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Runswick Bay Coastal Protection: Sandeel survey

Report to
Esh Construction Ltd.

Institute of Estuarine and Coastal Studies
University of Hull

23rd May 2017

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Report: YBB357-D-2017

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Document control

Title: Runswick Bay Coastal Protection: Sandeel survey
Report No.: YBB357-D-2017
Status: Draft
Version: D
Issue date: 23rd May 2017
Client: Esh Construction Ltd
Client contact: Dorian Latham, JBA Consulting

Version and approval history

Date	Report Version	Name & Company	Action
23/05/2017	D	A. Franco & K. Smyth, IECS	Report written, checked and approved by

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Suggested citation

Franco, A., Smyth, K., 2017. Runswick Bay Coastal Protection: Sandeel survey. An IECS report to Esh Construction Ltd. Report No. YBB357-D-2017, May 2017.

TABLE OF CONTENTS

List of Figures

List of Tables

List of Appendices

SUMMARY

A grab survey was undertaken in Runswick Bay in May 2017 to establish the presence and distribution of sandeel in the bay to support a planning application of Esh Construction Ltd for proposed coastal defence developments on the shore near Runswick village. The survey was conducted at night in order to target resident populations of sandeels which, if present, would be located in their burrows in the sediment during the hours of darkness.

In the absence of pre-existing information on sediment distribution in the bay that would have allowed to target suitable habitats for sandeel, 26 survey stations were distribution throughout the bay and across depth levels to increase the chances of covering different types of habitats, including possible sandeel habitats. Valid sediment samples could be obtained from 13 of the 26 stations. Rejected grab samples were due to the presence of a hard substratum that would be unsuitable for sandeel habitat.

No sandeels were found in any of the samples collected, and this was likely the result of no or low suitability of the sediment characteristics for sandeel use.

Generally, muddier sediments were found in the deeper waters in the central part of the outer bay (>10 m depth), with sandier sediments in the shallower waters (<10 m depth), and a number of stations around the southeast and northwest margins of Runswick Bay showed a hard substratum. Sandeels are known to prefer a substratum of medium to very coarse sand (median particle size of 0.25 to 2 mm) and are considered to be rare in sediments where the silt component is greater than 4 % and to avoid sediments with a mud content greater than 10 %. These conditions were met only in one station (station 20 which is located outside of the main bay), whereas the remaining sediment samples showed too fine sand in and too high mud content (mostly >6 %, with values up to 62-79 %).

The observed sediment characteristics would explain the absence of sandeel from the grab samples in and near Runswick Bay, and this may be indicative of the absence of a resident population in the seabed within Runswick Bay at the time of sampling. Observations made in 2014 during the baseline survey of the intertidal area showed seabirds taking sandeels in the bay (Hull and Johnson, 2014), and this would suggest that sandeels may visit Runswick Bay for feeding in the water column during the day, while more suitable areas where sandeel are buried at night are likely to occur on the seabed further offshore, where coarser sediments have been reported. Sandeels feeding in the water column would be more mobile than sandeels buried in the sediments, thus reducing potential exposure to any impact arising from the planned coastal defence works due to a higher ability to vacate the area of impact and feed elsewhere.

1. INTRODUCTION

The Institute of Estuarine and Coastal Studies (IECS, University of Hull) was commissioned to undertake a grab survey at Runswick Bay in May 2017 with the aim of establishing the presence and distribution of sandeel in the bay. The results of this assessment will support the planning application for a coastal protection scheme to be undertaken in Runswick Bay and involving the addition of rock revetment on the shore to protect the existing sea wall.

Sandeel is a small fish, with five species occurring in the North Sea, including Raitt's sandeel (*Ammodytes marinus*), greater sandeel (*Hyperoplus lanceolatus*), smooth sandeel (*Gymnammodytes semisquamatus*), lesser sandeel (*Ammodytes tobianus*), and Corbin's sandeel (*Hyperoplus immaculatus*). The lesser sandeel is the most widespread in the North Sea, where it is also the target of the largest single-species fishery (Furness, 2002). Sandeels provide an important part of the diet of many top predators, being commonly eaten by diving birds (e.g. puffins), marine mammals (e.g. seals and porpoises) and fish (e.g. mackerel and whiting), thus being an important component of the marine pelagic food web (Furness, 2002).

A number of terns/gulls were observed taking sandeels as prey during the baseline intertidal survey undertaken in 2014 on the northern end of Runswick Bay in the region of the proposed coastal defence developments needed to protect the village (Hull and Johnson, 2014). Based on this and on one sand eel (*Ammodytes* sp.) observed at edge of the waves at low water, the report concluded that the soft sediments below low water mark appeared to support a good population of sandeels (Hull and Johnson, 2014). It is probably this conclusion that raised concerns about the possible effect of the coastal protection scheme on the sandeel population in Runswick Bay and led Scarborough Council to request the present assessment.

Sandeels have a close relationship with the seabed, as they spend most of their time buried in the sediment. They emerge into the water column only briefly in winter for spawning and performing diurnal migrations during the spring and summer, when they move from the seabed where they are buried at night to deeper areas of the water column during the day to feed (Cefas, 2004; Van der Kooij et al., 2008). Therefore, sampling sandeels when in the sediment is considered the best opportunity to assess the population, particularly during the autumn and spring or during the night in the early summer, when sandeels are not believed to be actively feeding in the water column (Macer 1966, Reay 1970, Winslade 1974).

The ease of penetration into the sediment is considered an important factor in determining sediment habitat choice, resulting in highly patchy distribution and a clear association of sandeel with specific type of substratum. The preferred substratum includes medium to very coarse sands, sediment habitats with a median particle size of 0.25 to 2.0 mm, whereas the species are considered to be rare in sediments where the silt (particle size <0.63 µm) content is greater than 4 % and to avoid sediment habitats with a silt content of more than 10 % (Wright et al., 2000; Holland et al., 2005; Brown and May Marine Ltd, 2013).

No detailed information on sediment types and distribution could be found for the seabed within Runswick Bay. However, sediment distribution maps were produced by Allen (2008) for the ecological assessment of the prohibited trawling areas along the Yorkshire coast, within the North Eastern Sea Fisheries Committee (NESFC[1]) jurisdiction, including the coastal area north of Whitby and fronting Runswick Bay. This assessment reported the presence of rougher/rocky ground close inshore fronted by an area of sand or muddy sand which runs along the coast

[1] Now North Eastern Inshore Fisheries and Conservation Authority, NEIFCA.

moving offshore, where it becomes progressively muddier. Based on this information, the presence of suitable sandeel grounds within Runswick Bay cannot be excluded.

2. MATERIALS AND METHODS

A grab survey was undertaken in Runswick Bay during the night of 10th to11th May 2017. The field survey was carried out by two IECS surveyors on board the R/V "Huntress of Grimsby" of the Holderness Fishing Industry Group (HFIG), and a 0.1 m^2 Day grab was used. Grab sampling is considered to be particularly efficient in catching sandeels buried in the sediment, as they have little opportunity to escape, particularly at night, and sandeels will normally be buried at a depth that is readily accessible to a grab (Girsa and Danilov, 1976).

Runswick Bay is located at the north-east edge of the North York Moors National Park, around 10 km to the northwest of the historic fishing town of Whitby. The intertidal portion of the bay is characterised by a rocky shoreline to northern and southern margins, with a sandy beach spanning in between, giving a range of different topographic conditions. As there was no pre-existing available information on the sediment characteristics and distribution within the subtidal area of Runswick Bay, an *a priori* assessment of suitable sandeel substrata to be targeted during the survey could not be made. Therefore, sampling stations where located on a grid covering the whole bay and different depth strata (Figure 1 and Appendix 1). Spring tide conditions on the survey dates allowed access (at high water) to shallower areas closer to shore. A total of 26 sampling stations were targeted, with further stations to be identified and sampled during the survey in the proximity of stations where sandeel occurred, in order to confirm the presence and extent of the patch.

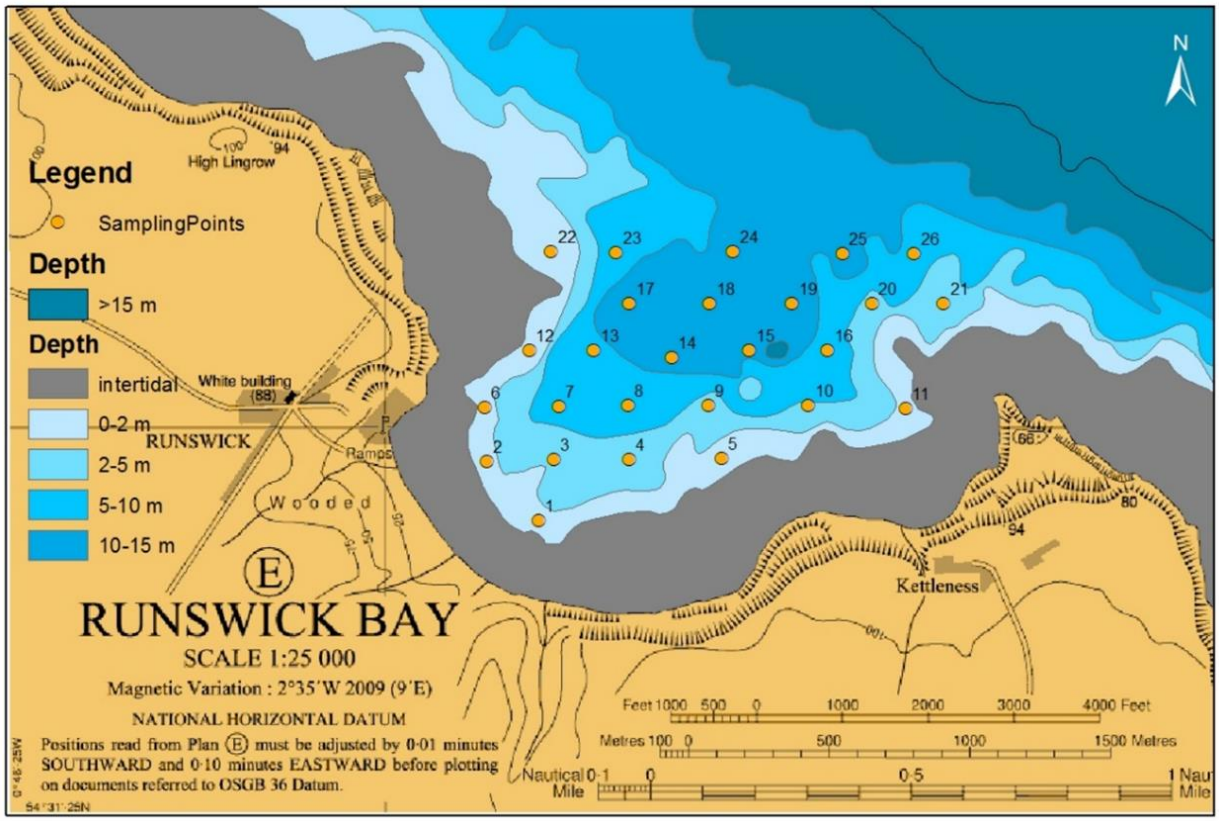

Figure 1. Targeted sampling locations in Runswick Bay.

The Day grab was deployed at each sampling station following standard operating procedures. Briefly, the grab is positioned onto the boat's A-frame and weighted appropriately then lifted

over the side of the vessel. The grab is lowered at around 1 m/s^{-1} through the water column in order to avoid a sudden impact of water on the bottom of the grab. When contact is made with the seabed, the grab automatically operates and is then left for several seconds on a slack line before retrieval and sample removal.

Samples were checked for validity by opening the flaps of the grab. If the jaws of the grab failed to close properly, resulting in loss of material, the contents were discarded and the grab re-deployed. If an undisturbed sample was present, then the depth in the centre of the sample is measured. If the sediment depth was less than 6 cm, then the contents were discarded and the grab re-deployed. A minimum sediment depth of 6-8 cm in the grab was used to accept valid sample in this survey as eight centimetres is the maximum depth of the oxic layer that is common in the seabed sediment of the North Sea (Lohse et al., 1996), and thus identifies the depth at which sandeels are more likely to occur.

Up to five attempts were made at each sampling station before abandonment, excluding misfires. There were no instances where the jaw jammed. At the discretion of the on-board Scientist-in-Charge a shallower depth sample was accepted if there was thought to be some merit in obtaining indicative (e.g. qualitative) information from a location that would otherwise be abandoned.

Sediment grab samples were visually inspected and qualitative appraisals of the substratum composition were undertaken. A sediment sub-sample was collected from valid grab samples to undertake further particle size analysis (PSA) in the IECS laboratory and the rest was sieved on-board to collect any sandeels and other organisms. Any sandeel in the samples was to be identified, measured for total body length and enumerated.

Water quality (water temperature, dissolved oxygen, turbidity, pH and salinity) at the study site was monitored using a Hydrolab Quanta Water Quality Monitoring System (accuracy: salinity ± 1% of reading ± 1 count, Resolution 0.01 PSS) (see Appendix 2).

A full survey log was maintained throughout the fieldwork including date, time, tidal state, location of sample point (dGPS coordinates, using a Magellan Professional CX +/- 1 m accuracy), method used, equipment including grab dimensions and the name of each surveyor, as well as additional field notes as mentioned above.

3. RESULTS

Valid sediment samples could be obtained from 13 stations in total (namely, station 1, 2, 3, 7, 8, 10, 14, 15, 16, 17, 18, 20 and 25), from the 26 stations where a grab was attempted. Sediment samples were also obtained from stations 6, 13 and 24, but grab penetration into the sediment was not optimal (1 to 3 cm) at these stations. The samples were examined nevertheless for presence of sandeels, but these were not considered further in the sediment particle size analysis. In the remaining stations, mostly located along the southeast and northwest margins of the bay, the presence of hard substratum did not allow penetration of the grab and no samples could be obtained.

No sandeels were found in any of the samples.

A small number of other faunal taxa were found in 8 of the 13 valid sampling stations and are summarised below:

- Station 1: Hydrozoa and *Nephtys sp.* (Polychaeta);
- Station 2: *Nephtys sp.* (Polychaeta);
- Station 6: Polychaeta, Amphipoda, Isopoda, Barnacles, Hydrozoa;
- Station 7: Cumacea;
- Station 14: Bivalvia, Polychaeta;
- Station 15: Polychaeta, Hydrozoa;
- Station 17: Bivalvia, Polychaeta;
- Station 18: Crustacea (*Liocarcinus holsatus*).

Particle size analysis of the sediment samples collected in the bay showed that generally the valid stations sampled fell into the textural group of slightly gravelly sand (stations 1, 2, 3, 8, 10, 18, 20 and 25) or slightly gravelly sandy mud (stations 7, 14, 16 and 17). Station 15 contained sandy mud (Table 1A, Figure 2).

Mean sediment type in the samples included medium sand at stations 3, 10, 16, 20 and 25, fine sand at stations 1, 2, 8, and 18, coarse silt at stations 7, 15 and 17, and a very coarse silt occurred at station 14 (Table 1A).

There appeared to be quite a marked split between samples into two main groups, sand and mud, with stations 1, 2 ,3, 8, 10, 18, 20 and 25 all having over 90 % sand, and the remaining stations having over 60 % mud as the main component. Gravel made up less than 1 % of every sample except for station 16 where it accounted for 2.5 % of the sediment (Table 1B).

A qualitative visual assessment of the sediments at stations 6 and 24 showed that station 6 appeared to also consist of a fine sand and station 24 a fine to medium sand, with the poor penetration of the grab indicating a hard substratum just beneath this shallow top layer in both instances. However as these were surficial sediments only (1-3 cm in depth), these samples are not comparable with the data from the other stations where full grab samples could be obtained and were not included in the PSA analysis. The shallow depth of sediment means these stations are also unlikely to be suitable for sandeel burrows.

Spatially, the central part of the bay appears to be the muddiest and the northeast and southwest parts the sandiest. Sand appears to occur in greater proportions in the shallower depths 0-10 m, with silts and clays in the largest proportions in the deeper waters >10 m, with the exception of station 7 with a large mud component but at a depth of 5-10 m. Where samples could not be taken (mostly on the southeast and northwest margins of the bay) this indicates a likely rocky or otherwise hard substratum (Figure 3).

Sandeels are known to prefer a substratum of medium to very coarse sand with a median particle size of 0.25 to 2 mm (250-2000 µm). Furthermore, they are considered to be rare in sediments where the mud (< 63 µm) content is greater than 4 % and to avoid sediments where this is greater than 10 %. Stations 3, 10, 16, 20 and 25 were the only one with median grain size within the range of medium to very coarse sand, this component accounting for between 57 % and 85 % of the total sediment in stations 20 and 10, respectively (Table 1B, Figure 2). It should be noted, however, that the median particle size recorded in these samples was at the finer end of the preferred range of particle sizes (Table 1B). However, mud content in the samples collected at the stations mentioned above was almost always >6 %, reaching 14.8 % in station 16. Station 20, with a mud content of 3.3 %, was the only station showing sediment characteristics potentially suitable for sandeels (Table 1B, Figure 4). This station was located outside Runswick Bay.

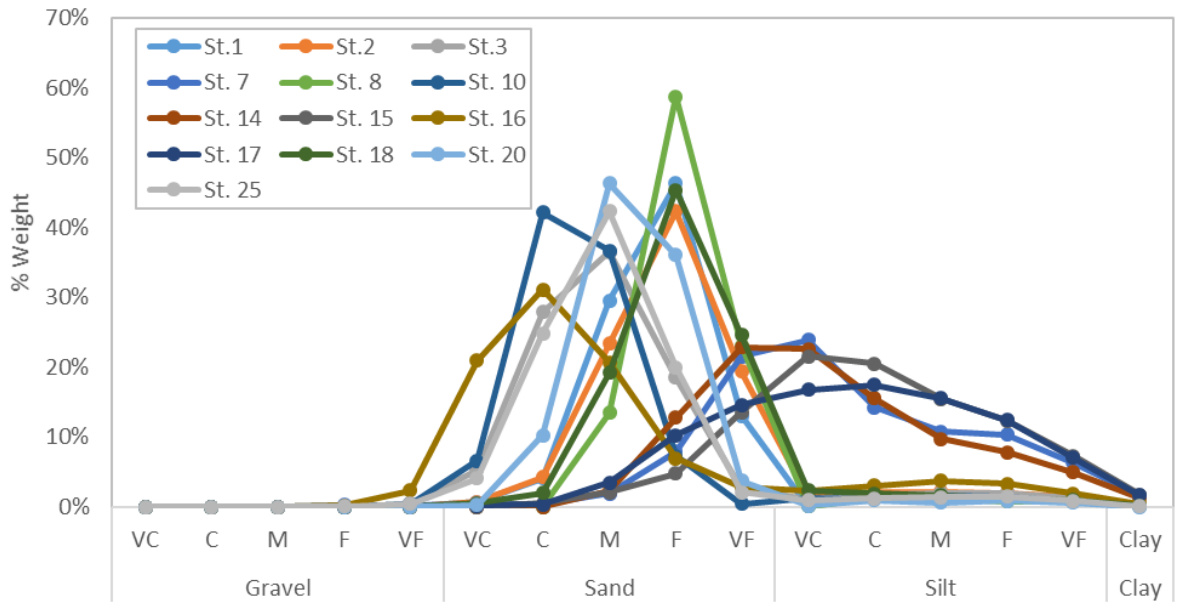

Figure 2. Sediment particle size distribution in samples collected at stations within Runswick Bay (VC, very coarse; C, coarse; M, medium; F, fine; VF, very fine).

Table 1. Sediment characteristics in samples collected at Runswick Bay.

(A) Descriptive

Station	Textural Group	Sediment Description	Mean Sediment Type	Sediment Sorting
St.1	Slightly Gravelly Sand	Slightly Very Fine Gravelly Fine Sand	Fine Sand	Poorly Sorted
St.2	Slightly Gravelly Sand	Slightly Very Fine Gravelly Fine Sand	Fine Sand	Poorly Sorted
St.3	Slightly Gravelly Sand	Slightly Very Fine Gravelly Medium Sand	Medium Sand	Poorly Sorted
St. 7	Slightly Gravelly Sandy Mud	Slightly Fine Gravelly Very Fine Sandy Very Coarse Silt	Coarse Silt	Poorly Sorted
St. 8	Slightly Gravelly Sand	Slightly Fine Gravelly Fine Sand	Fine Sand	Moderately Well Sorted
St. 10	Slightly Gravelly Sand	Slightly Very Fine Gravelly Coarse Sand	Medium Sand	Poorly Sorted
St. 14	Slightly Gravelly Sandy Mud	Slightly Very Fine Gravelly Very Fine Sandy Very Coarse Silt	Very Coarse Silt	Poorly Sorted
St. 15	Sandy Mud	Very Fine Sandy Very Coarse Silt	Coarse Silt	Poorly Sorted
St. 16	Slightly Gravelly Muddy Sand	Slightly Very Fine Gravelly Medium Silty Coarse Sand	Medium Sand	Very Poorly Sorted
St. 17	Slightly Gravelly Sandy Mud	Slightly Very Fine Gravelly Very Fine Sandy Coarse Silt	Coarse Silt	Very Poorly Sorted
St. 18	Slightly Gravelly Sand	Slightly Very Fine Gravelly Fine Sand	Fine Sand	Poorly Sorted
St. 20	Slightly Gravelly Sand	Slightly Very Fine Gravelly Medium Sand	Medium Sand	Moderately Sorted
St. 25	Slightly Gravelly Sand	Slightly Very Fine Gravelly Medium Sand	Medium Sand	Poorly Sorted

(B) Quantitative

Station	Median particle size (µm)	Mean particle size (µm)	Sorting (µm)	Gravel	Sand	Mud
St.1	201.80	199.03	2.16	0.1%	93.7%	6.2%
St.2	176.88	173.84	2.47	0.2%	90.1%	9.8%
St.3	371.92	352.76	2.86	0.5%	91.0%	8.5%
St. 7	38.54	30.03	3.74	0.5%	32.3%	67.3%
St. 8	159.99	157.51	1.59	0.0%	95.5%	4.5%
St. 10	494.01	478.22	2.32	0.5%	93.2%	6.3%
St. 14	44.10	36.50	3.57	0.0%	38.0%	62.0%
St. 15	24.70	22.38	3.51	0%	21.0%	79.0%
St. 16	552.69	385.84	4.45	2.5%	82.7%	14.8%
St. 17	26.48	26.32	4.07	0.0%	28.9%	71.1%
St. 18	160.92	160.24	2.12	0.1%	91.7%	8.3%
St. 20	273.41	270.33	1.70	0.0%	96.7%	3.3%
St. 25	360.71	353.01	2.35	0.5%	93.4%	6.1%

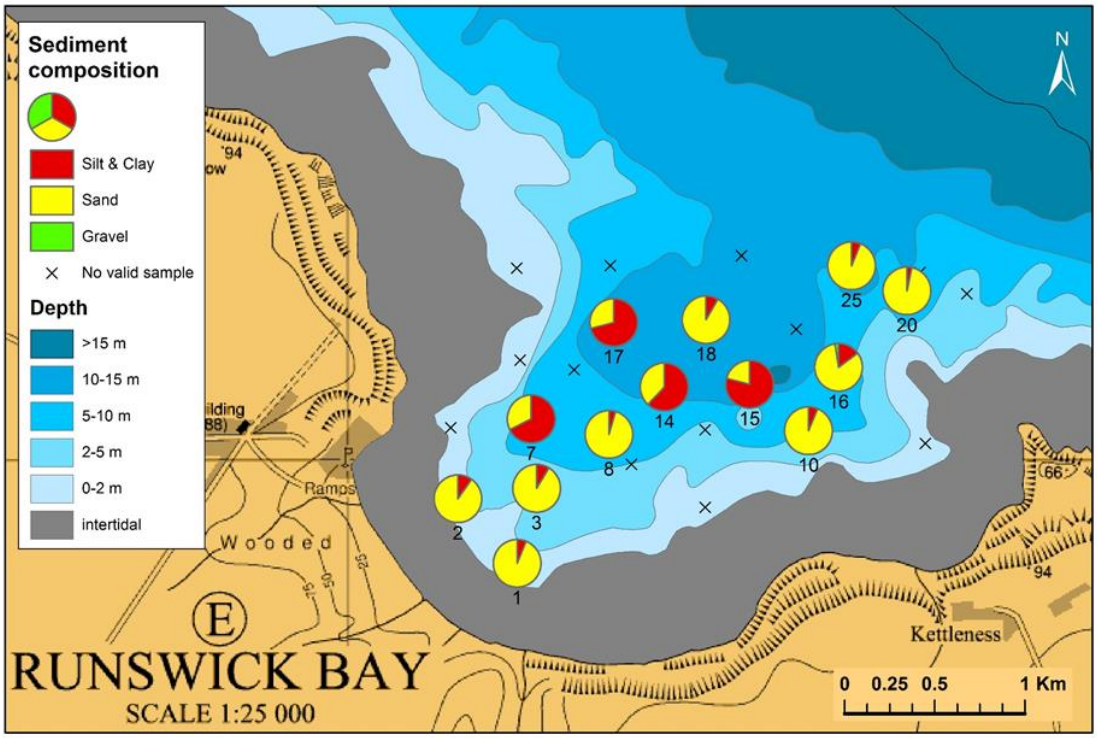

Figure 3. Sediment composition (gravel, sand, silt and clay) in samples collected at Runswick Bay. Station numbers are indicated where valid samples were obtained.

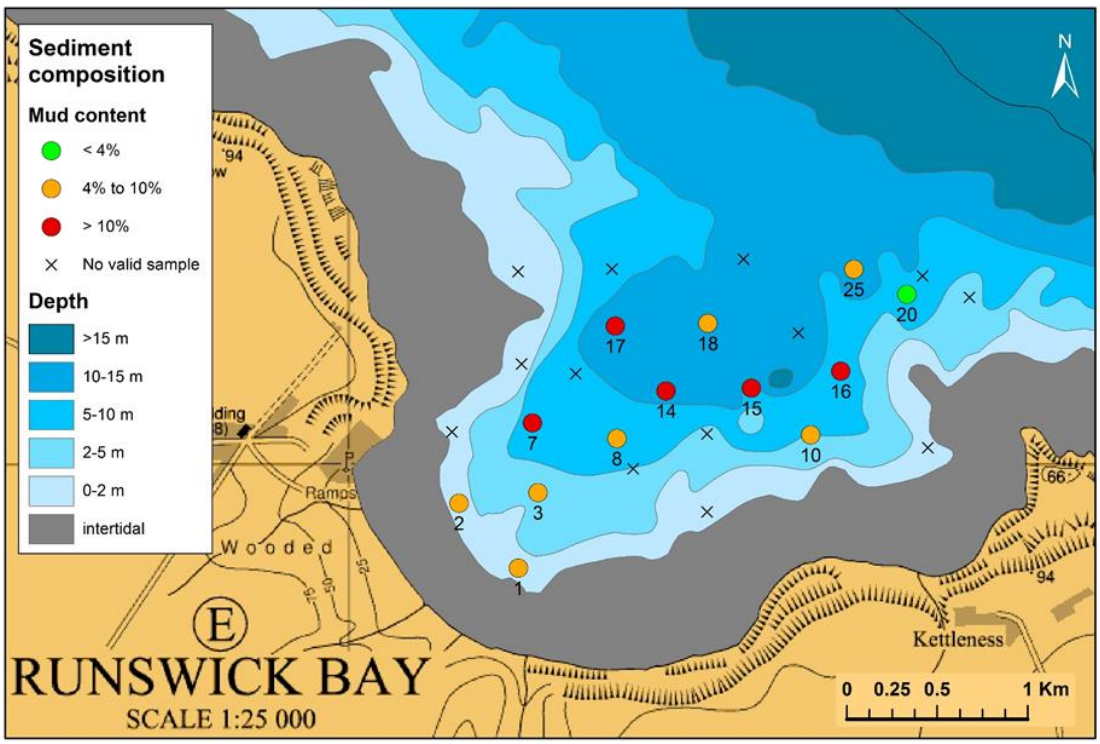

Figure 4. Mud (silt and clay, grain size < 63 µm) content (%) in samples collected at Runswick Bay. Results are colour coded according to relevant suitability criteria for sandeel use of the sediment (see legend). Station numbers are indicated where valid samples were obtained.

4. DISCUSSION

No sandeels were found in any of the stations sampled. This is in contrast to the conclusions of the baseline report (Hull and Johnson, 2014) which suggested an apparent good population of sandeels in Runswick Bay. It must be noted that those conclusions were based on qualitative observations undertaken during an intertidal survey when of only one sandeel was seen in the water from the shore, and birds feeding on sandeels were seen in the bay. The quantitative assessment undertaken with the present grab survey in the subtidal area of Runswick Bay highlighted unsuitable or suboptimal sediment characteristics of the sampled sediments compared to sandeel preferences, this being the likely cause for the absence of the species from the grab samples.

Holland et al. (2005) suggest that grab sampling for sandeels should be undertaken by targeting the sediment habitats most likely to be occupied by sandeels so that adequate numbers of sandeels may be sampled for a reasonable expenditure of sampling effort. However, as there was no pre-existing information on sediment distribution in the bay, the current grab survey was designed to give a distribution of stations throughout the bay and across depth levels. Although this did not grant that all habitat patches occurring in the bay were sampled, it increased the chances of covering different types of habitats, including possible suitable sandeel habitats. As a result, the absence of sandeels from the grab samples may be indicative of the absence of a resident population in Runswick Bay at the time of sampling.

In the coastal area north of Whitby and fronting Runswick Bay, Allen (2008) reported the presence of rougher/rocky ground close inshore, fronted by an area of sand or muddy sand which runs along the coast moving offshore, where the substratum becomes progressively muddier. This spatial pattern is consistent with the results of the current survey within Runswick Bay, where muddier sediments were found in the deeper waters in the central part of the outer bay, with sandier sediments occurring in the shallower waters. A number of stations around the southeast and northwest margins of the bay could not be sampled due to the presence of a hard substratum which is unlikely to be suitable habitat for sandeel use.

Where grab samples could be collected in Runswick Bay, the sediment characteristics showed no or low suitability for sandeels according to the criteria indicated in the literature (medium-coarse sand with mud content <10 % and preferably <4 %; Wright et al., 2000; Holland et al., 2005; Brown and May Marine Ltd, 2013). This may explain the absence of sandeels from the samples. Sandy sediments sampled in the bay appeared to be too fine grained (medium-fine sand) and with a mud content too high (mostly >6 %, up to 14.8 %), with also muddy sediments (62 to 79 % mud content) occurring in the central and deeper areas of the bay. Medium sand sediments with low mud content (3.3 %) were only recorded in station 20, located outside the bay, possibly suggested the presence of more suitable habitats for sandeel further offshore, where Allen (2008) reported coarser sediments to occur.

Although the sediment characteristics may explain the absence of sandeel from the grab samples in and near Runswick Bay, this does not mean that the fish are not using the bay. For example, the observations made in 2014 (Hull and Johnson, 2014) of terns and gulls taking sandeels would suggest the presence of sandeels feeding in the water column, where they are more likely to be preyed upon by seabirds. However, this is not necessarily an indication of the presence of suitable sandeel habitats in the bay, as sandeels can undertake diurnal migrations of a few kilometres between the seabed where they are buried at night and feeding areas in the water column (Cefas, 2004; Van der Kooij et al., 2008). Hence it is possible be

that sandeels are using Runswick Bay during the day for feeding, but are not resident in the bay.

Although this report is not intended to assess impacts on sandeel of the works to be undertaken on the shore as part of the planned coastal defence works at Runswick Bay, it is highlighted that the possible presence of sandeels in the water column would be of less concern than if a resident population was using sediment habitats within Runswick Bay. Sandeels residing elsewhere but using the waters of the bay as a feeding area are less likely to be affected by exposure to the impacts of coastal protection scheme works due to a greater mobility compared to sandeels buried in the sediment, and hence a higher ability to vacate the area of impact if needed and to feed elsewhere. Furthermore, the water column itself if less likely to be affected by the placement of the proposed rock revetments than the seabed which could encounter sediment changes, smothering, flow rate changes etc. which may be detrimental to the sandeel sediment habitat if it was present.

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APPENDICES

Appendix 1. Targeted grab survey locations in Runswick Bay (WGS 1984).

Station no.	Latitude (deg)	Longitude (deg)
1	54.5303	-0.741576
2	54.5322	-0.744429
3	54.5323	-0.740739
4	54.5323	-0.736594
5	54.5323	-0.731507
6	54.5339	-0.744521
7	54.5340	-0.740449
8	54.5340	-0.736631
9	54.5340	-0.732243
10	54.5340	-0.726763
11	54.5339	-0.721392
12	54.5357	-0.742080
13	54.5357	-0.738542
14	54.5355	-0.734266
15	54.5357	-0.729999
16	54.5357	-0.725700
17	54.5372	-0.736565
18	54.5372	-0.732153
19	54.5372	-0.727667
20	54.5372	-0.723274
21	54.5372	-0.719323
22	54.5389	-0.740864
23	54.5389	-0.737292
24	54.5389	-0.730911
25	54.5388	-0.724886
26	54.5388	-0.720967

Appendix 2. Water quality data for Runswick Bay (10th -11th May 2017).

Station	Temperature °C	pH	Salinity PSS	Dissolved Oxygen % Saturation	Dissolved Oxygen mg/L	Turbidity NTU
1	9.97	8.61	36.36	71.8	6.38	17.2
2	9.87	8.6	36.35	75	6.68	13.6
3	9.92	8.61	36.36	77.4	6.88	15.8
4	9.94	8.6	36.36	75.4	6.7	16.8
5	9.87	8.6	36.43	75.3	6.7	14.8
6	9.93	8.6	36.36	75.7	6.73	15.5
7	10.19	8.56	36.38	76	6.72	18.4
8	10.12	8.56	99.99	82.3	9.26	57.5
9	10.47	8.57	36.33	76.2	6.7	16.7
10	9.64	8.61	36.41	75.6	6.76	20.1
11	9.49	8.61	36.39	77.4	6.95	16.2
12	10.07	8.61	36.37	72.6	6.43	12.8
13	10.68	8.58	36.35	76.2	6.68	19.3
14	9.94	8.54	36.36	71.7	6.37	12.4
15	9.9	8.52	36.36	70.2	6.25	14.9
16	9.7	8.57	36.41	77.9	6.97	14.3
17	10.39	8.6	36.4	77.9	6.86	17.3
18	10.47	8.59	36.4	79.6	6.99	22.4
19	9.75	8.5	36.41	70.2	6.26	15.2
20	9.54	8.57	36.4	77.1	6.91	14.7
20	9.85	8.58	36.42	83.8	7.46	13.5
21	9.87	8.59	36.35	81.8	7.28	16.5
23	9.59	8.6	36.33	75.9	6.8	14.1
24	10.22	8.58	36.31	82.3	7.27	18.1
25	9.99	8.47	36.22	66	5.87	18
26	9.89	8.49	36.33	65.8	5.85	18.3