Cyfoeth Naturiol Cymru
Natural Resources Wales

Bait Digging Management Options




Report No: 602

Author Name: West, V., Robbins, K., Frost, N., Hull, S.

Author Affiliation: ABPmer

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Mae llawer o dystiolaeth am effeithiau negyddol palu am abwyd. Yng Nghymru, dangoswyd bod palu am abwyd yn arwain at ddirywiad yng nghyflwr cynefinoedd sydd wedi'u dynodi'n Ardaloedd Cadwraeth Arbennig (ACA) ac yn Safleoedd o Ddiddordeb Gwyddonol Arbennig (SoDdGA). Nodwyd hefyd ei fod yn effeithio'n negyddol ar gynefinoedd pwysig iawn o dan Ddeddf yr Amgylchedd (Cymru) (2016) Adran 7, sy'n cynnwys *Zostera noltei* (gwellt-y-gamlas bach), graean lleidiog cysgodol a fflatiau llaid rhynglanw.

Yn 2019, comisiynodd CNC astudiaeth i ganfod dosbarthiad gofodol a dwysedd gweithgarwch palu am abwyd yng Nghymru (Perrins *et al.* 2020). Yn dilyn yr astudiaeth hon, comisiynwyd ABPmer gan CNC i archwilio'r dulliau rheoli potensial sydd ar gael ar gyfer palu am abwyd ym mhob un o'r safleoedd a archwiliwyd yn Perrins *et al.* (2020).

Gyda'i gilydd, archwiliwyd 11 o safleoedd, saith ohonynt yng Ngogledd Cymru, tri yn Aberdaugleddau, ac un ym Mae Abertawe. Ar gyfer pob safle, ystyriwyd nifer o feini prawf penodol i'r safle i asesu i ba raddau roedd pob safle yn agored i balu am abwyd, ac yn dilyn hynny i asesu ar ba rai o'r safleoedd roedd y bygythiad cymaint fel bod angen rheoli gweithgareddau palu am abwyd. Nododd yr asesiad o fygythiad dri safle – Bae Angle, Pontrhydybont a Phenmon-Biwmares – fel y rhai a oedd fwyaf tebygol o elwa ar fesurau rheoli i leihau effeithiau gweithgarwch palu am abwyd ar y blaendraeth.

Tanlinellodd adolygiad o fesurau rheoli posib mai cau yn llwyr neu'n rhannol drwy gyfrwng gorchymyn neu is-ddeddf sydd â'r potensial mwyaf i leihau effaith palu am abwyd mewn lleoliadau o fygythiad uchel. Fodd bynnag, mae angen ystyried yn ofalus mewn perthynas â'r nodweddion y mae angen eu gwarchod ym mhob safle a'r pwerau cyfreithiol y gellir gweithredu gorchymyn neu is-ddeddf ar eu cyfer.

Gellir defnyddio mesurau gwirfoddol ym mhob safle ac yn aml caiff y rhain eu ffafrio ar gyfer gwaith rheoli dros fesurau statudol. Gallant fod yn ffordd effeithiol o reoli amrywiaeth o weithgareddau didrwydded ble mae'r canllawiau wedi'u diffinio'n glir a ble mae cefnogaeth yn lleol. Fodd bynnag, mewn ardaloedd lle mae'n hysbys bod gweithgarwch palu am abwyd dwys neu ddiffyg cydymffurfio â mesurau gwirfoddol, gall is-ddeddfau neu orchmynion fod yn fecanwaith rheoli mwy effeithiol.

Mae nifer o enghreifftiau o achosion ble mae awdurdodau rheoli wedi rhoi cyfuniad o fesurau ar waith i warchod cynefinoedd sensitif rhag gweithgareddau masnachol a hamdden ar draws y DU. Ymysg y rhain mae, er enghraifft, gofyniad am drwyddedau, cau yn dymhorol, a chyfyngiadau ar fagiau a meintiau.

Mae'n bwysig ystyried y gallai cau safleoedd neu fesurau rheoli cyfyngol eraill arwain at fod y rhai sy'n palu am abwyd yn symud i fannau eraill. Mae potensial i'r adleoli hwn effeithio'n sylweddol ar safleoedd ble mai ychydig o balu am abwyd sy'n digwydd ar hyn o bryd. Felly mae'n bwysig cydnabod y gallai mesurau rheoli newid canlyniadau'r sgoriau bygythiad a wnaed yn yr astudiaeth hon.

Er bod nifer o fesurau rheoli wedi'u nodi ac argymhellion wedi'u gwneud fel rhan o'r astudiaeth hon, dylid cynnal asesiadau unigol o safleoedd i ystyried goblygiadau mesurau o'r fath cyn eu gweithredu. Yn ogystal, ychydig iawn o astudiaethau sydd wedi gwerthuso llwyddiant mesurau rheoli ar ôl eu rhoi ar waith. Byddai gwybodaeth ar y graddau y

cydymffurfir yn gyffredinol â mesurau rheoli yn rhoi gwybodaeth ddefnyddiol ynghylch y tebygolrwydd y bydd mesurau o'r fath yn llwyddo. Dylai hyn asesu'r tebygolrwydd y bydd gweithgarwch palu am abwyd yn adleoli a'r gofynion tebygol o ran gorfodi a chydymffurfio yng nghyd-destun y buddion y gellid eu cyflawni.

Yn olaf, gallai defnyddio dulliau mwy arloesol, fel cydreoli palu am abwyd neu ffermio abwyd, gynnig ffyrdd amgen o reoli gweithgareddau palu am abwyd. Yn gyffredinol, mae gan ddulliau arloesol y potensial i reoli palu am abwyd heb fod angen gorfodi llym. Fodd bynnag, dylid gwneud ymchwil pellach i ddulliau arloesol, eu haddasrwydd a'u heffeithiolrwydd o safbwynt rheoli cyn eu gweithredu.

2 Executive summary

The negative impacts of bait digging are well documented. In Wales, bait digging has been shown to lead to the deterioration of the condition of habitats for which Special Areas of Conservation (SACs) and Special Site of Scientific Interest (SSSIs) are designated. It has also been noted to negatively affect habitats which are of principal importance under the Environment (Wales) Act (2016) Section 7, which include *Zostera noltei* (seagrass), sheltered muddy gravels and intertidal mudflats.

In 2019, NRW commissioned a study to determine the spatial distribution and intensity of bait digging in Wales (Perrins *et al.* 2020). Following on from this study, ABPmer was commissioned by NRW to explore the potential bait digging management options available for each of the sites examined in Perrins *et al.* (2020).

In total, 11 sites were examined, seven in north Wales, three in Milford Haven, and Swansea Bay. For each site a number of site-specific criteria were considered to assess the degree to which each site was susceptible to bait digging and subsequently assess which of the sites were sufficiently vulnerable to require management for bait digging activities. The vulnerability assessment identified three sites; Angle Bay, Four Mile Bridge and Penmon-Beaumaris, as most likely to benefit from management measures to reduce the impacts of bait digging activity on the foreshore.

A review of potential management measures highlighted that full or partial closure by means of an order or byelaw has the highest potential to reduce the impact of bait digging in high vulnerability locations. However, careful consideration is needed with regard to the features that require protection at each site and the legal powers for which an order or byelaw can be implemented.

Voluntary measures can be used at all sites and are often the preferred option for management over statutory measures. They can be an effective mechanism for managing a range of unlicensed activities where guidelines are well defined and have local support. However, in areas where intense bait digging activity or lack of compliance to voluntary measures are known to occur, byelaws or orders may provide a more effective management mechanism.

There are several case examples of where management authorities have implemented a combination of measures to protect sensitive habitats from commercial and recreational activities across the UK. These include, for example, the requirement for licences, seasonal closures and bag and size limits.

It is important to consider that any closure of sites or other restrictive management measures could lead to the displacement of bait diggers to other locations. This displacement has the potential to have significant impacts on sites which currently have a low level of bait digging. It is therefore important to acknowledge that the implementation of management measures may change the results of the vulnerability scoring undertaken in this study.

Whilst a number of management measures have been identified and recommendations made as part of this study, individual site assessments should be undertaken to consider the implications of such measures before implementation. In addition, there are very few studies which have evaluated the success of management measures once implemented.

Information on the general compliance with management measures would greatly inform the likelihood of success of introducing such measures. This should assess likelihood of bait digging displacement and likely compliance and enforcement requirements in the context of the benefits that could be achieved.

Finally, the use of more innovative approaches, such as co-management of bait digging or bait farming, could provide alternative means to manage bait digging activities. Overall, innovative approaches have the potential to manage bait digging without the need for strict enforcement. However, further research into innovative approaches and their applicability and effectiveness from a management perspective should be undertaken prior to implementation.

3 Introduction

3.1 Background

Bait digging is the harvesting of organisms from the sediment for use as bait for angling and is a widespread and long-established activity in the UK. As such, the impacts of bait digging on the UK foreshore have long been recognised and studied (Fowler, 1999; Boyes *et al.*, 2006).

In Wales, bait digging has been shown to lead to the deterioration of the condition of habitats for which Special Areas of Conservation (SACs) and Special Site of Scientific Interest (SSSIs) are designated. This is especially the case where the volume of digging is causing long term changes and damage to sensitive habitats which are slow to recover (Evans *et al*., 2015).

Bait digging has also been noted to negatively affect habitats which are of principal importance under the Environment (Wales) Act (2016) Section 7, which include *Zostera noltei* (seagrass), sheltered muddy gravels and intertidal mudflats (Perrins *et al.*, 2020). Seagrass beds can be damaged by both trampling and bait digging as it loosens and uproots plants and can lead to smothering. This physical damage can lead to plants being washed away and can make these habitats more susceptible to erosion (Duggan-Edwards & Brazier, 2015).

Bait digging is a particular concern within sheltered muddy gravels where digging causes finer sediments to be washed away with the incoming tide, subsequently changing the sediment composition. Watson *et al.* (2007) found that dug areas differ in their median particle size and organic content when compared to undug control areas. This was due to turning of the sediment resulting in loss of finer sediments, which has the potential to significantly affect sediment load and turbidity. The macrofaunal species associated with these sediments can also be affected, for example through physical damage, smothering and exposure to desiccation or predation, particularly where holes are not back-filled.

There is conflicting evidence on the impact of disturbance from bait diggers on the behaviour, population and foraging efficiency of bird species protected under national and international legislation. In the Exe Estuary, bait digging was observed to be the most likely activity to cause major flight events in overwintering bird species (Liley *et al.,* 2011). Watson *et al.* (2017) also found that bait collector numbers negatively correlated with wader and gull abundance. Bait digging further results in a decrease in diversity and abundance of key intertidal prey species for birds and fish which decreases foraging success and increases the foraging time (Clarke *et al.,* 2017; Watson *et al.,* 2017). However, recent studies suggest that disturbance does not have a significant impact on waders or wildfowl (Biermann, 2020; Goss-Custard *et al*., 2020).

3.2 Aims and objectives

In 2019, NRW commissioned a study to determine the spatial distribution of bait digging in Wales. In total, 12 sites were examined, seven in north Wales, four in Milford Haven, and Swansea Bay (Perrins *et al*., 2020). Using an unmanned aerial vehicle (UAV), the sites were photographed and the bait digging extent and intensity estimated, along with a measure of confidence in the assessment. Site walkovers were undertaken to ground-truth

the bait digging evidence. The longevity of bait digging impacts on each site were also investigated by assessing the recovery of experimental bait digging holes.

All of the sites surveyed showed signs of bait digging activity, and it was evident that visible damage lasted longest on sheltered / extremely sheltered shores, particularly those with muddy gravels present. In addition, each of the sites are located within either a SAC and/or a SSSI (with the exception of Penrhos Beach). The majority of these protected areas are in part designated for their sediment habitats, or to support birds which are dependent on these habitats.

ABPmer was commissioned by NRW to explore the potential bait digging management options available for 11 of the sites examined in Perrins *et al.* (2020). This involved developing an evidence database to assess which of the sites are sufficiently vulnerable to require management for bait digging activities. A literature review of potential bait digging management options was used to inform the identification of appropriate site-specific management measures.

In summary, the key aims and objectives of the project were to:

- Compile an evidence database for assessing the overall impact of bait digging at different sites across Wales;
- Determine the conservation designations and biotopes present at each site and their sensitivity to bait digging;
- Produce a prioritised list of sites highlighting those most vulnerable to bait digging;
- Review potential bait digging management measures and assess their benefits and limitations; and
- Determine, where appropriate, site-specific management options.

4 Methodology

4.1 Site selection

Building upon the work undertaken by Perrins *et al.* (2020), this project assessed the vulnerability of 11 sites across Wales to bait digging. The sites included were:

- Penmon-Beaumaris (Menai Strait);
- Y Foryd Estuary (Menai Strait);
- Penrhos Beach (Holyhead);
- Beddmanarch Bay (Holyhead);
- Four Mile Bridge (Cymyran Strait);
- Llanfair yn Neubwll (Cymyran Strait);
- Inland Sea (Cymyran Strait);
- Sandy Haven (Milford Haven);
- Gelliswick Bay (Milford Haven);
- Angle Bay (Milford Haven); and
- Swansea Bay (Bristol Channel).

The Gann in Milford Haven was removed from this assessment as this site already has a programme of work linked to bait digging management.

4.2 Site assessment

To obtain an overall indication of the impact of bait digging at each of the identified sites an evidence review was conducted. Information sourced during the review process was captured within a proforma evidence database, which is presented in a spreadsheet (R3772_BaitDiggingEvidenceDatabase_100222.xlsx; see Appendix A), hereafter referred to as the Evidence database. A number of criteria were captured for each site in the proforma, including:

- A high-level description of the site including location, sediment type, shore exposure and surveyed area of the site (ha) (from Perrins *et al.,* 2020);
- The total area of bait digging evidence, assumed intensity of bait digging and recovery time of experimental bait digging holes (from Perrins *et al.,* 2020);
- Ease of site access;
- Intra-site variability (particularly for larger sites);
- SAC and SSSI designations that overlap with the sites;
- Features of overlapping SSSIs and SACs that could be affected by bait digging;
- Consideration of potential impacts in the context of the respective conservation objectives and site condition; and
- Proximity of similar habitat to demonstrate the likelihood of displacement to nearby sites which could be affected if management measures were implemented.

Data regarding the high-level description of the site and the overall impact of bait digging were based on the available evidence from Perrins *et al.* (2020). These data allowed for an assessment of the differences in site characteristics such as sediment type, shore exposure and spatial variability with bait digging extent and hole recovery.

Perrins *et al.* (2020) described that bait digging appeared to be more intense in areas with easier access to the shore and adjacent car parking. To determine the accessibility of the sites to bait diggers, satellite imagery of each site and the adjacent areas was used to review whether public parking was in close proximity to the shore. Access was deemed easy (public car parking was in close proximity to the shore), medium (no obvious public parking was available but on road parking was not restricted, or difficult (no parking availability).

Consideration of the potential impacts on protected features were based upon a review of the published advice and conservation objectives for the relevant SAC and SSSI. The potential impacts identified were, for example, modification of habitat structure, sedimentology and topography, disturbance/transport of fine sediments (NRW 2018a, and b), and changes to macrofaunal community structure (NRW 2018b).

If management measures are implemented, there is a potential that nearby sites may be impacted by increased bait digging due to displacement of diggers. Therefore, sites in close proximity, where bait digging is known to occur, were identified and the straight-line distances measured. Where a body of water separated the two sites, the straight-line distance was measured via an appropriate crossing point.

Findings from the evidence review were used to inform a site vulnerability assessment, discussed in Section 4.3 below.

4.3 Site vulnerability

4.3.1 Vulnerability criteria

To assess the degree to which each site is susceptible to bait digging, a vulnerability assessment was undertaken taking into account the exposure and sensitivity of the sites to bait digging activities. A number of site-specific criteria were considered at each site, including the extent of bait digging, the intensity of digging, recovery of holes, biotope sensitivity, the presence of Section 7 muddy gravels, the ease of access to the site and whether the site overlaps with a SAC/ SSSI designation. Each criterion is described in more detail below.

The assessment of vulnerability within this report focussed on the impact of bait digging on habitat features. Although it is acknowledged that bait digging has potential to cause disturbance to birds, there is contrasting evidence on the impacts of disturbance from bait diggers on birds, and more data are needed on site-specific populations. Bird features were therefore not assessed in this report.

Bait digging extent

For the purposes of informing site vulnerability, exposure to bait digging was calculated as the proportion of the site with evidence of bait digging. This was calculated by comparing the total area of the site surveyed and the spatial extent of bait digging evidence from Perrins *et al.* (2020). This proportion was calculated to allow for a more a direct comparison of bait digging extent across different sites. This was then categorised into:

- High – extent of digging covers more than 20% of the shore;
- Medium – extent of digging covers between 2% and 20% of the shore; and
- Low – extent of digging covers less than 2% of the shore.

It is important to note that there are some instances where the survey by Perrins *et al*. (2020) did not survey the entire shore, such as at Swansea Bay. Therefore, the categorisation of bait digging extent may over- or under-estimate bait digging extent.

Bait digging intensity

In order to compare across the sites, bait digging intensity at each site from Perrins *et al.* (2020) was transformed into an intensity score. Firstly, the proportion of the bait digging area, being dug at high, medium or low intensity was calculated. These were then weighted (high intensity = 3, medium = 2 and low = 1) and summed together to determine the intensity score. Intensity scores ranged from 1.6 to 2.4. Therefore, overall intensity was determined by applying a threshold to the scores (see the Intensity scoring tab within the Evidence database for more details). These were categorised into:

- High – overall intensity greater than 2.2;
- Medium – overall intensity between 1.8 and 2.2; and
- Low – overall intensity between 1.6 and 1.8.

Recovery of bait digging holes

Recovery time of the sediment from bait digging was determined for each site based on the evidence of the experimental bait digging holes after 3-4 months from Perrins *et al*. (2020). This was categorised into:

- Fast – no evidence of holes after 3-4 months;
- Medium – some evidence of holes after 3-4 months; and
- Slow – clear evidence of holes visible after 3-4 months.

Due to the experimental design in Perrins *et al.* (2020), there was no measure of bait digging hole recovery before 3-4 months. It is acknowledged that recovery could occur within a few tidal cycles, however, for the purposes of this report recovery was categorised based on the data available in Perrins *et al.* (2020).

Site access

For the vulnerability assessment, site access was based on the assessment described in Section 4.2 where access was deemed easy (public car parking was in close proximity to

the shore), medium (no obvious public parking was available but on road parking was not restricted), or difficult (no parking availability).

Biotope sensitivity

Along with the site-specific data in the Evidence database, the sensitivity of biotopes at each site were determined based on previous work undertaken by ABPmer in March 2018 as part of the Wales non-licensable activities project (Roberts *et al.*, 2020). Roberts *et al.* (2020) reviewed information on the potential sensitivity of biotopes to certain activities, including bait digging and collection. A number of pressures (developed by the OSPAR Intercessional Correspondence Group on Cumulative Effects (ICG-C)) were considered to be associated with bait digging. These included:

- Abrasion/ disturbance of the substrate on the surface of the seabed;
- Habitat structural changes – removal of substratum (extraction);
- Penetration and/ or disturbance of the substrate below the surface of the seabed, including abrasion;
- Removal of non-target species;
- Removal of target species; and
- Visual disturbance (not relevant for habitats).

Roberts *et al.* (2020) subsequently assessed the exposure of biotopes within Welsh waters to each of the listed pressures and the sensitivity (high, medium or low) of each 'exposed' biotope to the activity based upon MarLIN sensitivity assessments. This assessment of biotope sensitivity was then further tailored in the NRW internal report by Grant (2020). For the present study, the biotopes at each site were determined and the sensitivity of each biotope based on the sensitivity in Grant (2020). A summary of the biotopes present at each site is shown in Appendix Table B1.

Due to the known damage that bait digging can have on habitats of principal importance under Section 7 of the Environment (Wales) Act (2016), the biotope assessment ultimately considered seagrass beds and intertidal mudflats with presence of polychaete/bivalve-dominated sediments to be more vulnerable to bait digging compared to other shores. Section 7 sheltered muddy gravels have been assessed separately in the vulnerability assessment as detailed below.

Section 7 muddy gravels

Muddy gravels are listed as a habitat of principal importance under the Environment (Wales) Act (2016) Section 7. Muddy gravels are known to be particularly sensitive to bait digging activities as it results in habitat modification through physical change in the sediment structure due to enduring loss of fine silts. Due to this particular sensitivity, muddy gravels have been assessed separately from other biotopes. Spatial layers for muddy gravels were obtained from the Welsh Government Marine Planning Portal (Welsh Government, 2021a) and the extent of muddy gravels in each site was determined. The spatial extents of bait digging on each shore were then overlaid and the area of overlap with muddy gravels calculated. The proportion of muddy gravels being dug was then determined in order to make comparisons between sites. This was then categorised into:

- High – extent of muddy gravel being dug is more than or equal to 20%;
- Medium – extent of muddy gravels being dug is less than 20%; and
- Low – muddy gravels present but no evidence of muddy gravels being dug.

Designation overlap

Each of the sites were assessed for their overlap with designated SACs and/or SSSIs. The sites which overlapped with one or more of these designations were categorised accordingly due to the potential to impact protected features. This criterion was defined as:

- Yes – overlaps with one or more SACs or SSSIs; and
- No – does not overlap with a SAC or SSSI.

4.3.2 Site vulnerability scoring

To form a prioritised list of sites which might require the implementation of bait digging management measures, the results from the review outlined above were used to assign a vulnerability score to each site.

For each of the criteria, the categories were scored between 1 (lowest vulnerability) and 3 (highest vulnerability). The resulting scores were then combined to provide a total vulnerability score for each site. The total scores could then be used to rank the sites and categorise them as high, medium or low vulnerability. This categorisation infers which sites are most likely to benefit from measures to manage bait digging.

It is important to note that each of the criteria used within the vulnerability assessment were given equal weighting to provide a simple and effective method of assessing site vulnerability. However, it is acknowledged that some criteria could have a greater influence on site vulnerability than others. In practice, the severity and significance of any activities will be site-specific, depending on bait digging extent, intensity and site characteristics and scoring could be further refined depending on features which are of particular conservation concern. However, despite these issues, this method has highlighted key sites most likely to benefit from the introduction of measures to manage the adverse impacts from bait digging.

4.4 Review of potential management measures

A literature review was undertaken to identify potential management options for bait digging activities. The review largely focussed on previous bait digging case studies in Wales and England, but also considered management options that have been implemented for other recreational activities. An assessment of the associated advantages and disadvantages of each management option was also undertaken. This included evaluating the potential implementation, compliance and enforcement of the measures, and likely effectiveness of measures in protecting habitats and species from bait digging.

Other more innovative management options were also explored, based on recent research in the field including a PhD being undertaken at Bangor University on Alternative Management of Living Resources (Morris-Webb, 2021), and anecdotal industry evidence.

4.5 Site-specific management options

Following the site vulnerability scoring and the review of the potential bait digging management options, management options for each site were reviewed. This included consideration of the vulnerability score, and subsequent site prioritisation, along with site-specific differences such as sediment type, site access and overlapping designations. Any significant site-specific barriers to potential management activities were considered, along with the potential for different management measures for sub-areas within large sites.

Additionally, the potential for management measures to result in the displacement of bait digging activity to nearby sites and the resulting implications of displacement were noted. The quantification of such displacement is outside of the scope of this project, however, was inferred on the basis of parameters such as distance.

5 Results

5.1 Site overviews

5.1.1 Menai Strait

Penmon-Beaumaris

The beach between Penmon and Beaumaris is located on the Isle of Anglesey on the north-eastern end of the Menai Strait. In total, the beach (surveyed by Perrins *et al*., 2020) covers an area of 176 ha, is approximately 5.5 km long, and is a mix of muddy sand and sandy mud sediments. The biotopes associated with this site include polychaete/bivalve dominated muddy and sandy, mid estuarine mud, and littoral sandy mud shores. This includes *Macoma balthica* and *Arenicola* marina in littoral muddy sand, and *Nephtys hombergii* and *Streblospio shrubsolii* in littoral sandy mud both of which are assessed as being highly sensitive to bait digging activities (Roberts *et al.*, 2020).

The beach overlaps with the Glannau Penmon – Biwmares SSSI which is designated for its species rich communities, communities of restricted national distribution and ice age sediments. The lower shore muddy gravel in this SSSI is designated due to the identification of a diverse group of small marine worms. It is likely these worms would be vulnerable to bait digging activities. Penmon-Beaumaris also overlaps with the Menai Strait and Conwy Bay SAC which is designated for features such as mud and sand flats, and large shallow inlets and bays (Appendix Figure C1).

Public access to the beach is relatively easy with several car parks adjacent to the shore along the extent of the beach.

Evidence from Perrins *et al*. (2020) suggests that bait digging occurs across the entire length of the site, with a larger extent of the shore being dug in the northern and southern regions. Evidence of bait digging holes covered approximately 11% of the total site (Figure 1). Towards the northeast of the beach near Penmon, where sediments consist of predominately mud, recovery from single bait digging events is likely slow as the mud retains evidence of bait digging holes after 4-5 months (Perrins *et al.*, 2020).

Section 7 muddy gravels are particularly sensitive to damage as a result of bait digging activities. Muddy gravels are present thorough the Penmon-Beaumaris site, covering an area of approximately 48 ha, 2 ha (4.5%) of which overlap with areas of identified bait digging (Figure 1, Appendix Table B2).

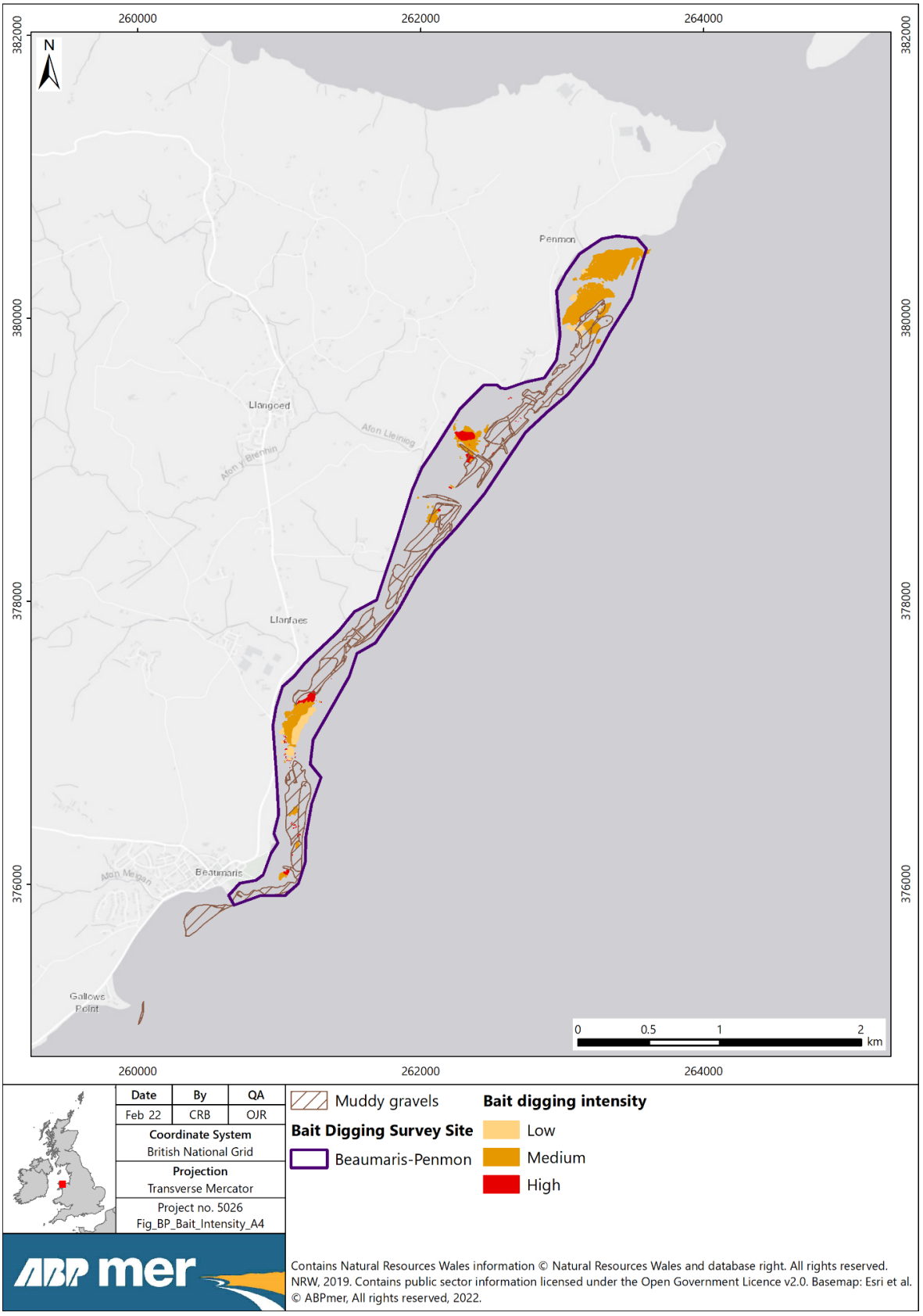

Figure 1 Bait digging intensity and presence of muddy gravels at Penmon-Beaumaris

Y Foryd Estuary

Y Foryd is an estuary in Gwynedd on the south-western end of the Menai Strait. The bay covers an area of 145 ha and consists of fine rippled sand with a sub-surface black layer just below the surface in the mid shore where *Arenicola* sp. and *Cerastoderma* sp. are found. *Scrobicularia* sp. are found in finer mud sediments next to a creek. Habitats at this site are classified as polychaete/bivalve dominated muddy and sandy, and mid estuarine mud shores. This includes *Macoma balthica* and *Arenicola* marina in littoral muddy sand, and *Nephtys hombergii*, *Macoma balthica* and *Streblospio shrubsolii* in littoral sandy mud which are assessed as being highly sensitive to bait digging activities (Roberts *et al.*, 2020).

The site overlaps with Y Foryd SSSI which is designated for seagrass beds and overwintering waterbirds, in particular a national important population of wigeon. The site also overlaps with the Menai Strait and Conwy Bay SAC (Appendix Figure C1).

Public car parking facilities are adjacent to the east side of the shore and thus access to the shore is relatively easy.

Evidence from Perrins *et al*. (2020) suggests that bait digging occurs across a large proportion of the site with evidence of bait digging holes covering more than 20% of the shore (Figure 2). Evidence suggests that holes from a single bait digging event do not persist for more than a few tidal cycles within the mobile sediments but that within the more cohesive muddier sediments evidence persists for longer. However, recovery is likely to be short-term as holes disappear within 4 months (Perrins *et al.*, 2020).

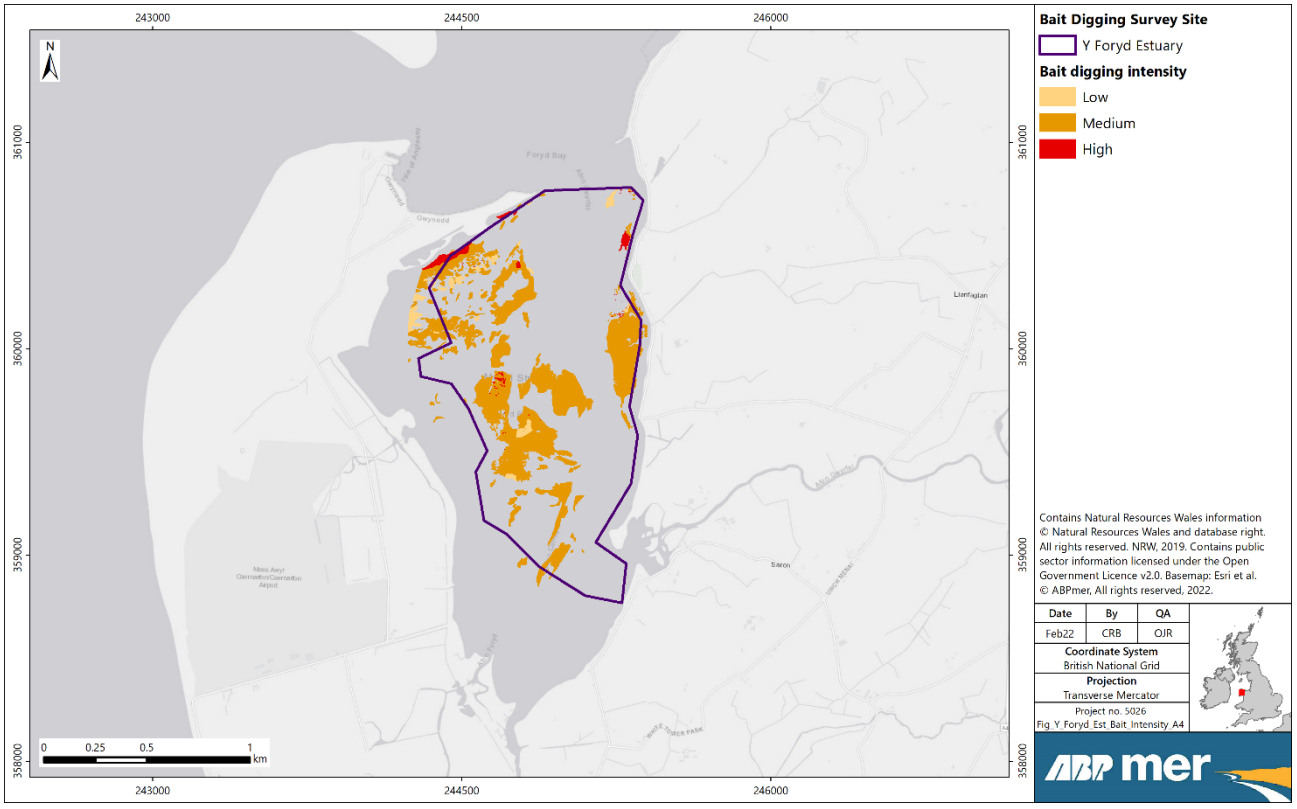

Figure 2 Bait digging intensity at Y Foryd Estuary

5.1.2 Holyhead and Cymyran Strait

Penrhos Beach

Penrhos Beach is on the north-eastern side of Holy Island, east of Holyhead. The beach covers an area of 37 ha and consists of sandy sediments. Penrhos Beach does not overlap with any designated sites and does not have any habitats of principal importance listed under the Environment (Wales) Act (2016) Section 7 (Appendix Figure C2). The biotopes present at Penrhos Beach are polychaete/bivalve-dominated muddy sand shores, including *Macoma balthica* and *Arenicola marina* in littoral muddy sand which are assessed as highly sensitive to bait digging activities (Roberts *et al.*, 2020). Access to the beach is relatively easy with parking adjacent to the shore.

Evidence from Perrins *et al*. (2020) suggests that bait digging occurs across approximately 2% of the beach, however confidence in the extent of bait digging is low due to the mobile nature of the sediments (Figure 3; Perrins *et al.*, 2020). It is likely that recovery from bait digging holes is fast, no more than a few tidal cycles, due to the semi-mobile and coarse nature of the sands (Perrins *et al.*, 2020).

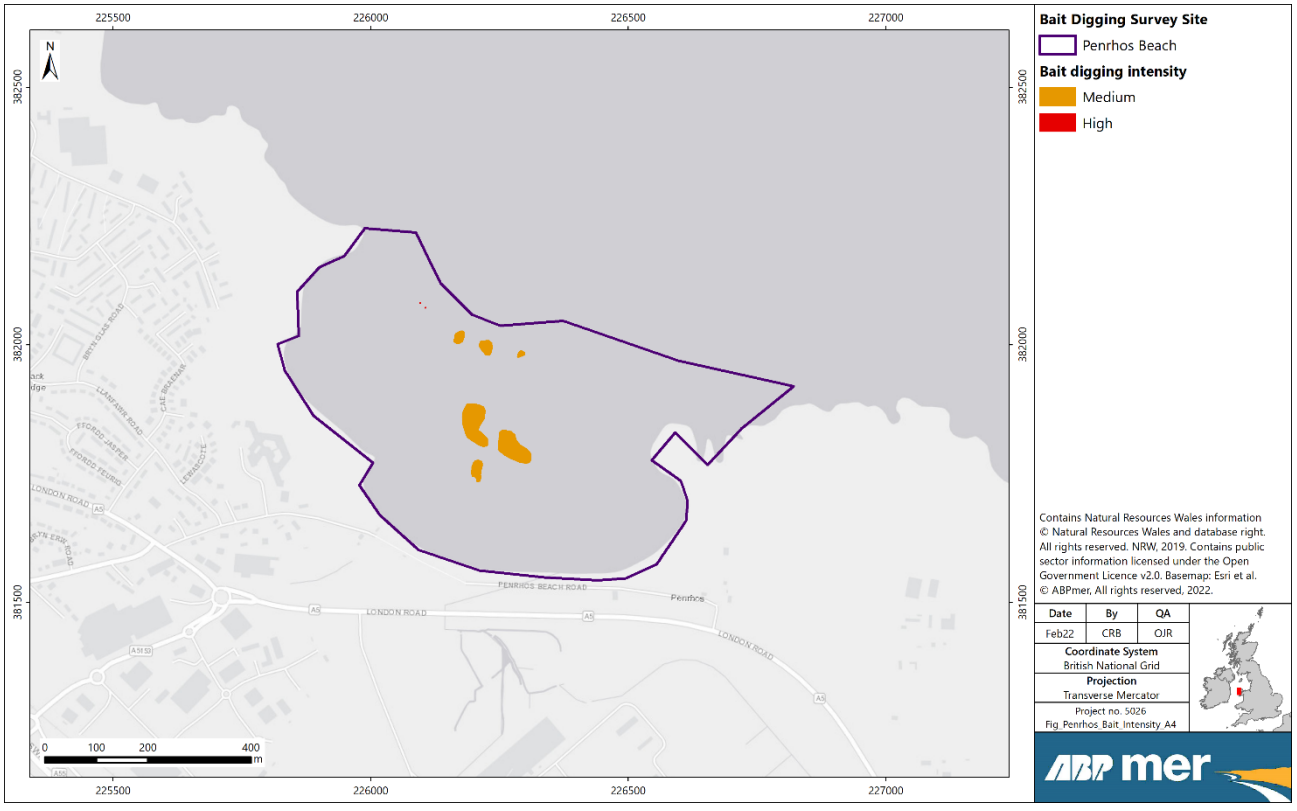

Figure 3 Bait digging intensity at Penrhos Beach

Beddmanarch Bay

Beddmanarch Bay is located on the north-western side of the Isle of Anglesey on the north-eastern side of the Cymyran Strait. The bay covers 338 ha, approximately 4.5 km in length, and consists of sandy mud with a coarse gravel sublayer in the outer bay and sandy mud sediments towards the bridges linking Holy Island and Anglesey. Habitats at this site are classified as *Hediste*-dominated gravelly sandy mud shores and polychaete/bivalve dominated mid estuarine mud shores. This includes *Nephtys hombergii*, *Macoma balthica* and *Streblospio shrubsolii* in littoral sandy mud which are assessed as being highly sensitive to bait digging activities (Roberts *et al.*, 2020).

The bay is part of the Beddmanarch-Cymyran SSSI which is designated for seagrass, saltmarsh, coastal dune heath and overwintering waterbirds, such as Ringed Plover, Curlew, Greenshank, Red-breasted Merganser, Goldeneye and Brent Geese (Appendix Figure C2).

There is evidence that bait digging occurs across 7% of the bay with more intense digging on the southern end of the shore which is more accessible by road and public footpaths (although there are no obvious public car parking areas) (Figure 4). Signs of bait digging in Perrins *et al*. (2020) were more obvious in the gravelly mud along the shoreline and towards the bridges where the sediment is predominately muddy fine sand. Section 7 muddy gravels occur south of the bridge where bait digging was not measured in Perrins *et al*. (2020). Recovery from one bait digging event is likely slow as Perrins *et al.* (2020) found that although experimental holes had filled, they were still identifiable in the gravelly mud after 4 months. This was attributed to the stable nature of the muddy sediments.

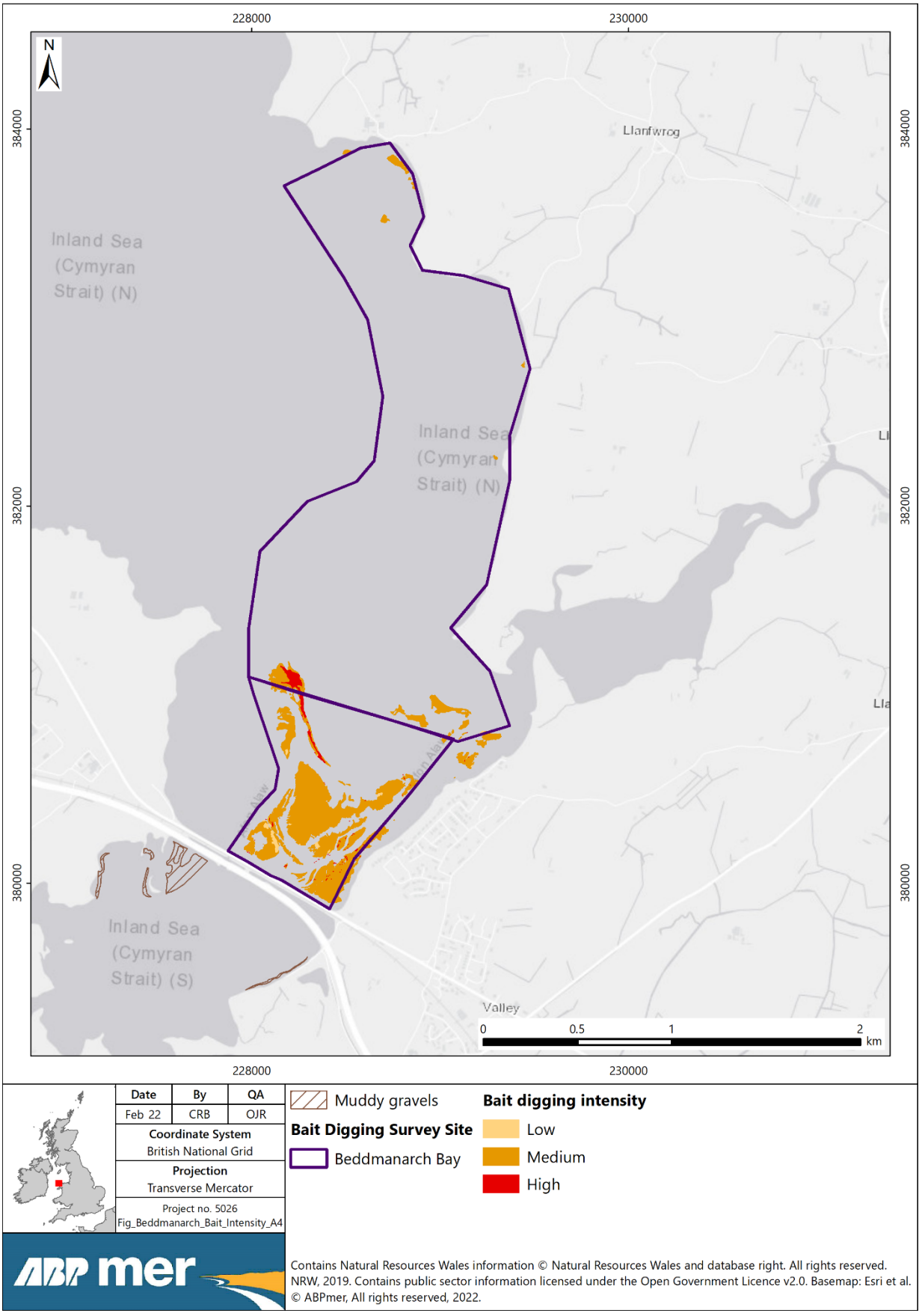

Figure 4 Bait digging intensity and presence of muddy gravels at Beddmanarch Bay

Four Mile Bridge

Four Mile Bridge connects Holy Island with Anglesey across the Cymyran Strait. Expanding north and south of the bridge is an 8 ha area of muddy sand where bait digging has been known to occur. The biotope associated with this site is littoral mixed sediment which is assessed as having a medium sensitivity to bait digging (Roberts *et al.*, 2020). This area overlaps with the Beddmanarch-Cymyran SSSI (Appendix Figure C2).

Access to the shore is relatively easy from the bridge, particularly on the southeast side, however, there is no obvious public parking nearby.

Evidence suggests that bait digging occurs across approximately 8% of the southern half of the site, southeast of the bridge. Unfortunately, no data could be obtained for the northern part of the shore. A large proportion of the digging in this area has been observed to be of high intensity (Perrins *et al.*, 2020). It is likely that recovery is slow due to the ultra-sheltered nature of this site and mix of coarse gravel and muddy sediments.

Section 7 muddy gravels are present in both the northern and southern part of the site, covering approximately 0.5 ha. The results from Perrins *et al.* (2020) show that bait digging occurs in approximately 18% of the known muddy gravels (Figure 5, Appendix Table B2).

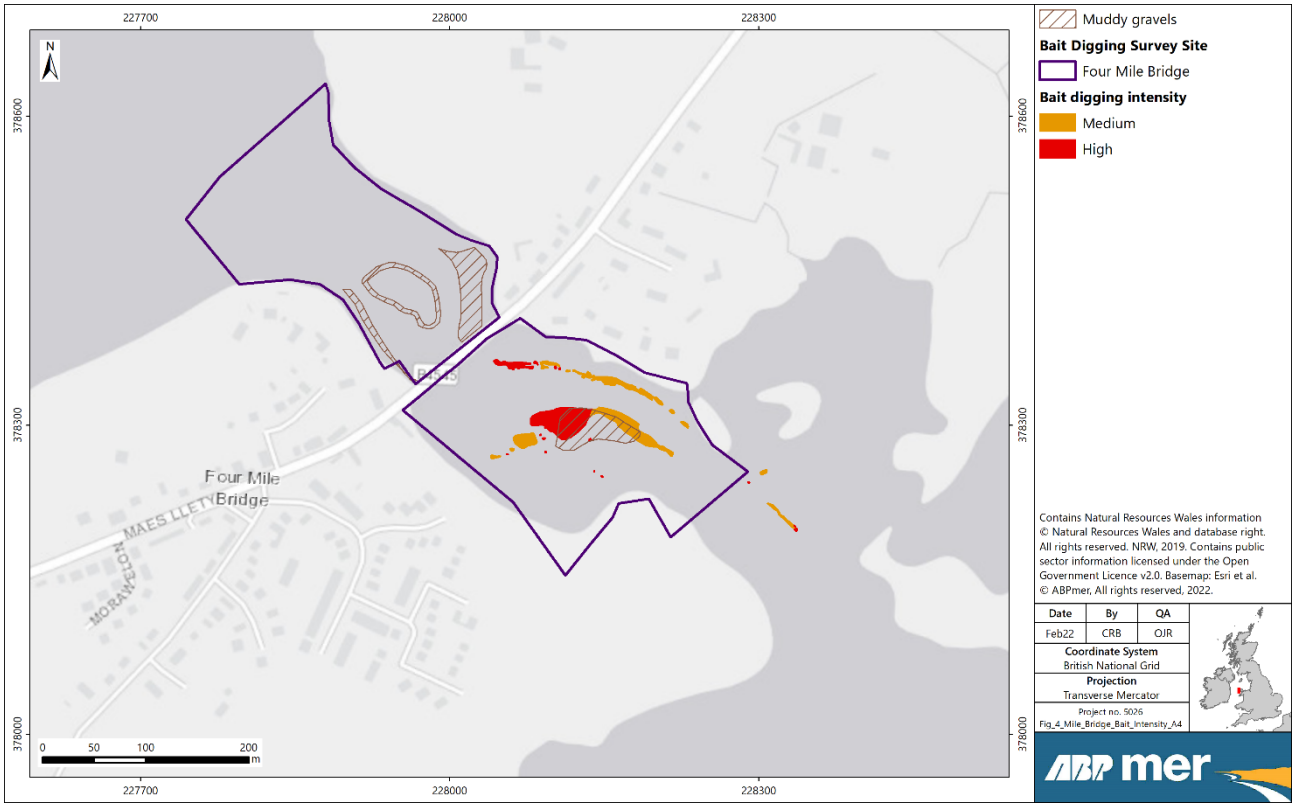

Figure 5 Bait digging intensity and presence of muddy gravels at Four Mile Bridge

Llanfair yn Neubwll

Southeast of Four Mile Bridge in the Cymyran Strait is an area of intertidal sandy mud sediment, known as Llanfair yn Neubwll, which is used for bait digging. Three biotopes are associated with this site, firstly, *Zostera noltei* beds in littoral muddy sand which is assessed as highly sensitive to bait digging activities. Secondly, polychaete/bivalve-dominated muddy sand shores which includes *Macoma balthica* and *Arenicola marina* in littoral muddy sand which is also assessed as highly sensitive to bait digging activities. Lastly, littoral mixed sediment which is assessed as having a medium sensitivity to bait digging (Roberts *et al.*, 2020). The area of the site covers approximately 10 ha and overlaps with the Beddmanarch-Cymyran SSSI (Appendix Figure C2).

Access to this location is limited, with no obvious public parking in the area and access to the shore is down small lanes from minor roads.

Evidence suggests that bait digging occurs across 47% of this site at a medium intensity (Figure 6). Perrins *et al*. (2020) observed that a small proportion of bait digging also occurs in the seagrass beds. Recovery from a single bait digging event is likely to be slow as the mud retains very clear evidence of bait digging holes after 4 months. This is likely due to little wave action at the site and the cohesive nature of the sediments.

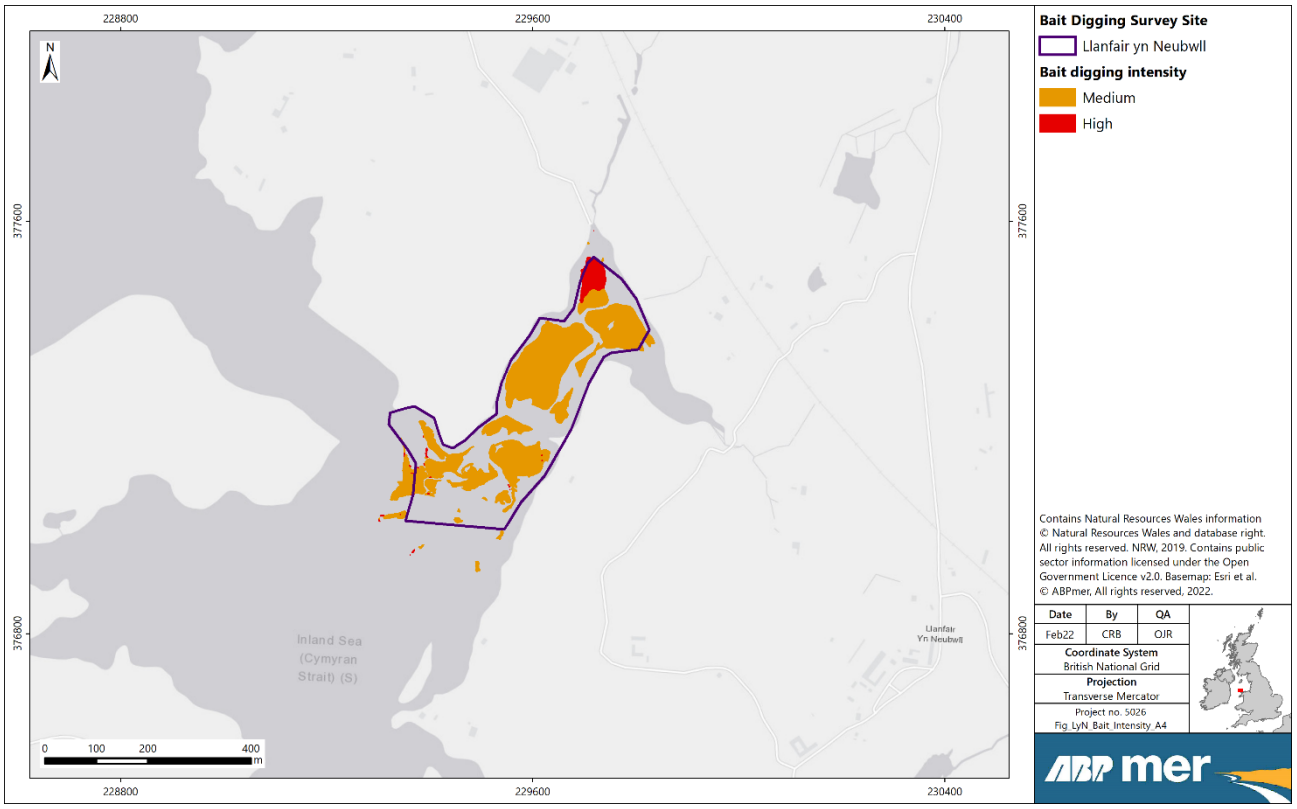

Figure 6 Bait digging intensity at Llanfair yn Neubwll

Inland Sea

Inland Sea is an intertidal section of Cymyran Strait between the A5/A55 bridge and Four Mile Bridge between Holy Island and Anglesey. The sediment consists of cohesive and fine muddy sand bound together with filamentous algae and seagrass. Habitats at Inland Sea are classified as *Zostera noltei* beds in littoral muddy sand which is assessed as highly sensitive to bait digging activities (Roberts *et al.*, 2020). Inland Sea overlaps with the Beddmanarch-Cymyran SSSI (Appendix Figure C2).

There is limited access to the shore with no obvious parking around Inland Sea, however, there is relatively easy road access, particularly on the eastern shore.

There is relatively little information regarding bait digging at this location, however, based on sites with similar characteristics, it is expected that recovery of holes from bait digging would be slow due to the extremely sheltered nature of the site and the cohesive sediments.

5.1.3 Milford Haven

Sandy Haven

Sandy Haven is a beach and estuarine inlet located on the north shore of Milford Haven, west of Milford Haven town. In total, the inlet and bay beach area cover 46 ha and comprise of muddy fine sand sediments with hard coarse material present to 30 cm depth. The biotope associated with this site is *Hediste diversicolor* in littoral gravelly muddy sand and gravelly sandy mud which is assessed as having a medium sensitivity to bait digging (Roberts *et al.*, 2020).

Sandy Haven overlaps with Milford Haven Waterway SSSI which is designated for a range of features including specialised marine habitats, waterbirds (Shelduck, Wigeon, Teal, Curlew, Dunlin, Little Grebe), seagrass, saltmarsh and species rich communities (Appendix Figure C3). Sandy Haven is also part of the Pembrokeshire Marine SAC which is designated for mudflats and sandflats, shallow water inlets and bays, estuaries and a range of marine and terrestrial species. The seagrass beds at Sandy Haven are recognised as nationally rare/scarce vascular plant populations.

Access to the beach on the southern end of the site is easy with public car parking facilities. Access onto the shore further north is via minor roads to the north or small lanes to the east and west with no obvious car parking areas.

Evidence suggests that bait digging occurs across less than 1% of the site, and in low to medium intensities (Figure 7). Recovery from bait digging holes is likely very slow with holes still present (and larger) after 3-4 months (Perrins *et al.*, 2020). This persistence is likely due to the extremely sheltered nature of the upper reaches of the inlet and the fine sediments.

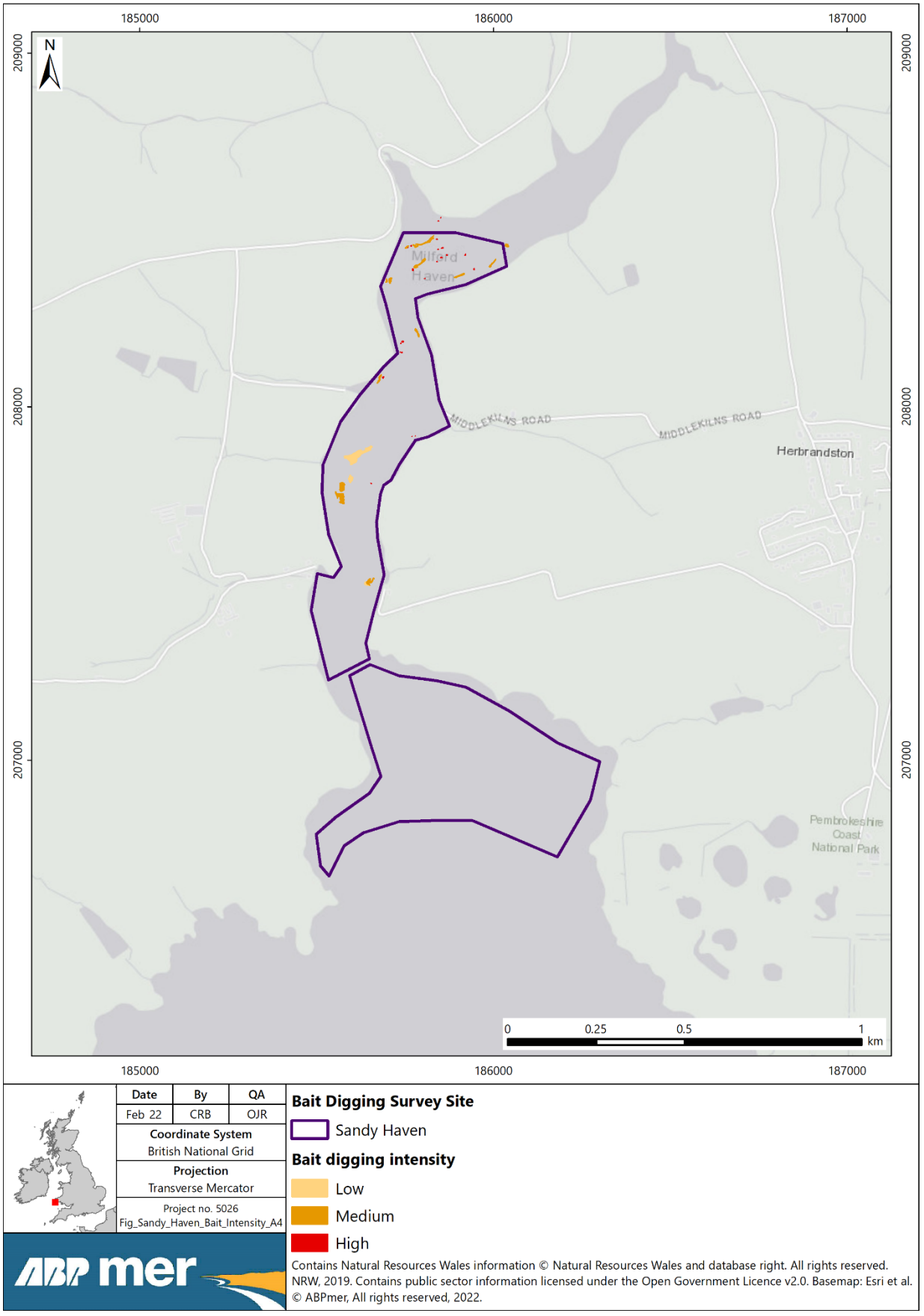

Figure 7 Bait digging intensity at Sandy Haven

Gelliswick Bay

Gelliswick Bay is located on the northern shore of Milford Haven adjacent to a vessel terminal jetty. The beach covers approximately 8 ha and consists of muddy sand sediments. Habitats at this site are classified as littoral mixed sediments which are assessed as having a medium sensitivity to bait digging activities (Roberts *et al.*, 2020). However, there is a small patch of Section 7 muddy gravel to the eastern edge of the site, covering less than 0.1 ha (Figure 8, Appendix Table B2).

Gelliswick Bay overlaps with the Milford Haven Waterway SSSI and the Pembrokeshire Marine SAC (Appendix Figure C3).

Access to the shore is relatively easy with car parking available adjacent to the shore.

There is evidence suggesting bait digging occurs across 0.08% of the bay on the lower shore. However, bait digging extent could be an underestimation due to evidence of the deposition of sand on the shore being observed during the 2019 survey (Perrins *et al.*, 2020). Despite the small extent of bait digging mapped within this area, it is generally of high intensity, though it does not overlap with the Section 7 muddy gravel (Appendix Table B2. The time taken for the recovery of bait digging holes is uncertain, however it is likely that holes would not persist longer than 3-4 months (Perrins *et al.*, 2020).

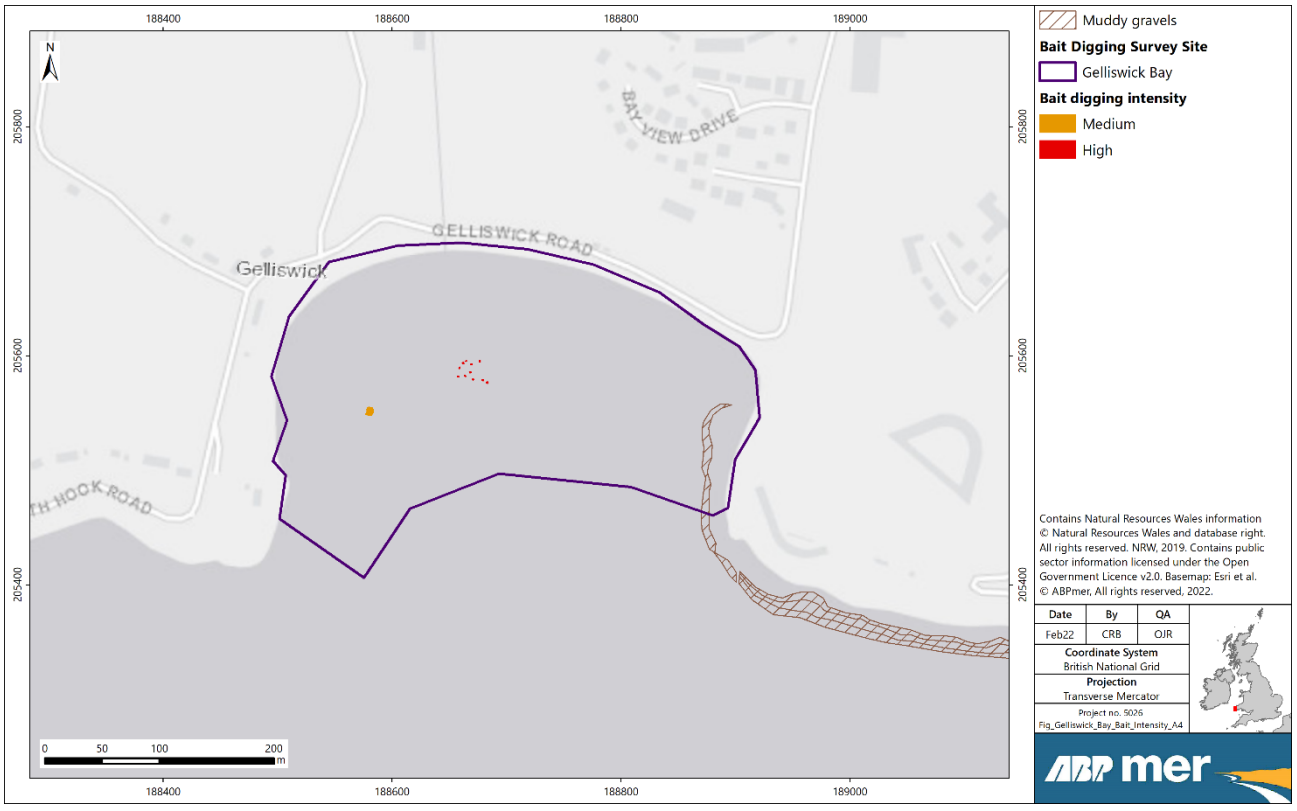

Figure 8 Bait digging intensity and presence of muddy gravels at Gelliswick Bay

Angle Bay

Angle Bay is located on the southern shore of Milford Haven with sediments ranging from medium sand to muddy sands and gravel. The east side of the bay, covering approximately 62 ha, has been recognised as an area where bait digging occurs. Biotopes associated with this site are *Cerastoderma edule* and polychaetes in littoral muddy sand and *Zostera noltei* beds in littoral muddy sand. The latter is assessed as being highly sensitive to bait digging activities (Roberts *et al.*, 2020).

Angle Bay overlaps with the Milford Haven Waterway SSSI and the Pembrokeshire Marine SAC (Appendix Figure C3). The seagrass beds at Angle Bay are recognised as nationally rare/scarce vascular plant populations. Additionally, Section 7 muddy gravels are present to the north of the site extending across approximately 6.3 ha, 10% of the site (Appendix Table B2). There is no obvious public parking on the east side of the bay but there is parking to the west. Access onto the east side of the shore is by minor roads and the southern part of the bay is only accessible by public footpath.

Evidence suggests that bait digging occurs across almost 45% of the east side of the bay at a medium intensity. Extensive digging has been observed by Perrins *et al*. (2020) within the seagrass beds in the mid shore (one hole per 2 m²) and within approximately 35% of the muddy gravels to the north of the site (Figure 9, Appendix Table B2). Recovery from bait digging holes is likely slow within the seagrass beds with evidence of holes after 3 months and holes becoming filled with liquified sediment (Perrins *et al.*, 2020). Digging is less intensive lower on the shore where recovery is likely faster.

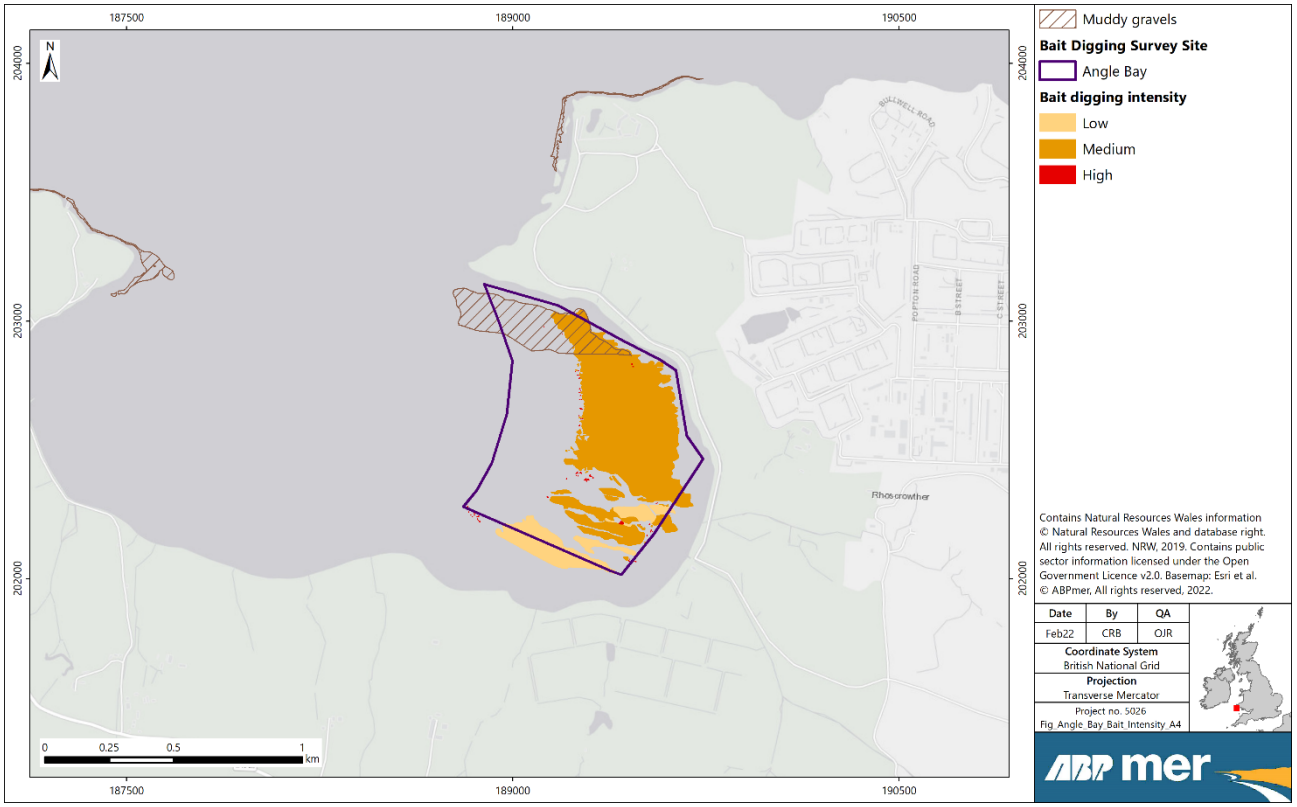

Figure 9 Bait digging intensity and presence of muddy gravels at Angle Bay

5.1.4 Bristol Channel

Swansea Bay (Blackpill)

Swansea Bay is located on the northern shore of the Bristol Channel adjacent to Swansea and covers an area of 624 ha. To the west of the bay, adjacent to Blackpill, bait digging has been measured and observed across an area of 474 ha. This area consists of mainly sand and shell sediments and the biotope polychaetes in littoral fine sand which is assessed as having a medium sensitivity to bait digging (Roberts *et al.*, 2020).

Swansea Bay overlaps with the Blackpill SSSI which is designated due to the presence of waterbirds, particularly overwintering Sanderling, Ringed Plover and Oystercatcher (Appendix Figure C4).

Access to the bay is easy with several public car parks and on road parking close to the shore along the extent of the bay.

Evidence suggests bait digging occurs across approximately 1.5% of the shore (Figure 10), however, recovery from bait digging holes is likely fast, no more than a single tidal cycle, due to the mobile nature of the sediments (Perrins *et al.*, 2020).

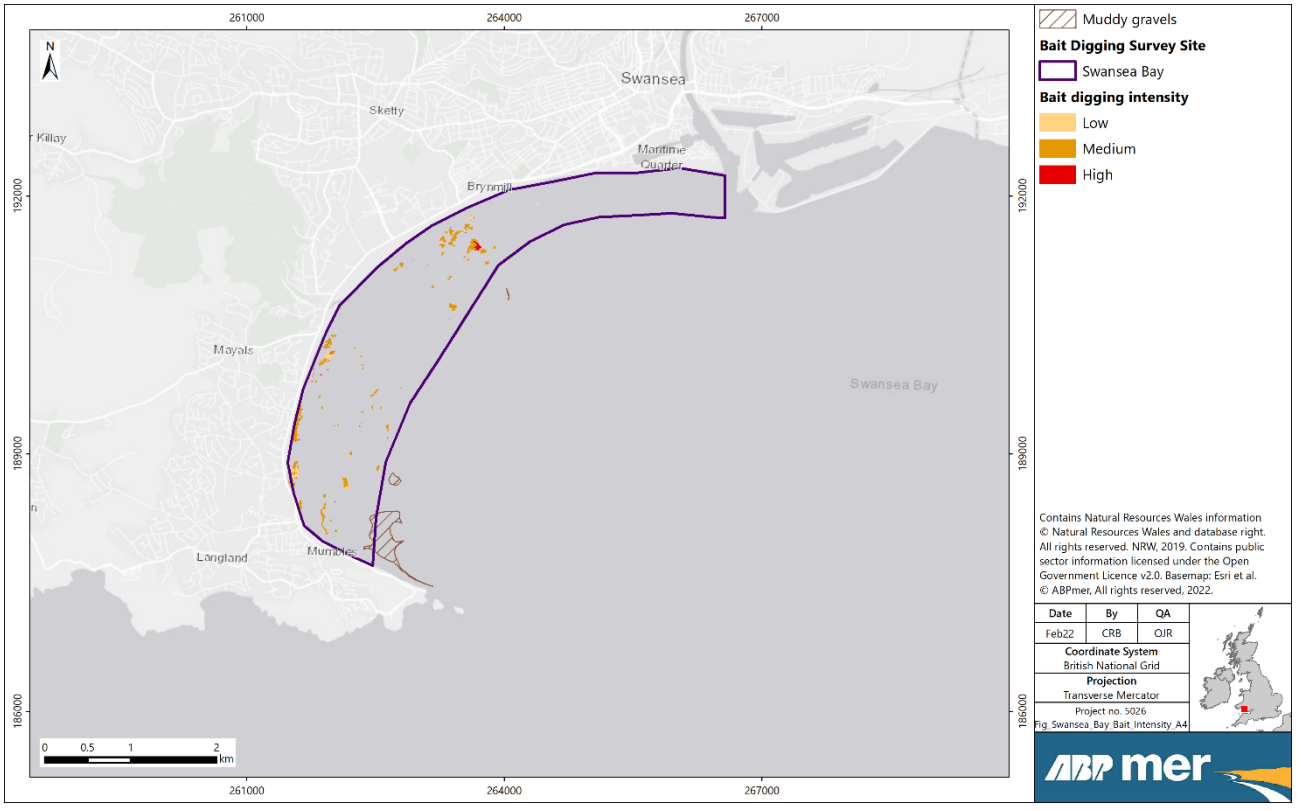

Figure 10 Bait digging intensity and presence of muddy gravels at Swansea Bay (Blackpill)

5.2 Site vulnerability assessment

The site vulnerability assessment has allowed a comparison of the 11 sites across Wales in terms of their potential vulnerability to bait digging. It has identified the sites which are most likely to benefit from measures to manage bait digging activities on the shore. Below, the sites are grouped from high to low vulnerability and the specific vulnerability scores for each site is detailed. A summary of the scoring is provided in Table 1.

Based on the outputs of the site vulnerability assessment, the sites were grouped into the following categories:

High vulnerability:

- Angle Bay;
- Four Mile Bridge; and
- Penmon-Beaumaris.

Medium vulnerability:

- Llanfair yn Neubwll;
- Y Foryd Bay;
- Gelliswick; and
- Beddmanarch Bay / Cymyran Strait.

Low vulnerability:

- Sandy Haven;
- Swansea Bay (Blackpill): and
- Penrhos.

Not assessed:

- Inland Sea (due to limited evidence on bait digging activity).

Table 1 Vulnerability scoring for each site

Site	Bait digging extent	Bait digging intensity	Recovery times of holes	Biotope sensitivity	Muddy gravels	Ease of access	Designation overlap	Total score	Vulnerability
Angle Bay	3	2	3	3	3	2	3	19	High
Penmon-Beaumaris	2	2	3	3	2	3	3	18	High
Four Mile Bridge	2	3	3	2	2	2	3	17	High
Y Foryd Bay	3	2	2	3	N/P	3	3	16	Med
Llanfair yn Neubwll	3	2	3	3	N/P	2	3	16	Med
Gelliswick	1	3	2	2	1	3	3	15	Med
Beddmanarch Bay	2	2	3	2	N/P	2	3	14	Med
Swansea Bay	1	2	1	2	1	3	3	13	Low
Sandy Haven	1	1	3	2	N/P	3	3	13	Low
Penrhos	1	2	1	3	N/P	3	N/P	10	Low
Inland Sea	N/A	N/A	3	3	N/P	2	3	11	N/A

Scoring: high/ slow/ easy = 3, medium = 2, low/ fast/ difficult = 1
N/A = data not available
N/P = not present at the site

5.2.1 High vulnerability score

The sites which are deemed as potentially being in greatest need of bait digging management measures are Angle Bay, Four Mile Bridge and Penmon-Beaumaris. In combination, these sites had a high extent and intensity of bait digging, slow recovery time of holes, and sensitive biotopes present on site.

Angle Bay was identified as having the highest vulnerability score. Seagrass beds occur across a large proportion of Angle Bay and almost all bait digging occurs within the seagrass beds (Perrins *et al.*, 2020). Similarly, compared to other sites, a relatively high proportion of digging occurs within the muddy gravels present at the site.

Four Mile Bridge had the second highest vulnerability score. This was again due to the extent and intensity of bait digging, particularly the extent of which was being undertaken within the muddy gravels present at the site. It should be noted that a number of medium vulnerability sites, such as Llanfair yn Neubwll, are in close proximity to Four Mile Bridge and there is potential that management at Four Mile Bridge could lead to the displacement of bait diggers if they are not all potentially afforded the same protection.

Penmon-Beaumaris scored highly across recovery of bait digging holes, biotope sensitivity, site access and had muddy gravels at risk on the shore.

5.2.2 Medium vulnerability score

Llanfair yn Neubwll, Y Foryd Bay, Gelliswick and Beddmanarch Bay received medium vulnerability scores for a variety of different reasons.

Llanfair yn Neubwll and Y Foryd Bay had bait digging occurring across the entire shore but at a medium intensity. Both sites contained sensitive biotopes but do not have Section 7 muddy gravel present, and hence received a medium vulnerability score. Llanfair yn Neubwll and Y Foryd Bay are both located within the Cymyran Strait, alongside Four Mile Bridge and as such are at risk of bait digging displacement should management measure be introduced. However, Y Foryd is on the mainland and potentially less likely to see displacement of digging activities than the other two sites.

The extent of bait digging was very low at Gelliswick, but the intensity high. These criteria in combination with medium-term recovery of bait digging holes, easy site access and the presence of muddy gravels, resulted in this site receiving a medium vulnerability score. It was stated by Perrins *et al.* (2020) that recent deposition of sand on the shore, potentially from storms, may have led to faster recovery. Further investigations into bait digging at this site may be warranted.

Beddmanarch Bay had slow recovery times of bait digging holes but bait digging extent and intensity were not as high as other sites. Muddy gravels were not present within the area examined by Perrins *et al*. (2020) hence the site received a medium vulnerability score. However, muddy gravels are present south of the bridge and any implementation of management measures has the potential to displace digging to the muddy gravels to the south.

5.2.3 Low vulnerability score

Sandy Haven had low bait digging extent and intensity compared to other sites with no muddy gravels present, hence it received a low vulnerability score. However, recovery time of bait digging holes was slow, and biotopes sensitive to bait digging are present. With relatively easy access at this site there is a high likelihood that any management measures implemented at other sites within Milford Haven could displace bait digging to this site, depending on the species targeted. Anecdotal evidence supplied to NRW suggests that bait diggers stop off at Sandy Haven to dig for lugworm before moving onto the Gann, as the tide drops first at Sandy Haven. Sandy Haven may warrant further investigation.

Swansea Bay (Blackpill) was identified as one of the least vulnerable sites requiring bait digging management measures, predominantly due to fast recovery of holes from bait digging and low bait digging extent and intensity. It is likely that the only feature which could be negatively affected by bait digging at this site are overwintering waders.

Penrhos scored the lowest for vulnerability due to its fast recovery of bait digging holes and low bait digging extent and intensity. In addition, sensitive muddy gravels are not present at the site and it does not overlap with a SSSI or SAC.

5.2.4 Not assessed

There was no existing information regarding the extent or intensity of bait digging at Inland Sea. Due to this lack of information, the score is likely not reflective of the overall vulnerability of the site, hence it cannot be assessed and directly compared to the other sites. Inland Sea is in close proximity to other sites around the Cymyran Strait which received high vulnerability scores due, in part, to high levels of bait digging. It should also be noted that sensitive biotopes are present at the site and that due to the habitats present, recovery of bait digging holes is expected to be slow. Displacement of bait digging to this site has the potential to cause negative impacts. It is recommended that further study is conducted at Inland Sea before the vulnerability of the site is assessed further.

5.3 Review of management measures

Several strategies have been identified for implementing management for bait digging and other recreational activities. These include:

- Byelaws and orders;
- Licensing / permits; and
- Voluntary codes of conduct.

These strategies can be used to implement a range of management measures which include:

- Full and partial area closures;
- Seasonal closures;
- Bag limits;
- Prohibition of commercial bait digging; and
- Innovative management approaches.

Overall, there are relatively few case studies that have evaluated the success of management measures in terms of the recovery of habitats and compliance following implementation. Where available, these case studies have been detailed below.

5.3.1 Management strategies

Byelaws and orders

The collection of bait for personal use is ancillary to the public right to fish in England and Wales and cannot be curtailed other than by an Act of Parliament. However, orders and byelaws can be implemented by a number of different management authorities in order to regulate bait collection activities.

Collection activities can be regulated by byelaw or orders in a number of ways and in Wales the most likely being by:

- NRW, under Section 28 of the Wildlife and Countryside Act 1981;
- Relevant County Council / Local Authority, under the Public Health Act Amendment Act 1907 (Seashore byelaws);
- NRW, National Park Authority and Relevant County Councils / Local Authorities under Section 20, 21 or 90 (respectively) of the National Parks and Access to the Countryside Act 1949 (which can be applied to National Parks or Areas of Outstanding Natural Beauty (AONB));
- Welsh Ministers, under the Marine and Coastal Access Act 2009 / Section 40 of the Habitat Regulations; and
- Welsh Ministers, under Special Nature Conservation Order (SNCO) made under regulation 25 of the Habitats Regulations.

Byelaws

Byelaws are used to regulate a range of activities across the UK and give legal support for action and enforcement to protect sensitive habitats and species from damage. Byelaws can be used to protect the features of SSSIs in England and Wales. In Wales, byelaws in the marine and coastal environment can be implemented by bodies such as NRW, National Park Authorities, The Crown Estate or relevant county or town Councils / Local Authorities.

To pursue a byelaw for the protection of SSSI features, NRW must be satisfied that the designated features are impacted by bait digging and the byelaw is necessary to prevent damage to these SSSI features only.

Byelaws for bait digging are often implemented to protect sensitive species, such as overwintering birds, seagrass and shellfish from disturbance or damage, as opposed to the protection of targeted bait species and associated habitat. These byelaws generally specify closed areas where bait digging is temporarily or permanently prohibited or activities which require a licence (see ‘Licences and permits’ Section 5.3.1 and ‘Full and partial area closures’ Section 5.3.2 below).

Byelaws have been used in Wales to restrict bait digging. For example, under Schedule 3 Byelaw 20 of the Marine and Coastal Access Act 2009 (Commencement No. 1, Consequential, Transitional & Savings Provisions) (England and Wales) Order 2010 (2010/630), any damage to the seabed, including bait digging, is prohibited within cockle beds in Burry Inlet. Similarly, under Schedule 4 Byelaw 12 digging is banned within any mussel beds for any purpose without written authorisation. These were originally Sea Fisheries Committees (SFCs) byelaws and on the abolishment of the SFCs, now have effect in Wales as if made by the Welsh Ministers in a statutory instrument.

Byelaws have also been used to control bait digging near coastal structures for public safety and to protect flood defences, jetties and boats from damage. Under the Seashore Model Byelaws Set 6, councils can enact byelaws made under Section 82 of the Public Health Acts Amendment Act 1907 for the prevention of danger, obstruction, or annoyance to persons using the seashore. For example, a byelaw was implemented in the River Hamble by Hampshire County Council to stop bait digging within 15 metres of any mooring or 6 metres of any infrastructure in order to minimise damage and risk of injury to people. Hampshire Country Council also included backfilling of holes as part of this byelaw for public safety (Hampshire County Council, 2021).

Due to the statutory nature of byelaws and the legal powers behind enforcement, it is likely that they are more successful than other measures for limiting bait digging activities. Watson *et al.* (2015) concluded that a byelaw at Dell Quay, Chichester, which limits bait digging near jetties and moorings, was very successful after surveys and video footage showed that the majority of bait digging activity occurs outside of these prohibited areas. This success was attributed to unofficial enforcement activities by Chichester Harbour Conservancy Council. Watson *et al.* (2015) also suggested that legislation to promote the safety of shore users and reduce potential damage to boats may be a stronger deterrent than legislation for conservation purposes.

However, byelaws are not always favourable among bait diggers and anglers. Stakeholder consultation on the management of bait digging by Devon and Severn IFCA found that most respondents were not in favour of introducing new byelaws and the continued access or ‘right’ to collect bait for personal use was of importance to them (Devon and Severn IFCA, 2019). This could result in a lack of compliance, or need for enforcement, should a byelaw be implemented at a site.

Implementing byelaws is often a lengthy and costly process and once in place they can be expensive to enforce. Consideration is needed over the cost of fines for breaching of byelaws as if they are too low, they may not deter bait digging.

Orders

In Wales, it is important to distinguish that there are orders that relate primarily to nature conservation and orders which relate to the management of fisheries, but which can protect marine sites and features.

Orders can be used to protect European Sites from damage or deterioration under Regulation 40 of the Habitats Regulations (within England these are referred to as byelaws[1]), in Wales, these are made by Welsh ministers. Therefore, these Orders (made

[1] In the Conservation of Habitats and Species Regulations 2017, Regulation 40 distinguishes between the terminology used for protecting European Marine Sites in England and Wales:

under Section 134 of the Marine and Coastal Access Act) will apply to SACs and Special Protection Areas (SPAs).

In Wales, Section 134a of the Marine and Coastal Access Act also allows Welsh Ministers to make one or more orders relating to the exploitation of marine sea fisheries resources in Wales for the purposes of conserving marine flora, fauna or habitats.

Prohibiting bait digging activities across an entire European marine site by an order is recognised as a potentially necessary conservation measure under Article 6(2) of the Habitats Directive for the protection of SAC features in Wales. Partial closures for bait digging activities within SACs may require a Habitats Regulations Assessment (HRA) to ensure no adverse impacts on the designated features of the SAC from continued bait digging.

Special Nature Conservation Orders (SNCOs), also made under the Habitats Regulations (Regulation 27, and Schedule 1) can also be issued by the Secretary of State (in England) or Welsh Ministers (in Wales), based on recommendations from Natural England or NRW, respectively. SNCOs for European Marine Sites (EMS) can be used to prohibit specific activities from a location or time of the year. Natural England or NRW can request a SNCO only if:

- The site cannot be protected by other regulations (e.g., planning or byelaws);
- Other measures have not worked or are not possible (e.g., voluntary agreements);
- Monitoring shows a site is being damaged; and
- Monitoring shows a site is at risk.

SNCOs are often used as a 'last resort' warning to potentially damaging activities and take effect immediately. Welsh Ministers must then serve a stop notice in order to prohibit the activity. The SNCO automatically ceases after nine months, however, the stop notice can remain in place.

SNCOs have been established to restrict a range of activities in the UK, such as off-road driving, bonfires and bait digging (Welsh Government, 2021b). SNCOs are infrequently used and will generally only be used in the marine environment if byelaws are deemed inadequate for the protection of a site (Natural England, 2012). Two sites have been protected by restricting all bait digging, or commercial bait digging activities – Lindisfarne National Nature Reserve (NNR) and Portsmouth Harbour respectively. The SNCO for Portsmouth Harbour SPA was established in 2003 – 2004 with the aim to limit commercial bait digging disturbance on protected bird species. A study by Watson *et al.* (2015) found that after the SNCO was established, significant levels of digging still occurred inside the closed area. Therefore, despite its introduction and efforts by the police to enforce it, the SNCO was considered to be ineffective due to difficulties in proving that the collection is for commercial purposes rather than personal use.

"(1) The Marine Management Organisation may make byelaws for the protection of a European marine site in England under section 129 of the Marine Act (byelaws for protection of marine conservation zones in England) (2) The Welsh Ministers may make orders for the protection of a European marine site in Wales under section 134 of that Act (orders for protection of marine conservation zones in Wales)".
https://www.legislation.gov.uk/uksi/2017/1012/regulation/40/made?view=plain

At Lindisfarne NNR an SNCO was implemented in October 1993 following multiple failed attempts to regulate bait digging within the NNR through other measures including the implementation of a voluntary digging zone and a byelaw. Bait digging at Lindisfarne NNR was causing displacement of bird populations, damage to commercial mussel beds operated under licence in the bay and mobilisation of heavy metals into the sediment. Despite the virtual depletion of dug areas, lugworm numbers recovered very rapidly after bait digging ceased at the site and bird numbers using the area after the closure also rose considerably.

Relating more to fisheries, in England, the Association of Inshore Fisheries and Conservation Authorities (IFCA) have been granted the ability to introduce and enforce byelaws. IFCAs are required to ensure the sustainable exploitation of sea fisheries resources within their districts and have a duty under Section 154 of the Marine and Coastal Access Act 2009 to introduce byelaws regulating fishing activity where necessary (Defra, 2011). This has made the implementation of statutory management measures, through the implementation of byelaws, easier and faster for the coastal regions in England. In Wales, the Welsh Ministers may by Order make any provision in relation to managing sea fisheries resources in Wales which the authority for an IFCA district may make for that district by a byelaw under Section 155 of MCCA. This power is more directly related to management of the fisheries themselves, rather than impacts on protected sites.

Licences and permits

The issuing of licences and permits for regulating activities is commonly used across hand gathering and fishing activities on regional and national scales. On a regional scale, permits have been used to regulate commercial and recreational shellfish collection. For example, North Eastern IFCA has a limited shellfish permit which applies to recreational fishermen to limit the fishing effort of lobsters, crabs and whelks (North Eastern IFCA, 2021). Kent and Essex IFCA have implemented permits for the collection of whelk and cockles specifically to protect against the over exploitation of stocks whilst balancing the need for harvesting (Kent and Essex IFCA, 2021).

Bait digging for commercial use requires permission, however, digging for personal use typically does not require a licence under the public right to fish in tidal waters. However, some sites have regulated recreational bait digging through the use of licences or permits. At Cleethorpes, on the Humber Estuary, North East Lincolnshire, a licence is required to dig bait in permitted areas and a bait digging code of conduct is given out when people apply for licences, which states that recreational anglers may gather bait but digging is restricted in certain areas (North East Lincolnshire Council, 2016). A ‘Beach Safety Team’ is used for policing bait digging at Cleethorpes. Around Cleethorpes, bait digging is not permitted along the main stretch of the beach or on any saltmarsh habitats but is permitted towards the northern and southern limits (Cruikshanks *et al.*, 2010).

Some agencies charge for issuing licences and money raised from selling licences or issuing fines can be directly used to benefit the activity. For example, on a national scale rod fishing licences are required for fishing freshwater fish, salmon, trout, smelt or eel with a rod and line in England (except the River Tweed) and Wales. Anglers without a rod licence can be fined up to £2,500. Money raised from issuing rod licences is used for

enforcement, undertaking stock surveys, improving fish habitats and stocks and maintaining/developing fisheries (Environment Agency, 2014). Specific licences are also required for catching salmon and sea trout and anglers with a licence have a legal responsibility to submit a catch return every year, even if they have not landed any fish.

A licensing system has the potential benefit of being able to regulate bait digging. However, assessing the number of licences needed in an area is difficult as the number issued may not reflect actual extent or intensity of bait digging activity on the shore. For example, frequency of visits to the site and total duration of digging varies between bait diggers (Watson, 2014). It is also difficult to scientifically assess what a sustainable level of bait digging might be for vulnerable habitats. Other issues associated with licences were highlighted by Carvalho *et al*. (2013) which showed that in Portugal, where personal bait collection licences are required by law, licences can be ineffective if there is no supervision or control and lead to the continued unsustainable collection of bait. Importantly, under current legislation there can be no limits to the number of permits issued, therefore permits cannot be used as a mechanism to minimise the number of bait diggers accessing a site.

A limitation to the use of licences or permits for the regulation of bait digging activity is enforcement. Anecdotal evidence from some areas where permits have been implemented suggests that some diggers continue to harvest without applying for a permit, undermining the system.

The issuing of licences/permits even if for improving the management of the SAC may still undermine the conservation objectives at the site due to continued disturbance to the designated features. It is therefore likely that a permit scheme would not be compliant with Article 6(3) of the Habitats Directive which requires NRW and/or Welsh Government to be satisfied that permitting would not cause continued adverse impacts. A HRA would also be required prior to the implementation of permits for bait digging.

Voluntary codes of conduct

Voluntary codes of conduct are frequently used across bait digging sites and although the codes vary between sites, they often cover the same principles. These codes can be produced in partnership with local clubs, bait diggers and anglers. For example, a Memorandum of Agreement for bait digging in Poole Harbour was produced in partnership with bait diggers and anglers to protect the local habitats and allow sustainable bait collection (Southern IFCA, 2021b). At Sandwich and Pegwell Bay NNR in Kent, a workshop with Thanet Coast Project, Kent Wildlife Trust, local bait diggers and bird watchers led to an agreement to reduce disturbance to wildlife (Thanet Coast Project, 2007). Similarly, angling bodies (for example the Angling Trust) and local clubs often promote a sea anglers' code that includes guidelines for protecting and mitigating harmful impacts to the marine environment whilst protecting the interests of bait collectors.

Voluntary codes most often cover guidelines such as:

- Back-filling holes and trenches;
- Avoiding digging close to boat moorings, sea walls or other structures;
- Only taking the minimum bait required; and
- Leaving immature or ripe worms.

However, other voluntary codes can also include measures such as:

- Area restrictions or zonation; and
- Seasonal closures.

These codes are often promoted in the form of on and off-site education such as signs at the entrance to the site, leaflets, on-site engagement, or workshops and focus groups. A report commissioned by Defra (Boyes *et al.*, 2006) found that voluntary codes of conduct are more likely to be complied with where the users are recreational and members of clubs or organisations that promote codes of conduct. However, it was acknowledged that the majority of bait diggers are unattached to a local or national body (Boyes *et al.*, 2006). The report also found that codes of conduct for activities of commercial or economic interest, such as bait digging, were less effective. It is important to note that commercial digging without landowner permission is unlawful and therefore voluntary management measures would not be used to manage commercial digging.

Voluntary measures cannot be strictly enforced and can lead to the continued negative impacts of bait digging on sensitive areas. One such example is at Budle Bay, Northumberland in the 1980s where a voluntary agreement with the National Anglers Council and Northern Federation of Sea Anglers Society (NFSAS) was used to test an experimental digging area. Intensive bait digging took place in the experimental area and after depletion of all lugworm, digging took place in restricted zones. Since then, a SNCO has been implemented to prohibit bait digging across the entire site.

The Orwell and Stour River Estuaries implemented a voluntary code to restrict bait digging to certain stretches of the mudflats during the winter to protect overwintering birds (Suffolk Coast & Heaths, 2010). This code has been relatively unsuccessful and Eastern IFCA have considered implementing a byelaw in the area. It was noted that the code of conduct could be publicised better as although leaflets have been issued to tackle shops and websites, no signs had been put up along the riverbanks (BBC, 2013).

A joint voluntary code of conduct between the Welsh Federation of Sea Anglers, National Federation of Sea Anglers and the Marine Conservation Society, and led by CCW at the time, for angling and bait collection was successful in raising awareness for local recreational anglers who may have an interest ensuring the sustainability of their local environment. However, there were incidences where non-local commercial bait diggers used Welsh intertidal areas to take bait from sensitive habitats, which both negatively impacted the habitats and reduced the support for the code of conduct (Boyes *et al.*, 2006). However, this code of conduct is now no longer in place with most areas implementing or planning to implement their own voluntary codes.

Stakeholder consultation by Devon and Severn IFCA showed that the knowledge of voluntary codes was lacking, and many bait diggers thought the development of these codes would be beneficial. Other respondents, such as anglers and members of the public had concerns over the effectiveness of voluntary codes. It was highlighted that better promotion of voluntary codes was necessary for their success (Devon and Severn IFCA, 2019).

It should be noted that voluntary measures can be used in the interim of implementing a byelaw. Monitoring of voluntary measures can also be used to observe compliance prior the consideration or implementation of a byelaw.

5.3.2 Types of management measures

Full and partial area closures

Full and partial closures of sites (the exclusion of an activity in an area or for a particular period of time) are considered a common management options for the protection of MPAs and are often used to restrict bait digging activities (Watson *et al.*, 2015). Closures can be implemented in the form of statutory (orders/ byelaws) or voluntary closures. They can range from permanent exclusion zones to temporary and rotational zonation (from months to years) with the aim of allowing habitats to recover or reduce disturbance.

Full or partial closures can be implemented to protect specific species or features which are designated under MPAs. Protection of seagrass beds is common with the partial closure of sites to prevent damage from activities including bait digging. For example, part of the Humber Estuary SAC is closed to bait digging and fishing activities under local authority byelaws for the protection of seagrass habitats (North Eastern IFCA, 2019). Southern IFCA manage hand gathering, including bait digging, through a byelaw to protect seagrass beds from damage from digging and trampling (Southern IFCA, 2021a). This byelaw prohibits any hand gathering activities within seagrass beds (Southern IFCA, 2013). Similarly, collection of bait in the Morecambe Bay SAC is prohibited in the seagrass bed closed areas without written authorisation (North Western IFCA, 2014).

Although there is conflicting evidence on the impact of disturbance from bait diggers on the behaviour of wading birds, full closure of Budle Bay, Northumberland, was observed to have a positive impact on waterfowl populations. Following the closure of the bait digging area in Budle Bay, Northumberland, there was a considerable increase in Wigeon, Bar-tailed godwit, Redshank, Shelduck, Teal, Mallard and Eider populations, with some more than doubling within a year of closure (Townshend and O'Connor, 1993). Similarly, the population of lugworms increased significantly by immigration of juveniles from adjacent areas. However, closure of sites can lead to displacement of diggers (either due to lack of space or depletion of bait) and potential increased pressure from bait digging activities at other locations. Tinlin-Mackenzie (2019) stated that further closures at Boulmer on the northeast coast of England would need to be considered carefully. Boulmer accounts for an estimated 57% of total harvests in the area and displacement would likely lead to intense digging at other sensitive locations (Tinlin-Mackenzie *et al.*, 2019).

Currently, there is little scientific understanding on the appropriate size or type of area closures needed in order to protect sensitive features. It is likely that characteristics of the features themselves would be important, such as sensitivity to disturbance and recovery time. Equally, the intensity of the disturbance activity will influence the size of an area to be protected. In general, partial closures are more favourable with bait diggers and have the potential to reduce conflict by not completely stopping bait digging in an area to ensure that alternative sources of bait remain accessible (Fowler, 1999). Overall, the size or type of area closures are likely to be most effective when site specific and tailored to local needs (Watson, 2014).

Watson *et al.* (2015) stated that protection of areas can fail to mitigate the impacts of bait digging if there is a lack of enforcement. After using video footage, Watson *et al.* (2015) found that digging was evident in closed areas at Fareham Creek (Portsmouth Harbour SPA). At Dell Quay in Chichester, nearly all digging took place outside of closed areas

likely due to regular on-the-ground 'unofficial' enforcement by the managing NGO. On the northeast coast, bait digging area closures using byelaws have had varying success. At Newton, the entire shore is closed to digging but bait digging still occurs. At Boulmer where half the shore is closed to digging, the closure is generally complied with, however, harvesting is now more intensive in the remaining area (Tinlin-Mackenzie *et al.*, 2019). Carvalho *et al.* (2013) suggested that partial closures could reduce overall impact of bait collection, however, clear signs at the shore and the use of public forums to improve environmental awareness of protected areas and sustainable bait collection are needed.

Byelaws which aim to prevent bait digging causing health and safety issues, such as the dangers posed by holes left on the shore, are likely to be appropriate at sites which are heavily dug in the summer particularly in areas which are subject to high levels of tourism. Whilst bait digging may be regulated by these byelaws, the activity may not be prohibited altogether. Thus, closures can only be for a set period of time (not year-round) or for a particular part of the shore with open areas within reasonable distance where the activity can persist (Ministry of Housing, Communities & Local Government, 2018).

Another consideration for site management is identifying other methods (other than digging) for collecting bait. The closure of a site to prevent bait collection in general could displace the collection of other bait, for example using crab tiles, where the impacts of the activities are currently unknown.

Seasonal closures

The closure of bait digging beds during peak growth or spawning season has been suggested as a way to improve recruitment rates and maintain future stocks (Clarke *et al.*, 2017). Similarly, seasonal closures during the peak overwintering bird season are also utilised by a range of management authorities which aim to reduce the impacts of commercial and recreational activities on birds. This type of closure is only likely to be useful where SAC or SSSI features do not require year-round protection from bait digging.

Hand gathering, including bait digging, is managed by Southern IFCA through a byelaw to protect overwintering birds from disturbance and decreased food availability (Southern IFCA, 2021a). This byelaw prohibits hand gathering within Poole Harbour between 1 November and 31 March (Southern IFCA, 2014). Similar seasonal closure byelaws have been used in northeast England (Humber Estuary and Teesmouth and Cleveland) where removing cockles from the shore is prohibited between 1 May – 31 August. These closures are implemented along with other management measures such as bag and size limits and permits (North Eastern IFCA, 2021). It should be acknowledged that effective advertisement and enforcement of temporary closures can be difficult.

Bag and size limits

The aim of implementing a bag limit is to reduce the intensity of bait digging by limiting the number or weight of individuals of target species that can be collected per person. There are few examples of bag limits being implemented for bait digging for polychaetes. One such example is on the northwest Atlantic coast of Portugal where a daily catch limit representing the maximum sustainable yield for targeted polychaete was implemented (Xenarios *et al.*, 2018). Xenarios *et al.* (2018) found that the limit was controversial and

overall, there is a lack of enforcement on the site. It was acknowledged that in person and remote monitoring is likely needed along with a review of the socio-economic and environmental impacts for the policy to be effective.

To protect cockle beds throughout the Burry Inlet, the former Welsh Office (South Wales Sea Fisheries Committee) initially suggested that bait digging activity throughout the Burry Inlet should be limited by quota and by permit, with a bag limit of 100 lugworms per bait digger imposed. This aimed to restrict bait digging activity to collection for personal use only and exclude commercial collectors. Bag limits, however, proved to be impossible to enforce and Byelaw 20 was implemented stopping all damage to the seabed (Woolmer, 2010; Welsh Assembly Government, 2011). Following the Marine and Coastal Access Act 2009 (Commencement No. 1, Consequential, Transitional & Savings Provisions) (England and Wales) Order 2010 (2010/630) the byelaw now takes effect as if made by the Welsh Ministers by statutory instrument (Schedule 3).

Bag limits also do not reflect the experience of the bait diggers. More experienced diggers may dig less holes than an inexperienced digger for the same number of worms. Therefore, the impact on the shore may not be reduced as the number of worms collected does not necessarily correlate with the damage to the shore.

Size limits are often used to ensure juveniles of target species are not removed from the population, thus allowing them to mature and reproduce. The Welsh Government have implemented minimum size byelaws in the old South Wales Sea Fisheries Committee District on a large range of shellfish and fish (Byelaws 3-14) (Welsh Assembly Government, 2011). It is likely size limits are difficult to enforce for bait digging where landing sizes are not recorded. It is likely that ragworms would be difficult to measure as they break easily especially in any attempt to measure them. However, it has the potential of being more successful in implementation than bag limits due to the knowledge of diggers that they are preserving future stocks.

Prohibition of commercial bait digging

Commercial bait digging generally requires the collection of a large volume of bait and requires landowner permission prior to collection. Prohibition of commercial diggers has the potential to significantly reduce the impacts of bait digging to a shore, however, enforcement is challenging due to the difficulty in identifying commercial bait diggers or proving commercial collection (Fowler, 1999). There is the added complication that a commercial collector may be replaced by a larger number of inexperienced diggers which may increase the amount of digging and damage. Prohibition has the potential to displace this intense bait digging to other potentially sensitive shores and cause conflict with recreational bait diggers. It is not known whether any permission has been given by a landowner (usually the Crown Estates) to gather bait commercially.

Innovative approaches

Current management approaches are usually formed from an ecological based management perspective which focuses on the location, frequency, and intensity of a harvesting activity. They do not necessarily include full engagement with collectors or the understanding of the social driver behind harvesting activities.

Morris-Webb (2021) assessed the potential to implement regulation supported and co-designed with the stakeholders involved in the collection process, suggesting this would lead to self-enforcement of regulation and therefore greater sustainability and compliance of management measures. Designing management interventions which consider the behavioural motivations behind harvesting, and by considering a co-management approach may foster custodianship among collectors and increase further compliance with future regulation. This approach would also align with the Wellbeing of Future Generations Act (Wales) 2015, under which "*public bodies need to make sure that when making their decisions they take into account the impact they could have on people living their lives in Wales in the future*".

However, further research into the applicability of such an approach from a management perspective is required, and there are concerns that if collectors fail to engage that there could be continued lack of regulation which threatens stocks and/ or the environment.

The Uruguayan yellow clam fishery provides an example of an effectively co-managed fishery (Pittman *et al*., 2019). Concerns over the impacts of increasing land pollution led clam collectors to instigate a management process alongside the management agency National Direction of Aquatic Resources. The voluntary participation of the fishers in determining and enforcing rules lead to the creation of a co-management regime.

Within the yellow clam fishery there has been a highly positive response in abundance and biomass of the harvestable stock through time, stabilisation in individual sizes above the minimum landing size limit, and a fairly constant exploitation rate at low levels. Subsequently, the government implemented high-level policies as an attempt to transform local fisheries into sustainable systems and in 2013, a new national Fishery Law (20 December 2013, Montevideo, Uruguay) was passed. The law explicitly promoted the creation of Local Fishery Councils as a formal strategy to engage local communities in fisheries co-management (Pittman *et al.,* 2019). Despite the overall success of the co-managed Uruguayan yellow clam fishery the overall process has taken 30-40 years to develop and refine into the current system, during which time there were multiple stock crashes.

The farming of bait has also been identified as a potential approach to reduce commercial bait digging. Farming is recognised as a reliable source of bait to shops throughout the year with the ability to harvest large numbers of farmed ragworm daily. However, farming bait is currently limited to a small selection of species. Digging for wild bait often produces a wider variety of species, such as large king ragworms up to 18 inches to small harbour ragworms, which are required for different types of fishing. In contrast, farmed ragworm are often a standard size, approximately three inches, which is deemed limiting for the variety for fishing that takes place in Wales. Advancements in the breeding of worms throughout the year to limit broodstock collections and potentially increase in the variety of bait types is likely to make this approach more attractive to bait diggers. Tackle shops could also be targeted to encourage the selling of farmed bait.

Increases in bait digging intensity in certain areas have been linked to recreational angling matches. Angling competitions have the potential to influence bait digging activities. For example, white ragworm *Nephtys* sp. are recognised as a very effective bait and are highly prized by anglers for their competitive advantage. This recognised advantage led to intense digging of white ragworm in the UK. In combination with their infrequent reproduction and low recruitment rates (Olive, 1985), intense digging led to a rapid

depletion in their stocks. To make competitions fairer, white ragworms have been known to be banned, and competitions have been known to supply bait, for example from bait farms (NRW, pers, comms). Measures such as this may reduce intense digging of highly prized species and aid in protecting their populations and habitat.

Slipper limpets are another example of a bait favoured for use when fishing for Bass, however, as a non-native species its use in competitions poses a biosecurity risk if translocated from one site to another. Banning its use from competitions aims to prevent translocation but also reduces demand for the species for recreational fishing as anglers utilise alternative baits. However, this approach is largely applicable to larger competitions which have the financial backing and not applicable for smaller, open competitions.

5.3.3 Summary of management measures

Byelaws or orders are likely the most effective way of managing bait digging due to their statutory nature. However, implementing them is a lengthy and costly process. Additionally, once in place they can be expensive to enforce and potentially require 24-hour surveillance. Often, fines issued for breaching of byelaws are low and unlikely to deter bait digging.

Whilst licences and permits have the potential to regulate bait digging activities, there can be no official limit on the number of permits which can be given out. The issuing of licences and permits also requires enforcement to ensure compliance. Licences can be used as a tool to engage with bait diggers by ensuring diggers are aware of codes of conduct in place.

Area closures are recognised as the most effective way to reduce the impacts of bait digging on sensitive habitat and species features. The full closure of a site may comply with the conservation objectives of a SACs and benefit SSSI features, however it is important to acknowledge that closures of sites would likely lead to the displacement of bait diggers to other locations within a reasonable distance.

Partial closures and permits/licences may risk breach of the Habitats Regulations where sites overlap with a SAC, where management authorities permit activities that they know will damage a SAC feature and have an adverse effect on the integrity of the site.

Voluntary measures may be an effective mechanism to manage a range of unlicensed activities if they are well defined and have local support. However, areas of intense activity or lack of compliance to voluntary measures could result in the requirement for codes of conducts (underpinned by byelaws). Byelaws have generally been shown to be more effective than voluntary measures for bait digging/collection and are easier to enforce (Boyes *et al.*, 2006).

Several management authorities have implemented a combination of measures to protect sensitive habitats from commercial and recreational activities, for example, the requirement for licences, seasonal closures and bag and size limits used by North Eastern IFCA (Teesmouth and Cleveland) for the management of shellfish stocks (North Eastern IFCA, 2021). In general, IFCAs in England provide a good example of successful in-combination management measures, likely due to the relative ease and speed for them to implement byelaws. In combination, implementing a range of measures could lead to

effective management of activities, however, more studies are needed to evaluate their success and levels of compliance.

There are few studies which have assessed the success of bait digging management measures. It is therefore suggested that further studies are undertaken to assess the effectiveness of management on the shore after implementation in terms of recovery of the shore and compliance.

Farming of bait is also potentially an alternative approach to help minimise the impact of bait digging, however, there is currently little evidence of its exact impact in reducing bait digging extent and intensity.

Overall, the potential management strategies such as byelaws, orders and licences that can be implemented at a site will be dependent on the current conservation designations on the shore. Implementation of appropriate management measures will ultimately depend on site characteristics and the current extent or intensity of bait digging. Collaborative working with stakeholders is likely to achieve the most effective results in terms of compliance.

Table 2 Summary of the advantages and disadvantages of the management options for bait digging activities.

Management option	**Advantages**	**Disadvantages**
Legislations / byelaws	• Easier to enforce than other management options and higher likelihood of compliance. • Gives more power for enforcement. • Can help support voluntary management systems.	• Displacement of bait diggers to other sites, leading to increased pressure on habitats and stocks and potential conflicts with other bait diggers. • Can take time and significant cost to implement. • Can be difficult to maintain local support. • Lack of resources for enforcement could undermine byelaw.
Licences and permits	• Easier to enforce than voluntary management options. • Have potential to control the intensity of bait digging activities. • Used as an engagement tool to raise awareness of codes of conduct.	• Little understanding on appropriate numbers of licences to issue. • Unable to limit the number of permits issued. • May not be possible for European Marine Sites (EMS) due to the likely outcome of an HRA.
Voluntary codes of conduct	• More likely to be supported by bait diggers, provides opportunities for discussion and reduce conflicts.	• Impossible to strictly enforce. • Requires significant resource input for on and off-site education and promotion.

Management option	Advantages	Disadvantages
	• User groups may already promote such codes. • Can respond easily to changes in circumstances. • Could be self-regulating. • Flexibility in operation.	• Difficult to disseminate to *ad hoc* recreational users or users not part of local clubs or national bodies. • No statutory penalties.
Full and partial area closures	• Protection of localised habitats, species, recreation, infrastructure from disturbance and damage.	• Difficult to enforce. • Displacement of bait diggers to other sites, leading to increased pressure on stocks and potential conflicts with other bait diggers. • Potential for more intense digging of bait in zones open to bait digging. • Partial closure may not be possible for EMS due to the likely outcome of an HRA.
Seasonal closures	• Protection of bait species during breeding season will allow recruitment which may sustain future populations. • Protection of overwintering birds.	• Difficult to enforce. • Peak bait demand occurs during lugworm breeding season and bird overwintering season. • May not be possible for EMS due to the likely outcome of an HRA.
Bag and size limits	• Intended to reduce bait collection intensity. • Intended to conserve stocks and reduce overall impact (particularly commercial collection). • Likely to be more acceptable to recreational collectors.	• Difficult to enforce. • May increase collection effort. • Does not take into account bait digger experience.
Prohibition of commercial bait digging	• Reduced pressure from large-scale bait digging on sensitive areas.	• Difficult to identify commercial bait diggers. • Displacement of commercial bait diggers to other sites, leading to increased pressure on stocks and potential conflicts with other bait diggers.
Innovative approaches: co-management	• Potential for higher compliance and self-enforcement.	• Lack of regulation could threaten stocks and/ or the environment. • Long time to implement, develop and refine management system

Management option	Advantages	Disadvantages
Innovative approaches: Farmed bait	• Reliable source of bait for anglers. • Reduced pressure from bait digging on wild stocks and sensitive habitats.	• Farmed bait is limited to a select number of species and size class. • Outside of NRW scope to implement.

5.4 Potential site-specific management options

Following the review of management strategies, potential management measures for each of the 11 Welsh sites are suggested based on the vulnerability of each site to bait digging activities from Section 5.2. A summary of the potential management options for each site is presented in Table 3.

It is recognised that management of bait digging needs to be site specific and tailored to local circumstances such as the intensity of bait digging, species being dug at each site, the specific SSSI and SAC features in need of protection and sensitivity of biotopes to bait digging. It is also important to acknowledge that the effects of bait digging are not uniform across sites, for example, areas with lower mud content or those which are less sheltered have shown faster signs of recovery from bait digging (Carvalho *et al*., 2013; Perrins *et al*., 2020). Equally, levels of compliance will also be variable depending on the management measures implemented on the shore (Watson *et al*., 2015; Bean & Appleby, 2014). To ensure compliance, measures such as enforcement officers, CCTV and/or fines could be used.

5.4.1 High vulnerability sites

Angle Bay, Four Mile Bridge and Penmon-Beaumaris were all identified as the sites with the highest vulnerability to bait digging and therefore have the potential to benefit most from the implementation of management measures (Section 5.2.1).

Angle Bay

Seagrass beds at Angle Bay are designated under the Milford Haven Waterway SSSI but are extensively dug (Perrins *et al.*, 2020). Closures of the seagrass beds at Angle Bay could prevent ongoing damage to the seagrass (assuming they are complied with/enforced) and likely have secondary benefits to other SAC and SSSI designated features at this site. Legislative routes for closure could include a byelaw under Section 28 of the Wildlife and Countryside Act 1981 as Angle Bay is within a SSSI or using a Welsh Government Order under Section 40 of the Habitat Regulations (or Marine and Coastal Access Act 2009) as it is also in a SAC. A full closure of the site would be required to comply with the SAC conservation objectives to ensure there is no continued damage to SAC features. Closure of the site could also lead to the protection of Section 7 muddy gravels which are also extensively dug on the shore.

Closure of Angle Bay would likely lead to the displacement of diggers from these sites to other vulnerable sites around Milford Haven, such as Sandy Haven and Gelliswick Bay. It is therefore important to monitor potential displacement of bait diggers and consider the potential secondary effects on shores which are currently not considered highly vulnerable. Similar management measures across neighbouring sites could be trialled in an attempt to mitigate the effects of this displacement. For closure of SACs using an Order, it would be important to identify where diggers could potentially be displaced to for undertaking an HRA, however, predicting displacement would be difficult.

Four Mile Bridge

Within the Cymyran Strait, Four Mile Bridge was recognised as highly vulnerable. To protect the designated features, a full or partial site closure could be used. NRW have the option to implement this under using a byelaw under Section 28 of the Wildlife and Countryside Act 1981 as Four Mile Bridge is within a SSSI. It is not within a SAC so the implementation of an Order by Welsh Government under Section 40 of the Habitat Regulations would not be appropriate, although management by Welsh Ministers under the Marine and Coastal Access Act 2009 could be investigated.

Due to the close proximity of Four Mile Bridge to Llanfair yn Neubwll and Inland Sea, management at one site has the potential to lead to displacement of bait diggers to other vulnerable sites. Therefore similar management measures could be implemented across all of these locations to reduce the likelihood of displacement.

Four Mile Bridge is subject to increased bait digging intensity in the summer due to holiday trade and increased tourism (NRW pers. comms). With this in mind, seasonal closures, potentially through Seashore Byelaws or other mechanisms, could be put in place to limit intense digging during the holiday period.

Penmon-Beaumaris

Section 7 muddy gravel exist across the entire extent of Penmon-Beaumaris. Full closure of Penmon-Beaumaris for protecting the mudflats and sandflats could be considered to protect this sensitive habitat. It is possible that this could be done through a byelaw under Section 28 of the Wildlife and Countryside Act 1981 as Penmon-Beaumaris is within a SSSI or using an Order under Section 40 of the Habitat Regulations (or Marine and Coastal Access Act 2009) as it is also in a SAC. As the proportion of bait digging extent covers only 11% of the shore, options for partial closures could be explored, however, it could displace diggers to other areas where muddy gravels are present. Partial closures would also result in the need for an HRA. Due to the close proximity, digging at Penmon Beaumaris may likely be displaced to Y Foryd Estuary in the event of a full site closure. However, it ragworm is the target species then this displacement may not happen as these shores have different sediment types and target species.

5.4.2 Medium vulnerability sites

Llanfair yn Neubwll, Y Foryd Bay, Beddmanarch Bay and Gelliswick were identified as having medium vulnerability to bait digging impacts.

Llanfair yn Neubwll

Bait digging occurs across the entire extent of Llanfair yn Neubwll and hence partial closures would not be effective. Licences or permits could be used to regulate bait digging at this site and encourage compliance with codes of conduct. NRW have the option to implement management using a byelaw under Section 28 of the Wildlife and Countryside Act 1981 as Llanfair yn Neubwll is within a SSSI. It is not within a SAC so the implementation of an Order by Welsh Government under Section 40 of the Habitat Regulations would not be appropriate, although management by Welsh Ministers under

the Marine and Coastal Access Act 2009 could be investigated. The site is also subject to increased bait digging intensity in the summer due to holiday trade and increased tourism (NRW pers. comms). With this in mind, seasonal closures could be put in place to limit intense digging during the holiday period.

Y Foryd Bay

Bait digging occurs across the entire extent of the shore at Y Foryd Bay and hence partial closures would not be effective.

Beddmanarch Bay

The southern end of Beddmanarch Bay was inferred as most likely to benefit from management due to the slow recovery of sediment and where digging was more intense due to better site access. Partial closures could be used to protect SSSI features being impacted by bait digging. However, bait digging could then be displaced to south of the bridge where muddy gravels are present. Digging at Beddmanarch Bay could also be displaced to any of the sites within Holyhead or the Cymyran Strait, some of which have been identified as highly vulnerable to the effects of bait digging (Section 5.4.2). NRW have the option to implement this under using a byelaw under Section 28 of the Wildlife and Countryside Act 1981 as Beddmananarch Bay is within a SSSI. It is not within a SAC so the implementation of an Order by Welsh Government under Section 40 of the Habitat Regulations would not be appropriate, although management by Welsh Ministers under the Marine and Coastal Access Act 2009 could be investigated.

Gelliswick

The extent of bait digging was very low at Gelliswick and, along with a relatively fast recovery time of bait digging holes, this site was scored as having medium vulnerability. However, it was stated by Perrins *et al.* (2020) that recent deposition of sand on the shore, potentially from storms, may have led to faster recovery. Further investigations into bait digging at this site may be warranted before management can be considered or implemented.

5.4.3 Low vulnerability sites

Swansea Bay, Sandy Haven and Penrhos were identified as low vulnerability sites. Voluntary codes of conduct could be implemented at all low vulnerability sites to encourage sustainable collection and awareness for potentially sensitive features. These voluntary codes could promote measures such as back-filling of holes.

Swansea Bay

Swansea Bay is a popular tourist beach and therefore seasonal closures under the Seashore Byelaw Set 6 are more likely than other sites to be able to be used during the summer months to manage bait digging for public health and safety. However, further investigation is needed into whether bait digging has the potential to negatively impact health and safety at this site. Disturbance of waders designated under Blackpill SSSI is a

potential issue during the winter months and a seasonal closure may reduce disturbance of these birds. However, Swansea Bay is a large site and bait digging extent is low, thus the level of disturbance on overwintering birds could be minor. Further investigation into bird disturbance could be warranted.

Sandy Haven

Sandy Haven had low bait digging extent and intensity, therefore management may be more difficult to justify. However, biotopes sensitive to bait digging are present at the site and sediments show slow recovery time of bait digging holes. Should bait digging intensity or extent increase the site may benefit from management. Additionally, Sandy Haven overlaps with Milford Haven Waterway SSSI (designated for marine invertebrates, waterbirds, and specialised marine habitats). Management could therefore be considered to protect features from potential increases in bait digging extent and intensity if there is significant displacement of bait diggers from other sites within the Milford Haven area (as mentioned in Section 5.4.1).

Penrhos

Penrhos scored the lowest out of all the sites, and it does not overlap with a SSSI or SAC. Due to the potential low level of impact on this shore and no formal designation, management measures could be difficult to justify.

5.4.4 Measures across all shores

In general, the lack of back-filling of holes has been identified across all sites and is likely leading to increased physical changes to sites (Perrins *et al*., 2020). Lack of back-filling holes can also impact infaunal communities and is potentially hazardous to public safety. Overall, it would likely be beneficial for all shores open to bait digging to have codes of conduct clearly visible on site to encourage back-filling of holes. An all-Wales bait digging code of conduct could also be implemented and promoted at angling events, on signs and on local authority and government websites.

In general, educational boards /signs at the access points to all shores or in car parks, targeted campaigns, leaflets and promotion of codes of conduct at tackle shops have the potential to raise awareness and promote compliance. Providing maps of closed bait digging sites at local tackle shops alongside information on codes of conduct could also be effective. Outreach could focus on the potential damage of bait digging to the shore and the conservation objectives of specific sites. It should be noted that in areas where bait digging is well established, signs may not be read by bait diggers and thus would not be targeting the appropriate audience. Notices on signs could be used to encourage the public to report bait diggers at protected sights. Overall, however, the use of signs can be ineffective for leading to behavioural change.

Further investigation may be needed on the cost-benefit of using such approaches for reducing bait digging at SACs and SSSIs.

Table 3. The potential management measures which apply to specific sites in Wales

Site	Designations	Relevant legislation for management using byelaws and / or orders	Licences and permits	Voluntary codes of conduct	Full area closure	Partial area closure	Seasonal closures	Bag and size limits
Angle Bay	SSSI, SAC, National Park	• Welsh Ministers, under the Marine and Coastal Access Act 2009 / Section 40 of the Habitat Regulations; • NRW under Section 28 of the Wildlife and Countryside Act 1981 / Section 20 of the National Parks and Access to the Countryside Act 1949; • Local Authorities under the Public Health Act Amendment Act 1907 (Seashore byelaws) / Section 90 National Parks and Access to the Countryside Act 1949; and • Welsh Ministers, under Special Nature Conservation Order (SNCO) under regulation 25 of the Habitats Regulations	No	Yes	Yes	No	No	No
Penmon-Beaumaris	SSSI, SAC, AONB	• Welsh Ministers, under the Marine and Coastal Access Act 2009 / Section 40 of the Habitat Regulations; • NRW under Section 28 of the Wildlife and Countryside Act 1981; • Local Authorities under the Public Health Act Amendment Act 1907 (Seashore byelaws) / Section 90 National Parks and Access to the Countryside Act 1949; and • Welsh Ministers, under Special Nature Conservation Order (SNCO) under regulation 25 of the Habitats Regulations	No	Yes	Yes	Yes	No	No

Site	Designations	Relevant legislation for management using byelaws and / or orders	Licences and permits	Voluntary codes of conduct	Full area closure	Partial area closure	Seasonal closures	Bag and size limits
Four Mile Bridge	SSSI, AONB	• Welsh Ministers, under the Marine and Coastal Access Act 2009; • NRW under Section 28 of the Wildlife and Countryside Act 1981; • Local Authorities under the Public Health Act Amendment Act 1907 (Seashore byelaws) / Section 90 National Parks and Access to the Countryside Act 1949	Yes	Yes	No	Yes	Yes	No
Y Foryd Bay	SSSI, SAC	• Welsh Ministers, under the Marine and Coastal Access Act 2009 / Section 40 of the Habitat Regulations; • NRW under Section 28 of the Wildlife and Countryside Act 1981; • Local Authorities under the Public Health Act Amendment Act 1907 (Seashore byelaws); and • Welsh Ministers, under Special Nature Conservation Order (SNCO) under regulation 25 of the Habitats Regulations	No	Yes	Yes	No	No	No
Llanfair yn Neubwll	SSSI, AONB	• Welsh Ministers, under the Marine and Coastal Access Act 2009; • NRW under Section 28 of the Wildlife and Countryside Act 1981; • Local Authorities under the Public Health Act Amendment Act 1907 (Seashore byelaws) / Section 90 National Parks and Access to the Countryside Act 1949	Yes	Yes	No	Yes	Yes	No

Site	Designations	Relevant legislation for management using byelaws and / or orders	Licences and permits	Voluntary codes of conduct	Full area closure	Partial area closure	Seasonal closures	Bag and size limits
Gelliswick	SSSI, SAC	• Welsh Ministers, under the Marine and Coastal Access Act 2009 / Section 40 of the Habitat Regulations; • NRW under Section 28 of the Wildlife and Countryside Act 1981; • Local Authorities under the Public Health Act Amendment Act 1907 (Seashore byelaws) / Section 90 National Parks and Access to the Countryside Act 1949; and • Welsh Ministers, under Special Nature Conservation Order (SNCO) under regulation 25 of the Habitats Regulations	No	Yes	Yes	No	No	No
Beddmanarch Bay	SSSI, AONB	• Welsh Ministers, under the Marine and Coastal Access Act 2009; • NRW under Section 28 of the Wildlife and Countryside Act 1981; • Local Authorities under the Public Health Act Amendment Act 1907 (Seashore byelaws) / Section 90 National Parks and Access to the Countryside Act 1949	Yes	Yes	No	Yes	No	No
Swansea Bay	SSSI	• Welsh Ministers, under the Marine and Coastal Access Act 2009; • NRW under Section 28 of the Wildlife and Countryside Act 1981; • Local Authorities under the Public Health Act Amendment Act 1907 (Seashore byelaws)	Yes	Yes	No	Yes	Yes	Yes

Site	Designations	Relevant legislation for management using byelaws and / or orders	Licences and permits	Voluntary codes of conduct	Full area closure	Partial area closure	Seasonal closures	Bag and size limits
Sandy Haven	SSSI, SAC, National Park	• Welsh Ministers, under the Marine and Coastal Access Act 2009/ Section 40 of the Habitat Regulations; • NRW under Section 28 of the Wildlife and Countryside Act 1981 / Section 20 of the National Parks and Access to the Countryside Act 1949; • Local Authorities under the Public Health Act Amendment Act 1907 (Seashore byelaws) / Section 90 National Parks and Access to the Countryside Act 1949; and • Welsh Ministers, under Special Nature Conservation Order (SNCO) under regulation 25 of the Habitats Regulations	No	Yes	Yes	No	No	Yes
Penrhos	AONB	• Local Authorities under the Public Health Act Amendment Act 1907 (Seashore byelaws) / Section 90 National Parks and Access to the Countryside Act 1949	No	Yes	No	No	No	Yes
Inland Sea	SSSI, AONB	• Welsh Ministers, under the Marine and Coastal Access Act 2009; • NRW under Section 28 of the Wildlife and Countryside Act 1981; • Local Authorities under the Public Health Act Amendment Act 1907 (Seashore byelaws)	Yes	Yes	No	Yes	No	Yes

6 Discussion and Conclusions

The negative impacts of bait digging are well documented and in Wales bait digging has been shown to lead to the deterioration of protected habitats and associated species at some locations. This study aimed to explore potential measures for managing bait digging at 11 sites across Wales.

Undertaking a vulnerability assessment identified three sites; Angle Bay, Four Mile Bridge and Penmon-Beaumaris, as most likely to benefit from management measures to reduce the impacts of bait digging activity on the foreshore. A review of potential management measures highlighted that full or partial closure by means of an order or byelaw has the highest potential to reduce the impact of bait digging on these shores. However, careful consideration is needed concerning the features that require protection at each site and the legal powers for which an order or byelaw can be implemented.

The sites used in this study are known to be key areas for bait digging across Wales. Therefore, any closure of sites or other restrictive management measures of these popular sites could lead to the displacement of bait diggers to other locations. This displacement has the potential to have significant impacts on sites which currently have a low level of bait digging. In particular, this may apply to sites around Holyhead/ Cymyran Strait and Milford Haven where there are multiple suitable bait digging sites within close proximity. It is important to acknowledge therefore that the implementation of management measures may change the results of the vulnerability scoring undertaken in this study.

Voluntary measures can be used at all sites and are often the preferred option for management over statutory measures. They can be an effective mechanism for managing a range of unlicensed activities where guidelines are well defined and have local support. However, in areas where intense bait digging activity or lack of compliance to voluntary measures are known to occur, byelaws or orders may be needed. Byelaws have generally been shown to be more effective than voluntary measures for bait digging/collection and should be easier to enforce.

Several management authorities have implemented a combination of measures to protect sensitive habitats from commercial and recreational activities, including the requirement for licences, seasonal closures and bag and size limits. IFCAs (in England) provide good examples of where in-combination management measures have been successful, however, this is largely due to the ease and speed in which they are able to implement byelaws for the purposes of fisheries management.

Whilst a number of management measures have been identified and recommendations made as part of this study, individual site assessments should be undertaken to consider the implications of such measures before implementation. This should assess likelihood of bait digging displacement and likely compliance and enforcement requirements in the context of the benefits that could be achieved.

6.1 Limitations

As acknowledged in Section 4.3.2, the criteria used to assess site vulnerability were given equal weighting. In practice some criteria could have a greater influence on site vulnerability than others making them more important for scoring the vulnerability of the

sites. Whilst assigning standard pressures to activities has inherent problems (as discussed in Roberts *et al.,* 2020), this method has highlighted key sites likely to benefit most from the introduction of measures to manage the adverse impacts from bait digging.

In addition, the bait digging extent and intensity used in this study to assess vulnerability of the sites were based solely on the data collected by Perrins *et al.* (2020). This study was based on a single time point and thus may not have captured a representative sample of bait digging on each shore. However, the study provides a valuable first insight into bait digging on a range of Welsh shores from which to assess the potential requirements for management measures.

Due to the experimental design in Perrins *et al.* (2020), there was no measure of bait digging hole recovery before 3-4 months. It is acknowledged that recovery at some locations could occur within a few tidal cycles, and therefore future studies should look to return more regularly to better understand recovery times.

Site specific information on bait digging was based on data collected in the winter of 2019/2020. As mentioned in Perrins *et al.* (2020), the winter of 2019/2020 was considered exceptionally stormy in Wales and likely resulted in greater than normal wave action on some sites which resulted in the unusual smoothing of sheltered habitats and the possibility of sedimentation of fine sediments. It is important to note that the impact of bait digging could therefore have been underestimated on some shores.

Importantly, whilst bait digging extent and intensity on each shore, along with a review of shore characteristics can provide a useful indication of the potential vulnerability, the direct impacts of bait digging on the current condition of protected features remains unknown. Relating bait digging extent and intensity to the deterioration of feature condition is ultimately needed to warrant management measures.

For the purposes of the current project, each site boundary was arbitrarily drawn. As bait digging extent was quantified as a proportion of the site over which it occurred, changes to the drawing of the site boundary may alter the estimates used in this study. Further research may be required to more appropriately define the impacted site boundary and therefore the refine extent of digging within that site.

6.2 Future investigations

A range of future studies are recommended in line with increasing the understanding of the impact of bait digging on the Welsh foreshore. Firstly, repeating the bait digging survey by Perrins *et al.* (2020) would allow the potential variability in bait digging extent and intensity at these sites to be better understood. Bait digger effort can change with season across different sites. Equally, Perrins *et al*. (2020) experienced winter storms whilst surveying which may have led to the underestimation of bait digging extent, intensity and sediment recovery time on some shores due to increased wave action. It is therefore important to understand how this variability may affect estimates of bait digging at different times of the year.

Secondly, an investigation is needed to understand the impacts of bait digging on the condition of the protected features of SSSIs and SACs. Evidence that bait digging is leading to the deterioration of feature condition would help justify the implementation of management measures and has the potential to lead to greater uptake by bait diggers.

These impacts have the potential to be influenced by natural variability and the changes in bait digging effort over time (for example with season) and therefore any investigations should examine these temporal trends.

In addition, the assessment of vulnerability within this report focussed on the impact of bait digging on habitat features. It is acknowledged that bait digging has potential to cause disturbance to birds but there is contrasting evidence on the impacts of disturbance from bait diggers on birds. More data are needed on species-specific impacts and on site-specific populations to accurately assess bait digging impacts on a site-by-site basis and therefore inform potential site management measures.

There are very few studies which have evaluated the success of management measures once implemented. Information on the potential recovery of the shore and designated features, displacement of diggers, and general compliance with management measures would greatly inform the likelihood of success of introducing such measures.

Finally, the use of more innovative approaches, such as co-management of bait digging or bait farming, could provide alternative means to manage bait digging activities. Co-management could result in the implementation of regulation supported and co-designed with bait diggers, leading to self-enforcement of regulation and therefore greater sustainability and compliance of management measures. Alternatively, bait farming could help reduce the levels of bait digging around Wales by providing a reliable, year-round, supply of bait. Overall, innovative approaches have the potential to manage bait digging without the need for strict enforcement and should be considered as a management option. Further research into innovative approaches and their applicability and effectiveness from a management perspective should be undertaken prior to implementation. NRW are keen to investigate sustainable ways of managing the bait resource to allow the continued use of preferred bait species for angling whilst also ensuring that protected sites are not damaged.

7 Abbreviations

AONB	Areas of Outstanding Natural Beauty
BBC	British Broadcasting Corporation
CCTV	Closed-Circuit Television
CCW	Countryside Council for Wales
EMS	European Marine Site
GIS	Geographic Information System
HRA	Habitats Regulation Assessment
ICG-C	Intercessional Correspondence Group on Cumulative Effects
IFCA	Inshore Fisheries Conservation Authority
KEIFCA	Kent and Essex Inshore Fisheries Conservation Authority
MarLIN	Marine Life Information Network
MCCA	Marine and Coastal Access Act
MPA	Marine Protected Area
NFSAS	National Anglers Council and Northern Federation of Sea Anglers Society
NGO	Non-Governmental Organisation
NNR	National Nature Reserve
NRW	Natural Resources Wales
NWIFCA	North West Inshore Fisheries Conservation Authority
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic
PhD	Doctorate of Philosophy
SAC	Special Area of Conservation
SNCO	Species Nature Conservation Orders
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
UAV	Unmanned Aerial Vehicle
UK	United Kingdom

8 References

BBC 2013. Stour and Orwell bait-digging code ignored by anglers [online]. Available from: https://www.bbc.co.uk/news/uk-england-22080492 [Accessed August 2021].

Bean E.J and Appleby T.P.S. 2014. Guidelines for Sustainable Intertidal Bait and Seaweed Collection in Wales: Legislative Review. A report to the Pembrokeshire Marine SAC Relevant Authorities Group. University of the West of England: Bristol. 46.

Boyes, S., Burdon, D., and Elliot, M. 2006. Unlicensed activities: A review to consider the threats to marine biodiversity. Defra CRO354 Living Land and Seas Science Division, 97.

Biermann, L., 2020. Assessing the impacts of human disturbance on wildlife: insights from wildfowl on the Exe Estuary. Doctoral Thesis. Bournemouth University.

Carvalho, S., Constantino, R., Cerqueira, M., Pereira, F., Subida, M.D., Drake, P. and Gaspar, M.B. 2013. Short-term impact of bait digging on intertidal macrobenthic assemblages of two south Iberian Atlantic systems. Estuarine, Coastal and Shelf Science 132, 65-76.

Clarke, L.J., Hughes, K.M., Esteves, L.S., Herbert, R.J. and Stillman, R.A. 2017. Intertidal invertebrate harvesting: a meta-analysis of impacts and recovery in an important waterbird prey resource. Marine Ecology Progress Series 584, 229-244.

Cruickshanks, K., Liley, D., Fearnley, H., Stillman, R., Harvell, P., Hoskin, R. and Underhill-Day, J. 2010. Desk Based Study on Recreational Disturbance to birds on the Humber Estuary. Footprint Ecology / Humber Management Scheme. Available from: https://www.humbernature.co.uk/admin/resources/humber-disturbance-report-final-1.pdf [Accessed August 2021].

Department for Environment, Food and Rural Affairs. 2011. IFCA Byelaw Guidance: Guidance on the byelaw making powers and general offence under Part 6, Chapter 1, Sections 155 to 164 of the Marine and Coastal Access Act. Available from: http://www.association-ifca.org.uk/Upload/About/ifca-byelaw-guidance.pdf [Accessed November 2021]

Devon and Severn IFCA. 2019. Managing Hand Working Fishing Activity: A focus on Bait Digging. Available from: http://www.solentems.org.uk/sems/SEMS_Activities/Shore_based_fisheries/Bait%20Digging%20B&PSC%20Supplement%20May%202019%20v2%20.1.pdf [Accessed August 2021].

Duggan-Edwards, M. and Brazier, D.P. 2015. Intertidal SAC monitoring *Zostera noltii* at Angle Bay, Pembrokeshire Marine SAC 2013. Report for NRW. Report No. 55. https://cdn.naturalresources.wales/media/686195/eng-report-055-intertidal-sac-monitoring-zostera-noltii-at-angle-bay-pembrokeshire-marine-sac-2013.pdf [Accessed August 2021].

Environment Agency. 2014. Where does your rod licence money go? [online]. Available from: https://environmentagency.blog.gov.uk/2014/07/17/where-does-your-rod-licence-money-go/ [Accessed August 2021].

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, 34. NRW: Bangor.

Fowler, S.L. 1999. Guidelines for managing the collection of bait and other shoreline animals within UK European marine sites, English Nature (UK Marine SACs Project). Available from: http://ukmpa.marinebiodiversity.org/pdf/Activities/bait.pdf [Accessed August 2021].

Goss-Custard, J.D., Hoppe, C.H., Hood, M.J. and Stillman, R.A., 2020. Disturbance does not have a significant impact on waders in an estuary close to conurbations: importance of overlap between birds and people in time and space. Ibis, 162(3), pp.845-862.

Grant, L. 2020. Bait Digging and Collection of Living Resources in Wales – 2018/2019. Summary Report (Internal only). 1-26.

Hampshire County Council. 2021. Byelaws and general directions [online]. Available from: https://www.hants.gov.uk/thingstodo/riverhamble/waterways/byelaws [Accessed August 2021].

Kent and Essex IFCA. 2021. KEIFCA District Byelaws [online]. Available from: https://www.kentandessex-ifca.gov.uk/i-want-to-find-out-about/regulations/keifca-byelaws/keifca-district-byelaws [Accessed August 2021].

Liley, D., Cruickshanks, K., Waldon, J. and Fearnley, H. 2011. Exe Estuary Disturbance Study. Footprint Ecology. Available from: https://www.footprint-ecology.co.uk/reports/Liley%20et%20al.%20-%202011%20-%20Exe%20Disturbance%20Study.pdf [Accessed August 2021].

Ministry of Housing, Communities and Local Government. 2018. Model byelaw set 6: guidance notes [online]. Available from: https://www.gov.uk/government/publications/the-seashore-model-byelaw-6/the-seashore-model-byelaw-6-guidance-notes. [Accessed November 2021].

Morris-Webb, L., St. John, F. and Jenkins, S. (2021) Understanding the collection of living coastal resources. PhD thesis. Bangor University.

Natural England. 2012. Identifying best practice in management of activities on Marine Protected Areas. Natural England Commissioned Report NERC108. 155.

North East Lincolnshire Council. 2016. Cleethorpes Habitat Management Plan 2016 – 2021. Available from: https://www.nelincs.gov.uk/assets/uploads/2020/09/Cleethorpes-Habitat-Management-Plan-2016-2021.pdf.

North Eastern IFCA. 2019. Appendix 1 – Marine Protected Areas Byelaw 2019. Available from: https://www.eastern-ifca.gov.uk/wp-content/uploads/2019/06/2019_05_15_Item_13_Marine_Protected_Area_Byelaw_2019_draft.pdf.

North Eastern IFCA. 2021. Apply for Permits [online]. Available from: http://www.ne-ifca.gov.uk/apply-for-a-permit/ [Accessed August 2021].

North Western IFCA. 2014. NWIFCA Byelaw 6: protection for European Marine Site features. Available from: https://www.nw-ifca.gov.uk/app/uploads/NWIFCA-Byelaw-6.pdf [Accessed August 2021].

NRW. 2018a. Menai Strait & Conwy Bay / Y Fenai a Bae Conwy Special Area of Conservation Advice provided by Natural Resources Wales in fulfilment of Regulation 37 of the Conservation of Habitats and Species Regulations 2017. pp. 107 [online] Available from: https://naturalresources.wales/media/688114/sac_uk0030202_enreg_37.pdf [Accessed November 2021].

NRW. 2018b. Pembrokeshire Marine / Sir Benfro Forol Special Area of Conservation Advice provided by Natural Resources Wales in fulfilment of Regulation 37 of the Conservation of Habitats and Species Regulations 2017. pp 131 [online] Available from: https://naturalresources.wales/media/691808/pembrokeshire_marine-_reg_37_report.pdf. [Accessed November 2021].

Olive, P.J.W. 1985. Slow grow white ragworm. The Sea Angling Handbook. Winter 85/86. 28-31

Perrins, J., Lush, M., Taylor, T., Holt, R and Bunker, F. 2020. Investigating the location and intensity of bait digging in Wales. NRW Evidence Report Series Report No: 449, 170. NRW: Bangor.

Pittman, J., Gianelli, I. and Defeo, O. 2019. Securing sustainable small-scale fisheries through co-management – the yellow clam fishery in Uruguay. Food and Agriculture Organization of the United Nations. Technical Paper No. 644.

Roberts, C.A., Pearson, A.J., Hull, S.C., and Frost, N.J. 2020. Assessing Sensitivity of Welsh Marine SAC and SPA Features to Non-Licensable Activities. NRW Evidence Report Series Report No: 350, 64. NRW: Bangor.

Southern IFCA. 2013. Southern Inshore Fisheries and Conservation Authority Marine and Coastal Access Act 2009. 2009 C23. Prohibition of Gathering (Sea Fisheries Resources) in Seagrass Beds Byelaw. Available from: https://secure.toolkitfiles.co.uk/clients/25364/sitedata/Redesign/Byelaws/Gathering-Seagrass-Beds-Byelaw-FINAL.pdf [Accessed August 2021].

Southern IFCA. 2014. Southern Inshore Fisheries and Conservation Authority Marine and Coastal Access Act 2009. 2009 C23. Poole Harbour Shellfish Hand Gathering Byelaw. Available from: https://secure.toolkitfiles.co.uk/clients/25364/sitedata/Redesign/Byelaws/PH-Shellfish-Hand-Gathering-v4.0-FINAL.pdf.

Southern IFCA. 2021a. Hand gathering fisheries [online]. Available from: https://www.southern-ifca.gov.uk/district-handgathering [Accessed August 2021].

Southern IFCA. 2021b. Poole Harbour Bait Digging Agreement [online]. Available from: https://secure.toolkitfiles.co.uk/clients/25364/sitedata/Redesign/Codes_of_Practice/Poole-Hrbr-Bait-Digging-Agreement.pdf [Accessed August 2021].

Suffolk Coast & Heaths. 2010. Looking after our Estuaries [online]. Available from: https://www.ipswich.gov.uk/sites/default/files/8898_SCH_Bait_digging.pdfdraft11.pdf [Accessed August 2021].

Thanet Coast Project. 2007. Sandwich and Pegwell Bay National Nature Reserve [online]. Available from: http://www.thanetcoast.org.uk/factfile/thanet-coastal-codes/bait-digging-and-collecting-code/ [Accessed August 2021].

Tinlin-Mackenzie, A., Delany, J., Scott, C.L. and Fitzsimmons, C. 2019. Spatially modelling the suitability, sensitivity, and vulnerability of data poor fisheries with GIS: A case study of the Northumberland lugworm fishery. Marine Policy 109, 103707.

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. Available from: https://sora.unm.edu/sites/default/files/journals/iwsgb/n068/p00047-p00052.pdf [Accessed August 2021].

Watson, G.J., Farrell, P., Stanton, S. and Skidmore, L.C., 2007. Effects of bait collection on *Nereis virens* populations and macrofaunal communities in the Solent, UK. Journal of the Marine Biological Association of the United Kingdom, 87(3), pp.703-716.

Watson, G., 2014. Does local marine conservation work?: a case study of bait collection in the UK. Available from: https://researchportal.port.ac.uk/portal/en/publications/does-local-marine-conservation-work(8e048843-e9ac-4904-a52b-a3a6498ac25a).html [Accessed August 2021].

Watson, G.J., Murray, J.M., Schaefer, M. and Bonner, A. 2015. Successful local marine conservation requires appropriate educational methods and adequate enforcement. Marine Policy 52, 59-67.

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

Welsh Assembly Government. 2011. Inshore fishery legislation (South Wales, 0-6 nautical miles). Available from: https://gov.wales/sites/default/files/publications/2018-05/south-wales-inshore-fishery-legislation.pdf [Accessed August 2021].

Welsh Government. 2021a. Welsh Government Marine Planning Portal [online] Available from: https://lle.gov.wales/home [Accessed January 2022].

Welsh Government. 2021b. Special Nature Conservation Orders and Stop Notices [online]. Available from: https://gov.wales/sites/default/files/pdf-versions/2021/3/4/1614870467/special-nature-conservation-orders-and-stop-notices.pdf. [Accessed November 2021].

Woolmer, A.P. 2010. Provisional review and advice of cockle management in the Burry Inlet. Shellfish Association of Great Britain. Available from: http://www.shellfish.org.uk/files/Literature/Projects-Reports/1005-Cockle_Report-Bury-Inlet-A-Woolmer.pdf [Accessed August 2021].

Xenarios, S., Queiroga, H., Lillebø, A.I. and Aleixo, A. 2018. Introducing a regulatory policy framework of bait fishing in European coastal lagoons: The case of Ria de Aveiro in Portugal. Fishes 3 (1), 2.

9 Appendices

A Evidence Database

Data has been provided to NRW which reviews the extent and intensity of bait digging on Welsh shore to inform potential management of bait digging activity. The data was provided, in Microsoft Excel format, via email on 09/02/2022 and is named R3772_BaitDiggingEvidenceDatabase_100222.xlsx

The data can be requested from NRW quoting metadata number NRW_DS125288.

B Site Characteristics and Biotope Sensitivity

Table B1 Site characteristics and biotope sensitivity (based on Perrins *et al*., 2020 and Grant, 2020)

Site	Biotope	Sensitivity of biotope	Sediment types	Exposure	Target species
Penmon-Beaumaris	LS.LSa.MuSa - Polychaete/bivalve-dominated muddy sand shores. LS.LMu.MEst - Polychaete/bivalve-dominated mid estuarine mud shores. LS.LMu.MEst.HedMacScr - *Hediste diversicolor*, *Macoma balthica* and *Scrobicularia plana* in littoral sandy mud.	High – Medium High – Medium Medium	Muddy sediments Fine muddy sand	Sheltered	*Alitta virens* (King ragworm) across the whole shore *Hediste diversicolor* (Ragworm) across whole shore *Arenicola marina* (Lugworm) towards Beaumaris
Y Foryd Bay	LS.LMu.MEst - Polychaete/bivalve-dominated mid estuarine mud shores. LS.LSa.MuSa - Polychaete/bivalve-dominated muddy sand shores.	High – Medium High – Medium	Fine muddy sand	Very sheltered	*Hediste diversicolor* *Arenicola marina*
Penrhos	LS.LSa.MuSa Polychaete/bivalve-dominated muddy sand shores.	High – Medium	Sand	Fairly sheltered	*Arenicola marina*
Beddmanarch Bay / Cymeran Strait	LS.LMx.GvMu - *Hediste*-dominated gravelly sandy mud shores. LS.LMu.MEst - Polychaete/bivalve-dominated mid estuarine mud shores.	Medium	Fine sandy mud Fine sandy mud with coarse gravel sub-layer	Moderately exposed (outer bay) to very sheltered (bridge area)	*Alitta virens* *Hediste diversicolor*

Site	Biotope	Sensitivity of biotope	Sediment types	Exposure	Target species
Four Mile Bridge	LS.LMx - Littoral mixed sediment.	Medium	Muddy sand with coarse gravel sub-layer	Ultra-sheltered	*Alitta virens* *Hediste diversicolor*
Llanfair yn Neubwll	LS.LMp.LSgr.Znol - *Zostera noltei* beds in littoral muddy sand. LS.LSa.MuSa - Polychaete/bivalve-dominated muddy sand shores. LS.LMx Littoral mixed sediment.	High High – Medium Medium	Cohesive fine muddy sand	Ultra-sheltered	*Alitta virens* *Hediste diversicolor* *Arenicola marina*
Inland Sea	LS.LMp.LSgr.Znol - *Zostera noltei* beds in littoral muddy sand.	High	Muddy sand	Ultra-sheltered	N/A
Sandy Haven	LS.LMx.GvMu.HedMx - *Hediste diversicolor* in littoral gravelly muddy sand and gravelly sandy mud.	Medium	Muddy sand	Extremely sheltered in Pill Sheltered on beach	*Hediste diversicolor* *Arenicola marina*
Gelliswick	LS.LMx - Littoral mixed sediment.	Medium	Fine muddy sand	Sheltered	*Alitta virens* (west side only) *Arenicola marina* (east and west sides)
Angle Bay	LS.LMp.LSgr.Znol - *Zostera noltei* beds in littoral muddy sand. LS.LSa.MuSa.CerPo - *Cerastoderma edule* and polychaetes in littoral muddy sand.	High Medium	Muddy sand Medium to fine sand	Very Sheltered	*Hediste diversicolor* *Arenicola marina*
Swansea Bay (Blackpill)	LS.LSa.FiSa.Po - Polychaetes in littoral fine sand.	Medium	Medium to fine sand and shell	Moderately Exposed	*Arenicola marina*

Table B2 Estimate of the proportion of muddy gravels impacted by bait digging at each site

Site	Site area (ha)	Total area of bait digging (ha)	Extent of muddy gravels (ha)	Extent of bait digging within muddy gravel areas (ha)	Proportion of muddy gravels impacted by bait digging (%)
Penmon-Beaumaris	176	20.1	48.0	2.1	4.4
Y Foryd Estuary	145	29.8	Not present	N/A	N/A
Penrhos Beach	37	0.7	Not present	N/A	N/A
Beddmanarch Bay	338	24.1	Not present	N/A	N/A
Four Mile Bridge	8	0.3	0.5	0.1	17.8
Llanfair yn Neubwll	10	4.6	Not present	N/A	N/A
Inland Sea	4	0	Not present	N/A	N/A
Sandy Haven	47	0.4	Not present	N/A	N/A
Gelliswick Bay	8	0	0.1	0	0
Angle Bay	62	26.5	6.3	2.1	33.2
Swansea Bay	624	8.2	2.0	0	0

C Site Designations

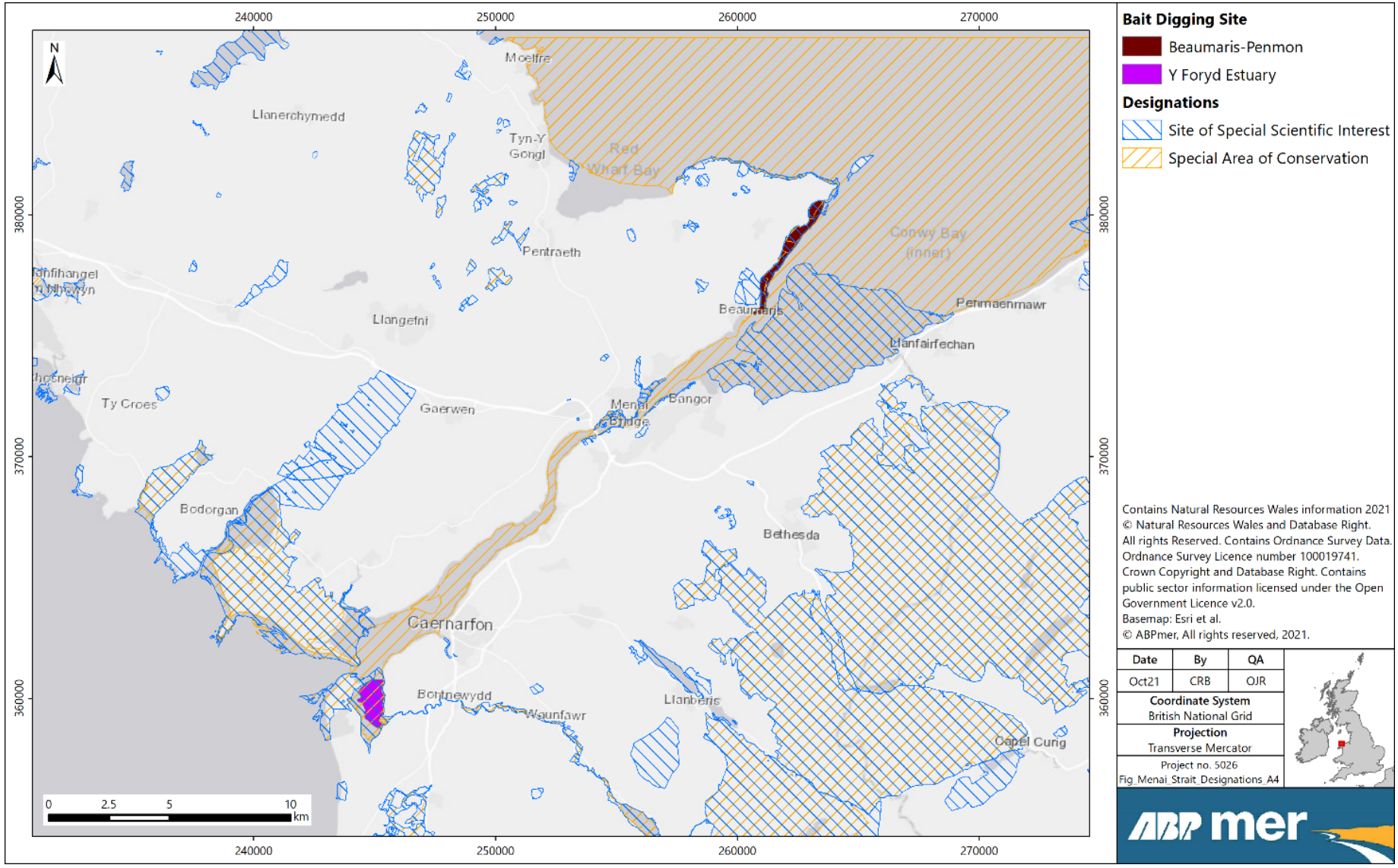

Figure C1 Bait digging sites and their overlap with SSSIs and SACs in the Menai Strait

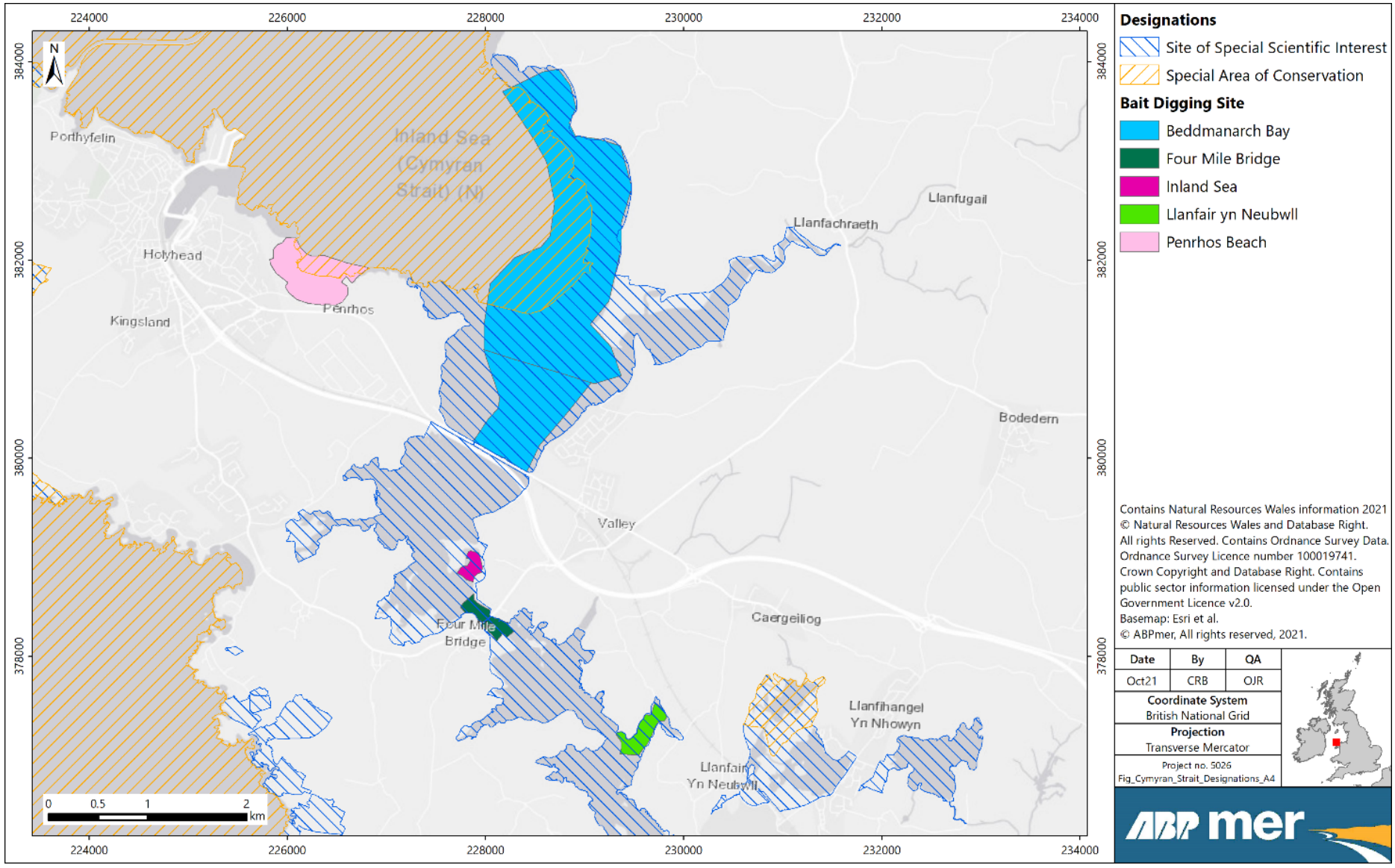

Figure C2 Bait digging sites and their overlap with SSSIs and SACs around Holyhead and the Cymyran Strait

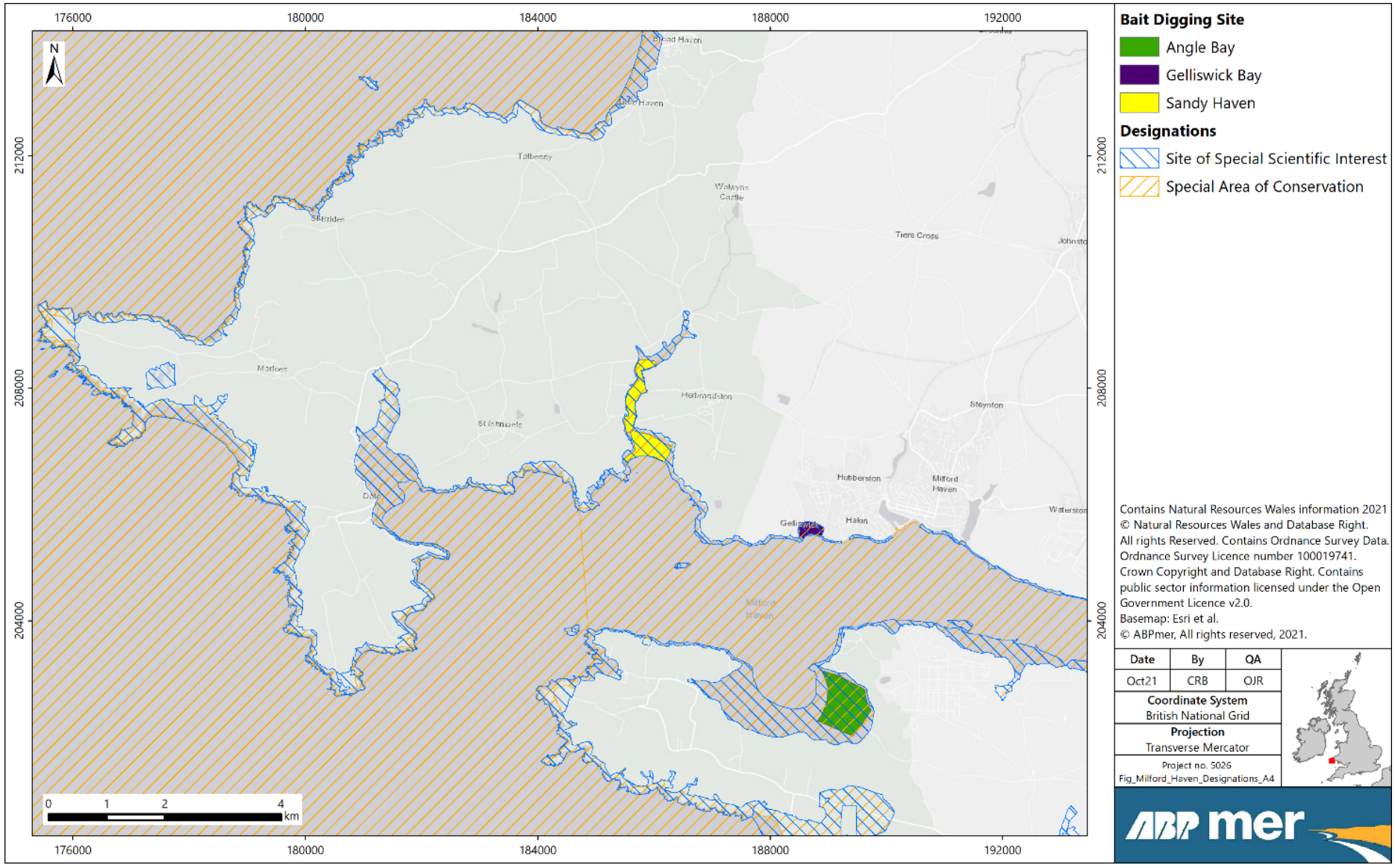

Figure C3 Bait digging sites and their overlap with SSSIs and SACs in Milford Haven

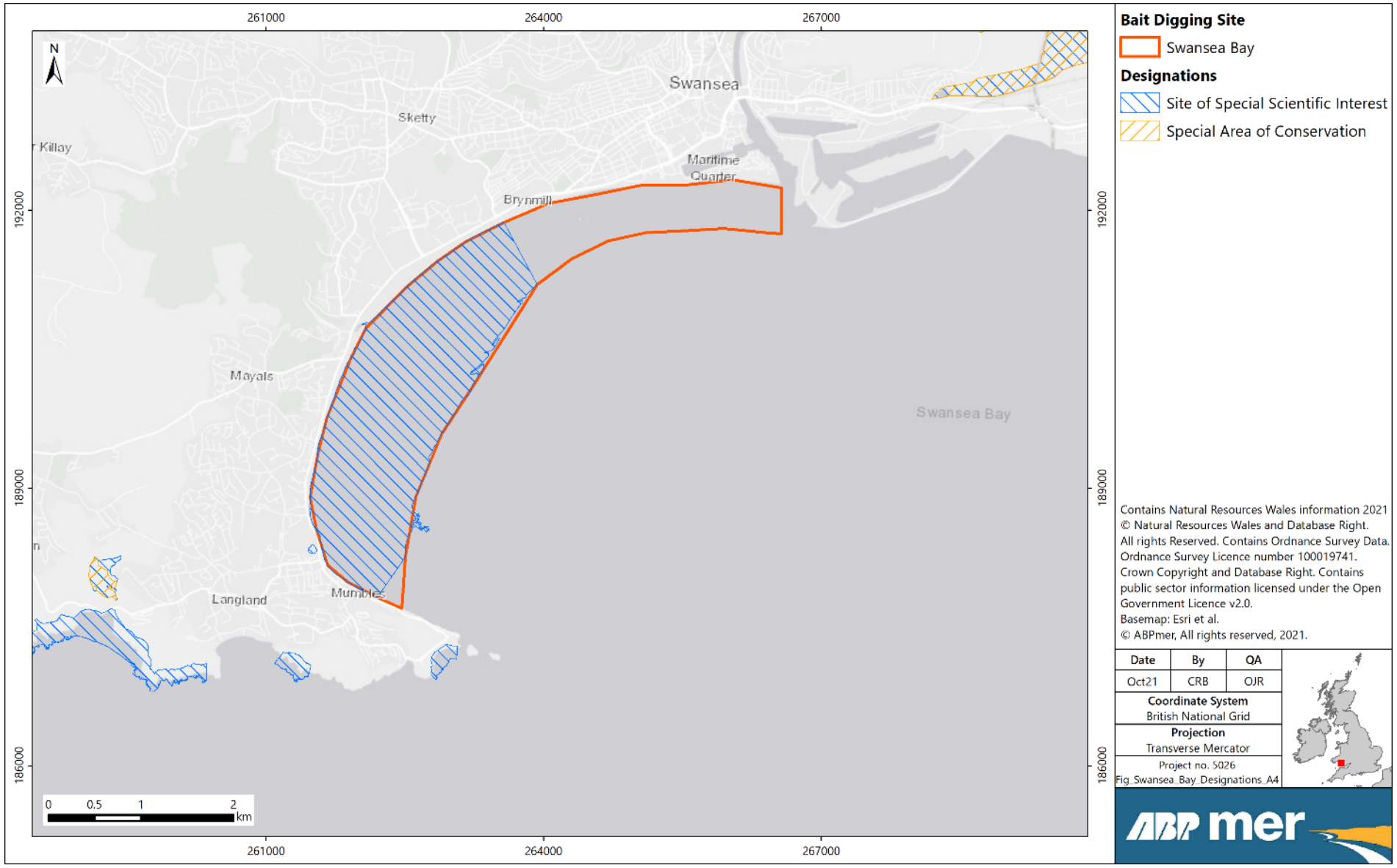

Figure C4 Bait digging sites and their overlap with SSSIs and SACs in the Bristol Channel

Data Archive Appendix

The data archive contains:

[A] The final report in Microsoft Word and Adobe PDF formats.

[B] An Excel spreadsheet [R3772_BaitDiggingEvidenceDatabase_100222.xlsx]

Metadata for this project is publicly accessible through Natural Resources Wales' Library Catalogue https://libcat.naturalresources.wales (English Version) and https://catllyfr.cyfoethnaturiol.cymru (Welsh Version) by searching 'Dataset Titles'. The metadata is held as record no NRW_DS125288.

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