Document Control

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Southern Inshore Fisheries and Conservation Authority (IFCA)
Marine Conservation Zone Fisheries Assessment (Part B)

Marine Conservation Zone: Studland Bay MCZ

Feature: Seagrass Beds

Broad Gear Type: Intertidal Handwork / Miscellaneous / Bait collection

Gear type(s) Assessed: Hand Work (access from land) / Digging with Forks

Technical Summary

As part of the MCZ assessment process for the tranche three Studland Bay MCZ, it was identified that Hand gathering (specifically hand work/ digging with forks/prawn push netting) and their potential impacts required an in-depth assessment. Hand work in the site is low, with the activity thought to occur approximately 3-4 times a month. Southern IFCA was made aware that a Marine Management Organisation call for information returned information regarding prawn netting in the bay. No further details were available.

The potential pressures likely to be exerted by the activities upon designated features were identified as abrasion, disturbance and penetration of the seabed below and on the surface, Habitat structure changes - removal of substratum (extraction) and, the removal of non-target and target species.

Scientific literature shows that hand work/ digging and trampling activity lead to the direct removal and burial of the substratum, mortality of target and non-target species and sediment structure changes. There is some variability in the level of the impact depending on the activity type, scale and method.

When considering that the activity occurs within the Studland Bay MCZ at a light level, in combination with other evidence (scientific literature, sightings data, feature mapping) it was found that the activities were likely to pose a significant risk to the seagrass beds feature. Therefore, current management is not considered sufficient to protect seagrass beds from hand work/digging and prawn netting activity. This was concluded due to knowledge that the activities do occur within the site and, that literature shows that the occurrence of the activities within seagrass beds can lead to the feature’s immediate removal. Prawn netting whilst likely to have less sever impacts and unlikely to lead to immediate removal, does have the possibility to lead to trampling affects which have been shown to reduce seagrass density. Therefore, additional management which prohibits the activities from taking place within seagrass beds will be produced.

As such, when current and proposed management are considered, it is concluded that the activities will not hinder the achievement of the designated features ‘recover’ general management approach and that the activities will be compatible with the site’s conservation objectives. Existing and proposed management measures are therefore considered sufficient to ensure that hand work/ digging with forks/ prawn netting will remain consistent with the conservation 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 Studland Bay 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.

This MCZ assessment will complement 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 a new approach to manage fishing activities within EMSs. This change in approach will promote sustainable fisheries while conserving the marine environment and resources, securing a sustainable future for both.

1.1 Documents reviewed to inform this assessment

- Reference list (Section 8)
- Defra's matrix of fisheries gear types and European Marine Site protected features[1]
- Site map(s) – feature location and extent (Annex 1)
- Natural England's Advice on Operations for The Needles MCZ[2]
- Fishing activity data (map(s), etc) (Annex 5)
- Fisheries Impact Evidence Database (FIED)

2 Information about the MCZ

2.1 Overview and designated features

Studland Bay MCZ was designated in May 2019 and covers the bay between Old Harry rocks, Studland Bay and the entrance to Poole Harbour. The site covers an area of approximately 4 km^2 and protects intertidal coarse sediment, seagrass beds and subtidal sand, which supports a range of communities including worms, crustaceans and molluscs. The site also protects the species the long-snouted seahorse (*Hippocampus guttulatus*).

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

[2] https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UKMCZ0040&SiteName=the%20needles&SiteNameDisplay=The%20Needles%20MCZ&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=&HasCA=1

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.

Table 1. Designated features and General Management Approach

Designated Feature	General management approach
Intertidal coarse sediment	Maintain in favourable condition
Subtidal Sand	Maintain in favourable condition
Long-snouted seahorse (*Hippocampus guttulatus*)	Recover to favourable condition
Seagrass beds	Recover to favourable condition

Please refer to Annex 1 for site feature maps of broad-scale habitats and features of conservation importance. This feature data comes from the Natural England, 2019 data set given to Southern IFCA, containing a collation of marine habitat and species records that contribute to the designation of marine habitats and features. This corresponds with the feature data on Magic Map which represents Natural England's best available evidence (https://magic.defra.gov.uk/MagicMap.aspx).

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 Bay MCZ will be undertaken using a staged process, akin to that proposed by the Marine Management Organisation (MMO)[3], for marine license applications (Annex 2). 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 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 Studland Bay 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 Studland Bay 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).

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

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

3.3 Screening of commercial fishing activities based on occurrence

Initial screening was undertaken to identify the commercial fishing activities which currently occur within the site, together with those which have the potential to occur or/and are reasonably foreseen to occur in the future (Annex 3). To maintain consistency with Southern IFCA's assessment of commercial fishing activities in European Marine Sites, the individual gear types identified in Defra's matrix were assessed and these were grouped into broad gear types.

3.4 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 4) and Supplementary Advice for The Needles 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 Studland Bay 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 Needles MCZs used is provided in Annex 4. The resultant activity pressure-feature interactions which have been screened in for Hand Work for the part B assessment are summarised in Table 2 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 The Studland Bay MCZ.

Table 2. Summary of fishing pressure-feature screening for Seagrass beds and intertidal handwork/ digging with forks. Please note only pressures screened in for the part B assessment are presented here.

Potential Pressures	Sensitivity	Part B Required?	Justification	Relevant Attributes
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 spatial scale/intensity of the activity and location of the activity in relation to the feature.	Distribution: presence and spatial distribution of biological communities; Extent and distribution; Extent of supporting habitat; Structure and function: presence and abundance of key structural and influential species; Structure: biomass; Structure: rhizome structure and reproduction; Structure: sediment composition and distribution; Structure: species composition of component communities

Habitat structure changes - removal of substratum (extraction)	S	Y	This gear type is known to cause abrasion and disturbance to the seabed surface which causes habitat structure changes. Further investigation is needed on the magnitude of the pressure including spatial scale/intensity of the activity and location of the activity in relation to the feature.	Extent and distribution; Extent of supporting habitat; Structure: biomass; Structure: rhizome structure and reproduction; Structure: sediment composition and distribution;
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 surface. Further investigation is needed on the magnitude of the pressure including spatial scale/intensity of the activity and location of the activity in relation to the feature.	Distribution: presence and spatial distribution of biological communities; Extent and distribution; Extent of supporting habitat; Structure and function: presence and abundance of key structural and influential species; Structure: biomass; Structure: rhizome structure and reproduction; Structure: sediment composition and distribution; Structure: species composition of component communities
Removal of non-target species	S	Y	Impacts on the feature and associated community may occur through the removal of the feature itself through digging with forks or by trampling of the feature. There is no site-specific information on the communities associated with this feature as it is newly designated. General information on the designated features from the MCZ features catalogue. Seagrass beds provide nursery habitat for young fish and shellfish, as well as sheltered home for other animals such as pipefish and seahorses. 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; Structure and function: presence and abundance of key structural and influential species; Structure: species composition of component communities
Removal of target species	S	Y	Impacts on the feature and associated community may occur through the removal of the feature itself through digging with forks or by trampling of the feature. The removal of ragworm, bivalves or crab could also lead to impacts on the feature. There is no site-specific information on the communities associated with this feature as it is newly designated.	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

			General information on the designated features from the MCZ features catalogue. Seagrass beds provide nursery habitat for young fish and shellfish, as well as sheltered home for other animals such as pipefish and seahorses. Further investigation is needed as to the magnitude of disturbance to associated communities/species and location of the activity in relation to the feature.	

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. No Supplementary Advice is currently available for Studland Bay MCZ, therefore after relevant pressures were identified from the pressure-feature interaction screening (part A assessment), suitable attributes were identified from existing Natural England's Supplementary Advice packages for the Needles MCZ. These are outlined in Table 2.

4.1 Assessment of Trawling and Dredging in the Studland Bay MCZ

4.1.1 Summary of the Fishery

Hand work can take place all year around in the area of the Studland Bay MCZ. The level of activity is however believed to be low. Target species can include the common cockle, ragworm and lugworm.

4.1.2 Technical gear specifications

4.1.3 Hand Work (Access from Land) / Digging with Forks

Hand work and digging with forks refer to the more commonly named hand gathering fishing method. People access the intertidal zone from the shore by foot and collect shellfish and bait by hand. The activity is carried out both commercially and recreationally. Some species can be easily found by looking for their syphon holes or casts in the sand, and then simply grabbing the animal out of the sand with the hand. Other species such as lug and ragworm are more often collected using a fork or spade instrument, which is placed in the sediment and used to lift a section of sediment, from which the worms are removed. Forks can vary in size from large garden instruments to small hand-held forks.

Figure 1. Man digging for bait with a spade © Adams K.

4.1.4 Prawn push netting

Prawn push netting is a recreational activity where a person pushes a small (approx. 1 x 0.5m) net along the seabed in an area where prawns are known to be. The net skims the surface of the sediment collecting the prawns (*Palaemon spp.)* in the back of the net

Figure 2 Shrimp/prawn push netting ©North Western IFCA

4.1.5 Location, Effort and Scale of fishing activity

The effort and scale of the activity is not well known in Studland Bay, particularly on South Beach where much of the seagrass beds are present. Seagrass beds are predominantly found subtidally, although, on very low tides, the fringes of the beds are exposed. However, evidence from historic aerial imagery suggests that the beds may be migrating very slowly towards the intertidal.

Observations of the activity suggest it occurs only at a very low level. Parking and access to South beach is a 300m walk through woodland. On Middle and Knoll Beach where access can be gained directly from a car park, bait collection activity has been observed at a very light level, of up to 4 instances a month by single individuals in the summer. None have been witnessed using large forks/rake equipment, however they are likely to use smaller hand-held digging equipment. However, hand gathering activity has not been witnessed within the seagrass beds.

Data on the location of the Studland Bay seagrass beds provided by Natural England shows that the beds are predominantly below Mean Low Water.

Since this assessment has been written Southern IFCA has been made aware that a Marine Management Organisation call for information regarding the Studland Bay MCZ was submitted information relating to netting for prawns in the MCZ (Perrs. comms R Morgan). It is not known at what scale, location or intensity the activity may occur not is it understood what gear type is used.

4.2 Seagrass Beds – *Zostera marina*

Z. marina is a salt water flowering plant which resembles terrestrial grass in appearance. It grows seasonally (spring and summer) governed by environmental parameters such as light, nutrients and temperature. Optimum growth temperature is between 10 and 20°C (Nejrup and Pedersen, 2008). Shoots of *Z. marina* are anchored into the sediment via a network of horizontal rhizomes and roots. These rhizomes produce a mat which expands horizontally and can produce further shoots.

Seagrass beds are considered to be one of the most productive of shallow sedimentary marine habitats. The complex nature of the shoots, rhizomes and roots provides habitat for a wide range of flora and fauna. The leaves and shoots themselves provide substrate for algae and anemones, whilst the space between shoots provide nursery habitat for a range of fish (including seahorses), crustaceans, amphipods and cephalopods (Davison and Hughes, 1998).

Seagrass in Studland bay is spread throughout the bay with the largest beds along the sheltered southern half, with smaller patches in the northern areas. The site is known to support immature commercial species including pollack, wrasse, cuttlefish and the common cockle as well as many other crustaceans, molluscs, polychaetes and cnidaria (Seastar Survey, 2012).

4.3 Pressures

4.3.1 Abrasion/disturbance of the substrate on the surface of the seabed / Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion / Habitat structure changes - removal of substratum (extraction)

Abrasion and disturbance are generally related to the direct and physical effects of handwork activity including digging and trampling. Such impacts include the creation of basins and mounds, burial and removal of the substratum, sediment disturbance, changes in vertical distribution of sediment layers and changes in the properties of the sediment (McLusky *et al.,* 1983; Travaille *et al.,* 2015; Watson *et al.,* 2017).

Sedimentary effects

Turning over the sediment leads to the loss of finer sediment and associated organic content (Watson *et al.,* 2017). A study in Portsmouth Harbour on the South Coast of England, found that areas which had not been disturbed by bait collectors, contained higher levels of organic contents within the sediments (Watson *et al.,* 2017). The fine sediments and organic matter are washed away by tides and waves (Watson *et al.,* 2017). The effects of this could have wider implications, leading to increased turbidity, pollutants within the water column and potential eutrophication (Watson *et al.,* 2017).

Comparison of carbon and nitrogen levels in mounds and basins left by diggers has found that 29 days after digging enhanced C and N levels are found in dug basins (McLusky *et al.,* 1983). In mounds, C and N are suppressed for more than 50 days.

Dug areas develop a black sulphide area much shallower at just 3.4cm than in control plots where the layer was at 50cm (Wynberg & Branch (1994). Furthermore, chlorophyll levels in a dug site can be significantly higher for one to two months after digging, although chlorophyll can return to that of control levels within four months (Wynberg & Branch, 1994). Contrary to this Wynberg & Branch (1997) found the act of trampling alone led to decreases in sediment chlorophyll content.

Hand work in seagrass beds

Access to seagrass beds by hand workers results in trampling of the substratum as individuals and groups walk over the sediment surface. The higher the activity level the worse the effects of the trampling might be (Eckrich & Holmquist, 2000). Intensive trampling from tourist visitors over *Zostera marina* beds, resulted in a significant reduction of seagrass cover (Travaille *et al.,* 2015). Seagrass (*Thalassia testudinum)* biomass directly relates to trampling intensity and duration (Eckrich & Holmquist, 2000; Major *et al.,* 2004). As well as trampling intensity, the substrate type plays an important role in the severity of trampling impacts to seagrass beds; with softer substrates more vulnerable to significant biomass reductions (Eckrich & Holmquist, 2000). Different types of foot wear can also lead significant effect levels (Major *et al.,* 2004).

The effects of digging can be seen throughout both the infauna and epifauna found within seagrass habitats. The action of digging removes, uproots & buries seagrass shoots and rhizomes (Barañano *et al.,* 2018). Digging for clams in *Z. marina* reduced eelgrass cover, shoot density and above and below ground biomass (Boese, 2002; Barañano *et al.,* 2018). Similarly, in *Zostera noltii*, clam harvesting decreased shoot density (Alexandre *et al.,* 2005).

Seagrass (*Z. noltii*) is highly sensitive to burial at just 2-16cm depth (Cabaço & Santos, 2007). Burial leads to the reduction of leaf and rhizome carbon and starch content, as well as death of shoots, and reductions in leaf and sheath lengths (Cabaço & Santos, 2007).

Within the sediments, digging changes the chemical properties. The sedimentary carbon stock of *Z. marina* beds is reduced by 50 percent in clam harvested areas, reflecting similar levels to those found in unvegetated areas (Barañano *et al.,* 2018). However, low intensity digging in *Z. noltii* beds in Portugal did not cause significant changes in sediment variables or photosynthetic efficiency (Branco *et al.,* 2018).

Recovery of seagrass

Seagrass species can respond in a number of ways to hand work activity. In response to disturbance seagrass beds often increase their reproductive effort (Cabaço & Santos, 2012). Mechanical disturbances such as clam harvesting have resulted in a nine and four-fold increase in plant reproductive effort (Cabaço & Santos, 2012; Alexandre et al., 2005; Suonan *et al.,* 2017). Reproductive effort is a measure of parameters such as; the number of flowering shoots, the number of spathes per flowering shoot and flowering period (Alexandre et al., 2005; Suonan *et al.,* 2017; Park *et al.,* 2011). However, the response of reproductive effort is species specific, with a strong positive correlation apparent between rhizome diameter and increased reproductive effort (Cabaço & Santos, 2012). The correlation indicates that species with a higher storage capacity *(Z. marina)* have a higher capacity of investing in sexual reproduction (Cabaço & Santos, 2012). Those with lower storage capacity such as *Z. noltii* may not be able to recover through reproduction (Cabaço & Santos, 2012).

On the other hand, research has found that seedlings do not contribute to the recovery of *Z. marina* and therefore increased reproductive effort my not be an effective recovery strategy (Qin *et al.,* 2016). When shoots and rhizomes were removed/buried by clam harvesting in China, seedlings were observed almost as soon as the disturbance had ceased. However, seedlings in both a disturbed and control areas did not survive the following winter, unlike the perennial beds in the control site (Qin *et al.,* 2016).

Recovery time varies considerably between species and location. Boese *et al.,* (2009) stimulated disturbance to a *Z. marina* bed by removing the shoots. Disturbed areas recovered through the growth of rhizomes from perennial seagrass beds. Recovery of an area disturbed within a well-established seagrass bed took 24 months, however in a disturbed area located in the transition zone of seagrass beds (where the bed ends and bare sediment begins) seagrass took 32 months to recover (Boese *et al.,* 2009). The estimated rhizome growth rate was 0.5m per year. Meanwhile *Zoster noltii* has been found to take approximately five years to recover in Wales, although there is strong variability in seagrass beds from year to year (Bertelli *et al.,* 2018).

Zostera japonica in Korea can recover from clam harvesting vehicles within 5 months of the immediate elimination of shoots (Park *et al.,* 2011). Post recovery the bed had higher above and below ground biomass and rhizome internode length than the control (Park *et al.,* 2011).

Where seagrass declines the habitat can be recolonised by other species. However, research has shown that *A. marina* may colonize a declining seagrass bed and the presence of the annelid prevented the recovery of the *Z. marina.* Sediment reworking by the worm led to rapid burial of eelgrass seeds below critical depth where they could not develop (Valdemarsen *et al.,* 2011).

4.3.2 Removal of non-target species / Removal of target species

Target Species

Hand work activity directly targets and removes bivalve and annelid species from within the substrate. The activity by which this is achieved e.g. digging/hand picking can also lead to the removal of non-target species through indirect mortality, damage and disturbance (Jackson & James, 1979; Dernie *et al.,* 2003; Rossi *et al.,* 2007).

When diggers are actively searching for bait, larger annelids are collected more easily and therefore in greater number (Blake, 1979a; 1979b). Blake (1979a, b) calculated that the amount of time available to a single digger during an individual tide is relatively small (90 minutes), however in this time an experienced digger can turn over roughly 200 m^2 of sediment. Heiligenberg (1987) estimated this to be much lower at only 50 m^2 per tide.

In Whitley Bay, Northumberland, Blake (1979a) estimated that bait diggers in this region removed 7.8% of the target species, lugworm (*Arenicola marina),* population. However, on the Black Middens, the Tyne Estuary diggers here were estimated to remove 23% of the target species, ragworm (*Neris virens),* population. However, numbers of diggers were higher. Heiligenberg (1987) found that diggers removed about half the population of *A. marina* in the Dutch Wadden Sea.

De Cubber *et al. (*2018) studied the carrying capacity of French sandy shores for lugworm (*A. marina*) collection at four sites. In one site removal of the population at approximately 14% was considered to be above the carrying capacity of the beach. At the other three locations removal was between only 3.6 and 0.9 percent of the populations.

Within an area the population of those target species removed will respond to the disturbance. Watson *et al.,* (2007) found that sites which had been dug, had significantly higher densities of the target species *N. virens*, however those individuals that were present showed a significantly lower mean weight. Indicating that immature individuals migrate to an area from which larger worms have been removed.

Non- target species

Whilst digging leads to the direct removal of target species such as worms for bait, impacts can also be seen in the wider sediment community. Macrofaunal biomass is significantly reduced after digging (Wynberg & Branch, 1994) although this is not always the case (Wynberg & Branch, 1997). Digging to 10 and 20 cm depth, where sediment was removed from the area, led to immediate declines in total abundance and species richness (Dernie *et al.,* 2003).

Effects on macrofauna are also species specific. Just 11 days after digging in Norfolk, mortality had occurred in 85% of cockles (*Cerastoderma edule*) (Jackson & James 1979). The effect is greater on juvenille cockles, and laboratory experiments suggest that burial of cockles beneath the depth at which they can regain their near surface positions, leads to mortality (Jackson & James, 1979). Heiligenberg (1987) and Kaiser *et al.* (2001) also found a significant effect of digging/hand raking on cockles.

Other species can be negatively impacted by digging for *A. marina* and *N. virens*. Heiligenberg (1987) found that digging negatively affected populations of *Scoloplos armiger*, *Heteromastus*, and *Macoma baltica*. The density of polychaetes (such as *Heteromastus filiformis*, *Streblospio benedicti and Tharyx acutus)* and total number of taxa can be significantly reduced by digging (Brown, 1997; Wynberg & Branch 1994). On the other hand, oligochaetes are not affected by the activity (Brown, 1997). The frequency of the activity does not appear to have an effect (Brown, 1997).

On the other hand, Gastropods, such as *Peringia (formally Hydrobia) ulvae*, have been found to be positively affected by the presence of disturbance including digging (Carvalho *et al.,* 2013; Watson *et al.,* 2007).

Many studies have found that meiofauna exhibit a different response to disturbance than macrofauna. Some meiofauna show very little, or short-term effects of disturbance, whilst others can utilise increases in resources and benefit from disturbance (Wynberg & Branch 1994; Sherman *et al.,* 1980; Wynberg & Branch, 1997; Johnson *et al.,* 2007). Turbellarians significantly increased after digging and remained above control levels for 35 days (Wynberg & Branch, 1994). However, copepods and polychaetes were significantly reduced immediately after digging, and whilst numbers did bounce back approximately 10 days after the disturbance, they did not return to control levels for more than 70 days (Wynberg & Branch, 1994).

The process of digging for bait, namely *A. marina* leads to the creation of pits and mounds of sediment (McLusky *et al.,* 1983). The effect on fauna can vary between these artificial habitats. In mounds *Macoma balthica* numbers were double control levels for 11 days after digging, but then fell back to the very low levels of the basins from day 15 onwards.

Experimental digging in Spain and Portugal has found that the effects are correlated to the sediment type. Dug areas with the highest mud content, and microbenthic assemblages dominated by only a few species were most greatly affected and had not recovered after 7 days (Carvalho *et al.,* 2013).

However, the depth to which sediment is turned over or removed does not appear to play a significant role in the effect on benthic community parameters (Dernie *et al.,* 2003).

As with seagrass beds, the act of trampling over sediments can also lead to visible negative effects such as foot prints, mounds and troughs, but also effects on the macrofauna (Rossi *et al.,* 2007). In the Netherlands, mature individuals of the clam *M. baltica* declined, and later more newly recruited individuals were found in disturbed plots (Rossi *et al.,* 2007).

Marine reserves have been used as an effective tool to protect against the effects of activities such as bait and shellfish collection. In Washington, USA, reserves sites had greater clam abundance, overall species infaunal and epifaunal richness and total polychaete richness (Griffiths *et al.,* 2006). The reserves had led to a healthier benthic ecosystem. Experimental digging within the reserve lead to a significantly reduced species and polychaete richness (Griffiths *et al.,* 2006). However, within the mounds of dug sediment left by diggers there was no difference between these and control treatments (Griffiths *et al.,* 2006).

Recovery of target/non-target species

Both the meiofauna and macrofauna are affected by the disturbance of sediments through digging and trampling. Recovery times of these groups vary considerably within groups and between species.

Meiofauna has been found to recover quickly, within just one tidal cycle, after mud had been turned over (Sherman *et al.,* 1980). Some groups, such as foraminifera, even benefited from the disturbance and increased in number after digging (Sherman *et al.,* 1980). Wynberg & Branch (1994) also found that meiofauna react positively to disturbance after initial declines, but they then return to control levels. On the other hand, Johnson *et al.,* (2007) found that meiofauna reacted negatively to trampling on an English Mudflat. Similarly, though the recovery period for this group of species was short, between 36 and 144 hours (Johnson *et al.,* 2007). Hand raking for clams led to a significantly lower nematode assemblage 12h after disturbance, however the meiofaunal community had once again recovered within 48 hours (Mistri *et al.,* 2009).

Declines in macrofauna abundance, biomass and species richness from digging can take up to 18 months to recover from disturbance (Wynberg & Branch 1994).

Cockles *(C. edule)* may take five years to recover from the impacts of digging (Watson *et al.,* 2007). Whilst the size of the area disturbed was found to have an effect on the speed of recovery of cockle populations (Kaiser *et al.,* 2001). Recovery in small hand raked plots recovered within 56 days, however large plots remained changed, but had recovered within two years (Kaiser *et al.,* 2001).

The process of digging for bait, namely *A. marina* leads to the creation of pits and mounds of sediment. The recovery of fauna varies between these artificial habitats. Additionally, recovery is modified depending on whether basins are left or infilled. After digging *A. marina* recovers more quickly in basins (24 days) than in mounds (>122 days) (McLusky *et al.,* 1983). In the basins *A. marina* increased significantly beyond control levels after 45 days. Numbers of *P. ulvae and M. balthica* were little effected within mounds, however numbers in basins were negatively affected for up 31 and 20 days after digging.

When basins were infilled after digging *A. marina* recovered in just 22 days, compared to mounds which had not recovered after 92 days (McLusky *et al.,* 1983). 138 days after digging mounds and basins had flattened out (McLusky *et al.,* 1983).

When sediment is removed entirely through digging, recovery of species such as *Pygospio elegans, S. armiger, Bathyporeia sarsii, Corophium arenarium* and *Tubificoides benedii* can take between 64 and 208 days. Moreover, digging depth has been shown to increase the time taken to achieve recovery (Dernie *et al.*, 2003).

4.3.3 Sensitivity

A number of studies have endeavoured to map the sensitivity of habitats to different pressures (Tillin *et al*., 2010), fishing activities (Hall *et al*., 2008) and access to the intertidal (Tyler-Walters & Arnold, 2008).

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 activities chosen were 'casual hand gathering' and 'professional hand gathering' as these encompassed the fishing activities under consideration. Generally, stable habitat types exhibit high sensitivity to heavy fishing intensities for hand gathering activities (Table X). Generally, habitat types exhibit medium to high sensitivity to moderate intensities. Casual hand gathering at light intensity lead to a low sensitivity of all habitats, however for professional hand gathering intertidal muds and sands exhibit medium sensitivity at a light intensity. All habitat types, exhibit low sensitivity to a single visit (Table 4).

Table 3. Sensitivity of SAC features to different intensities (high, medium, low, single pass) of hand gathering as identified by Hall *et al.* (2008).

Gear type	Habitat type	Gear intensity*			
		Heavy	Moderate	Light	Single visit
Casual Hand Gathering	Intertidal muddy sands – exc. gaper clams	Medium	Low	Low	Low
	Intertidal muds + sands – Inc. gaper clams	High	Medium	Low	Low
	Intertidal muds	High	Medium	Low	Low
Professional Hand Gathering	Intertidal muddy sands – exc. gaper clams	High	Medium	Low	Low
	Intertidal muds + sands – Inc. gaper clams	High	High	Medium	Low
	Intertidal muds	High	High	Medium	Low

*Heavy - Access by >10 people per hectare per day often using vehicles. Large numbers of individuals mainly concentrated in one area: daily activity, Moderate - Access by 3-9 people per hectare per day, Light - Access by 1-2 people per hectare per day, Single – single visit by individual per day

Tyler-Walters & Arnold (2008) conducted a literature review of the effects of trampling and vehicles on a number of intertidal habitats. The results of the literature review were interpreted using expert judgment to conduct a sensitivity assessment, which followed the methodology developed by Hall *et al.,* (2008) of intertidal habitats to access to fishing grounds. Muds, sands and seagrass beds were found to be highly sensitive to heavy intensity, medium sensitivity to moderate and light intensity. Sensitivity is low for single visits. This is presented in Table. 5.

Table 4. Sensitivity of habitats to different intensities (heavy, moderate, light, single pass) of access by foot as identified by Tyler-Walters & Arnold (2008).

Habitat type	Gear 'access by foot' intensity*			
	Heavy	**Moderate**	**Light**	**Single visit**
Muddy sands, excluding *Mya arenaria*	High	Medium	Medium	Low
Muds & sands supporting *Mya arenaria*	High	Medium	Medium	Low
Intertidal muds	High	Medium	Medium	Low
Seagrass beds	High	Medium	Medium	Low

*Heavy - Access by >10 people per hectare per day. Large numbers of individuals mainly concentrated in one area, Moderate - Access by 3-9 people per hectare per day, Light - Access by 1-2 people per hectare per day, Single - Access on a single occasion

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 penetration and abrasion of the seabed and removal of non-target and target species. Sensitivity of intertidal sediment types to these pressures vary from medium to low, generally with high confidence in these assessments (Table X). Seagrass beds appear to be sensitive, followed by intertidal mudflats, intertidal sand and muddy sand, and mud have relatively low sensitivity overall.

Table 5. Sensitivity of habitats to pressure identified by Tillin *et al. (2010)*. Confidence sensitivity assessment is included in brackets.

Feature	Pressure				
	Penetration and/or disturbance of the substrate below the surface of the seabed – structural damage to seabed >25mm	Shallow abrasion/penetration – damage to seabed surface and penetration <25mm	Surface abrasion: damage to seabed surface features	Removal of target species	Removal of non-target species
Intertidal sand and muddy sand	Medium (Low)	Low (High)	Low (High)	Not sensitive – medium (low)	Not sensitive – medium (low)
Intertidal mud	Low (High)	Low (high)	Not sensitive (high)	Not sensitive – medium (low)	Medium (medium)
Intertidal mudflats	Low (High)	Low (high)	Low (High)	Medium (high)	Medium (medium)
Seagrass beds	High (low)	High (high)	Low (low)	Not-sensitive (high)	High (high)

4.4 Existing Management Measures

- Southern IFCA has a **Minimum Fish Sizes** byelaw, which states that no person shall take from the fishery any fish of the following species (black seabream, brill, dab, conger eel, flounder, lemon sole, red mullet, shad, turbot, witch flounder) that measures less than the size listed when measured from the tip of the snout to the end of the tail. The minimum sizes contained within this byelaw differ from that in EU legislation.
- A further Minimum size byelaw exists for **American hard-shelled clams** which states that no person shall remove from a fishery any clam of the species *Mercenaria mercenaria* which measures less than 63mm across the longest part of the shell.
- The **Fishing for Oysters, Mussels and Clams** byelaw states that the permitted methods of fishing for the aforementioned species are handpicking and dredging using a dredge with a ridged framed mouth.
- **Oyster closed Season** – no person shall dredge or fish for in or take oysters during the period from 1st March to 31st October in any year.
- **Fishing for Cockles** must not take place in the Southern IFCA district between 1st February and 30th April. Cockle can only be fished for using handpicking, a rake or similar instrument, or with a dredge. Cockles which pass through a square gauge opening measuring 23.8mm along each side must not be removed from the fishery.
- **Periwinkles –** no person shall take any periwinkles between the 15th of May in any year and the 15th of September in the same year. No person shall take periwinkles except by hand picking.

4.5 Table 6. Assessment of Hand Work on seagrass beds.

Feature	Attribute	Target	Potential pressure(s) and Associated Impacts	Likelihood of Impacts Occurring/Level of Exposure to Pressure	Mitigation measures
Seagrass beds	Structure and function: presence and abundance of key structural and influential species; Extent and distribution; Extent of supporting habitat; Structure: biomass; Structure: rhizome structure and reproduction	Not available; Recover the total extent and spatial distribution of seagrass beds; Maintain the area of habitat that is likely to support the sub-feature; Recover the leaf / shoot density, length, percentage cover, and rhizome mat across the feature at natural levels (as far as possible), to ensure a healthy, resilient habitat; Recover the extent and structure of the rhizome mats across the site, and conditions to allow for regeneration of seagrass beds.	Hand work activity is known to cause abrasion, penetration and disturbance to the seabed surface, habitat structure changes and removal of target and non-target species. Trampling negatively impacts seagrass beds leading to significant reductions in seagrass extent and biomass. Both the trampling intensity and the softness of the substrate have a significant effect on how severe the impact may be. Digging removes, uproots and buries seagrass shoots and rhizomes. When seagrass is buried at depths of just 2cm it does not survive for more than a week. Recovery of *Z. marina* took two years in a well-established perennial bed, but on the fringes of the bed recovery took 32 months. Recovery occurred through the growth of rhizomes from perennial seagrass beds at 0.5m per year.	The effort and scale of the activity is not well known in Studland Bay. Throughout the bay seagrass beds are predominantly subtidal, however the fringes may be exposed on spring low tides. Parking and access to South beach limits the likelihood of activity. On Middle and Knoll Beach where access can be gained directly from a car park, bait collection activity has been observed at a very light level, of up to 4 instances a month by single individuals in the summer. However, hand gathering activity has not been witnessed within the seagrass beds. Hand netting activity for prawns may also occur, but it is not known at what scale or intensity. No biotope information is available for Studland Bay MCZ. The generic description of the habitat indicates that common eelgrass is the only species that occurs in British waters below the low water mark, which grows typically to a depth of 4m. Seagrass beds are typically used as a nursery area, protecting young fish and shellfish, and provide a sheltered home for other animals such as pipefish and seahorses. The communities are likely to be similar to those which exist in the sediment types present which elsewhere do not have seagrass. Dive surveys found that characterising species in the sites included snake lock anemone, lugworm, peacock worm, sand mason worm, netted dog whelk, two spotted goby, pollock, corkwing wrasse and goldsinny wrasse (. Apart from Z. marina other characterising algae species include sea lettuce, fork weed, siphoned feather weed and black beard algae (Seastar Survey, 2012). Literature has found that digging and trampling leads to significant reductions in seagrass extent, biomass and	**Fishing for cockles** – prohibits fishing for cockles between 1st Feb and 30th April, Cockle minimum size, and can only be carried out using hand picking, a rake or dredge. **Oyster closed seasons** – prohibits fishing for oysters between 1st march and 31st October. **Periwinkles** – prohibits taking periwinkles between 15th May and 15th September **Southern IFCA minimum sizes** –

				shoot density as it removes/uproots and buries seagrass shoots and rhizomes. Recovery of *Z. marina* from such impacts takes between 2 and 3 years and occurs through the growth of rhizomes from perennial seagrass beds. No research has been conducted on the effects of push netting over seagrass. The activity is likely to occur only very infrequently over the habitat in the site. The nature of gear makes it unlikely to penetrate the sediment, uproot rhizomes or leaves of seagrass. The activity involves a person moving slowly but consistently across the sediment and therefore trampling effects are possible. Seagrass beds are considered to have a medium sensitivity to ‘light’ (1-2 people per day) hand work activity. They are considered to be highly sensitive to removal of non-target species and shallow and deep abrasion/penetration to the seabed surface. D’Avack *et al.* (2019) indicates that seagrass beds have a medium sensitivity to abrasion/disturbance of the surface of the substratum or seabed. In summary, activity levels in the Studland bay MCZ are considered to be light. Seagrass beds have a medium sensitivity to this activity level. Literature has shown than digging and trampling can have severe impact to seagrass beds extent, biomass, rhizome and reproduction, with recovery periods of more than 2 years. Therefore, based on the available evidence it is considered that hand work activity and push netting will pose a significant risk to the seagrass habitat feature in the Studland Bay MCZ and therefore will hinder the ability of the feature to achieve its ‘recover’ general management approach. It is worth noting that in the absence of a condition assessment for the site, Natural	American hard-shelled clam

				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; Structure: species composition of component communities	Maintain the presence and spatial distribution of subtidal seagrass bed communities; Recover the species composition of component communities.	Hand work activity is known to cause abrasion, penetration and disturbance to the seabed surface, habitat structure changes and removal of target and non-target species. Bait diggers can remove between 0.9 and 23 % of the target annelid population. Larger worms are removed leaving behind immature individuals who will relatively quickly recolonize the dug areas. Digging can lead to indirect mortality of other macrofaunal species, at high levels such as 85% for the common cockle. A wide range of macrofauna species are negatively affected by digging activity, including the overall macrofaunal biomass, total abundance and species richness. Where mounds and basins are created through digging, macrofauna show varied responses between the two microhabitats. Meiofauna can be negatively affected by hand work disturbances, however some species benefit and increase in number after disturbance. Trampling also leads to negative effects on macrofauna numbers. Recovery is both site, species and impact specific. Meiofauna have been found to recover quickly, often within 48hour of disturbance.	The effort and scale of the activity is not well known in Studland Bay. Throughout the bay seagrass beds are predominantly subtidal, however the fringes may be exposed on spring low tides. Parking and access to South beach limits the likelihood of activity. On Middle and Knoll Beach where access can be gained directly from a car park, bait collection activity has been observed at a very light level, of up to 4 instances a month by single individuals in the summer. However, hand gathering activity has not been witnessed within the seagrass beds. No biotope information is available for Studland Bay MCZ. The generic description of the habitat indicates that common eelgrass is the only species that occurs in British waters below the low water mark, which grows typically to a depth of 4m. Seagrass beds are typically used as a nursery area, protecting young fish and shellfish, and provide a sheltered home for other animals such as pipefish and seahorses. The communities are likely to be similar to those which exist in the sediment types present which elsewhere do not have seagrass. Dive surveys found that characterising species in the sites included snakelocks anemone, lugworm, peacock worm, sand mason worm, netted dog whelk, two spotted goby, pollock, corkwing wrasse and goldsinny wrasse (Seastar Survey, 2012). Apart from *Z. marina* other characterising algae species include sea lettuce, forkweed, siphoned feather weed and black beard algae (Seastar Survey, 2012).	Addressed above

			Macrofaunal recovery time are substantially longer however. Cockles can take as many as five year to recover from the impacts of digging. Although the size of the disturbed plot does have an effect on recovery. Similarly, recovery time vary between the basins and mounds created through digging, with some species such as A. marina recovering more quickly in basins, and within 22 days if basins are infilled.	Research literature has found that digging & trampling lead to the indirect mortality and removal of a number of different species including cockles, annelids and copepods, as well as decreasing overall infaunal biomass, abundance and species richness. Recovery times vary considerably between species but can be many years (in the case of cockles). However, Meiofauna respond less severely and can often recover within 48hours. Push nets may be used over sediment when a small amount of water is present (approx. knee deep). It is therefore possible that seahorse could be captured by push nets. However, this is very unlikely for a number of reasons. Push nets are used in very shallow water (less than 0.5m) where seahorses are unlikely to be found. Each net session lasts approximately 3 minutes and therefore only covers a very small area before being emptied. In addition, seagrass beds are not the target habitat of push netters and therefore they will only visit these area's incidentally. Seahorses are a mobile species and whilst they swim slowly, they would be likely to retreat to deeper water if they felt disturbance in the water column. In the very unlikely event seahorse were to be captured it is highly likely they would survive undamaged. The nets themselves are small and light in nature and do not have parts which could 'crush' captures animals. Nets are sorted approximately every 3 minutes whilst remaining in the water so any unwanted bycatch would be immediately returned to the sea close to that area from which it originated. Fishers have no interest in seahorses and any caught would be returned alive, immediately. Therefore, the likelihood of seahorses being captured is very low, with the likelihood of damage or mortality also very low. Anecdotal information form push netters in other areas of the district indicate that a seahorse has never been captures in push nets.	

				Seagrass beds are considered to have a medium sensitivity to ‘light’ (1-2 people per day) hand work activity. They are considered to be highly sensitive to removal of non-target species and shallow and deep abrasion/penetration to the seabed surface. D’Avack *et al.* (2019) indicates that seagrass beds have a medium sensitivity to abrasion/disturbance of the surface of the substratum or seabed. In summary, activity levels in the Studland bay MCZ are considered to be light. Seagrass beds have a medium sensitivity to this activity level. Literature has shown than digging and trampling can have severe impact to macrofaunal biomass, abundance and species richness, with recovery periods from months to years. Therefore, based on the available evidence it is considered that hand work and push netting activity will pose a significant risk to the seagrass habitat feature in the Studland Bay MCZ and therefore will hinder the ability of the feature to achieve its ‘recover’ general management approach. 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	Maintain the distribution of sediment composition types across the feature/sub-feature.	Hand work activity is known to cause abrasion, penetration and disturbance to the seabed surface and habitat structure changes. Digging activity can lead to the loss of finer sediment and organic content from the benthos. In dug areas a black sulphide layer	The effort and scale of the activity is not well known in Studland Bay. Throughout the bay seagrass beds are predominantly subtidal, however the fringes may be exposed on spring low tides. Parking and access to South beach limits the likelihood of activity. On Middle and Knoll Beach where access can be gained directly from a car park, bait collection	Addressed above

			can develop much shallower than is found in undisturbed sites. Changes in chlorophyll levels in dug plots have also been observed. Additionally, when digging basins are not infilled, basins show enhanced carbon and nitrogen content, whilst in mounds these are suppressed.	activity has been observed at a very light level, of up to 4 instances a month by single individuals in the summer. However, hand gathering activity has not been witnessed within the seagrass beds. No post survey sediment information is available for the Studland MCZ. Seastar Survey (2012) found the sediment to be homogenous being sandy/ muddy sand. Collins *et al.,* 2010 found the silt fraction in seagrass beds to be an average of 5.1 %, however this was only 2.7% in seagrass bed anchor/mooring scars. Research literature has found that digging can lead to the loss of finer sediment particles and organic matter, as well as changes in anoxic layers, chlorophyll levels, carbon and nitrogen. No research has been conducted on the effects of push netting over seagrass. The activity is likely to occur only very infrequently over the habitat in the site. The nature of gear makes it unlikely to penetrate or disturb the structure of the sediment. The activity involves a person moving slowly but consistently across the sediment and therefore trampling effects are possible. Seagrass beds are considered to have a medium sensitivity to 'light' (1-2 people per day) hand work activity. They are considered to be highly sensitive to shallow and deep abrasion/penetration to the seabed surface. D'Avack *et al.* (2019) indicates that seagrass beds have a medium sensitivity to abrasion/disturbance of the surface of the substratum or seabed. Therefore, based on the available evidence it is considered that hand work activity will pose a significant risk to the seagrass habitat feature in the Studland Bay MCZ and therefore will hinder the ability of the feature to achieve its 'recover' general management approach. 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 Management options

In recognition of the potential pressures of handwork/digging with forks and push netting upon designated features and their supporting habitats, Southern IFCA recognises that management measures will need to be put in place to protect sensitive; seagrass beds from the effects of handwork / digging with forks and push netting activities in areas which are not currently protected by the hand gathering byelaw. This is due to the result of this MCZ assessment which has found that hand work/ digging with forks and push netting is likely to pose a significant risk to the seagrass features of the Studland Bay MCZ.

Based on the findings of the assessment, the Authority is therefore required to develop management that will provide protection to the seagrass features within the site from the relevant fishing activities. Spatial closures, based on the most up to date data for the location of seagrass features, will be introduced and incorporated into appropriate management following best practice[4]. 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 up-to-date 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 hand gathering activity (hand work and digging with forks, push netting) 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 (seagrass beds) of 'recover 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.

The review of the impacts of hand work/digging with forks and push netting on seagrass beds reported the habitat to have a medium sensitivity to light fishing activity (1-2 persons per day). Literature showed that hand work/digging activity can lead to the immediate removal of the feature, with a minimum of a two-year recovery period. Push netting could lead to trampling affects which have been shown to reduce seagrass density. Therefore, it was concluded that the fishing activities will prevent the ability of seagrass beds to attain their 'recover' general management approach.

Having reviewed a wide range of evidence, including scientific literature, IFCO and site owner knowledge and habitat feature mapping, it was concluded that hand work/digging/push netting is likely to pose a significant risk to seagrass beds within the Studland Bay MCZ. The rationale for this conclusion is summarised below:

- IFCO and Ranger knowledge indicates that hand work activity does occur within the site at a low level, but does not occur within the sea grass beds.

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

- Southern IFCA does not have and sighting data of the activity in the site.
- Southern IFCA has been made aware that prawn netting may occur within the site. It is not known at what scale or intensity.
- A review of scientific literature revealed that hand work/digging at any level/intensity can lead to the direct removal/ burial and mortality of the feature itself as well as indirect mortality of the communities found within the feature. Target (worms and shellfish) and non-target species (seagrass, crustaceans, bivalves) can be significantly reduced and the character of the sediment can be altered significantly. The activity leads to the creation of basins and mounds, bare sediment and mixing of sediment layers. Push netting may lead to trampling effects which have been shown to reduce seagrass density.
- Sensitivity of seagrass habitats to pressures associated with the activity is high. Sensitivity of seagrass beds to the activity at a light level is medium.
- Recovery of seagrass beds from hand work and trampling activity have been found to be two or more years.

It is therefore recognised that the activities have the potential to pose a significant risk upon the seagrass beds attributes:

- Structure: sediment composition and distribution
- Distribution: presence and spatial distribution of biological communities
- Structure: species composition of component communities
- Structure and function: presence and abundance of key structural and influential species
- Extent and distribution
- Extent of supporting habitat
- Structure: biomass
- Structure: rhizome structure and reproduction

In recognition that the feature will be at risk from hand work/ digging with forks and push netting additional management measures are required to ensure the MCZs conservation objective can be furthered. The location, timing, duration and intensity of the activities within the site will be influenced by new management measures being developed, which will protect the sensitive feature (seagrass beds), by prohibiting the activities over the feature. This is to support the general management approach of the features discussed to a favourable condition.

When the above evidence, fishing activity levels, current and proposed management measures are considered it has been concluded that hand work/ digging with forks and push netting will not pose a significant risk to the achievement of sites conservation objectives to 'recover' seagrass beds to favourable condition. Southern IFCA must seek to ensure that the conservation objectives of any MCZ in the district are furthered.

7 In-combination assessment

7.1 Other fishing activities

Fishing activity	**Potential for in-combination effect**
Static – pots/traps (Pots/creels – crustacean & cuttle pots)	Potting for crab and lobster takes place over subtidal rocky substrate and will therefore not overlap with hand work / digging activity which takes place over intertidal sediments. Therefore, there is no spatial overlap between the activities and in-combination effects are not feasible.
Static – fixed & passive nets (Gill nets, trammels, entangling, drift nets)	It is anticipated that static fixed nets are used within the site in areas of shallow water. Netting does not occur in the intertidal and therefore the two activities do not overlap spatially. Therefore, the activity is not likely to lead to any in-combination effects.
Lines (Longlines – demersal, Handlines)	It is anticipated that demersal longlines and handlines are used within the site. The activity does not exhibit the same pressures as Hand work/ digging with forks and therefore, there will not be any in-combination effects.

Demersal trawl and pump scoop dredges	Demersal trawls and pump scoop dredges exhibit the same pressures as hand work / digging. However, all kinds of bottom towed fishing gear (demersal trawls and dredges) will be prohibited over the seagrass beds. Therefore, the two activities will not overlap spatially and cannot lead to in-combination effects.

7.2 Other activities

Activity	Potential for in-combination effect
Recreational Anchoring	Studies into the effects of anchoring on seagrass beds have shown that the activity exhibits the same pressures as hand work / digging including abrasion, penetration and removal of non-target species. Hand work / digging will be permanently prohibited over the entirety of the seagrass beds. Therefore, there will be no in-combination effect. The Marine Management Organisation is responsible for assessing and managing the impacts of anchoring on the Studland Bay MCZ.

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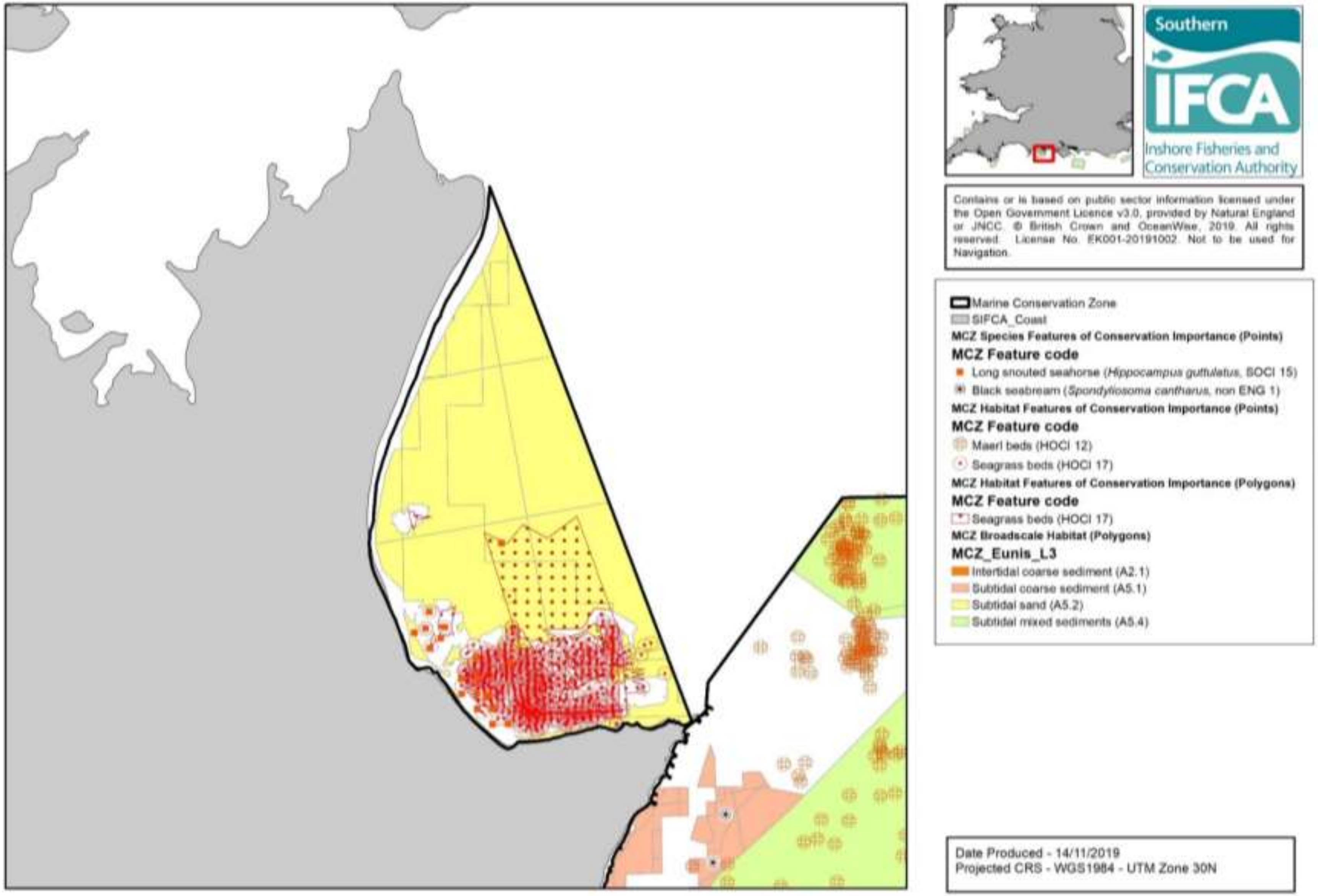
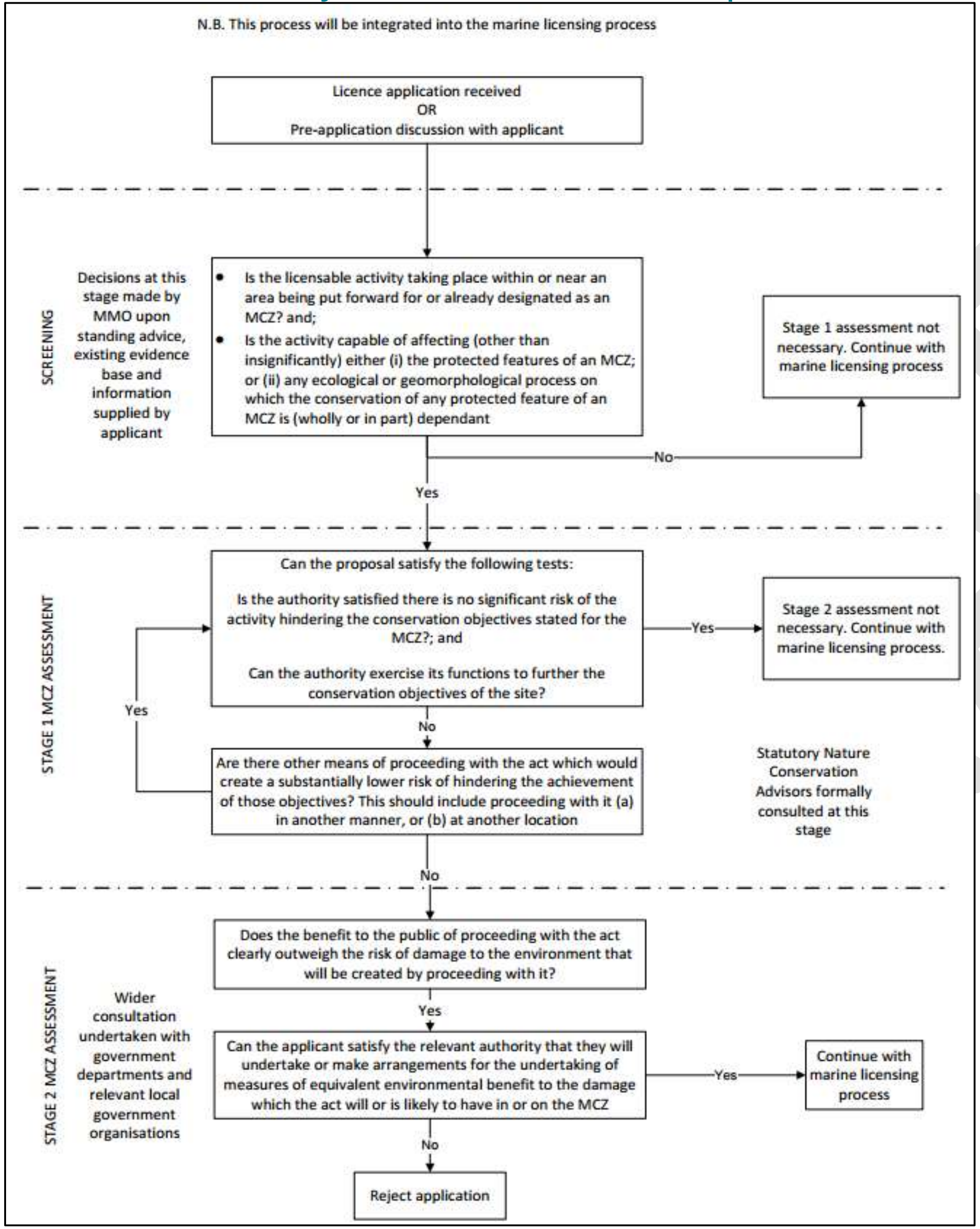
Annex 1. Broad scale habitat and species features of conservation importance (FOCI) map of the Studland Bay MCZ.



Annex 2. Summary of MMO assessment process for MCZs



Annex 3. Initial screening of commercial fishing activities in the Studland Bay MCZ.

Broad Gear Type (for assessment)	Aggregated Gear Type (EMS Matrix)	Fishing gear type	Does it Occur?	Details	Sources of Information	Potential for Activity to Occur/ Is the activity anticipated to occur?	Justification	Suitable for Part A Assessment?	Priority
Hand work / digging	**Towed (demersal)**	Beam trawl (whitefish)	N	Currently not known to occur.	Local IFCO	Y	This activity has the potential to occur. Soft bottomed substrate lends itself to this method. One vessel comes into to the district occasionally but it is not known if fish in the MCZ.	Y	Medium to High
		Beam trawl (shrimp)	N		Local IFCO		Target species does not occur.		
		Beam trawl (pulse/wing)	N		Local IFCO		Prohibited via Electric fishing byelaw.		
		Heavy otter trawl	N		Local IFCO	N	The activity has the potential to occur but is not anticipated to occur. The boats which operate within the district (and the Solent) are small in nature (restricted to 12 m or less in length) and so are restricted in the size of gear used. This means light otter trawls are used instead of heavy otter trawls.		
		Multi-rig trawls	N		Local IFCO	N	Has not historically occurred and is not currently anticipated to occur, the boats which operate within the district (and the Solent) are small in nature (restricted to 12 m or less in length) and so are restricted in the size of gear used. This means multi rig trawls are not used and the activity is not anticipated to occur.		

		Light otter trawl	N		Local IFCO	Y	The activity has the potential to occur and the target species is likely to occur. However, there are currently no vessels actively trawling in this area.	Y	High
		Pair trawl	N		Local IFCO	N	It is not anticipated to occur as it has not historically occurred. Furthermore, there is limited potential due to the space required to accommodate two vessels and the size/power of vessels needed.		
		Anchor seine	N		Local IFCO	N	Gear type has not been historically used within the area and is not anticipated to occur. Activity needs a large area and, in the site, considered would be limited. In addition, large vessels are also required for this gear type and vessels over 12 m in length are prohibited from fishing within the Southern IFCA district.		
		Scottish/fly seine	N		Local IFCO	N	Gear type has not been historically used within the area and is not anticipated to occur. Activity needs a large area and, in the site, considered would be limited. In addition, large vessels are also required for this gear type and vessels over 12 m in length are prohibited from fishing within the Southern IFCA district.		
Pelagic towed fishing gear	**Towed (pelagic)**	Mid-water trawl (single)	N		Local IFCO	N	Gear type has not been historically used within the area. Activity has the potential to occur however this gear type does not come into contact with the seabed and therefore there is no chance for interaction with designated features.		

		Mid-water trawl (pair)	N		Local IFCO	N	Gear type has not been historically used within the area. Furthermore, there is limited potential due to the space required to accommodate two vessels and the size/power of vessels needed. This gear type does not come into contact with the seabed and therefore there is no chance for interaction with designated features.		
		Industrial trawls	N		Local IFCO	N	Activity is not able to occur due to the size of vessel required. Vessels over 12 m are prohibited from fishing within the Southern IFCA district.		
Hand work / digging	**Dredges (towed)**	Scallops	N		Local IFCO	N	Gear type has not historically occurred within the site and is not anticipated to occur.		
		Mussels, clams, oysters	N		Local IFCO	N	Historic trails of this method of fishing in the area proved not commercially viable due to species present and substrate type. Therefore, it is not anticipated that the activity will occur.	Y	Medium to High
		Pump scoop (cockles, clams)	N		Local IFCO	N	Historic trails of this method of fishing in the area proved not commercially viable due to species present and substrate type. Therefore, it is not anticipated that the activity will occur.	Y	Medium to High
Suction	**Dredges (other)**	Suction (cockles...)	N	Not allowed in the district.	Local IFCO	N	Suction dredging for cockles, clams, mussels and oysters is prohibited (by default) in the Southern IFCA district (by Southern IFCA byelaws).		
Tractor		Tractor	N		Local IFCO	N	The activity has not historically occurred within the site and is not anticipated to occur.		

Intertidal work	**Intertidal handwork**	Hand working (access from vessel)	N		Local IFCO	Y	Hand working with access from a vessel infers a muddy habitat where there difficulty accessing areas. At this site, the dominance of sand and coarse sediment substrate means there is limited need for a vessel as the substrate means the area is accessible on foot.		
		Hand work (access from land)	Y		Local IFCO	Y	The activity is known to occur within the site.	Y	low to medium
Static - pots/traps	**Static - pots/traps**	Pots/creels (crustacea/gastropods)	Y		Local IFCO	Y	Activity is known to occur. In the Area but not inside the MCZ.	Y	low
		Cuttle pots	Y	Unknown	Local IFCO	Y	Activity is known to occur.		low
		Fish traps	N		Local IFCO	N	Activity has not historically occurred within the site and is not anticipated to occur.		
Demersal nets/lines	**Static - fixed nets**	Gill nets	Y	Up to six vessels may net in the MCZ. Targeting plaice, sole, ray skate.	Local IFCO		It is anticipated that static fixed nets are used within the site in areas of shallow water, although effort is likely to be low with the area worked by 1 to 2 vessels at a time. The activity is unlikely in deeper water due to the rushing tide in the outer reaches of the site.	Y	Low to Medium
		Trammels	Y	See 'gill nets'	Local IFCO		See 'gill nets'		Low to Medium
		Entangling	Y	See 'gill nets'	Local IFCO		See 'gill nets'		Low to Medium

Pelagic nets/lines	**Passive - nets**	Drift nets (pelagic)	N		Local IFCO	N	Activity is not anticipated to occur and potential for the activity is limited by shallow waters and the rushing tide that effects the site, particularly the outer areas.		
Demersal nets/lines		Drift nets (demersal)	Y		Local IFCO	Y		Y	low to medium
	Lines	Longlines (demersal)	Y		Local IFCO	Y	It is anticipated that demersal longlines are used within the site,	Y	
Pelagic nets/lines		Longlines (pelagic)	N		Local IFCO	N	The activity has not historically occurred within the site and is not anticipated to occur.		
		Handlines (rod/gurdy etc)	Y	The activity is known to occur however this gear type does not come into contact with the seabed and therefore there is no chance for interaction with designated features. Shore-based angling is limited and due to the nature of the shoreline is unlikely to interact with venerable	Local IFCO		The activity is known to occur however this gear type does not come into contact with the seabed and therefore there is no chance for interaction with designated features. Shore-based angling is limited and due to the nature of the shoreline is unlikely to interact with venerable designated features.		

				designated features.					
		Jigging/trolling	Y	See 'handlines (rod/gurdy etc)'	Local IFCO		See 'handlines (rod/gurdy etc)'		
Purse seine	**Seine nets and other**	Purse seine	N		Local IFCO	N	Activity has not historically occurred within the site and is not anticipated to occur.		
Demersal nets/lines		Beach seines/ring nets	N		Local IFCO	Y	The activity has not historically occurred within the site but has the potential to occur. Possible ring netting for mullet maximum 6 vessels.	Y	

Miscellaneous		Shrimp push-nets	N	Unknown	Local IFCO		The occurrence of the activity is unknown. It is not anticipated to occur as it is not thought to have occurred historically within the site. The activity has the potential to occur but is unlikely to because of a lack of areas with suitable substrate to support the target species. In addition, activity is conducted intertidally and designated features are not intertidal and therefore whilst there is limited potential for the activity to occur it will not take place over designated features.		
EA Only		Fyke and stake nets			EA Only			EA Only	
Miscellaneous	**Miscellaneous**	Commercial diving	N			N	Activity has not historically occurred and is not anticipated to occur.		
Hand work / digging		Bait dragging	N			N	Activity has not historically occurred within the site and is not anticipated to occur. The majority substrate present is not suitable for the activity to take place. As such, the target species are also not present.		
Miscellaneous		Crab tiling	N			N	Activity has not historically occurred within the site or Southern IFCA district and therefore is not anticipated to occur.		
Intertidal work	**Bait collection**	Digging with forks	Unknown			Y	Activity has the potential to occur as the site may support lugworm, and access to the intertidal is possible by foot.	Y	

Annex 4. Natural England's Advice on Operations for Studland Bay MCZ and Shore Based Activities.

	Habitat			Species
Pressure Name	**Intertidal coarse sediment**	**Seagrass beds**	**Subtidal sand**	**Long snouted seahorse**
Abrasion/disturbance of the substrate on the surface of the seabed	NS	S		IE
Habitat structure changes - removal of substratum (extraction)	S	S		S
Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion	NS	S		
Removal of non-target species		S		S
Removal of target species		S		
Visual disturbance				S
Collision BELOW water with static or moving objects not naturally found in the marine environment				IE
Deoxygenation	NS	NS		S
Hydrocarbon & PAH contamination	NA	NA		NA
Introduction of light		S		
Introduction or spread of invasive non-indigenous species (INIS)		S		IE
Litter	NA	NA		IE
Synthetic compound contamination (incl. pesticides, antifoulants, pharmaceuticals)	NA	NA		NA
Transition elements & organo-metal (e.g. TBT) contamination	NA	NA		NA
Underwater noise changes				S