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_AO40	Digging with forks	Estuaries	Estuarine bird community

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.

4. Information about the fishing activities within the site

D&S IFCA has carried out a detailed review of the fishing activities taking place within the Severn Estuary EMS (Ross, 2015). D&S IFCA carried out bait digging surveys between 2012 and 2015 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*. *Alitta virens* tends to be targeted in areas of sediment such as areas of pebbles or stones. Bait digging effort at Hinkley Point, the only site surveyed where these more mixed sediments are targeted, appears to be much lower than at the sites where lugworm are targeted. D&S IFCA has 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, has 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.

Fishing Activities occuring in the Seve

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)	**Bird feature(s):** • Above water noise • Removal of non-target species • Visual disturbance **See Annex 5 for pressures 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?	Direct effects of 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, bait diggers can disturb birds which can impact on breeding success through several factors e.g. nest abandonment, increased mortality of eggs due to predation and increased mortality of young through reduced feeding.	
5. Is the potential scale or magnitude of any effect likely to be significant?	**Alone**	**Unsure,** an interaction is present between bait digging and the estuarine bird community of the Severn Estuary SAC. 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

6.1 Potential risks to features

Table 2: Summary of Impacts

Feature/Sub feature(s)	**Conservation Objective**	**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**
Annex I species: - Bewick's swan Regularly occurring migratory species: - Greater white-fronted goose - Dunlin - Redshank - Shelduck - Gadwall Internationally important assemblage of waterfowl	The populations of the qualifying features: Maintain the 5-year peak mean population size for the… - Bewick's swan population is no less than 289 individuals - Wintering European white fronted goose population is no less than 3,002 individuals - Wintering dunlin population is no less than 41,683 individuals - Wintering redshank population is no less than 2,013	Removal of non-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 lug worm. 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 (Heilgenberg 1987, Blake 1979) but D&S IFCA's observations suggest this may be much lower in some areas, especially where	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. - 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	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

	individuals - Wintering shelduck population is no less than 2,892 individuals - Wintering gadwall population is no less than 330 -Waterfowl assemblage is no less than 68,026 individuals (i.e. the 5-year peak mean between 1988/9-1992/3) The distribution of the qualifying features within the site: Maintain aggregations of the… - Bewick's swan - European white-fronted goose - Dunlin - Redshank - Shelduck - Gadwall - Waterfowl aggregations at feeding, roosting and refuge sites are not subject to		large areas of lugworm exist and holes are relatively well spread out. 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 x 10^7 individuals take 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	hour between 0.2-0.8 per hour and median values for the number of holes observed on a survey being close to 0. - 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 angling effort, possibly relating to 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 - The areas dug for worm tended to be very small in comparison to the overall available habitat - Digging primarily occurred around low tide although it was generally middle to upper shore areas which were dug 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 - Some commercial activity has occurred in the past	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 this may include the requirement to back fill holes and trenches.

	significant disturbance. The populations of the qualifying features: Maintain the 5-year peak mean population size for the: - Bewick's swan population is no less than 289 individuals - Wintering European white fronted goose population is no less than 3,002 individuals - Wintering dunlin population is no less than 41,683 individuals - Wintering redshank population is no less than 2,013 individuals - Wintering shelduck population is no less than 2,892 individuals - Wintering gadwall population is no less than 330 - Waterfowl assemblage is no		to bait digging. King ragworm, *Alitta 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. 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 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 generally preferred). *H. diversicolor* is widely distributed	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 This effort is significantly 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. 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	

	less than 68,026 individuals (i.e. the 5-year peak mean between 1988/9-1992/3)		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	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.	

			population of *H.diversicolor* to bait digging may depend on local population dynamics as well as the intensity of the activity. 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 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 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 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). 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. Lugworm is an important prey item for the Grey Plover and the Bar-Tailed Godwits in the Severn (Goss-Custard et al., 1991). There is an important link between macrofaunal biomass (energy content) and the behaviour of wading birds. Wading birds have been shown to extend their feeding period, increase their attack rate, broaden their prey or move to different areas in order to cope with reductions in infaunal biomass (Zwarts, 1993). Although the process of bait digging can directly target prey items for certain bird species, it can also indirectly impact the forging efficiency of wading birds through increased mortality of associated invertebrate fauna. For example, Shepherd and Boates (1999) found that foraging efficiency of sandpipers was significantly lower in areas targeted for bait digging of bloodworms. Foraging efficiency decreased by 68.5%. This species of bait is not a prey item for the sandpiper but the process of bait digging resulted in a 38% decrease in density of their amphipod prey, *Corophium volutator,* after one year of baitworm harvesting in the Bay of Fundy. This decrease was as a result of direct mortality and lower juvenile recruitment.		

			It was also observed that sandpipers on dug regions took longer to build up fat deposits needed for migration. However, although the high mud content of many of the Severn Estuary's intertidal mud and sandflats might suggest that the habitat is more sensitive to disturbance, the extreme tidal range and exposed nature of the Severn intertidal mud & sand flats means that these habitats in the Severn are not comparable to low-energy sheltered mud habitats elsewhere. In other mud habitats, physical disturbance from bait digging is often visible for extended periods of time, in the Severn holes are generally not visible after one tidal cycle, even though back filling does not occur.		
Annex I species: - Bewick's swan Regularly occurring migratory species: - Greater white-fronted goose - Dunlin - Redshank - Shelduck - Gadwall Internationally important	The populations of the qualifying features: Maintain the 5-year peak mean population size for the… - Bewick's swan population is no less than 289 individuals - Wintering European white fronted goose population is no less than 3,002 individuals - Wintering	- Above water noise - Visual disturbance	Bird disturbance is also a major concern, especially where peak bait digging coincides with peak bird abundance or intertidal activity (Townsend & O'Connor, 1993). A review by Hockin *et al.* (1992), shows disturbance can have an effect on breeding success through several factors e.g. nest abandonment, increased mortality of eggs due to predation and increased mortality of young through reduced feeding. Disturbance can reduce use of sites by birds, and can affect nest site choice, having a negative effect on population density. It can also have a negative effect on energy budgets – time spent flying, reduces time spent feeding. Sustained, localised disturbance in	The ringed plover, grey plover, dunlin, curlew, redshank and shelduck predominantly forage intertidally (Burton *et al.* 2010). Noise and the presence of bait diggers may cause disturbance to bird species. Temporal peaks in bait digging (Autumn and Winter, West 2019) do coincide with the peak abundance of overwintering birds. However, the diggers presence is generally around low tide (West 2019) and bait digging activity is concentrated on the lower parts of the upper shore over relatively small	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

assemblage of waterfowl	dunlin population is no less than 41,683 individuals - Wintering redshank population is no less than 2,013 individuals - Wintering shelduck population is no less than 2,892 individuals - Wintering gadwall population is no less than 330 - Waterfowl assemblage is no less than 68,026 individuals (i.e. the 5-year peak mean between 1988/9-1992/3) The distribution of the qualifying features within the site: Maintain aggregations of the… - Bewick's swan - European white-fronted goose - Dunlin - Redshank		feeding areas can lead to shifts to alternative feeding sites (Tasker *et al.* 2000). Bait collection has been found to induce a 'temporary loss of habitat' for some bird species, with bait collector numbers negatively correlating with wader and gull abundance (Watson et al., 2017a). Wildfowl, such as mute swans may be the least likely group to be vulnerable to disturbance, as many of these species are fed directly by humans (Liley and Fearnley 2012, Watson et al. 2017a) Goss-Custard and Verboven (1993) found that the presence of people in areas used for feeding and breeding can alter the behaviour and distribution of estuarine birds, meaning the birds may become displaced into areas with a lower prey density. A disturbance review by the Exe Estuary Management Partnership (2016) summarised that disturbance levels can be dictated by a number of factors such as noise level, amount of activity and number of people present. However, disturbance by bait collection generally occurs via visual (seeing the collector and responding as if they were a potential predator) and/or noise disturbance (causing distress via deviation from the "natural" ambient noise). Liley et al. (2011) found that whilst bait-digging and crab-tiling accounted for 7% of bird disturbance events in their study on the Exe Estuary, this was just a count of number of events, and bait-digging actually	areas (Annex 4, Figures 12-15). This reduces the pressure of disturbance as there is a large area available for birds to feed at low tide and the birds are often widely distributed across the intertidal area (Annex 3, Figures 2-8) but often with concentrations further out than the bait digging activity. Maximum numbers of bait diggers were recorded as 2-4 individuals, and these would often (but not always) be digging in close proximity to each other (E West pers obs). There has been a steady increase in winter shelduck population in the Severn estuary over the last 30 years (Burton *et al.* 2010; Cook *et al.* 2013). Cook *et al.* suggested that the environmental conditions remain relatively favourable and that the Severn Estuary is becoming increasingly important for shelduck, because the population is not tracking regional or country trends. Shelduck are most abundant in Bridgwater Bay, containing 71% of the total Severn Estuary population (Table 3, Annex 7) and it is an important moulting area for shelduck	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 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

	- Shelduck - Gadwall - Waterfowl aggregations …at feeding, roosting and refuge sites are not subject to significant disturbance. The populations of the qualifying features: Maintain the 5-year peak mean population size for the… - Bewick's swan population is no less than 289 individuals - Wintering European white fronted goose population is no less than 3,002 individuals - Wintering dunlin population is no less than 41,683 individuals - Wintering redshank population is no less than 2,013 individuals - Wintering shelduck		accounted for 16% of all major flight events. Liley et al. (2012) carried out observational surveys in Poole Harbour, recording activities which resulted in bird disturbance. For 93% of observations there was no response from birds, only 1% resulted in major flights. 1558 potential disturbance events were recorded over 63 hours of survey. During the 63 hours of surveillance there were just five individual disturbance events involving bait collection, none resulted in the birds being flushed. Townsend and O'Connor (1993) found that disturbance caused by bait digging activity greatly reduced the extent of use of the Lindisfarne National Nature Reserve (NNR) by wigeon, bar-tailed godwit and redshank. However, significant increases in the populations of wildfowl were recorded in the year following a ban on bait digging. In addition to the disturbance to birds from bait digging, there have been several studies that have shown dog walkers can induce anti-predator responses in birds including increased vigilance (Randler, 2006) and early flight, as well as disturbing some species of breeding shorebirds from their nests (Lord et al., 2001) which may lead to a cascade of related responses that negatively affect birds, such as areas of intertidal habitat being unavailable to the birds (Liley et al., 2011). However, the	during later summer and autumn (Natural England, 2009; Burton *et al.* 2010). Moulting shelduck are present in high numbers in Bridgwater Bay between June and October. Mean counts of moulting shelduck between 2005 and 2014 from June to October were 1075, 2460, 3930, 2697 and 2334 respectively (Best, 2015). They are more vulnerable to disturbance when moulting due to their inability to fly away. However, they utilise a wide area of Bridgwater Bay and the frequency of disturbance likely to be caused by bait digging would not have an impact on the species. Additionally, peak bait digging activity would only overlap with the latter part of Shelduck moulting, and much of it would fall outside this season. Other species in Bridgwater Bay which represent a high number of the total Severn Estuary population are grey plover (54%), dunlin (53%), lapwing (47%), spotted redshank (45%), redshank (43%) and ringed plover (36%). An additional eight other species are present in significant numbers (<30%) and can be seen in Table 3, Annex 7. Data from the first year of bait	introduce formal management this may include the requirement to back fill holes and trenches.

	population is no less than 2,892 individuals - Wintering gadwall population is no less than 330 - Waterfowl assemblage is no less than 68,026 individuals (i.e. the 5-year peak mean between 1988/9-1992/3)		impact of dog walkers on wading birds will be subject to the duration, frequency and location of disturbance as well as being species specific.	digging surveys suggest *relatively* high levels of bait digging (2 individuals observed) at Hinkley Point (West 2019) but no bait diggers were observed in 2014-2015. The low sampling effort for this site makes these results unreliable. Certainly, this site is harder to reach, and only targeted for ragworm, suggesting the relatively high levels observed in 2012-2013 at Hinkley Point may be mis-leading. Digging at Burnham-on-Sea peaked in the winter months, suggesting impacts on moulting shelduck might be minimal (West 2019). The parts of the shore dug at Burnham-on-Sea (Annex 4, Figure 12) also suggest that minimal disturbance will take place in comparison to the distribution of birds at low tide in Bridgwater Bay (Annex 3, Figures 2-4). The sector Brean Down to Anchor Head encompasses Weston Bay (Annex 7, Figure 19). Weston Bay contains significant numbers of redshank (17%), gadwall (11%) and teal (11%) when compared to the Severn Estuary as a whole (Table 5, Annex 7). Another 12 species are also present in high	

				numbers (<10%). Latham (2015) identified high tide waterbird roost sites situated at the southern end of the sector, which includes the Axe Estuary. The latest five-year summary of WeBS data indicate the number of waterbirds within the sector peaked during the winter months (November to March). The number of redshanks within the sector tends to peak during the autumn period (July to October), although this species is also present in high numbers during the winter period (Latham, 2015). The distribution of red shank at low tide in Weston Bay (Annex 3, Figure 8) suggests that bait digging activity at this site (Annex 4, Figure14) will not overlap significantly. Redshanks favour river mouths where there is freshwater input such as the River Axe (Burton *et al*. 2010) which is located within this sector. Sand Bay contains significant numbers of shelduck (14%), ringed plover (4%), curlew (3%), grey plover (3%), redshank (3%) and dunlin (1%), see Table 4, Annex 3.	

				The latest five-year summary WeBS data indicated that the sector from Anchor Head to Sand Point supports three SPA qualifying species: shelduck (Annex 3, Figure 5), dunlin (Annex 3, Figure 7) and redshank (Annex 3, Figure 6). According to the WeBS data the number of all three species tends to peak within the sector during the winter months. The sector supported, on average, 12% of the wintering shelduck population, 1.5% of the wintering dunlin population, and 1.2% of the wintering redshank population, of the entire Severn Estuary between 2008/09 and 2012/13 (Latham, 2015). There has been an increase in redshank numbers at Sand Bay within the last 30 years (Burton *et al.* 2010). In the south of Sand Bay, a mixed waterbird roost site in open water was identified, which was typically dominated by shelduck and black-headed gulls (Latham, 2015). WeBS interviews identified potential sources of disturbance in Sand Bay from jet skiing and lifeboat manoeuvres, predominantly during the summer months (Latham, 2015). As with other sites, bait digging activity at Sand Bay (Annex 4, Figure 5) tends to occur much higher on	

				the shore than peak bird counts at Sand Bay (Annex 3, Figures 5-7). Burton *et al.* (2010) analysed WeBS data in order to identify the status of birds in the Severn Estuary and Bristol Channel, compared to historic numbers and in relation to any site-specific or broad scale patterns. The study found that the proportion of wader numbers wintering in south west Britain and the Severn Estuary, are decreasing, with the highest declines in grey plovers and dunlins over the past 20 years. The decline is negatively correlated with mean winter temperatures. The decline of grey plovers and dunlins in the Severn Estuary may be a consequence of climate change, rather than site-specific issues (Austin and Rehfisch, 2005). The SPA Toolkit assessed Bewick's swan, white-fronted goose, dunlin, redshank, shelduck, gadwall, curlew and pintail from WeBS alerts as having no site-specific decline. The ringed plover was not assessed.	

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 or SPA interest features. However, the management of bait collection should be considered by D&S IFCA as a commencement of commercial bait digging activity at a higher level could result in an adverse effect on the conservation objectives and site integrity of the SAC. Best practice outlined in 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

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.

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 fixed nets 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 and temporal and spatial distribution of bait digging is 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.

Wildfowling

Description of activities
Wildfowling occurs in the Severn Estuary EMS. The majority is undertaken by wildfowling clubs, by Sites of Special Scientific Interest (SSSI) consent or National Nature Reserve (NNR) permits. However, there is still a certain amount of non-permitted wildfowling taking place. There are five wildfowling clubs on the English side of the Severn Estuary:

1) Highbridge, Huntspill & Burnham District Wildfowlers Club (HHBWC)

The club shoot over the Crown Estate land Bridgwater Bay SSSI, and also are primary shooters on the excepted (see Annex 6, Figure 11) NNR land at Bridgewater Bay. This is licenced by Natural England, via a permit system.

2) Bridgwater Bay Wildfowlers Association (BBWA)

At Bridgwater Bay, BBWA shoot over the NNR at Comwich which is licenced by Natural England via a permit system. BBWA are the other primary shooters on the excepted (see Annex 6, Figure 11) NNR land at Bridgwater Bay. BBWA also shoot over Crown Estate and Non-Crown Estate land on the River Axe.

3) Weston Sporting Club (WSC)

WSC shoot over Crown Estate and Non-Crown Estate land on (and adjacent to) the River Axe on the Severn Estuary

4) Clevedon Wildfowling Association (CWA)

The CWA shoot over Crown Estate and Non-Crown Estate land at Woodspring Bay on the Severn Estuary

5) Gloucestershire Wildfowlers Association (GWA)

The open season for wildfowling in England and Wales, above the mean high water mark is 1st September to 31st January. The open season for duck and goose species below the mean high water mark is 1st September to 20th February (BASC, 2015). Sunday shooting of wildfowl is not permitted and there may be local restrictions on shooting at night. The species that can be shot during their open season and are a Severn SPA feature are;

Gadwall, Pintail, Pochard, Shoveler, Teal, Tufted duck, Wigeon, White fronted geese and Mallard (Wildlife and Countryside Act 1981).

Pressures

- Above water noise
- Litter
- Removal of target species
- Visual disturbance

In-combination assessment

Wildfowling occurs to the west of the fished area in Sellick Zone 1 (Annex 6, figure 11 and Annex 4, Figure 10). The pressures of visual disturbance and noise from bait digging could have an in-combination effect with wildfowling. Disturbance from wildfowling would be in the form of presence by wildfowlers and the noise from a fired shot. Wildfowling for ducks and goose species can only occur below mean high water between 1st September and 20th February (except on Sundays). Natural England has carried out HRAs for wildfowling licenses which conclude no adverse impact on site integrity. The spatial and temporal distribution of bait digging will have no impact on the features of the EMS and will occur at different times to the wildfowling (low vs high tide) so no adverse effect will occur.

Coastal Path

Description of activities

The South West Coast Path and the England Coast Path are to be extended from Minehead to Bristol. The final route of the coastal path has not yet been released. Minehead to Brean Down is now open to the public, coastal access rights came into force on 15th March 2016. There is a restricted coastal margin access to the saltmarsh and mudflats of Steart Flats (Bridgwater Bay). Coastal access from Brean Down to Aust is currently in development and expected to be open in 2017.

Pressures

- Above water noise
- Collision ABOVE water with static or moving objects not naturally found in the marine environment (e.g. boats, machinery, and structures)
- Barrier to species movement
- Visual disturbance
- Introduction of light
- Litter

In-combination assessment

At the present time, there is not enough information to make a detailed judgement on in-combination effects from the coast path development. Associated pressures would be from a result of construction work to create the coast path. Recreational activity is thought to increase due to the new coast path, as there will be access to previously inaccessible areas. Due to the lack of impact of bait digging and its limited spatial and temporal distribution, it is not thought that any in-combination effects will prevent the conservation objectives of the Severn Estuary EMS from being met.

Other

The impact of future plans or projects will require assessment in their own right, including accounting for any in-combination effects, alongside existing activities.

D&S IFCA conclude there is no likelihood of significant adverse effect on the interest features from in-combination effects with other plans or projects addressed within section 8.2.

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.

Annex 1: Reference list

Austin, G., Rehfisch, M.M. (2005) Shifting non-breeding distributions of migratory fauna in relation to climatic change. Global Change Biology 11, 31–38.

BASC (The British Association for Shooting & Conservation), Revised October 2015. Available at: http://basc.org.uk/cop/wildfowling/ [Accessed: 22/03/2016]

Beukema JJ. (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: 2019-227

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.

Burton, N.H.K., Musgrove, A.J., Rehfisch, M.M., Clark, N.A. (2010) Birds of the Severn Estuary and Bristol Channel: Their current status and key environmental issues. Marine Pollution Bulletin, 61: 115-123.

BTO (2016a) Bridgwater Bay sector 13411. Available from: http://app.bto.org/websonline/public/gpub-boundary.jsp?loclabel=13411_Bridgwater%20Bay%20(Severn%20Estuary)~ST259470 [Accessed: 13/07/2016]

BTO (2016b) Sand Bay sector 14402. Available from: http://app.bto.org/websonline/public/gpub-boundary.jsp?loclabel=14402_Sand%20Bay%20(Severn%20Estuary)~ST315642 [Accessed: 13/07/2016]

BTO (2016c) Axe Estuary sector 14401. Available from: http://app.bto.org/websonline/public/gpub-boundary.jsp?loclabel=14401_Axe%20Estuary%20(Severn)%20(Severn%20Estuary)~ST296598 [Accessed: 13/07/2016]

Carvalho S, Constantino R, Cerqueria M, Pereira F, Subida M, Drake P, Gaspar M (2013). Short term impact of bait digging on intertidal microbenthic assemblages of two south Iberian Atlantic systems. Estuarine, Coastal and Shelf Science. 132 pp65-75.

Cook, A.S.C.P., Barimore, C., Holt, C.A., Read, W.J. and Austin, G.E. (2013). Wetland Bird Survey Alerts 2009/2010: Changes in numbers of wintering waterbirds in the Constituent Countries of the United Kingdom, Special Protection Areas (SPAs) and Sites of Special Scientific Interest (SSSIs). BTO Research Report 641. BTO, Thetford.

Cryer, M., Whittle, G.N. & Williams, R. (1987) The impact of bait collection by anglers on marine intertidal invertebrates. Biological Conservation. 42: 83-93.

Davey J.T. and C.L. George (1986) Specific interactions in soft sediments: factors in the distribution of *Nereis* (Hediste) *diversicolor* in the Tamar Estuary, Ophelia 26: 151-164.

De Boer W.F. and Longamane F.A. (1996) The exploitation of intertidal food resources in Inhaca Bay, Mozambique, by shorebirds and humans. Biological Conservation. 78: 295-303

Dernie K.M., Kaiser M.J., Warwick R.M. (2003) Recovery rates of benthic communities following physical disturbance J App Ecol 72: 1043-1056

Evans, S., Moon, J., Bunker, A.R. and Green. M. 2015. Impacts of Bait Digging on the Gann: An Evidence Review. NRW Evidence Report No: 81 34pp, NRW, Bangor.

Exe Estuary Management Partnership (2016) Bait Collection Disturbance Literature Review 2016 – Exe Estaury EMS Case Study.

Fowler SL. (1999). Guidelines for managing the collection of bait and other shoreline animals within UK European marine sites. UK Marine SAC project.

Goss-Custard J.D., Warwick R.M., Kirby R., McGrorty, S., Clarke, R.T., Pearson, B., Rispin, W.E., Durell, S.E.A. le V. dit & Rose, R.J. (1991). Towards predicting wading bird densities from predicted prey densities in a post-barrage Severn estuary. Journal of Applied Ecology 28:1004-1026.

Goss-Custard J & Verboven N (1993). Disturbance and feeding shorebirds on the Exe estuary. Wader Study Group Bulletin. 68: 59-66.

Grant, A., J. G. Hateley & N. V. Jones, 1990. Interpopulation variation of life history and metal tolerance in *Nereis diversicolor*. In Scaps P. (2002) A review of the biology, ecology and potential use of the common ragworm *Hediste diversicolor* (O.F. Müller) (Annelida: Polychaeta), Hydrobiologia 470: 203–218, 2002.

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. Biological Conservation, 39, 165-177.

Hockin, D., Ounsted, M., Gorman, M., Hill, D., Keller, V., & Barker, M. A. (1992) Examination of the effects of disturbance on birds with reference to its importance in ecological assessments. Journal of Environmental Management, 36: 253-286

Jackson 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.

Johnson G. (1984) Bait collection in a proposed marine nature reserve, MSc Report, Ecology and Conservation Unit, University College London in http://www.ukmarinesac.org.uk/activities/bait-collection/, accessed February 2019.

Latham, J. (2015) Identification of wintering waterbird high tide roosts on the Severn Estuary SSSI/SPA (Brean Down to Clevedon). Report for Natural England (RP2262).

Liley D., Cruickshanks K., Waldon J., Fearnley H. (2011). Exe Estuary Disturbance Study. Footprint Ecology Ltd., Wareham, Dorset.

Liley D. and Fearnley H. (2012) Poole Harbour Disturbance Study, Report for Natural England, Footprint Ecology Ltd, Dorset, p.75

Liley, D., Cruickshanks, K, Fearnley, H. & Lake, S. (2012) The effect of bait collection on waterfowl foraging behaviour in Holes Bay, Poole Harbour. Report for Natural England. Footprint Ecology Ltd., Wareham, Dorset.

Lord A, Waas JR, Innes J, Whittingham MJ (2001). Effects of human approaches to nests of northern New Zealand dotterels. Biological Conservation. 98: 233-240.

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

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

Natural England and the Countryside Council for Wales' Conservation Advice – formal advice given under Regulation 33(2)(a) of the Conservation (Natural Habitats, &c.) Regulation 1994, as amended. June 2009.

Natural England (2015) Marine conservation advice for Special Area of Conservation: Severn Estuary (UK0013030)

Natural England's risk assessment Matrix of fishing activities and European habitat features and protected species

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

Randler, C. (2006). Disturbances by dog barking increase vigilance in coots Fulica atra. European Journal of Wildlife Research. 52. 265-270.

Ross E.J. (2015) Fishing Activities Occurring in the Severn Estuary European Marine Site, Devon and Severn IFCA Report

Ross E.J (2013) Site Specific Assessment for Red High Risk Categories, Severn Estuary SAC. Devon and Severn IFCA

Ross E.J (2013b) Blow lug *Arenicola marina* density in the Severn Estuary European Marine Site: A baseline survey 2012-2013. Devon and Severn IFCA.

Rossi, F., Forster, R.M., Montserrat, F., Ponti, M., Terlizzi, A., Ysebaert, T. & 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.

Scaps, P. (2002) A review of the biology, ecology and potential use of the common ragworm *Hediste diversicolor* (O.F. Müller) (Annelida: Polychaeta), Hydrobiologia 470: 203–218, 2002.

Shepherd, P.C.F. and Boates, S.J. (1999). Effects of a commercial baitworm harvest on Semipalmated Sandpipers and their prey in the Bay of Fundy hemispheric shorebird reserve. Conservation Biology. 13: 347-356.

Shull, D.H., (1997) Mechanisms of infaunal polychaete dispersal and colonisation in an intertidal sandflat. Journal of Marine Research. 55: 153-179.

SPA Toolkit

Tasker, M.L., Camphuysen, C.J., Cooper, J., Garthe, S., Montevecchi, W.A., Stephen, J.M.B. (2000) The impacts of fishing on marine birds. ICES Journal of Marine Science, 57: 531-547

Townshend, D.J. & O'Connor, D.A. (1993) Some Effects of Disturbance to Waterfowl from Bait Digging and Wildfowling at Lindisfarne National Nature Reserve, North-east England. Wader Study Group Bulletin. 68**:** 47–52.

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

Watson, G.J., Murray, J.M., Schaefer, M. and Bonner, A. (2017b). Bait worms: a valuable and important fishery with implications for fisheries and conservation management. Fish and Fisheries. 18: 374-388

West E.J. (2019) Bait digging in the Severn Estuary European Marine Site, Data Analysis Report. Devon and Severn IFCA.

Wynberg, R.P. & Branch, G.M. (1997) Trampling associated with bait-collection for sandprawns *Callianassa kraussi* Stebbing: effcts on the biota of an intertidal sandflat. Environmental Conservation 24(2): 139-148

Zwarts, L. and Wanink, J. (1993). How the food supply harvestable by waders in the Wadden Sea depends on the variation in energy density, body weight, biomass, burying depth and behaviour of tidal-flat invertebrates. Netherlands Journal of Sea Research, 31(4), pp.441-476.

Annex 2: Natural England's consultation advice

Annex 3: Site Maps

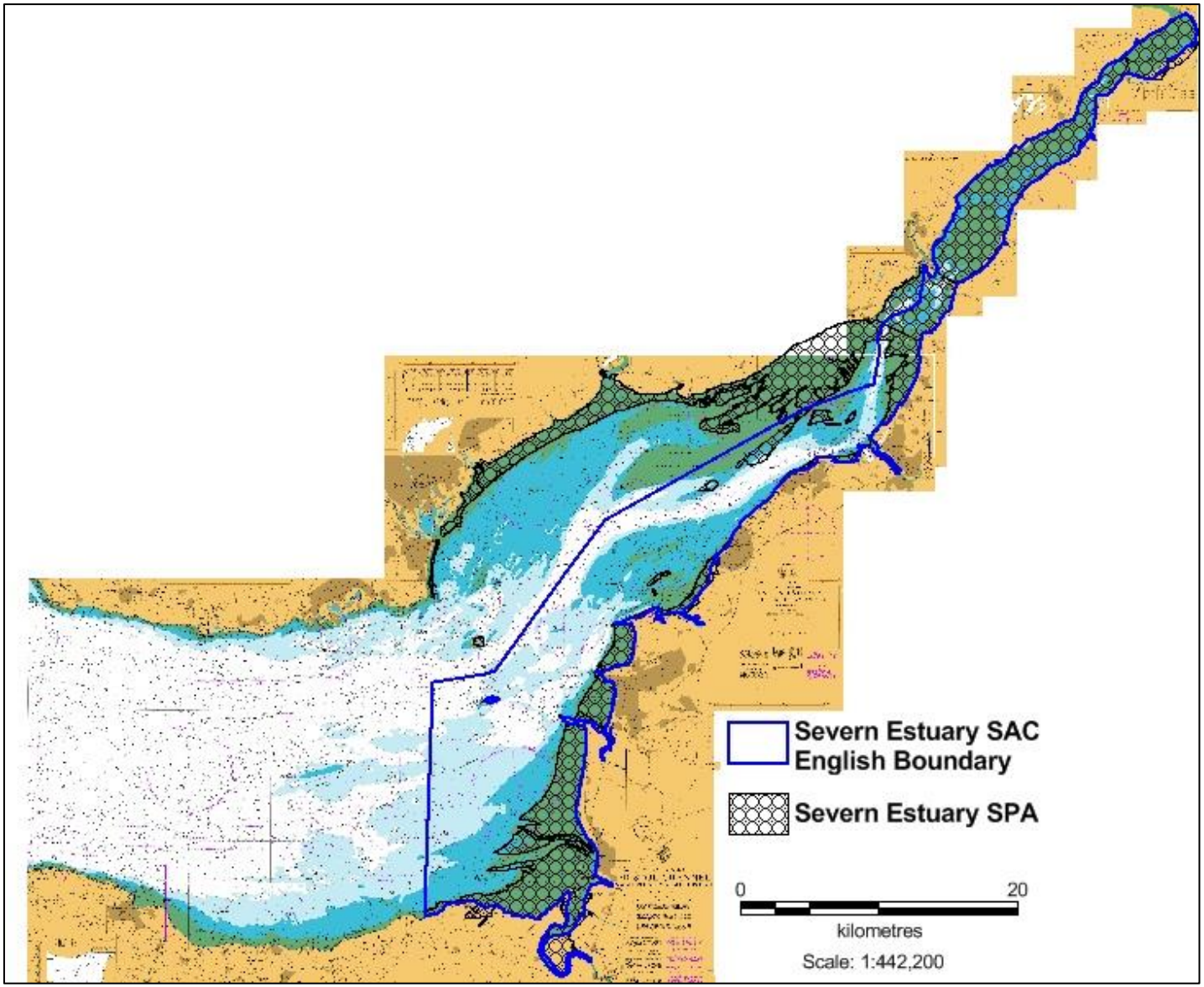


Figure 1 - Map showing the extent of the Severn Estuary SPA

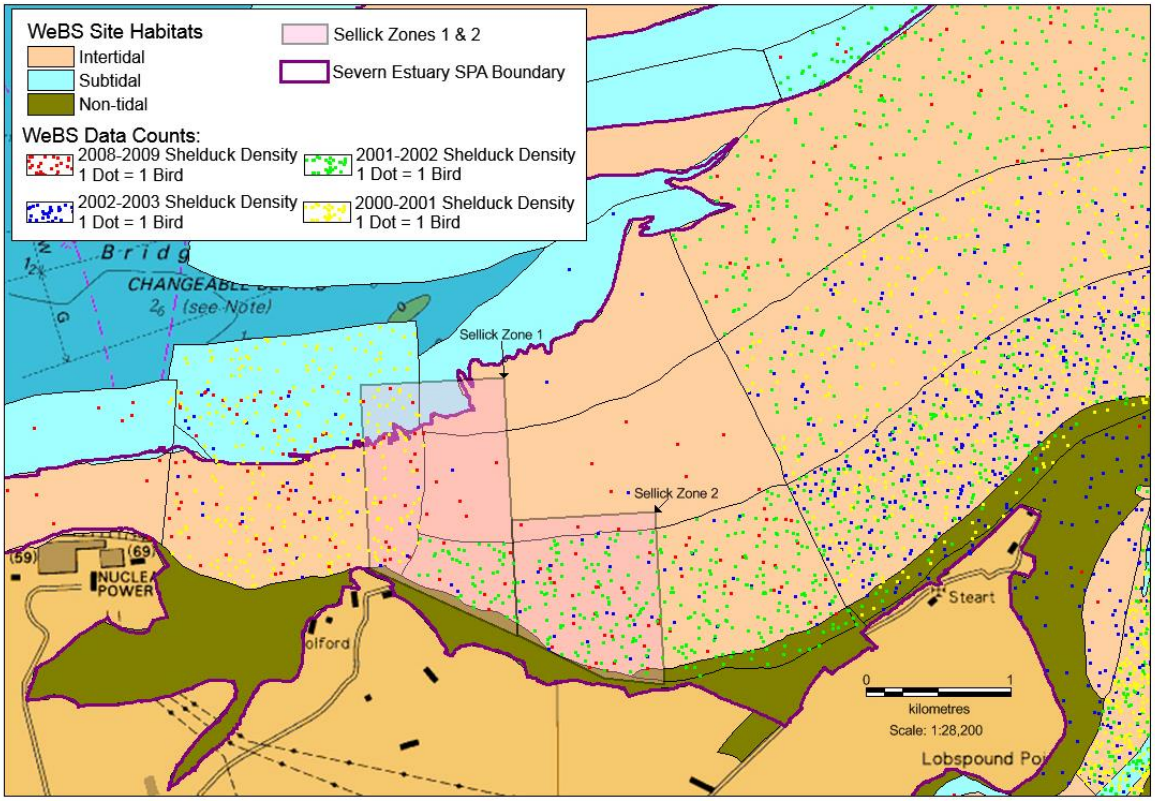


Figure 2 – WeBS low tide count data for Shelduck density in Bridgewater Bay

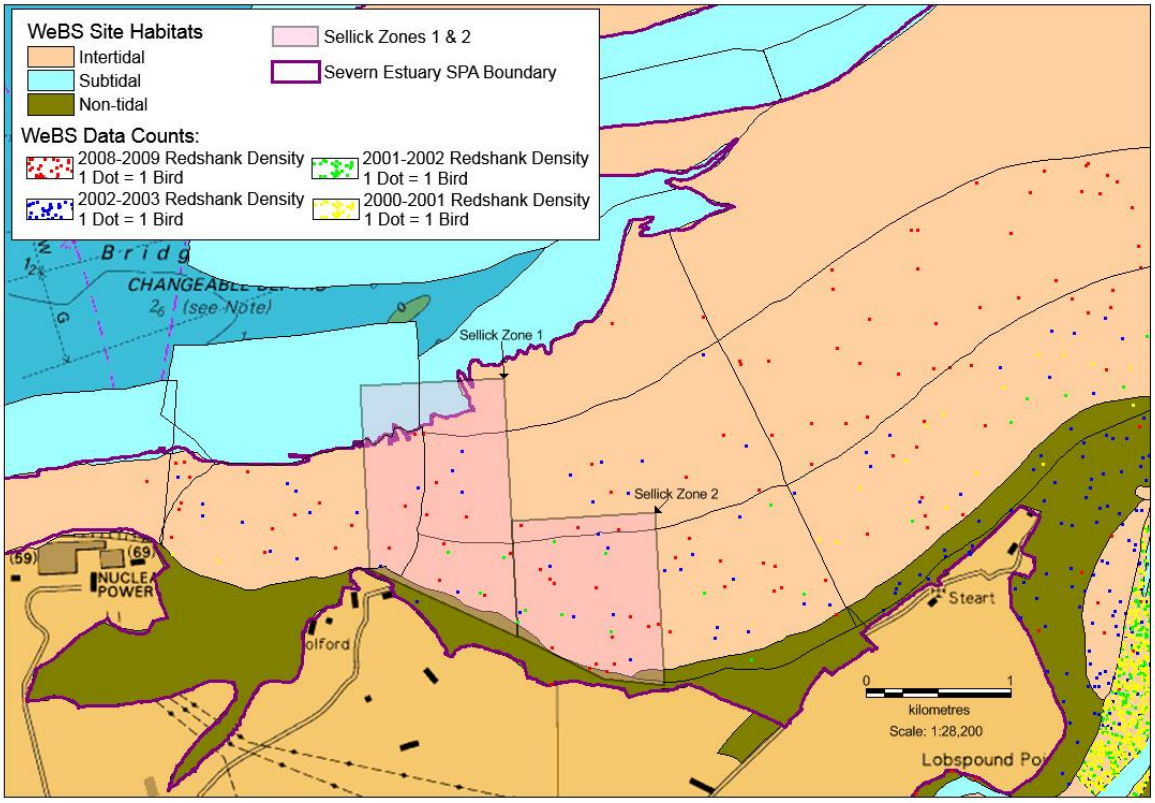


Figure 3 - WeBS low tide count data for Redshank density in Bridgewater Bay

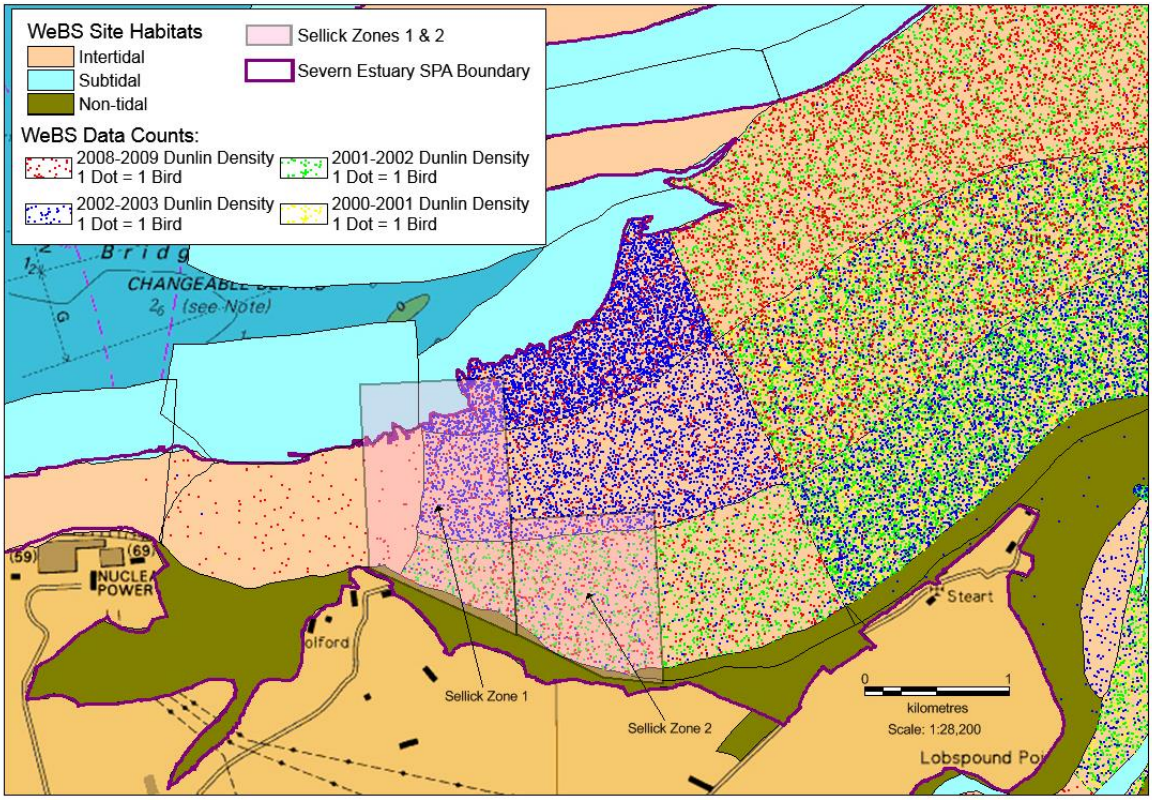


Figure 4 - WeBS low tide count data for Dunlin density in Bridgewater Bay

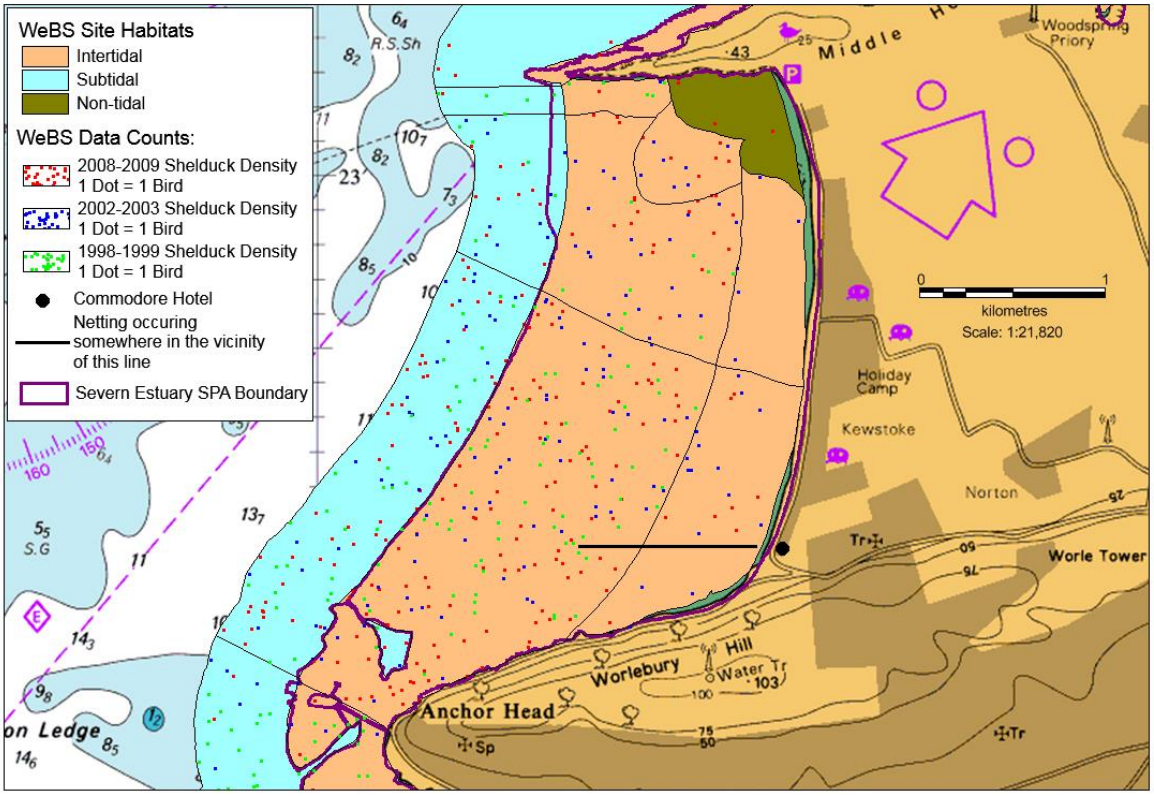


Figure 5 - Fishing Activity and WeBS data low tide count for Shelduck density in Sand Bay

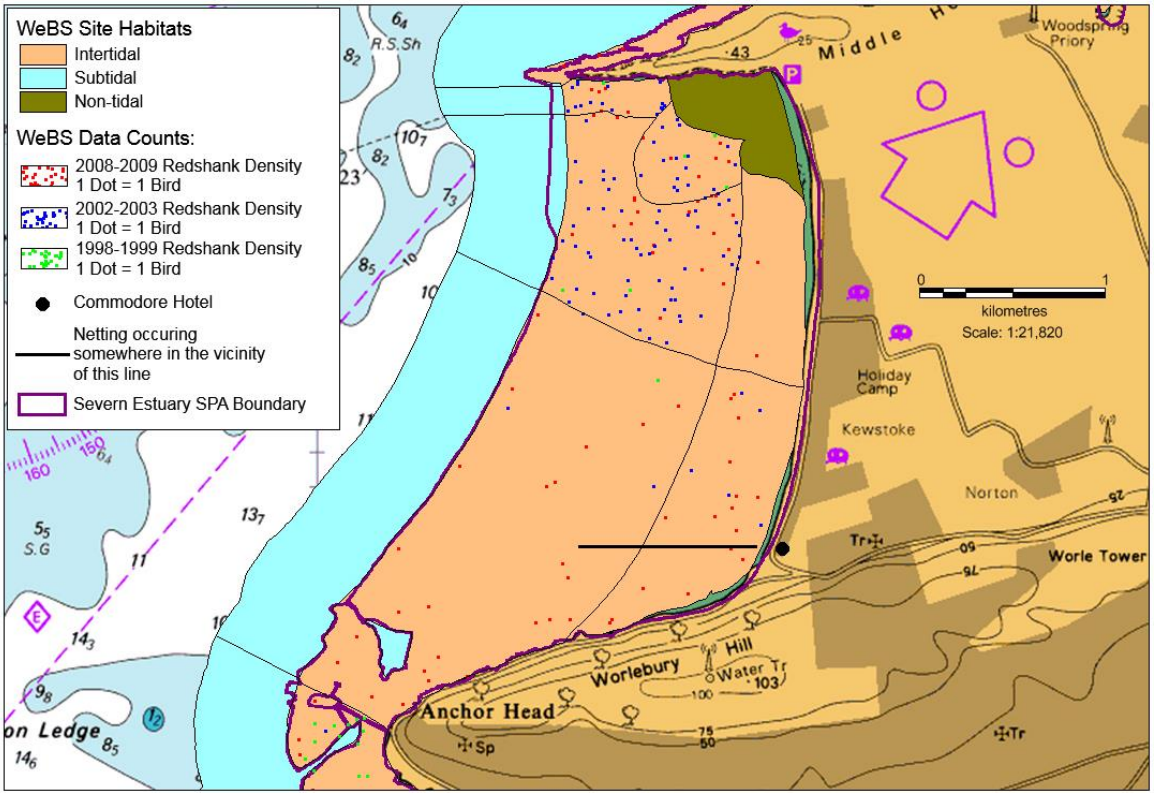


Figure 6 - Fishing Activity and WeBS low tide count data for Redshank density in Sand Bay

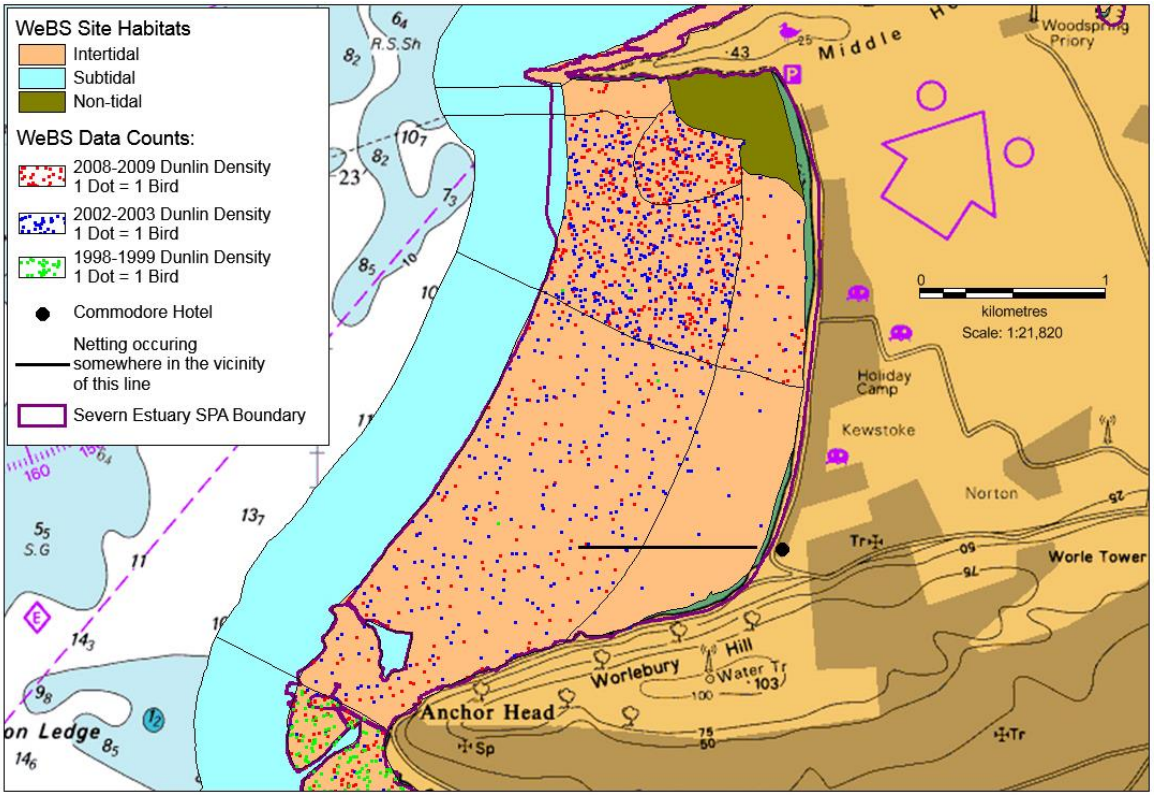


Figure 7 - Fishing Activity and WeBS low tide count data for Dunlin density in Sand Bay

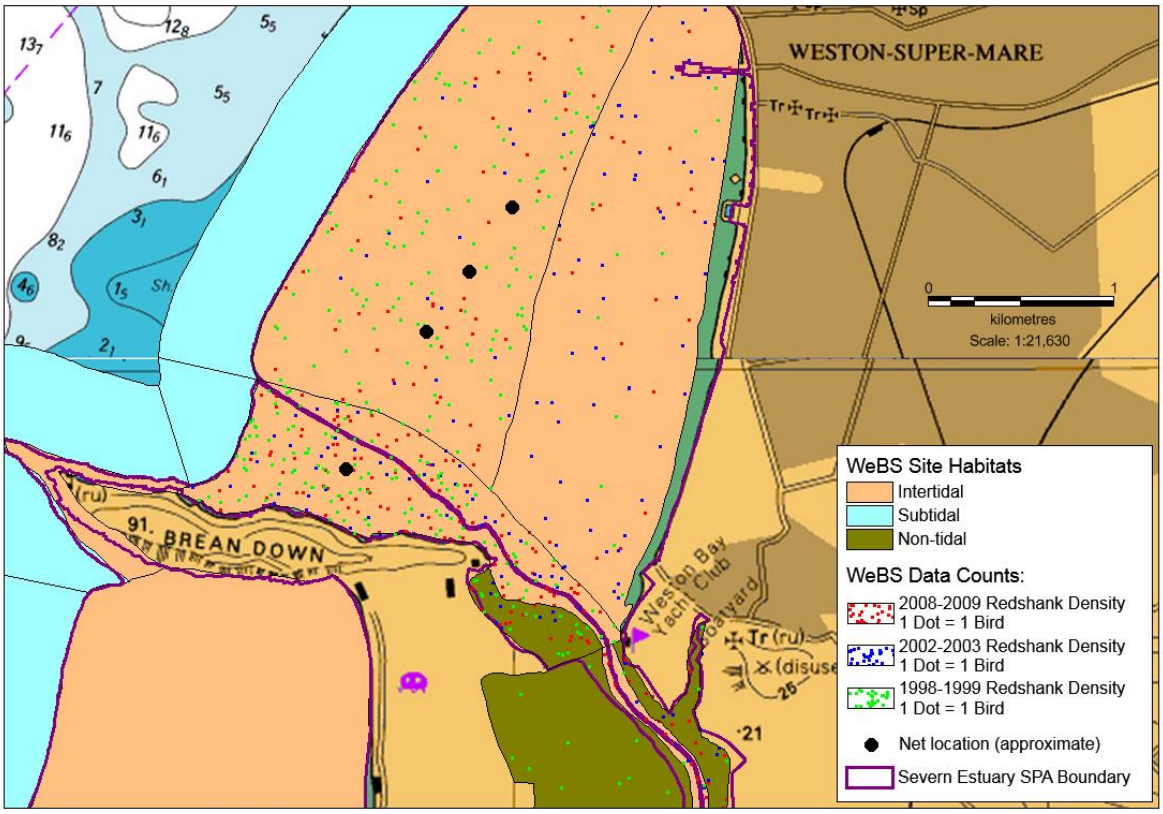


Figure 8 - Fishing Activity and WeBS low tide count data (November to February) for Redshank density in Weston Bay.

Annex 4: Fishing Activity Information

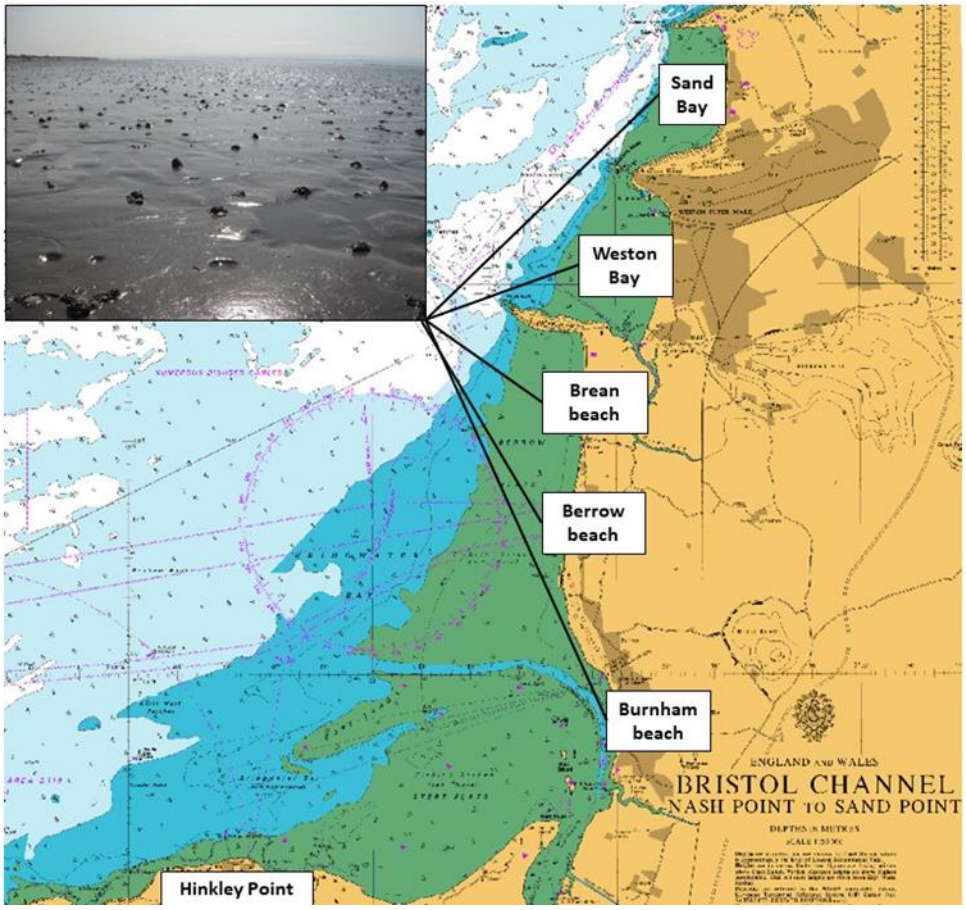


Figure 9. Survey locations for bait digging for lugworm (Weston Bay to Burnham-On-Sea) and ragworm (Hinkley Point) (see West 2019)

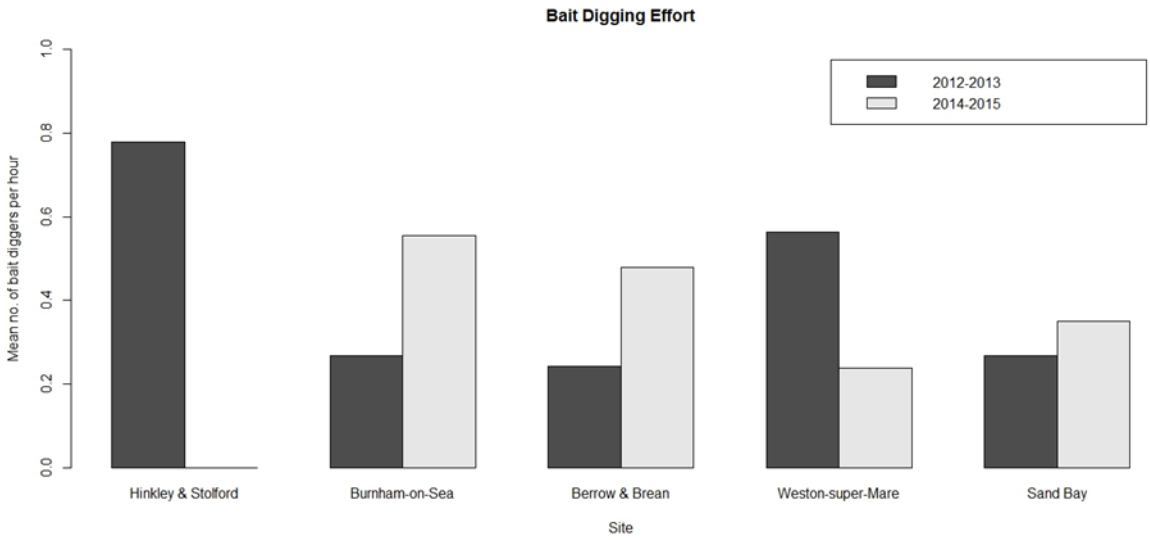
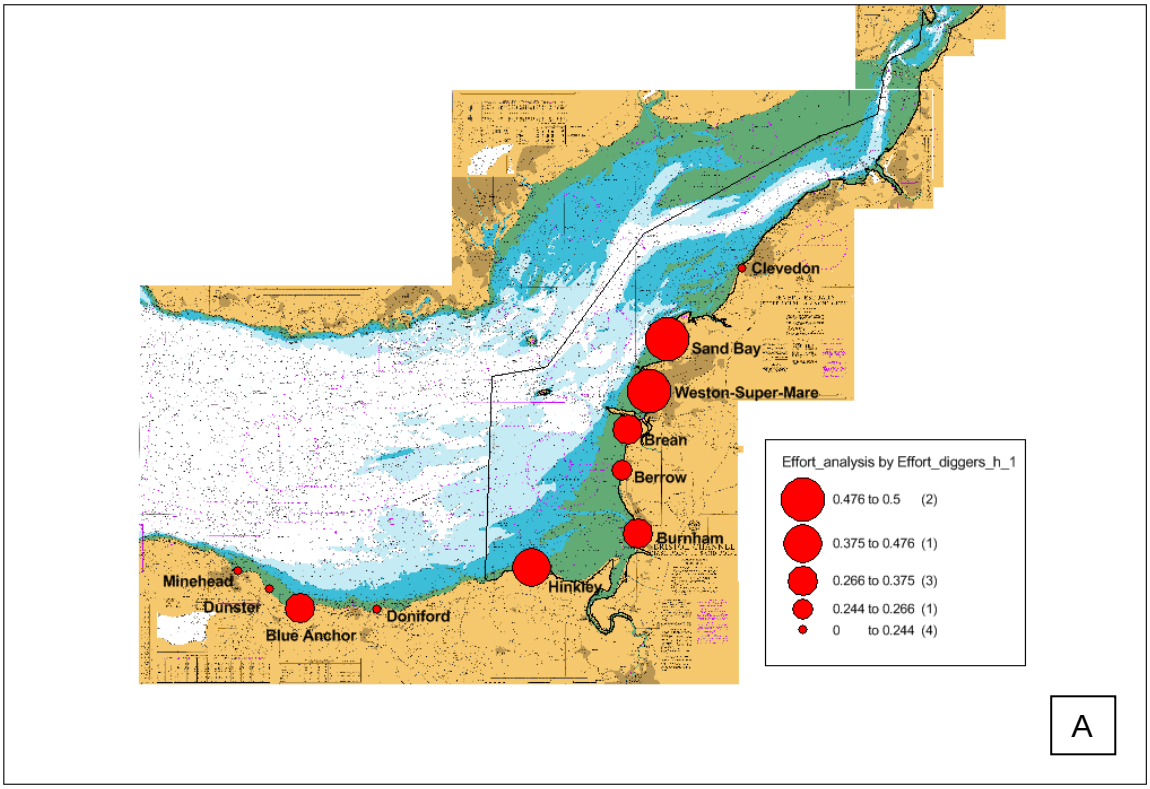


Figure 10. Mean number of bait diggers per hour for both sampling years (see West 2019)



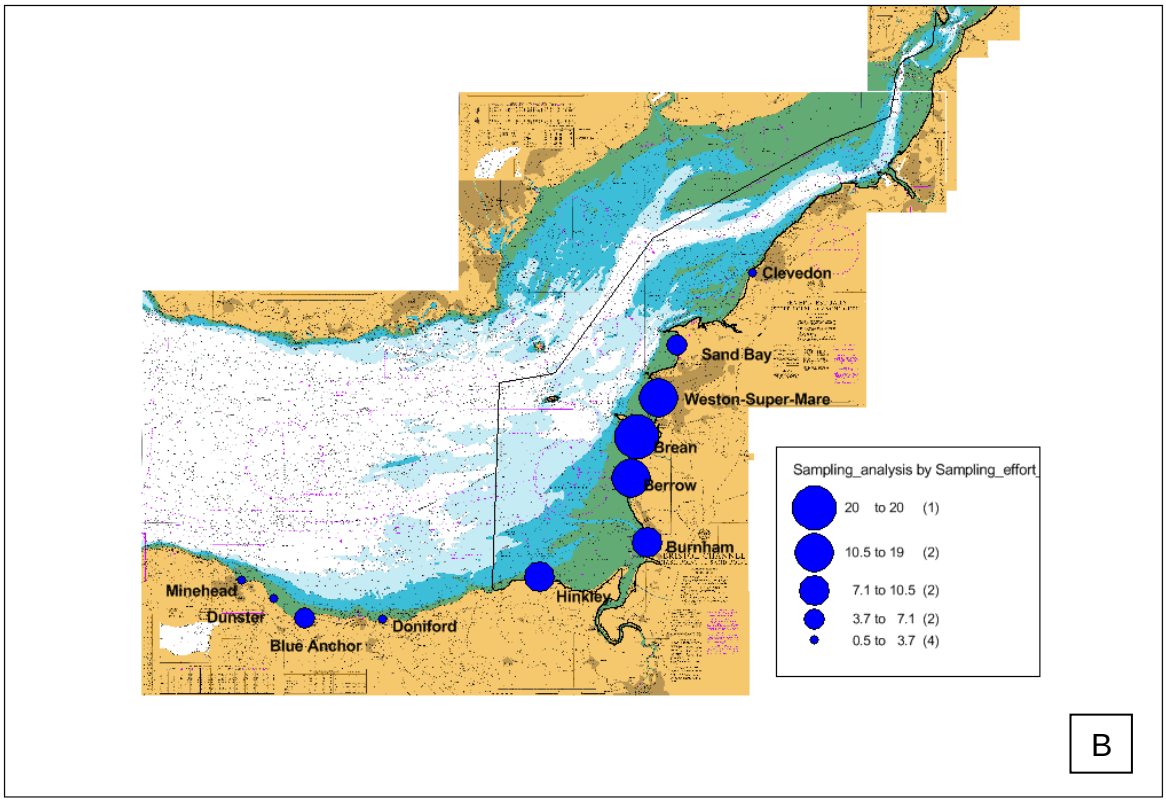


Figure 11 – Survey results 2012-2015, Popularity of different locations in the Severn Estuary for bait digging; A) bait digging intensity (number of bait diggers per sampling hour) and B) sampling effort across the sites.

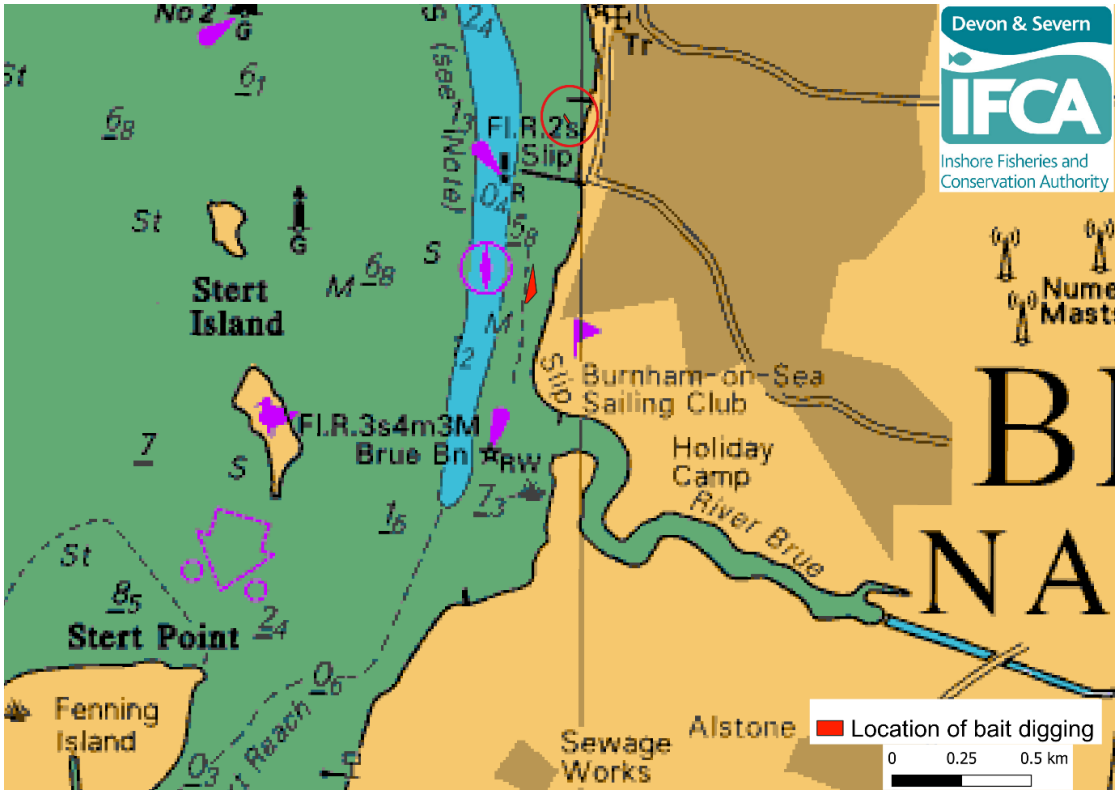


Figure 12. Location of bait digging activity observed at Burnham beach

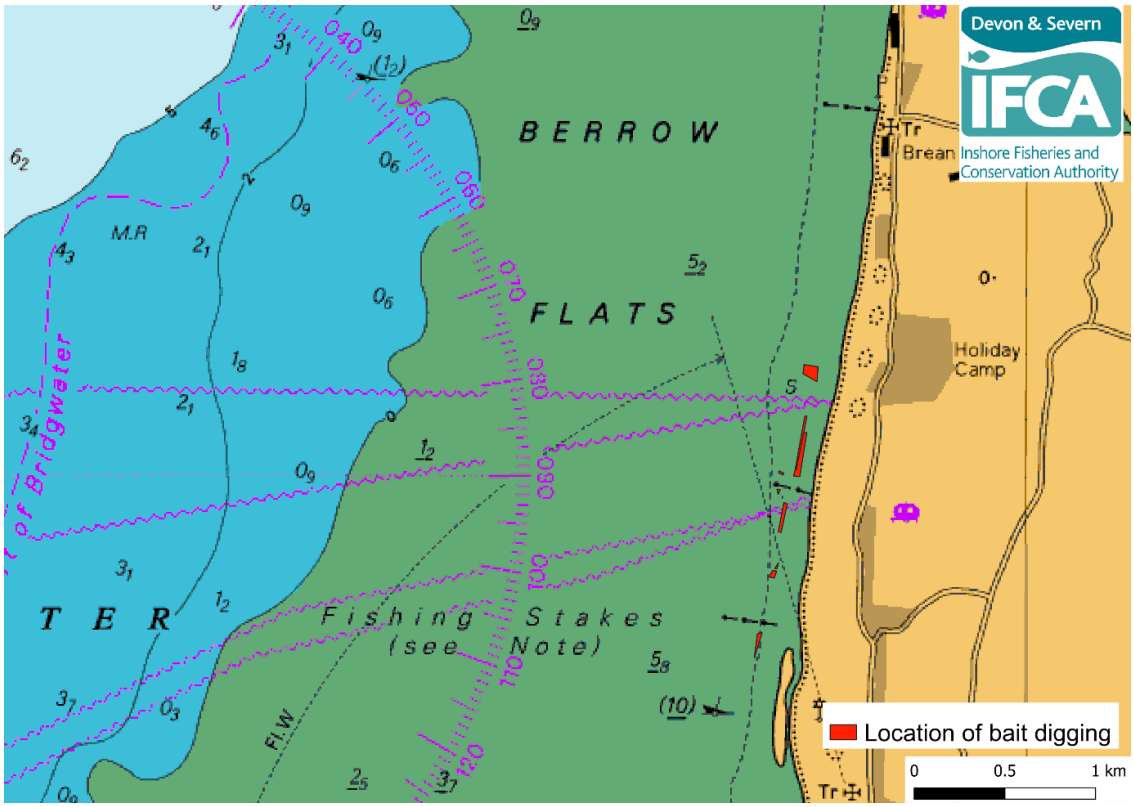


Figure 13. Location of bait digging activity observed at Berrow

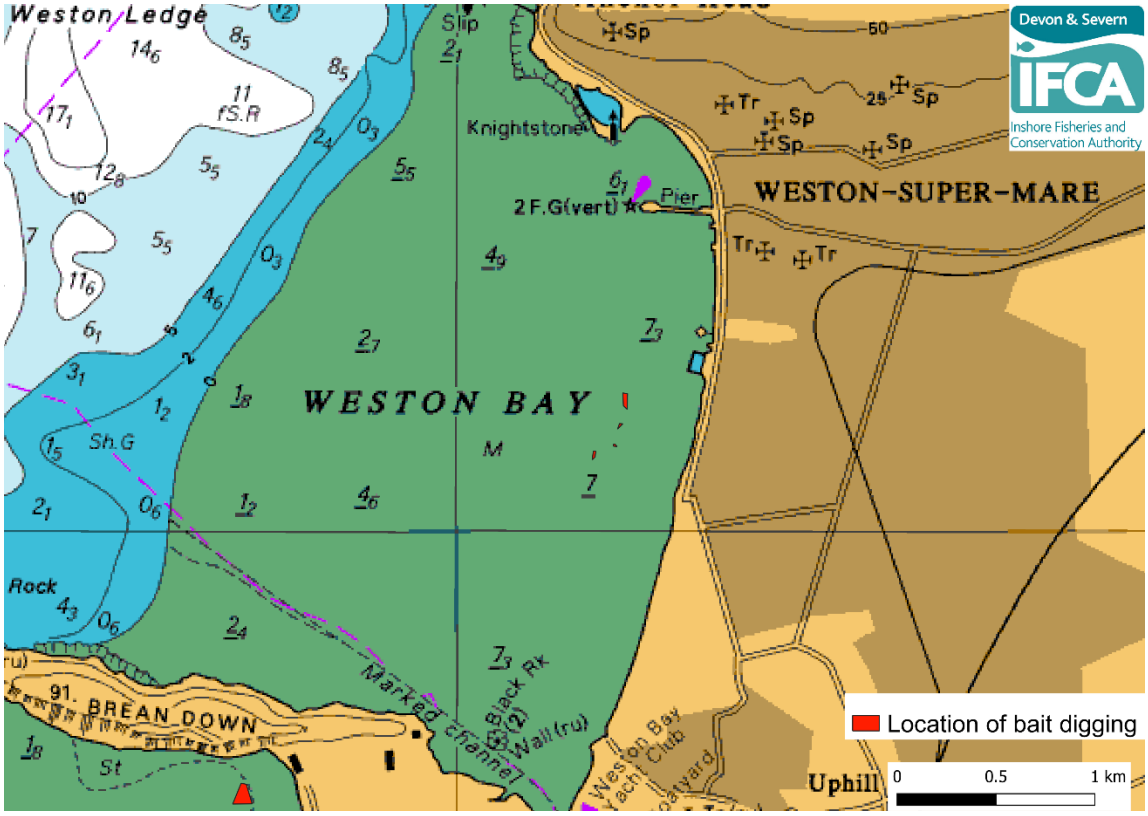


Figure 14. Location of bait digging activity observed at Weston Bay

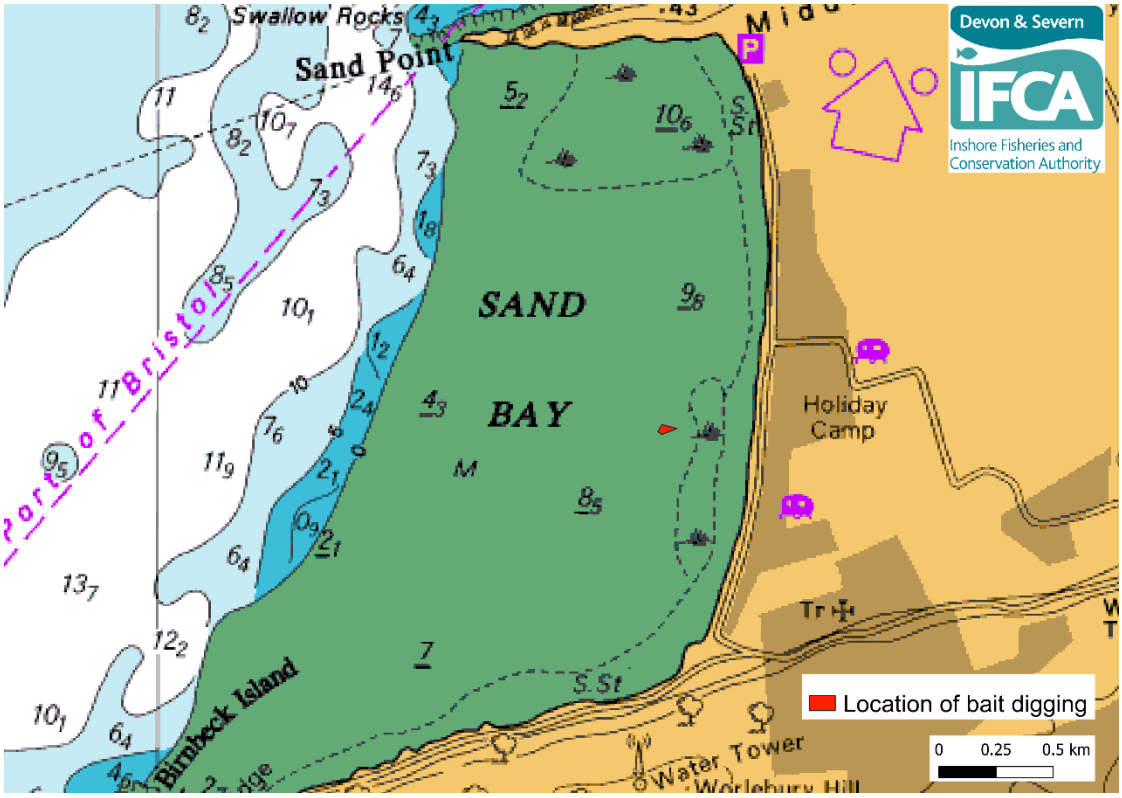


Figure 15. Location of bait digging activity observed at Sand Bay

9. Summary of consultation with Natural England

10. Integrity test

Conclusion of adverse effect/non-adverse effect either alone or in-combination. This will be reliant on the consideration of mitigation measure(s) documented in the AA and summarised here in conclusion.

Annex 1: Reference list

Natural England and the Countryside Council for Wales' Conservation Advice – formal advice given under Regulation 33(2)(a) of the Conservation (Natural Habitats, &c.) Regulation 1994, as amended. June 2009.

Natural England (2015) Marine conservation advice for Special Area of Conservation: Severn Estuary (UK0013030)

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Ross E.J (2013) Site Specific Assessment for Red High Risk Categories, Severn Estuary SAC. Devon and Severn IFCA XXXX

Annex 2: Natural England's consultation advice

Annex 3: Site Map

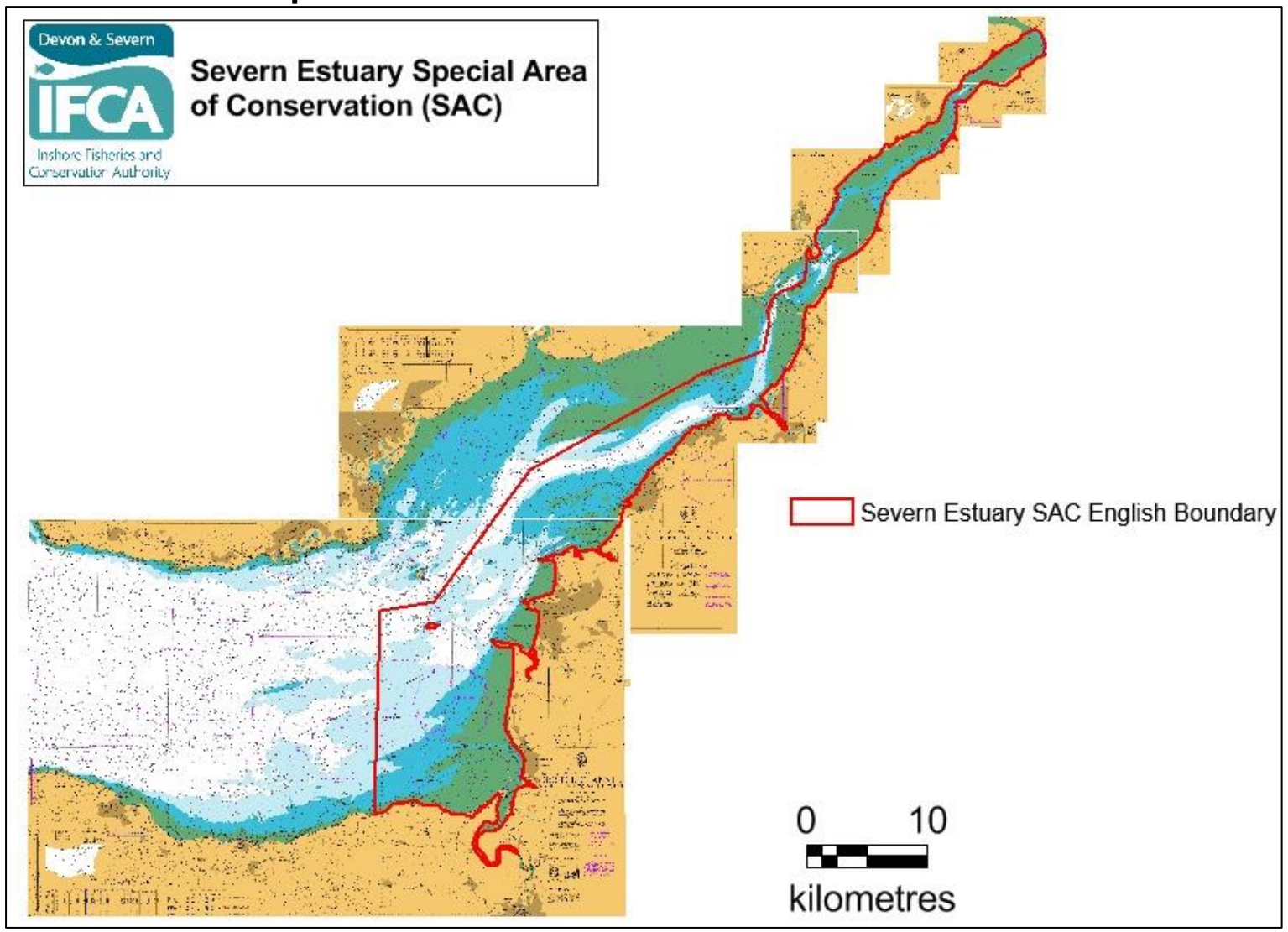

Figure 8 - Map showing the extent of the Severn Estuary SAC

Annex 4: Fishing activity maps

Annex 5: Pressures Audit Trail

Table 1: Severn Estuary SPA Advice on Operations (Natural England, 2015b). Estuarine bird community not assessed in draft advice on operations for Severn Estuary SAC (Natural England, 2015a) so the draft advice on operations for Severn Estuary SPA bird sub-features was used as a proxy (Natural England, 2015b).

Pressure(s): Shore-based activities	**Bird features**							**Screening Justification**
	Bewick's swan	Dunlin	Gadwall	Greater White-Fronted Goose	Redshank	Shelduck	Internationally important assemblage >20,000 waterfowl	
Above water noise	**S**	**S**	**S**	**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**					**OUT** - Insufficient activity levels to pose risk of large scale pollution event
Collision BELOW water with static or moving objects not naturally found in the marine environment (e.g., boats, machinery, and structures)			**NS**					**OUT** – Pressure not thought to be associated with activity
Hydrocarbon & PAH contamination. Includes those priority substances listed in Annex II of Directive 2008/105/EC.	**IE**	**IE**	**IE**	**IE**	**IE**	**IE**		**OUT** - Insufficient activity levels to pose risk of large scale pollution event
Introduction of light	**S**	**S**	**IE**	**S**	**S**	**S**		**OUT** - Activity not thought to be occurring at night
Introduction of other substances (solid, liquid or gas)	**IE**	**IE**	**IE**	**IE**	**IE**	**IE**		**OUT** - Insufficient activity levels to pose risk of large scale pollution event
Introduction or spread of non-indigenous species	**IE**	**S**	**NS**	**IE**	**S**	**S**		**OUT** – Activity operates in local area only so risk considered extremely low
Litter	**IE**	**IE**	**S**	**IE**	**IE**	**IE**		**OUT** – Activity not thought to be associated with litter

Removal of non-target species	**S**	**S**	**S**	**S**	**S**	**S**		**IN** – Need to consider intensity of activity
Synthetic compound contamination (incl. pesticides, antifoulants, pharmaceuticals). Includes those priority substances listed in Annex II of Directive 2008/105/EC.	**IE**	**IE**	**IE**	**IE**	**IE**	**IE**		**OUT** - Insufficient activity levels to pose risk of large scale pollution event
Transition elements & organo-metal (e.g. TBT) contamination. Includes those priority substances listed in Annex II of Directive 2008/105/EC.	**S**	**S**	**IE**	**S**	**S**	**S**		**OUT** - Insufficient activity levels to pose risk of large scale pollution event
Underwater noise changes	**IE**		**IE**	**IE**		**IE**		**OUT** – Pressure not thought to be associated with activity
Visual disturbance	**S**	**S**	**S**	**S**	**S**	**S**		**IN** - Need to consider spatial scale/intensity of activity to determine likely magnitude of pressure

Table 2: Severn Estuary SPA Advice on Operations (Natural England, 2009).

Internationally important waterfowl assemblage					
Sensitivity:		Exposure:		Vulnerability:	
Non-physical disturbance	**High**	Noise & visual presence	**Medium**	Noise & visual presence	**High**
Biological disturbance	**Moderate**	Selective extraction of species	**Medium**	Selective extraction of species	**Moderate**