Document Control

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

Marine Conservation Zone: Bembridge MCZ

Feature: Seagrass beds

Broad Gear Type: Intertidal Handwork / Miscellaneous / Bait collection

Gear type(s) Assessed: Hand Work (access from land) / Digging with Forks / Crab tilling / Shrimp/prawn push netting

Technical Summary

As part of the MCZ assessment process for the tranche three Bembridge MCZ, it was identified that Hand gathering (specifically hand work/ digging with forks/ crab tilling/push netting) and their potential impacts required an in-depth assessment. Fishing activity in the site is not well understood, however, due to habitat type and access it is believed the activity only occurs at a light level.

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, 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. Crab tilling has been shown to reduce the infaunal diversity and abundance in the substrate, and anecdotal evidence indicates the sediment structure changes over time, with the object slowly sinking into the sediment. No research evidence on the effects of push netting is available.

When considering that the activities occur within the Bembridge MCZ at a maximum of a light level, in combination with other evidence (scientific literature, sightings data, feature mapping) it was found that the hand work/digging with forks, crab tilling & push netting were likely to pose a significant risk to the seagrass beds feature. Therefore, current management is not considered sufficient to protect seagrass beds from these activities.

For hand work and crab tilling this was concluded due to knowledge that the activity may 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. Therefore, additional management which prohibits the activities from taking place within seagrass beds will be developed.

For push netting the activity is believed to occur at a maximum light level within the site, but more likely as a single pass over seagrass, the nature of the gear used does not penetrate the sediment but trampling effects may be possible. Seagrass has a medium sensitivity to abrasion and literature shows trampling can lead to reduced seagrass density. Therefore, additional management which prohibits the activities from taking place within seagrass beds will be developed.

When the current and proposed management is considered it is concluded that the activities will not hinder the achievement of the designated features 'recover' general management approach and that they 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, crab tilling and push netting will remain consistent with the conservation objectives of the site.

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 Bembridge 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.

1.2 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)
- Fishing activity data (map(s), etc) (Annex 5)
- Natural England's Advice on Operations for the Needles MCZ[2]
- 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 Bembridge MCZ was designated in May 2019 and covers an area of Coast surrounding the Isle of Wight's stretching from Seaview on the north east of the Island, to Dunnose, Bonchurch on the south east. The site covers an area of approximately 75km^2 an protects a number of rare and fragile habitats including Maerl beds, seagrass beds, subtidal sediments and sheltered muddy gravels. Additionally, the site protects a number of rare species including two stalked jellyfish species, sea pens and burrowing megafauna, peacock's tail (*Padina pavonica*) and the short snouted seahorse (*Hippocampus hippocampus*).

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

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

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

[3] https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UKMCZ0040&SiteName=the%20needles&SiteNameDisplay=The+Needles+MCZ&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=,0

be recovered to favourable condition (if it is currently in a damaged state) and then to be maintained in favourable condition.

Figure 1. Designated features and their general management approach for the Bembridge MCZ.

Designated feature	General Management Approach
Short-snouted seahorse (*Hippocampus hippocampus*)	Maintain in favourable condition
Stalked jellyfish (*Calvadosia campanulata*)	Maintain in favourable condition
Stalked jellyfish (*Haliclystus* species)	Maintain in favourable condition
Subtidal coarse sediment	Maintain in favourable condition
Subtidal sand	Maintain in favourable condition
Sheltered muddy gravels	Maintain in favourable condition
Sea-pens and burrowing megafauna	Recover to favourable condition
Native oyster (*Ostrea edulis*)	Recover to favourable condition
Peacock's tail (*Padina pavonica*)	Recover to favourable condition
Maerl beds	Recover to favourable condition
Seagrass beds	Recover to favourable condition
Subtidal mixed sediments	Recover to favourable condition
Subtidal mud	Recover to favourable condition

Please refer to Annexes 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 Bembridge MCZ will be undertaken using a staged process, akin to that proposed by the Marine Management Organisation (MMO)[4], 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 Bembridge 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 Needles MCZ, which contains the feature seagrass beds.

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

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.

1. The activity does occur but the pressure(s) does not significantly affect/ interact with the designated feature(s).
2. The activity does occur but the designated feature(s) is not sensitive to the pressure(s) exerted by the activity.

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

3.2.1 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.

3.2.2 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 for The Needles MCZ (Annex 4). Supplementary Advice on Conservation Objectives was also used from these sites. 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 (Annex 4). 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 Bembridge 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.

As Bembridge MCZ is a new site Natural England has not yet produced a site-specific Conservation Advice Package. However, Conservation advice packages, containing Advice on Operations and Supplementary Advice on Conservation Objectives for the relevant features is available in other MCZ Conservation Advice Packages. This applies to seagrass beds, which is a feature of the The Needles MCZ. As the Advice on Operations in these packages is generic and not site specific these can be used to provide the sensitivity of the feature to the pressure. Similarly, in the Supplementary Advice on Operations the attributes and targets (not including the specification of maintain or recover) are also generic for these features, and can be used as the framework for assessing whether the activity will hinder the sites ability to meet its conservation objectives.

Figure 2. Summary of fishing pressure-feature screening for seagrass beds and hand work (Access from land) and Digging with forks. Please not 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)
Abrasion/disturbance of the substrate on the surface of the seabed	S	Y	Hand work and digging with forks are 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. Over time as the tide pushes past and around the artificial structures of crab tilling abrasion may be caused by the objects moving with the tide or waves. 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. Shrimp push nets are pushed along the surface	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

			of the sediment at low spring tides. The base of the net is a flat or rounded piece of wood or plastic and does not have any teeth or other means of penetrations the sediment. 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.	structure and reproduction; Structure: sediment composition and distribution; Structure: species composition of component communities
Habitat structure changes - removal of substratum (extraction)	S	Y	Hand work, digging with forks are known to cause habitat structure changes through abrasion and penetration to the seabed or through the introduction of artificial structures to the habitat. 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. Crab tilling is known to cause habitat structure changes through the introduction of artificial structures to the habitat. 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	Hand work and digging with forks are known to cause penetration 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. Over time as the tide pushes past and around the artificial structures of crab tilling penetration may be caused by the objects sinking into the sediment. 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 is available. Seagrass beds provide nursery habitat for young fish and shellfish, as well as shelter for other animals such as pipefish and seahorses. Further investigation is	Distribution: presence and spatial distribution of biological communities; Structure and function: presence and abundance of key structural and influential species; Structure: species composition of

			needed for hand work and digging with forks to investigate the magnitude of disturbance to associated communities/species and location of the activity in relation to the feature. Crab tilling may remove non-target species by smothering the benthic environment. Further investigation is needed in a part B assessment.	component communities
Removal of target species	S	Y	Hand work and digging with forks may remove species such as rag and lug worm, cockles and clams. 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

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 Bembridge 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 The Needles MCZ. These are outlined in Table 2.

4.1 Assessment of trawling & dredging in the Bembridge MCZ

4.1.1 Summary of the Fishery

Hand work can take place all year around in the area of the Bembridge 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 by hand. The activity is carried out both commercially and recreationally. Some species can be easily found by looking for their syphon holes 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 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.

4.1.4 Crab tilling

Crab tilling refers to the process by which people access the shore by foot and place artificial structures, such as tyres, bricks and mats on the seabed between the high and low water mark. These are left in place permanently, with persons periodically returning at low water to collect green shore crabs (*Carcinus maenas*) from within, under or around the structures.

4.1.5 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 3. (a) Man digging for bait with a spade © Adams K. (b) Crab tilling tyre on beach © UGC. (c) Shrimp/prawn push netting © North Western IFCA

4.1.6 Location, Effort and Scale of fishing activity

Very little is known about hand work activity occurring in Seagrove Bay and Priory Bay north of Bembridge harbour where unprotected seagrass is located.
Access by foot is possible from a number of locations throughout Seagrove Bay, however the nearest car park is approximately 400m away. Habitat data available on https://magic.defra.gov.uk/MagicMap.aspx indicates that the intertidal habitat in the bay is a mixture of '*Bathyporeia* and *Corophium arenarium* in littoral muddy sand' and 'barren littoral coarse sand'. These habitats do not usually support populations of polychaetes and bivalves. In Seagrove Bay Natural England data indicates that the seagrass beds are subtidal.

In Priory Bay the nearest car park is much farther away, with the bay being boarded by a woodland and then grassland areas. Access by foot is possible along the length of the bay. The seagrass beds in the bay are predominantly subtidal however, there is an area of intertidal which goes somewhat out from the shore, over which seagrass beds have been recorded. The intertidal is recorded as intertidal sandflats in Priory Bay however, biotope information is not available.

Therefore, there is unlikely to be a high levels of hand work activity occurring in these bays, within or near to seagrass beds.

Very little is known about crab tilling activity in Bembridge MCZ. It is anticipated that the activity may occur at low levels over intertidal sediment habitats. Crab tilling usually occurs over mud, sand and cobbly intertidal areas.

Prawn push netting is known to occur on the Isle of Wight at the entrance to Wootton Creek and at Ryde Sands. It is believed the activity may occasionally occur at Bembridge MCZ, carried out by up to five people at any one time in the pools in and around the ledges to the east and west of the harbour entrance. Therefore, the activity has the potential to overlap with seagrass beds. Prawn push netting occurs only at low, spring tides, for approximately 1 to 1.5 hours either side of the low tide. It occurs from July to mid-September, and is carried out only in calm weather when the tide times are appropriate.

4.1.7 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).

4.2 Pressures

4.2.1 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).

No research or published papers could be found on the effect of shrimp/prawn push netting activity on marine habitats.

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 may 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).

4.2.2 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.

Crab tilling directly targets Carcinus maenas crabs. Sheehan *et al.,* 2008 found that when compared to non-tilled estuaries, tilled estuaries supports a significantly greater abundance of crabs particularly juvenile individuals. This was believed to be due to the provision of additional habitat. However, there were more reproductively active crabs in non-tilled estuaries (Sheehan *et al.,* 2008).

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).

One study has been completed on the effects of crab tilling on estuarine infauna. Sheehan *et al.* (2010) found that crab tilling reduced the diversity and abundance of macro infauna and altered assemblage structure. The trampling aspect of this activity was that which contributed most to the results (Sheehan *et al.,* 2010).

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).

4.2.3 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 3). 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 3).

Figure 4. 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	Seagrass beds	Medium	Low	Low	Low
Professional Hand Gathering	Seagrass beds	High	High	High	Low

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. 4.

Figure 5. 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**
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 5). Seagrass beds appear to be sensitive, followed by intertidal mudflats, intertidal sand and muddy sand, and mud have relatively low sensitivity overall.

Figure 6. 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	Removal of target species	Removal of non-target species
Seagrass beds	High (low)	High (high)	Not-sensitive (high)	High (high)

4.3 Existing Management Measures

- **Prohibition of Gathering (Sea Fisheries Resources) in Seagrass Beds** byelaw prohibited the digging for, fishing for or taking of any sea fisheries resources unless by means of a net, rod and line or hook and line. The majority of seagrass beds within the sites are currently protected by this byelaw.
- **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.
- 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.

4.4 Figure 7. 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	Current Mitigation measures
Seagrass beds	Structure and function: presence and abundance of key structural and influential species; Structure: species composition of component communities; Extent and distribution; Extent of supporting habitat; Structure: biomass; Structure: rhizome structure and reproduction;	Not available	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. Crab tilling can lead to a reduction in diversity and abundance of infaunal species in estuarine habitats, but increases the abundance of shore crabs. No studies on the effects of push netting are available.	Very little is known about hand work activity occurring in Seagrove Bay and Priory Bay north of Bembridge harbour. Access by foot is possible from a number of locations throughout Seagrove Bay, however the nearest car park is approximately 400m away. The same goes for those off of Bembridge Point. In Seagrove Bay Natural England's data indicates that the seagrass beds are subtidal and therefore will not be impacted by hand work, digging with forks or crab tilling activities. However, anecdotal information and Google Earth Pro satellite footage suggests that the seagrass bed in Seagrove Bay is no longer present. Those beds of off Bembridge Point are also subtidal and will therefore not be likely to interact with hand work/ digging or crab tilling activities. In Priory Bay access by foot is possible along the length of the bay however, there are no nearby carparks and the bay is boarded by woodland and grassland reducing the likelihood of hand work activities. The seagrass beds in the bay are predominantly subtidal however, there are small areas of intertidal habitat, over which seagrass beds have been recorded. Therefore, in Priory Bay the level of activity is likely to be very light within or near to these seagrass beds. Stretching from Tyne Ledge around to White ledge (Bembridge Ledges) are a number of elongate seagrass beds sandwiched in between rocky substrates. The rocks are exposed at low tides however the seagrass beds are located in pools which are found below mean low water. Therefore, once again these seagrass beds are unlikely to overlap with hand work, digging or crab tilling activities.	**Prohibition of Gathering (Sea Fisheries Resources) in Seagrass Beds** byelaw prohibited the digging for, fishing for or taking of any sea fisheries resources in many of the seagrass areas within the site (with exceptions).

				Due to their location, near to rocks and in shallow pools, push netting in the site has the possibility to overlap with seagrass beds within these areas. No biotope information is available for Bembridge 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. The site supports predominantly sandy substrates which intern support the growth of the seagrass beds. Ragworms do not tend to occur in mainly sandy substrates and therefore bait collection of ragworm is unlikely in the site. Sandy substrates do support lugworm another common target species of bait collectors. However, lugworm do not tend to inhabit seagrass beds, most likely due to their predominantly subtidal location and the presence of rhizomes in the substrate. Literature has found that digging and trampling leads to significant reductions in seagrass extent, biomass and 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. Crab tilling is unlikely to occur over seagrass beds but if it were to occur the seagrass would become smothered, starved of light and may die. In addition, the movement of water around the crab-tiles could lead to the exposure of rhizomes and instability in the sediments. Crab tiles have been found to reduce the abundance and diversity of infauna in the sediments.	

				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 low to medium sensitivity to 'light' (1-2 people per day) hand work activity, and a low sensitivity to a single incident. They are considered to be highly sensitive to removal of non-target species (being the removal of seagrass itself) 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 of hand work, crab tilling & push netting in the Bembridge MCZ are considered to be maximum light due to access and habitat type. Seagrass beds have a low sensitivity to this activity level. However, if the activities were to occur literature has shown than digging and trampling can have severe impacts to seagrass beds extent, biomass, rhizome and reproduction, with recovery periods of more than 2 years. Crab tilling could quickly lead to the death of seagrass leaves and potentially exposed rhizomes. Therefore, based on the available evidence it is considered that hand work, crab tilling activity and push netting will pose a significant risk to the seagrass habitat feature in the Bembridge 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 MA for each feature. However, such an assessment is	

				relatively generic and does not take into a account a number of site specific factors.	
	Distribution: presence and spatial distribution of biological communities;	Not available	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 over-all 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. 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	Very little is known about hand work activity occurring in Seagrove Bay and Priory Bay north of Bembridge harbour. Access by foot is possible from a number of locations throughout Seagrove Bay, however the nearest car park is approximately 400m away. The same goes for those off of Bembridge Point. In Seagrove Bay Natural England's data indicates that the seagrass beds are subtidal and therefore will not be impacted by hand work, digging with forks or crab tilling activities. However, anecdotal information and Google Earth Pro satellite footage suggests that the seagrass bed in Seagrove Bay is no longer present. Those beds of off Bembridge Point are also subtidal and will therefore not be likely to interact with hand work/ digging or crab tilling activities. In Priory Bay access by foot is possible along the length of the bay however, there are no nearby carparks and the bay is boarded by woodland and grassland reducing the likelihood of hand work activities. The seagrass beds in the bay are predominantly subtidal however, there are small areas of intertidal habitat, over which seagrass beds have been recorded. Therefore, in Priory Bay the level of activity is likely to be very light within or near to these seagrass beds. Stretching from Tyne Ledge around to White ledge (Bembridge Ledges) are a number of elongate seagrass beds sandwiched in between rocky substrates. The rocks are exposed at low tides however the seagrass beds are located in pools which are found below mean low water. Therefore, once again these seagrass beds are unlikely to overlap with hand work, digging or crab tilling activities. Due to their location, near to rocks and in shallow pools, push netting in the site has the possibility to overlap with seagrass beds within these areas.	

			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. Crab tilling can lead to a reduction in diversity and abundance of infaunal species in estuarine habitats, but increases the abundance of shore crabs. No studies on the effects of push netting are available.	No biotope information is available for Bembridge 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. ***Hand work/digging with forks and crab tilling*** 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. The site supports predominantly sandy substrates which intern support the growth of the seagrass beds. Ragworms do not tend to occur in mainly sandy substrates and therefore bait collection of ragworm is unlikely in the site. Sandy substrates do support lugworm another common target species of bait collectors. However, lugworm do not tend to inhabit seagrass beds, most likely due to their predominantly subtidal location and the presence of rhizomes in the substrate. Crab tilling is unlikely to occur over seagrass beds but if it were to occur the seagrass would become smothered, starved of light and may die. In addition, the movement of water around the crab-tiles could lead to the exposure of rhizomes and instability in the sediments. Crab tiles have been found to reduce the abundance and diversity of infauna in the sediments. ***Push netting***	

				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 does not penetrate the sediment, uproot rhizomes or tear leaves of seagrass. The activity involves a person moving slowly but consistently across the sediment and therefore trampling effects are possible. Five records of Short-snouted seahorses (*Hippocampus hippocampus*) have been made within the site. In general, it is regarded that seagrass beds are the main supporting habitat of seahorses, however within the site none of the records of these fish have been made in seagrass beds. The full size and extent of the seahorse populations is not known. Push nets are 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 from one fisher reported zero catches of seahorses in approximately 20 push netting sessions (~4 push netting sessions each season over a five-year period). Another fisher reported push net fishing between 6 and 12 times a year for two or more decades and has not yet captured a seahorse. It should be noted that these fishing activities have occurred both inside and outside of the MCZ. Stalked jellyfish are associated with seagrass habitats, as they attach to the blades of seagrass. A total of seven records of the two stalked jelly fish species have been recorded within the Bembridge Ledges seagrass beds. Stalked jellyfish are not a mobile species. They attach themselves to a blade of seagrass or algae from which they feed, and carry out their life cycle. The activity of push netting, pushes a net often with a straight bar at the bottom along the seabed. It is therefore likely that stalked jelly fish within seagrass could be dislodged from their attachment by this process. Stalked jelly fish are considered to have a medium sensitivity to abrasion/disturbance of the surface of the substratum or seabed (Tyler-Walters & Heard, 2017). ***Summary*** In summary, hand work and crab tilling activity levels in the Bembridge MCZ have the potential to be at maximum light levels due to access and habitat type, although they are unlikely to interact with seagrass beds which are predominantly subtidal. Seagrass beds have a medium sensitivity to this activity level. Literature has shown than digging and trampling from these activities 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 crab tilling activity if it were to occur over seagrass beds will pose a significant risk to the habitat feature in the Bembridge MCZ and	

				therefore the activity therefore could hinder the ability of the feature to achieve its 'recover' general management approach. Shrimp push netting occurs at a maximum light level in the site and likely only single passes over seagrass beds the activity is non-penetrative and small-scale in nature. The likelihood of netters catching seahorse is very low and in the unlikely event of a seahorse being caught the quick release would make it likely to survive. However, due to the activity and possibility of trampling effects leading to the removal of non-target seagrass blades rhizomes etc. and stalked jelly fish it is considered that push net activity is likely to hinder the ability of the seagrass beds feature to achieve its 'recover' general management approach through the removal of non-target species. 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 MA for each feature. However, such an assessment is relatively generic and does not take into account a number of site-specific factors.	
	Structure: sediment composition and distribution;	Not available	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 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.	Very little is known about hand work activity occurring in Seagrove Bay and Priory Bay north of Bembridge harbour. Access by foot is possible from a number of locations throughout Seagrove Bay, however the nearest car park is approximately 400m away. The same goes for those off of Bembridge Point. In Seagrove Bay Natural England's data indicates that the seagrass beds are subtidal and therefore will not be impacted by hand work, digging with forks or crab tilling activities. However, anecdotal information and Google Earth Pro satellite footage suggests that the seagrass bed in Seagrove Bay is no longer present. Those beds of off Bembridge Point are also subtidal and will therefore not	

			No information is available on the impacts of crab tilling and push netting on the sediment structure and composition.	be likely to interact with hand work/ digging or crab tilling activities. In Priory Bay access by foot is possible along the length of the bay however, there are no nearby carparks and the bay is boarded by woodland and grassland reducing the likelihood of hand work activities. The seagrass beds in the bay are predominantly subtidal however, there are small areas of intertidal habitat, over which seagrass beds have been recorded. Therefore, in Priory Bay the level of activity is likely to be very light within or near to these seagrass beds. Stretching from Tyne Ledge around to White ledge (Bembridge Ledges) are a number of elongate seagrass beds sandwiched in between rocky substrates. The rocks are exposed at low tides however the seagrass beds are located in pools which are found below mean low water. Therefore, once again these seagrass beds are unlikely to overlap with hand work, digging or crab tilling activities. Due to their location, near to rocks and in shallow pools, push netting in the site has the possibility to overlap with seagrass beds within these areas. No post survey sediment information is available for intertidal and seagrass areas in the Bembridge MCZ. 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. Crab tilling is unlikely to occur over seagrass beds but if it were to occur the crab tiles could alter the sediment structure as water movement around the object may wash away sediments and lead to the tiles sinking into the sediments over time. 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 if hand work, crab tilling and push netting activity were to occur in the habitat they will pose a significant risk to the seagrass habitat feature in the Bembridge 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 MA for each feature. However, such an assessment is relatively generic and does not take into account a number of site-specific factors.	

5 Management options

In recognition of the potential pressures of handwork/digging with forks, crab tilling & 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 these activities in areas which are not currently protected. This is due to the result of this MCZ assessment which has found that hand work/ digging with forks, crab tilling & push netting is likely to pose a significant risk to the seagrass features of the Bembridge 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[5]. 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), crab tilling and 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.

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 with forks activity is likely to pose a significant risk to seagrass beds within the Bembridge MCZ. The rationale for this conclusion is summarised below:

- A general lack of understanding of the handwork activity in Bembridge is apparent. However due to access difficulties and habitat types is it considered that hand work could only occur at a maximum of a light level. Seagrass beds are predominantly subtidal and therefore hand work activities and crab tilling are unlikely to overlap with the habitats.
- Southern IFCA does not have sightings data of handwork activity.
- A review of scientific literature revealed that hand work 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.
- Sensitivity of seagrass habitats to pressures associated with the activity is high. Sensitivity of seagrass beds to the activity at a light level is low - medium.

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

- Recovery of seagrass beds from this activity have been found to be two or more years.
- The review of the impacts of hand work/digging with forks on seagrass beds reported the habitat to have a low to medium sensitivity to light fishing activity (1-2 persons per day). Literature showed that the activity can lead to the immediate removal of the feature, with a minimum of a two-year recovery period. Therefore, it was concluded that the fishing activity if it were to occur over the habitat will prevent the ability of seagrass beds to attain their 'recover' general management approach.

For crab tilling activity it was also concluded that crab tilling is likely to pose a significant risk to seagrass beds within the Bembridge MCZ. The rationale for this conclusion is summarised below:

- A general lack of understanding of the crab tilling activity in Bembridge is apparent. However due to access difficulties and habitat types is it considered that crab tilling could only occur at a maximum of a light level. Seagrass bed are predominantly subtidal and therefore interaction with the activities is unlikely.
- Research suggests that crab tilling negatively affects the diversity and abundance of infauna, whilst increasing the abundance of shore crab.
- Anecdotal evidence indicates that crab tiles would smother and cause the death of seagrass leaves and rhizomes and when crab-tiles are left on the shore the water movement around the object can lead to changes in the sediment structure and the gradual sinking of the object.
- Sensitivity of seagrass beds to the activity at a light level is low - medium. Sensitivity of seagrass habitats to pressures associated with the activity is high.
- The review of the impacts of crab tilling on seagrass beds reported the habitat to have a low to medium sensitivity to light fishing activity (1-2 persons per day). Literature showed that the activity can lead to the death of the feature and changes in sediment structure. Therefore, it was concluded that the fishing activity if it were to occur over the habitat will prevent the ability of seagrass beds to attain their 'recover' general management approach.

For push netting activity it was concluded that the activity is likely to pose a significant risk to the seagrass beds within the Bembridge MCZ. The rationale for this conclusion is summarised below:

- The activity occurs at a maximum of a light level in the site but is actually much more infrequent over seagrass beds as this is not the target habitat. The activity occurs on low spring tides for up to 3 hours at a time.
- There is no research available which describes the impact of the activity to seagrass or other benthic habitats.
- The review of the impacts of casual gathering on seagrass beds reported the habitat to have a low to medium sensitivity to light fishing activity (1-2 persons per day) and low sensitivity to a single pass.
- The gear does not contain any teeth or other part which would penetrate the seabed however, the gear is pushed over the surface of the seabed and the activity involves walking over the seabed surface/substratum. Literature indicates that seagrass beds have a medium sensitivity to abrasion/disturbance of the surface of the substratum or seabed.
- The activity does not target seagrass so the capture of seahorses is very unlikely and, due to the small, light nature of the gear combined with short push periods, there is a high likelihood that any caught would be returned alive to the sea. However, stalked jelly fish could be removed from the blade of seagrass through abrasion from the push nets.

It is therefore recognised that the hand work/digging with forks, crab tilling and push netting 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, crab tilling activity 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, crab tilling and push netting will not pose a significant risk to the achievement of sites conservation objectives to ‘recover’ seagrass beds to favourable condition.

7 References

Alexandre, A, Santos, R, Serrã, E. 2005. Effects of clam harvesting on sexual reproduction of the seagrass Zostera noltii. Marine Ecology Progress Series**. 298**: 115-122.

Barañano, C. Fernández, E. & Méndez, G. 2018. Clam Harvesting decreases the sedimentary carbon stock of a *Zostera marina* meadow. Aquatic Botany. **146**: 48-57

Bertelli, C.M., Robinson, M.T., Mendzil, A.F., Pratt, L.R. & Unsworth, R.K.F. 2018. Finding some seagrass optimism in Wales, the case of Zostera noltii. Marine Pollution Bulletin. **134**:216-222.

Blake, R. W. 1979a. Exploitation of a natural population of *Arenicola marina* (L.) from the North-East Coast of England. Journal of Applied Ecology. **16 (3**): 663-670

Blake, R. W. 1979b. On the exploitation of a natural population of *Nereis virens* Sars from the North-East Coast of England. Estuarine and Coastal Marine Science**. 8:**141-148

Boese, B.L. 2002 Effects of recreational clam harvesting on eelgrass (Zostera marina) and associated infaunal invertebrates: in situ manipulative experiments. Aquatic Botany**. 73**:63-74

Boese, B., Kaldy, J.E., Clinton, P.J., Eldridge, P.M. & Folger, C.L. 2009. Recolonization of intertidal *Zostera marina* L. (eelgrass) following experimental shoot removal. J. Exp. Mar. Biol. Ecol**. 347**: 69-77.

Boese, B.L. 2002 Effects of recreational clam harvesting on eelgrass (Zostera marina) and associated infaunal invertebrates: in situ manipulative experiments. Aquatic Botany. **73**:63-74

Branco, J., Pedro, S., Alves, A.S., Ribeiro, C., Materatski, P., Pires, R,. Caçador, I., Adão, H., 2018. Natural recovery of Zostera noltii seagrass beds and benthic nematode assemblage responses to physical disturbance caused by traditional harvesting activities. Journal of Experimental Marine Biology and Ecology. **502:** 191-2020

Brown, B., Wilson Jr, W.H. 1997. The role of commercial digging of mudflats as an agent for change of infaunal intertidal populations. Journal of experimental marine biology and ecology. **218**:49-61

Cabaço, S. & Santos, R. 2007. Effects of burial and erosion on the seagrass Zostera noltii. Journal of experimental marine biology. **340**:204-212.

Cabaço, S. & Santos, R. 2012. Seagrass reproductive effort as an ecological indicator of disturbance. Ecological Indicators. **23**:116-122.

Carvalho, S., Constantino, R., Cerqueira, M., Pereira, F., Subida, M>D>, Drake, P., & Gaspar, M.B. 2013. Short term impact of bait digging on intertidal microbenthic assemblages of two south Iberian Atlantic systems. Estuarine, Coastal and shelf science. **132**: 65-76

D'Avack, E.A.S., Tyler-Walters, H., Wilding, C., Garrard, S.M., 2019. [Zostera (Zostera) marina] beds on lower shore or infralittoral clean or muddy sand. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 21-12-2020]. Available from: https://www.marlin.ac.uk/habitat/detail/257

Davison, D.M. and Hughes, D.J. 1998. Zostera biotopes: An overview of dynamics and sensitivity characteristics for conservation management of marine SACs, Scottish Association for Marine Science, (UK Marine SACs Project). **1**: 40-41.

De Cubber, L., Lefebvre, S., Fisseau, C., Cornille, V., Gaudron, S.M. 2018. Linking life-history traits, spatial distribution and abundance of two species of lugworms to bait collection: A case study for sustainable management plan. Marine Environmental Research. **140**:433-443

Dernie, K.M., Kaiser, M.J., Richardson, E.A. & Warwick, R.M. 2003b. Recovery of soft sediment communities and habitats following physical disturbance. J. Exp. Mar. Biol. Ecol. **285-286**: 415-434.

Eckrich C, Holmquist J (2000) Trampling in a seagrass assemblage: direct effects, response of associated fauna, and the role of substrate characteristics. Mar Ecol Prog Ser **201**: 199–209

Griffiths, J., Dethier, M.N., Newsom, A., Byers, J.E., Meyer, J.J., Oyarzun, F. & Lenihan, H. 2006. Invertebrate community responses to recreational clam digging. Mar. Biol. **149**: 1489– 1497.

Hall, K., Paramor, O.A.L., Robinson L.A., Winrow-Giffin, A., Frid C.L.J., Eno, N.C., Dernie, K.M., Sharp, R.A.M., Wyn, G.C.& Ramsay, K. (2008). Mapping the sensitivity of benthic habitats to fishing in Welsh waters-development of a protocol. CCW [Policy Research] Report No: [8/12], 85pp.

Jackson, M. J. & James, R. 1979. The influence of bait digging on cockle, Cerastoderma edule, Populations in North Norfolk. Journal of Applied Ecology. **16(3**):671-679.

Johnson, G. E. L., Attrill, M.J., Sheehan, E.V. & Somerfield, P.J. 2007. Recovery of meiofauna communities following mudflat disturbance by trampling associated with crab tiling. Mar Env. Res. **64**: 409-416.

Kaiser, M.J., Borad, G. & Hall, S.J., 2001. Disturbance of intertidal soft-sediment benthic communities by cockle hand ranking. J. Sea Res. **45**: 119-130.

Major, W.W., Grue, C.E., Grassley, J.M., & Conquest, L.L. 2004. Non- target impacts to eelgrass from treatments to control spartina in Willapa Bay, Washington. Journal of Aquatic Plant Management. **42**:11-17.

McLusky, D.S., Anderson, F.E., Wolfe-Murphy, S. 1983. Distribution and population recovery of Arenicola marina and other benthic fauna after bait digging. Marine Ecology Progress Series. **11**:173-179.

Mistri. M., Cason, E., Munari, C., Rossi, R. 2009. Disturbance of a soft-sediment meiobenthic community by clam hand raking. Italian Journal of Zoology. **71(2):** 131-133.

Nejrup, L.B. and Pedersen, M.F. 2008. Effects of salinity and water temperature on the ecological performance of Zostera marina. *Aquatic Botany*. **88**: 239-246.

Park, S.R., Kim, Y. K., Kim, J-H., Kang, C-K., Lee, K-S. 2011. Rapid recovery of the intertidal seagrass Zostera japonica following intense Manila clam (*Ruditapes philippinarum*) harvesting activity in Korea. Journal of Experimental Marine Biology and Ecology. **407**:275-283

Qin, L-Z., Li, W-T., Zhang, X., Zhang, P., Qiao, W. 2016. Recovery of the eelgrass Zostera marina following intense Manila clam (*Ruditapes philippinarum*) harvesting disturbance in China: The role and fate of seedlings. Aquatic Botany. **130** :27-36.

Rossi, F., Forster, R.M., Montserrat, F., Ponti, M., Terlizzi, A., Ysebaert, T. & Middleburg, J.J. 2007. Human trampling as short-term disturbance on intertidal mudflats: effects on macrofauna biodiversity and population dynamics of bivalves. Mar. Biol. **151**: 2077-2090.

Sheehan, E.V, Coleman R.A, Thompson, R.C, Attrill, M.J. 2010. Crab-tiling reduces the diversity of estuarine infauna. *Marine ecology progress series.* **411:** 137–148.

Sheehan, E.V, Thompson, R.C, Coleman, R.A, Attrill, M.J. 2008. Positive feedback fishery: population consequences of 'crab-tiling' on the green crab Carcinus maenas. *Journal of Sea Research.* **60:** 303–309

Sherman K.M. & Coull, B.C. 1980. The response of meiofauna to sediment disturbance. Journal of Experimental Marine Biological Ecology.**46**: 59-71.

Suonan, Z., Kim, S.H., Qin, L-Z., Lee, K-S. 2017. Reproductive strategy of the intertidal seagrass Zostera japonica under different levels of disturbance and tidal inundation. Estuarine, Coastal and Shelf Science. **197**:185-193

Tillin, H.M., Hull, S.C., Tyler-Walters, H. 2010. Development of a Sensitivity Matrix (pressures-MCZ/MPA features). Report to the Department of Environment, Food and Rural Affairs from ABPMer, Southampton and the Marine Life Information Network (MarLIN) Plymouth: Marine Biological Association of the UK. Defra Contract No. MB0102 Task 3A, Report No. 22.

Thistle, D. 1981. Natural physical disturbances and communities of marine soft bottoms. Marine Ecological Progress Series. **6**:223-228

Travaille, K.L., Salinas-de-Leon, P., Bell, J.J. 2015. Indication of visitor trampling impacts on intertidal seagrass beds in a New Zealand marine reserve. Ocean & coastal Management. **114:** 145-150.

Tyler-Walters, H. & Arnold, C. 2008. Sensitivity of Intertidal Benthic Habitats to Impacts Caused by Access to Fishing Grounds. *Report to Cyngor Cefn Gwlad Cymru / Countryside Council for Wales from the Marine Life Information Network (MarLIN).* Marine Biological Association of the UK, Plymouth. [Contract no. FC 73-03-327]

Tyler-Walters, H. & Heard, J.R. 2017. Calvadosia campanulata A stalked jellyfish. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 21-12-2020]. Available from: https://www.marlin.ac.uk/species/detail/2101

Watson, G.J. Murray, J.M., Schaefer, M., Bonner, A., Gillingham, M. 2017. Assessing the impacts of bait collection on inter-tidal sediment and the associated macrofaunal and bird communities: The importance of appropriate spatial scales. Marine Environmental Research. **130**: 122-133

Watson, G.J., Farrell, P., Stanton, S. & Skidmore, L.C. 2007. Effects of bait collection on *Nereis virens* populations and macrofaunal communities in the Solent. UK. Journal of Marine Biological association**. 87**: 703-716

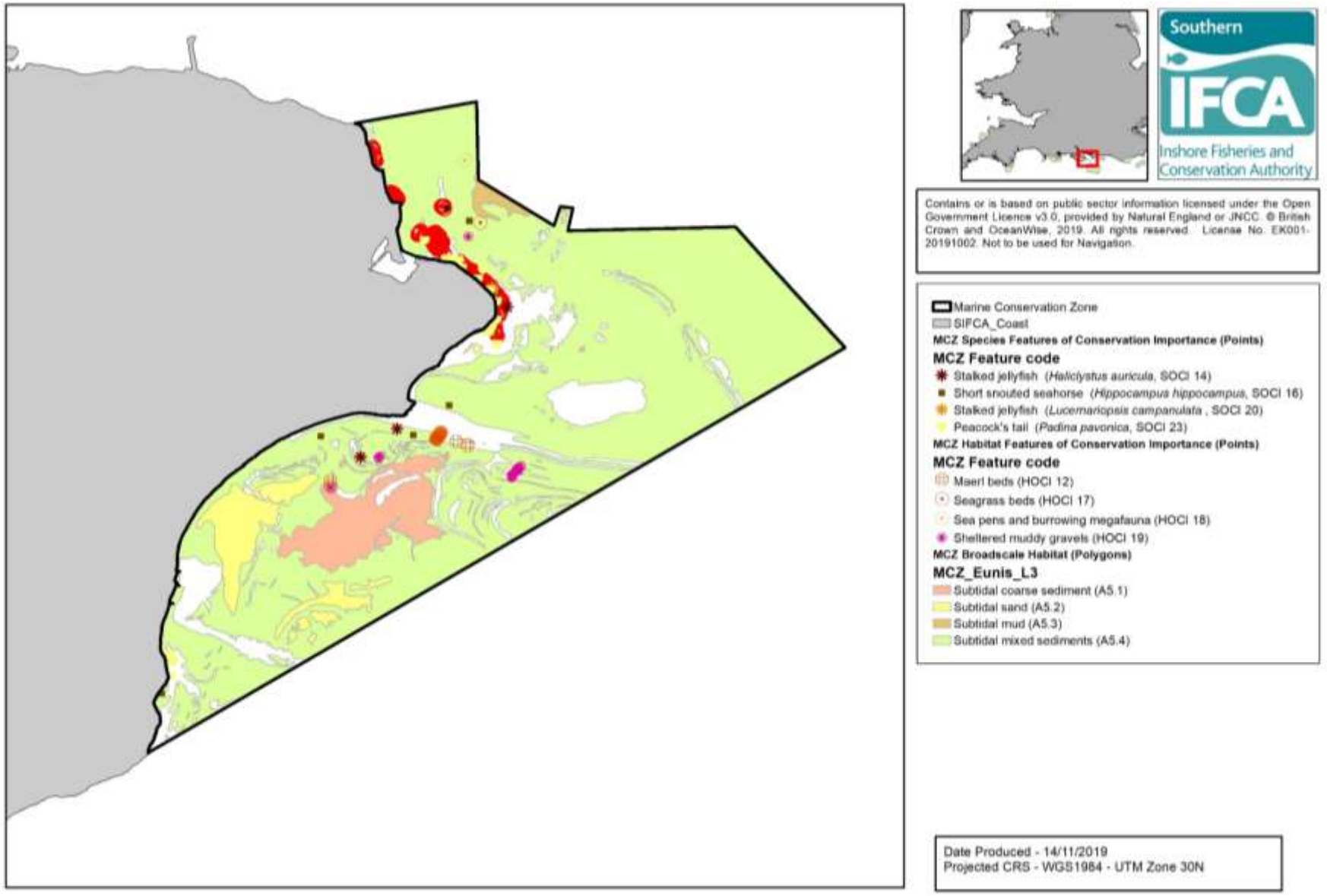
Wynberg, R.P. & Branch, G.M. 1994. Disturbance associated with bait collection for sand prawns (*Callianassa kraussi*) and mudprawns (*Upogebia africana*): Long term effects in the biota of intertidal sandflats. Journal of marine research. **52**:523-558.

Wynberg, R.P. & Branch, G.M. 1997. Trampling associated with bait collection from sand prawns *Callianassa kraussi* Stebbing: effects on the biota of an intertidal sandflat. Environmental conservation **2:**139-148

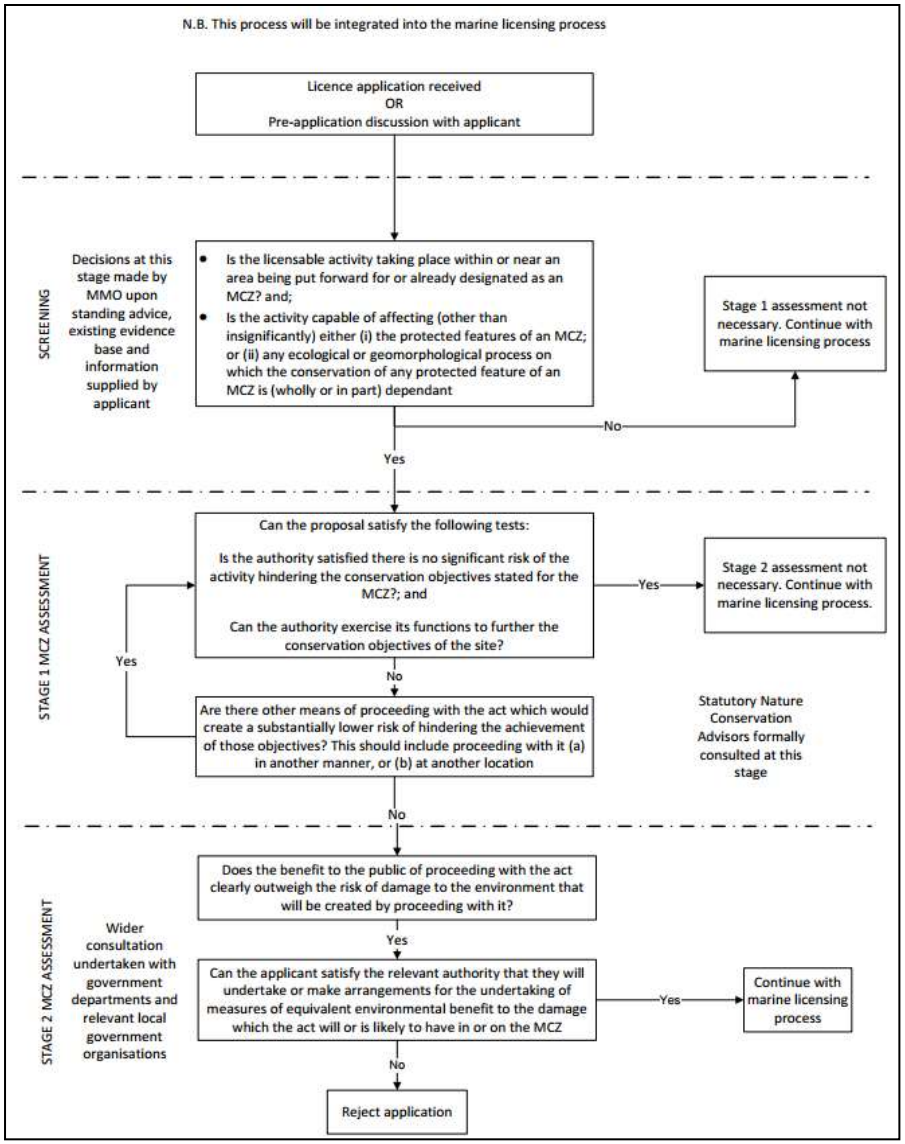
Valdemarsen, T., Wendelboe, K., Egelund, J.T., Kristensen, E. & Flindt, M.R. 2011. Burial of seeds and seedlings by the lugworm *Arenicola marina* hampers eelgrass (*Zostera marina*) recovery. Experimental Marine Biology and ecology. **410**:45-52

Van den Heiligenberg, T. 1987. Effects of Mechanical and manual harvesting of lugworms *Arenicola marina* L. on the benthic fauna of tidal flats in the Dutch Wadden Sea. Biological Conservation. **39**: 165-177.

Annex 1 Broad-scale habitat and features of conservation Importance (FOCI) map for the Bembridge MCZ. Source: Natural England Marine Protected Area feature data set 2019.



Annex 2 Summary of MMO assessment process for MCZs



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

Broad Gear Type (for assessment)	Aggregated Gear Type (EMS Matrix)	Fishing gear type	Does it Occur?	Details	Sources of Information	Potential For Acivity Occur/ Is the activity anticipated to occur?	Justification	Suitable for Part A Assessment?
Bottom towed fishing gear	**Towed (demersal)**	Beam trawl (whitefish)	Unknown		Local IFCO	**Y**	**Vessels in the area activly light otter trawl. Some of these have beam trawl equipment and so this activity has the potential to occur (i.e. suitable trawl ground due to coarse substrate). If the activity were to occur, it would most likely be on an irregular basis on the fringes of the site and has nott been seen in the site. The likeliood of the activity occuring is therefore considered to be low.**	**Y**
		Beam trawl (shrimp)	N		Local IFCO	**N**	**Target species does not occur.**	

		Beam trawl (pulse/wing)	N		Local IFCO	**N**	**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	**Y**	**Has not historically occurred and is not currently known to occur, however one small vessel operating within district has the gear but has not been seen active in the area therfore it is not anticipated to occur.**	

		Light otter trawl	Y	Approx 3 vessels, fishing when weather permits, on the fringes of the site, mainly between March and October when it is not clamming season.	Local IFCO	**Y**	**Activity is known to occur.**	**Y**
		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 histoircally 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. 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. Also limited potential due to the restricted area of the site to accommodate for two vessels.**	
		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.	
Bottom towed fishing gear	**Dredges (towed)**	Scallops	Y	The activity occurs with up to 5 vessels taking part in the fishery. However, a maxium of 3 at a time are seen on the fringes of the site. The fishery occurs over the winter and usually lasts around one month.	Local IFCO	**Y**		**Y**

		Mussels, clams, oysters	N		Local IFCO	**N**	**Clam and mussel target species are not known to occur within the site. Oyster dredging has historically taken place within the Solent which the site sits within proximity to. The Solent oyster population has since been in decline and there are currently no indications of recovery, however restoration efforts commenced in 2015 and continue to do so. Based on the current status of the Solent oyster population and the direction of decline (from west to east) in the Solent, the activity is not anticipated to occur within the site within the foreseeable future.**	
		Pump scoop (cockles, clams)	N		Local IFCO	**N**	**A Statutory instrument prohibits pump scoop fishing in the Solent.**	

Suction	**Dredges (other)**	Suction (cockles...)	N		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. The potential for activity to occur is limited due to limited access and substrate suitability.**	
Intertidal work	**Intertidal handwork**	Hand working (access from vessel)	N		Local IFCO	**N**	**Handworking with access from a vessel infers a muddy habitat where there difficulty accessing areas. At this site, the dominance of mixed sediments 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**	**Activity is known to occur.**	**Y**

Static - pots/traps	**Static - pots/traps**	Pots/creels (crustacea/gastropods)	Y		Local IFCO	**Y**	**Activity is known to occur.**	**Y**
		Cuttle pots	Y		Local IFCO	**Y**	**Activity is known to occur.**	
		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	Less than ten vessels use nets in the site. Some are active all year round whilst others only operate the acitivty in the summer. The target species are bream, sole, plaice, smoothhound and others.	Local IFCO	**Y**	**Activity is known to occur.**	**Y**
		Trammels	Y		Local IFCO		**See 'gill nets'**	
		Entangling	Y		Local IFCO		**See 'gill nets'**	

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 the rushing tide that effects the site, particularly the outer areas. Because of other gear….**	
Demersal nets/lines		Drift nets (demersal)	N		Local IFCO	**N**	**Activity is not anticipated to occur and potential for the activity is limited by the rushing tide that effects the site, particularly the outer areas.**	
	Lines	Longlines (demersal)	Unknown		Local IFCO	**Y**	**It is anticipated that demersal longlines have the potential to be used used within the site as they are used in the Solent.**	**Y**
Pelagic nets/lines		Longlines (pelagic)	Uknown		Local IFCO	**Y**	**It is anticipated that demersal longlines have the potential to be used used within the site as they are used in the Solent.**	

		Handlines (rod/gurdy etc)	Y		Local IFCO	**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 highly unlikely to interact with any of the designated features (which are predominantly subtidal).**	
		Jigging/trolling	Y	see handlines	Local IFCO	**Y**	**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	**N**	**Activity has not historically occurred within the site and is not anticipated to occur.**	

Miscellaneous		Shrimp push-nets	Unknown		Local IFCO	**Y**	**The activity is known to occur else where around the Isle of Wight. It is not known to occur in the Bembridge MCZ but may have the potential to occur.**	**Y**
EA Only		Fyke and stakenets			**EA Only**			
Miscellaneous	**Miscellaneous**	Commercial diving	N			**N**	**Activity has not historically occurred and is not anticipated to occur.**	
Bottom towed fishing gear		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			**Y**	**The activity is not known to occur within the Bembridge MCZ but there is the potential that the activity could occur within the site.**	**Y**
Intertidal work	**Bait collection**	Digging wth forks	Y			**Y**	**Activity know to occur.**	**Y**

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

Pressure Name	Habitat									
	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
Abrasion/disturbance of the substrate on the surface of the seabed			S	S						
Habitat structure changes - removal of substratum (extraction)			S	S						
Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion			S	S						
Removal of non-target species			S	S						
Removal of target species			S							
Deoxygenation			NS	S						
Hydrocarbon & PAH contamination			NA	NA						
Introduction of light			S	IE						
Introduction or spread of invasive non-indigenous species (INIS)			S	S						
Litter			NA	NA						
Synthetic compound contamination (incl. pesticides, antifoulants, pharmaceuticals)			NA	NA						
Transition elements & organo-metal (e.g. TBT) contamination			NA	NA						
Underwater noise changes										