30 minutes of air onboard a fishing vessel, the equivalent time to that which it takes to sort the catch for commercial sizes (>55mm). Survival of this scallop species was high with a mean value of 95.5%, with more than 90% of scallops surviving exposure times of up to 4 hours (Bremec *et al.,* 2004). Jenkins and Brand (2001) found that exposure to air (20 mins) had a negative effect on 3 out of 4 predator response variables of *P. maximus*.

Specific experiments have looked at the effect of simulated dredging and tow speed on the stress of small scallops (<75mm) (Maguire *et al.,* 2002). Higher tow speeds led to greater stress, however, the low tow speed also caused to stress. The ability of scallop to self-right and recess into the sediment declined only in individuals exposed to the high tow speed (Maguire *et al.,* 2002). Tow length does not have a significant effect on scallop stress level. Repeated dredging at a lower speed after 24 hours leads to a cumulative effect of scallop stress but no additional increases was found after repeated dredging at 48 h. Tows at the higher speed additional dredge disturbance did not lead to a cumulative effect (Maguire *et al.,* 2002). Importantly for all stimulation's scallops recovered relatively quickly, between 2 and 6 hours after dredging (Maguire *et al.,* 2002).

When areas of the seabed are protected from scallop dredging and other forms of towed gears, the density of scallops on the seabed can increase (Leigh *et al.,* 2014). Scallops can live for considerably longer and grow to much larger sizes if not harvested, with exploitable and reproductive biomass also increasing, compared to open fishing grounds (Leigh *et al.,* 2014). Juvenile scallops can be as much as 350% more abundant in no take zones than in fished areas. Overall, it has been found that bottom towed gear closures or no take zones, not only increase the productivity of scallop populations inside the zones, but this also positively effects scallop populations on active fishing grounds (Leigh *et al.,* 2014).

A study of the effects of scallop dredging in Lyme bay found that within three years an area was closed to all bottom towed gears, scallop numbers had significantly increased in a newly closed area when compared to open controls (Sheehan *et al.,* 2013). On the other hand, a study in the same area found fishing history treatment and time had no significant effect upon the abundance of king scallops in a before and after study (9 years) (Kaiser *et al.,* 2018).

Changes in scallop density have been found to be primarily driven by seasonal fluctuations in Cardigan Bay, Wales (Sciberras *et al.,* 2013).

4.4 Changes in suspended solids/ Smothering and siltation rate changes

The resuspension of fine sediments takes place as fishing gear is towed along the seafloor (Johnson *et al*., 2002). Larger sand particles are redeposited near the dredge whilst measurable amounts of fine silt and clay particles remain in suspension and are potentially transported away by currents (Godcharles, 1971; Tuck *et al*., 2000). The effects of sediment resuspension include increased turbidity and thus a reduction in light, burial of benthic biota, smothering of adjacent areas including potential spawning areas, and negative effects on the feeding and metabolic rates of organisms (Johnson *et al*., 2002). These effects are site-specific and depend on grain size, sediment type, water depth, hydrological conditions, sensitivity of fauna, currents, tides and water mass properties (Coen, 1995).

Where gear is towed over rocky habitat the impact of this will be significantly reduced due to the low or non-existence level of sediment present within the sea habitats. However, if gear is towed between reef areas in coarse and mixed sediment the suspension of sediment is likely.

Dale *et al.,* (2011) used a particle tracking model to determine the effect of a vessel towing eight dredges on either side in a water current of 0.1m per second. The model suggested that the majority of all sediment size classes suspended settles within 100 meters of the dredge (Dale *et al.,* 2011). Of the suspended sand and larger particles, only 10m from the dredge all but 3.6% of these particles will have settled (Dale *et al.,* 2011). However, of the fraction of silt that makes up the sediment, 92.5% persists in the water column 100m away from the dredge site (Dale *et al.,* 2011). The total sediment accumulation immediately outside the dredge is just 1.6mm, and, after 1 hour, just 8,2% of the suspended silt remains in suspension at 315m away from the dredge which is comparable to low natural suspended sediment levels (Dale *et al.,* 2011).

For a 48-minute dredge tow, in combination with tidal period, in the far field (where the sediment has been carried by the current away from the dredge site) the maximum suspended concentration is 0.24g per m cubed, with a maximum settled thickness of 0.0012mm (Dale *et al.,* 2011). If sediment hotspots from multiple vessels coincided it would take more than 15 tows for silt concentrations to match low natural levels, and more than 200 tows for the levels to equal that seen during stormy conditions (Dale *et al.,* 2011). The model therefore suggests that reefs in the area are only at risk if they are within 10m of the dredge site, and that those which lay further afield will not be significantly affected by changes in turbidity, siltation or smothering rates beyond natural levels (Dale *et al.,* 2011).

The resuspension of sediment can impact upon benthic communities through smothering, burial and increased turbidity. These effects may extend to organisms living a distance away from the fished area (Kyte & Chew, 1975). If high levels of sediment are resuspended and exposure to such events is regular, impacts may be severe (Mercaldo-Allen & Goldberg, 2011). Increased turbidity can inhibit respiratory and feeding functions of benthic organisms, in addition to causing hypoxia or anoxia (Morgan & Chuenpagdee, 2003). Sediment resuspension can jeopardise the survival of bivalves and fish as a result of clogged gills and inhibition of burrowing activity (Dorsey & Pederson, 1998). Small organisms and immobile species are particularly vulnerable to smothering (Manning, 1957). A redistribution of finer sediment can also hinder the settlement of organisms if hard surfaces are smothered (Tarnowski, 2006). The severity of such impacts is largely determined by sediment type, the level of sediment burden and the tolerance of organisms which is largely related to their biology (i.e. size, relationship to substrate, life history, mobility) (Coen, 1995).

4.5 Natural Disturbance

Communities that exist in areas of high natural disturbance rates are likely to have characteristics that provide resilience to additional disturbance (Hiddink *et al*., 2006a). Any vulnerable species would be unable to exist within conditions of frequent disturbance (Hiddink *et al*., 2006a). The impact of bottom towed fishing gear (such as trawling and scallop dredging is therefore expected to be higher in areas that experience low levels of natural disturbance and lower at locations of high levels of natural disturbance (Hiddink *et al*., 2006a). Despite the significance between benthic community responses to bottom towed gears disturbance and levels of natural disturbance, the relationship remains unquantified (Hiddink *et al*., 2006a). There can often be a failure to detect the effect of experimental fishing disturbance in areas exposed to high levels of natural disturbance (Thrush & Dayton, 2002). Whilst it may be appropriate to equate effects of natural disturbance to some effects of trawling disturbance, it is not always the case. Fishing can involve a higher intensity of disturbance, although this is dependent on frequency and extent (Thrush & Dayton, 2002). Bottom towed gear effects small-sized organisms through sediment perturbations, which is comparable to that of natural disturbance, whereas its impacts on larger-bodied organisms will be through physical contact with fishing gear (Bergman & van Santbrink, 2000). The relatively low impact on benthic communities inhabiting mobile sediments might therefore only apply to small-bodied animals (Bergman & van Santbrink, 2000).

South of the Isle of Portland is a very dynamic area, with very strong tidal flows off of Portland Bill reaching up to 7 knots on a spring tide and creating near constant races[6]. Bolam *et al*. (2014) modelled natural seabed

[6] Information and diagrams on the tidal streams experienced around Portland can be found at https://www.visitmyharbour.com/articles/3181/hourly-tidal-streams-approaches-to-portland-and-the-portland-race-np257

disturbance as part of a study looking at the sensitivity of microbenthic second production to trawling in the English sector of the greater North Sea. Natural seabed disturbance was represented by tidal bed stress and kinetic energy at the seabed. Maps showing the probability of natural forces disturbing the seabed to 1 and 4 cm for a range of frequencies (once, 10 times, and 17 times were also created. These maps cover the Isle of Portland(Figure 4 & Figure 5), although the resolution is low as the area covered includes the North Sea and western English Channel. These maps however do demonstrate that Portland Bill, is subject to high levels of natural disturbance. Annual tidal bed stress ranges from 2.5-7.5 NM^2 south of the Bill. Kinetic energy at the seabed is high within the site. The probability of natural forces disturbing the seabed to 1 cm reach the highest probability (0.61-1.00) at all frequencies.

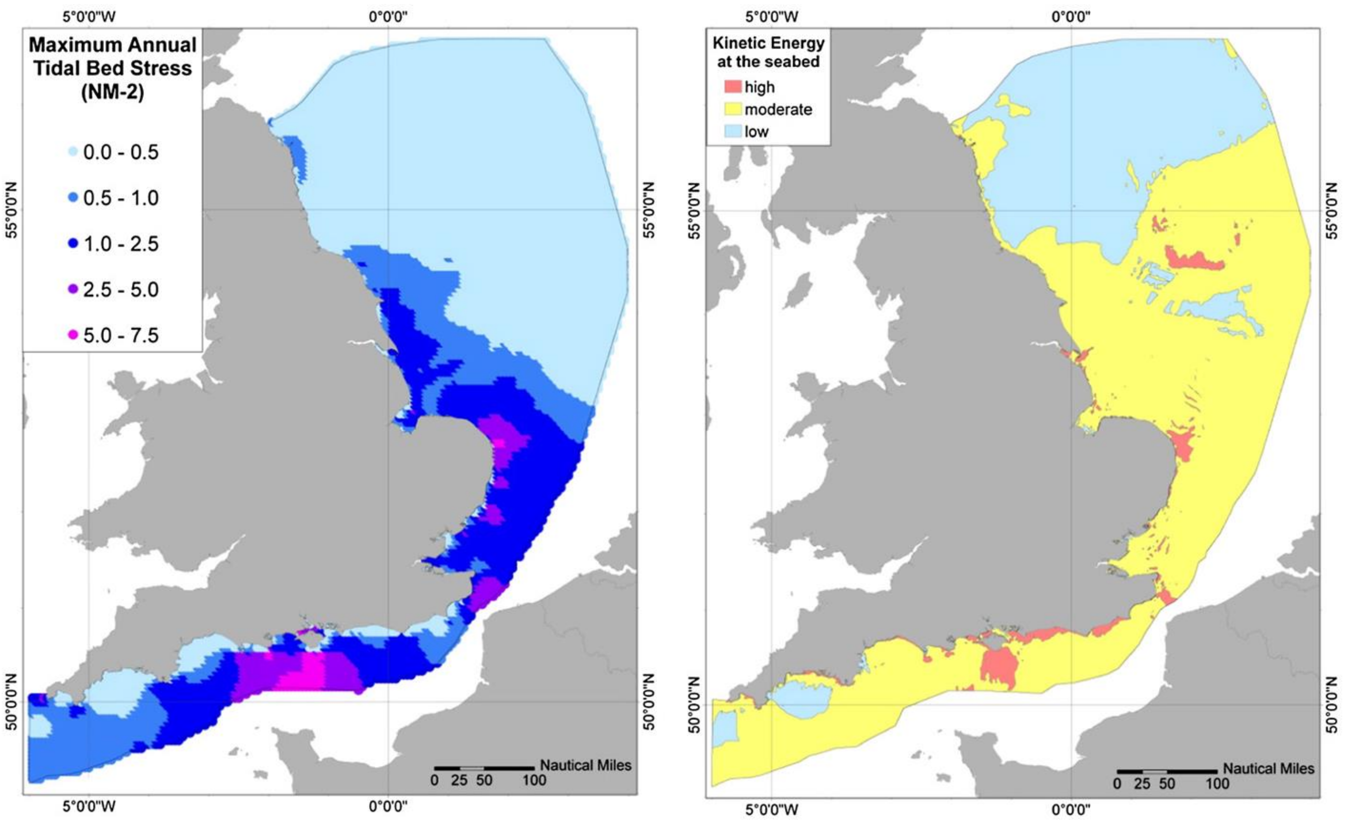


Figure 4. Maps of modelled natural disturbance of the seabed, represented by tidal bed stress (left) and kinetic energy (right). Source: Bolam et al*., 2014*

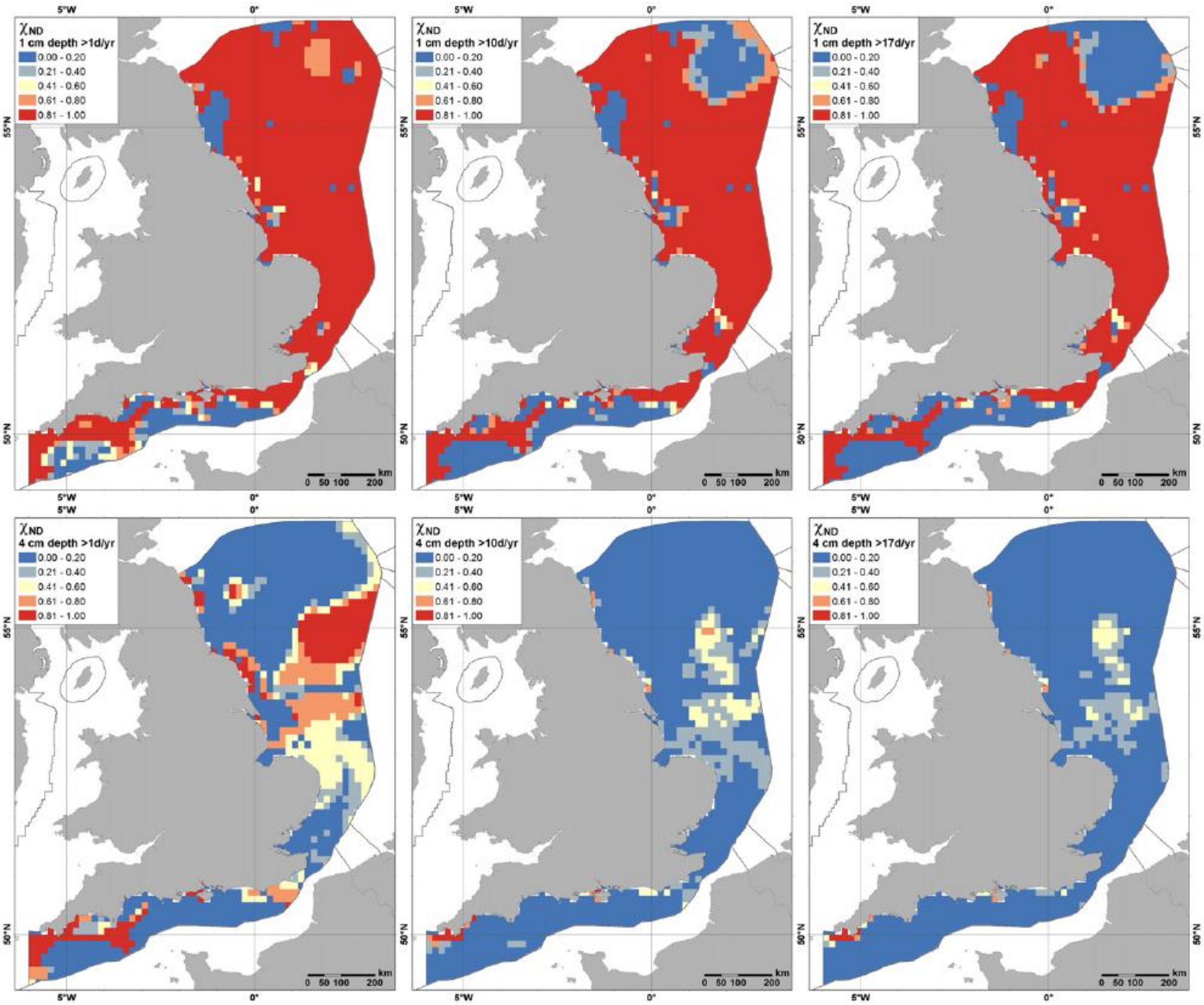


Figure 5. Maps of the modelled probability that natural forces disturb the seabed to different depths of 1 and 4 cm for a range of frequencies per year (once, 10 and 17 times). Source: Bolam et al*., 2014*

In the context of MPA management, it is important to qualify which changes occur to naturally dynamic communities as a result of natural variability within the environment, as opposed to that resulting from anthropogenic pressures (Goodchild *et al*., 2015). The reason being that the conservation objectives of a site are ‘subject to natural change’ (Goodchild *et al*., 2015). It can therefore prove difficult in ascertaining if the conservation objective of a site is being compromised by anthropogenic pressures if the MPA feature is also subject to natural variability (Goodchild *et al*., 2015). Potential changes caused by towed fishing gear could be masked by the impacts of natural sediment movements which maintain the benthic community in a state of successional flux (Løkkeborg, 2005; Goodchild *et al*., 2015). A recent study attempted to analyse existing data to study effects of towed fishing gears on mobile sediments against a background of natural variability, however, it concluded the results of the study were of little direct value in terms of MPA management (Goodchild *et al*., 2015)

4.5.1 Sensitivity

A number of recent studies have endeavoured to map the sensitivity of habitats to different pressures (Tillin *et al*., 2010) and fishing activities (Hall *et al*., 2008).

Tillin *et al*. (2010) developed a pressure-feature sensitivity matrix, which in effect is a risk assessment of the compatibility of specific pressure levels and different features of marine protected areas. The approach used considered the resistance (tolerance) and resilience (recovery) of a feature in order to assess its sensitivity to relevant pressures (Tillin *et al*., 2010). Where features have been identified as moderately or highly sensitive to benchmark pressure levels, management measures may be needed to support achievement of conservation objectives in situations where activities are likely to exert comparable levels of pressure (Tillin *et al*., 2010). In the context of this assessment, the relevant pressures likely to be exerted are surface abrasion, shallow abrasion/penetration and penetration and/or disturbance of the substrate below the surface of the seabed. Sensitivity to all pressures is considered high for Pink sea-fans, with medium confidence in these assessments (Table 5).

Hall *et al*. 2008 aimed to assess the sensitivity of benthic habitats to fishing activities. A matrix approach was used, composed of fishing activities and marine habitat types and for each fishing activity sensitivity was scored for four levels of activity (Hall *et al*., 2008). The matrix was completed using a mixture of scientific literature and expert judgement (Hall *et al*., 2008). The type of fishing activity chosen was 'beam trawls and scallop dredges' and 'light demersal trawls and seines' as they best encompassed the fishing activities under consideration. The majority towed bottom gears where considered unlikely to be deployed in these habitat types and as such were not assessed for heavy to light gear intensities. Rock with erect and branching species appears to be slightly less sensitive to a single pass of the heavier gear types than very slow growing erect and branching species (Table 6). On the other hand, the assessment for the lighter gear type revealed a high sensitivity for both habitat types to a single pass, which may be inaccurate when considering against the sensitivity assigned for heavier gear types.

Table 7. Sensitivity of features to pressures identified by Tillin et al. (2010). Confidence of sensitivity assessment is included in brackets.

	Pressure			
Feature	**Surface abrasion: damage to seabed surface features**	**Shallow abrasion/penetration: damage to seabed surface and penetration**	**Penetration and/or disturbance of the substrate below the surface of the seabed**	**Siltation rate changes (low)**
Moderate energy circalittoral rock	Medium (low)	Medium (low)	Medium (low)	Not sensitive to medium (low)
High energy circalittoral Rock	Medium to High (low)	Medium to High (low)	Medium to High (low)	Medium to High (low)
Subtidal Sand	Not sensitive to medium (low)	Not sensitive to medium (low)	Low to medium (Low)	Medium (low)
Subtidal mixed sediments	Medium (low)	High (low)	High (low)	Not Sensitive (low)
Subtidal coarse sediment	Not sensitive to high (low)	Low to medium (Low)	Low to medium (Low)	Not sensitive to medium (low)

Table 8. Sensitivity of relevant features to different intensities (high, medium, low, single pass) of static gear (fishing activities which anchor to the seabed) as identified by Hall et al. *(2008).*

Habitat Type	**Gear Type**	**Gear Intensity***			
		Heavy	Moderate	Light	Single pass
Kelp + Seaweeds on sand scoured rock	Beam trawls and scallop dredges	High	High	High	Medium
	Light demersal trawls and seines	High	Medium	Medium	Medium
	Demersal trawls	High	High	Medium	Medium

Rock with low-lying fast-growing faunal turf	Beam trawls and scallop dredges				Low
	Light demersal trawls and seines				Medium
	Demersal trawls				Low
Rock with erect and branching species	Beam trawls and scallop dredges				Medium
	Light demersal trawls and seines				High
	Demersal trawls				Medium
Stable subtidal fine sands	Beam trawls and scallop dredges	High	Medium	Low	Low
	Light demersal trawls and seines	Medium	Medium	Low	Low
	Demersal trawls	Medium	Medium	Low	Low
Stable spp. Rich mixed sediments	Beam trawls and scallop dredges	High	High	Medium	Low
	Light demersal trawls and seines	High	Medium	Low	Low
	Demersal trawls	High	Medium	Medium	Low
Unstable coarse sediments – robust fauna	Beam trawls and scallop dredges	Medium	Medium	Low	Low
	Light demersal trawls and seines	Low	Low	Low	Low
	Demersal trawls	Medium	Medium	Low	Low

*Gear activity levels are defined as follows; Heavy – Daily in 2.5 nm x 2.5 nm, Moderate – 1 to 2 times a week in 2.5 nm x 2.5 nm Light – 1 to 2 times a month during a season in 2.5 nm x 2.5 nm, Single pass – Single pass of fishing activity in a year overall

4.5.2 Recovery

Since the introduction of a statutory closed area in Lyme Bay it has provided the opportunity to study the recovery of rocky reef habitats and species from the effects of scallop dredging. Three years after the gear was prohibited, overall sessile reef associated species (RAS) were significantly greater within the Marine Protected Area compared to before and still open controls (Sheehan *et al.,* 2013). The mean abundance of RAS increased by 158%. Analysis of the assemblage compositions revealed that before the closure open to fishing and MPA sites were similar to one another, however after three years before and after sites assemblage composition were significantly different. Four species (ross coral, sea squirt (*P. mammillata)*, dead man's fingers and branching sponges) significantly increased in abundance from before the MPA to the after the MPA relative to open to fishing controls (Sheehan *et al.,* 2013). These species were found in coarse, cobbled and boulder sediment areas between those areas of solid bedrock, showing that the exclusion of bottom towed fishing gear not only enables the reef itself to recover, but also enables reef associated species to thrive in areas between reef structures (Sheehan *et al.,* 2013).

A longer-term study of the Lyme Bay reefs found that species recovery within these sites showed that recovery is linked to life history characteristics (Kaiser *et al.,* 2018). Species with high dispersal rates and less specific habitat requirement such as soft corals (dead men's fingers) and king scallops recovered within 3 years, whilst longer lived ross corals, white sea squirts and pink sea fans increased in abundance but had not fully recovered after 10 years (Kaiser *et al.,* 2018). Kaiser *et al.,* predicted that these species could take 17 to 20 years to recover fully from the damage of scallop dredging (Kaiser *et al.,* 2018).

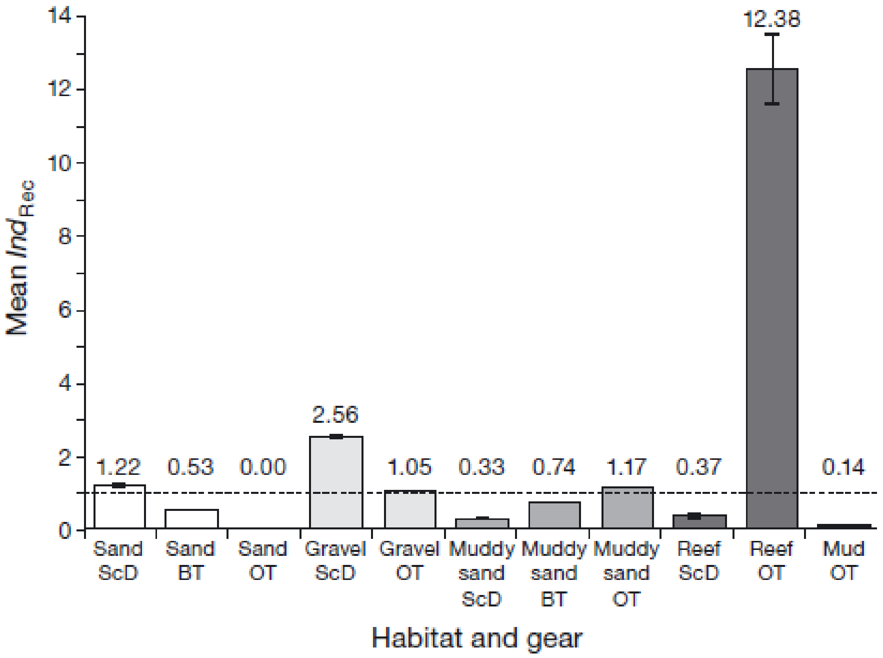
Foden *et al*. (2010) investigated recovery of different sediment types based on the spatial and temporal distribution of benthic fishing. Vessel monitoring system data (2006 to 2007) was used to estimate the distribution and intensity of scallop dredging, beam trawling and otter trawling in UK marine waters. This data was then linked to habitat in a geographic information system. Recovery periods for different habitats were estimated based on existing scientific literature for gear types and fishing intensity (Table 10), with recovery rates generally increasing with sediment hardness. It was estimated that based on mean annual trawl frequencies that 80% of bottom-fished areas were able to recover completely before repeat trawling. In 19% percentage bottom-fished areas however, the frequency of scallop dredging in sand and gravel and otter trawling in muddy sand and reef habitats occurred at frequencies that prevented full habitat recovery. At average fishing intensities (for each gear type), sand and mud habitats were able to recover fully, whilst gravel, muddy sand and reef habitats were fished at frequencies in excess of the estimated recovery period (shown in Figure 6 where the mean index of recovery exceeds 1).

Table 9 Recovery rates (days) of different habitats for different fishing gear types. ND: No Data. Source: Foden et al., 2010.

Gear Type	**Reef**	**Sand**	**Gravel**	**Muddy Sand**
Beam trawl	ND	182[a]	nd	236[b]
Otter trawl	2922[a]	0[b]	365[d]	213[c]
Scallop dredge	1175[a]	2922[b]	2922[b]	589[b]

A Kaiser *et al.* (1998); b Kaiser *et al.* (2006); c Ragnarsson & Lindegarth (2009); d Kenchington *et al.* (2006); e Gilkinson *et al.* (2005)

Figure 6 Mean index of recovery (Ind_{Rec}) for gear-habitat combinations using fishing intensity data derived from Vessel Monitoring Systems in 2007. At Ind_{Rec} Rec = 1, the recovery period is equal to fishing frequency (horizontal dashed line), at Ind_{Rec} <1 fishing frequency is less than the predicted recovery period and at Ind_{Rec} fishing frequency exceeds the recovery period. BT: Beam Trawl, OT: Otter Trawl and ScD: Scallop Dredge. Source: Foden et al., 2010.



Physical disturbance from chronic trawling occurs over large spatial scales and it may be expected that recovery rates will be slower than those assumed from experimental studies (Hinz *et al*., 2009). Recovery at small experimental scales is likely to simply be immigration, which is a form of recovery that is unlikely in large and repeatedly trawled areas (Jennings *et al*., 2001). The recovery of chronically disturbed benthic communities on fishing grounds will be largely dependent on recruitment and population growth, rather than on immigration from adjacent untrawled areas (Hiddink *et al*., 2006b). The importance of larval recruitment for the recolonization of a disturbed area increases with the size of the disturbed area (Smith & Brumsickle, 1989; Foden *et al*., 2010). The time of year when disturbance takes place may also influence the mode of recovery and recovery rate of the affected community (Foden *et al*., 2010). The recruitment supply of larvae and adult infauna will vary at different times of year and in relation to the physical characteristics at a specific location (Foden *et al*., 2010). The hydrodynamic regime will influence the rate of recolonization by influencing the deposition of infaunal adults and larval stages (Foden *et al*., 2010).

Population recovery rates are known to be species specific (Roberts *et al*., 2010). Long-lived bivalves will undoubtedly take longer to recovery from disturbance than other species (Roberts *et al*., 2010). Megafaunal species such as molluscs and shrimp over 10 mm in size, especially sessile species, are more vulnerable to impacts of fishing gear than macrofaunal species as a result of their slower growth and therefore are likely to have long recovery periods (Roberts *et al*., 2010). Short-lived and small benthic organisms on the other hand have rapid generation times, high fecundities and therefore excellent recolonization capacities (Coen, 1995). For example, slow-growing large biomass biota such as sponges and soft corals are estimated to take up to 8 years, whilst biota with short life-spans such as polychaetes are estimated to take less than a year (Kaiser *et al*., 2006).

4.6 Existing management measures

All Bottom Towed Gears:

- **Bottom Towed Fishing Gear** byelaw 2016 – prohibits bottom towed fishing gear over sensitive features including reef features and seagrass within the District, closing most of the site to these activities.
- **Vessels Used in Fishing** byelaw – prohibits commercial fishing vessels over 12 metres from the Southern IFCA district. The reduction in vessel size also restricts the type of gear that can be used, with vessels often using lighter towed gear and restricted to carry less static gear.

Trawling:

- Southern IFCAs **Minimum Fish Sizes** Byelaw prohibits the taking of fish under the specified size (Black Seabream, Brill, Dab, Conger Eel, Flounder, Red Mullet, Shad, Turbot, Witch Flounder).
- A separate Minimum Size Southern IFCA byelaw exists for Skates and Rays and this states that no person shall take any ray that measures less than 40 cm between the extreme tips of the wings or any wing which measures less than 20 cm in its maximum dimension and which is detached from the body of a skate or ray.
- Other regulations include minimum sizes, mesh sizes and catch composition as dictated by European legislation. European minimum sizes, listed under Technical Conservation Regulation 1241/2019 and Bass Emergency Measures 2020/123 specify the minimum size for bass is 42 cm

Scallop dredging:

- The **Scallop Fishing (England) Order 2012** provides details for dredge configuration (i.e. a dredge cannot exceed 150 kg including all fittings).
- **The Scallop Fishing** byelaw – prohibits any person from taking or fishing for scallops before 0700 local time and after 1900 local time. The byelaw dictates the fishing set up that can be used including a limit on the maximum which number of dredges that can be towed at any one time (up to 12), all dredges must be fitted with a spring loaded tooth bar, the mouth of a dredge must not exceed 85 cm in overall width and no more than two tow bars can be used any time with a maximum length of 5.18 metres (including attachments).
- **European minimum size**, listed under Technical Conservation Regulation 1241/2019, specify the minimum conservation reference size for King Scallop (*Pecten maximus*) is 110mm in area 7d and 100mm in 7e.

4.7 Table 7 Assessment of trawling and dredging activity in the South of Portland MCZ.

Feature	Attribute	Target	Potential pressure(s) and Associated Impacts	Likelihood of Impacts Occurring/Level of Exposure to Pressure	Current mitigation measures
High energy circalittoral rock, moderate energy circalittoral rock	Distribution: presence and spatial distribution of biological communities, Structure and function: presence and abundance of key structural and influential species Structure: species composition of component communities	**Not available**	Abrasion/disturbance of the substrate on the surface of the seabed and penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion, and removal of non-target species were identified as potential pressures. Bottom towed fishing gear directly impacts on rock habitats through physical passage of fishing gear over the seabed. The otter doors, chains and net bag found on trawl gear and the teeth and dredge on a shellfish dredge scrape the surface and can lead to the damage and removal of erect, branching and soft epifaunal species. Recovery of these species will take years and is dependent upon the life history characteristics of the species, with some predicted to require 20 years to recover.	Demersal trawling and scallop dredging are not known to occur within the South of Portland MCZ. Local fishers describe the conditions of the site to be too deep, tidal and rocky to allow for BTFG activity. No sightings of the activities have been made in the site. Outside of the site historic sightings of both dredging and trawling activities have been made. Rocky reef habitats support a wide range of fauna including algae, hard corals, soft corals, hydrozoans, sea squirts, sponges, crustaceans, echinoderms, fish and many more. In addition, they can support nationally rare species such as the pink sea fan and sunset cup coral. Scientific literature has indicated that dredging and trawling can have significant negative effects on the presence, diversity and abundance of many reef associated species. Additionally, trawling will drag boulders, cobles, species and biogenic structures across the seafloor. The intensity of the activity is linked to the severity of the affects. Recovery of reef associated species in Lyme Bay, Dorset is between 3 and 20 years depending on the life history characteristics of the species. Hall *et al.,* (2008) assessed the sensitivity of reef habitats to all bottom towed fishing gear types for a single pass to be medium to high. Whilst BTFG does not currently take place in the site there is potential for it to occur as it occurs in the bays	See Section 2.6 for list of all current management measures

				either side and historically has occurred close to the MCZ. The habitats and associated communities are highly sensitive to these types of fishing gear and have a long recovery period. If fishing were to occur over the habitats it could lead to significant damage and changes to the communities associated with the feature which would take many years to recover. Therefore, it is believed that trawling will pose a significant risk to the rock features within the South of Portland MCZ. Through abrasion/penetration and disturbance of the seabed, and will hinder the ability of the feature to achieve it's 'recover' general management approach (GMA). It is worth noting that in the absence of a condition assessment for the site, Natural England undertook a vulnerability assessment for each feature as a proxy for condition. This assessment considers the activities which take place in the site and determines the GMA for each feature. However, such an assessment is relatively generic and does not take into a number of site-specific factors.	
	Distribution: presence and spatial distribution of biological communities		Removal of target species (Scallop dredging) was identified as a potential pressure. Commercial fishing directly removes and harvests a specific species or group of fauna. The sustainability, including the size and age composition, of the stock can be compromised if unmanaged, leading to indirect effects such as impacts to energy flows through food webs.	Demersal trawling and scallop dredging are not known to occur within the South of Portland MCZ. Local fishers describe the conditions of the site to be too deep, tidal and rocky to allow for BTFG activity. No sightings of the activities have been made in the site. Outside of the site historic sightings of both dredging and trawling activities have been made. Scallop dredges are considered to be relatively selective with 81% of biomass caught comprising of scallops (Szostek *et al.,* 2017). Their capture efficiency however is relatively low (20%), being considerably less for small scallops (3.3%) (Chapman *et al.,* 1977). Levels of mortality in the dredge track are only 1.8% greater than natural mortality (Chapman *et al.,* 1977). Only scallops which are severely damaged may die. Of all scallops (left in dredge	Addressed Above

				track and brought to surface) sever damage occurs in only 5%. Scallops which are both exposed to air or disturbed by a dredge do experience a level of stress which can inhibit their predator response and recessing behaviours (Jenkins and Brand 2201 and Maguire *et al.,* 2002). However, scallops have been found to r3ecover from this stress within 6 hours (Maguire *et al.,* 2002). Areas of the seabed protected from scallop dredging have been found to have greater numbers of scallops (Leigh *et al.,* 2014) however this has not been found in all cases (Kaiser *et al.,* 2018 and Sciberras *et al.,* 2013) where it has been found that scallop populations are driven greatly by seasonal fluctuations and habitat suitability. Scallop dredging is a closely managed fishery in England with minimum conservation reference sizes, gear configuration regulations and within the southern in IFCA district the activity is not permitted between the hours of 19:00 and 07:00. Based upon no scallop dredging occurring actually within the MCZ, the low efficiency of scallop dredges along with high survival rates of both scallops returned to sea or left within the dredge track, with the current mitigation of the current management measures it is believed that dredging will not pose a significant risk to the high and moderate energy circalittoral rock biological communities in the MCZ through removal of target species, and will not therefore hinder the ability of the features to achieve their ‘recover’ general management approach (GMA). It is worth noting that in the absence of a condition assessment for the site, Natural England undertook a vulnerability assessment for each feature as a proxy for condition. This assessment considers the activities which take place in the site and determines the GMA for each	

				feature. However, such an assessment is relatively generic and does not take into a number of site-specific factors.	
	Structure: physical structure of rocky substrate		Physical impacts on the seabed from trawling and dredging include scraping and ploughing, creation of depressions, trenches, scouring and flattening of the seabed, and dragging of large boulders/rock features. Studies on the effects of otter trawling in variable habitats have revealed trawling can lead to the removal of biogenic structures, moved or overturn stones and boulders, smooth the seafloor and exposed sediment/shell fragments.	Addressed above	Addressed Above
	Supporting processes: water quality – turbidity Supporting processes: sedimentation rate		Smothering and siltation rate changes (Light) and Changes in suspended solids (water clarity) were identified as potential pressures. The resuspension of sediment can impact upon benthic communities through smothering, burial and increased turbidity. These effects may extend to organisms living a distance away from the fished area. The timescale for recovery after trawling disturbance largely depends on sediment type, associated fauna and rate of natural disturbance, and variation in recovery arises from characteristics specific to the site.	Demersal trawling and scallop dredging are not known to occur within the South of Portland MCZ. Local fishers describe the conditions of the site to be too deep, tidal and rocky to allow for BTFG activity. No sightings of the activities have been made in the site. Outside of the site historic sightings of both dredging and trawling activities have been made. Rocky reef habitats support a wide range of fauna including algae, hard corals, soft corals, hydrozoans, sea squirts, sponges, crustaceans, echinoderms, fish and many more. In addition, they can support nationally rare species such as the pink sea fan and sunset cup coral. Scientific literature has indicated that dredging and trawling may resuspend sediment which can lead to changes in smothering and siltation rate. This can negatively affect communities through smothering, burial and restriction of respiratory or feeding processes. The	Addressed Above

			Generally speaking, locations subject to high levels of natural disturbance, the associated fauna are likely to be adapted to withstand and recover from disturbance.	timescale for recovery for these processes however varies considerably depending on the scale of the impact. Dale *et al.,* (2011) used a model to track suspended sediment from a boat towing 8 dredges on either side. The model suggested that reefs in the area are only at risk if they are within 10m of the dredge site, and that those which lay further afield will not be significantly affected by changes in turbidity, siltation or smothering rates beyond natural levels (Dale *et al.,* 2011). Tillin *et al.,* (2010) completed a sensitivity assessment of rock habitats to siltation rate changes. He found that high energy infralittoral rock and moderate energy infralittoral rock were not sensitive to this pressure. Moderate energy circalittoral rock was not sensitive to medium sensitivity to this pressure. The site is located south of the Portland Bill where very strong tidal flows are frequent and energy at the seabed is high. The features themselves are high - moderate energy indicating that they are exposed to strong to moderate wave action and the water does not lie still. Therefore, resuspended sediment would be unlikely to settle over the feature. The activities are not known to occur in the site. The habitats are not sensitive to medium sensitivity to this pressure as they are high to moderate energy and therefore particles are unlikely to settle over the feature. Therefore, it is believed that changes bottom towed fishing gears will not significantly affect the turbidity, smothering and siltation rates of the rock features in the South of Portland MCZ and will not hinder the ability of the feature to achieve it's 'recover' general management approach (GMA). It is worth noting that in the absence of a condition assessment for the site, Natural England undertook a	

				vulnerability assessment for each feature as a proxy for condition. This assessment considers the activities which take place in the site and determines the GMA for each feature. However, such an assessment is relatively generic and does not take into a number of site-specific factors.	
Subtidal sand, subtidal mixed sediments, subtidal coarse sediments	Distribution: presence and spatial distribution of biological communities, Structure and function: presence and abundance of key structural and influential species, Structure: species composition of component communities	Not Available	Removal of non-target species, abrasion/ disturbance of the substrate on the surface of the seabed and penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion were identified as potential pressures. Bottom towed gear can lead to the removal, damage or mortality of non-target species particularly epifaunal species, reduction in structural complexity and reduction in biodiversity and composition of benthic assemblages. Studies on the impacts of trawling and dredging in gravel, mixed and sand habitats reported a reduction in abundance, biomass and species diversity, with undisturbed and lightly fished sites showing a greater abundance of epifauna. Benthic macrofauna in poorly sorted, gravelly or muddy sediments are reported to be more sensitive to trawling disturbance than well-sorted sandy sediments. The timescale for recovery after trawling and dredging disturbance largely depends on sediment type, associated fauna and rate of natural disturbance, and variation in recovery	Demersal trawling and scallop dredging are not known to occur within the South of Portland MCZ. Local fishers describe the conditions of the site to be too deep, tidal and rocky to allow for BTFG activity. No sightings of the activities have been made in the site. Outside of the site historic sightings of both dredging and trawling activities have been made. There is a lack of information surrounding the biotope and species present within the South of Portland MCZ. A species list is provided within the post-survey site report, however no information on the substrate type and certain species are found is provided, making it hard to ascertain site-specific impacts of bottom towed fishing gear (BTFG) on associated communities. The generic description of subtidal mixed sediments identifies that species associated with this habitat type live both on and in the sediment including worms, bivalves, starfish and urchins, anemones, sea firs and sea mats. The generic description of subtidal coarse sediment identifies the majority of species that live within this habitat type are infaunal including bristle worms, sand mason worms, small shrimp-like animals, burrowing anemones, carpet shell clams and *Venus* cockles. The generic description of subtidal sand found in estuaries indicates that flat fish and sand eels heart urchins, razor shells and sea cucumbers may be present.	Addressed Above

			arises from characteristics specific to the site. Generally speaking, locations subject to high levels of natural disturbance, the associated fauna are likely to be adapted to withstand and recover from disturbance.	Scientific literature generally highlights that benthic communities associated with coarse and mixed sediments (typically characterised by epifaunal species) can be vulnerable to trawling & dredging disturbance and subsequent negative changes can be observed across a number of community measures (abundance, biodiversity etc.). Fauna living within unconsolidated sediments, such as those in shallow and sandy environments, are however more adapted to dynamic environments and as such species are adapted to withstand recover from disturbance. From this, sensitivity to trawling disturbance may be inferred. Motile groups and infaunal bivalves have shown mixed responses to trawling disturbance, with habitat requirements and feeding modes influencing a species response. Experimental fishing manipulations have shown trawling impacts on annelids are limited, and in some instances may be positive, particularly with respect to polychaetes. The sand mason worm, *Lanice conchilega*, on the other hand has showed a mixed response to beam trawling on hard medium hardy-sand with large declines in the density of small individuals but increases in larger individuals. A number of studies have shown mixed impacts on echinoderms. Some studies have reported reductions in the sea star, *Asterias rubens* as well as species of sea urchin. In contrast, epifaunal biomass at heavily trawled sites is often dominated by *A. rubens*, as they are able to respond rapidly to changes in prey availability and are known to be relatively resilient from the damaging impacts of trawls. Hall et al. (2008) assessed the sensitivity of relevant habitats to a single pass of fishing gear. Stable subtidal fine sands, Stable spp. Rich mixed sediments and Unstable coarse sediments – robust fauna all have a low sensitivity to this activity level. Foden et al (2010) estimated recovery rates of similar habitats. Mixed sediment is composed of a matrix of different sediment types. Sand can recover from 0 to 2922	

				days after trawling and dredging disturbance. Muddy sand may take between 213 and 589 days to recover from bottom towed fishing gear and gravel between 365 to 2922 days. A study which looked at levels of natural disturbance in seabed habitats found that tidal bed stress is high, kinetic energy in the site is also high, and that natural forces are likely to disturb the seabed more than 17 times per year (Bolam et al., 2014). Only one record of mixed sediment has been found in the site – almost the entirety of the sediments in the site are sand or coarse. Trawling and scallop dredging do not occur within the site. The site is thought to be exposed to high natural disturbance levels. Sensitivity of the habitats to a single pass of the activities is low, but recovery times can vary considerably. Therefore, due to the current absence of fishing activity within the site, low sensitivity to a single pass and high levels of natural disturbance within the site it is believed that trawling and scallop dredging will not pose a significant risk to the features and will therefore not hinder the ability of the subtidal mixed and coarse sediments to achieve there 'restore' general management approach (GMA) and subtidal sands to achieve its 'maintain' GMA. It is worth noting that in the absence of a condition assessment for the site, Natural England undertook a vulnerability assessment for each feature as a proxy for condition. This assessment considers the activities which take place in the site and determines the GMA for each feature. However, such an assessment is relatively generic and does not take into a number of site-specific factors.	
	Distribution: presence and spatial distribution of		Removal of target species (Scallop dredging) was identified as a potential pressure.	Demersal trawling and scallop dredging are not known to occur within the South of Portland MCZ. Local fishers describe the conditions of the site to be too deep, tidal and rocky to allow for BTFG activity. No sightings of the activities have been made in the site. Outside of the site	Addressed Above

	biological communities		Commercial fishing directly removes and harvests a specific species or group of fauna. The sustainability, including the size and age composition, of the stock can be compromised if unmanaged, leading to indirect effects such as impacts to energy flows through food webs.	historic sightings of both dredging and trawling activities have been made. Scallop dredges are considered to be relatively selective with 81% of biomass caught comprising of scallops (Szostek *et al.,* 2017). Their capture efficiency however is relatively low (20%), being considerably less for small scallops (3.3%) (Chapman *et al.,* 1977). Levels of mortality in the dredge track are only 1.8% greater than natural mortality (Chapman *et al.,* 1977). Only scallops which are severely damaged may die. Of all scallops (left in dredge track and brought to surface) sever damage occurs in only 5%. Scallops which are both exposed to air or disturbed by a dredge do experience a level of stress which can inhibit their predator response and recessing behaviours (Jenkins and Brand 2201 and Maguire *et al.,* 2002). However, scallops have been found to r3ecover from this stress within 6 hours (Maguire *et al.,* 2002). Areas of the seabed protected from scallop dredging have been found to have greater numbers of scallops (Leigh *et al.,* 2014) however this has not been found in all cases (Kaiser *et al.,* 2018 and Sciberras *et al.,* 2013) where it has been found that scallop populations are driven greatly by seasonal fluctuations and habitat suitability. Scallop dredging is a closely managed fishery in England with minimum conservation reference sizes, gear configuration regulations and within the southern in IFCA district the activity is not permitted between the hours of 19:00 and 07:00. Based upon the current absence of scallop dredging occurring within the MCZ, the low efficiency of scallop dredges along with high survival rates of both scallops returned to sea or left within the dredge track, in-	

				combination with the current mitigation of management measures it is believed that dredging will not pose a significant risk to the subtidal mixed sediment and sand biological communities in the MCZ through removal of target species, and will not therefore hinder the ability of the feature to achieve their ‘recover’ and ‘maintain’ general management approach (GMA). It is worth noting that in the absence of a condition assessment for the site, Natural England undertook a vulnerability assessment for each feature as a proxy for condition. This assessment considers the activities which take place in the site and determines the GMA for each feature. However, such an assessment is relatively generic and does not take into a number of site-specific factors.	
	Structure: sediment composition and distribution Supporting processes: water quality - turbidity		Physical impacts on the seabed from trawling include scraping and ploughing, creation of depressions, trenches, scouring and flattening of the seabed, sediment resuspension and changes in the vertical distribution of sediment layers. The teeth of scallop dredges can penetrate up to 12 cm of the seabed leading to flattening of the seabed, visible teeth marks and mixing of the sediments. Studies on the effects of otter trawling and dredges in gravel and variable habitats have revealed trawling can	Demersal trawling and scallop dredging are not known to occur within the South of Portland MCZ. Local fishers describe the conditions of the site to be too deep, tidal and rocky to allow for BTFG activity. No sightings of the activities have been made in the site. Outside of the site historic sightings of both dredging and trawling activities have been made. There is a lack of information surrounding the biotope and species present within the South of Portland MCZ. A species list is provided within the post-survey site report, however no information on the substrate type and certain species are found is provided, making it hard to ascertain site-specific impacts of bottom towed fishing gear (BTFG) on associated communities.	Addressed Above

			lead to the removal of fine sediments and biogenic structures, moved or overturn stones and boulders, smooth the seafloor and exposed sediment/shell fragments. Dredges, otter boards and tickler chains can leave distinct grooves or furrows. The depth of such marks on the seafloor depend on the nature of the substrate, and are more in areas of finer sediments. Smothering and siltation rate changes (Light) and Changes in suspended solids (water clarity) were identified as potential pressures. The resuspension of sediment can impact upon benthic communities through smothering, burial and increased turbidity. These effects may extend to organisms living a distance away from the fished area. The timescale for recovery after trawling disturbance largely depends on sediment type, associated fauna and rate of natural disturbance, and variation in recovery arises from characteristics specific to the site. Generally speaking, locations subject to high levels of natural disturbance, the associated fauna are likely to be adapted to withstand and recover from disturbance.	The generic description of subtidal mixed sediments identifies that species associated with this habitat type live both on and in the sediment including worms, bivalves, starfish and urchins, anemones, sea firs and sea mats. The generic description of subtidal coarse sediment identifies the majority of species that live within this habitat type are infaunal including bristle worms, sand mason worms, small shrimp-like animals, burrowing anemones, carpet shell clams and *Venus* cockles. The generic description of subtidal sand found in estuaries indicates that flat fish and sand eels heart urchins, razor shells and sea cucumbers may be present. Research has found that high levels of sediment and regular exposure can cause sever impacts. Increased turbidity can inhibit respiratory and feeding functions of benthic organisms, and cause hypoxia or anoxia. Small organisms and immobile species are particularly vulnerable to smothering. The severity of the impact is determined by sediment type, the level of sediment burden and the sensitivity of organisms which is largely related to their biology (i.e. size, relationship to substrate, life history, mobility). Sand and coarse sediments contain very low quantities of silt/organics and therefore turbidity/smothering is unlikely to be affected. The post survey site report for coarse sediment shows an average of 2.69 % (14 records). Two records of sand in the site have 0.55 and 0.69 % silt/clay. Mixed sediments may contain patches of course, sandy and muddy sediment types and therefore fishing activity could lead to increases in turbidity over patches of muddy sediment. However, no mixed sediment polygon has been identified within the site and there is only one-point sample	

				of mixed sediment recorded within the site which contained 7.92 % silt/clay. Hall et al. (2008) assessed the sensitivity of relevant habitats to a single pass of fishing gear. Stable subtidal fine sands, Stable spp., Rich mixed sediments and Unstable coarse sediments – robust fauna all have a low sensitivity to this activity level. A study which looked at levels of natural disturbance in seabed habitats found that tidal bed stress is high, kinetic energy in the site is also high, and that natural forces are likely to disturb the seabed more than 17 times per year (Bolam et al., 2014). Only one record of mixed sediment is present within the site, with almost the entirety of the sediments are therefore subtidal sands or coarse sediments. Bottom Towed Fishing Gear Activities are not known to occur in the site. The site is thought to be exposed to high natural disturbance levels. Sensitivity of the habitats to the pressure is not sensitive to medium. Therefore, due to absence of fishing activity within the site, combined with low sensitivity of the habitats to this level, and high natural variability it is believed that trawling and scallop dredging will not pose a significant risk of increasing turbidity levels and the feature and will not therefore hinder the ability of the feature to achieve its ‘restore’ and ‘maintain’ general management approaches (GMA). It is worth noting that in the absence of a condition assessment for the site, Natural England undertook a vulnerability assessment for each feature as a proxy for condition. This assessment considers the activities which take place in the site and determines the GMA for each feature. However, such an assessment is relatively generic and does not take into a number of site-specific factors.	

5 Proposed mitigation measures

In recognition of the potential pressures of bottom towed fishing gear upon designated features and their supporting habitats, Southern IFCA recognises that management measures will need to be put in place to protect sensitive; High energy circalittoral rock and Moderate energy circalittoral rock features from the effects of all forms of bottom towed fishing gears. This is due to the result of this MCZ assessment which has found that bottom towed fishing gears are likely to pose a significant risk to the rock features of the South of Portland MCZ.

Based on the findings of the assessment, the Authority is therefore required to develop management that will provide protection to the rock features within the site from the relevant fishing gears. Spatial closures, based on the most up to date data for the location of rock features, will be introduced and incorporated into appropriate management following best practice[7]. This will involve consultation with the local community and the consideration of formal advice from the Authorities Statutory Nature Conservation Body Natural England. Existing closures will be considered against the updated data to determine the most appropriate course of action to protect the features and ensure Southern IFCA meets its responsibilities afforded by the Marine and Coastal Access Act 2009.

6 Conclusion

In order to conclude whether types of bottom towed fishing gear (trawling & dredging) pose a significant risk, it is necessary to assess whether the impacts of the activities will hinder the achievement of the general management approach of the designated feature (high energy circalittoral rock, moderate energy circalittoral rock) of restore to favourable condition' and the sites conservation objectives, namely:

"The conservation objective of each of the zones is that the protected habitats:

1. are maintained in favourable condition if they are already in favourable condition

2. be brought into favourable condition if they are not already in favourable condition

For each protected feature, favourable condition means that, within a zone:

1. its extent is stable or increasing

2. its structure and functions, its quality, and the composition of its characteristic biological communities (including diversity and abundance of species forming part or inhabiting the habitat) are sufficient to ensure that its condition remains healthy and does not deteriorate

Any temporary deterioration in condition is to be disregarded if the habitat is sufficiently healthy and resilient to enable its recovery.

[7] http://www.association-ifca.org.uk/Upload/About/ifca-byelaw-guidance.pdf

Having reviewed a wide range of evidence, including scientific literature, IFCO knowledge, habitat feature mapping, it has been concluded that bottom towed fishing gear activity as it is currently managed is not likely to pose a significant risk to subtidal sand, subtidal mixed and subtidal coarse sediments within the South of Portland MCZ. In summary, this was based upon the following evidence:

- IFCO knowledge indicates that BTFG does not currently occur within the site, but that it occurs in the bays either side and has historically occurred within close proximity.
- Sightings data shows historic sightings east and west of the site.
- Subtidal sands and coarse sediments have a low sensitivity to Bottom towed fishing gears at both a light and single pass level. Species rich mixed sediments have a low sensitivity to a single pass and a medium to low sensitivity to light fishing activity, however there is only one record of mixed sediments in the site. The site is dominated by subtidal sand and coarse sediments.
- A study which looked at levels of natural disturbance in seabed habitats found that in the site tidal bed stress is high, kinetic energy in the site is also high, and that natural forces are likely to disturb the seabed more than 17 times per year. Therefore, the site is exposed to high levels of natural disturbance.
- Recoverability of sediments can vary greatly from 0 days to several years' dependant upon the scale, intensity and level of impact.

Having reviewed a wide range of evidence, including scientific literature, IFCO knowledge, habitat feature mapping, it has been concluded that bottom towed fishing gear activity as it is currently managed is likely to pose a significant risk to high and moderate energy circalittoral rock within the South of Portland MCZ. In summary, this was based upon the following evidence:

- IFCO knowledge indicates that BTFG does not currently occur within the site, but that it occurs in the bays either side and has historically occurred within close proximity.
- Sightings data shows historic sightings east and west of the site.
- A review of scientific literature demonstrated that bottom towed fishing gear at any intensity can lead to the direct removal, damage and mortality of the associate's species and communities found on rock habitats. BTFG can drag boulders, cobbles, species and biogenic structures.
- Sensitivity of rock habitats to pressures associated with trawls is medium to high.
- Rock associated species can take 3 to 20 years to recover.

It was determined that the potential for fishing activity to occur over or in close proximity to the features of the site could prevent the ability of subtidal rock habitats to attain their 'recover' general management approach. It is therefore recognised that the activities have the potential to pose a significant risk upon the rock feature attributes:

- Distribution: presence and spatial distribution of biological communities
- Structure and function: presence and abundance of key structural and influential species
- Structure: species composition of component communities
- Structure: physical structure of rocky substrate

In recognition that the rock features will be at risk from BTFG activity, additional management measures are required to ensure the MCZs conservation objectives can be furthered. The location, timing, duration and intensity of bottom towed fishing gear within the site will be influenced by new management measures being developed, which will protect the sensitive features (high and moderate energy circalittoral rock) by prohibiting all BTFG activities over the feature. This is to support the general management approach of the features discussed at a favourable condition.

When the above evidence, fishing activity levels, current, and proposed management measures are considered it has been concluded that bottom towed fishing gear will <u>not</u> pose a significant risk to the achievement of sites conservation objectives to ‘restore’ high and moderate energy circalittoral rock to favourable condition, nor to subtidal coarse and mixed sediments to favourable condition, or ‘maintain’ subtidal sand at favourable condition.

Fishing activity will continue to be monitored.

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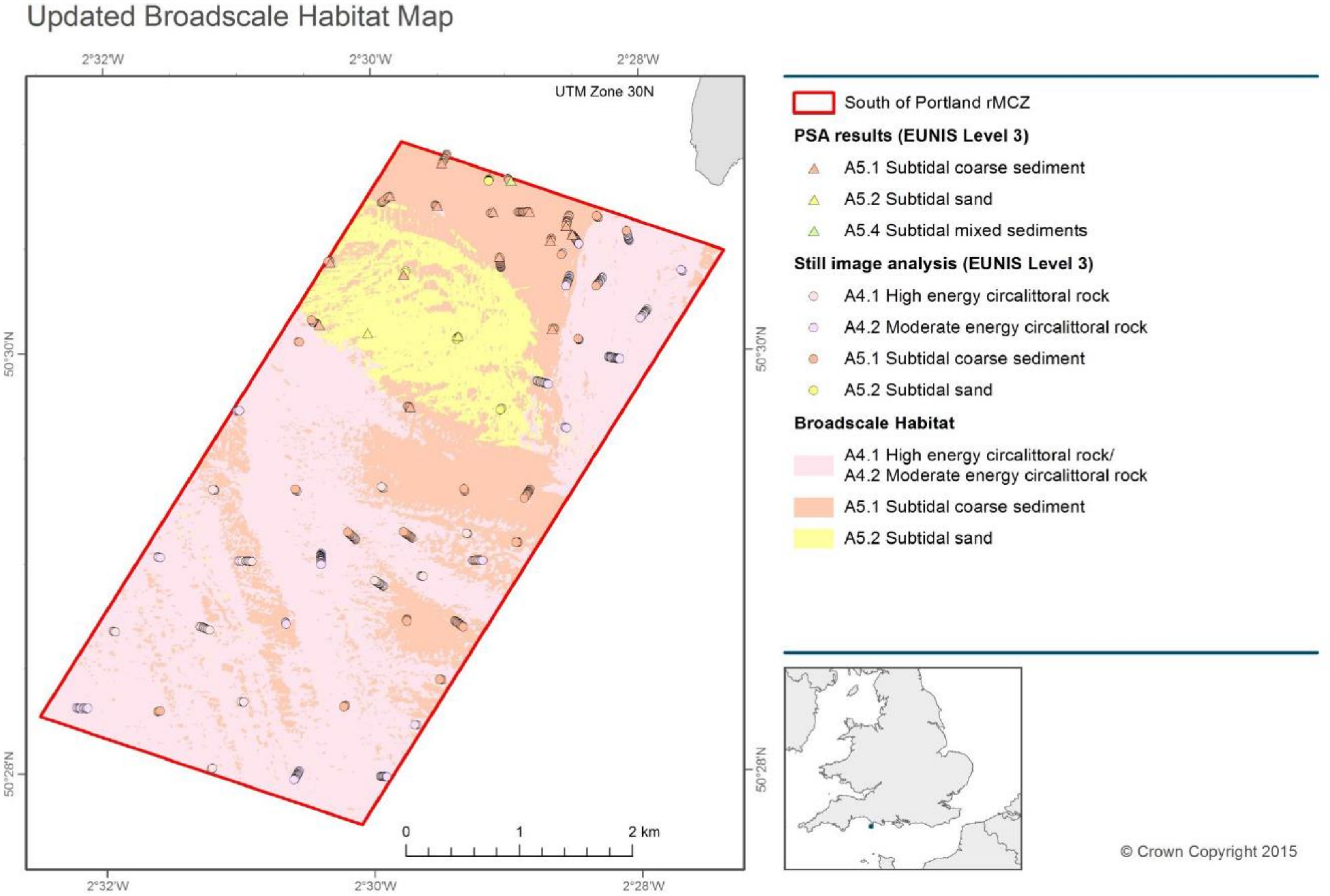
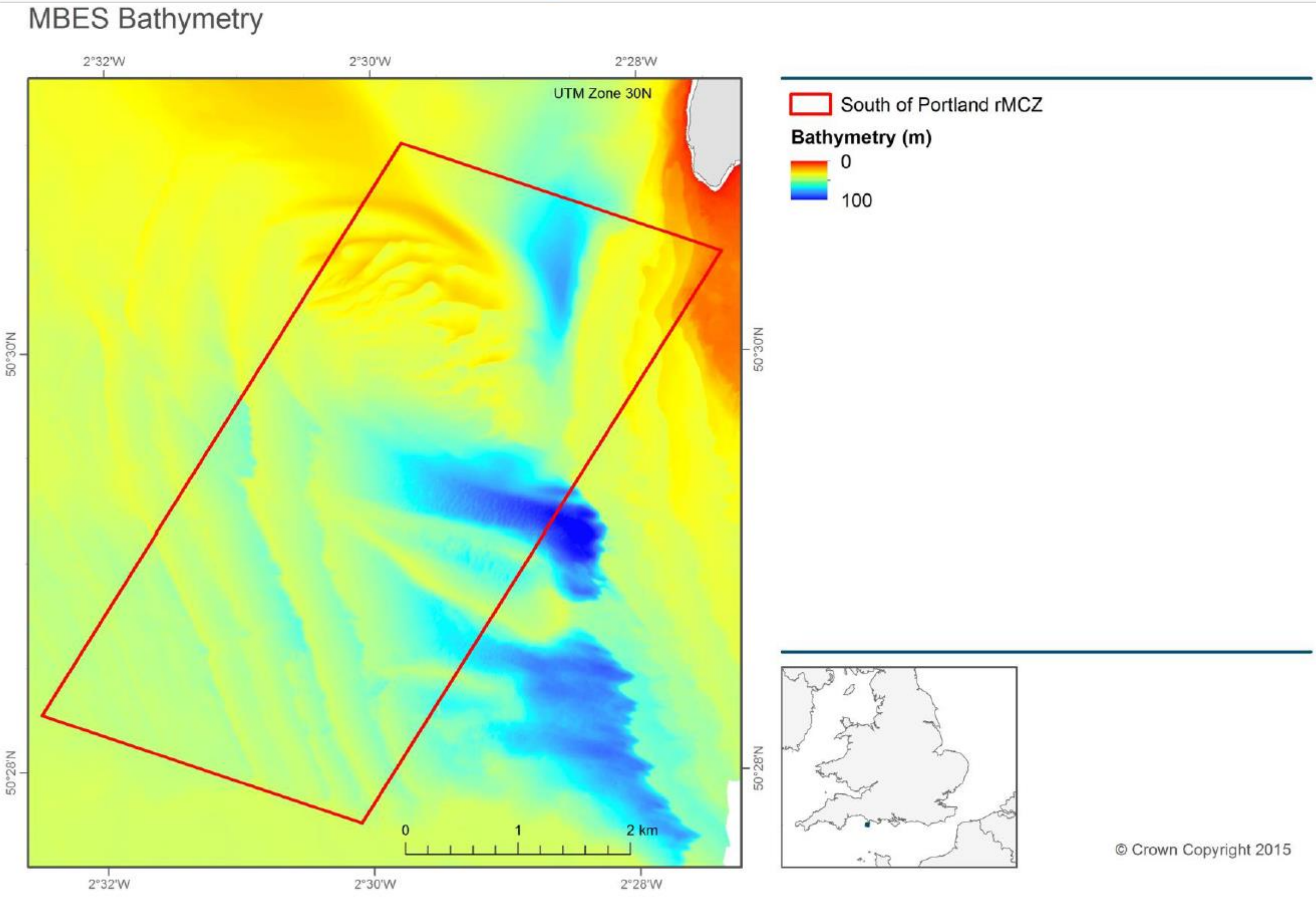
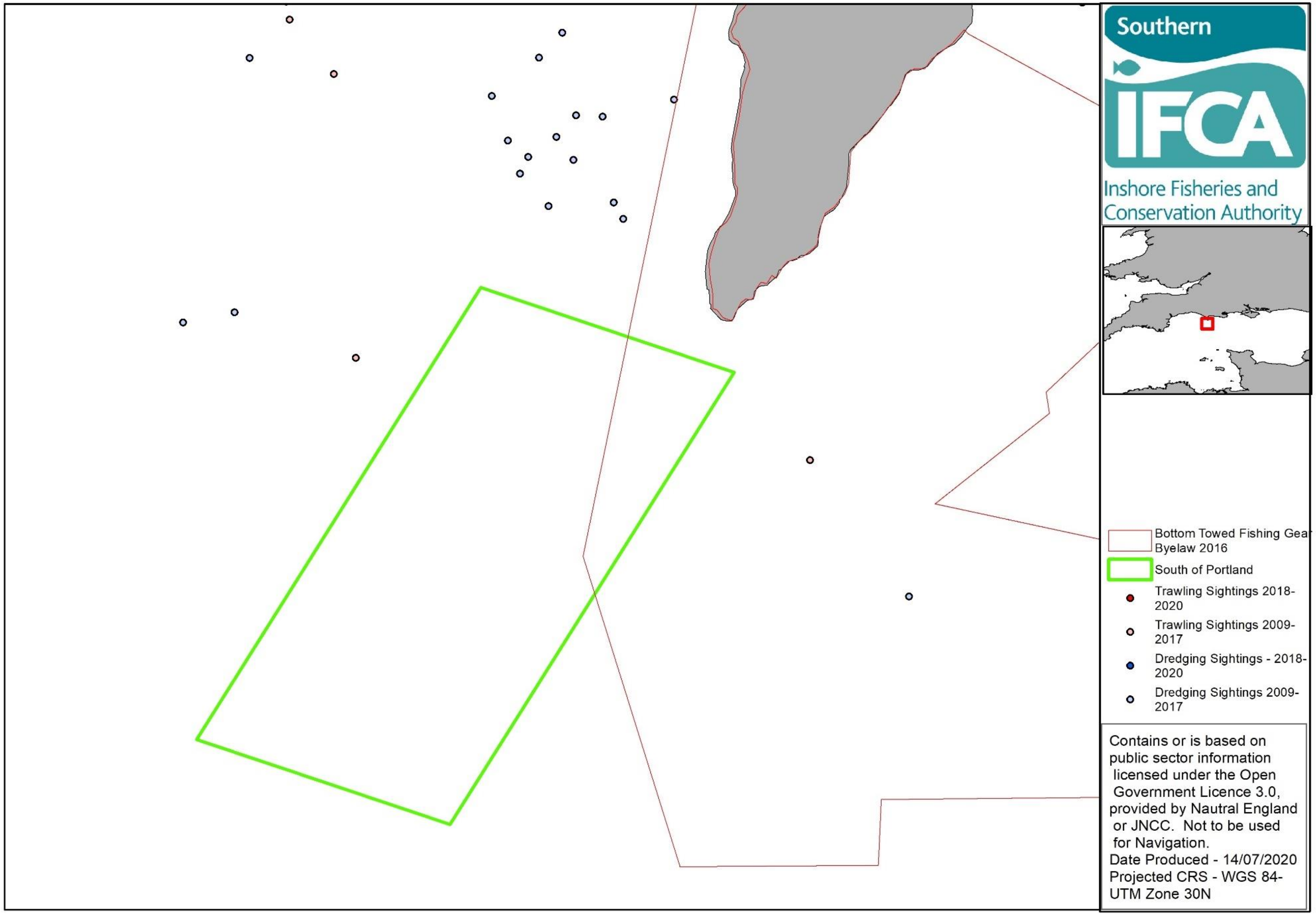
Annex 1. Map of broadscale habitats in the South of Portland MCZ (Taken from the Post-survey site report 2016).



Annex 2. Map of bathometry for South of Portland MCZ (Taken from the post-survey site report 2016).



Annex 3. Map of South of Portland MCZ with Bottom Towed Fishing Gear Byelaw and fishing activity sightings data (2009-2020).



Annex 4 Advice on operations for trawling and dredging activities in the Needles MCZ and Chesil Beach and Stennis Ledges MCZ.

The Needles - Trawling

Pressure Name	Habitat										Species		
	High energy infralittoral rock	Moderate energy infralittoral rock	Seagrass beds	Sheltered muddy gravels	Subtidal chalk	Subtidal coarse sediment	Subtidal mixed sediments	Subtidal mud	Subtidal sand	Moderate energy circalittoral rock	Native oyster	Peacock's tail	Stalked jellyfish (Calvadosia campanulata)
Abrasion/disturbance of the substrate on the surface of the seabed	S	S	S	S	S	S	S	S	S	S	S	S	S
Changes in suspended solids (water clarity)	S	S	S	S	S	S	S	S	S	S	S	NS	S
Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion		S	S	S	S	S	S	S	S	S	S		S
Removal of non-target species	S	S	S	S	S	S	S	S	S	S	S	S	S
Smothering and siltation rate changes (Light)	NS	S	S	S	S	IE	S	S	S	S	S	S	S
Deoxygenation	IE	S	NS	S	IE	S	S	S	S	S	NS	NS	IE
Hydrocarbon & PAH contamination	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Introduction of light	S	S	S	IE	S	IE	IE	NS	S	IE	NS	NS	IE

Introduction or spread of invasive non-indigenous species (INIS)	S	S	S	S	S	IE	S	S	S	S	S	IE	IE
Litter	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nutrient enrichment	S	NS	S	NS	NS	NS	NS	NS	NS	NS	NS	NS	S
Organic enrichment	S	S	S	S	NS	S	S	S	S	S	IE	NS	S
Physical change (to another seabed type)	S	S		S						S	S	S	S
Physical change (to another sediment type)			S		S	S	S	S	S		NS		S
Synthetic compound contamination (incl. pesticides, antifoulants, pharmaceuticals)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Transition elements & organo-metal (e.g. TBT) contamination	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Underwater noise changes							NS	NS	NS	NS			
Visual disturbance		NS			NS		NS	NS	NS	NS			

The Needles - Dredging

	Habitat										Species		
Pressure name	**High energy infralittoral rock**	**Moderate energy infralittoral rock**	**Seagrass beds**	**Sheltered muddy gravels**	**Subtidal chalk**	**Subtidal coarse sediment**	**Subtidal mixed sediments**	**Subtidal mud**	**Subtidal sand**	**Moderate energy circalittoral rock**	**Native oyster**	**Peacock's tail**	**Stalked jellyfish (Calvadosia campanulata)**

Abrasion/disturbance of the substrate on the surface of the seabed	S	S	S	S	S	S	S	S	S	S	S	S	S
Changes in suspended solids (water clarity)	S	S	S	S	S	S	S	S	S	S	S	NS	S
Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion		S	S	S	S	S	S	S	S	S	S		S
Removal of non-target species	S	S	S	S	S	S	S	S	S	S	S	S	S
Removal of target species	S	S	S		S	NS	S	S	S	S	S		
Smothering and siltation rate changes (Light)	NS	S	S	S	S	IE	S	S	S	S	S	S	S
Visual disturbance		NS			NS		NS	NS	NS	NS			
Deoxygenation	IE	S	NS	S	IE	S	S	S	S	S	NS	NS	IE
Hydrocarbon & PAH contamination	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Introduction of light	S	S	S	IE	S	IE	IE	NS	S	IE	NS	NS	IE
Introduction of microbial pathogens	S	S	S	S	NS	IE	S	S	S	S	S	IE	IE
Introduction or spread of invasive non-indigenous species (INIS)	S	S	S	S	S	IE	S	S	S	S	S	IE	IE
Litter	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nutrient enrichment	S	NS	S	NS	NS	NS	NS	NS	NS	NS	NS	NS	S
Organic enrichment	S	S	S	S	NS	S	S	S	S	S	IE	NS	S

Physical change (to another seabed type)	S	S		S						S	S	S	S
Physical change (to another sediment type)			S		S	S	S	S	S		NS		S
Synthetic compound contamination (incl. pesticides, antifoulants, pharmaceuticals)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Transition elements & organo-metal (e.g. TBT) contamination	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Underwater noise changes							NS	NS	NS	NS			

Chesil Beach and Stennis Ledges - Trawling

	Habitat							Species	
Pressure name	**High energy intertidal rock**	**Intertidal coarse sediment**	**High energy infralittoral rock**	**Subtidal coarse sediment**	**Subtidal mixed sediments**	**Subtidal sand**	**High energy circalittoral rock**	**Native oyster**	**Pink sea-fan**
Abrasion/disturbance of the substrate on the surface of the seabed		NS	S	S	S	S	S	S	S
Changes in suspended solids (water clarity)		NS	S	S	S	S	S	S	NS
Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion		NS		S	S	S	S	S	
Removal of non-target species			S	S	S	S	S	S	S
Smothering and siltation rate changes (Light)		NS	NS	S	S	S	S	S	NS
Deoxygenation		NS	IE	S	S	S	S	NS	S
Hydrocarbon & PAH contamination		NA	NA	NA	NA	NA	NA	NA	NA

Introduction of light			S	IE	IE	S	NS	NS	
Introduction or spread of invasive non-indigenous species (INIS)			S	S	S	S	IE	S	S
Litter		NA	NA	NA	NA	NA	NA	NA	NA
Nutrient enrichment		NS	S	NS	NS	NS	NS	NS	NS
Organic enrichment		NS	S	S	S	S	S	IE	IE
Physical change (to another seabed type)			S				S	S	S
Physical change (to another sediment type)		S		S	S	S		NS	
Synthetic compound contamination (incl. pesticides, antifoulants, pharmaceuticals)		NA	NA	NA	NA	NA	NA	NA	NA
Transition elements & organo-metal (e.g. TBT) contamination		NA	NA	NA	NA	NA	NA	NA	NA
Underwater noise changes					NS	NS	NS		
Visual disturbance					NS	NS			

Chesil Beach and Stennis Ledges - Dredgling

Pressure name	Habitat							Species	
	High energy intertidal rock	Intertidal coarse sediment	High energy infralittoral rock	Subtidal coarse sediment	Subtidal mixed sediments	Subtidal sand	High energy circalittoral rock	Native oyster	Pink sea-fan
Abrasion/disturbance of the substrate on the surface of the seabed		NS	S	S	S	S	S	S	S
Changes in suspended solids (water clarity)		NS	S	S	S	S	S	S	NS
Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion		NS		S	S	S	S	S	
Removal of non-target species			S	S	S	S	S	S	S

Removal of target species			S	NS	S	S	S	S	
Smothering and siltation rate changes (Light)		NS	NS	S	S	S	S	S	NS
Visual disturbance					NS	NS			
Deoxygenation		NS	IE	S	S	S	S	NS	S
Hydrocarbon & PAH contamination		NA	NA	NA	NA	NA	NA	NA	NA
Introduction of light			S	IE	IE	S	NS	NS	
Introduction of microbial pathogens			S	IE	S	S	S	S	S
Introduction or spread of invasive non-indigenous species (INIS)			S	S	S	S	IE	S	S
Litter		NA	NA	NA	NA	NA	NA	NA	NA
Nutrient enrichment		NS	S	NS	NS	NS	NS	NS	NS
Organic enrichment		NS	S	S	S	S	S	IE	IE
Physical change (to another seabed type)			S				S	S	S
Physical change (to another sediment type)		S		S	S	S		NS	
Synthetic compound contamination (incl. pesticides, antifoulants, pharmaceuticals)		NA	NA	NA	NA	NA	NA	NA	NA
Transition elements & organo-metal (e.g. TBT) contamination		NA	NA	NA	NA	NA	NA	NA	NA
Underwater noise changes					NS	NS	NS		