Annex 1: Reference list

Atkinson, PW *et al*. 2003. Changes in commercially fished shellfish stocks and shorebird populations in the Wash, England. *Biol Con*, 114, 127-141

Bell, MC *et al*. 2001. Fisheries and bird predation as components of cockle (Cerastoderma edule) mortality in the Burry Inlet, South Wales. In: The Life History, Dynamics and Exploitation of Living Marine Resources: Advances in Knowledge and Methodology CM 2001/J:02 ICES

Bustnes, JO. (1998). Selection of blue mussels Mytilus edulis, by Common eiders, Somateria mollisima, by size in relation to shell content. Canadian Journal of Zoology **76**: 1987 – 1790.
http://www.nrcresearchpress.com/doi/abs/10.1139/z98-111

CCW? (2011). *Consideration of risks involved with the removal of mussel seed from the Salisbury Bank, Dee Estuary, that may contain the non-native Chinese Mitten Crab Eriocheir sinensis.* Report for Welsh Government.

Cook, B. (2008). *Seed mussel removal from Foulney Twist Appropriate Assessment*. North Western and North Wales Sea Fisheries Committee – unpublished.

Cook, A.S.C.P, & Burton, N.H.K. 2010. *A review of the potential impacts of marine aggregate extraction on Seabirds*. Marine Environment Protection Fund (MEPF) Project 09/P130

Dare, P.J. (1976). *Settlement, growth and production of the mussel Mytilus edulis L. in Morecambe Bay, England.* Fish. Invest. Minist. Agric. Fish. Food lond. Ser. II. 28: 1-25

Dare, P.J. (1971). Preliminary studies on the utilisation of the resources of spat mussels, (Mytilis edulis L.) occurring in Morecambe Bay, England. International Council on the Exploration of the Sea Committee Meeting, K11. 1–6 (Shellfish and Benthos Comm.).

Dubois, S., Retiere, C. & Olivier, F. (2002). *Biodiversity associated with Sabellaria alveolata (*Polychaeta: Sabellariidae*) reefs: effects of human disturbance*. Journal of the Marine Biological Association of the UK. 82. pp. 817-826.

Dubois, S., Barille, L., Cognie, B. & Beninger, P. (2005). *Particle capture and processing mechanisms in Sabellaria alveolata (*Polychaeta: Sabellariidae*).* Marine Ecology Progress Series. 301. pp. 159-171.
.
Dubois, S., Barille, L., Cognie, B. & Beninger, P. (2006a). *Feeding mechanisms of the polychaete Sabellaria alveolata revisited: reply to Riisgard & Nielson (2006).* Marine Ecology Progress Series. 328. pp. 307-311.

Dubois, S., Commito, J.A. Olivier, F. & Retiere, C. (2006b). *Effects of epibionts on Sabellaria alveolata* (L.) *biogenic reefs and their associated fauna in the Bay of Mont Saint-Michel.* Estuarine, Coastal and Shelf Science. 68. pp. 635-646.

Dubois, S., Comtet, T., Retiere, C. & Thiebaut, E. (2007). *Distribution and retention of Sabellaria alveolata larvae (*Polychaeta: Sabellariidae*) in the Bay of Mont Saint-Michel, France.* Marine Ecology Progress Series. 346. pp. 243-254.

Essink, K. 1999. Ecological effects of dumping of dredged sediments; options for management. *Journal of Coastal Conservation*. 5: 69-80.

Egerton, S. (2014). *Distribution mapping and health assessment of honeycomb worm, Sabellaria alveolata, reefs on Heysham Flat, Lancashire.*

Foster, V. (2015). Update 2014: Distribution mapping and health assessment of honeycomb worm, *Sabellaria alveolata,* reefs on Heysham Flat, Lancashire.

Frechette, M., Aitken, A.E. & Page, L. 1992). *Interdependence of food and space limitation of a benthic suspension feeder: consequences for self-thinning relationships. Mar. Ecol. Prog. Ser. 83: 55-62.*

Furness, R, W., Tasker, M, L. 2000. Seabird – fishery interactions: quantifying the sensitivity of seabirds to reductions in sandeel abundance and identification of key areas for sensitive seabirds in the North Sea. Marine Ecology Progress Series, Vol 202: 253-264.

Gascoigne, J., Osborn, G., Kantola, K., Cook, B., Galanidi, M., Saurel, C., Donald, E. and Kaiser, M. (2007). *Partial harvesting of intertidal seed mussel beds: consequences for mussel growth and mussel bed biodiversity. (*Unpublished*?)*

Goss-Custard JD *et al*. 2004. When enough is not enough: shorebirds and shellfishing. *Proc R Soc Lond* B 271, 233-237

Goss-Custard, J.D., Stillman R.A., West, A.D., Caldow, R.W.G., Triplet, P., le V. dit Durell S.E.A. & McGrprty, S. (2004). *When enough is not enough: shorebirds and shellfishing.* Proceedings of the Royal Society of London. B. **271**, 233-237.

Gruet, Y. (1984). *Granulometric Evolution of the Sand Tube in Relation to growth of the Polychaete Annelid Sabellaria alveolata (*Linne*) (Sabellariidae).* Ophelia. 23(2). pp. 181-193

Gruet, Y. (1986). *Spatio-temporal Changes of Sabellarian Reefs Built by Sedentary Polychaete Sabellaria alveolata (*LINNE*).* Marine Ecology. 7(4). pp. 303-319.

Hamilton, D.J., Nudds, T.D. and Neate, J. (1999). Size-Selective Predation of Blue Mussels (*Mytilus edulis*) by Common Eiders (*Somateria mollissima*) under Controlled Field Conditions. The Auk. Vol. **116**, No. 2 (Apr., 1999), pp. 403-416 http://www.jstor.org/stable/4089374?seq=1#page_scan_tab_contents

Hilgerloh (1997). Predation by birds on blue mussel *Mytilus edulis* beds of the tidal flats of Spiekeroog (southern North Sea). Marine Ecology Progress Series. Vol. **146**. 61-72.

Knott, M. (2009). The Effect on the Stability of the Reefs Built by the Honeycomb Worm (*Sabellaria alveolata*) in relation to the population density of the Blue Mussel (*Mytilus edulis*) and the Implications for the management of the seed mussel fishery at Heysham Flat Skear, Morecambe Bay, England. Dissertation as part of BSc (Hons) Degree in Marine Biology & Coastal Zone Management. Lancaster University with Blackpooland the Fylde College.

Larsen, J.K. and Guillemette, M. (2000). Influence of annual variation in food supply on abundance of wintering common eiders *Somateria mollissima* MARINE ECOLOGY PROGRESS SERIES. Vol. **201**: 301–309. http://www.int-res.com/articles/meps/201/m201p301.pdf

MAFF and NW&NWSFC Surveys. 1968 – 2001.

Maree, B.A, Wabless, R.M, Fairweather T.P, Sullivan, B.J, Yates, O 2014. Significant reductions in mortality of threatened seabirds in a South African trawl fishery. *Animal Conservation.* Volume 17, issue 6 pages 520-529.

Mettam, C., Conneely, M.E. & White, S.J. (1994). *Benthic macrofauna and sediments in the Severn Estuary.* Biological Journal of the Linnean Society. 51 pp. 71-81.

Natural England Marine Interim Conservation Advice for Special Protection Area (UK9005081), UK9005081_Morecambe_Bay_SPA_Advice_on_Operations
UK9005081_Morecambe_Bay_SPA_SAT_Birds

Natural England Marine Interim Conservation Advice for Special Area of Conservation (UK0013027), UK0013027_Morecambe_Bay_SAC_Advice_on_Operations
UK0013027_Morecambe_Bay_SAC_Generic_SAT_Habitats
UK0013027_Morecambe_Bay_SAC_Generic_SAT_Species

NWIFCA – TSB Minutes. (9th August 2016). http://www.nw-ifca.gov.uk/app/uploads/TSB-2016-Minutes-9-Aug.pdf

Oliver, C. (2016). Update 2015 Distribution mapping and health assessment of honeycomb worm, Sabellaria alveolata, reefs on Heysham Flat, Lancashire.

Porras, R., Bataller, J.V., Murgui, E. & Torregrosa, M.T. (1996). *Trophic Structure and Community Composition of Polychaetes Inhabiting Some Sabellaria alveolata* (L) *Reefs Along the Valencia Gulf Coast, Western Mediterranean.* Marine Ecology. 14(4). pp. 583-602.

Thaxter et al. (2010). Wintering population of eider currently exceeds the SPA baseline but Morecambe Bay has shown greater decline from the post-designation increase regionally and nationally in wintering eider population than at the national scale, suggesting site specific pressures. http://app.bto.org/webs-reporting/?tab=alerts

Tyler-Walters, H. & Arnold, C. (2008). *Sensitivity of Intertidal Benthic Habitats to Impacts Caused by Access to Fishing Grounds.* Report to Cyngor Cefn Gwlad Cymru / Countryside Council for Wales from the Marine Life Information Network. (MarLIN). UK.
UKBAP. 2008.

Wilson, D.P. (1968a). *The settlement behaviour of the larvae of Sabellaria alveolata* (L.*)* Journal of the Marine Biological Association of the UK. 48. 387-435.

Wilson, D.P. (1968b). *Some aspects of the development of eggs and larvae of Sabellaria alveolata* (L.) Journal of the Marine Biological Association of the UK. 48. 367-386.

Wilson, D.P. (1971). *Sabellaria colonies at Duckpool, North Cornwall. 1961 – 1970.* Journal of the Marine Biological Association of the UK. 51. 509-580.

Wilson, D.P. (1974). *Sabellaria colonies at Duckpool, North Cornwall. 1971 – 1972, with a note for May 1973.* Journal of the Marine Biological Association of the UK. 54. 393-436.

Wilcox, R. (2013). Review of the incidence of pearling in the mussel, *Mytilus edulis*: With reference to the mussel beds of the Walney Channel, Barrow-in-Furness, Cumbria, England. Cumbria Wildlife Trust and NWIFCA.

Woolmer, A.P. 2011a*. Standard Operating Procedure for screening seed mussel beds for the Chinese mitten crab (Eriocheir sinensis)*. Report to Bangor Mussel Producers Association. pp 11.

Woolmer, A.P. 2011b. *Chinese mitten crab (Eriocheir sinensis) Assessment Salisbury Bank Seed Mussel Bed (Dee Estuary): Dredge Survey*. Report to Bangor Mussel Producers Association. pp 5

Woolmer, A.P. 2011c. *Chinese mitten crab (Eriocheir sinensis) Assessment Salisbury Bank Seed Mussel Bed (Dee Estuary): Timed Search Foot Survey*. Report to Bangor Mussel Producers Association. pp 8

Woombs, M. (1999). *Monitoring of Biotopes on Rocky Skears in Morecambe Bay, European Marine Site. A Report for English Nature.* W.A. Marine & Environment.

Annex 2: Heysham inspection reports

Heysham Flat Mussel Inspection 01-03-22

LW 117:10 1.2m (Liverpool Tides)

Officers accessed the skear on foot to inspect the mussel on Heysham Flat. Dallam Dyke was not crossed due to water depth and tide.

There is still a significant *Sabellaria alveolata* reef distributed across much of the skear, with large areas covered by reef, some living and some deteriorated with thin mud/sand on top (Figure 1). Accessing all areas of the skear was made difficult by the extent of reef. The extensive area of reef was present on the North and South of the Skear as seen it previous years but as in 2021 it now extends across the skear from Conger Rock to Dallam Dyke (Figures 2 and 3). The extent is similar to that observed pre 2016 where much of the end of the skear was covered by *Sabellaria alveolata*.

Some mussel had persisted over the winter, with patches of 25-40mm mussel, particularly along the Northern edge of the skear and Dallam Dyke. Much of the live mussel was mixed in with the *Sabellaria alveloata*. There was the occasional size mussel present across the bed. The cleaner and more consistent mussel was found along Dallam Dyke, with some areas of 80-90% coverage. There were no signs of a 2022 mussel settlement but this could be due to the early time of year of the survey. Some areas of bare cobble and dead shell were also present on the skear.

Knott End Skear appeared similar in colour to the main skear so it is presumed that there is mussel present but this cannot be confirmed as access was not possible by foot. There are a number of skear present beyond Knott End skear. Oystercatcher in large numbers feeding on the Southern edge of Heysham Flat skear.

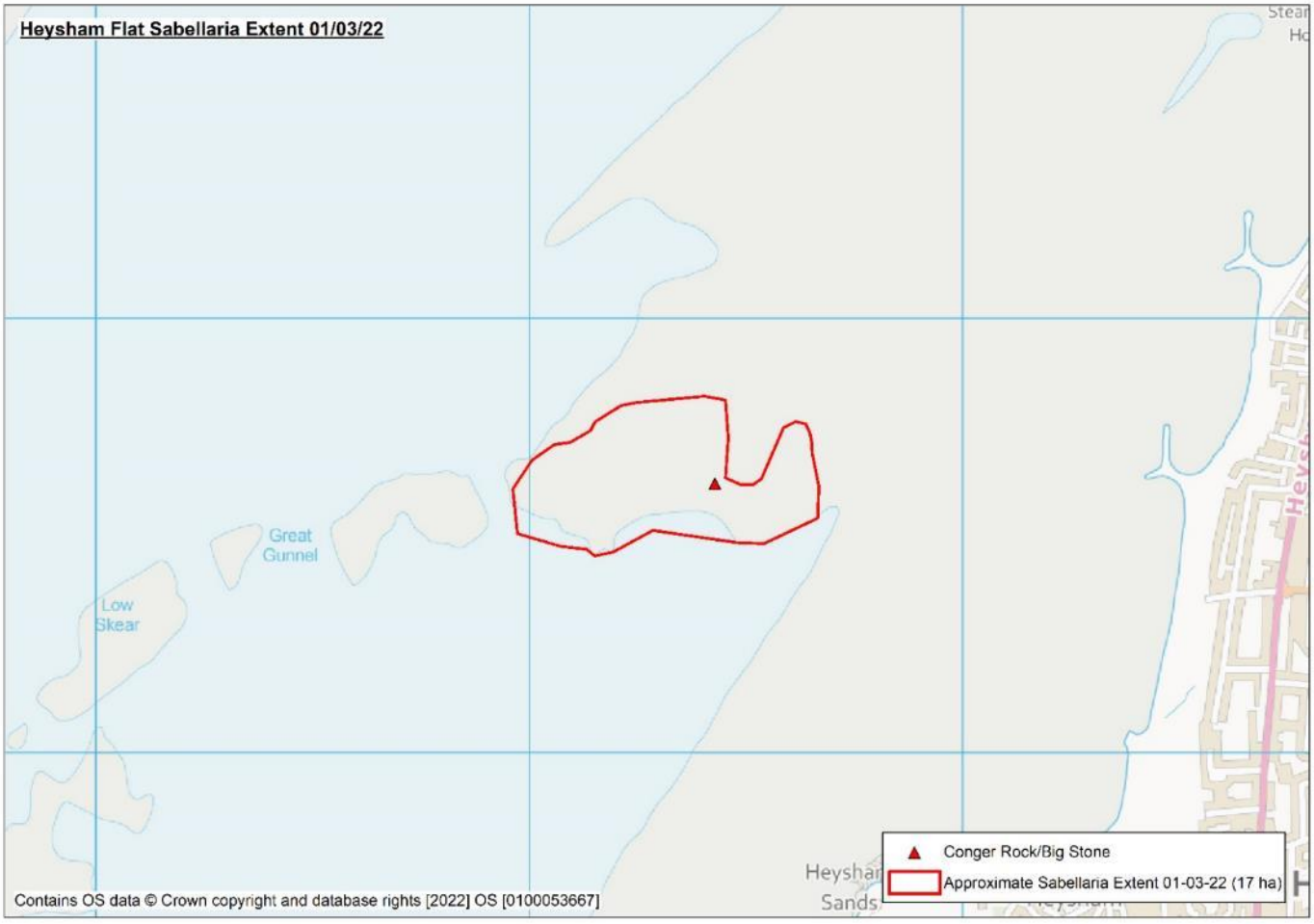


Fig.1 *Sabellaria alveolata* approximate extent 01-03-22.

Fig. 2 Extensive *Sabellaria alveolata* reefs 01-03-22.

Fig. 3 Extensive *Sabellaria alveolata* reefs 01-03-22.

Fig. 4 25-40mm mussel in mud on Heysham Flat 01-03-22.

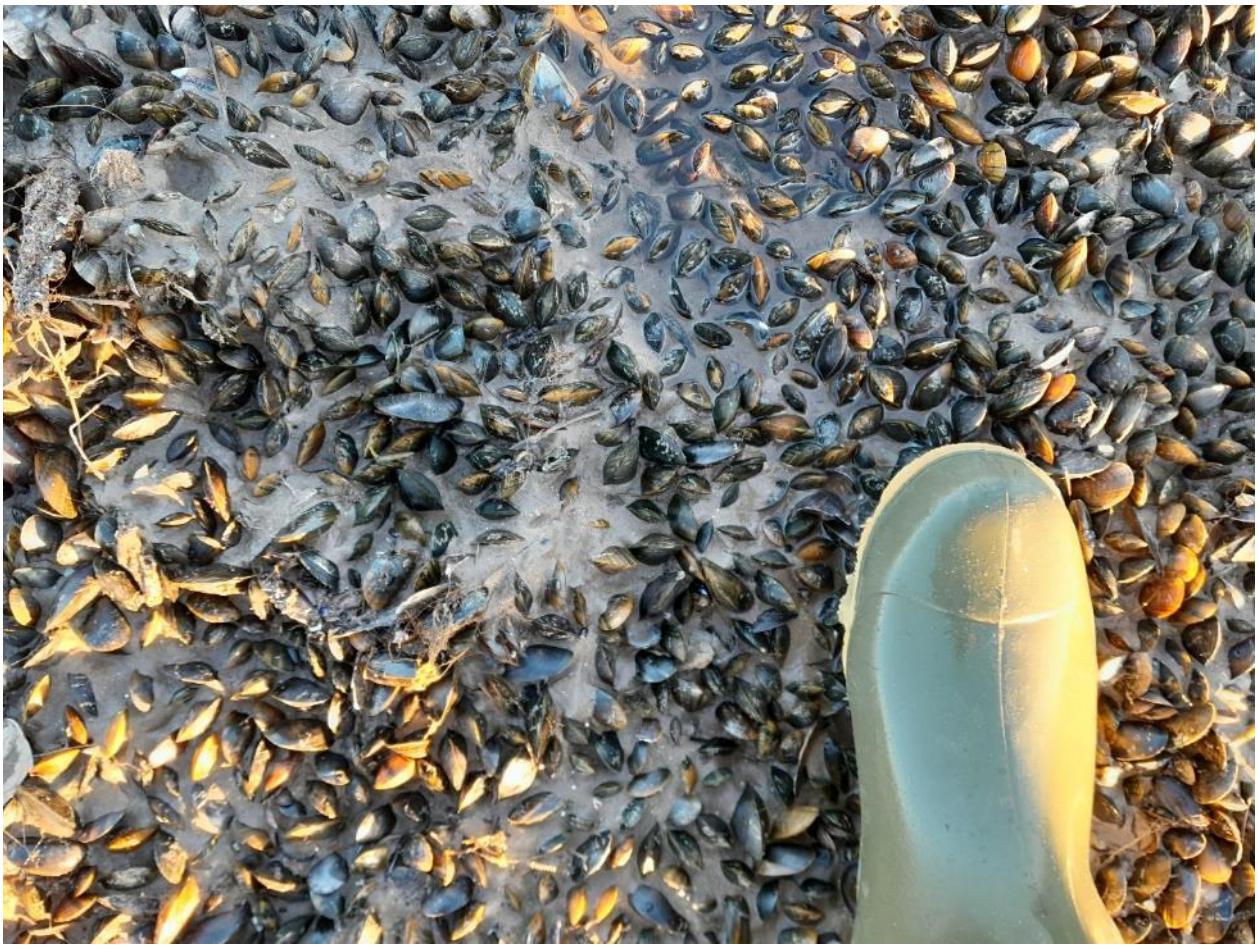


Fig. 5 Cleaner mussel of 25-40mm along the edge of Dallam dyke 01-03-22.

Fig. 6 Cleaner mussel of 25-40mm along the edge of Dallam dyke 01-03-22.

Heysham Flat Mussel Inspection 16-05-22

LW 06:29 1.1m (Liverpool Tides)

Officers accessed the skear on foot to inspect the mussel on Heysham Flat. Dallam Dyke was not crossed due to water depth and tide.

The *Sabellaria alveolata* reef that has been seen distributed across much of the skear is now less obvious. It is likely that the majority is now covered and smothered by substrate of mud and sand with mussel seed coverage high. Some areas, particularly on the Southern extent of the skear, are covered by reef, some living and some deteriorated with thin mud/sand on top. Accessing the skear was easier due to the lower extent of reef. The extensive areas of reef present on the North and South of the Skear were as seen it previous years but it no longer extends across the skear from Conger Rock to Dallam Dyke as seen on the March inspection.

Mussel has persisted over the winter, with large areas of 30-40mm mussel, particularly in the area before Dallam Dyke. Much of the live mussel was mixed in with seed settlement. There was the occasional size mussel present across the bed. The cleaner and more consistent mussel was found before reaching and along Dallam Dyke, with some areas of 80-90% coverage. Some areas of bare cobble and dead shell were also present on the skear, particularly on the boundary with Sabellaria reef on the Southern edge of the skear.

Knott End Skear appeared dark in colour, similar to the main skear so it is presumed that there is mussel present but this cannot be confirmed as access was not possible by foot. There are a number of skear present beyond Knott End skear.

Oystercatcher and gulls were present in large numbers feeding on the Southern edge of Heysham Flat skear.

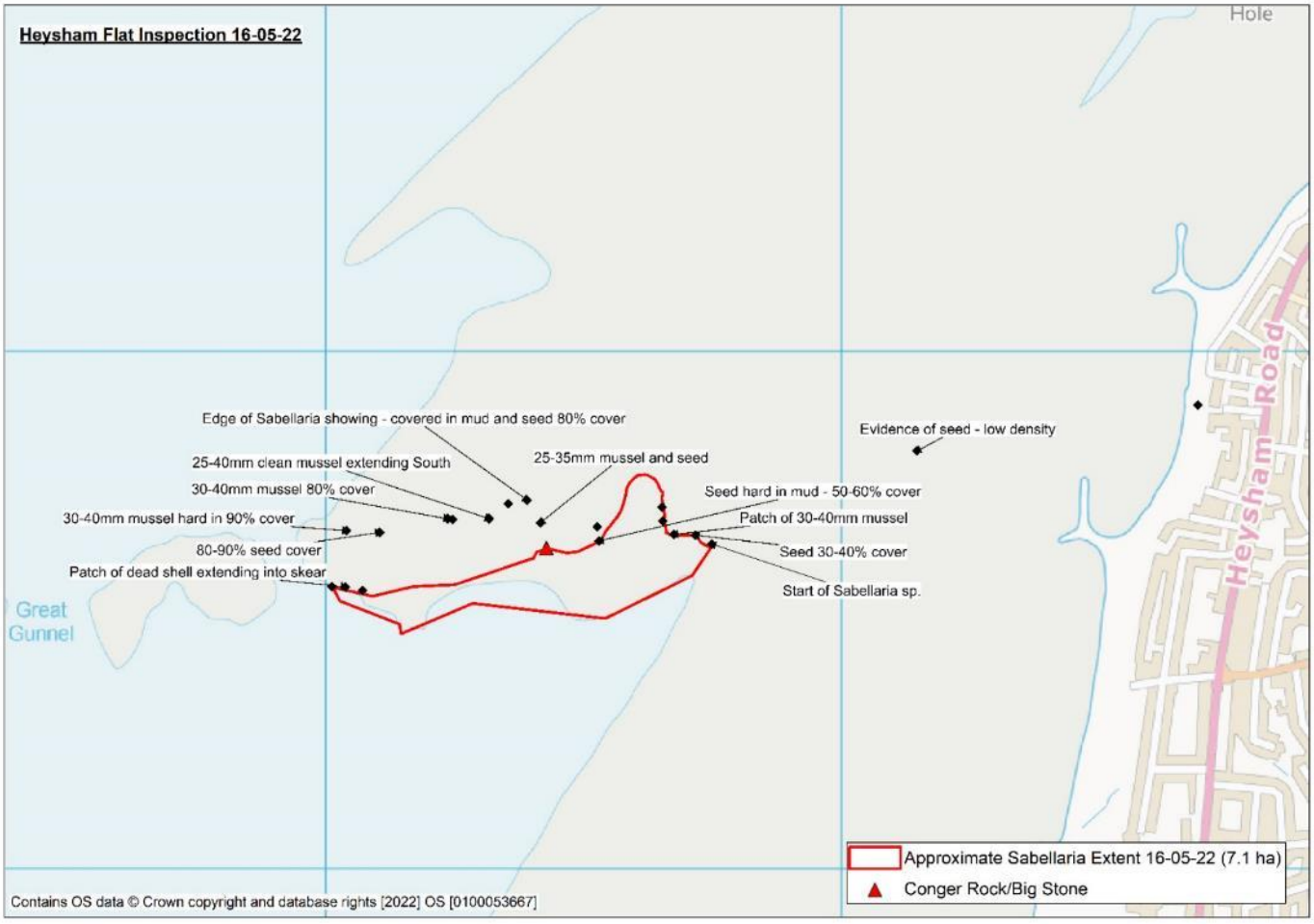


Fig.1 *Sabellaria alveolata* approximate extent 16-05-22.

Fig.2 Sabellaria sp. covered by mud/sand and seed mussel 16-05-22.

Fig.3 30-40mm mussel 16-05-22.

Fig.4 Band of potentially old Sabellaria sp. majority smothered by mud/sand and seed mussel 16-05-22.

Fig. 5 High density 30-40mm mussel towards Dallam Dyke.

Fig. 6 Large area of Mussel 30-40mm towards Dallam Dyke.

Heysham Flat Mussel Follow Up Inspection 27-05-22

Officers present: JH, AP
Tides LW 16:51 1.9m (Liverpool tides)

An inspection was carried out on 16th May where it was reported that there were areas of 30-40mm mussel remaining from 2021 which were free of the 2022 seed settlement. In previous years any remaining mussel is usually smothered by the following year settlement, but as there were areas of seed free 2021 mussel, officers wanted to complete a follow up inspection to monitor the situation. The other consideration were that these areas were present on *Sabellaria alveolata* reef which had been smothered.

The inspection focussed on the areas where 2021 mussel remained. Some areas of clean 2021 persisted closer to Dallam Dyke (Figure 1 and 2). The areas of 2021 mussel which were free from seed has reduced with more 2022 seed persistently mixed in (Figure 3 and 4). The mussel present from Conger Rock to Dallam Dyke is likely present on 2021 *Sabellaria alveolata* which is evident in areas (Figure 5 and 6).

A further inspection will be planned to monitor the development of the areas of mixed 2021 / 2022 seed.

Fig 1. Area of 2021 30-40mm mussel which is free of 2022 seed 27-05-22

Fig 2 – Area of 2021 30-40mm mussel which is free of 2022 seed with evidence of sand on top of mussel 27-05-22

Fig 3 – Area of 2021 30-40mm mussel mixed with 2022 seed 27-05-22

Fig 4 – Overview of skear, 2021 30-40mm mussel mixed with 2022 seed 27-05-22

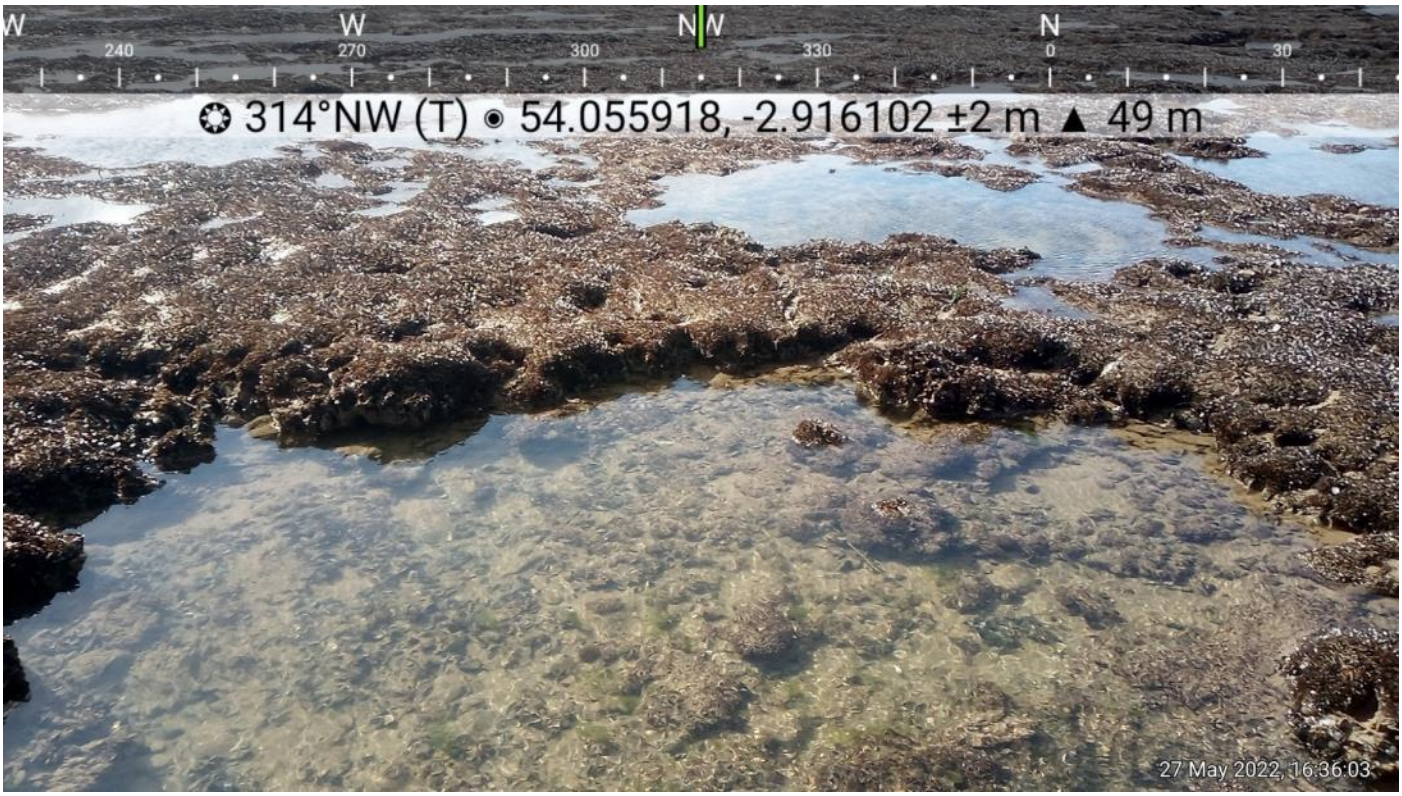


Fig 5 – Evidence of mussel present on 2021 *Sabellaria alveolata* 27-05-22

Heysham Flat Mussel Inspection 16-07-22

Officers present: JH, AG
Tides LW 08:351 0.7m (Liverpool tides)

The area on the higher shore to conger rock consisted of mussel 15 to 20mm with ~ 90-95% coverage (Figure 1). The mussel was hard in a layer of sandy mud (Figure 2).

The area from conger rock to Dallam dyke has changed considerably since the last inspection with a significant layer of sediment under the mussel. The underlying substrate is a mix of sand and mud and is firm unlike the usual mussel mud present on heysham. The layer of sediment is ~1m in depth with no visable presence of *Sabellaria alveolata* other than on the North and South of the skear away from the main mussel bed. There is a range of size classes of mussel across the area from 15-50mm in length (Figures 5 and 7). There are very few areas where there is one size class of mussel. Figure 6 shows a small are ~2m² of size mussel free of 2022 seed. There are no signs of scouring although the mussel is loose in some areas (Figures 7 and 8).

Access to the outer skears was not possible across Dallam dyke although anglers had accessed the outer skear using a sandbank to the North of Heysham Flat. It is possible that there would be access to the outer skear via quad bike on spring tides.

Fig 1. Dense 2022 seed mussel higher up the shore 16-07-22

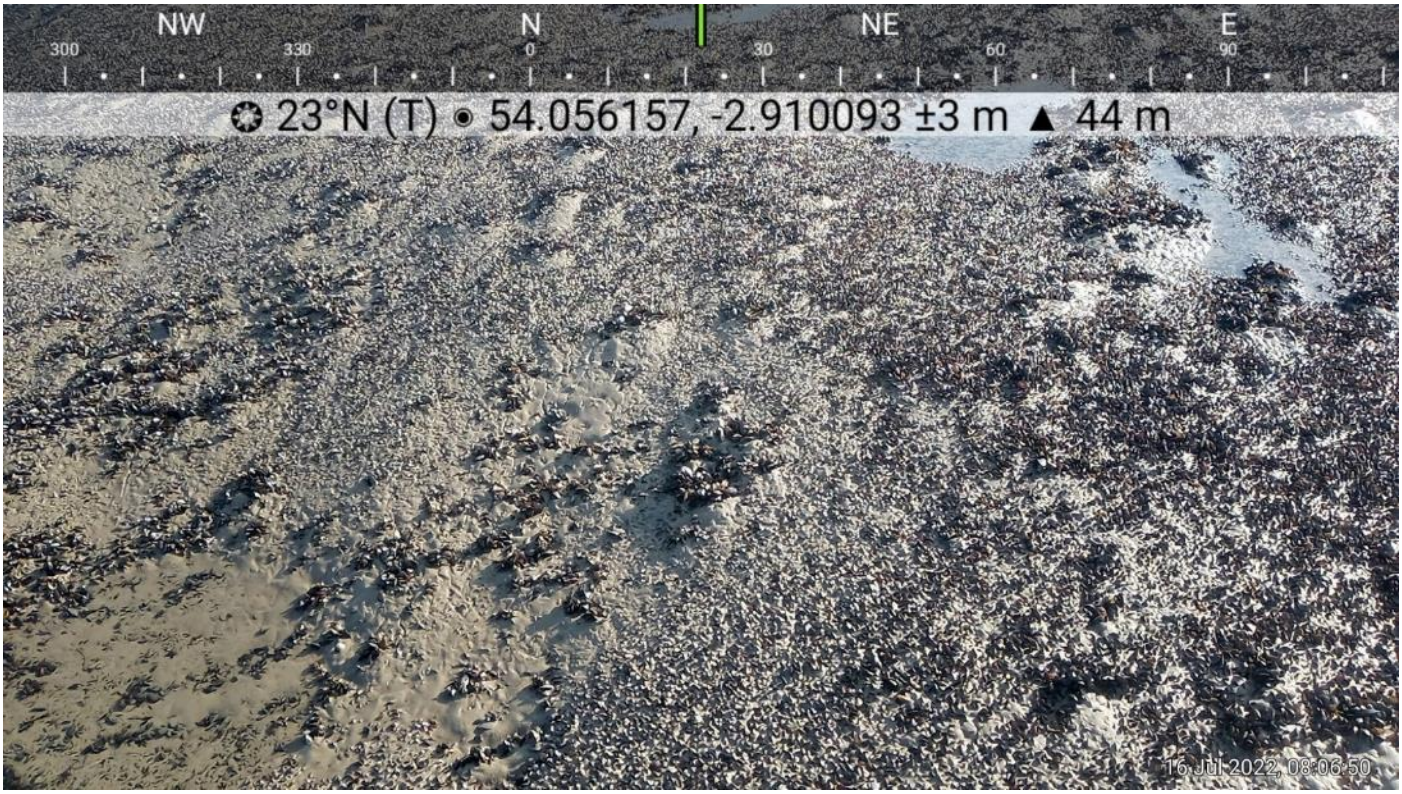


Fig 2 – Dense 2022 seed mussel on a sandy mud substrate and relatively hard in 16-07-22

Fig 3 – Channel through the mussel bed showing the depth of sediment above hard substrate 16-07-22

Fig 4 – Channel through the mussel bed showing the depth of sediment above hard substrate 16-07-22

Fig 5 – Mix size classes of mussel present on most of the skear between Conger rock and Dallam Dyke 16-07-22

Fig 6 – Small area of size mussel present ~2m² 16-07-22

Fig 7 – Area of loose mussel and mixed size classes 15-50mm 16-07-22

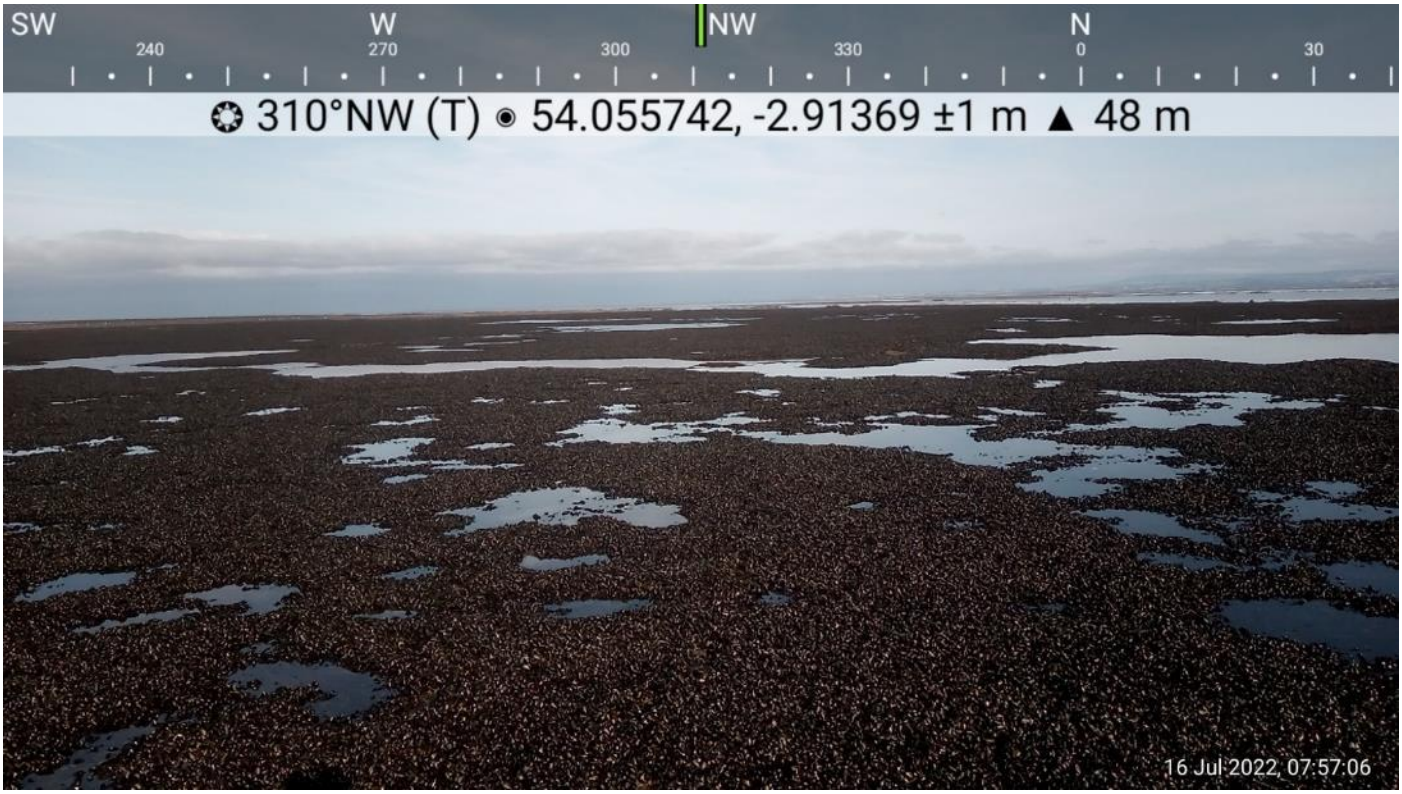


Fig 8 – Area between Conger rock and Dallam Dyke with no signs of scouring 16-07-22

Heysham Flat Mussel Inspection 12-08-22

Officers present: JH, AP, MC
Tides LW 06:44 1.0m (Liverpool tides)

The area on the higher shore to conger rock consisted of mussel 20-25mm with some up to 35mm mixed in ~ 80-90% coverage. The mussel was predominantly loose with some hard in and scoured areas were present.

The area from conger rock to Dallam dyke has a mix of two different size/year classes, 25-35 mm mixed with larger mussel of 35-55mm. Areas further down the skear were very mixed, with size mussel making up approximately 40-50% of overall weight. The underlying substrate is a mix of sand and mud and is firm unlike the usual mussel mud present on Heysham. Visable presence of *Sabellaria alveolata* was found, with a band present across much of the skear to the West of conger rock (Figure 1). *Sabellaria* was also still present on the North and South of the skear away from the main mussel bed. Both sides of Dallam Dyke were scoured in large areas.

Access to the outer skears was not possible across Dallam dyke although anglers had accessed the outer skear using a sandbank to the North of Heysham Flat.

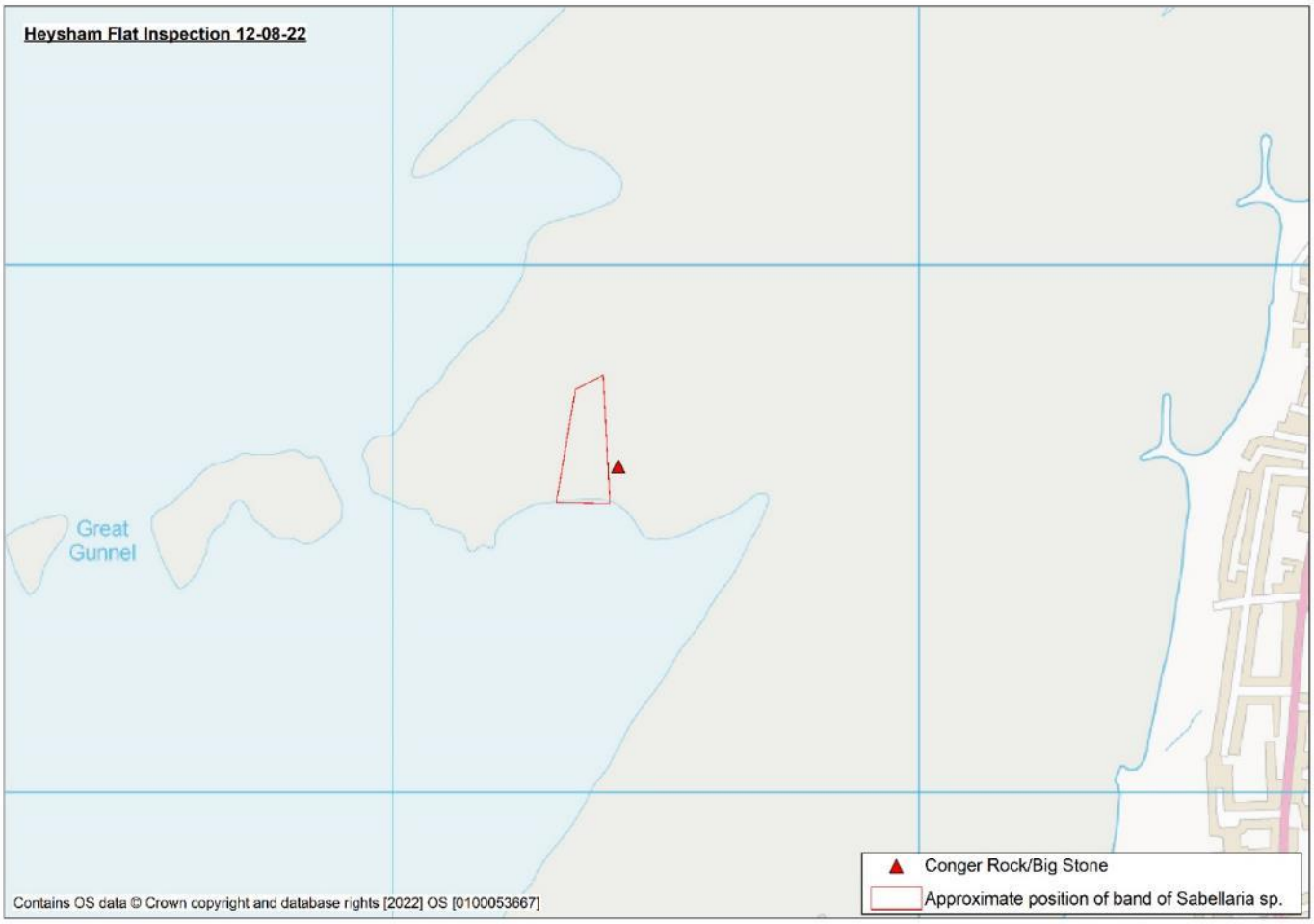


Figure 1. Map to show the approximate extent of the band of *Sabellaria sp.* present on Heysham Flat 12-08-22.

Fig 2. Area of seed before Conger Rock 12-08-2022

Fig 3. Dense seed mussel present on Heysham Flat before Conger Rock

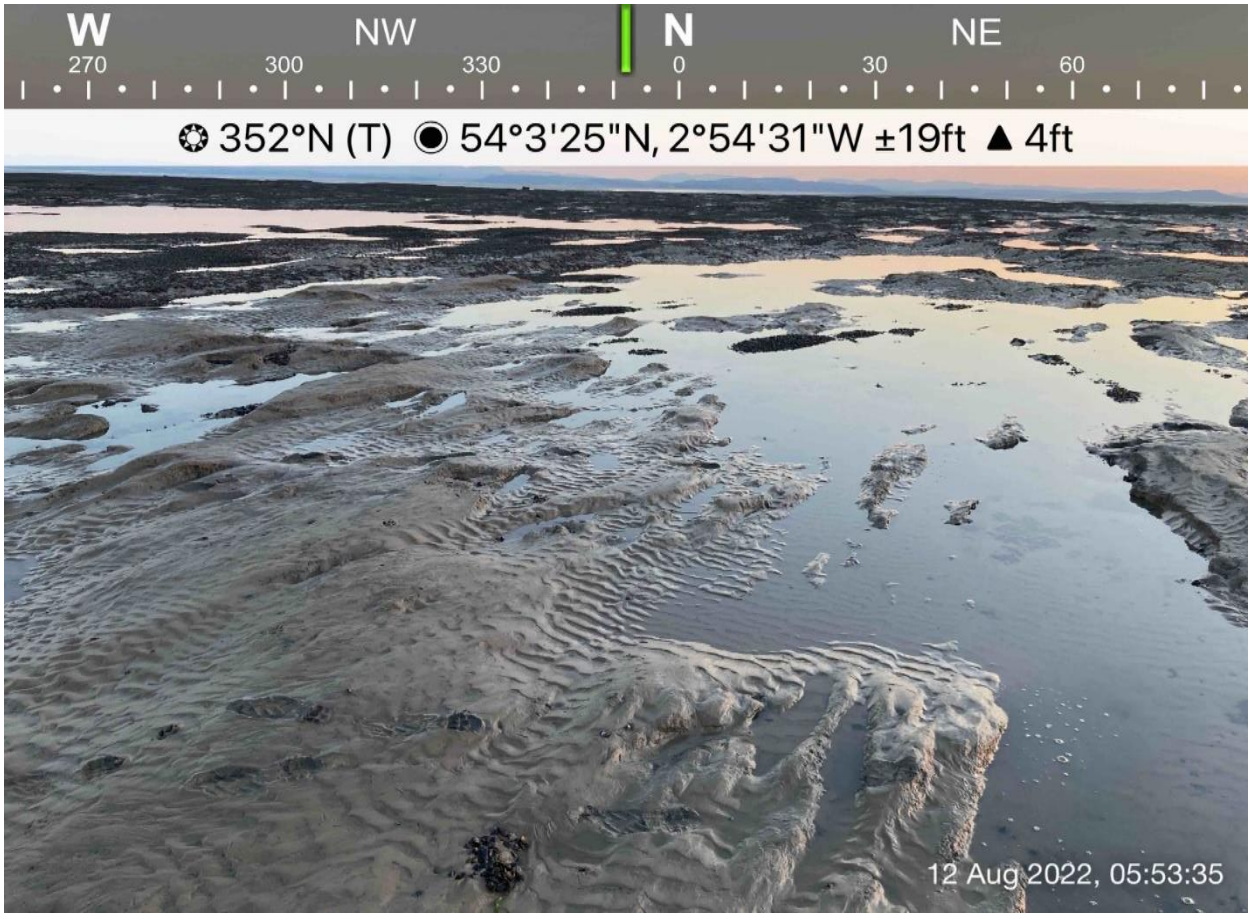


Fig 4. Evidence of early scouring in the foreshore part of the bed.

Fig 5. Evidence of scouring over the seaward side of Dallam Dyke.

Fig 6. Patchy, scoured mussel on the shoreward side of Dallam Dyke.

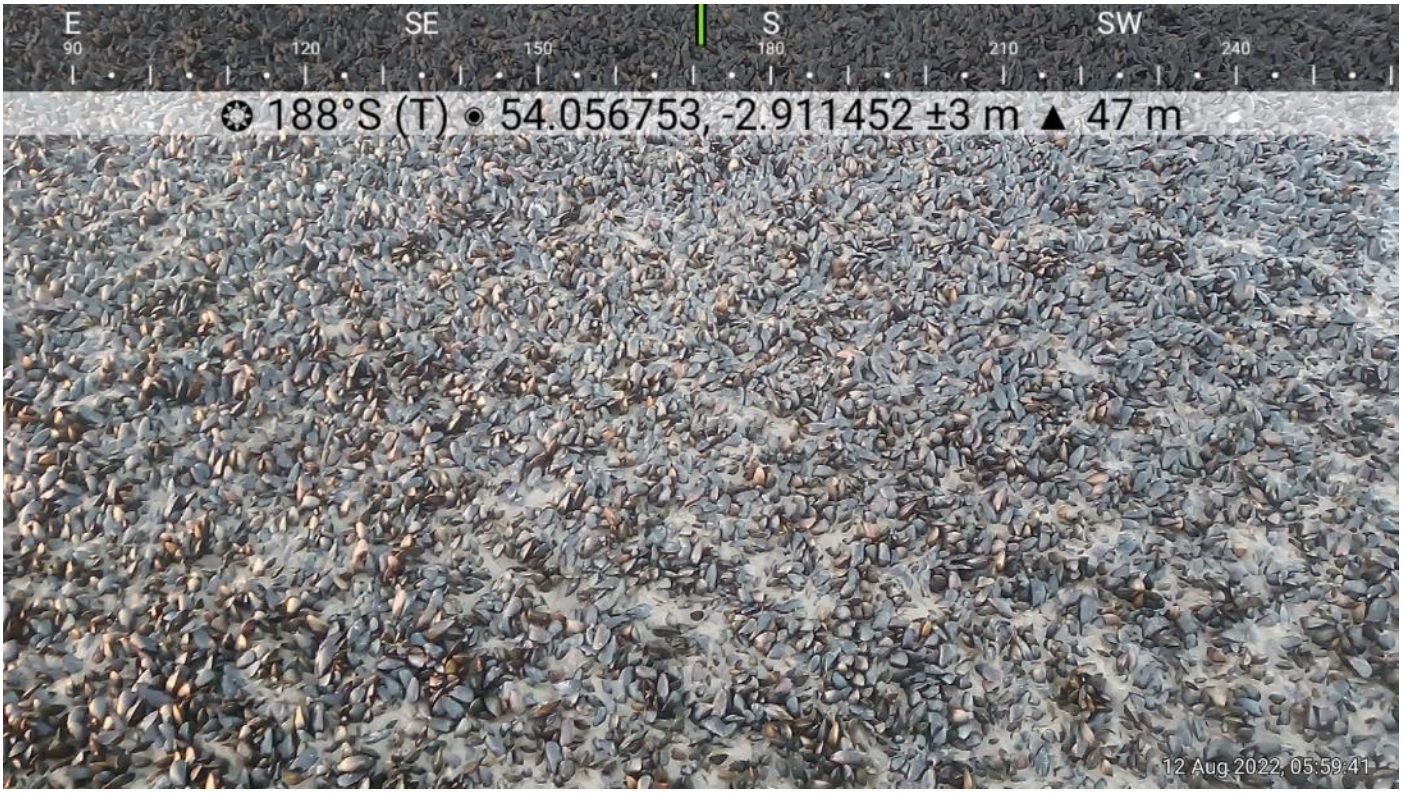


Fig 7. Size mussel present between Conger Rock and Dallam Dyke

Fig 8. Mix of size mussel on Heysham between Dallam and Conger Rock.

Fig 9. Size mussel

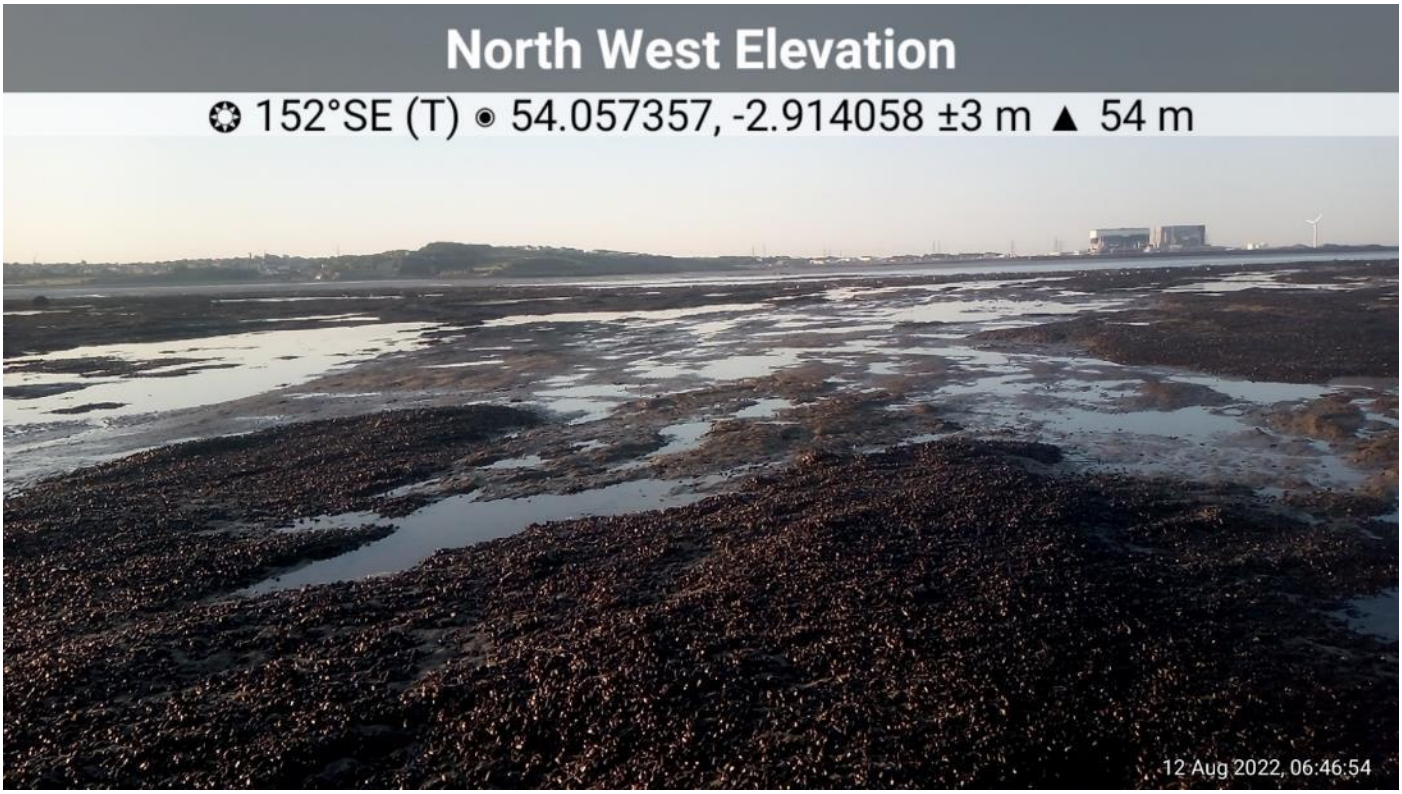


Fig 10. Scouring on the seaward side of Conger Rock.

Annex 3. South America mussel bed inspections

South America Mussel Inspection 19-04-22

LW 08:13 0.9m (Liverpool Tides)

An inspection of South America was completed to assess if any mussel persisted from 2021 and if there were signs of a 2022 settlement. There has been changes to the channels meaning that access was reduced to half an hour before low water.
NWIFCA track data has been provided in Figure 1 with the bed area mapped for reference from 2021. The area consisted of exposed hard substrate (mix of pebbles and small cobbles), sand and shell debris. There was the very occasional live mussel in the areas of shell debris. The mussel was 30-35mm in length. The area which dried out was walked but no 2022 mussel settlement was observed.

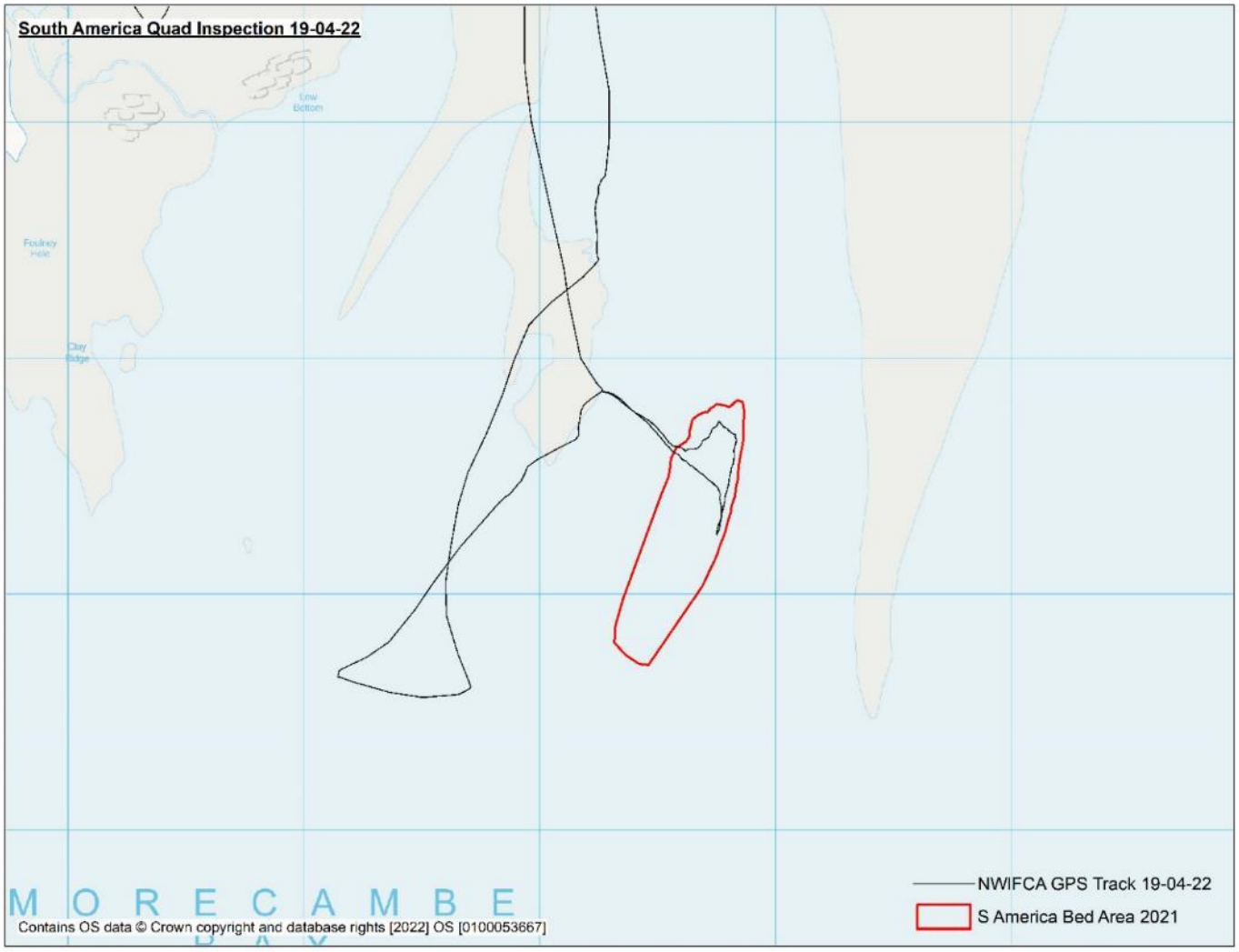


Fig 1. NWIFCA Track Data with 2021 Bed Area for Reference 19-04-22.

Fig 2. Shell Debris with Occasional Live Mussel 19-04-22.

Fig 3. Exposed Hard Ground 19-04-22.

Fig 4. Overview of South America 19-04-22.

Fig 5. Overview of South America 19-04-22.

South America Mussel Inspection (Quad) 17-06-22

LW: 08:39 1.0m (Liverpool tides)

An inspection of South America was completed to assess if the bed had received a 2022 mussel settlement, and assess the condition of the remaining mussel from 2021 since the inspection in April. There has been a change to the channel South America is located in with the shoreward side becoming deeper and returning back to hard substrate meaning that access was reduced to half an hour over low water.

NWIFCA track data has been provided in Figure 1 with the bed area mapped for reference from 2021. The area inspected was a mix of 2022 seed and 2021 mussel. The seed was approximately 10mm and the 2021 mussel 35-45mm. The seed was at a higher density (40% - 50% coverage) to the North (Figure 2 and 3) of the inspected area and became less dense to the South (Figure 4). Where the mussel is present it is on a very thin sand veneer, between the mussel there is a lot of exposed hard substrate (Figure 5).

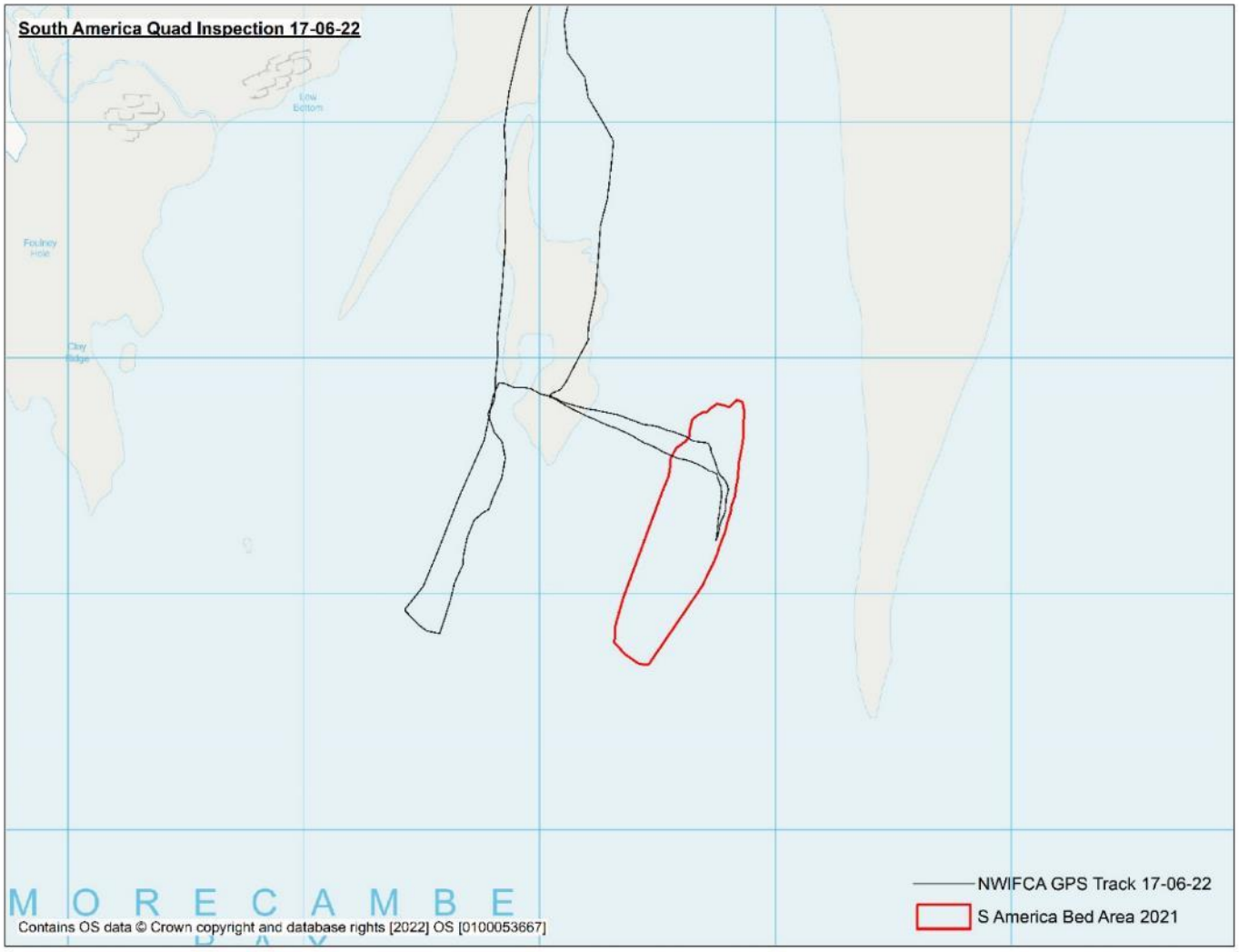


Fig 1. NWIFCA Track Data with 2021 Bed Area for Reference 17-06-22

Fig 2. Area of denser 2022 seed and 2021 mussel 17-06-22

Fig 3. Overview of the North End of the Skear 17-06-22

Fig 4. Southern extent of the inspected area consisting of shell debris, 2021 mussel and occasional patches of 2022 seed.

Fig 5. Exposed hard substrate present in between the areas of mussel 17-06-22

South America Mussel Inspection (Quad) 17-07-22

LW: 09:23 0.8m (Liverpool tides)

An inspection of South America was completed to assess the condition of the mussel previously inspected in June. Access has changed further with much of the sand being washed down to stony substrate to the west of the skear with a 500m channel needing to be crossed to access the bed (Figure 1 and 2). Due to the depth of the channel the bed was accessed on foot. Access for officers was approximately half an hour over low tide.

NWIFCA track data has been provided in Figure 1 with the bed area mapped for reference from 2021. The Northern end of the skear had sparse mussel with exposed stony substrate (Figure 3). The mussel increased in density towards the middle of the bed, the seed mussel was 15-25mm in length with the occasional size mussel mixed in Figure 4. In the middle of the bed the mussel was on a muddy substrate and was relatively loose. On the Eastern side of the bed, the mussel reduced in density moving South with the layer of sediment over the stony substrate reducing in depth until there was no mud/sand between the mussel and the stony subsrate (Figures 7, 9, 10 and 11). There was a patchy ~10m² consisting of barnacled size mussel (Figure 8). The end of the skear went to bare cobble (Figure 12). The Western side of the bed mainly consisted of loose 2022 seed, with occasional size mussel present on a muddy substrate (Figure 13 to 15).

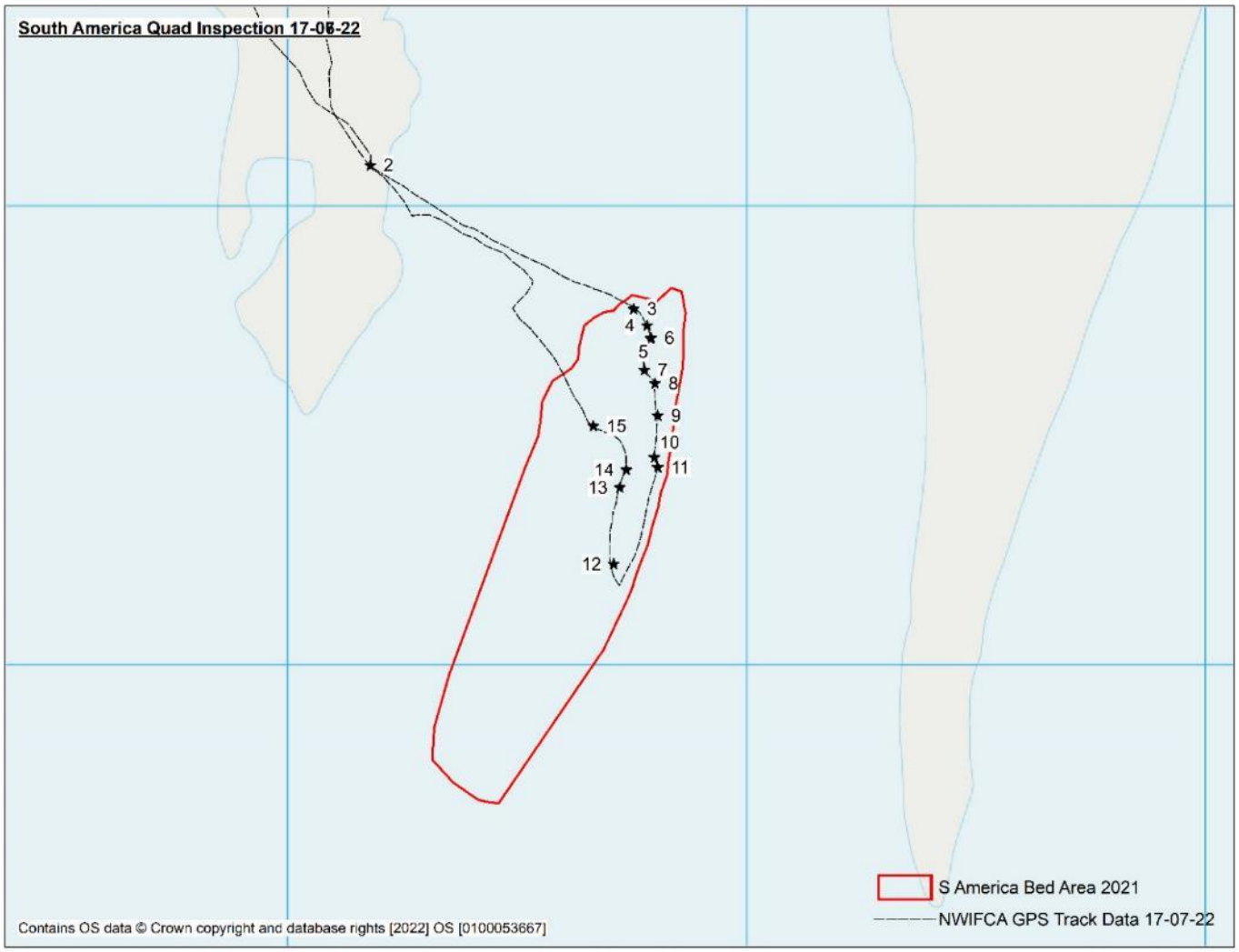


Fig 1. NWIFCA Track Data with Figure Number and 2021 Bed Area for Reference 17-07-22

Fig 2. Large area of bare ground exposed by changing channels with South America mussel bed in the background 17-07-22

Fig 3. Sparse 2022 seed mussel on the edge of the bed with exposed stony substrate

Fig 4. 15-25mm 2022 seed mussel with occasional size (+45mm) mussel present 17-07-22

Fig 5. Loose 2022 seed mussel with some size mussel present on a muddy substrate 17-07-22

Fig 6. Overview of loose 2022 seed mussel with some size mussel present on a muddy substrate 17-07-22

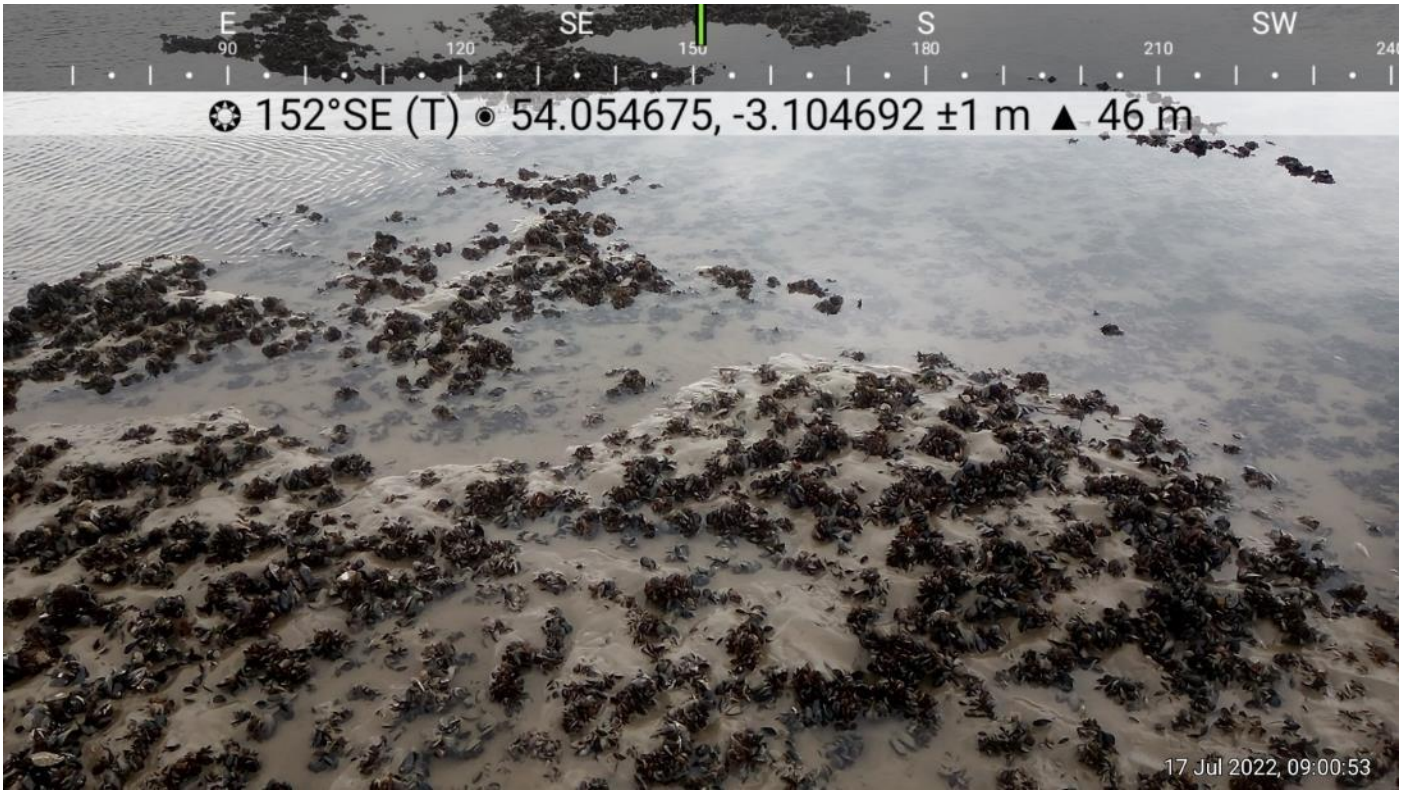


Fig 7. Mussel thinning out in density with some areas of exposed stony ground present 17-07-22

Fig 8. Area of barnacle mussel on stony substrate 17-07-22

Fig 9. Sparse mussel on stony substrate 17-07-22

Fig 10. Sparse mussel on stony substrate looking South down the skear 17-07-22

Fig 11. Sparse mussel on thin sandy layer 17-07-22

Fig 12. Bare stony substrate to the South of the skear 17-07-22

Fig 13. Mussel becoming denser on a muddy substrate 17-07-22

Fig 14. Overview of denser mussel on a muddy substrate 17-07-22

Fig 15. Overview of denser mussel on a muddy substrate 17-07-22

South America Mussel Inspection (Quad) 13-08-22

LW: 07:35 0.6m (Liverpool tides)

An inspection of South America was completed to assess the condition of the mussel previously inspected in July. Although tide and conditions were good, access remains limited to a short period over low water due to the depth and size of the channel needing to be crossed.

The area consisted of a mix of mussel on different substrates. Figure 1 highlights the different areas and includes NWIFCA track data. To the North of the mussel bed the mussel is patchy and on a thin layer of sediment, where there are bare areas the stony substrate is present. The mussel is a mix of 30-35mm mussel with size mixed in. The most size mussel is present in this area. The map indicates are area in red which would be suitable as a seed mussel fishery as the mussel is loose and on a soft sediment, there is already evidence of scouring (Figures 2 to 9). The mussel is 30-35mm with the occasional size mussel present. The further South the less size mussel is present. Beyond the South extent of the area suitable for fishing the mussel become less dense, with little to no settlement present between the mussel and the stony substrate until no mussel is present (Figures 10 and 11).

To the North East of mussel there is a large area of newly settled Sabellaria alveolata (Figures 12 and 13) which has inhabited the stony substrate exposed early this year.

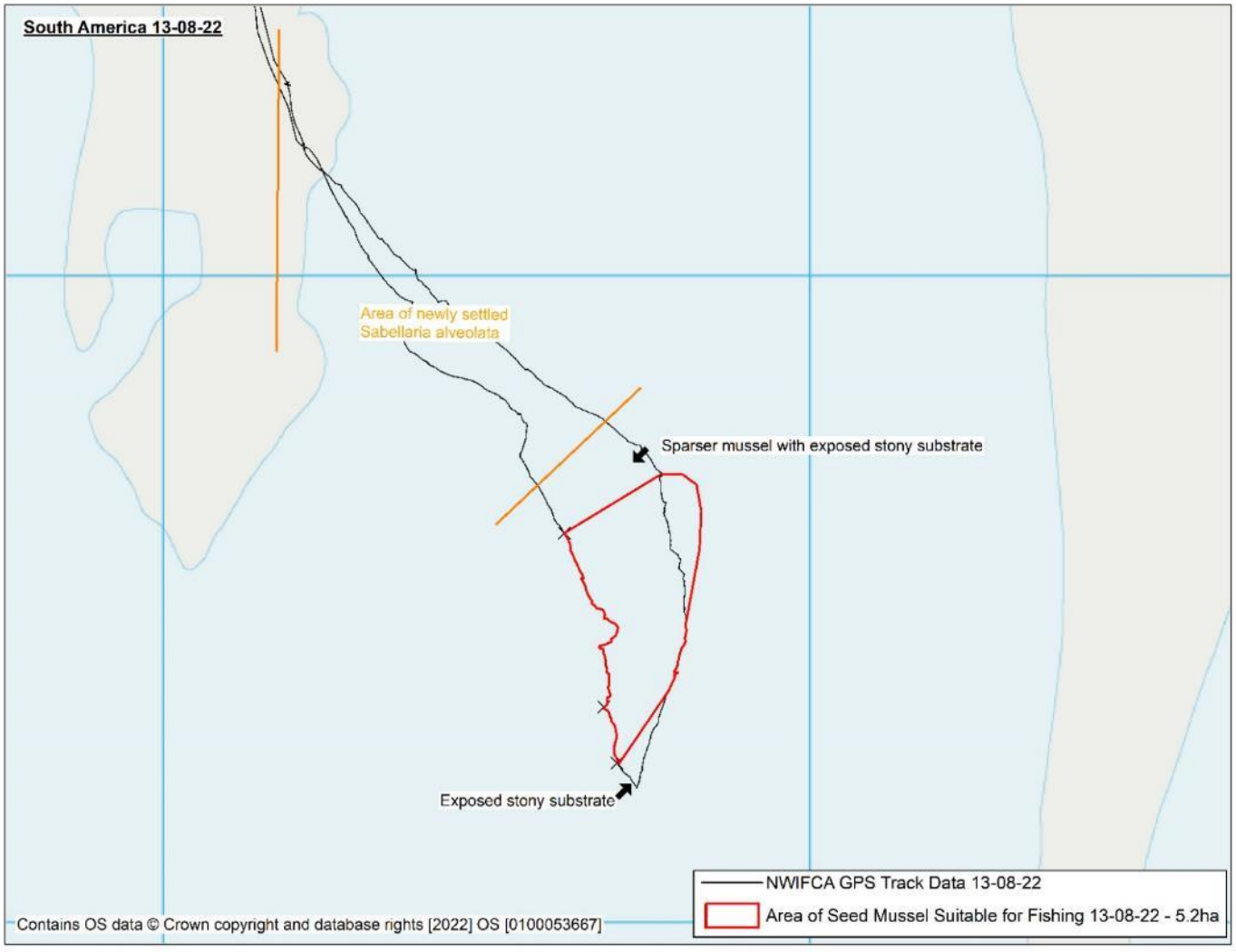


Fig 1. Map of South America including Area of Mussel Suitable for Fishing

Fig 2. North East of the mussel area, seed mussel with occasional size, with evidence of scouring 13-08-22

Fig 3. North East of the mussel bed, remaining mussel mud after scouring 13-08-22

Fig 4. North East of the mussel area, dense, loose seed mussel with occasional size mussel 13-08-22

Fig 5. Overview of the Eastern side of the skear looking west 13-08-22

Fig 6. Overview of the seed mussel from the West of the bed look East. Seed mussel with very little size present on layer of mussel mud 13-08-22

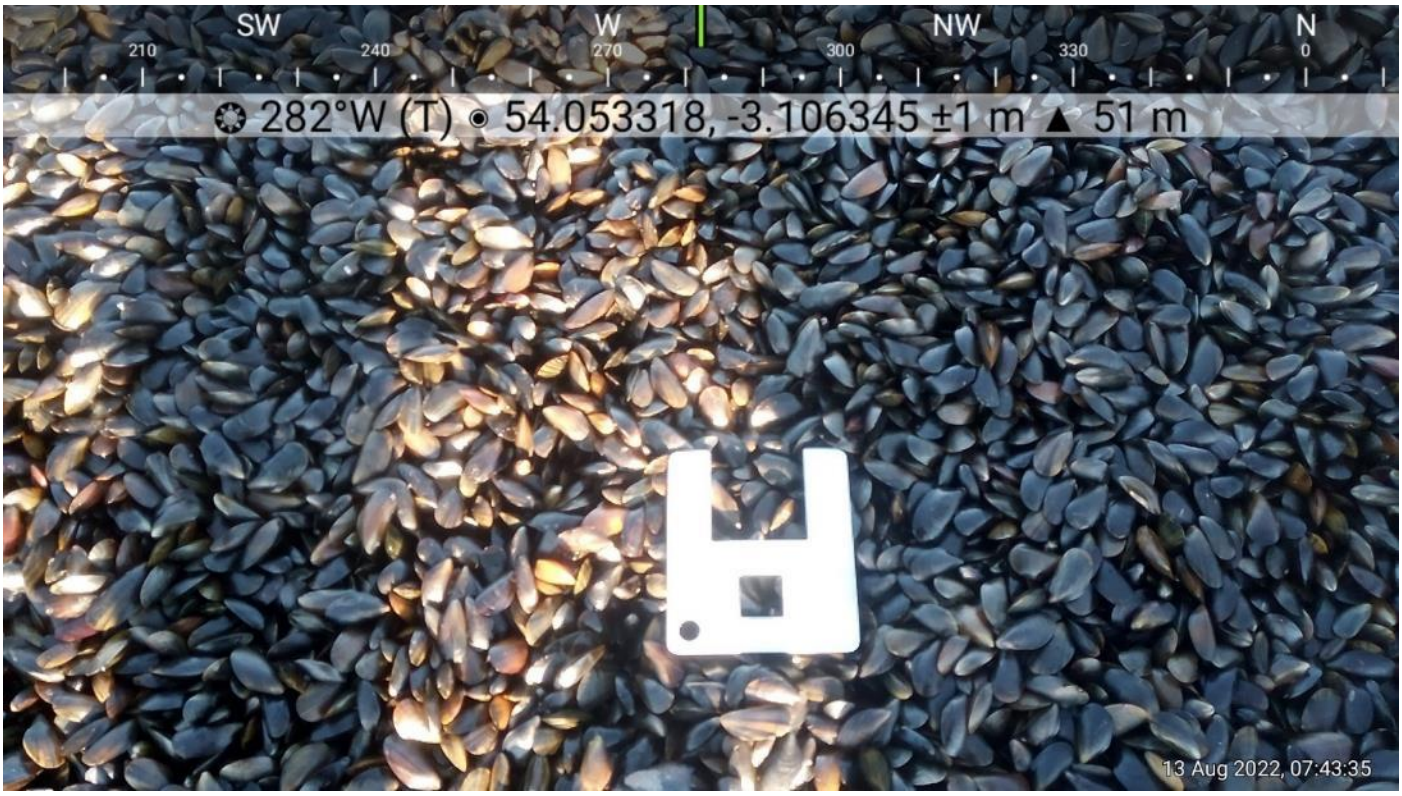


Fig 7. Seed mussel on the West of the bed 13-08-22

Fig 8. Area of scoured mussel on the West of the bed looking North 13-08-22

Fig 9. Area of denser seed mussel on the West of the bed looking North 13-08-22

Fig 10. Mussel reducing in density with less sediment between the mussel and stony substrate to the South East of the mussel bed 13-08-22

Fig 11. Sparse mussel with on stony substrate to the South of the mussel bed 13-08-22

Fig 12. Newly settled Sabellaria alveolata on the stony substrate to the North West of the mussel bed 13-08-22

Fig 13. Newly settled Sabellaria alveolata on the stony substrate to the North West of the mussel bed 13-08-22

Annex 4. Fleetwood mussel bed inspections

Fleetwood Mussel Inspection 19-05-22

Officers: AP, JH, MB, AG

LW: 08:42 1.1m (Liverpool Tides)

The Fleetwood mussel beds were inspected starting at Rossall Scar, then proceeding to Necking, Kings and finishing on Perch and Black Scar as shown in Figure 1.

Black Scar

Black Scar has had a 2022 mussel settlement of approximately 60% coverage. The mussel was approximately 5mm and had settled on the hard substrate / shell debris (Figure 2). The settlement was absent along the Eastern edge of the scar which was different from previous years. There were small areas of size mussel along the channel edge. The approximate area of the mussel was 4.6 hectares.

Perch Scar

Perch Scar can be split into two areas, the Northern area consisted of mussel mud from 2021 with no observed 2022 mussel settlement (Figure 3), and the Southern area which has had a 2022 mussel settlement of approximately 40% coverage. This is significantly reduced from previous years. The mussel was approximately 5mm in size (Figure 4). There were occasional small areas of 40-50mm mussel along the channel edge. The approximate area of the mussel was 4 hectares.

Kings Scar

Kings Scar consisted of area of mussel 10-20mm long which is likely to be a settlement from late 2021 or early 2022. There were no signs of a recent settlement. The area of mussel was 2.4 hectares and had 40-60% coverage (Figure 5). Kings Scar has a number of structures such as wrecks which have larger mussel which has persisted through the winter (Figure 6).

Neckings Scar

The tide did not ebb as usually expected for the size of tide and therefore access was limited to the higher reaches of the bed (Figure 6). There was 20-30mm mussel which had persisted through the winter on the scar. In the denser areas the mussel was had 60% coverage (Figure 7). No observed 2022 mussel settlement. There was *Saccharina sp.* present on some of the hard substrate.

Rossall Scar

The mussel on Rossall Scar was very patchy and interspersed with cobble and live *Sabellaria alveolata* (Figure 8).

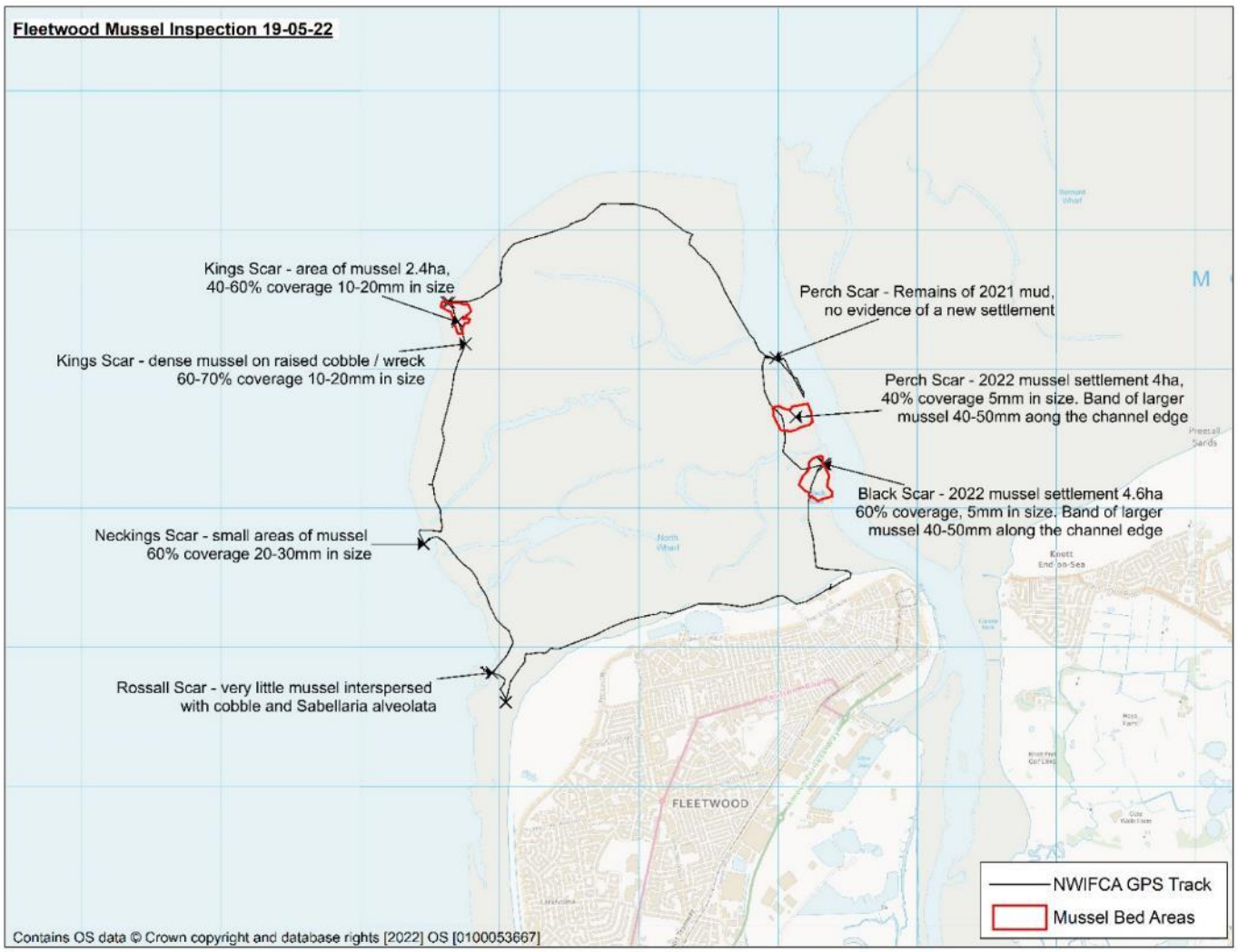


Figure 1. Overview of the mussel inspection 19-05-22.

Figure 2. Black scar 2022 mussel 19-05-2022.

Figure 3. Perch Scar 2021 mussel mud 19-05-2021.

Figure 4. Perch Scar 2022 mussel settlement 19-05-2022.

Figure 5. Kings Scar 2021 mussel 19-05-2022.

Figure 6. Kings Scar Mussel on Cobble / Wreck 19-05-2022.

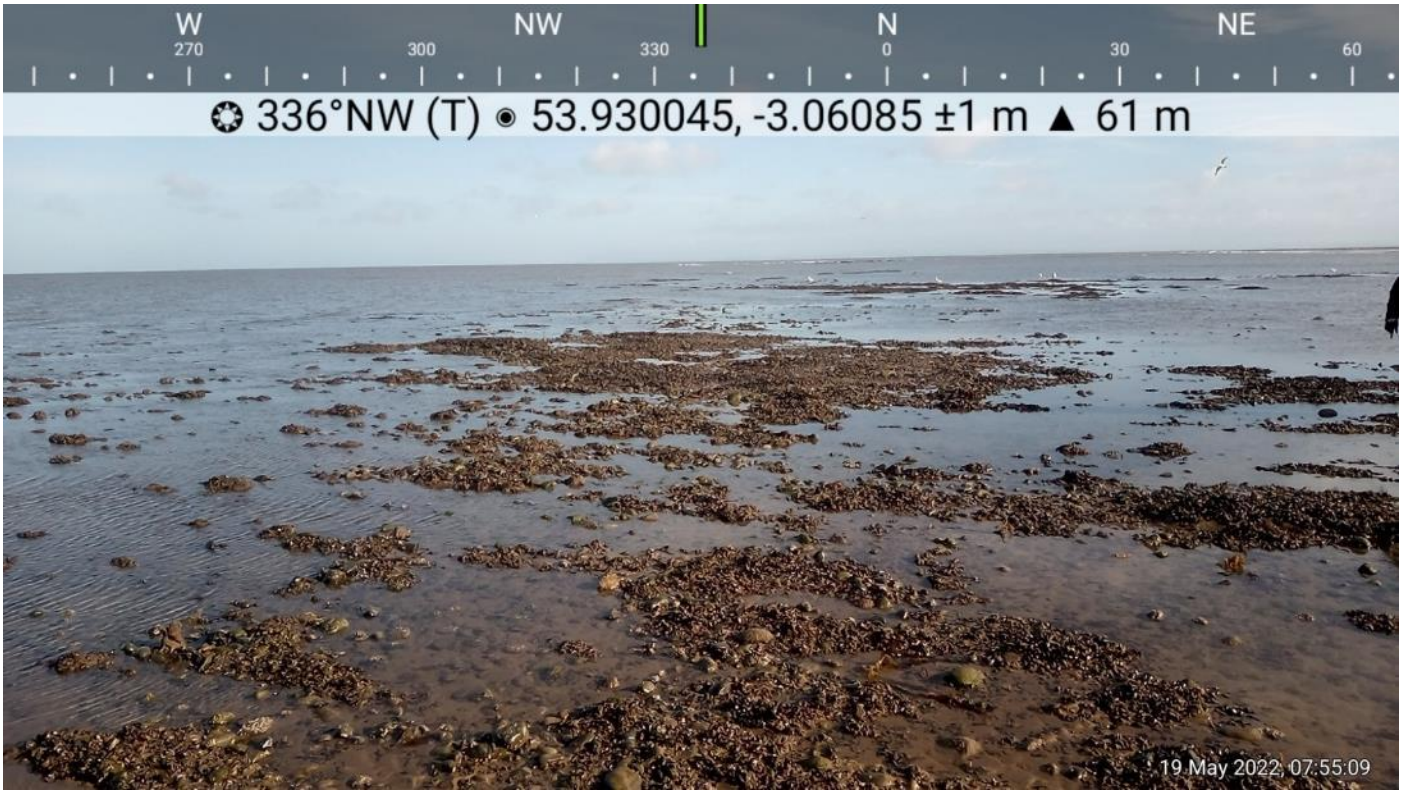


Figure 6: Neckings Scar Mussel 19-05-22.

Figure 7. Neckings Scar mussel 19-05-2022.

Figure 8. Rossall Scar mussel 19-05-2022.

Perch and Black Scar Mussel Inspection 15-07-22

Officers: JH, MB

LW: 07:43 0.8m (Liverpool Tides)

Black Scar

Black Scar is a mix of sandy, algal hummocks with 2022 seed mixed in (Figure 2) on the lower ground apart from a strip of mussel along the channel edge which persists throughout the year. The mussel on Black Scar was ~10mm (Figure 3). Percentage cover was difficult to estimate due to the sand and algal covering. It was also not possible to clearly define a bed area due to the patchy nature of the mussel. This is a change from previous years when the skear typically receives a dense settlement.

Perch Scar

There was no algal growth on Perch Scar. There was an area of 2022 seed mussel approximately 2.5ha in size (Figure 1) with a 60-70% coverage (Figure 4 and 5). The mussel was ~10mm in size (Figure 6). The mussel has started to put down some mud (~5cm). Large area along the Wyre channel edge and to the North of the skear have minimal seed mussel. There is a strip of mussel along the channel edge which persists throughout the year. This is a change from previous years when the skear typically receives a dense settlement across the entire area.

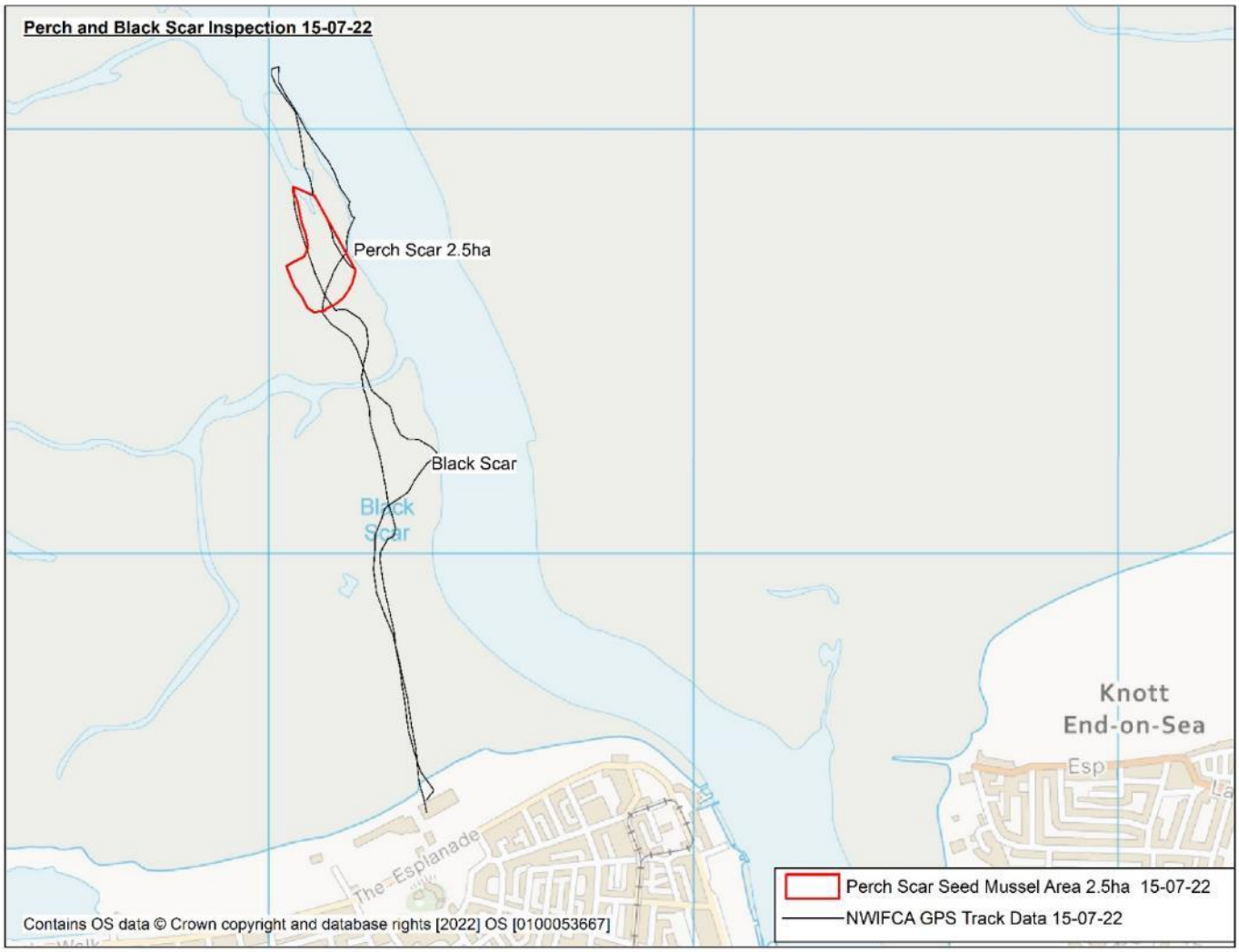


Fig. 1 – NWIFCA GPS Track Data and Area of 2022 Seed Mussel on Perch Scar 15-07-22.

Fig 2 – Black Scar, sandy, algal hummocks interspersed with 2022 seed mussel 15-07-22

Fig. 3 – Black Scar, patch of 10mm 2022 seed mussel 15-07-22.

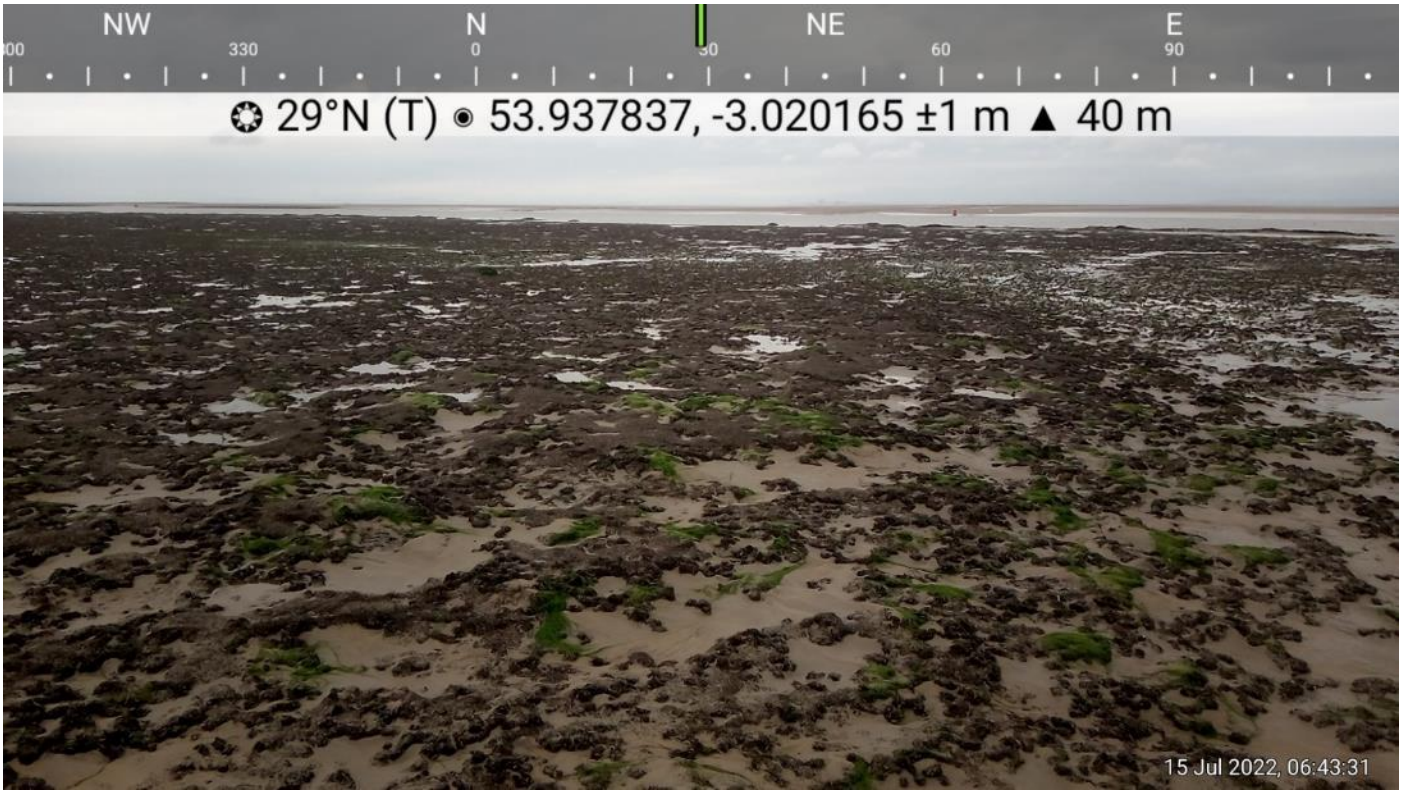


Fig. 4 – Perch Scar overview of 2022 seed mussel 15-07-22

Fig. 5 - Perch Scar overview of 2022 seed mussel 15-07-22

Fig. 6 – Perch Scar, 2022 seed mussel 15-07-22

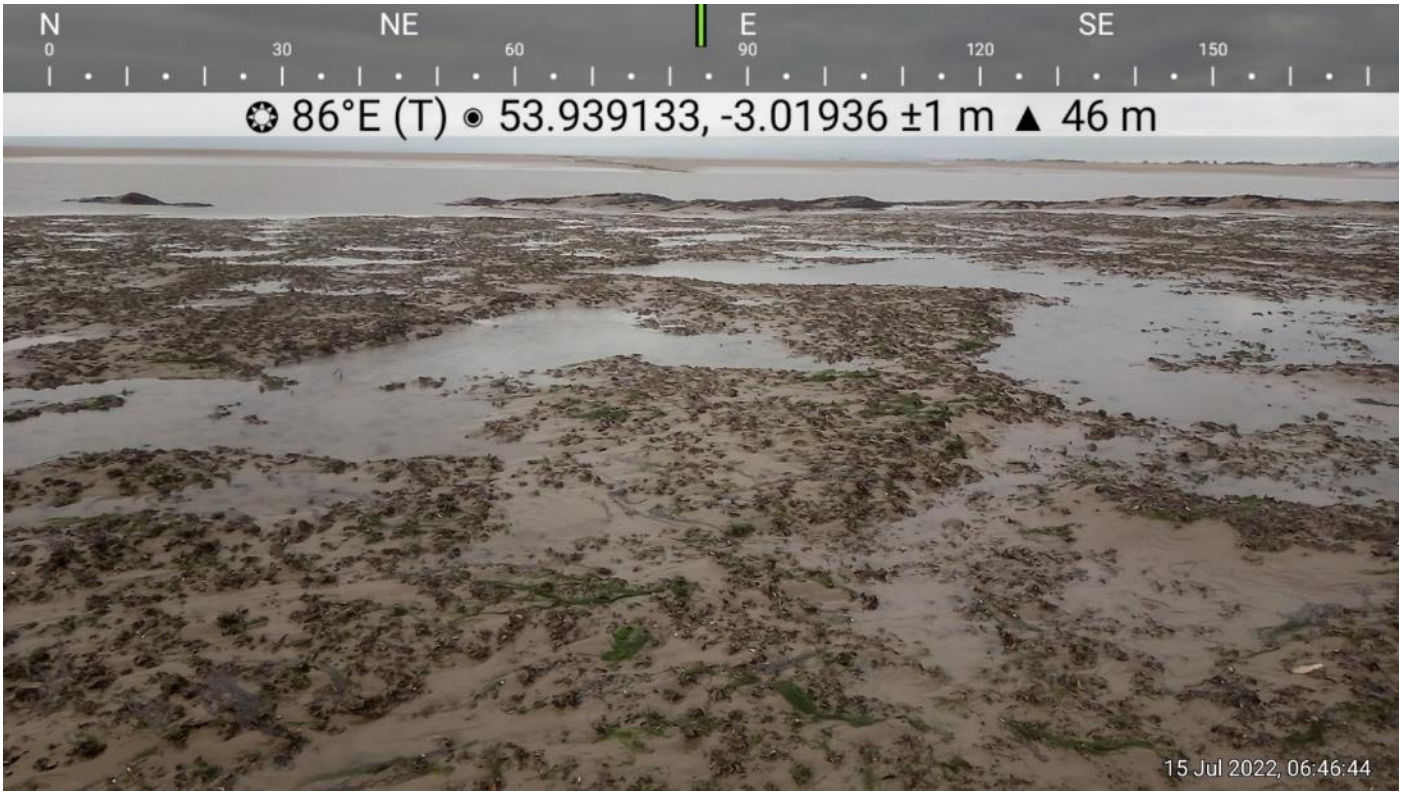


Fig 7 – Perch Scar, area of very sparse seed mussel near the Wyre channel edge 15-07-22

Perch and Black Scar Mussel Inspection 17-08-22

Officers: AP, JH

LW: 10:17 1.5m (Liverpool Tides)

Black Scar

Very little mussel persists on Black Scar, most of the area is bare stony substrate. There has been a reduction in algal when compared to the July inspection (Figure 2). There is an area of mussel mud, approximately 50m x 50m (Figure 3) in the centre of the hard ground which is likely to have had mussel which has scoured out. A small amount of seed mussel remains which is 20-25mm in length. The band of larger mussel along the channel edge remains.

Perch Scar

The area of seed mussel previously report in July has put down a layer of mussel mud (Figure 4 and 5). The mussel is 20-25mm in length (Figure 6). The area of seed does not cover the full extent of the hard substrate with little to no seed present near the channel and on the Northern end of the bed (Figure 7). The seed is not as dense as it has been in the previous years with 40-60% coverage. There are no obvious signs of scouring. The band of larger mussel along the channel edge remains.

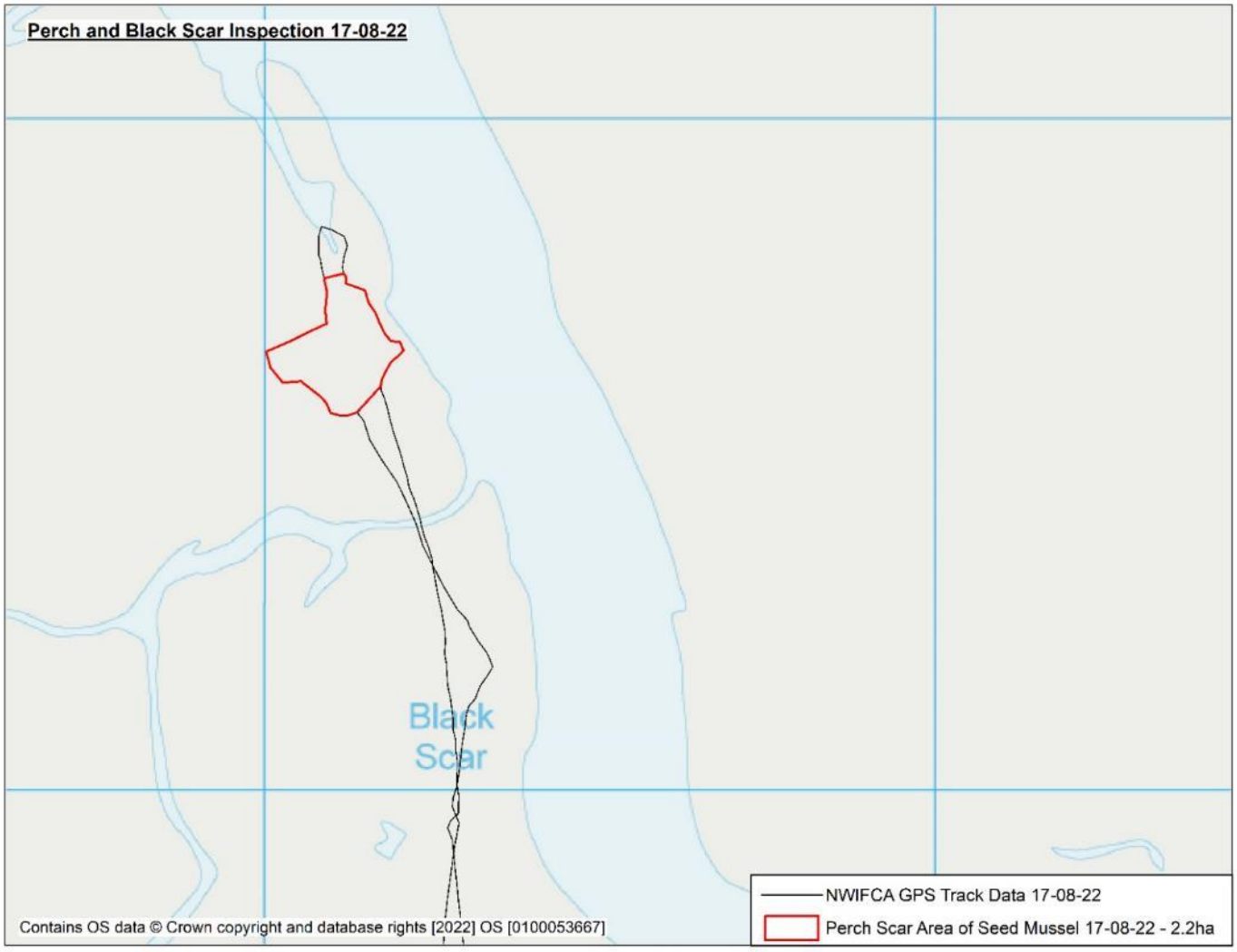


Fig. 1 – NWIFCA GPS Track Data and Area of 2022 Seed Mussel on Perch Scar 17-08-22.

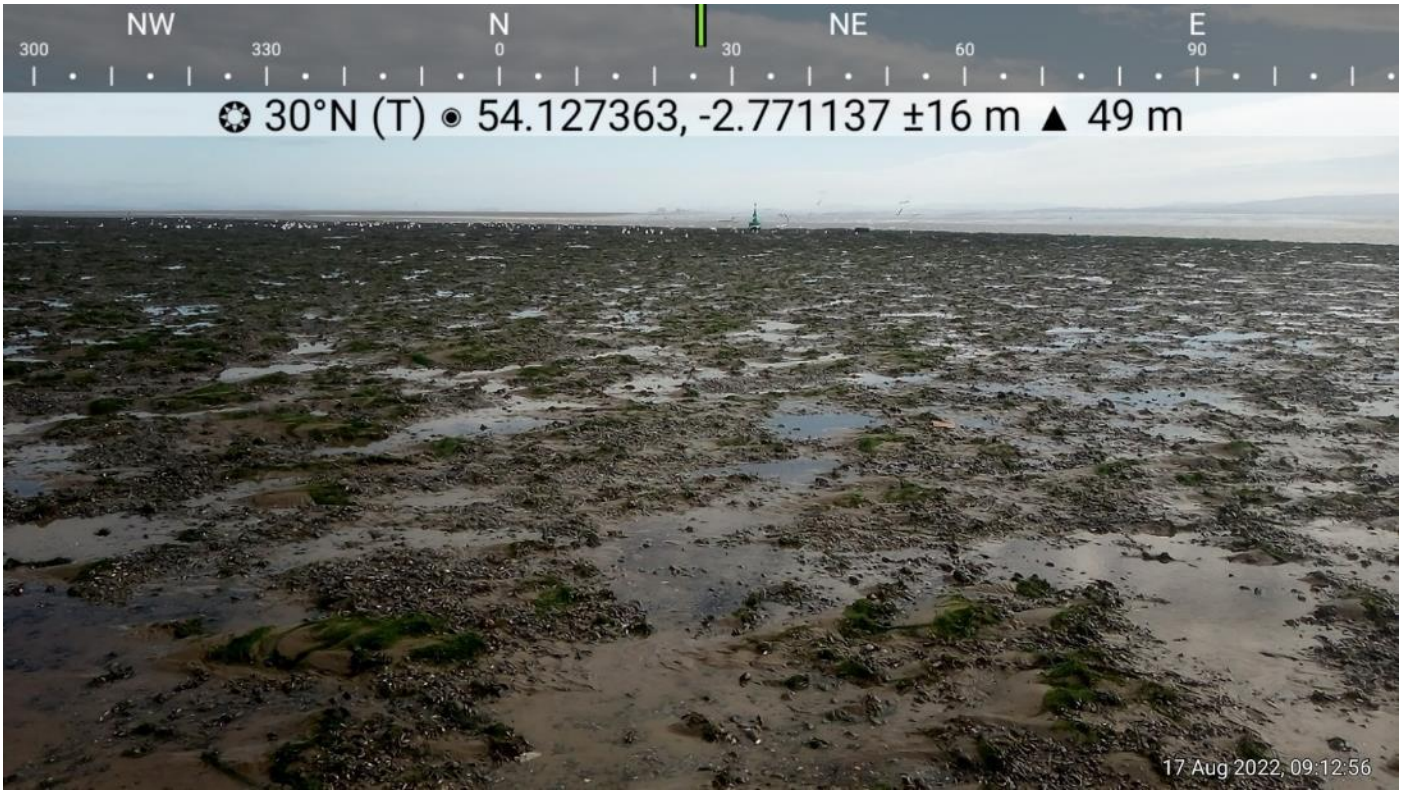


Fig 2 – Overview of Black Scar 17-08-22

Fig. 3 – Remains of scoured mussel and mussel mud on Black Scar 17-08-22

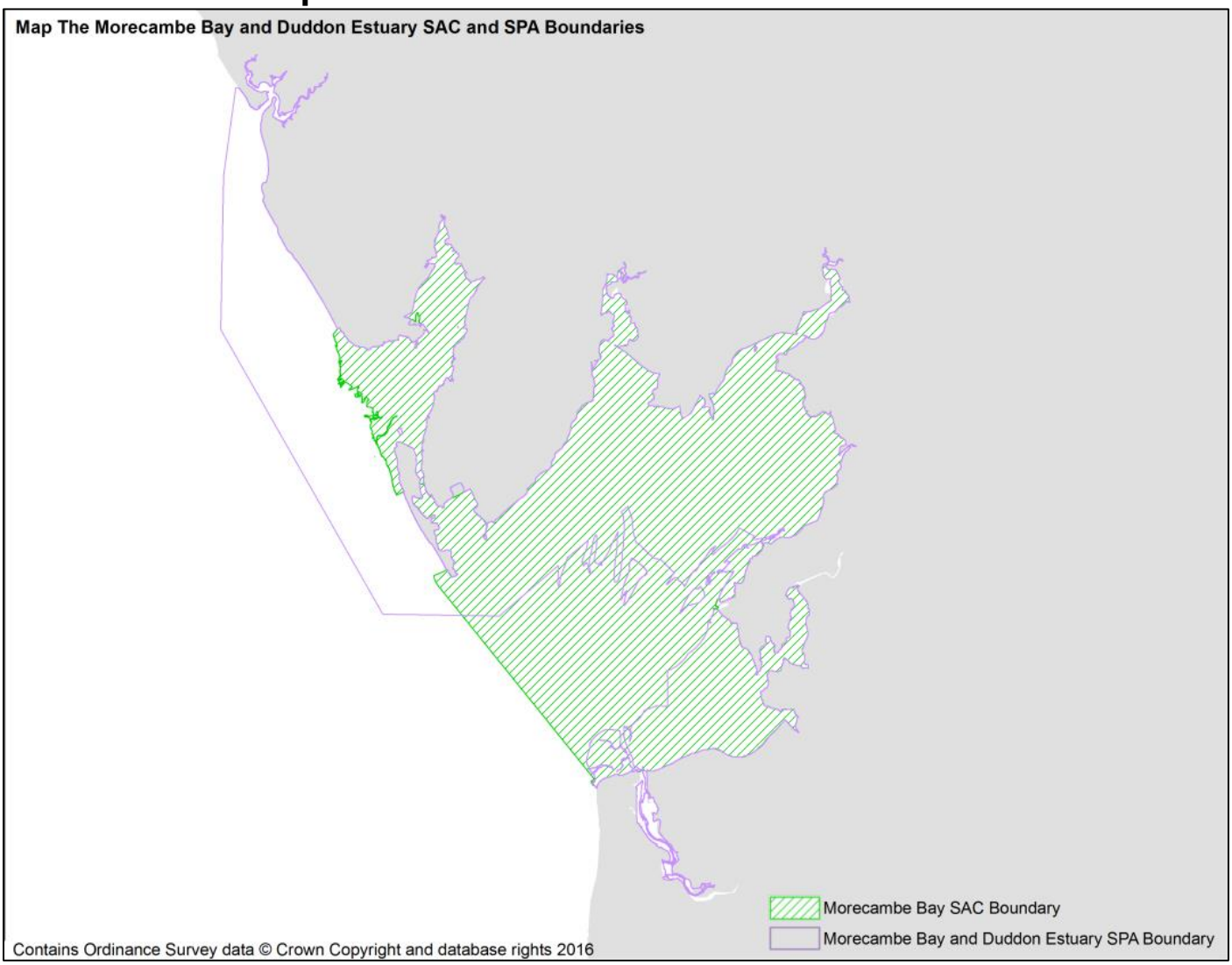
Fig. 4 – Perch Scar overview of 2022 seed mussel 17-08-22

Fig. 5 - Perch Scar overview of 2022 seed mussel 17-08-22

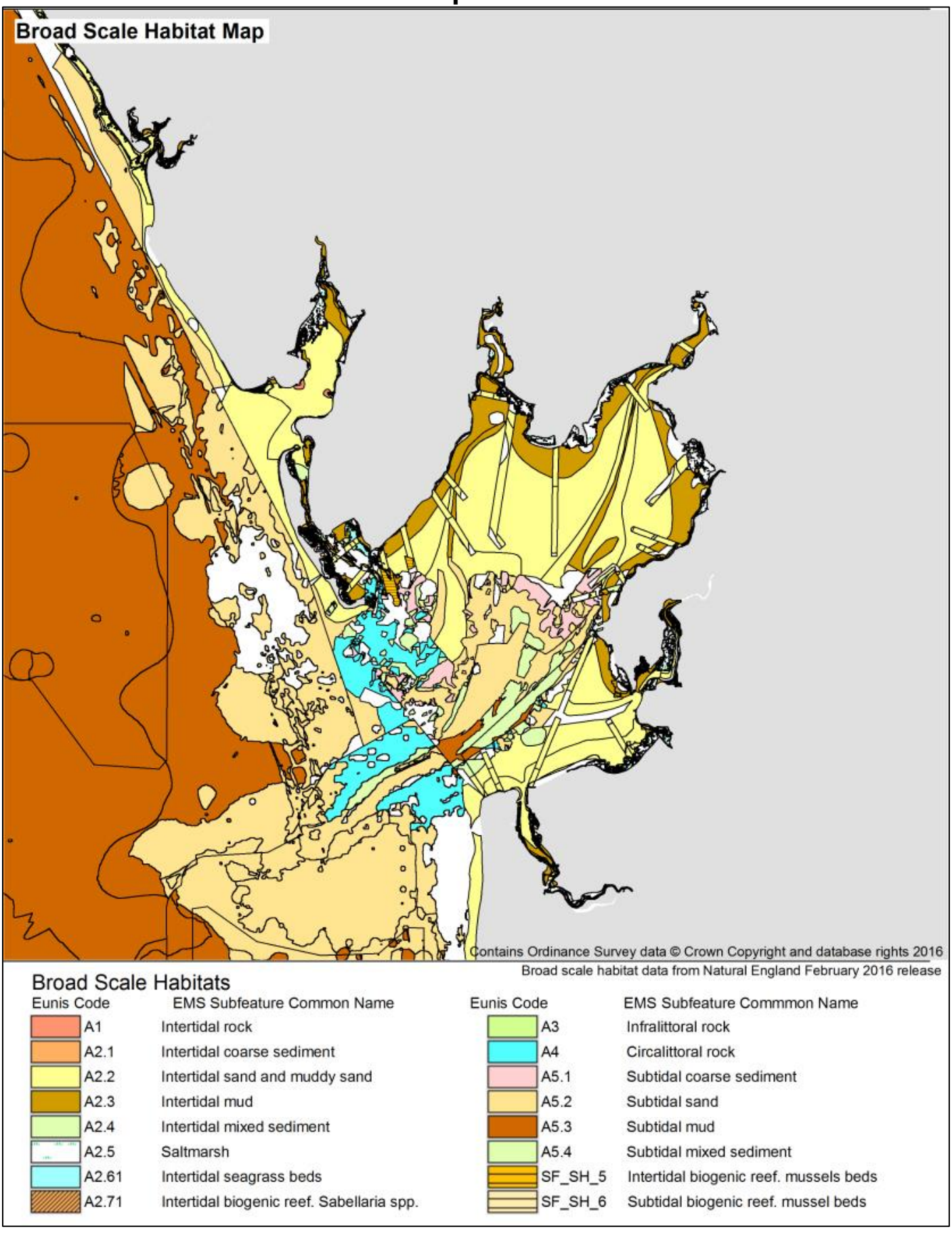
Fig. 6 – Perch Scar 20-25mm seed mussel 17-08-22

Fig 7 – Perch Scar, area of very sparse seed mussel at the Northern extent 17-08-22

Annex 5: Site Map



Annex 6: Broad Scale Habitat Map



Annex 7 – Summary of Recent Mussel Beds surveys in Morecambe Bay (NWIFCA August 2022).

the table provides survey/inspection reports in addition to those provided in Annex 1 to 3 of this report

Date	Location	Skear	Survey Method	Tide Height (m)	Description
30-03-22	Foulney	Foulney bed and Foulney Island	Dutch wand	1.2	From the transect and sample data the total mussel bed surveyed was 47.9 hectares. There was no separation made between the main Foulney bed and Foulney Island as the mussel had spread between the two. Biomass: 1055 tonnes size mussel and 4201 tonnes undersize mussel. Down from 2021. At the time, the majority of mussel present on Foulney Skear was undersize with a wide spread of mussel from 6mm to 68mm but mainly between 25mm and 45mm. At the time of writing, this will have grown on.
17-03-22	Foulney	Walney Channel	Dutch Wand	1.3	The total mussel bed surveyed was 10.67 hectares. Biomass: 455 tonnes of size mussel and 684 tonnes of undersize mussel. In March, the length frequency data of mussel present on the Walney Channel bed ranged from 15 – 70mm with the highest frequency of mussel being between 34mm and 45mm. This will have grown on.
18-05-22	Knott end	Wyre end	Inspection	0.9	There has been a 2022 settlement of seed mussel, varying in density across the main skear, with the northern edge of the bed having received no settlement. Towards the South of the bed a large area of 20-35mm mussel was present. This mussel had a coverage of 50-60% with dense seed cover and occasional size mussel mixed in. The western edge of the bed contained patches of 25-35mm mussel hard in the substrate with seed mixed in, with a coverage of 40-50%. A large flock of oystercatchers and other bird species were observed feeding on the South Western edge.
20-04-22	Foulney	Low Bottom	Dutch wand	1.1	From transect and sample data the total mussel bed surveyed was 27.2 hectares. Biomass: 1445 tonnes of size mussel and 1903 tonnes of total mussel. The most abundant size class is the 10-25 mm which is present across most of the bed with areas of 25-45mm and greater than 45mm mussels mixed in. There was very minimal 2022 spat observed.
13-08-22	Duddon	Hard Acre	Inspection	0.6	The mussel consists of patchy mussel in the North East of the bed, interspersed with large areas of bare sand substrate and scoured areas. In the South West area of the bed it appeared that mussel density has dropped, with increasingly bare areas, including a patch of old mussel mud that showed evidence of washout and containing dead shell. Smaller patches of mussel are present across much of the bed, but under 50% coverage overall.

					The mussel which remained was 40-60mm in length with the majority being above the MLS of 45mm.
14-08-22	Falklands	Falklands	Inspection		The main bed consisted of dense patches of size mussel 45 to 55 mm interspersed with bare substrate. The extent of the bed appears unchanged from previous years.
12-08-22	Heysham	Heysham Flat	Inspection	1.0	The area from conger rock to Dallam dyke has larger mussel present from 35-45mm. Areas further down the skear were very mixed, with size mussel making up approximately 40-50% of overall weight. The underlying substrate is a mix of sand and mud and is firm unlike the usual mussel mud present on Heysham.
13-08-22	South America	South America	Inspection	0.6	To the North of the mussel bed the mussel is patchy and on a thin layer of sediment, where there are bare areas the stony substrate is present. The mussel is a mix of 30-35mm mussel with size mixed in. The most size mussel is present in this area. Beyond the South extent of the area suitable for fishing the mussel become less dense, with little to no settlement present between the mussel and the stony substrate until no mussel is present.

Summary of Cockle Beds in Morecambe Bay (NWIFCA August 2022) from surveys

Cockle bed	Date survey	Area (ha)	Size cockle (tonnes)	Undersize cockle (tonnes)	Total cockle biomass (tonnes)
Aldingham and Newbiggin	1st of July 2022	1063	1050	315	1365
Leven	13th of July 2022	1047	500	225	725
Flookburgh	12th of July 2022	2240	850	600	1450
Warton Sands	15th of June 2022	na	na	na	Na
Middleton	25th July 2022	771	350	450	800
Pilling	20th of July 2022	1461	1200	400	1600

Annex 8 - South America mussel bed additional inspection

South America Mussel Inspection (Quad) 12-09-22

LW: 07:57 0.6m (Liverpool tides)

An inspection of South America was completed to assess the condition of the mussel previously inspected in August, and prior to any seed mussel fishery opening. Although tide and conditions were good, access remains limited to a short period over low water due to the depth and size of the channel needing to be crossed.

The mussel had changed considerably since the last inspection in August. The mussel to the North, East and South of the bed had reduced in coverage to less than 30% with only a thin layer of sediment or mussel being on hard substrate (Figure 2). Where mussel was on a layer of substrate the areas in between where there wasn't any mussel consisted of exposed hard substrate (Figure 3 and 4). The mussel was 30-35mm with the occasional size mussel present.

The mussel in the centre of the bed appears to have spread to the East. The mussel had approximately 30% coverage on a muddy substrate, the areas where mussel wasn't present still had a layer of muddy substrate, suggesting the mussel had recent scoured (Figure 5). The mussel is 30-35mm with the occasional size mussel present (Figure 6).

The *Sabellaria alveolata* has grown in size and area covered to the majority of the exposed hard substrate on the North East side of the channel.

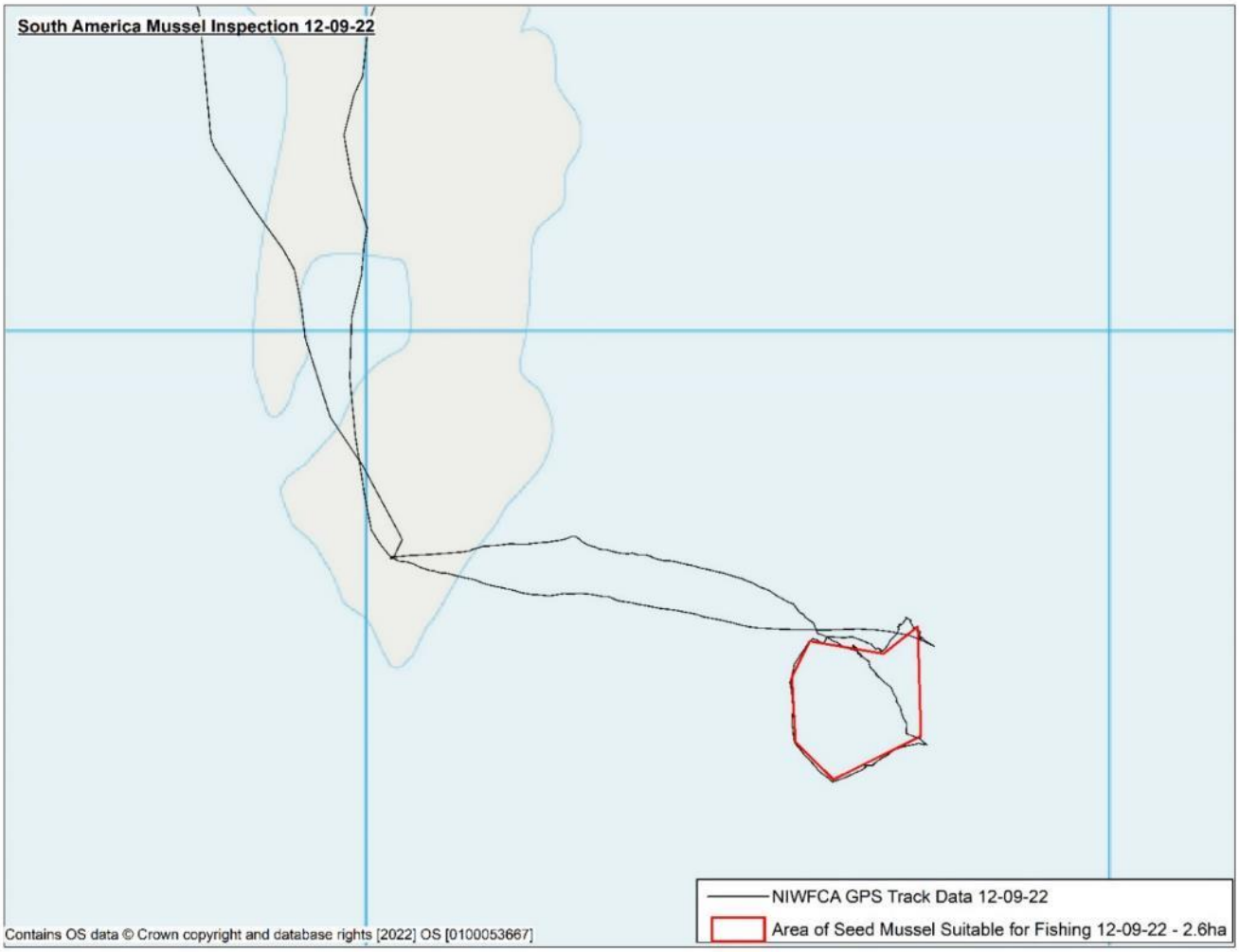


Fig 1. Map of South America including Area of Mussel Suitable for Fishing

Fig 2. South West of the mussel bed, mussel on thin layer of sediment / hard substrate 12-09-22

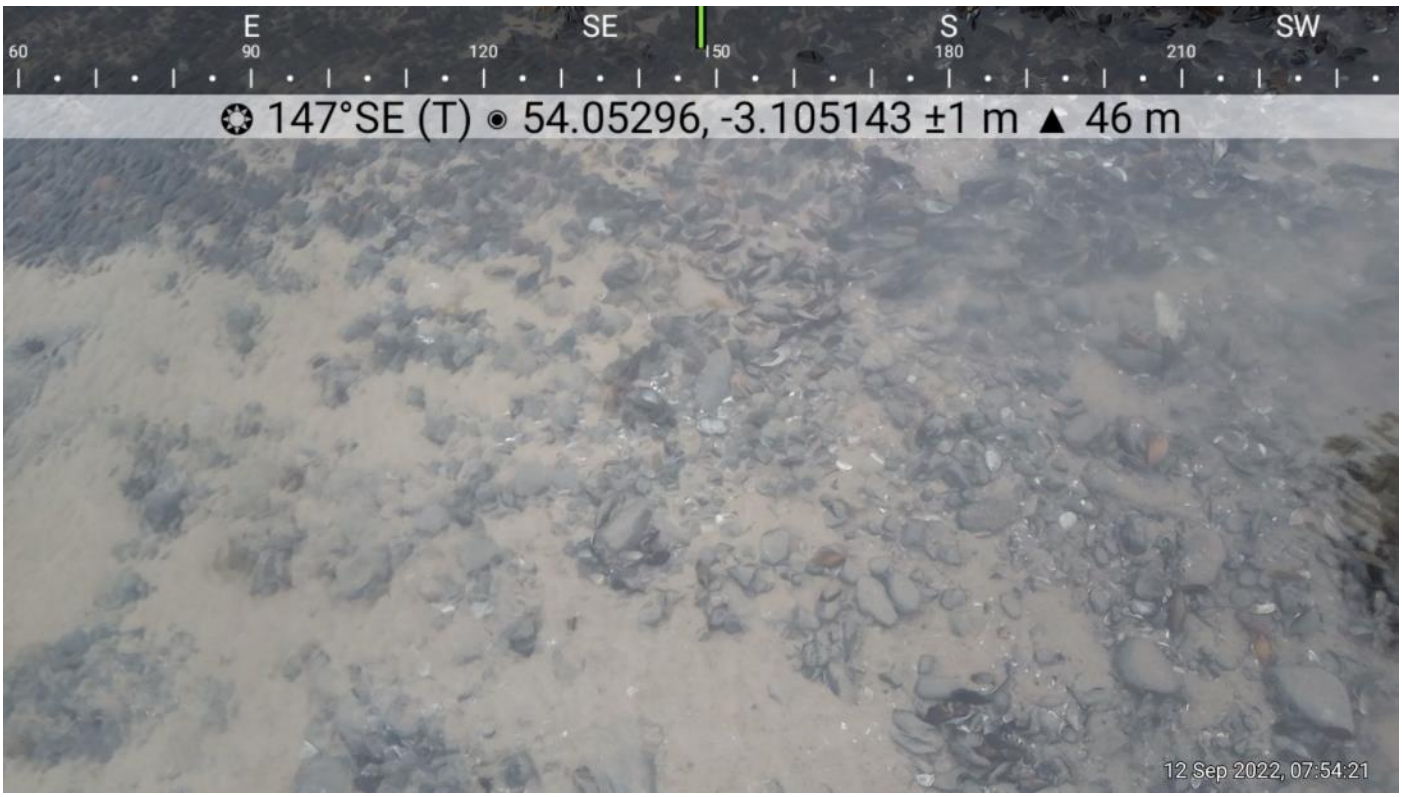


Fig 3. South West of the mussel bed, exposed hard substrate 12-09-22

Fig 4. North of the mussel bed, mussel on thin layer of sediment / hard substrate 12-09-22

Fig 5. Area of mussel which has likely scoured leave small mounds of mussel on a muddy substrate 12-09-22

Fig 6. Loose 30-35mm mussel with occasional size mussel 12-09-22