Fisheries in EMS Habitats Regulations Assessment for Amber and Green risk categories

European Marine Site: Severn Estuary SAC

Fishing activities assessed: Bait collection

Gear/feature interactions assessed:

D&S IFCA Interaction ID	Fishing Activity	Feature(s)	Sub-feature(s)
HRA_ UK0013030_AR40	Digging with forks	Estuaries; Mudflats and sandflats not covered by seawater at low tide	Intertidal coarse sediments
HRA_ UK0013030_P40			Intertidal mixed sediments
HRA_ UK0013030_K40			Intertidal mud
HRA_ UK0013030_L40			Intertidal sand and muddy sand

Contents

1. Introduction

1.1 Need for an HRA assessment

In 2012, the Department for Environment, Food and Rural Affairs (Defra) announced a revised approach to the management of commercial fisheries in European Marine Sites (EMS). The objective of this revised approach is to ensure that all existing and potential commercial fishing activities are managed in accordance with Article 6 of the Habitats Directive.

This approach is being implemented using an evidence based, risk-prioritised, and phased basis. Risk prioritisation is informed by using a matrix of the generic sensitivity of the sub-features of EMS to a suite of fishing activities as a decision making tool. These sub-feature-activity combinations have been categorised according to specific definitions, as red, amber, green or blue.

Activity/feature interactions identified within the matrix as red risk have the highest priority for implementation of management measures by the end of 2013 in order to avoid the deterioration of Annex I features in line with obligations under Article 6(2) of the Habitats Directive.

Activity/feature interactions identified within the matrix as amber risk require a site-level assessment to determine whether management of an activity is required to conserve site features. Activity/feature interactions identified within the matrix as green also require a site level assessment if there are "in combination effects" with other plans or projects.

Site level assessments are being carried out in a manner that is consistent with the provisions of Article 6(3) of the Habitats Directive. The aim of this assessment is to determine whether management measures are required in order to ensure that fishing activity or activities will have no adverse effect on the integrity of the site. If measures are required, the revised approach requires these to be implemented by 2016.

The purpose of this site specific assessment document is to assess whether or not in the view of Devon and Severn Inshore Fisheries and Conservation Authority (D&S IFCA) the current level of effort of use of digging with forks has a likely significant effect on the interest features of the Severn Estuary SAC, and on the basis of this assessment whether or not it can be concluded that the current levels of activity relating to digging with forks will not have an adverse effect on the integrity of this EMS.

1.2 Documents reviewed to inform this assessment

- Natural England's risk assessment Matrix of fishing activities and European habitat features and protected species[1]
- Reference list (Annex 1)
- Natural England's consultation advice (Annex 2)
- Site map(s) – sub-feature/feature location and extent (Annex 3)
- Fishing activity data (map(s), etc.) (Annex 4)

[1] See Fisheries in EMS matrix:
http://www.marinemanagement.org.uk/protecting/conservation/documents/ems_fisheries/populated_matrix3.xls

2. Information about the EMS

The Severn Estuary is the largest coastal plain estuary in the United Kingdom and one of the largest estuaries in Europe. It has the second largest tidal range in the world and the tidal regime determines not only the structure of the estuary and individual habitats but also the conditions affecting it and the biological communities it therefore supports (Natural England and CCW 2009). The Severn Estuary EMS includes both SAC and SPA designations which differ slightly in area although broadly overlap.

The Severn Estuary SAC includes the entire extent of the tidal influence from an upstream boundary between Frampton and Awre in Gloucestershire out seawards to a line drawn between Penarth Head in Wales and a location just west of Hinkley point in Somerset (Natural England and CCW 2009). It includes subtidal and intertidal areas landward to the line of high ground and flood defences (banks and walls) that provide the limit of tidal inundation. The overall area of the European conservation designations is 73,715.4 ha of which roughly two thirds is composed of subtidal habitats and one third is composed of intertidal habitats. The Estuary is an over-arching feature of the EMS which incorporates all aspects of the physical, chemical and biological attributes of the estuary as an ecosystem (Natural England and CCW 2009).

The estuary lies in the Severn Vale which includes the cities of Cardiff, Bristol, Newport and Gloucester, supporting a number of large-scale industries which exploit the estuaries natural resources.

2.1 Overview and qualifying features

Severn Estuary qualifies as a SAC for the following Annex I habitats as listed in the EU Habitats Directive (Natural England, 2015):

- **1330 Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)**
- **1130 Estuaries**, key sub-features are:
    - Circalittoral rock
    - Infralittoral rock
    - Intertidal biogenic reef: *Sabellaria* spp.
    - Intertidal coarse sediment
    - Intertidal mixed sediments
    - Intertidal mud
    - Intertidal rock
    - Intertidal sand and muddy sand
    - Subtidal biogenic reefs: *Sabellaria* spp.
    - Subtidal coarse sediments
    - Subtidal mixed sediments
    - Subtidal mud
    - Subtidal sand
    - Estuarine fish community (Natural England and CCW, 2009)
    - Estuarine bird community (Natural England and CCW, 2009)
- **1140 Mudflats and sandflats not covered by seawater at low tide**, key sub-features are:
    - Intertidal coarse sediment
    - Intertidal mixed sediments
    - Intertidal mud
    - Intertidal sand and muddy sand
- **1170 Reefs**, key sub-features are:
    - Circalittoral rock
    - Infralittoral rock
    - Intertidal biogenic reef: *Sabellaria* spp.
    - Intertidal rock
    - Subtidal biogenic reef: *Sabellaria* spp.
- **1110 Sandbanks which are slightly covered by sea water all the time**, key sub-features are:
    - Subtidal coarse sediment
    - Subtidal mixed sediments
    - Subtidal mud
    - Subtidal sand

Severn Estuary qualifies as a SAC for the following Annex II species as listed in the EU Habitats Directive (Natural England, 2015):

- **1099 River lamprey (*Lampetra fluviatilis*)**
- **1095 Sea lamprey (*Petromyzon marinus*)**
- **1103 Twaite shad (*Alosa fallax*)**

2.2 Conservation Objectives

Severn Estuary SAC conservation objectives for the following Annex I habitats and Annex II species (Natural England and CCW, 2009):

- **1330 Atlantic salt meadow**
  The conservation objective for the "Atlantic salt meadow" feature of the Severn Estuary SAC is to maintain the feature in favourable condition, as defined below:

  i. the feature will be considered to be in favourable condition when, subject to natural processes, each of the following conditions are met:
  ii. the total extent of Atlantic salt meadow and associated transitional vegetation communities within the site is maintained;
  iii. the extent and distribution of the individual Atlantic salt meadow and associated transitional vegetation communities within the site is maintained;
  iv. the zonation of Atlantic salt meadow vegetation communities and their associated transitions to other estuary habitats is maintained;
  v. the relative abundance of the typical species of the Atlantic salt meadow and associated transitional vegetation communities is maintained;
  vi. the abundance of the notable species of the Atlantic salt meadow and associated transitional vegetation communities is maintained.
  vii. the structural variation of the salt marsh sward (resulting from grazing) is maintained within limits sufficient to satisfy the requirements of conditions iv and v above and the requirements of the Ramsar and SPA features
  viii. the characteristic stepped morphology of the salt marshes and associated creeks, pills, drainage ditches and pans, and the estuarine processes that enable their development, is maintained.
  ix. Any areas of *Spartina anglica* salt marsh are capable of developing naturally into other saltmarsh communities.

- **1130 Estuaries**
  The conservation objective for the "estuaries" feature of the Severn Estuary SAC is to maintain the feature in favourable condition, as defined below:

  The feature will be considered to be in favourable condition when, subject to natural processes, each of the following conditions are met

  i. the total extent of the estuary is maintained;
  ii. the characteristic physical form (tidal prism/cross sectional area) and flow (tidal regime) of the estuary is maintained;
  iii. the characteristic range and relative proportions of sediment sizes and sediment budget within the site is maintained;
  iv. the extent, variety and spatial distribution[4] of estuarine habitat communities within the site is maintained;
  v. the extent, variety, spatial distribution and community composition of hard substrate habitats and their notable communities is maintained;
  vi. the abundance of the notable estuarine species assemblages is maintained or increased;
  vii. the physio-chemical characteristics of the water column support the ecological objectives described above;
  viii. Toxic contaminants in water column and sediment are below levels which would pose a risk to the ecological objectives described above.
  ix. Airborne nutrient and contaminant loads are below levels which would pose a risk to the ecological objectives described above

- **1140 Mudflats and sandflats not covered by seawater at low tide**
  The conservation objective for "mudflats and sandflats" feature of the Severn Estuary SAC is to maintain the feature in favourable condition, as defined below:

  The feature will be considered to be in favourable condition when, subject to natural processes, each of the following conditions are met:
  i. the total extent of the mudflats and sandflats feature is maintained;
  ii. the variety and extent of individual mudflats and sandflats communities within the site is maintained;
  iii. the distribution of individual mudflats and sandflats communities within the site is maintained;
  iv. the community composition of the mudflats and sandflats feature within the site is maintained;
  v. the topography of the intertidal flats and the morphology (dynamic processes of sediment movement and channel migration across the flats) are maintained.

- **1170 Reefs**
  The conservation objective for the "reefs" feature of the Severn Estuary SAC is to maintain the feature in a favourable condition, as defined below:

  The feature will be considered to be in favourable condition when, subject to natural processes, each of the following conditions are met:
  i. the total extent and distribution of *Sabellaria* reef is maintained;
  ii. the community composition of the *Sabellaria* reef is maintained;
  iii. the full range of different age structures of *Sabellaria* reef are present;
  iv. the physical and ecological processes necessary to support *Sabellaria* reef are maintained.

- **1110 Sandbanks which are slightly covered by sea water all the time**
  The conservation objective for the "subtidal sandbanks" feature of the Severn Estuary SAC is to maintain the feature in favourable condition, as defined below:

  The feature will be considered to be in favourable condition when, subject to natural processes, each of the following conditions are met:
  i. the total extent of the subtidal sandbanks within the site is maintained;
  ii. the extent and distribution of the individual subtidal sandbank communities within the site is maintained;
  iii. the community composition of the subtidal sandbank feature within the site is maintained;
  iv. the variety and distribution of sediment types across the subtidal sandbank feature is maintained;
  v. the gross morphology (depth, distribution and profile) of the subtidal sandbank feature within the site is maintained.

- **1099 River lamprey**

The conservation objective for the river lamprey Lampetra fluviatilis feature of the Severn Estuary SAC is to maintain the feature in a favourable condition, as defined below:

  i. the feature will be considered to be in favourable condition when, subject to natural processes, each of the following conditions are met:
  ii. the migratory passage of both adult and juvenile river lamprey through the Severn Estuary between the Bristol Channel and any of their spawning rivers is not obstructed or impeded by physical barriers, changes in flows, or poor water quality;
  iii. the size of the river lamprey population in the Severn Estuary and the rivers which drain into it, is at least maintained and is at a level that is sustainable in the long term;
  iv. the abundance of prey species forming the river lamprey's food resource within the estuary, is maintained.
  v. toxic contaminants in the water column and sediment are below levels which would pose a risk to the ecological objectives described above.

- **1095 Sea lamprey**
  The conservation objective for the sea lamprey Petromyzon marinus feature of the Severn Estuary SAC is to maintain the feature in a favourable condition, as defined below:

  The feature will be considered to be in favourable condition when, subject to natural processes, each of the following conditions are met:
  i. the migratory passage of both adult and juvenile sea lamprey through the Severn Estuary between the Bristol Channel and any of their spawning rivers is not obstructed or impeded by physical barriers, changes in flows, or poor water quality;
  ii. the size of the sea lamprey population in the Severn Estuary and the rivers which drain into it, is at least maintained as is at a level that is sustainable in the long term;
  iii. the abundance of prey species forming the sea lamprey's food resource within the estuary, is maintained.
  iv. toxic contaminants in the water column and sediment are below levels which would pose a risk to the ecological objectives described above.

- **1103 Twaite shad**
  The conservation objective for the twaite Shad Alosa fallax feature of the Severn Estuary SAC is to maintain the feature in a favourable condition, as defined below:

  The feature will be considered to be in favourable condition when, subject to natural processes, each of the following conditions are met:
  i. the migratory passage of both adult and juvenile twaite shad through the Severn Estuary between the Bristol Channel and their spawning rivers is not obstructed or impeded by physical barriers, changes in flows or poor water quality;
  ii. the size of the twaite shad population within the Severn Estuary and the rivers draining into it is at least maintained and is at a level that is sustainable in the long term.
  iii. the abundance of prey species forming the twaite shad's food resource within the estuary, in particular at the salt wedge, is maintained.
  iv. Toxic contaminants in the water column and sediment are below levels which would pose a risk to the ecological objectives described above.

3. Interest feature(s) of the EMS categorised as 'red' risk and overview of management measure(s)

The following features and sub-features of the Severn Estuary Severn Estuary SAC have been identified as high risk in relation to towed gear through the application of the Natural England risk matrix:

- **1130 Estuaries (SAC interest feature 1)**
  - High-risk sub-feature: Sabellaria spp. reef
  - High-risk sub-feature: Seagrass
- **1170 Reefs (SAC interest feature 5)**
  - High-risk sub-feature: Sabellaria spp.

Management has been implemented to protect the *Sabellaria* in both the subtidal reef feature and sub-feature of the Estuary feature and intertidal Sabellaria that is described within the Estuarine rock sub-feature of the Estuary. The D&S IFCA's Mobile Fishing Permit Byelaw prevents the use of towed gear throughout the whole of the portion of the Severn Estuary which sits within the Devon and Severn IFCA's District. The document 'Site Specific Assessment for Red High Risk Categories' (D&S IFCA 2013) covers these actions. Seagrass only occurs in the Welsh portion of the District, so has been screened out of the D&S IFCA's HRA process.

Severn site specific assessment for red hi

4. Information about the fishing activities within the site

Devon and Severn IFCA has carried out a detailed review of the fishing activities taking place within the Severn Estuary EMS (Ross, 2015). Devon and Severn IFCA carried out bait digging surveys between 2012 and 2015 and IFCA and a further report specifically focussed on bait digging activity has been produced (West, 2019).

Most of the bait digging effort is focused on sandy and muddy shorelines for *Arenicola marina*. *Allita virens* tends to be targeted in areas of sediment in areas of pebbles or stones. Bait digging effort at Hinkley Point, the only site surveyed where these more mixed sediments are targeted appears to much lower than at the sites where lugworm are targeted. D&S IFCA have not observed any sites where bait digging either occurs on or directly adjacent to *Sabellaria* or where trampling of *Sabellaria* occurs whilst accessing bait digging areas. Furthermore, the Association of Severn Estuary Relevant Authorities (ASERA), in partnership with D&S IFCA, have produced a code of conduct which specifically requests bait diggers to avoid areas of *Sabellaria* reef and saltmarsh which is actively promoted by all ASERA members, including D&S IFCA.

5. Test for Likely Significant Effect (LSE)

5.1 Table 1: Assessment of LSE

1. Is the activity/activities directly connected with or necessary to the management of the site for nature conservation?	**No**	
2. What pressures (such as abrasion, disturbance) are potentially exerted by the gear type(s)	• 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 **See Annex 5 for pressure audit trail**	
3. Is the feature potentially exposed to the pressure(s)?	Yes, there are no current management measures in place so theoretically an interaction could occur.	
4. What are the potential effects/impacts of the pressure(s) on the feature, taking into account the exposure level?	Bait digging can reduce the abundance of target bait species (such as lugworm and ragworm) and change the abundance, structure and diversity macrofaunal communities. Additionally, it can change the organic content, mixing and other physical characteristics of the sediment, as well as changing the topology of inshore areas.	
5. Is the potential scale or magnitude of any effect likely to be significant?	**Alone**	**Unsure**, an interaction occurs between intertidal sub-features of Severn Estuary SAC and digging with forks. Therefore an appropriate assessment has been carried out.
	In-combination	**See section 8 for more information**
6. Have NE been consulted on this LSE test? If yes, what was NE's advice?	**No,** not at this stage.	

6. Appropriate Assessment

Note: this is only to be undertaken if the Test for LSE (section 5) concluded 'Yes' or 'Uncertain' for LSE, either alone or in-combination.

6.1 Potential risks to features

Document the potential pressures, impacts and exposure by gear type(s) for each feature/sub-feature.

Table 2: Summary of Impacts

Feature/Sub feature(s)	**Target Attributes/ Conservation Objectives** (Natural England, 2015a)	**Potential pressure (such as abrasion, disturbance) exerted by gear type(s)**	**Potential ecological impacts of pressure exerted by the activity/activities on the feature** *(reference to conservation objectives)*	**Level of exposure of feature to pressure**	**Mitigation measures**
Estuaries; Mudflats and sandflats not covered by seawater at low tide: • Intertidal coarse sediment • Intertidal mixed sediments • Intertidal sand and muddy sand • Intertidal mud	**Target Attribute:** *The conservation objective for "mudflats and sandflats" feature of the Severn Estuary SAC is to maintain the feature in favourable condition, as defined below:* **Conservation Objectives:** • the total extent of the mudflats and sandflats feature is maintained;	• 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	Bait digging usually occurs to depths of 30cm, unearthing a deeper sediment that would usually remain undisturbed and increasing mixing of sediments to this depth. Changes can therefore occur in sediment characteristics as a result of bait digging. In unexploited sediments, a 10cm layer of well-mixed sand is created by bioturbation (primarily by lugworms), overlying a layer of sands and shell (Anderson and Meyer 1986). Undug sediment generally has a higher organic content because 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), although other studies have not found this to occur (Dernie et al. 2003) so these processes are likely to be site specific. Transport of fine	A detailed review of bait digging activity in the Severn Estuary has been undertaken by D&S IFCA (West 2019). Key findings are as follows: - The majority of digging effort is for lugworm on the sandy beaches at Burnham on Sea, Berrow, Brean, Weston-Super-Mare and Sand Bay with more localised targeting of ragworm in some locations (Annex 4, Figure 2). - Bait digging effort is greatest in Autumn and Winter, thought to be due to the popularity of sea angling for whiting and cod at this time of year. - Bait digging effort was relatively low with mean values of bait diggers per hour between 0.2-0.8 per hour and median values for the number of holes observed on a survey being close to 0 (Annex 4,	D&S IFCA worked with the Association of Severn Estuary Authorities (ASERA) to produce a bait digging code of conduct, published after the survey work discussed in this report took place. The code promotes back-filing of holes, encourages anglers to avoid saltmarsh and *Sabellaria* and to only take as much bait as they need. It also informs anglers that ragworm may be more sensitive to exploitation in the Severn, and to restrict their take of these species, and to consider

	• the variety and extent of individual mudflats and sandflats communities within the site is maintained; • the distribution of individual mudflats and sandflats communities within the site is maintained; • the community composition of the mudflats and sandflats feature within the site is maintained; • the topography of the intertidal flats and the morphology (dynamic processes of sediment movement and channel migration across the flats) are maintained.		sediment and previously buried contaminants may also take place at the sediment surface. 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). Coarse sand beaches with considerable wave action will recover more quickly than sheltered sites (Dernie et al. 2003). 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, as described in http://www.ukmarinesac.org.uk/activities/bait-collection, accessed February 2019). Other, less sheltered, sites have reported a timeframe of 30 days for holes to disappear (McLusky et al., 1983). Dernie et al. (2003) also found clean sand intertidal communities to recover the most quickly from physical disturbance and muddy sand intertidal communities to take the longest amount of time to recover. The dynamic nature of the Severn estuary's sedimentary regime (caused by the extreme tidal range) may make the Severn less sensitive than other muddy sand habitats. Observations suggest that bait digging holes are often completely infilled (naturally) after one tidal cycle and IFCA officers have observed that no long-term	Figures 3 & 4) - The maximum number of bait diggers observed ranged between 2 and 4 diggers per survey depending on the site and year - There was some inter-annual variation in bait digging effort, possibly relating to angling activity and the strength of the cod run - Bait digging was spatially limited at some sites depending on access points and the areas dug tend to be very small in relation to the size of the intertidal mudflats (Annex 4, Figures 5-8) - Digging primarily occurred around low tide although it was generally middle to upper shore areas which were dug (Annex 4, Figures 5-8) due to the distance to walk out to low tide, the prevalence of muddy habitat in many areas and the danger involved in walking out on the mudflats in the Severn - Bait diggers were aiming to dig up a mean of 2.9lbs of lugworm in 2012-2013 and a mean of 1.25lbs in 2014-2015. The reduction in the mean targeted amount may be due to the presence of possible commercial activity in 2012-2013 but not in 2014-2015. - Some commercial activity has occurred in the past and IFCA	purchasing farmed ragworm. Little commercial bait collection takes place, but where it has been suspected to occur the individuals involved did dig significantly more frequently and for greater quantities of worm than the average recreational angler. Through the IFCA's Byelaw Review process, D&S IFCA will be reviewing all byelaws relating to hand working (including bait digging). Options for management will include, no action, voluntary measures and the potential introduction of a Hand Working Byelaw, which would allow the IFCA to monitor levels of this activity in the future, and adapt to changes in effort/ environmental conditions if necessary. If the IFCA did introduce formal management

			visual evidence of bait digging exists.	officers did observe two individuals who were thought to be digging commercially. These diggers dug considerably more often and for more lugworm compared to recreational diggers. - Anglers did not backfill holes This effort is lower than that reported by Watson et al. in 2017b in the Solent. The study recorded an average of 3.14 collectors per tide and a mean collection rate per person per hour of 228 worms from direct measurements taken across three locations within the Solent European Marine Site (SEMS). Using a mean weight of *A.virens* collected by a commercial collector of 6.11g this gives a mean biomass removal rate of 1.4kg per person per hour. In a separate report, D&S IFCA undertook extensive survey work to look at lugworm density in the Severn (Ross 2013). The report found that lugworm density and population structure (adults: juveniles) varied spatially between Burnham-On-Sea and Sand Bay, probably due to sediment characteristics and the sedimentary regime in the Severn. Distribution and densities were found to be very similar to those reported in a paper in the 1970's. The large area of intertidal mudflats and	this may include the requirement to back fill holes and trenches.

				abundance of lugworm throughout the Severn suggest populations will be robust to exploitation.	
Estuaries; Mudflats and sandflats not covered by seawater at low tide: • Intertidal coarse sediment • Intertidal mixed sediments • Intertidal sand and muddy sand Intertidal mud	**Target Attribute:** *The conservation objective for "mudflats and sandflats" feature of the Severn Estuary SAC is to maintain the feature in favourable condition, as defined below:* **Conservation Objectives:** • the total extent of the mudflats and sandflats feature is maintained; • the variety and extent of individual mudflats and sandflats communities within the site is maintained;	Removal of target species	Both blow lugworm (*Arenicola marina*) and, to a lesser extent, king ragworm (*Alitta virens*) are targeted by bait diggers on the Severn Estuary. Contrasting evidence exists as to the *direct* environmental effects of bait digging for lugworm. Relative to other exploited intertidal invertebrates, blow lugworm are relatively resilient to exploitation and disturbance because of their relative fecundity and widespread distribution (Fowler, 1999). In addition, *A. marina* exhibits 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 (Heilgenberg 1987, Blake 1979) but D&S IFCA observations suggest this may be much lower in some areas, especially where large areas of lugworm exist and holes are relatively well spread out, such as in the Severn Estuary. 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	A detailed review of bait digging activity in the Severn Estuary has been undertaken by D&S IFCA (West 2019). Key findings are as follows: - The majority of digging effort is for lugworm on the sandy beaches at Burnham on Sea, Berrow, Brean, Weston-Super-Mare and Sand Bay with more localised targeting of ragworm in some locations (Annex 4, Figure 2). - Bait digging effort is greatest in Autumn and Winter, thought to be due to the popularity of sea angling for whiting and cod at this time of year. - Bait digging effort was relatively low with mean values of bait diggers per hour between 0.2-0.8 per hour and median values for the number of holes observed on a survey being close to 0 (Annex 4, Figures 3 & 4) - The maximum number of bait diggers observed ranged between 2 and 4 diggers per survey depending on the site and year - There was some inter-annual variation in bait digging effort, possibly relating to angling	D&S IFCA worked with the Association of Severn Estuary Authorities (ASERA) to produce a bait digging code of conduct, published after the survey work discussed in this report took place. The code promotes back-filing of holes, encourages anglers to avoid saltmarsh and *Sabellaria* and to only take as much bait as they need. It also informs anglers that ragworm may be more sensitive to exploitation in the Severn, and to restrict their take of these species, and to consider purchasing farmed ragworm. Little commercial bait collection takes place, but where it has been suspected to occur the individuals involved did dig significantly

	• the distribution of individual mudflats and sandflats communities within the site is maintained; • the community composition of the mudflats and sandflats feature within the site is maintained; the topography of the intertidal flats and the morphology (dynamic processes of sediment movement and channel migration across the flats) are maintained		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 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. *A.virens* is a keystone intertidal species as prey for fish, birds and	activity and the strength of the cod run - Bait digging was spatially limited at some sites depending on access points and the areas dug tend to be very small in relation to the size of the intertidal mudflats (Annex 4, Figures 5-8) - Digging primarily occurred around low tide although it was generally middle to upper shore areas which were dug (Annex 4, Figures 5-8) due to the distance to walk out to low tide, the prevalence of muddy habitat in many areas and the danger involved in walking out on the mudflats in the Severn - Bait diggers were aiming to dig up a mean of 2.9lbs of lugworm in 2012-2013 and a mean of 1.25lbs in 2014-2015. The reduction in the mean targeted amount may be due to the presence of possible commercial activity in 2012-2013 but not in 2014-2015. - Some commercial activity has occurred in the past and IFCA officers did observe two individuals who were thought to be digging commercially. These diggers dug considerably more often and for more lugworm compared to recreational diggers. - Anglers did not backfill holes	more frequently and for greater quantities of worm than the average recreational angler. Through the IFCA's Byelaw Review process, D&S IFCA will be reviewing all byelaws relating to hand working (including bait digging). Options for management will include, no action, voluntary measures and the potential introduction of a Hand Working Byelaw, which would allow the IFCA to monitor levels of this activity in the future and adapt to changes in effort/ environmental conditions if necessary. If the IFCA did introduce formal management this may include the requirement to back fill holes and trenches.

			crustaceans, is a predator of other invertebrates and has an important role in bioturbation of the sediment (Watson et al. 2017a). King ragworm are generally found in more sheltered sediment areas but they can also be found in more mixed sediments (E West, Pers. Obs.). 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 caused by bait digging has been thought to benefit *A.virens*, due to its opportunistic nature (Evans et al. 2015). Estuary ragworm is used for bait by some anglers, who generally just report using ragworm which could be A.virens or *H. diversicolor* when fishing (although king ragworm is	In a separate report, D&S IFCA undertook extensive survey work to look at lugworm density in the Severn (Ross 2013). The report found that lugworm density and population structure (adults: juveniles) varied spatially between Burnham-On-Sea and Sand Bay, probably due to sediment characteristics and the sedimentary regime in the Severn. Distribution and densities were found to be very similar to those reported in a paper in the 1970's. The large area of intertidal mudflats and abundance of lugworm throughout the Severn suggest populations will be robust to exploitation.	

			generally preferred). *H. diversicolor* is widely distributed throughout the North Temperate Zone from both the European and the North American coast of the Atlantic (Scaps 2002). *H. diversicolor* inhabits sandy muds but also gravels, clays and even turf (Scaps 2002). The species is able to tolerate great variations of temperature and salinity and to survive drastic conditions of hypoxia and is thus able to settle in naturally-fluctuant environments such as the upper waters of estuaries (Scaps 2002). Variation in the reproductive biology of this species over short distances has also been reported. Worms monitored near the mouth of the Humber estuary (England), spawning takes place in March; at the upriver end of the Humber; oocytes are spawned in June or July (Grant et al. 1990 in Scaps 2002). Individuals live up to 3 years, with maturity occurring somewhere between 1 and 2 years old. *H. diversicolor* is highly prone to predation by waders and shelducks, crabs, shrimps and small fish. In the Douro estuary it was estimated that 9.9tons of *H.diversicolor* are dug, however the total annual biomass collected was substantially less than the productivity estimated for the entire intertidal area of the site. The ability of a variety of age classes to swim, burrow and be carried by bedload transport is thought to aid the rapid recolonization of disturbed sediments (Shull 1997).		

			In the Tamar Estuary Davey & George (1986), found evidence that the larvae of *H.diversicolor* were tidally dispersed over a distance of 3 km. This suggests that, similar to *A.marina*, the resilience of a population of *H.diversicolor* to bait digging may depend on local population dynamics as well as the intensity of the activity.		
Estuaries; Mudflats and sandflats not covered by seawater at low tide: • Intertidal coarse sediment • Intertidal mixed sediments • Intertidal sand and muddy sand Intertidal mud	**Target Attribute:** *The conservation objective for "mudflats and sandflats" feature of the Severn Estuary SAC is to maintain the feature in favourable condition, as defined below:* **Conservation Objectives:** • the total extent of the mudflats and sandflats feature is maintained; • the variety and extent of	Removal of 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 double 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	A detailed review of bait digging activity in the Severn Estuary has been undertaken by D&S IFCA (West 2019). Key findings are as follows: - The majority of digging effort is for lugworm on the sandy beaches at Burnham on Sea, Berrow, Brean, Weston-Super-Mare and Sand Bay with more localised targeting of ragworm in some locations (Annex 4, Figure 2). - Bait digging effort is greatest in Autumn and Winter, thought to be due to the popularity of sea angling for whiting and cod at this time of year. - Bait digging effort was relatively low with mean values of bait diggers per hour between 0.2-0.8 per hour and median values for the number of holes observed on a survey being close to 0 (Annex 4, Figures 3 & 4) - The maximum number of bait	D&S IFCA worked with the Association of Severn Estuary Authorities (ASERA) to produce a bait digging code of conduct, published after the survey work discussed in this report took place. The code promotes back-filing of holes, encourages anglers to avoid saltmarsh and *Sabellaria* and to only take as much bait as they need. It also informs anglers that ragworm may be more sensitive to exploitation in the Severn, and to restrict their take of these species, and to consider purchasing farmed ragworm. Little

	individual mudflats and sandflats communities within the site is maintained; • the distribution of individual mudflats and sandflats communities within the site is maintained; • the community composition of the mudflats and sandflats feature within the site is maintained; • the topography of the intertidal flats and the morphology (dynamic processes of sediment movement and channel migration across the flats) are maintained.		slower establishing species. However, if disturbance by digging is short term, benthic communities can recover within six months (Beukema, 1995). In a disturbance study in a range of estuarine habitats Dernie et al. (2003) found the total numbers of individuals and species in disturbed treatment areas were reduced significantly immediately post-disturbance and differences were still observable 15, 35 and 105 days after the simulated disturbance. There was no indication of an influx of opportunistic species into disturbed areas at any of the 16 sites (Dernie et al. 2003). Moshabi 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 abundances estimated 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	diggers observed ranged between 2 and 4 diggers per survey depending on the site and year - There was some inter-annual variation in bait digging effort, possibly relating to angling activity and the strength of the cod run - Bait digging was spatially limited at some sites depending on access points and the areas dug tend to be very small in relation to the size of the intertidal mudflats (Annex 4, Figures 5-8) - Digging primarily occurred around low tide although it was generally middle to upper shore areas which were dug (Annex 4, Figures 5-8) due to the distance to walk out to low tide, the prevalence of muddy habitat in many areas and the danger involved in walking out on the mudflats in the Severn - Bait diggers were aiming to dig up a mean of 2.9lbs of lugworm in 2012-2013 and a mean of 1.25lbs in 2014-2015. The reduction in the mean targeted amount may be due to the presence of possible commercial activity in 2012-2013 but not in 2014-2015. - Some commercial activity has occurred in the past and IFCA officers did observe two individuals who were thought	commercial bait collection takes place, but where it has been suspected to occur the individuals involved did dig significantly more frequently and for greater quantities of worm than the average recreational angler. Through the IFCA's Byelaw Review process, D&S IFCA will be reviewing all byelaws relating to hand working (including bait digging). Options for management will include, no action, voluntary measures and the potential introduction of a Hand Working Byelaw, which would allow the IFCA to monitor levels of this activity in the future, and adapt to changes in effort/ environmental conditions if necessary. . If the IFCA did introduce formal management this may include the requirement to back

			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 clearly modified the abundance and population dynamics of the clam *Macoma balthica* and the cockle *Cerastoderma edule.* There was a negative impact on adults of both species, probably because footsteps directly killed or buried the animals, provoking asphyxia. However, trampling indirectly enhanced the recruitment rate of *M. balthica*. Small-sized *C. edule* showed no reaction to trampling. It is likely that small animals could recover more quickly because trampling occurred during the growing season and there was a continuous supply of larvae and juveniles. Trampling may also have weakened negative adult-juvenile interactions between adult cockles and juvenile *M. balthica*, thus facilitating the recruitment. Rossi et al. (2007) concluded that human	to be digging commercially. These diggers dug considerably more often and for more lugworm compared to recreational diggers. - Anglers did not backfill holes In a separate report, D&S IFCA undertook extensive survey work to look at lugworm density in the Severn (Ross 2013). The report found that lugworm density and population structure (adults: juveniles) varied spatially between Burnham-On-Sea and Sand Bay, probably due to sediment characteristics and the sedimentary regime in the Severn. Distribution and densities were found to be very similar to those reported in a paper in the 1970's. The large area of intertidal mudflats and abundance of lugworm throughout the Severn suggest populations will be robust to exploitation.	fill holes and trenches.

			trampling is a relevant source of disturbance for the conservation and management of mudflats. During the growing season recovery can be fast, but in the long-term it might lead towards the dominance of *M. balthica* to the cost of *C. edule*, thereby affecting ecosystem functioning. 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). This is of relevance in the Severn Estuary, where infilling is thought to occur naturally very rapidly because of the strong tidal currents and exposed nature of the beaches, despite the mud content of the sediments. The site-specific nature of the impacts of bait digging was also demonstrated by Watson et al. (2017a). They found that responses were both site and disturbance type specific. Their data also showed that responses were not consistent between species (e.g. *C. volutator* and *P. 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.		

7. Conclusion

Taking into account the information detailed in the Appropriate Assessment, it can be concluded that the current level of bait digging has no adverse effect on the integrity of the Severn Estuary SAC interest features. However, the management of bait collection should be considered by D&S IFCA, as an increase or commencement of commercial bait digging activity could result in an adverse effect on the conservation objectives and site integrity of the SAC. Best practice outlined in the Association of Severn Estuary Relevant Authorities (ASERAs) code of conduct should be actively promoted and encouraged.

8. In-combination assessment

8.1 Other fishing activities

The following fishing activities are either occurring or have not been able to have been ruled out as occurring in the Severn Estuary SPA.

Fish traps – Thought not to be occurring but hasn't been able to be ruled out. Therefore no in-combination effect thought to be possible.

Handlines – Thought not to be occurring but hasn't been able to be ruled out. Therefore no in-combination effect thought to be possible.

Drift nets, demersal and pelagic – Thought not to be occurring but haven't been able to be ruled out. Therefore no in-combination effect thought to be possible.

Purse seine – Thought not to be occurring but hasn't been able to be ruled out. Therefore no in-combination effect thought to be possible.

Shrimp push nets– Thought not to be occurring but hasn't been able to be ruled out. Therefore no in-combination effect thought to be possible.

Longlines, demersal and pelagic - Thought to be occurring at a very low level in the Severn Estuary. Due to the very low level of fishing activity relating to both activities it is thought that no in-combination effects will lead to the conservation objectives not being met for any of the bird features in this assessment.

Beach seine/ ringnets – Beach seines are thought to be occurring at a very low level and ring nets are not thought to be occurring in the Severn Estuary. Due to the very low level of fishing activity relating to both activities, it is thought that no in-combination effects will lead to the conservation objectives not being met for any of the bird features in this assessment.

Static netting - Fyke nets, stake nets, gill nets, trammels and entangling nets, are used in the Severn Estuary but at a low and decreasing level. Due to the low level of fishing activity and spatial and temporal distribution of bait digging effort in relation to the site as whole, it is thought that no in-combination effects will lead to the conservation objectives not being met for any of the features in this assessment.

D&S IFCA conclude there is no likelihood of significant adverse effect on the interest features from in-combination effects with other fishing activities addressed within section 8.1.

8.2 Other activities

The Severn Estuary is a large and complex European Marine Site with several large cities including Bristol, Gloucester, Newport and Cardiff and a number of major industrial areas within the catchment area. Currently there are a number of proposed plans or projects in the Severn Estuary EMS which could theoretically interact with the bird features addressed. These are in various stages of development – some are already occurring (e.g. Hinkley B, wildfowling), others are in the development stage with some on-the-ground activity (Hinkley C) and others are still in the early planning and development stages (e.g. Tidal Lagoons, Bridgwater Barrier, Coastal Path). These activities have been included following the informal advice from Natural England. Pressures which are highlighted in yellow are those thought to be most likely to be have an 'in-combination effect' with the fisheries activities described in this assessment.

Hinkley Point B & C

Description of activities
Hinkley Point nuclear power station sits on the edge of Bridgwater Bay on the edge of the Severn Estuary EMS. Hinkley Point B (HPB) has been active since 1976 and continues to operate. HPC is a proposed development for two new nuclear reactors currently being undertaken by EDF Energy, next to HPA and HPB.

Pressures
Because of the large-scale development of Hinkley C and decommissioning, it is impossible to consider all of the associated pressures from both direct operation of the site and the building of Hinkley C and the decommissioning of Hinkley B. It is possible that some of the works associated with both Hinkley B and Hinkley C may have similar pressures to those identified as being associated with fixed nets in the Severn Estuary.

In-combination assessment
Hinkley C has undergone an extensive Appropriate Assessment process with independent survey and monitoring through the BEEMS project, co-ordinated by Cefas. The extremely small-scale and localised potential impacts of bait digging on the bird features are considered insignificant compared to any potential adverse relating to Hinkley developments. Devon and Severn IFCA sits on the Hinkley C Marine Technical forum and has good links with EDF so has a direct mechanism for staying up-to-date on Hinkley developments, if any of the planned work changes substantially. Therefore it is not thought that any in-combination effects will prevent the conservation objectives of the Severn Estuary EMS from being met.

Tidal Lagoons – Cardiff and Newport

Description of activities
Tidal Lagoon Power has proposed the development of two new Tidal Lagoons on the Welsh coast; one near Cardiff and one in the Newport area. Final designs or locations of the lagoons have not yet been determined but it is thought that they would encompass large areas of intertidal and subtidal habitat in the Severn Estuary.

Pressures
- Above water noise
- Barrier to species movement
- Collision ABOVE water with static or moving objects not naturally found in the marine environment (e.g. boats, machinery, and structures)
- Emergence regime changes – local, including tidal level change considerations

- Hydrocarbon & PAH contamination. Includes those priority substances listed in Annex II of Directive 2008/105/EC
- Introduction of light
- Introduction of other substances (solid, liquid or gas)
- Introduction or spread of non-indigenous species
- Litter
- Synthetic compound contamination (incl. pesticides, antifoulants, pharmaceuticals). Includes those priority substances listed in Annex II of Directive 2008/105/EC.
- Transition elements & organo-metal (e.g. TBT) contamination. Includes those priority substances listed in Annex II of Directive 2008/105/EC.
- Visual disturbance

In-combination assessment
At the present time, there is not enough information to make a detailed judgement on in-combination effects from Tidal Lagoons. However, the scale of bait digging and its potential to the bird features of the Severn are tiny in comparison to the potential of large-scale developments such as those proposed by the Tidal Lagoons. Therefore, any in-combination effect will be negligible compared to those of the lagoons alone.

9. Summary of consultation with Natural England

N/A

10. Integrity test

It can be concluded that bait digging, alone or in-combination, within the Severn Estuary SAC & SPA will not adversely affect the features of the European Marine Site or prevent the conservation objectives being met.

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Annex 2: Natural England's consultation advice

Annex 3: Site Map

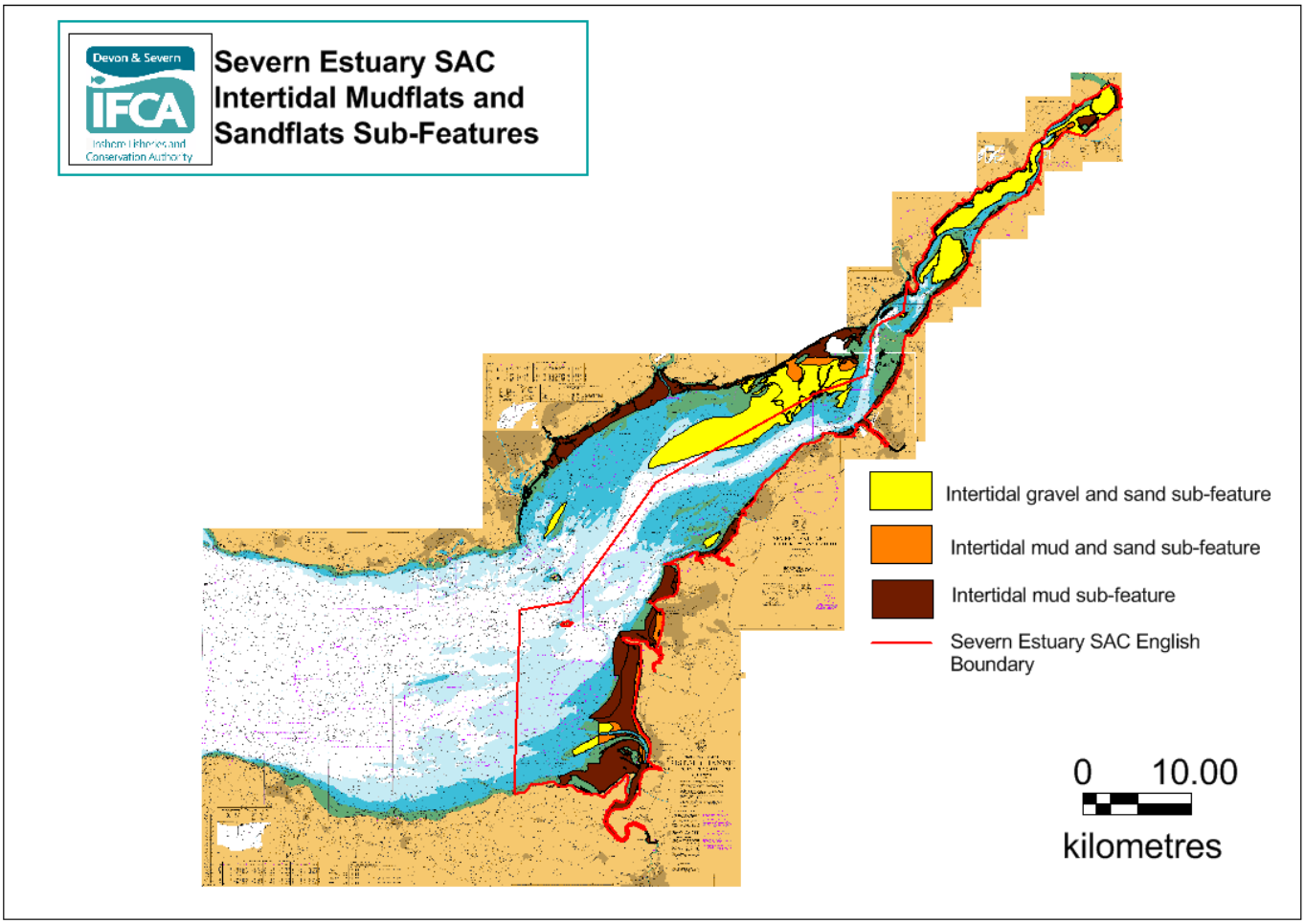


Figure 1 - Extent and distribution of the Intertidal Mudflats and Sandflats Sub-Features of the Severn Estuary SAC

Annex 4: Fishing Activity Information

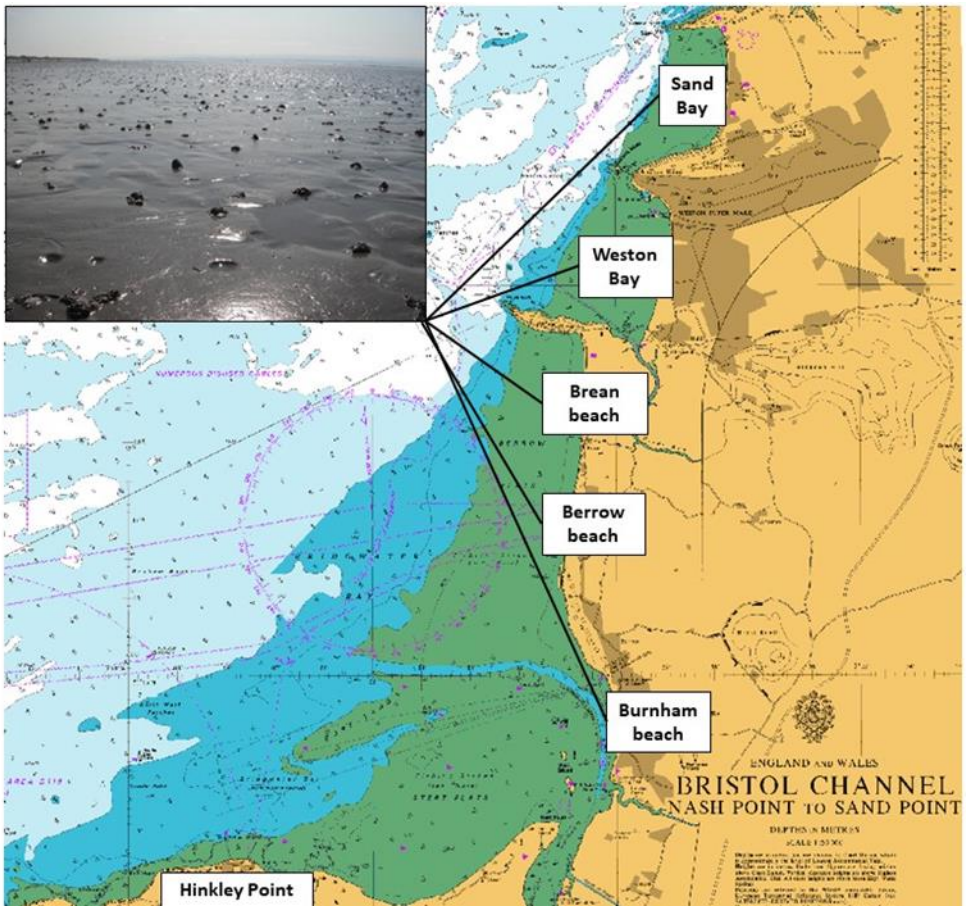


Figure 2. Survey locations for bait digging for lugworm (Weston Bay to Burnham-On-Sea) and ragworm (Hinkley Point) (see West 2019)

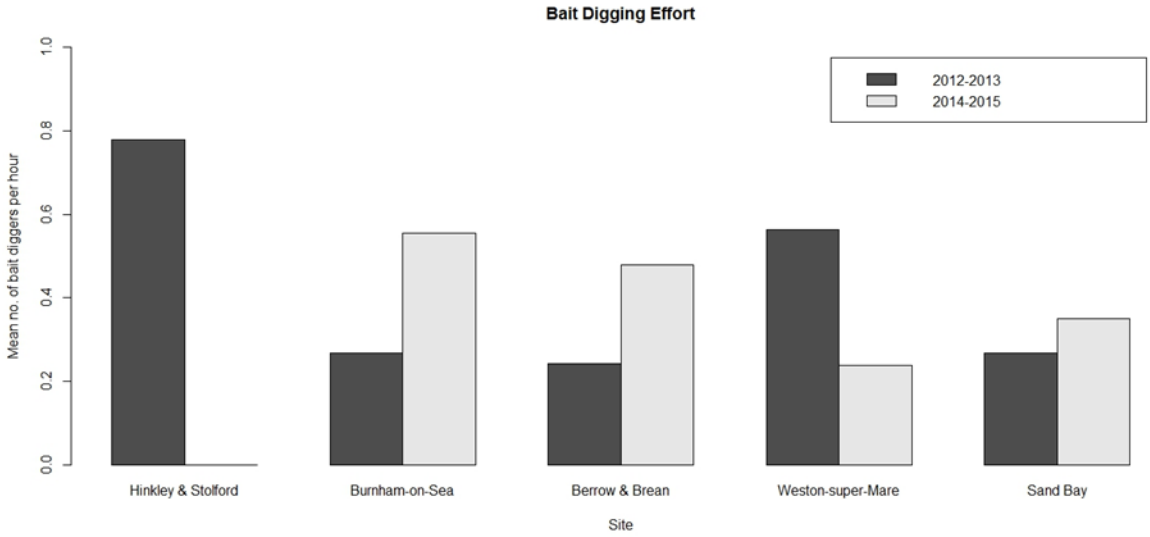
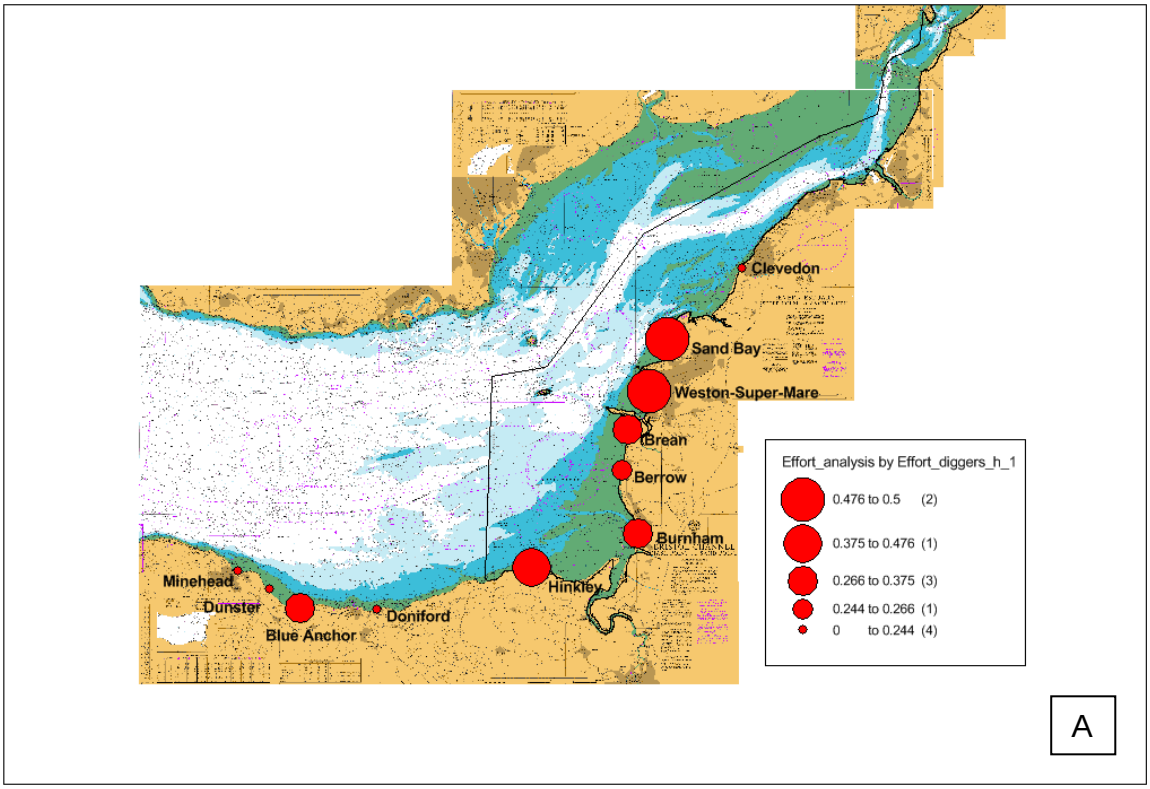


Figure 3. Mean number of bait diggers per hour for both sampling years (see West 2019)



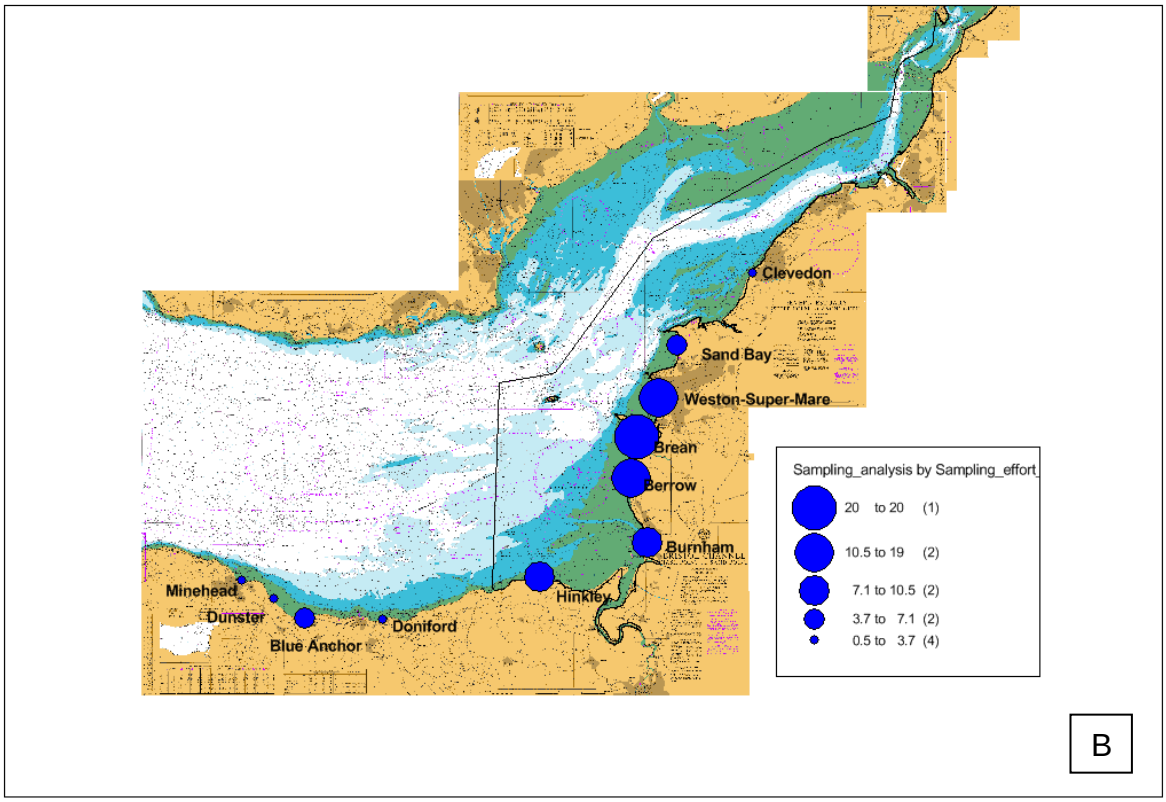


Figure 4. Survey results 2012-2015, Popularity of different locations in the Severn Estuary for bait digging; A) bait digging intensity (number of bait diggers per sampling hour) and B) sampling effort across the sites.

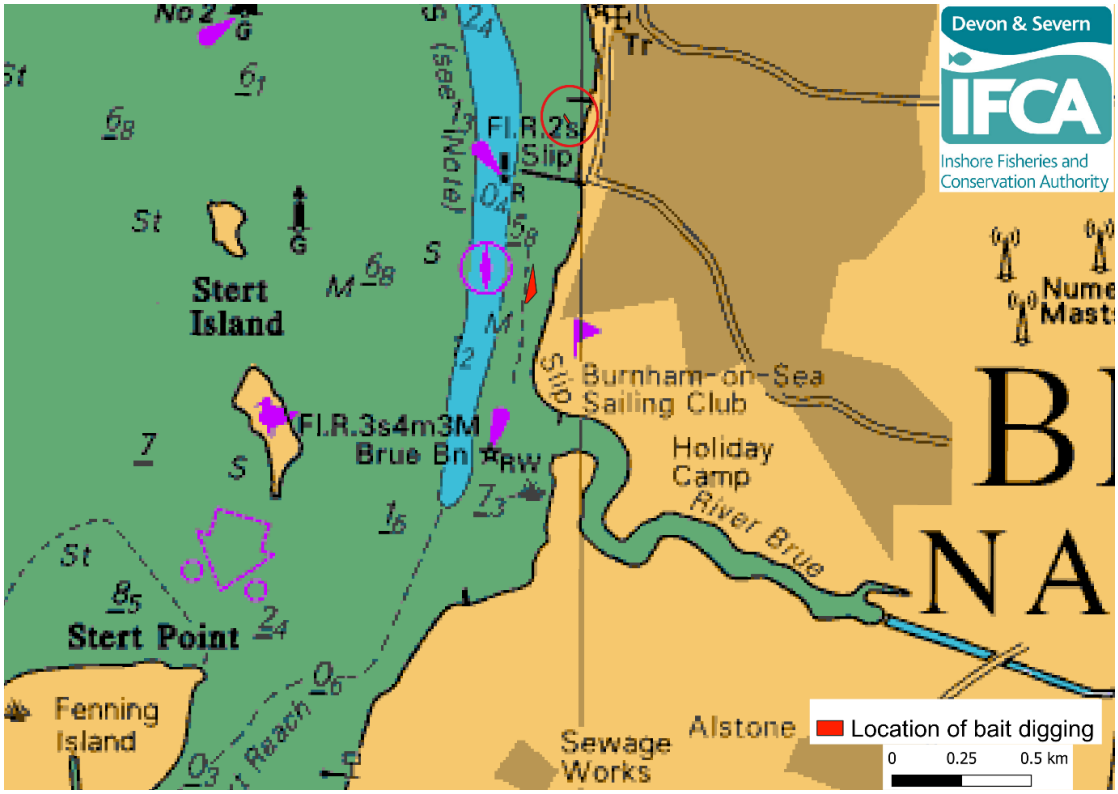


Figure 5. Location of bait digging activity observed at Burnham beach

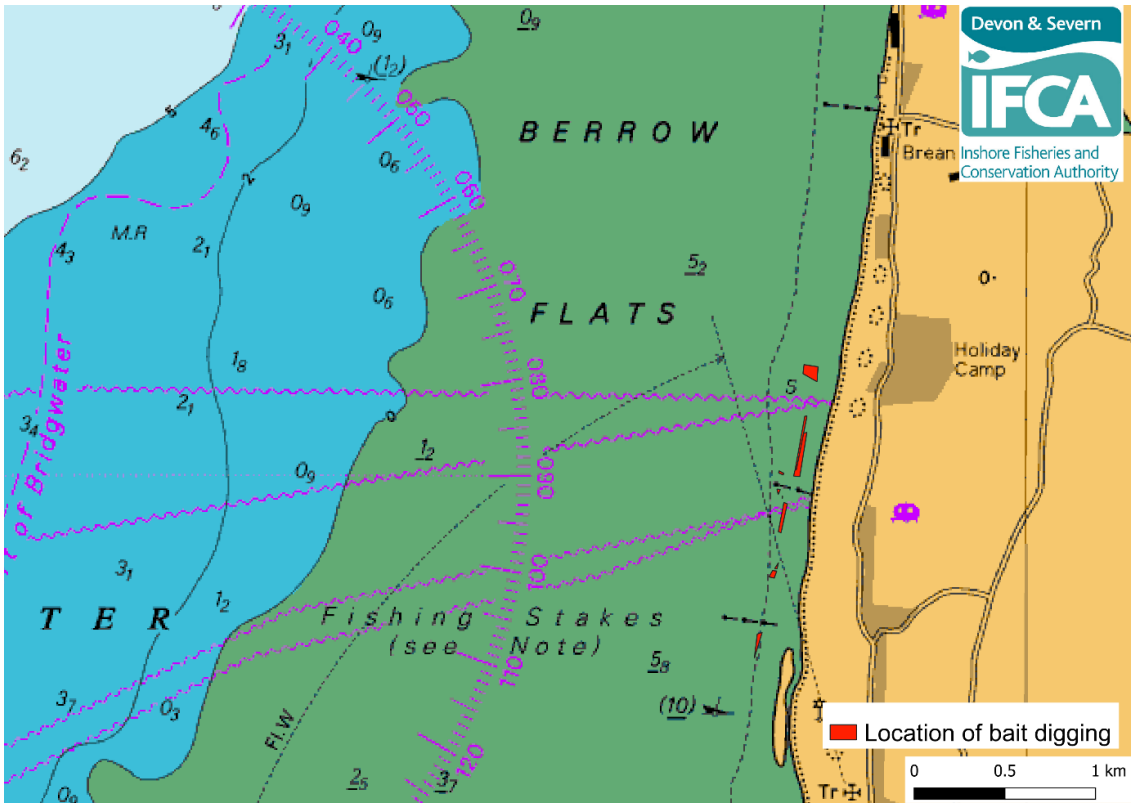


Figure 6. Location of bait digging activity observed at Berrow

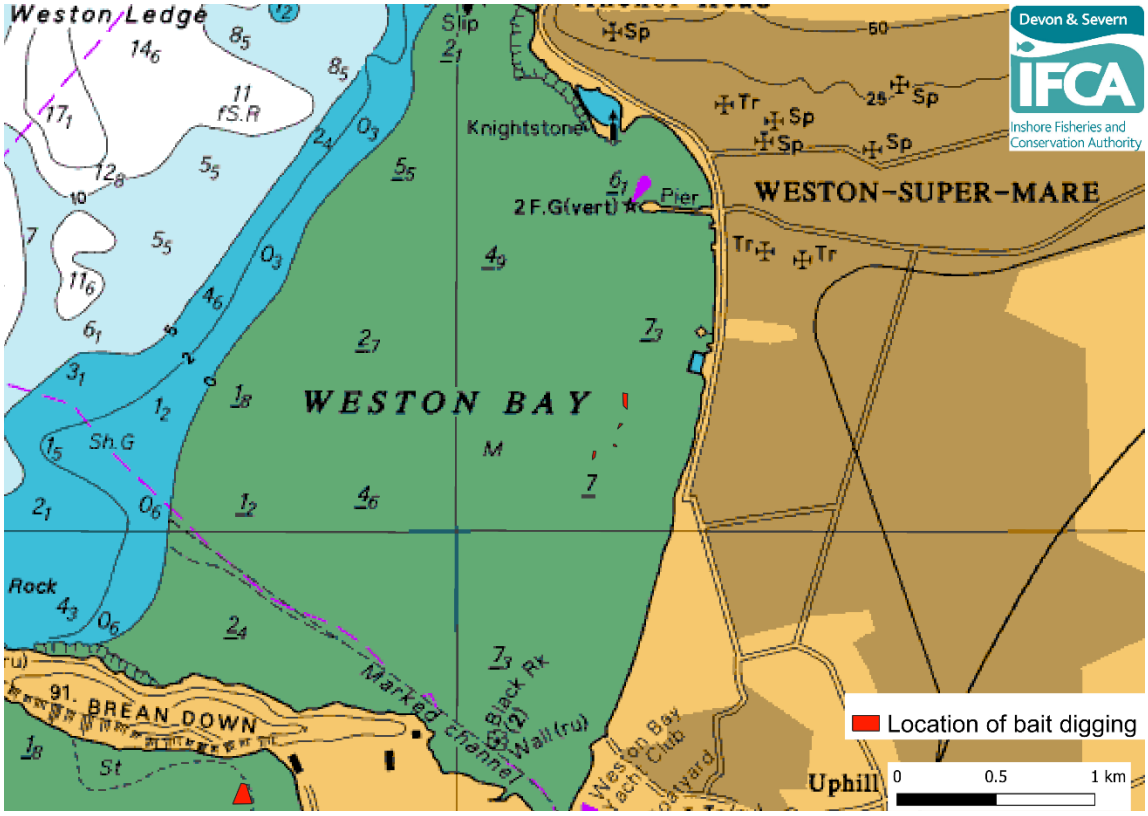


Figure 7. Location of bait digging activity observed at Weston Bay

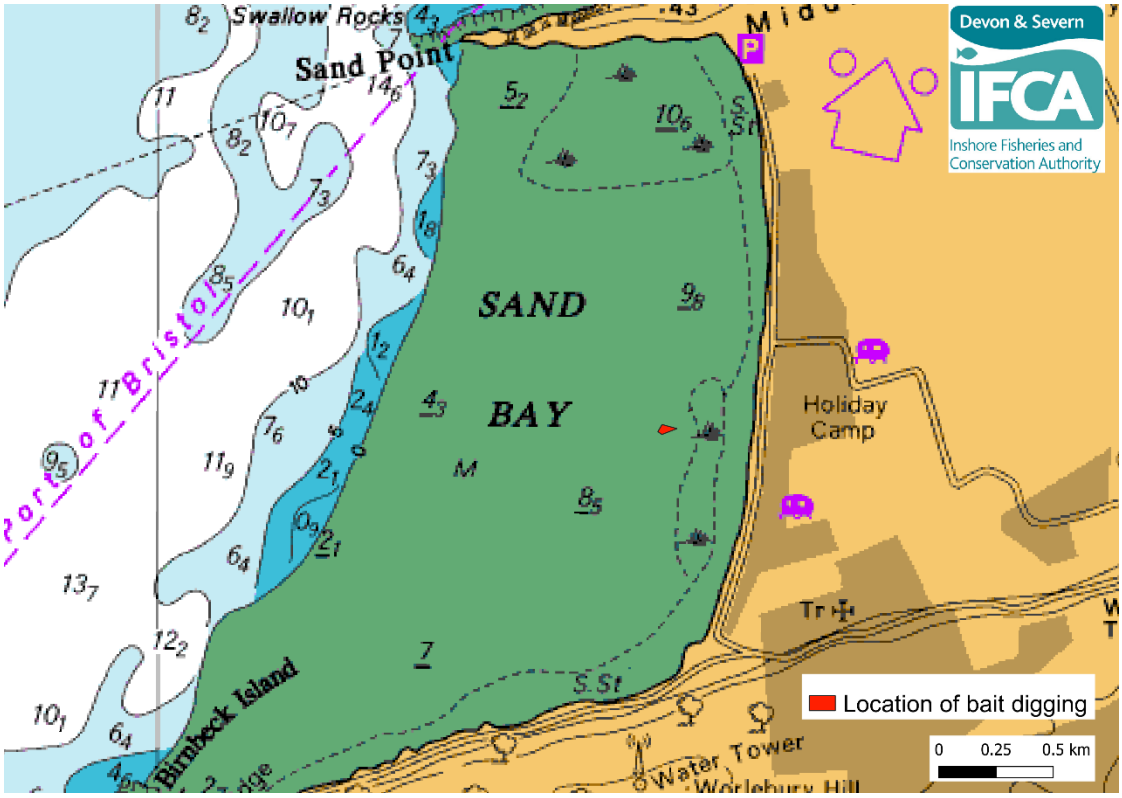


Figure 8. Location of bait digging activity observed at Sand Bay

Annex 5: Pressure Audit Trail

Pressures: Shore-based activities	Estuaries				Mudflats and sandflats not covered by seawater at low tide				Screening Justification
	Intertidal coarse sediment	Intertidal mixed sediment	Intertidal mud	Intertidal sand and muddy sand	Intertidal coarse sediment	Intertidal mixed sediment	Intertidal mud	Intertidal sand and muddy sand	
Abrasion/disturbance of the substrate on the surface of the seabed	NS	S	S	S	NS	S	S	S	**IN** – Need to consider spatial scale/intensity of activity to determine likely magnitude of pressure
Changes in suspended solids (water clarity)	NS	S	NS	NS	NS	S	NS	NS	OUT - Insufficient activity levels to pose high level of risk
Deoxygenation	NS	NS	NS	NS	NS	NS	NS	NS	OUT - Insufficient activity levels to pose high level of risk
Habitat structure changes- removal of substratum (extraction)	S	S	S	S	S	S	S	S	OUT - Insufficient activity levels to pose high level of risk
Hydrocarbon & PAH contamination. Includes those priority substances listed in Annex II of Directive 2008/105/EC.	NS	NS	NS	NS	NS	NS	NS	NS	OUT - Insufficient activity levels to pose pollution risk
Introduction of other substances (solid, liquid or gas)	IE	IE	IE	IE	IE	IE	IE	IE	OUT - Insufficient activity levels to pose pollution risk
Introduction or spread of non-indigenous species	IE	S	IE	S	IE	S	IE	S	OUT –Activity occurs in local area only so risk considered extremely low
Litter	IE	IE	IE	IE	IE	IE	IE	IE	OUT - Insufficient activity levels to pose pollution risk
Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion	NS	S	S	S	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	**IN** – Need to consider spatial scale/intensity of activity to determine likely magnitude of pressure

Removal of target species		S	S	S		S	S	S	**IN** – Need to consider spatial scale/intensity of activity to determine likely magnitude of pressure
Siltation rate changes (low)	S	S	NS	S	S	S	NS	S	OUT- Insufficient activity levels to pose pollution risk
Synthetic compound contamination (incl. pesticides, antifoulants, pharmaceuticals). Includes those priority substances listed in Annex II of Directive 2008/105/EC.	IE	NS	NS	NS	IE	NS	NS	NS	OUT- Insufficient activity levels to pose pollution risk
Transition elements & organo-metal (e.g. TBT) contamination. Includes those priority substances listed in Annex II of Directive 2008/105/EC.	IE	NS	NS	NS	IE	NS	NS	NS	OUT - Insufficient activity levels to pose pollution risk