

**Habitats Regulations Assessment document: BNNC SAC – tLSE 021**

<b>European Marine Site:</b>	<b>Berwickshire and North Northumberland Coast SAC</b>
<b>Generic sub-feature(s):</b>	<b>Intertidal mud, Intertidal sand and muddy sand</b>
<b>Gear type(s):</b>	<b>Digging with forks</b>
<b>NIFCA tLSE type:</b>	<b>Detailed</b>
<b>Gear/feature interaction reference(s):</b>	BNNCSAC-470, BNNCSAC-471

<b>Revision history</b>		
<b><i>Date</i></b>	<b><i>Revision</i></b>	<b><i>Editor</i></b>
13/08/2018	Document created	AA
19/09/2018	Mussel beds added as feature	NW
14/09/2021	Salicornia and other annuals, Atlantic salt meadows added as features	BH
17/09/2021	Document drafted	BH
20/09/2021	Document reviewed internally	AA
22/10/2021	Document reviewed. Mussel beds, intertidal coarse sediments, intertidal mixed sediments, Salicornia and other annuals and Atlantic salt meadows moved to Simple tLSE BNNC-tLSE 031	BH
18/01/2022	Document reviewed	CS BH AA
24/02/2022	Document revised.	BH
01/03/2022	Document reviewed	CS BH AA
02/03/2022	Document revised. Annex 3 Figure 4 added, information on adherence to Boulmer Haven byelaw from NIFCA sightings added.	BH
19/4/2023	Reviewed with NE. Annex 5 modified for clarity.	CS AA BH KS
20/4/2023	Document sent to NE for agreement	BH

<b>Has Natural England been formally consulted on this tLSE (and do they agree)?</b>	<b>Yes</b>
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<b>Date of document completion/'sign-off':</b>	<b>27/07/2023</b>
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## Test for Likely Significant Effect (LSE)

### **BNNC SAC – 471, 694 - Intertidal sand and muddy sand (Large shallow inlets and bays (LSIBs) & Mudflats and sandflats not covered by seawater at low tide)**

<p><b>1. Is the activity/activities directly connected with or necessary to the management of the site for nature conservation?</b></p>	<p>No</p>
<p><b>2. What pressures (such as abrasion, disturbance) are potentially exerted by the gear type(s)?</b></p> <p>Pressures listed are all those for which the feature is deemed to be sensitive. Pressures in bold are Medium-High Risk. The sensitivities listed are based on the 2021 Conservation Advice for BNNC SAC available on Natural England’s Designated Site System.</p>	<ul style="list-style-type: none"> <li>• <b>Abrasion/disturbance of the substrate on the surface of the seabed</b></li> <li>• <b>Habitat structure changes - removal of substratum (extraction)</b></li> <li>• <b>Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion</b></li> <li>• <b>Removal of non-target species</b></li> <li>• <b>Removal of target species</b></li> <li>• Deoxygenation</li> <li>• Introduction of light</li> <li>• Introduction or spread of invasive non-indigenous species (INIS)</li> </ul>
<p><b>3. Is the feature potentially exposed to the pressure(s)?</b></p>	<p>Yes</p>

#### 4. What are the conservation objectives for the feature?

Conservation Objectives which may be impacted by bait digging are underlined.

The Conservation Objectives for intertidal sand and muddy sand are to –

Maintain OR Recover OR Restore the abundance of listed species\*, to enable each of them to be a viable component of the habitat.

##### **Maintain:**

- The presence and spatial distribution of intertidal sand and muddy sand communities.
- The total extent of intertidal sand and muddy sand at 2480 ha, and spatial distribution.
- The distribution of sediment composition types across the feature.
- Total organic carbon (TOC) content in the sediment at existing levels.
- The species composition of component communities.
- The presence of topographic features, while allowing for natural responses to hydrodynamic regime, by preventing erosion or deposition through human-induced activity.
- The natural physical energy resulting from waves, tides and other water flows, so that the exposure does not cause alteration to the biotopes and stability, across the habitat.
- The natural physico-chemical properties of the water.
- Sediment transport pathways to and from the feature to ensure the replenishment of habitats that rely on the sediment supply.
- The dissolved oxygen (DO) concentration at levels equating to High Ecological Status (specifically  $\geq 5.7$  mg L<sup>-1</sup> (at 35 salinity) for 95 % of year), avoiding deterioration from existing levels.
- Natural levels of turbidity (e.g. concentrations of suspended sediment, plankton and other material) across the habitat.

##### **Restore:**

- Water quality to mean winter dissolved inorganic nitrogen levels at which biological indicators of eutrophication (opportunistic macroalgal and phytoplankton blooms) do not affect the integrity of the site and features.

##### **Restrict/reduce:**

- The introduction and spread of non-native species and pathogens, and their impacts.
- Surface sediment contaminants (<1cm from the surface) to below the OSPAR Environment Assessment Criteria (EAC) or Effects Range Low (ERL)
- Aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels.

**15. What are the potential effects/impacts of the pressure(s) on the feature, taking into account the exposure level?**

Intertidal sand and muddy sand in the BNNC SAC

The BNNC SAC (Annex 1) contains a very extensive and varied range of intertidal mudflats and sandflats, and large shallow bays important for their biological diversity and extent. These include Lindisfarne (including Fenham Flats and Holy Island sands) and Budle Bay, the most extensive in the northeast of England, as well as Beadnell Bay and Embleton Bay. These habitats range from wave exposed mobile coarse sand to sheltered fine sediments rich in faunal communities. Sediment types range from coarse sand and gravel in more open areas to finer sand and mud in more sheltered locations.

Intertidal sand and muddy sand represents the vast majority of the intertidal sediment within the site (2480 ha), forming wide beaches and sand and mudflats. They range from species-poor pure mobile sandy shores which are dominated by polychaete and oligochaete worms and amphipod communities to more sheltered locations where mud and finer sand accumulate such as the more sheltered area of flat muddy sand in the west of Budle Bay. This allows the features to support a much wider and diverse community, including burrowing infauna such as lugworm, horseshoe worms, and the Baltic tellin. Bait digging is more likely to occur in these sheltered areas.

Bait digging within the BNNC SAC

Bait digging is widely practiced to support both commercial and recreational fishing (Cunha *et al.*, 2005). The primary target species is *A. marina* (blow lug) as this is the most common although *A. defodiens* (black lug) is also targeted as it has a higher value. *A. marina* is commonly found in fine sand and muddy sand, and scarcely, or not found at all, in fine mud, gravel, and coarse sand (Bruce *et al.*, 1963; Longbottom, 1970). *A. defodiens* burrows are deeper (up to a meter) and further down the shore than *A. marina* (Cadman and Nelson-Smith, 1993). Ragworm (*Alitta virens*) are also targeted but on a much smaller scale in Northumberland (Tinlin-Mackenzie, 2018), as it occurs where sediments are finer (more muddy), for example in the Tyne and Blyth estuaries which are not in the BNNC SAC.

The main method used is digging using a fork, but some individuals have been observed using a spade. More experienced or local commercial collectors may dig trenches while less experienced or recreational collectors dig more scattered holes and are less likely to backfill them. Both species of lugworms and ragworm can be collected using a fork to dig them out of the sediment, however, only *A. defodiens* can be extracted by the use of a bait pump, which extracts with suction (Cadman and Nelson-Smith, 1993;

Brind and Darbyshire, 2015). The use of pumps by collectors has also been recorded throughout monitoring by NIFCA officers although are less popular as they are not as flexible as digging, can be difficult to use and can only target one species (Tinlin-Mackenzie, 2018).

Though covered by extensive sand and mudflats, bait digging only occurs at a few locations within the BNNC SAC. Tinlin-Mackenzie (2018) found Boulmer and Newton were popular sites with more collection in the southern part of the BNNC due to greater population density, with some collectors coming from Sunderland. Foxton also had small amounts of collection based on observation of a single day.

The increased value of and demand for lugworm as bait in the autumn and winter months (Fowler, 1999) means activity is concentrated at this time of year. Spring tides are favoured as a larger area of shore is exposed, and the body size of lugworms is thought to increase lower down the shore (Tinlin-Mackenzie, 2018). *A. defodiens* is only exposed by the lowest tides (Fowler, 1999) so bait pumping can only occur at these times (Tinlin-Mackenzie, 2018). Some collection does occur at neap tides but at a lower frequency and intensity, with some known commercial operators collecting at all tidal states despite conditions not being ideal (Tinlin-Mackenzie, 2018).

Tinlin-Mackenzie (2018) carried out a questionnaire on bait collectors in the BNNC SAC. 14% of questionnaire respondents in the BNNC stated they were commercial collectors. Commercial collectors harvest more intensively – higher quantities, longer durations, and with greater frequency. Commercial collectors took an average of 400 lugworms per trip while recreational collectors took an average of 94 (Tinlin-Mackenzie, 2018). Due to the differences in amounts collected, commercial collectors are estimated to harvest over 70% of the total lugworms harvested within the BNNC SAC.

Existing management of bait digging within the BNNC SAC includes prohibition in the Lindisfarne NNR to all types of bait collection except in a voluntary bait collection zone for bait digging for recreational use (Annex 2). Compliance is generally thought to be high in this area although the level of night-time exploitation is unknown (Tinlin-Mackenzie, 2018). The NIFCA Seagrass Protection byelaw protects seagrass within the BNNC SAC from hand and mechanical gathering activities including within the voluntary bait collection zone. The closure of the LNNR in 1982 led to displacement of the activity to other locations, namely Boulmer Haven and Newton (Fowler, 1999). An Alnwick District Council byelaw prohibits bait digging in the northern half of Boulmer

Haven, while the National Trust have a byelaw prohibiting bait collection for all NT-owned intertidal areas – at Newton – however these are not currently enforced as attempted prosecutions in the past have not been successful. The byelaw at Boulmer is more adhered to because it was introduced as a safety measure for fishers who launch from the beach (Tinlin-Mackenzie, 2018). Bait digging is seen at both sites, particularly Boulmer, despite legislative restrictions and substantial collection occurs at night, with the majority of collection at Newton during the night (Tinlin-Mackenzie, 2018).

#### NIFCA bait digging sightings in the BNNC SAC

NIFCA officers record sightings of intertidal hand work activity observed during routine patrols when a site visit coincides with low water ( $\pm 2$  hours). Between 2016 and October 2021, 104 patrols were made to locations within the BNNC SAC with bait digging observed on 37% of patrols. 44 sightings of bait digging activity and a total of 181 bait diggers were observed with a mean of 4 individuals per sighting.

Sightings from NIFCA patrols occurred at four locations within the BNNC SAC: Little Beach at Berwick, Newton, and two close together at Boulmer Haven and Seaton Point (for map see Annex 3 Figure 1). Bait digging hotspots for the whole NIFCA district were classified as High, Medium, Low and Very Low activity based on NIFCA patrol sightings data on the average number of individuals bait digging per NIFCA patrol to each area (see Annex 3 Table 1 for more information) where High  $\geq 1$  individual/patrol, Medium  $\geq 0.5$ , Low  $\geq 0.1$  and Very Low  $< 0.1$ . Classifications were checked against officers' knowledge. Berwick and Boulmer Haven had High levels of activity while Newton and Seaton Point had Low. Patrols are generally in daylight hours apart from a few targeted patrols to the LNNR to check adherence to the NE bait collection byelaw.

Based on officer input, locations with no sightings of bait digging were also categorised. Within the LNNR there were 12 recordings of 'no activity' and none of bait digging (see Annex 3 Figure 2) therefore it does not occur as much as at other sites, although there are less patrols to the area. Targeted NIFCA patrols for illegal bait digging including during the night have not recorded incidences of bait digging activity within the LNNR so this activity is probably quite rare. Fenham Flats and Budle Bay were therefore classified as Very Low levels of activity. Beadnell Bay and a section of beach between Beadnell and Seahouses, which are more rarely patrolled were classified as Low activity though with some degree of uncertainty.

Bait digging activity sightings were greatest from September to December, with an increase in both the number of sightings and the number of individuals per sighting (Annex 3 Figure 3). The highest number recorded at one time within the BNNC was 27 individuals in October 2020 in Berwick.

Bait digging sightings corresponded with Eunis habitat classification of 'littoral sand and muddy sand' at both Berwick and Boulmer (Annex 3 Figure 1). Designated Sites however describes mudflats at Boulmer Haven with slightly coarser and cleaner muddy sand lower on the same shore, indicating a mix of intertidal mud and intertidal sand and muddy sand features at Boulmer.

Additional data from Berwick Coastwatch 2019-21 confirms that at Berwick bait digging is highest from August to October (slightly earlier than indicated by NIFCA sightings) with an average of 5-7 individuals per sighting while the average for the remaining months surveyed was 1.75 individuals. The maximum number of individuals was 27 in October 2020 (which matches NIFCA data) followed by 18 in August 2019 showing these levels of collection are quite rare, perhaps just on the biggest spring tide of the year in autumn.

Bait digging (specifically digging with forks) is limited at Boulmer Haven due to an Alnwick District Council byelaw which prohibits bait digging in the northern half of bay. The byelaw was put in place to ensure the safety of boat users at Boulmer who use trailers to get their boats to the sea. The holes left by bait diggers posed a safety risk. Bait pumping is allowed within the prohibited area. NIFCA sightings from 2016-21 show that both digging with forks and bait pumping occur within the prohibited area, with a quarter of digging sightings occurring in the prohibited area (Annex 3 Figure 4). This confirms the suspected non-adherence to the byelaw which is unenforced, although could show that many individuals do avoid the area and dig mainly in the south. It should also be noted the positional accuracy of NIFCA sightings in addition to the prohibited area means this is just a rough estimate of numbers.

#### Physical impacts of bait digging

Bait digging can occur to depths of up to 30-40cm, unearthing a deeper sediment that would usually remain undisturbed (Jackson and James, 1979). Changes can therefore occur in sediment characteristics as a result of bait digging. A study within the BNNC (Tinlin-Mackenzie, 2018) found sediment characteristics were altered as a result of experimental digging, with deeper anoxic sediments transported to the surface and still visible three weeks later, and sediment penetrability and softness also altered.

Exposure of anoxic sediment layers can lead to reduced oxygen availability in surface sediments.

Undisturbed sediment has a higher organic content as digging can reduce the amount of organic matter within the sediment (Watson *et al.*, 2017). In unexploited sediments, a 10cm layer of well-mixed sand is created by bioturbation (primarily by lugworms), overlying a layer of sands and shell (Anderson and Meyer, 1986). The turning over of sediment by bait diggers and erosion of sediment mounds by tides and wave action leads to a loss of finer fractions and associated organic material. In contrast, the depressions from holes dug may accumulate fine sediments and organic matter resulting in an organically rich anoxic layer at the bottom of the depression (Fowler, 1999, Watson *et al.*, 2017; Anderson and Meyer, 1986). This could have implications for local sediment load and turbidity levels (Watson *et al.*, 2017). High turbidity can lead to a drop in dissolved oxygen, especially in warmer months, while long-term changes in turbidity can have a range of biological effects such as affecting fish health or clogging the filtering organs of suspension feeding animals, which can in turn adversely affect bird species.

Recovery rates of the sediment from bait digging are highly variable, depending on site characteristics such as habitat type, energy of the site (higher energy, more coarse sediments recover more quickly) as well as behaviour of bait diggers themselves (backfilling of holes significantly reduces impacts to the sediment).

There is local evidence of bait digging impacts on sediments. Howell (1985) found large increases in heavy metals lead and cadmium in the surface layers of Budle Bay caused by intensive bait digging (>50 people) and the exposure of anoxic sediments causing these to become bioavailable. Tinlin-Mackenzie (2018) simulated digging disturbance at Fenham Flats (LNNR) and found sediment characteristics were noticeably altered during treatments until the next treatment three weeks later, with anoxic sediments brought to the surface and changes to sediment penetrability and softness. The more sheltered intertidal mud flats at Budle Bay and Fenham Flats might be expected to have slower recovery rates than other locations within the BNNC SAC. For example, Blake (1979) reported holes at Whitley Bay (to the south of the SAC) were re-filled by mud and fine sand within about 2 days of digging which suggests that sediment may be more resilient at this location and potentially other areas with coarser, more sandy sediment than within the LNNR.

#### Biological impacts on communities

Bait digging causes mortality in lugworm populations, which can lead to reduced abundance and stock declines (Blake, 1979;



Beukema, 1995). Relative to other exploited intertidal invertebrates, blow lugworm (*A. marina*) are relatively resilient to exploitation and disturbance because of their relative fecundity and widespread distribution (Fowler, 1999). However, a wide range of responses by *A. marina* to exploitation have been found, relating to local environmental conditions and the intensity and distribution of bait digging activity. Stocks may be more seriously impacted by digging if they are isolated (e.g. small pocket beaches), as recruitment and migration of nearby stocks may not be possible (Fowler, 1999).

*A. defodiens* may be more resilient to bait collection than *A. marina* because of its subtidally extending distribution. This subtidal part of the population is not accessible to harvesters (Fowler, 1999), and therefore could act as a refuge, allowing continued recruitment and the migration of adult worms into disturbed areas (Rees and Eleftheriou, 1989; Spikes, 1993).

Lugworms are bioturbators and their removal can cause habitat alterations with knock-on impacts on other species (Tinlin-Mackenzie, 2018). Bait digging can cause physical damage, burial, smothering and/or exposure to desiccation or predation to non-target invertebrates (Chandrasekara and Frid, 1998; Fowler, 1999). While generally invertebrate biomass decreases, invertebrate communities impacted by bait digging vary substantially in their responses and recovery rates while some species are more sensitive than others to bait digging. Recovery of small short-lived invertebrates will usually occur within a year but populations of larger, long-lived invertebrates such as large bivalves and burrowing echinoderms may take much longer (Fowler 1999; Beukema, 1995). Reductions in invertebrate biomass can lead to a loss of prey for other species, especially birds (Van den Heiligenberg, 1987; Bowgen *et al.*, 2015).

Tinlin-Mackenzie (2018) studied impacts of bait digging on infaunal communities within the BNNC. Tinlin-Mackenzie compared three sites in the BNNC with different levels of collection: uncollected (Holy Island), low (Newton – average of 0.29 collectors per visit), and high collection (Boulmer – average 6.56 collectors). Lugworm densities and species richness were not related to collection pressure however the high collection site had less than half the average infaunal abundance of the other sites, despite it being a muddier site expected to have higher infaunal abundance, which could indicate long-term secondary impacts of bait digging. However, baseline data were not available to measure changes over time. Tinlin-Mackenzie also found an experimental reduction in lugworm abundance in dug plots compared to controls, with a recovery time of <11 weeks in low intensity plots but incomplete recovery in the high intensity plots. Other invertebrate species

were significantly impacted although recovered well after 11 weeks, after cessation of digging (which may not happen in real life).

Bird disturbance through visual and/or noise disturbance is one of the most serious impacts of bait collection (Davidson and Rothwell, 1993). Disturbance leads to birds searching for new feeding areas, increasing energy expenditure and food competition, and ultimately increasing winter mortality rates in some cases (West et al., 2002; Masero et al., 2008). Peak bait worm demand in winter coincides with the presence of overwintering and migrating populations of wildfowl and waders with international importance (Townshend and O'Connor, 1993). Bird disturbance is assessed in more detail in the Northumbria Coast SPA Detailed tLSE (NCSPA - tLSE 037 - Digging with forks) with a focus on purple sandpiper and turnstone. Disturbance will differ for different species, in the same species between different places and even the same individual at different times. In many locations bait digging is small scale (1-2 individuals) however where it occurs at higher intensity there is potential for disturbance for the birds feeding or loafing on the sand and mud.

Space for Shorebirds monitor bird disturbance events in Northumberland (Seaton Sluice to Berwick), recording species disturbed and activities causing disturbance. In 2020-21 they recorded 590 potential disturbance events (PDEs) of which almost half (47%) were caused by dog walkers while 39% were just walkers. 3% were caused by rockpooling or exploring the intertidal, while only a single disturbance event was caused by bait digging or gathering, and this was recorded on rock so was not bait digging. This highlights the relative importance of recreational activities in causing bird disturbance, compared to bait digging.

#### Vulnerability of habitats in the BNNC to bait digging

Tinlin-Mackenzie (2018) characterised sediments within the BNNC according to their sensitivity to bait digging based on habitat and sediment type (with muddy areas being more sensitive), and importance to birds (based on being within an SPA). Vulnerability is a measure of sensitivity combined with exposure to an impact. A habitat is vulnerable when it is both sensitive to the activity and the activity is likely to occur there.

Tinlin-Mackenzie (2018) found the most sensitive areas were inside the LNNR at Fenham Flats and Budle Bay, and were classified as having extremely high vulnerability as well as parts of Boulmer and Newton (see Annex 4). At Newton and Boulmer the impacts of each collection event may be smaller, with faster recovery, but they are likely to occur more often leading to a larger cumulative impact. Other areas of very high or high

	<p>vulnerability were the north and upper shores at Boulmer, Newton lower shore, Berwick shore to the north of the pier and stretches near Seahouses.</p> <p>Tinlin-Mackenzie (2018) concluded that although the majority of the vulnerable habitats in the BNNC SAC are protected from bait digging, there are exceptions at Berwick, Boulmer and Newton which are not currently protected (or protections are not enforced).</p> <p><u>Conclusions</u> Overall bait digging only occurs in a small proportion of the BNNC SAC and is therefore unlikely to have impacts on a site-wide level, especially because the majority of the intertidal habitats suitable for bait digging are protected in the LNNR. However there are small areas of higher intensity activity where impacts may occur.</p> <p>Annex 5 summarises differences between locations in the BNNC in terms of collection pressure, vulnerability, existing management and knowledge of impacts. Areas in the LNNR – Fenham Flats and Budle Bay – which are the most vulnerable to bait digging impacts, have low levels of collection, due to Natural England regulations, even within the voluntary bait digging zone. Newton has also been classified as low collection pressure (Tinlin-Mackenzie, 2018) and the lugworm populations and infaunal community are similar to those at a Fenham Flats. There are two sites, Berwick and Boulmer, where high collection intensity corresponds with high sediment vulnerability and either no restrictions or unenforced byelaws mean collection is not managed.</p> <p><b>NIFCA conclude with moderate confidence that this activity will not adversely impact the conservation objectives of the site, through the pressures listed above, at areas of low collection pressure. Bait digging is already prohibited in the most sensitive areas of the BNNC SAC, e.g. the LNNR. Areas classified as high collection will be taken to Appropriate Assessment.</b></p>
<p><b>6. Condition and Conservation Objective Inferences</b></p>	<p>No information on the condition of the BNNC SAC features are available on Natural England’s Designated Sites System.</p> <p>However, in relation to maintaining the total habitat extent of intertidal sand and muddy sand it states ‘there is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities’ (2010/15 Condition Monitoring Reports LSIBs; <u>Designated Sites System</u>).</p>

<p><b>7. Is the potential scale or magnitude of any effect likely to be significant?</b></p>	<p><b>Alone:</b>                  Low collection pressure areas: no                  High collection pressure areas: yes                   (See Annex 5).</p>	<p><b>OR In-combination</b>  <b>Uncertain.</b>                  Recreational activities leading to trampling of sediments could have an impact on sediment features, particularly in 'High' collection pressure areas. However, this will be much smaller than impacts from bait digging itself. See Annex 6.</p>
<p><b>8. Have NE been consulted on this LSE test? If yes, what was NE's advice?</b></p>	<p>Yes. Collaborative discussions between NIFCA and NE have occurred since 2018.</p>	

## Conclusion

### Is the proposal likely to have a significant effect 'alone or in combination' on the BNNC SAC?

Uncertain.

Bait digging is already prohibited in the most sensitive areas of the BNNC SAC, e.g. the LNNR.

NIFCA have concluded that in Low collection pressure areas where the activity is alone or in combination with other plans or projects, bait digging impacts are unlikely to have a significant impact on the site features of intertidal sand and muddy sand.

However, it is unknown whether impacts are significant in areas of Medium-High collection pressure (Berwick, Boulmer and Newton) therefore for these areas NIFCA will conduct an Appropriate Assessment. Effort will continue to be monitored at all sites within the BNNC SAC to ensure any changes in bait digging collection pressure are monitored. Changes in effort will be recorded in the Bait Digging Monitoring and Control plan with management put in place, if appropriate.

## Test for Likely Significant Effect (LSE)

### **BNNC SAC – 470 - Intertidal mud (Sub-feature of Mudflats and sandflats not covered by seawater at low tide)**

<p><b>1. Is the activity/activities directly connected with or necessary to the management of the site for nature conservation?</b></p>	<p>No</p>
<p><b>2. What pressures (such as abrasion, disturbance) are potentially exerted by the gear type(s)?</b></p> <p>Pressures listed are all those for which the feature is deemed to be sensitive. Pressures in bold are Medium-High Risk. The sensitivities listed are based on the 2021 conservation Advice for BNNC SAC available on Natural England’s Designated Site System.</p>	<ul style="list-style-type: none"> <li>• <b>Abrasion/disturbance of the substrate on the surface of the seabed</b></li> <li>• <b>Habitat structure changes - removal of substratum (extraction)</b></li> <li>• <b>Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion</b></li> <li>• <b>Removal of non-target species</b></li> <li>• <b>Removal of target species</b></li> <li>• Introduction or spread of invasive non-indigenous species (INIS)</li> </ul>
<p><b>3. Is the feature potentially exposed to the pressure(s)?</b></p>	<p>Yes</p>

#### 4. What are the conservation objectives for the feature?

Conservation Objectives which may be impacted by bait digging are underlined.

The Conservation Objectives for intertidal mud are to – Maintain OR Recover OR Restore the abundance of listed species\*, to enable each of them to be a viable component of the habitat.

##### **Maintain:**

- The presence and spatial distribution of intertidal mud communities.
- The total extent of intertidal mud at 101 ha, and spatial distribution.
- The distribution of sediment composition types across the feature.
- Total organic carbon (TOC) content in the sediment at existing levels.
- The species composition of component communities.
- The presence of topographic features, while allowing for natural responses to hydrodynamic regime, by preventing erosion or deposition through human-induced activity.
- The natural physical energy resulting from waves, tides and other water flows, so that the exposure does not cause alteration to the biotopes and stability, across the habitat.
- The natural physico-chemical properties of the water.
- Sediment transport pathways to and from the feature to ensure the replenishment of habitats that rely on the sediment supply.
- The dissolved oxygen (DO) concentration at levels equating to High Ecological Status (specifically  $\geq 5.7 \text{ mg L}^{-1}$  (at 35 salinity) for 95 % of year), avoiding deterioration from existing levels.
- Natural levels of turbidity (eg concentrations of suspended sediment, plankton and other material) across the habitat.

##### **Restore:**

- Water quality to mean winter dissolved inorganic nitrogen levels at which biological indicators of eutrophication (opportunistic macroalgal and phytoplankton blooms) do not affect the integrity of the site and features.

##### **Restrict/reduce:**

- The introduction and spread of non-native species and pathogens, and their impacts.
- Surface sediment contaminants (<1cm from the surface) to below the OSPAR Environment Assessment Criteria (EAC) or Effects Range Low (ERL)
- Aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels.

**5. What are the potential effects/impacts of the pressure(s) on the feature, taking into account the exposure level?**

Intertidal mud in the BNNC SAC

Intertidal mud occurs in the most sheltered, stable coastal inlets where fine sediments accumulate and covers a relatively small proportion of BNNC (101 ha). This habitat includes Fenham Flats at Lindisfarne and Budle Bay as well as the relatively smaller but more species-rich mudflats at Boulmer Haven where lugworms are abundant. Little Beach at Berwick may also have some finer sediments though is mainly muddy sand/sandy mud. The habitat is a nutrient rich, productive habitat with huge numbers of relatively few species, principally ragworms and lugworms, bivalve molluscs and snails and also supports the largest eelgrass beds on the east coast as well as internationally important bird species.

Vulnerability of intertidal mud to bait digging

The impacts of bait digging can be greatest on sheltered intertidal habitats, particularly inlets and harbours, where muddy sediments that have been overturned are slow to recover from disturbance (Fowler, 1999). Experimentally dug plots in a very sheltered location in the Menai Strait were still visible after a year, although this is thought to be due to the presence of boulder clay (Johnson, 1984). Other, less sheltered, sites have reported a timeframe of 25 days for holes to disappear (Johnson, 1984).

Impacts of bait digging on intertidal mud features may therefore be greater than intertidal sand and muddy sand, which was taken into account in the analysis of vulnerability by Tinlin-Mackenzie (2018) which identified the most vulnerable areas in BNNC SAC to bait digging. Intertidal mud occurs at Fenham Flats, Budle Bay and parts of the shore at Boulmer Haven making these extremely vulnerable to bait digging impacts. Annex 5 summarises differences between locations in the BNNC in terms of collection pressure, vulnerability, existing management and knowledge of impacts (see above for description).

**NIFCA conclude with moderate confidence that this activity will not adversely impact the conservation objectives of the site, through the pressures listed above, at areas of low collection pressure. Areas classified as high collection (Boulmer Haven, Berwick, Newton) will be taken to Appropriate Assessment.**

<p><b>6. Condition and Conservation Objective Inferences</b></p>	<p>No information on the condition of the BNNC SAC features are available on Natural England’s Designated Site System.</p> <p>However, in relation to maintaining the total habitat extent of intertidal mud it states ‘there is evidence from survey or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities’.</p> <p>It also states ‘The extent of intertidal mud in some locations with Lindisfarne has been decreasing due to an increase in saltmarsh accretion, this could be a result of anthropogenic processes or non-anthropogenic processes (and combination of both). Further investigation is required.’ This reduction in extent is highly unlikely to be related to bait digging.</p>	
<p><b>7. Is the potential scale or magnitude of any effect likely to be significant?</b></p>	<p><b>Alone:</b>                  Low collection pressure areas: no                  High collection pressure areas: yes                    (See Annex 5).</p>	<p><b>OR In-combination Uncertain.</b>                  Recreational activities leading to trampling of sediments could have an impact on sediment features, particularly in ‘High’ collection pressure areas. However, this will be much smaller than impacts from bait digging itself. See Annex 6.</p>
<p><b>8. Have NE been consulted on this LSE test? If yes, what was NE’s advice?</b></p>	<p>Yes. NE and NIFCA have worked collaboratively on the assessment since 2018.</p>	

## Conclusion

### Is the proposal likely to have a significant effect 'alone or in combination' on the BNNC SAC?

Uncertain.

Bait digging is already prohibited in the most sensitive areas of the BNNC SAC, e.g. the LNNR.

NIFCA have concluded that in Low collection pressure areas where the activity is alone or in combination with other plans or projects, bait digging impacts are unlikely to have a significant impact on the site features of intertidal sand and muddy sand.

However it is unknown whether impacts are significant in areas of Medium-High collection pressure (Boulmer Haven, Berwick) therefore for these areas NIFCA will conduct an Appropriate

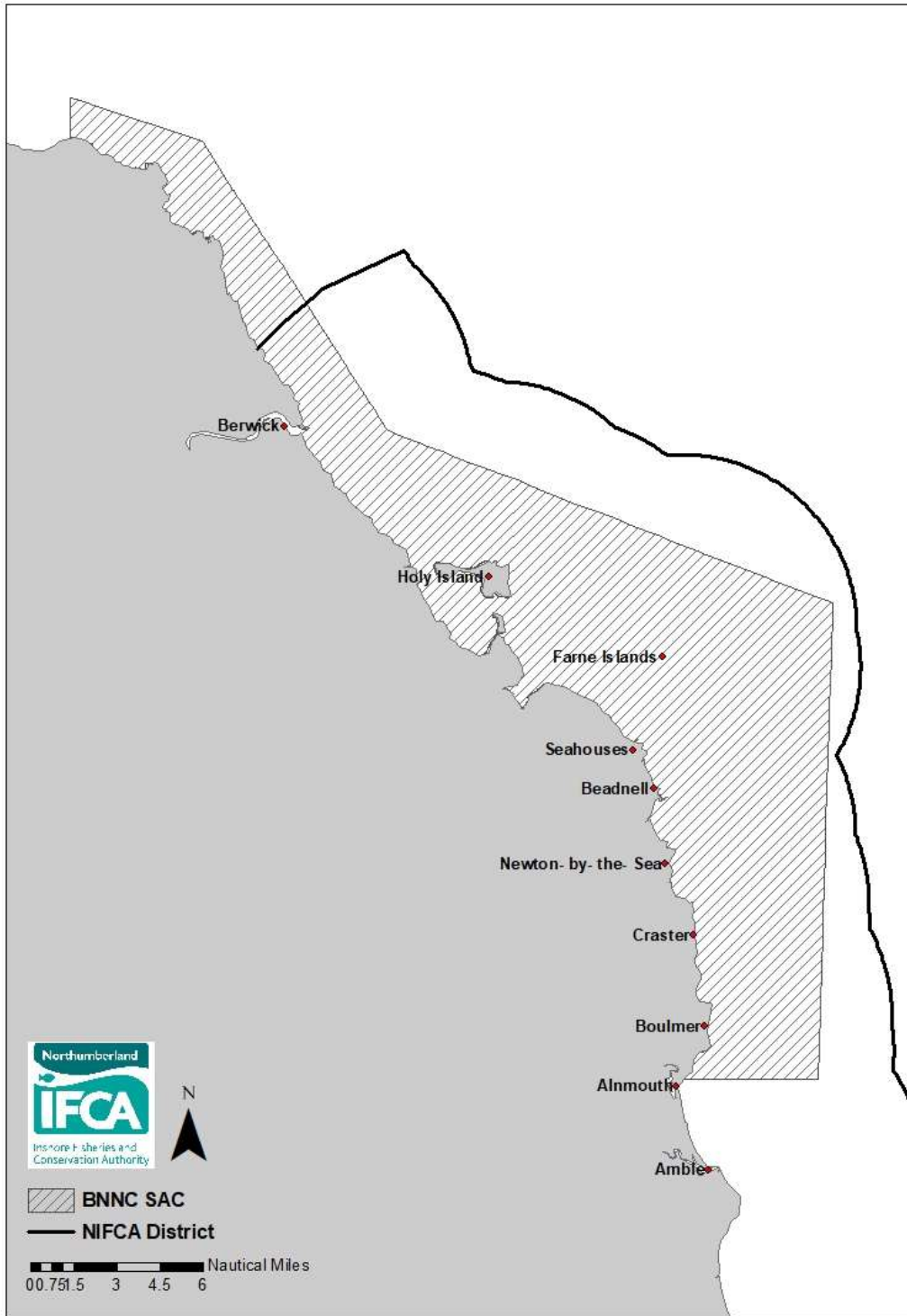


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Assessment. Effort will continue to be monitored at all sites within the BNNC SAC to ensure any changes in bait digging collection pressure are monitored. Changes in effort will be recorded in the NIFCA Bait Digging Monitoring and Control plan, with management put in place if appropriate.

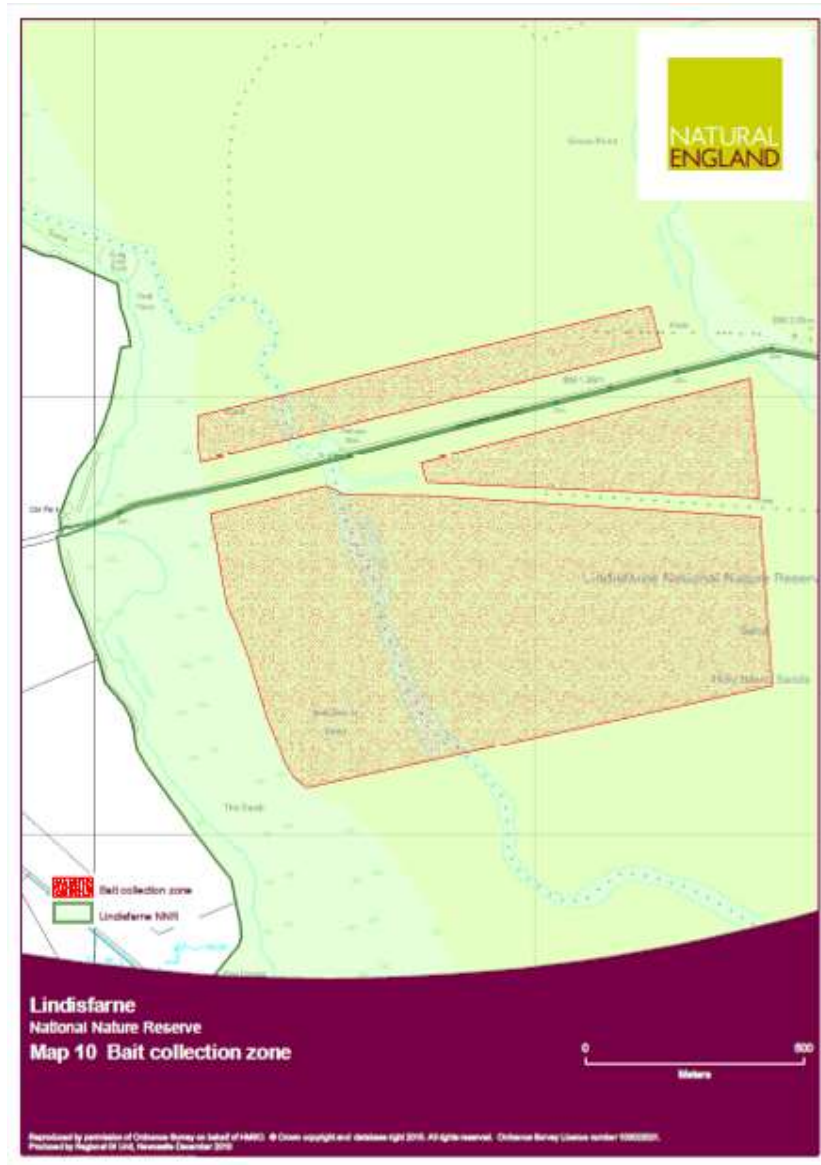
Annex 1

Map of Berwickshire and North Northumberland Coast SAC showing NIFCA district.



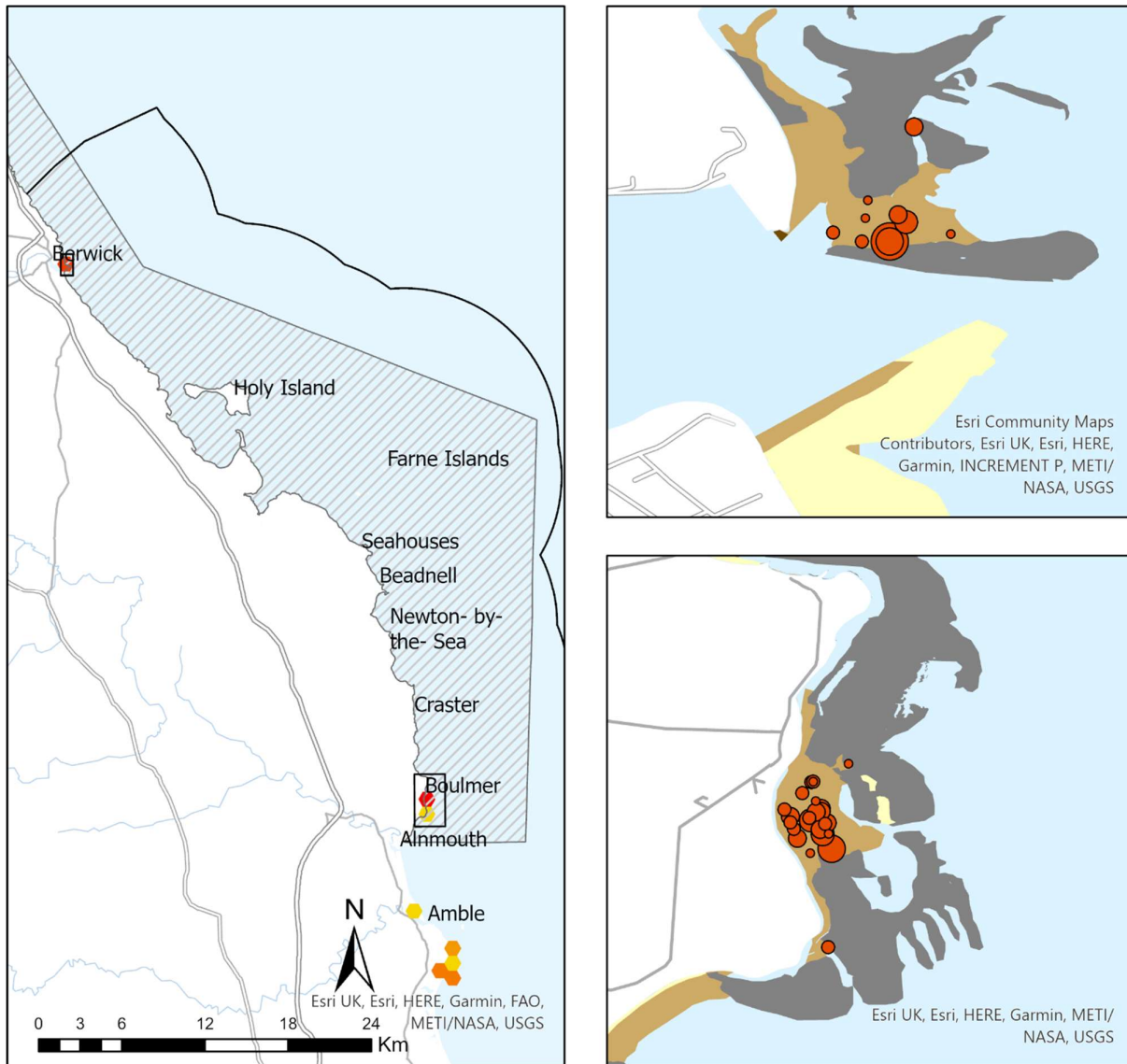
## Annex 2

Natural England voluntary bait collection zone at Lindisfarne National Nature Reserve.

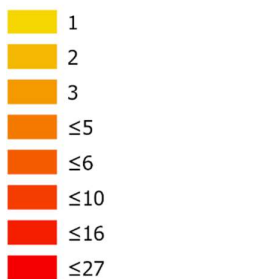


### Annex 3 NIFCA Patrols Sightings of Bait Digging Activity

**Figure 1.** Number of bait digging sightings within the BNNC SAC from NIFCA patrols from 2016-20 showing sighting hotspots at Berwick and Boulmer in areas of sand and muddy sand. There was a single sighting at Newton in 2021 which is not on the map.

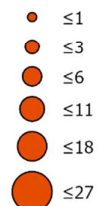


**Bait digging sightings**

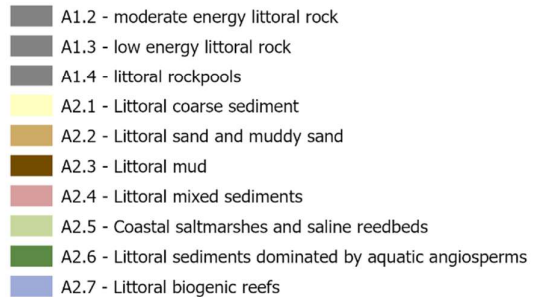
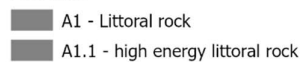


BNNC SAC

**Number of individuals bait digging**



**Habitats**



**Figure 2.** Intertidal activity sightings from NIFCA patrols in the Lindisfarne NNR from 2016-2020 showing sightings of periwinkle collection and 'no activity'.

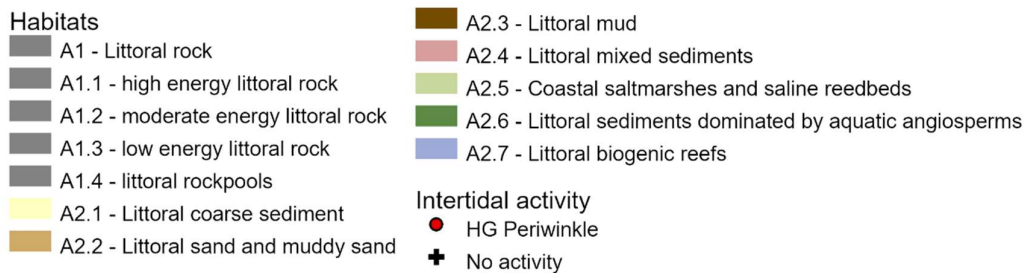
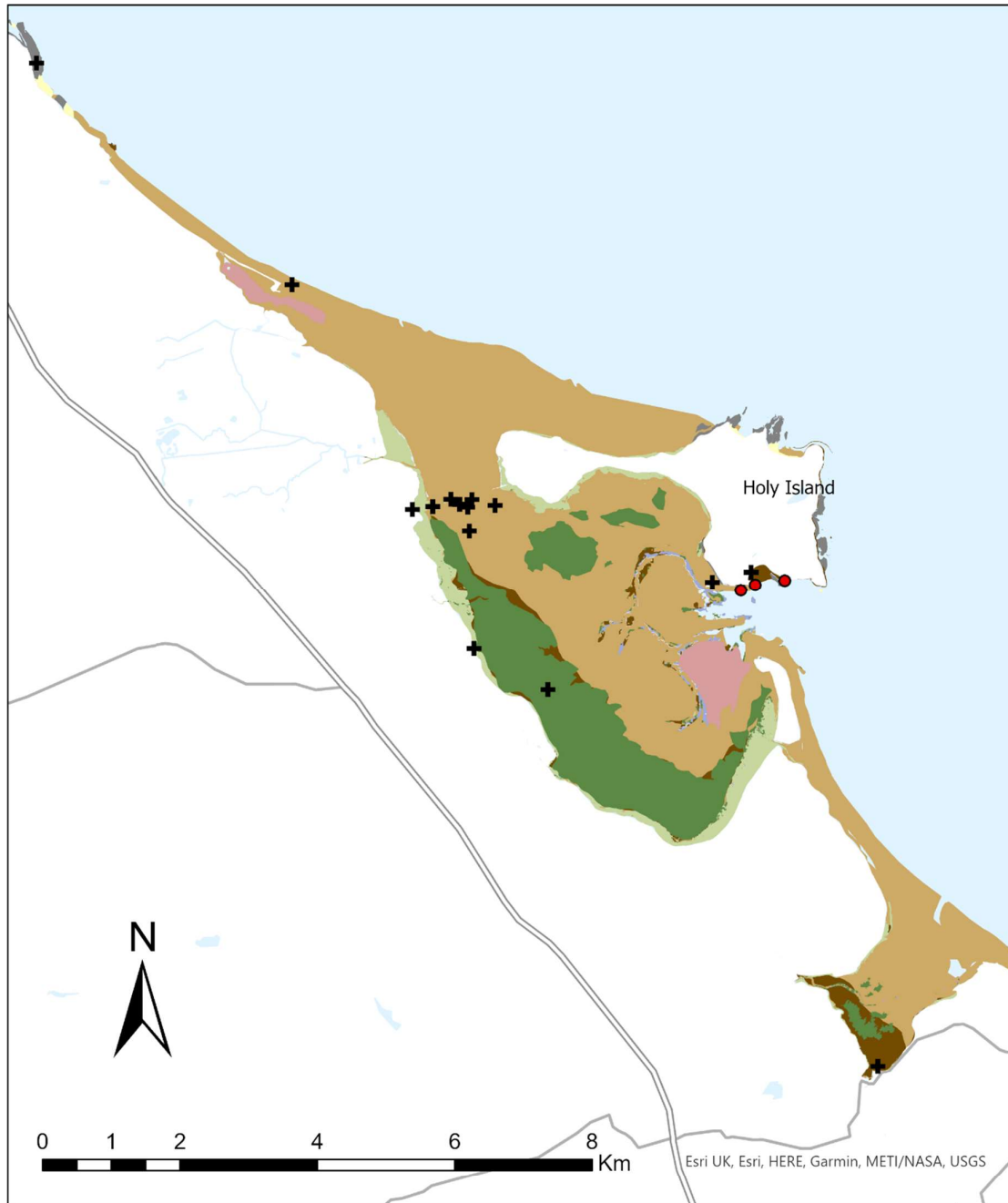


Table 1. Bait digging activity classifications for all bait digging sites within the BNNC SAC, from NIFCA intertidal patrols between 2016 and October 2021. Showing total number of patrols, the proportion of patrols bait digging was sighted on, the average number of individuals per sighting, the average number of individuals per patrol (proportion of patrols x average number per sighting) and the maximum number of collectors sighted at one time. Bait digging activity rankings (Very Low – High) were based on average number of collectors per patrol to the area from NIFCA patrols, in addition to officer knowledge.

Site	Number of patrols	Proportion of patrols activity sighted	Average no. of collectors per sighting	Average no. of collectors per patrol	Max. no of collectors	Bait Digging Activity
Berwick-Upon-Tweed	28	0.46	5.71	<b>2.65</b>	27	High
Boulmer Haven	48	0.56	3.46	<b>1.95</b>	14	High
Seaton Point	9	0.22	1.00	<b>0.22</b>	1	Low
Low Newton-by-the-Sea	7	0.14	1.50	<b>0.21</b>	2	Low
Beadnell Bay	7	0	-	-	-	Low
Beadnell-Seahouses	2	0	-	-	-	Low
Seaton Point-Foxton	5	0	-	-	-	Low
Fenham Flats/Holy Island	15	0	-	-	-	Very low
Budle Bay	2	0	-	-	-	Very low

Figure 3. Bait digging activity over the year from NIFCA patrols to the BNNC SAC between 2016 and October 2021, showing the proportion of patrols bait digging is seen on and the average number of individuals per sighting.

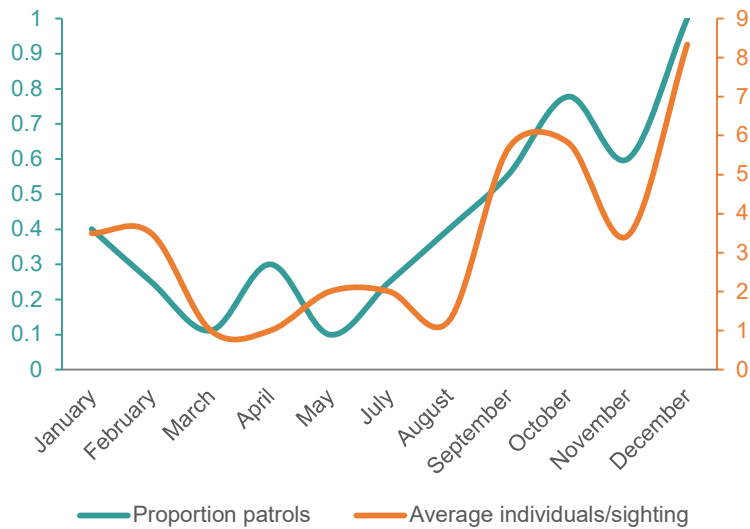
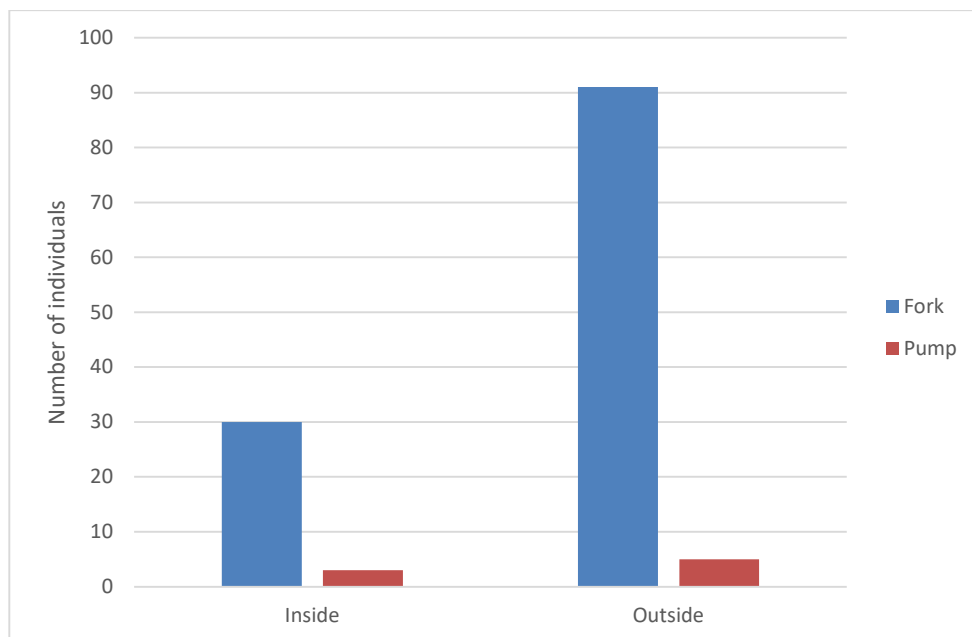
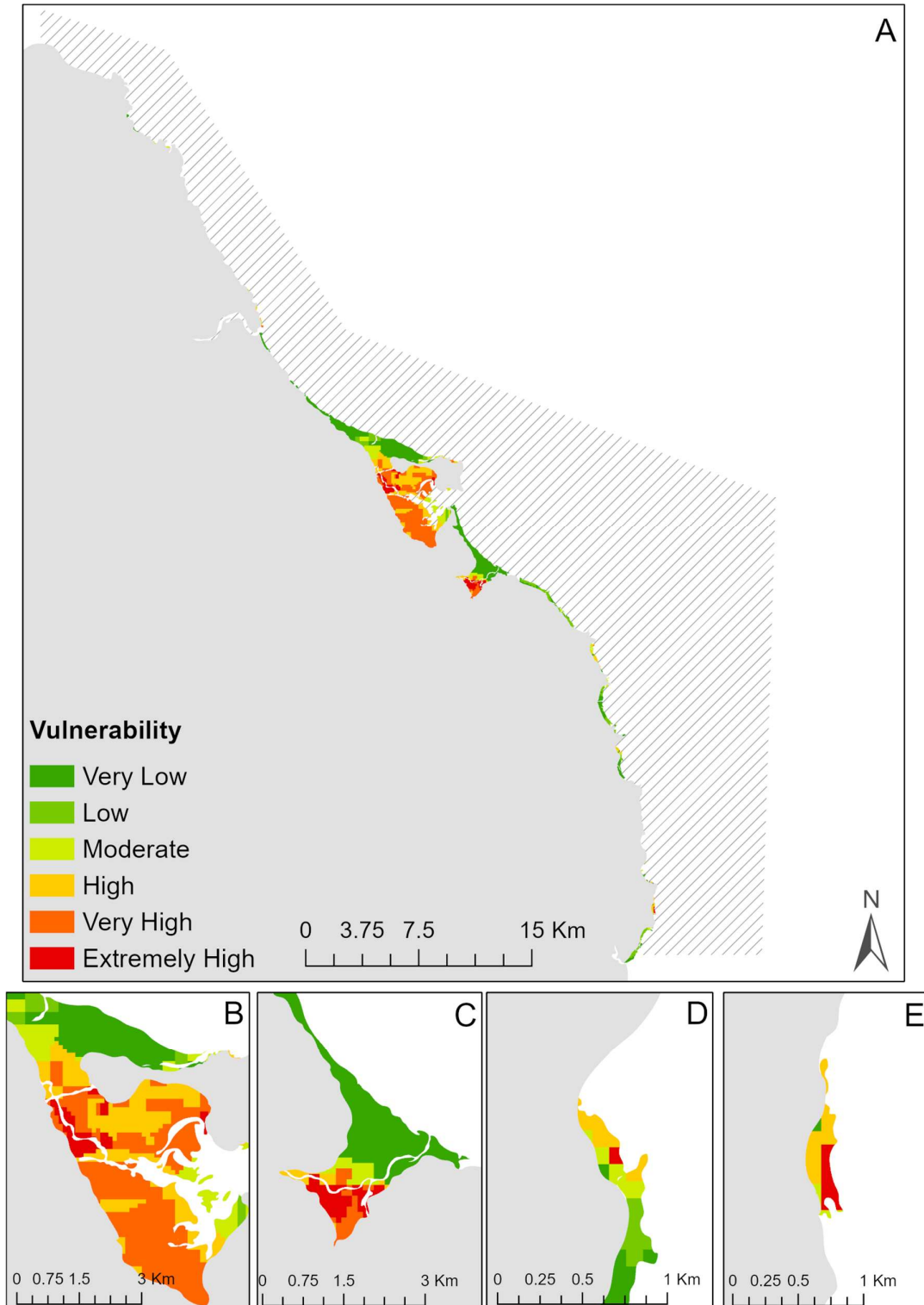


Figure 4. a) Map showing NIFCA sightings of bait digging activity (2016-2021) at Boulmer within and outside the prohibited Alnwick council zone. b) shows individuals using a pump or digging with forks. NOTE that in some cases pumping may not have been noted and this could therefore be an underestimate of pumping vs digging.



### Annex 4

Vulnerability model from Tinlin-Mackenzie (2018) for a) the BNNC SAC overall, b) Fenham Flats, c) Budle Bay, d) Newton and e) Boulmer. Vulnerability is defined here as a combination of sensitivity (how sensitive habitats are to bait digging) and suitability (modelled exposure to bait digging).





## Annex 5

Classification of all bait collection sites within the BNNC SAC. Bait digging activity is based on NIFCA patrol sightings (Annex 3 Table 1) and officer knowledge, while vulnerability (as defined and identified in Tinlin-Mackenzie 2018 as sensitivity to the activity, combined with exposure) and knowledge of impacts are from comparative and experimental studies at sites within the BNNC SAC from Tinlin-Mackenzie (2018).

Site	Bait digging activity	Vulnerability	Existing management	Knowledge of impacts specific to the area	Conclusion
<b>Berwick</b>	High	Very high	None	Unknown	Area of concern.  Take to AA
<b>Boulmer Haven</b>	High	High – extremely high	Northumberland County Council Byelaw (north). Not enforced	Lugworm populations maintained however lower infaunal abundance than expected when compared to Newton and Holy Island sites.	Area of concern.  Take to AA
<b>Seaton Point</b>	Low	Moderate	None	Unknown	Low concern – very low sightings, habitat not very suitable.  Monitor through M&C Plan.
<b>Newton</b>	Low	Mostly high	National Trust byelaw. Not enforced.	Lugworm populations and infaunal community abundance maintained.	Area of concern.  Take to AA
<b>Beadnell Bay</b>	Low	Moderate	None	Unknown	Low concern – very low sightings, habitat not very suitable.  Monitor through M&C Plan.
<b>Beadnell-Seahouses</b>	Low	Moderate-High	None	Unknown	Low concern – no NIFCA sightings of activity here

					and the habitat is much less suitable than other areas.  Monitor through M&C Plan.
<b>Seaton Point-Foxton</b>	Low	Low-Moderate	None	Unknown	Low concern – very low sightings, habitat not very suitable.  Monitor through M&C Plan.
<b>Fenham Flats/Holy Island</b>	Very low	High – extremely high	LNNR Byelaw. NE Rangers	High taxonomic richness and infaunal abundance at Holy Island compared to collected site (Boulmer). Experimental study showed lasting impacts of bait digging on sediment and infaunal community at simulated high digging intensity. At low digging intensity the infaunal community was not as impacted.	Low concern – LNNR byelaw prohibits bait digging and is enforced.  Monitor through M&C Plan.
<b>Budle Bay</b>	Very low	Very – extremely high	LNNR Byelaw. NE Rangers	Overexploitation caused historical lugworm population crash although recovery was also documented (Olive, 1993).	Low concern – LNNR byelaw prohibits bait digging and is enforced.  Monitor through M&C Plan.

## Annex 6

### In-combination assessment

<b>Plans and Projects</b>			
<b>Activity</b>	<b>Description</b>	<b>Assessment</b>	<b>Potential Pressure</b>
Fishing	<p>Hand gathering</p> <p>Hand gathering targeting shore crabs, periwinkles and lobster from rocky shore habitats. Activities occur year-round with the main peak in the summer as well as before Christmas, and commercial scale collection occurring within the district.</p>	<p>Peak hand gathering and periwinkle collection and peak bait digging season do not overlap, though these activities do co-occur.</p> <p>The limited number of people engaged in hand gathering on the rocky shore (especially during the winter) and the lack of activity on soft sediments, mean that a significant adverse effect on intertidal sediments is unlikely.</p>	Hand gathering could have similar impacts to recreational activities in terms of trampling, although this will mainly be limited to the rocky shore once accessed.
Coastal Infrastructure	<p>Outflow pipes</p> <p>Maintenance</p>	Appropriate licence conditions/monitoring has been incorporated to mitigate any impacts.	Small scale – low number of outfall pipes on intertidal sediments along the Northumberland Coast. Any intertidal impacts will be connected with maintenance and carried out infrequently.
Coastal management scheme - Northumberland and North Tyneside Shoreline Management Plan 2 (05/2009) covers the coastline from the Scottish border to the River Tyne.	Flood and erosion risk management	As stated in Section (2) of the document projects and plans within the Shoreline Management Plan are subjected to its own Appropriate Assessment for proposed work, which assesses any impacts to BNNC SAC.	Any coastal management works along the coast under the aegis of a Coastal Management Scheme.
Cable laying/infrastructure	Subsea cables with intertidal element	Appropriate licence conditions/monitoring has been incorporated to mitigate any impacts. Plans or projects must obtain a marine licence which must assess impacts to reef features within NCSA.	Any subsea cables, with an intertidal element, along the coast relating to the relevant plan or projects under Marine and Coastal Access Act.
Mine water discharge	<p>Abandoned mines are one of the biggest sources of water pollution by metals. There is drainage from the Scremerston coalfield to the sea at Spittal, near Berwick, and groundwater upwellings have occurred at Hauxley/Hadston just to the south of the SAC as well as water pumped</p>	Appropriate licence conditions/monitoring has been incorporated to mitigate any impacts.	Sediments and invertebrate communities could be negatively impacted by mine water discharges.

	from a mine, discharged through an existing outfall at Hauxley.		
<b>Other activities being considered (which are not plans or projects by definition)</b>			
<b>Activity</b>	<b>Description</b>	<b>Assessment</b>	<b>Potential Pressure</b>
Intertidal Recreational Activity	The intertidal sand and muddy sand features in BNNC SAC are popular places for recreational activities, namely walking and dog walking. This activity is seasonal with high numbers in the summer and just locals or dog walkers in the colder months.	Most walkers tend not to go as far down the shore as bait diggers so there is some spatial separation although in some areas both activities will occur. There are less recreational beach users in the autumn and winter however, which is when the majority of bait digging occurs.	Impacts of walkers are likely to be similar to the effects of bait diggers walking or 'trampling' the sediments. However, any impacts on the sediment will be far less than impacts of digging. Both walkers and in particular dogs are likely to cause bird disturbance however so there may be a combined impact on birds. There are normally higher numbers of recreational beach users than there are bait diggers.
Recreational shore angling	Recreational angling occurs throughout the MCZ.	This activity occurs year-round including in the winter which co-occurs with bait digging activity. However, angling occurs on all stretches of intertidal soft sediments in addition to rocky shores so there is a low chance of co-occurrence with bait digging and most sightings of angling activity do not co-occur with bait digging (NIFCA patrol sightings).	Impacts of angling are likely to be similar to the impacts of any other beach user and bait diggers when walking or 'trampling' the sediments, and may also contribute litter. However, they are unlikely to significantly impact intertidal sediment features.

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