Marine Conservation Zone Assessment

Site name: Erme Estuary MCZ
UKMCZ0059

Protected feature(s):
Intertidal coarse sediment
Intertidal mixed sediment
Sheltered muddy gravels
Tentacled lagoon worm (*Alkmaria romijni*)

Fishing activities assessed at this site:
Stage 1 Assessment
Intertidal handwork: Handworking (access from vessel), Handworking (access from land)
Miscellaneous: Crab tiling
Bait collection: digging with forks

D&S IFCA Reference
ERM-MCZ-002

Contents

Version control history			
Author	**Date**	**Comment**	**Version**
Sarah Curtin	October 2021	Draft assessment	0.1
	February 2022	Updated using other estuarine MCZ advice packages with similar habitat	0.2
	April 2022	Minor amendments by SC	0.3
	November 2022/January 2023	Finalised by J. Stewart and reviewed by S. Clark	1.0

1. Introduction

This assessment has been undertaken by Devon & Severn Inshore Fisheries and Conservation Authority (D&S IFCA) in order to document and determine whether management measures are required to achieve the conservation objectives of marine conservation zones (MCZs). The IFCA's responsibilities in relation to management of MCZs are laid out in Sections 124 to 126, & 154 to 157 of the Marine and Coastal Access Act 2009.

2. MCZ site name(s), and location

The Erme Estuary MCZ is an inshore site of approximately 1km^2 in size. The Erme is located in South Devon and opens into the Western Channel and Celtic Sea region. The MCZ designation covers the whole estuary from the mouth of the river to the limits of the tidal influence near the village of Ermington. The MCZ falls within the Erme Estuary Site of Special Scientific Interest as well as overlapping with the Prawle Point to Plymouth Sound and Eddystone Site of Community Importance at the mouth of the river.

The wide variety of habitats found within the Erme Estuary support a large number of important species including several that are rare, such as the tentacled lagoon worm, *Alkmaria romijni*. This tiny bristleworm grows up to 5mm in length and creates and lives in tubes within the mud habitats of the estuary. These worms have tentacles around their mouths used for gathering food from the surrounding muddy sediments. The tentacled lagoon worm is particularly vulnerable to activities that cause changes in its habitat.

Estuaries create important areas for wading and migratory birds to feed and rest and form nurseries for juvenile species of fish. The large areas of mudflats and muddy gravel produce films of algae which become exposed at low tide, making them important foraging grounds for several species. The estuarine rocky habitats provide a hard surface for algae and animals to attach in an area dominated by sand and mud with variable salinity. At low tide these areas become foraging grounds for birds and crustaceans and at high tide they create shelter for juvenile species of fish.

At the mouth of the river exposed rocks provide a hard surface for mussels, limpets and barnacles to attach to in areas dominated by sediment and muddy gravel (Defra, 2019).

Further information regarding the MCZ and its protected features can be found in the Erme Estuary MCZ Factsheet.

3. Feature(s) / habitat(s) of conservation importance (FOCI/HOCI) and conservation objectives

Table 1 - Protected features relevant to this assessment

Feature	General management approach
Intertidal coarse sediment	Recover to favourable condition
Intertidal mixed sediment	Maintain in favourable condition
Sheltered muddy gravels	Maintain in favourable condition
Tentacled lagoon worm (*Alkmaria romijni*)	Maintain in favourable condition

The conservation objectives for these features are that they are brought to, and remain in, favourable condition.

4. Gear/feature interaction in the MCZ categorised as 'red' risk and overview of management measure

None - There are no gear/feature interactions in the MCZ that are categorised as 'red' risk.

5. Activities under consideration

Intertidal handwork: Handworking (access from vessel), Handworking (access from land)
There may be some minor hand gathering for cockles, but this activity appears to be occurring at a very low level (one respondent replied out of a possible 148, to a request for information advising they carry out this activity on average twice a month).

Miscellaneous: Crab tiling
Surveys were not undertaken on the River Erme in 2020 due to no tiles being present in previous years. There is no evidence that this activity is taking place within the Erme Estuary MCZ. However, there is no evidence that it is not occurring at a low, undetected level and therefore cannot be completely ruled out.

Bait collection: digging with forks

D&S IFCA conducted bait digging surveys in summer and autumn of 2020. During these surveys no evidence was found of bait digging (or other forms of handworking) on the Erme Estuary.

D&S IFCA circulated a request for information on bait digging to the local community and the landowner of the Erme Estuary to gather evidence and better understand fishing activity within the site. The landowner of the Erme Foreshore and Estuary advised that low levels of bait digging (1-2 bait diggers three to four times a year) does occur on the western side of the estuary at low tide on the exposed sand flats in front of the coastguard cottages. In addition, one respondent from the request for information advised they dig for bait on average twice a month.

See Curtin (2022) for more information regarding fishing activities occurring in the Erme Estuary MCZ.

6. Is there a risk that activities are hindering the conservation objectives of the MCZ?

Yes,
Evidence:
To determine whether each pressure is capable of affecting (other than insignificantly) the site's feature(s), the sensitivity assessments and risk profiling of pressures from the advice on operations section of the Natural England conservation advice package were used (Natural England, 2021). Table 22 shows the fishing activities and pressures included for assessment. The justifications for the pressures chosen for inclusion in this assessment can be seen in Annex 2.

Table 2 - Fishing activities and pressures included in this assessment.

Activity	Pressures
Shore based activities: Handworking, crab tiling, bait collection	Abrasion/disturbance of the substrate on the surface of the seabed
	Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion
	Removal of target species
	Removal of non-target species

It should be noted that no conservation advice package is currently available (November 2022) for the Erme Estuary MCZ. Therefore, relevant advice on operations and supplementary advice tables for other sites with similar features were used (**Error! Reference source not found.**), alongside considering site specific information.

Table 3 - Relevant favourable condition targets for identified pressures.

Feature	Conservation advice package used
Intertidal coarse sediment	Axe Estuary MCZ
Intertidal mixed sediment	
Sheltered muddy gravels	No alternative CA package found, intertidal mud used as proxy
Tentacle lagoon worm (*Alkmaria romijni*)	Dart Estuary MCZ

7. Can D&S IFCA exercise its functions to further the conservation objectives of the site?

Yes,
Evidence: Monitoring and Control Arrangements

- Monitor activity levels
- Consideration of a new Hand Working Permit Byelaw to manage the use of crab tiles, bait digging and many other hand gathering types of fishing activity.

On the 14th November 2019, the D&S IFCA Byelaw & Permitting Sub-Committee discussed the different options that exist to manage hand working types of fishing activity as set out in a report (D&S IFCA, 2019). The development of a new byelaw was the option selected, however it is envisaged that it will be a slightly different regulatory format as compared to the D&S IFCA permit based byelaws already implemented to manage other fishing activity.

The potential need for a permit to conduct the different activities will become a factor in the future drafting work. It is envisaged that the requirement for a permit to conduct bait collection and hand gathering will be dependent on the amounts of resource taken. The Hand Working Permit Byelaw would introduce fixed provisions that apply to all persons. Fixed provisions are expected to include a series of catch limits (bag limits) for different species (sea fisheries resources) that are targeted by different types of hand working fishing methods. The bag limits would provide an upper level of catch (a threshold) that would apply to all persons but providing the individual take of the specified species was below the levels set for personal use, it is not envisaged that a permit would be required for the collection of the resources. Commercial activity would exceed the bag limits for recreational take and would therefore be regulated by conditions of use that would be placed in the permits issued by D&S IFCA. D&S IFCA will be seeking the views of all stakeholders to better inform the decision making needed to set the initial bag limits.

The development of a Hand Working Permit Byelaw is now a longer-term commitment for D&S IFCA. As a reflection of the time and resource required and available to conduct the required elements of the work, including reporting and the decision-making of D&S IFCA's Byelaw and Permitting Sub-Committee, the development of this Byelaw is not included in D&S IFCA's 2022–2023 Annual Plan (D&S IFCA, 2022). Key Tasks for 2022-2023 reflect what is deliverable with the current level of staffing and financial resourcing available to D&S IFCA

8. Referenced supporting information to inform assessment

Bait digging has been found to have a range of impacts on both the sediment it occurs on, and the communities within it:

Impacts on sediment

Bait digging usually occurs to depths of 30cm, unearthing a deeper sediment that would usually remain undisturbed (Jackson and James, 1979). Changes can therefore occur in sediment characteristics as a result of bait digging. Undug sediment was found to have a higher organic content than dug sediment. The process of turning over the sediment and erosion of sediment mounds by tides and wave action leads to a loss of finer fractions and associated organic material. In contrast, the basins may collect organic matter and fine sediments (Anderson and Meyer, 1986). This could have implications for local sediment load and turbidity levels (Watson *et al.*, 2017).

If the mounds of sediments are subsequently returned through the process of back- or in-filling, then the effect of the disturbance is reduced and recovery can occur within three weeks (Fowler, 1999). Recovery rates are therefore influenced by the energy of the site, and behaviour of the bait diggers. Coarse sand beaches with considerable wave action will recover more quickly than sheltered sites. Experimentally dug plots in a very sheltered location in the Menai Strait were still visible after a year, although this is thought to be due to the presence of boulder clay (Johnson, 1984). Other, less sheltered, sites have reported a timeframe of 25 days for holes to disappear (Johnson, 1984). It is not currently known whether the bait diggers on the Erme backfill holes.

Impacts on target species

Both blow lugworm (*Arenicola marina*) and king ragworm (*Alitta virens*) are targeted by bait diggers throughout the D&S IFCA's District.

Contrasting evidence exists as to the *direct* environmental effects of bait digging for lugworm. Relative to other exploited intertidal invertebrates, blow lugworms are relatively resilient to exploitation and disturbance because of their relative fecundity and widespread distribution (Fowler, 1999). In addition, *A. marina* exhibit a marked annual cycle in the numbers and condition of individuals, so that any changes in population structure correlated to bait digging, would have to control for these factors (Olive, 1993). Removal rates of 50-70% of worms in the area dug have been reported in the literature (Blake, 1979; Heiligenberg, 1987) but D&S IFCA's observations suggest this may be much lower in some areas, especially where large areas of lugworm exist and holes are relatively well spread out. A D&S IFCA bait density survey of lugworms at Burnham-on-Sea, Berrow, Brean, Weston-Super-Mare and Sand Bay found remarkably similar spatial patterns of abundance and densities to those reported in the 1970's, suggesting no long-term decline in lugworm populations (Ross, 2013).

A wide range of responses by *A. marina* to exploitation or experimental simulations of exploitation have been found, relating to local environmental conditions and the intensity and distribution of bait digging activity. Olive (1993) describes the scenario which led to complete removal of all lugworms from a large area of a National Nature Reserve in Northumberland in 1984, with densities falling from >$40m^{-2}$ to <$1m^{-2}$. When the site was closed to bait digging it repopulated within a matter of months, thanks to the presence of extensive non-exploited populations nearby. Similarly, lugworm populations in the Dutch Wadden Sea appear to be unaffected by large scale commercial exploitation, with an estimated 2×10^7 individuals taken annually. However, Cryer et al. (1987) found no recovery in worm densities after 6 months following experimental removal, although natural densities at the test site in South Wales were low (9-16 m^{-2}) and the survey ran through the less productive winter months. The capacity of a population to withstand bait digging activities therefore relies on a number of factors including the size of the exploited area relative to the total lugworm bed, the presence of other lugworm beds nearby, the presence of nursery areas, the relative exploitation of adult and juvenile lugworms, and the intensity and seasonality of bait digging. However, on the whole they are thought to be resilient to bait digging.

King ragworm, *A. virens,* is a keystone intertidal species as prey for fish, birds and crustaceans, is a predator of other invertebrates and has an important role in bioturbation of the sediment (Watson *et al.*, 2017). *A. virens* are generally found in more sheltered sediment areas but they can also be found in more mixed sediments. Differing reports exist of the life-history and population characteristics of *A. virens.* Whilst early studies of North American populations suggested a mean age at breeding of >3 years with the population dominated by 0-group individuals, a population from the Menai Straight, Wales was thought to mature later, and to have very few 0-group individual present. The latter population was therefore seen as being vulnerable to exploitation. On the North East coast of England, a study found similar densities (~15m^2 during the summer, ~3m^2 during the winter) of *A. virens* in both exploited and unexploited populations Blake (1979), suggesting that at least some populations are unaffected by bait digging. In other cases the change in macrofaunal community has been thought to benefit *A. virens*, due to its opportunistic nature (Evans *et al.*, 2015).

Impacts on non-target species

Bait digging can have adverse effects on a wide variety of species as a result of physical damage, burial, smothering and/or exposure to desiccation or predation to non-target invertebrates. Recovery of small short-lived invertebrates will usually occur within a year, but populations of larger, long-lived invertebrates may take much longer (Fowler, 1999). In some extreme cases local diversity may be reduced, which may be especially true in physically fragile environments such as eelgrass or mussel beds (Fowler, 1999). Similarly, Beukema (1995) found that within a 1km^2 area of the Dutch Wadden Sea, the local lugworm stock declined by more than 50% over a four-year mechanical digging period. As a result of this decline, total zoobenthic biomass also declined, with short lived species showing a marked reduction during the digging period. Recovery of the benthos took several years, especially by the slower establishing species. However, if disturbance by digging is short term, benthic communities can recover within six months (Beukema, 1995).

Mosbahi et al. (2015) also explored the impacts of bait digging on the macrofauna of intertidal mudflats. The fauna of their study area (the tidal mudflats of Kneiss Islands, Tunisia) was mainly composed of polychaetes, the more abundant families being the *Nereididae*, *Arenicolidae* (fishing target species) and the *Cirratulidae*. They found the number of taxa and abundance of individuals were affected by bait digging; the abundance estimates at the control stations were significantly higher than those estimated at the three stations before and after bait collection, with some polychaete species disappearing after one month of bait digging. This indicates that the intertidal macrozoobenthic biodiversity at the impacted stations is affected by the bait digging activity, or possibly by trampling.

Jackson and James (1979) investigated the effects of bait digging on cockle populations. They found that increased digging in an area caused higher cockle mortality, particular on smaller individuals. The cause of mortality was due to burial/smothering as individuals that were buried at a depth of 10cm rarely survived.

Rossi *et al*. (2007) investigated the effects of trampling on mudflats, such as that associated with recreational activities like bait digging. They found that trampling did not influence mobile species such as *Hydrobia ulvae* and *Hediste diversicolor,* but clearly modified the abundance and population dynamics of bivalves such as the clam *Macoma balthica* and the cockle *Cerastoderma edule.* There was a negative impact on adults of both species, which was attributed to footsteps directly killing or burying the animals, leading to asphyxia. Abundance of small-sized/juvenile *C. edule* showed no response to trampling. It is likely that the population-level abundance of small animals could recover more quickly because trampling occurred during the reproductive season (April to October), which meant that there was likely a continuous supply of larvae and juveniles in the water column to replace those displaced by the trampling. In contrast, trampling seemed to indirectly enhance the recruitment rate of *M. balthica*. In an environment with little trampling, adult cockles can easily outcompete larvae and spats of other bivalves; disturbance of sediment whilst feeding or moving and high filtration of planktonic larvae can reduce the settling and recruitment of other bivalves. The direct impacts of trampling (e.g. a reduction in adult cockle abundance), can therefore indirectly increase the recruitment opportunities for other bivalve species such as *M. balthica*, which take advantage of the reduced competition from *C. edule* adults. Over the long term, this could ultimately cause a shift towards a dominance of *M. balthica* in the macrofaunal assemblage, at the cost of *C. edule*, thereby potentially affecting ecosystem functioning.

Therefore, despite potentially fast recovery times, Rossi *et al*. (2007) concluded that human trampling is a relevant source of disturbance for the conservation and management of mudflats.

Wynberg & Branch (1997) assessed the impacts of trampling associated with the use of suction pumps for the collection of prawns as bait, by comparing areas that had been sucked over with a prawn pump, to areas that had been trampled only. Prawn densities were depressed six weeks following both sucking and trampling but recovered by 32 weeks. Macrofaunal numbers declined in most treatment areas and macrofaunal community composition in the most-disturbed areas was distinct from that in other areas. They determined that the trampling itself has almost the same effect as sucking for prawns, on both the prawns and on the associated biota.

It is important to note that the effects on macrofaunal communities can differ substantially between estuaries. For example, the mud content of an estuary can affect the resilience of the communities to bait digging. Although Dernie et al. (2003) found that it was not possible to predict the recovery rates of assemblages based on percentage of silt and clay in the sediment, there was a good relationship between recovery rate and infilling rate, which is linked to the physical characteristics of the sediment. Clean sand habitats were the quickest to recover both in terms of physical and biological characteristics. Other studies have also found extended recovery times for estuaries with high mud content (Carvalho *et al.*, 2013). Infilling rates are also thought to be directly affected by digger behaviour, with infilling rates being improved by diggers backfilling holes after digging.

The site-specific nature of the impacts of bait digging was also demonstrated by Watson et al. (2017). They found that responses were both site and disturbance type specific. Their data also showed that responses were not consistent between species (e.g. *Corophium volutator* and *Peringia ulvae* or even between those within the same trophic group. They therefore concluded that bait collection alters the macrofaunal community and the associated sediment characteristics across large spatial scales, but with the caveat that the strength (and type) of the response is site specific.

9. In-combination assessment

Table 4 - Relevant activities occurring in or close to the site

Plans and Projects		
Activity	**Description**	**Potential Pressure(s)**
No other plans or projects known to be occurring within Erme Estuary MCZ	The impact of future plans or projects will require assessment in their own right, including accounting for any in-combination effects, alongside existing activities.	N/A
Other activities being considered		
Activity	**Description**	**Potential Pressure(s)**
Static – pots/traps: Pots/creels, cuttlepots, fish traps	Potting for lobster and crab does occur but at low levels and at the seaward limit of the MCZ. In addition, these activities will not be occurring in the intertidal, therefore no in-combination effect is thought to be possible.	Abrasion/disturbance of the substrate on the surface of the seabed Removal of non-target species Removal of target species Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion
Static – fixed nets: Gill nets, Trammels, Entangling Passive – nets: Drift nets (demersal) Seine nets & other: shrimp push nets, Fyke and stakenets,	This activity is currently not permitted to take place within the Erme Estuary MCZ, in accordance with the D&S IFCA Netting Permit Byelaw. In the estuary landward of the coordinates set out in Annex 1, Figure 4, a permit holder or named representative is not authorised to use any net other than a seine net (in addition to other restrictions outlined in the permit conditions). Therefore no in-	

<table>
<tr><td>ring nets</td><td>combination effect is thought to be possible.</td><td rowspan="4">Changes in suspended solids (water clarity)

Smothering and siltation rate changes (Light)

Genetic modification & translocation of indigenous species

Introduction of microbial pathogens

Introduction or spread of invasive non indigenous species</td></tr>
<tr><td>Lines: Longlines (demersal)</td><td>As there is little to no level of this activity in the Erme Estuary MCZ, no in-combination effect thought to be possible.</td></tr>
<tr><td>Seine nets & other: Beach seine</td><td>As there is little to no level of this activity in the Erme Estuary MCZ, no in-combination effect thought to be possible.</td></tr>
<tr><td>Aquaculture</td><td>There is no evidence that this activity is occurring in the MCZ. It is thought there is no in-combination effect</td></tr>
</table>

D&S IFCA concludes there is no likelihood of significant adverse effect on the interest features from in-combination effects addressed within **Error! Reference source not found.**.

10. NE consultation response

N/A Natural England has not been consulted at this stage.

11. Conclusion

The literature detailed in section 8 found that trampling associated with bait digging and other shore-based activities including crab tiling and hand gathering has the potential to influence the species assemblages on the rocky habitats assessed if levels of shore-based activities were sufficiently high and over a prolonged period.

Within Erme Estuary MCZ, there is very little bait digging and hand gathering occurring. There may be some minor hand gathering for cockles, but this activity appears to be occurring at a very low level (one respondent replied out of a possible 148, to a request for information advising they carry out this activity, on average twice a month). The landowner advised that low levels of bait digging (1-2 bait diggers three to four times a year) does occur on the western side of the estuary at low tide on the exposed sand flats in front of the coastguard cottages. A conclusion that only very low levels of hand working exist is also supported by the evidence provided in Curtin (2022).

Based on the current levels of these activities on the Erme Estuary there is not believed to be a significant impact of the shore-based activities on the protected features assessed. It is believed that these activities are occurring infrequently and at low levels, which likely gives the disturbed areas time to recover before they are revisited and disturbed again. The evidence presented in section 8 suggests recovery times for both sediment and smaller invertebrates that are impacted by trampling and digging are shorter when activity levels are low.

D&S IFCA is considering the introduction of a new Hand Working Permit Byelaw to manage the use of crab tiles, bait digging and many other hand gathering types of fishing activity in the district. The introduction of a byelaw would introduce fixed provisions that apply to all persons. Fixed provisions are expected to include a series of catch limits (bag limits) for different species (sea fisheries resources) that are targeted by different types of hand working fishing methods. The bag limits would provide an upper level of catch (a threshold) that would apply to all persons thus limiting the effort of shore-based activities on the Estuary. As outlined in section 7, the development of a Hand Working Permit Byelaw is now a longer-term commitment for D&S IFCA and has not been included in D&S IFCA's Annual Plan for 2022–2023 due to time and resource constraints.

12. Summary table

Feature or habitat of Conservation interest	**Conservation objectives/ Target Attributes** (Natural England, 2021)	**Activity**	**Potential pressures from activity and sensitivity of habitats to pressures.** (Natural England, 2021)	**Potential exposure to pressures and mechanism of impact significance**	**Is there a risk that the activity could hinder the achievement of conservation objectives of the site?**	**Can D&S IFCA exercise its functions to further the conservation objectives of the site?** **If Yes, list management options**
Intertidal coarse sediment	Maintain the presence and spatial distribution of intertidal coarse sediment communities Maintain the total extent and spatial distribution of intertidal coarse sediment [Maintain OR Recover OR Restore] the abundance of listed species to enable each of them to be a viable component of the habitat Maintain the species composition of	Commercial fishing; Intertidal handwork: Handworking (access from vessel), Handworking (access from land) Miscellaneous: Crab tiling Bait collection: digging with forks	• Abrasion/disturbance of the substrate on the surface of the seabed • Habitat structure changes – removal of substratum • Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion • Removal of non-target species • Removal of target species See Annex 2 for pressures audit trail	Bait digging and disturbance of sediment from other shore-based activities including crab tiling and hand gathering could influence the sediment characteristics, the populations of the target species, and the macrofaunal communities if levels of shore-based activities were sufficiently high and over a prolonged period. Mosbahi et al. (2015) also explored the impacts of bait digging on the macrofauna of intertidal	Based on the current levels of these activities on the Erme Estuary there is not believed to be a significant impact of the shore-based activities on the protected features assessed	Yes, Management measures could include: 1. Monitor activity levels 2. Possible introduction of a new Hand Working Permit Byelaw to manage the use of crab tiles, bait digging and many other hand gathering types of fishing activity.

	component communities			mudflats.. They found the abundance estimates at the control stations were significantly higher than those estimated at the three stations before and after bait collection, with some polychaete species disappearing after one month of bait digging. This indicates that the intertidal macrozoobenthic biodiversity at the impacted stations is affected by the bait digging activity, or possibly by trampling. Olive (1993) describes the scenario which led to complete removal of all lugworms from a large area of a National Nature Reserve in Northumberland in 1984, with		

				densities falling from >40m^{-2} to <1m^{-2}. When the site was closed to bait digging it repopulated within a matter of months, thanks to the presence of extensive non-exploited populations nearby. Similarly, lugworm populations in the Dutch Wadden Sea appear to be unaffected by large scale commercial exploitation, with an estimated 2 x 10^7 individuals taken annually. However, Cryer et al. (1987) found no recovery in worm densities after 6 months following experimental removal, although natural densities at the test site in South Wales were low (9-16 m^{-2}) and the survey ran through the less productive		

				winter months. The capacity of a population to withstand bait digging activities therefore relies on a number of factors including the size of the exploited area relative to the total lugworm bed, the presence of other lugworm beds nearby, the presence of nursery areas, the relative exploitation of adult and juvenile lugworms, and the intensity and seasonality of bait digging. However, on the whole they are thought to be resilient to bait digging		
Intertidal mixed sediment	Maintain the presence and spatial distribution of intertidal mixed sediment communities	Commercial fishing; Intertidal handwork: Handworking (access from	• Abrasion/disturbance of the substrate on the surface of the seabed • Habitat structure changes – removal of substratum • Penetration and/or disturbance of the substratum below the surface	See above	See above	See above

	Maintain the total extent and spatial distribution of intertidal mixed sediment [Maintain OR Recover OR Restore] the abundance of listed species to enable each of them to be a viable component of the habitat Maintain the species composition of component communities	vessel), Handworking (access from land) Miscellaneous: Crab tiling Bait collection: digging with forks	of the seabed, including abrasion • Removal of non-target species • Removal of target species See Annex 2 for pressures audit trail			
Sheltered muddy gravels	Maintain the presence and spatial distribution of sheltered muddy gravel communities Maintain the total extent and spatial distribution of sheltered muddy	Commercial fishing; Intertidal handwork: Handworking (access from vessel), Handworking (access from land) Miscellaneous:	• Abrasion/disturbance of the substrate on the surface of the seabed • Habitat structure changes – removal of substratum • Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion • Removal of non-target species • Removal of target species See Annex 2 for pressures audit	See above	See above	See above

	gravel (Maintain OR Recover OR Restore) the abundance of listed to enable each of them to be a viable component of the habitat Maintain the species composition of component communities	Crab tiling Bait collection: digging with forks	trail			
Tentacled lagoon worm (*Alkmaria romijni*)	Maintain the population size within the site. Maintain the reproductive and recruitment capability of the species. Maintain connectivity of the habitat within sites and the wider environment to ensure larval dispersal and recruitment, and / or to allow movement of migratory	Commercial fishing; Intertidal handwork: Handworking (access from vessel), Handworking (access from land) Miscellaneous: Crab tiling Bait collection: digging with forks	• Abrasion/disturbance of the substrate on the surface of the seabed • Habitat structure changes – removal of substratum • Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion • Removal of non-target species • Removal of target species See Annex 2 for pressures audit trail	See above	See above	See above

	species. Maintain the extent and spatial distribution of the following known supporting habitat: intertidal mud.					

13. References

Anderson, F. E., and Meyer, L. M. 1986. The interaction of tidal currents on a disturbed intertidal bottom with a resulting change in particulate matter quantity, texture and food quality. Estuarine, Coastal and Shelf Science, 22: 19–29.

Beukema, J. J. 1995. Long-term effects of mechanical harvesting of lugworms Arenicola marina on the zoobenthic community of a tidal flat in the Wadden Sea. Netherlands Journal of Sea Research, 33: 219–227.

Blake, R. W. 1979. Exploitation of a Natural Population of Arenicola marina (L.) from the North-East Coast of England. Journal of Applied Ecology, 16: 663–670. [British Ecological Society, Wiley].

Carvalho, S., Constantino, R., Cerqueira, M., Pereira, F., Subida, M. D., Drake, P., and Gaspar, M. B. 2013. Short-term impact of bait digging on intertidal macrobenthic assemblages of two south Iberian Atlantic systems. Elsevier. https://digital.csic.es/handle/10261/103270 (Accessed 3 August 2021).

Curtin, S. (2022) Erme Estuary MCZ Fishing Activity Report. Devon and Severn IFCA Report.

Defra. 2019. Erme Estuary Marine Conservation Zone factsheet. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/914618/mcz-erme-estuary-2019.pdf.

Cryer, M., Whittle, G. N., and Williams, R. 1987. The impact of bait collection by anglers on marine intertidal invertebrates.

Dernie, K. M., Kaiser, M. J., and Warwick, R. M. 2003. Recovery rates of benthic communities following physical disturbance. Journal of Animal Ecology, 72: 1043–1056.

D&S IFCA. 2019. Managing Hand Working Fishing Activity: A Focus on Bait Digging. Supplementary Report for the B&PSC – Information & Evidence, V2.0. Devon & Severn Inshore Fisheries and Conservation Authority, Brixham, Devon.

Evans, S., Moon, J., Bunker, A., and Green, M. 2015. Impacts of Bait Digging on the Gann: An Evidence Review. Evidence Report, 81. Natural Resources Wales.

Fowler, S. L. 1999. Guidelines for managing the collection of bait and other shoreline animals within UK European marine sites. UK Marine SACs Project. http://spcsrp.org/sites/default/files/csrp/ressouces_documentaires/bait%20collection.pdf (Accessed 3 August 2021).

Heiligenberg, T. van den. 1987. Effects of mechanical and manual harvesting of lugworms Arenicola marina L. on the benthic fauna of tidal flats in the Dutch Wadden sea.

Jackson, M. J., and James, R. 1979. The Influence of Bait Digging on Cockle, Cerastoderma edule, Populations in North Norfolk. Journal of Applied Ecology, 16: 671–679. [British Ecological Society, Wiley].

Johnson, G. 1984. Bait collection in a proposed marine nature reserve. University College London, London, United Kingdom.

Mosbahi, N., Pezy, J.-P., Dauvin, J.-C., and Neifar, L. 2015. Short-term impact of bait digging on intertidal macrofauna of tidal mudflats around the Kneiss Islands (Gulf of Gabès, Tunisia). Aquatic Living Resources, 28: 111–118. EDP Sciences.

Natural England (2021) Draft Conservation Advice for Erme Estuary Marine Conservation Zone (MCZ)

Olive, P. J. W. 1993. Management of the exploitation of the lugworm Arenicola marina and the ragworm Nereis virens (Polychaeta) in conservation areas. Aquatic Conservation: Marine and Freshwater Ecosystems, 3: 1–24.

Ross, E. 2013. Blow lug *Arenicola marina* density in the Severn Estuary European Marine Site: A baseline survey 2012-2013. D&S IFCA Research Report

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

Watson, G. J., Murray, J. M., Schaefer, M., Bonner, A., and 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.

Wynberg, R. P., and Branch, G. M. 1997. Trampling associated with bait-collection for sandprawns Callianassa kraussi Stebbing: effects on the biota of an intertidal sandflat. Environmental Conservation, 24: 139–148. Cambridge University Press.

Annex 1: Site Map(s)

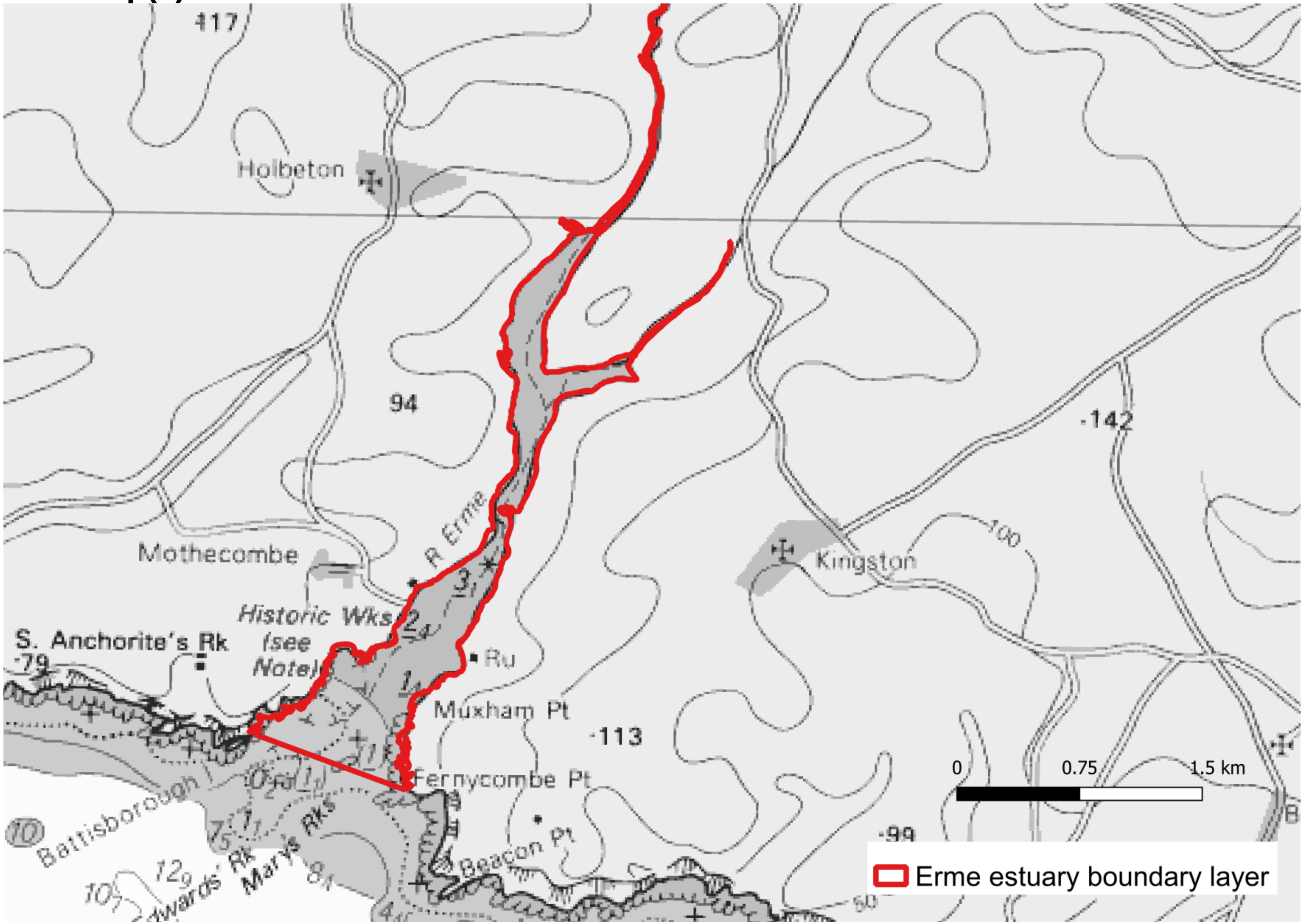


Figure 1 – Erme Estuary MCZ

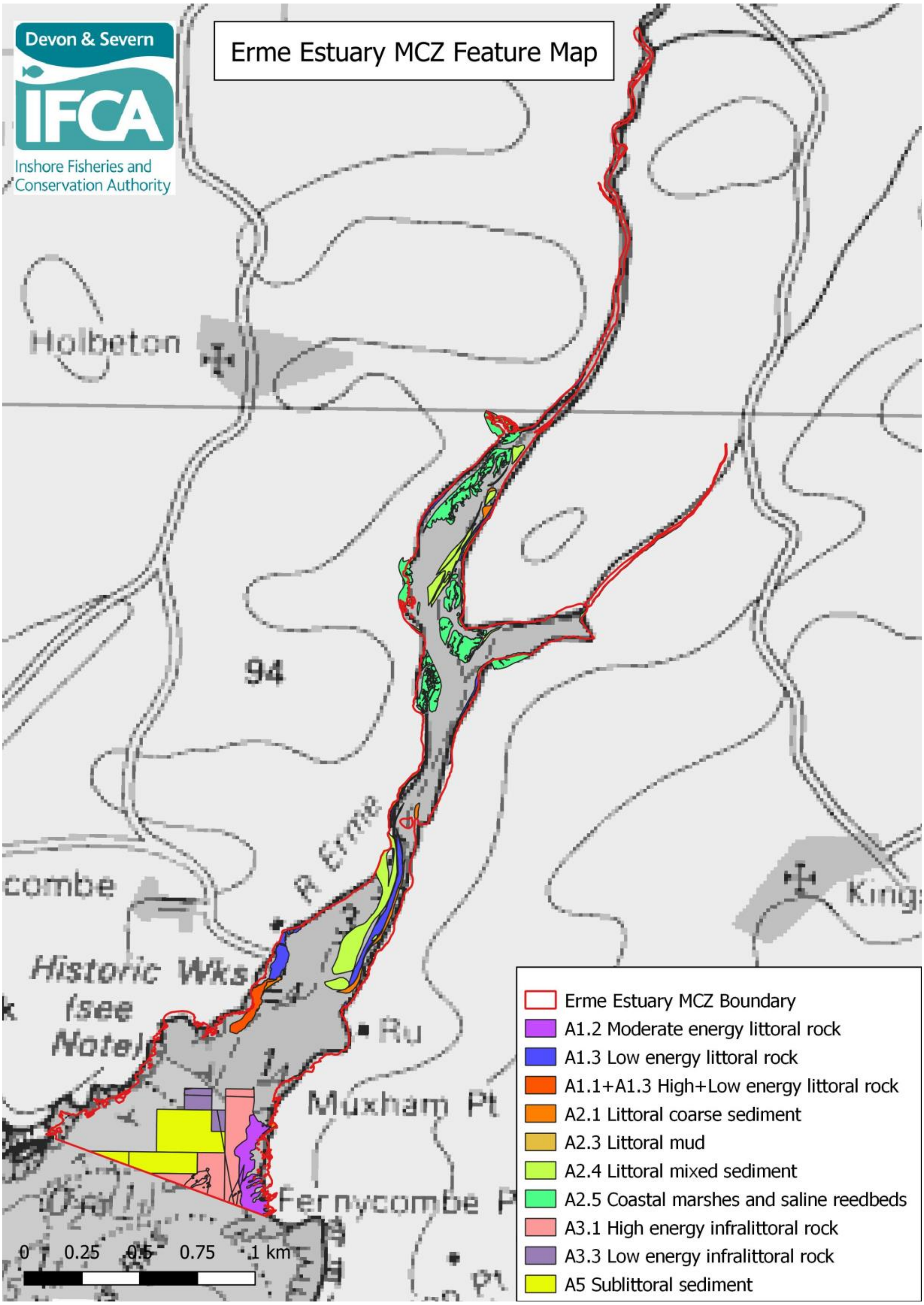
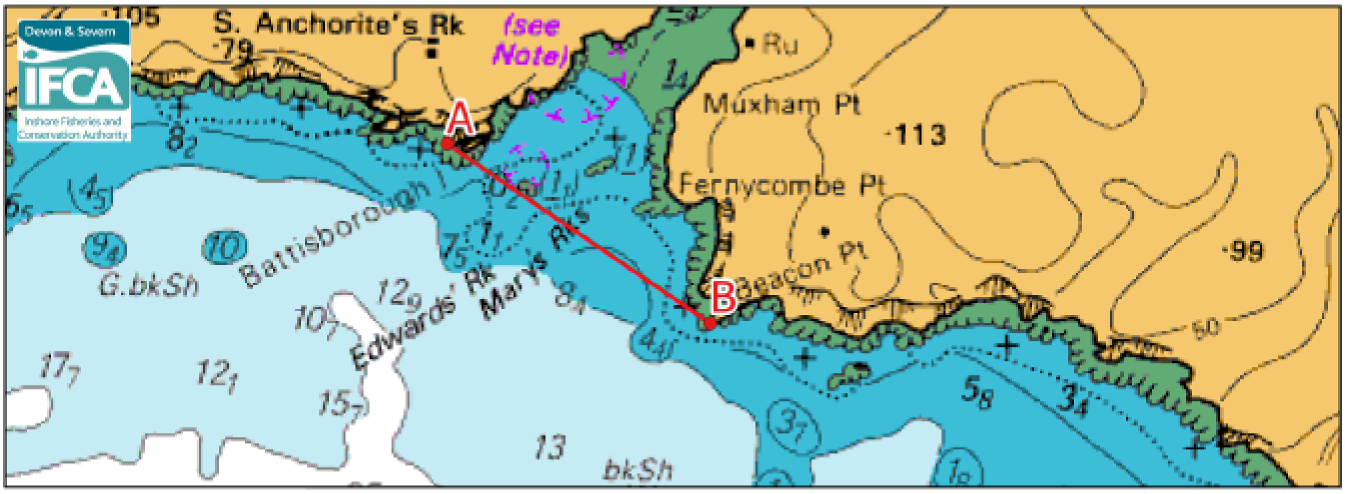


Figure 2: Extent of features designated in the Erme Estuary MCZ

Annex 2 Chart of River Erme closing line - No access to the use of nets other than a seine net in accordance with paragraph 3.2 of the Netting Permit Conditions



Estuary closing line

River Erme closing line latitude and longitude positions:

Point	Latitude	Longitude
A (Battisborough Island)	50° 18.243'N	003° 57.834'W
B (Beacon Point)	50° 17.750'N	003° 56.657'W

Figure 3: River Erme closing line latitude and longitude, from Annex 2 to the Netting Permit Byelaw. No access landward of the line to the use of nets other than a seine net in accordance with paragraph 3.2 of the Netting Permit Conditions.

Annex 2: Pressures Audit Trail

Fishing Activity Pressures: Shore based activities	**Intertidal coarse sediment**	**Intertidal mixed sediment**	**Sheltered muddy gravels**	**Tentacled lagoon worm *(Alkmaria romijni)***	**Screening Justification**
Abrasion/disturbance of the substrate on the surface of the seabed	NS	S	S	S	IN - Need to consider spatial scale/intensity of activity to determine likely magnitude of pressure
Habitat structure changes - removal of substratum (extraction)	S	S	S	S	IN – Need to consider spatial scale/intensity of activity to determine likely magnitude of pressure
Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion	NS	S	S	S	IN – Need to consider spatial scale/intensity of activity to determine likely magnitude of pressure
Removal of non-target species		S	S	IE	IN – Need to consider spatial scale/intensity of activity to determine likely magnitude of pressure
Removal of target species		S	S		IN – Need to consider spatial scale/intensity of activity to determine likely magnitude of pressure
Deoxygenation	NS	S	NS	NS	OUT – Insufficient activity levels to pose risk at level of concern
Hydrocarbon & PAH contamination	NA	NA	NA	NA	OUT – Not applicable
Introduction of light		IE	NS		OUT – Not applicable
Introduction or spread of invasive non-indigenous species (INIS)		S	S	IE	OUT – Insufficient activity levels to pose risk at level of concern
Litter	NA	NA	NA	NA	OUT – Not applicable
Synthetic compound contamination (incl. pesticides, antifoulants, pharmaceuticals)	NA	NA	NA	NA	OUT – Not applicable
Transition elements & organo-metal (e.g. TBT) contamination	NA	NA	NA	NA	OUT – Not applicable