

Natural England Commissioned Report NECR247

# Mersey Estuary Saltmarsh Survey 2016

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# Foreword

Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

## Background

Natural England commissioned this project to determine changes in the saltmarsh attributes: vegetation structure (zonation and sward height), vegetation composition (characteristic species and negative indicator species) and other negative indicators over two time periods. No other data were collected and the assessment methods used prevents a wider analysis of any change.

The analysis has enabled a preliminary assessment of current condition of the saltmarsh habitat. The results will be used by Natural England, in combination with information from additional sources, to undertake an assessment of the overall SSSI units' condition.

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**Keywords** - Mersey Estuary, SSSI, saltmarsh, vegetation

### Further information

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## Mersey Estuary Saltmarsh Survey 2016



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## Executive Summary

The Mersey Estuary was designated as a Special Protection Area (SPA) for birds in 1995, to protect important populations of waders and wildfowl. The SPA is underpinned by two Sites of Special Scientific Interest (SSSI) (New Ferry and Mersey Estuary) which are further subdivided into units.

Natural England have an obligation to carry out monitoring of the habitats that support the bird species for which the SPA is designated to ensure that the Conservation Objectives are being achieved. Natural England contracted NIRAS Consulting in 2016 to carry out surveys of the saltmarsh in units 7, 8, 9, 10 and 11 of the Mersey Estuary SSSI to inform a condition assessment of the habitats that support the SPA features.

In addition to carrying out surveys to capture data on the floral communities and to inform a condition assessment of the saltmarsh, information was also collected on the abundance and distribution of Canada geese on the marsh to inform an assessment of their impact on the suitability of the saltmarsh to support the SPA features.

Surveys were carried out in early September 2016 by two surveyors walking 30 pre-determined transects and recording the flora within five metres of the transect line, using field notes and photographs which were georeferenced with GPS waypoints. This was supplemented with collection of precise abundance data from 2m x 2m quadrats, some of which were repeats of stations from a previous survey.

The saltmarsh on the eastern side of the survey area in Unit 7 was a relatively narrow strip along the top of the shore with a steep eroding edge at the seaward boundary. This part of the marsh was cropped to a low sward (1-2cm) by grazing sheep but also by Canada geese based on the density of droppings observed there. The floral community here was mainly made up of creeping bent *Agrostis stolonifera*, red fescue *Festuca rubra* and sea milkwort *Glaux maritima*. This was generally classified as the SM16 NVC community with the exception of areas where creeping bent was dominant which were classified as MG11a.

Further to the west, the saltmarsh was much broader and there was a greater variety of floral communities. The upper shore was generally the SM16 community seen on the eastern side of the marsh but the middle and lower marsh was dominated by common saltmarsh grass *Puccinellia maritima* and spear-leaved orache *Atriplex prostrata* which was classified as SM13. There were also patches dominated by common cord grass *Spartina anglica* which were classified as SM6. Large swathes of these communities were grazed by livestock; sheep in Unit 8 and cows in Unit 9, which kept the sward height typically below 20cm, but much lower in many areas.

On the western side of Unit 9 there was no grazing and the upper marsh community was mainly made up of creeping bent, red fescue and spear-leaved orache (SM16) but there were also areas dominated by couch grass *Elytrigia* sp. which were classified as SM24/SM28. The middle marsh community was dominated by common saltmarsh grass, sea aster *Aster tripolium* and spear-leaved orache (SM13) but there were also some areas where sea aster was particularly abundant and this was classified as SM12. Owing to the lack of grazing the sward height on the western side of Unit 9 was generally over 20cm.

In units 10 and 11, there was no grazing on the marsh and the upper marsh was quite variable; some areas were of a relatively rich community dominated by Yorkshire-fog *Holcus lanatus* (classified as SM16) whereas further to the west couch grass was the predominant plant (SM24) but with areas of sea club-rush *Bolboschoenus maritimus* (S21) and monospecific stands of common reed *Phragmites australis* (S4). The middle marsh was mainly common saltmarsh grass, spear-leaved orache and sea aster but with a variety of other saltmarsh plants occasionally occurring and was classified as SM13 but with occasional areas of SM12 where sea aster was particularly abundant. In contrast to units 7, 8 and 9, there was no eroding edge at the seaward edge of

the marsh in units 10 and 11, allowing full saltmarsh zonation to form. The lower marsh was dominated mainly by common cord grass which was generally classified as SM6 but occasionally as SM10 where the community was slightly different. At the bottom of the marsh, the mud was colonised by glasswort *Salicornia* sp. which was classified as SM8.

On the saltmarsh, Canada geese were only seen in the areas of moderate or heavy grazing on the eastern side of the marsh, and were seen in groups of 100 to 600 individuals. Canada geese were also recorded on the ship canal immediately landward of the marsh and in the vicinity of the grazed areas.

Comparison of the recently acquired data with a previous survey data from 2003 indicated that, for the most part, the saltmarsh flora is stable and subject only to minor change in community composition with time. The main exception to this was the loss of pioneer marsh in units 7, 8 and 9 owing to erosion from a shift in the location of one of the river channels in the estuary.

A Common Standards Monitoring assessment of the Mersey Estuary saltmarsh determined that it was in favourable condition with respect to the metrics measured.

## 1. Introduction

### Mersey Estuary SPA

- 1.1. The Mersey Estuary was designated as Special Protection Area (SPA) under the EC Birds Directive on 20<sup>th</sup> December 1995 for the internationally and nationally important populations of waders and wildfowl the estuary supports. When the site was designated, the principal habitats of the SPA were intertidal sandflat and mudflat which together covered an area of 2819 hectares. In addition, there were 603 hectares of saltmarsh which are important roosting areas for waders and wildfowl as well as providing grazing for wildfowl such as teal *Anas crecca* and wigeon *Anas penelope*.
- 1.2. The Mersey Estuary SPA is composed of two Sites of Special Scientific Interest (SSSI) which are subdivided into 'units'. The surveys reported here were carried out on the saltmarsh areas within units 7, 8, 9, 10 and 11 (Figure 1.1). The balance of area of these five units are estuarine sand and mud flats, the condition of which have been assessed in separate surveys (e.g. CMACS, 2011).
- 1.3. There are five Conservation Objectives for the Mersey SPA and of these, two are relevant to the saltmarsh:
  - Maintain or restore the extent and distribution of the habitats of the qualifying features;
  - Maintain or restore the structure and function of the habitats of the qualifying features.

(from Natural England, 2014).

- 1.4. In order to gather data on the marsh in relation to these conservation objectives, Natural England have commissioned NIRAS Consulting Ltd to carry out surveys of the saltmarsh on the Ince and Stanlow Banks on the southern side of the estuary.

### Mersey Estuary Saltmarsh

- 1.5. The main expanses of saltmarsh in the Mersey Estuary SSSI and SPA are between Frodsham Score and Mount Manisty on the southern side and between Hale and Garston on the northern side. There are other areas of saltmarsh within the SPA/SSSI at New Ferry and further large areas around Widnes and Runcorn, although these latter areas are not within the boundary of the SSSI/SPA.
- 1.6. A previous survey at Frodsham, Ince and Stanlow Banks (Skelcher, 2003) reported that the marsh was predominantly made up of the SM13 *Puccinellia maritima* community with a lower marsh of SM6 *Spartina anglica*, SM8 Annual *Salicornia* and SM9 *Suaeda maritima* saltmarsh communities. The upper marsh was more variable with SM16 *Festuca rubra*, SM23 *Spergularia marina* and SM28 *Elytrigia repens* saltmarsh communities as well as S4 *Phragmites australis*, S12 *Typha latifolia* and S21 *Bolboschoenus maritimus* swamp communities, and MG11 *Festuca rubra* grassland community.
- 1.7. Skelcher (2003) reported that the Mersey Estuary saltmarsh had an area of 724.1 ha (including the saltmarsh between Hale and Garston) and therefore had increased in area since the designation of the site in 1995. Of this total, 626 ha were on the southern side, but it was reported that the marsh was eroding at Ince Banks and was accreting at Stanlow Banks.
- 1.8. This report presents the results of a survey carried out in late summer of 2016 and describes the saltmarsh between Frodsham Score and Mount Manisty on the southern side of the Mersey Estuary.

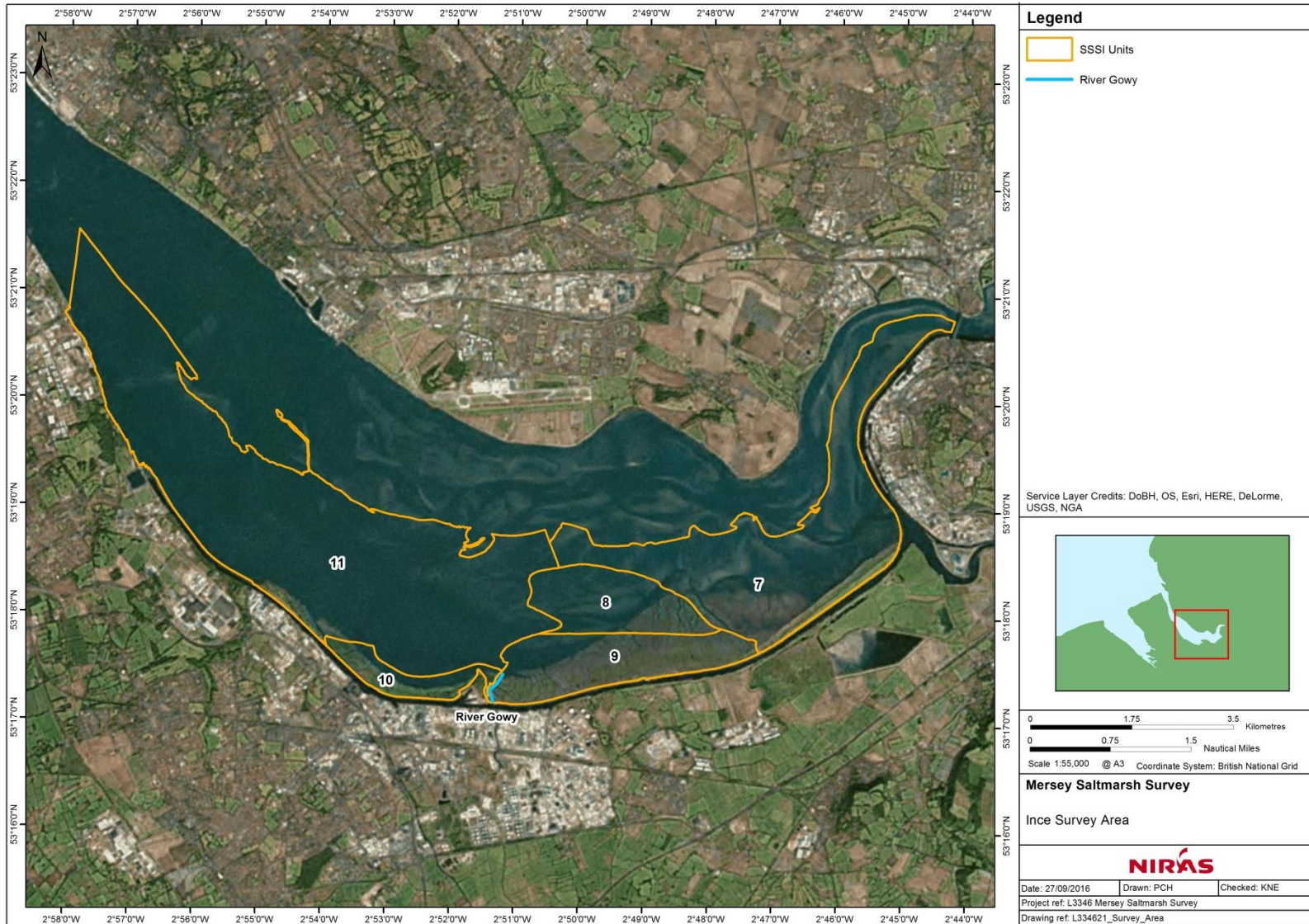


Figure 1.1. Area of saltmarsh surveyed for this report. Unit 7 is Frodsham Score, Units 8 and 9 are Ince Banks, Units 10 and 11 are Stanlow Banks.

## 2. Methods

### Survey

- 2.1. Surveys were planned according to requirements specified by Natural England as well as guidance issued by statutory authorities (JNCC, 2004 and WFD-UKTAG, 2014). The intention was to take 'samples' of the marsh (in the form of fieldnotes, photographs and quadrats) at a sufficient number of locations to characterise it without surveying and mapping the entire area. The suggested survey techniques in these guidance documents, either a 'W'-shaped walk (JNCC, 2004) or a transect every 1,000m (WFD-UKTAG, 2014), would have led to a prohibitively long survey and therefore a compromise was reached: transects were placed so that the large majority of communities from previous surveys (Skelcher, 2003) were covered. These transects ranged from less than 100m to over 1400m in length depending on location on the marsh (Figure 2.1 and Figure 2.2).
- 2.2. Four days of survey were planned on the basis that the surveyors would move at an average of 1 mile per hour (1.6km/hr), these were carried out from 8<sup>th</sup> to 11<sup>th</sup> September 2016.
- 2.3. The saltmarsh was surveyed by two personnel who walked the transects from the upper marsh to the lower marsh taking notes on NVC communities within five metres of the transect line and marking boundaries of different plant assemblages with a hand-held GPS. The survey method determined the vegetation composition and zonation of the saltmarsh communities but notes were also taken on sward height as well as negative indicators (e.g. invasive species or anthropogenic impacts).
- 2.4. Target notes on NVC communities from transects were supplemented with photographs and 2m x 2m quadrats in which abundance of saltmarsh plants was estimated using the DAFOR (JNCC, 2004) and Domin scales (Rodwell, 2000). Where possible, the quadrats repeated locations from previous survey (Skelcher, 2003) but new locations were also sampled, all of which were within five metres of the transect line.
- 2.5. Surveys were planned to be undertaken during neap tides for two reasons: firstly because in the Mersey Estuary low water on neaps is in the middle of the day thus maximising daylight available for survey, and secondly because the low amplitude of the neaps meant that even at high water the marsh and creeks were flooded to a minimal degree. All of the creeks encountered were firm enough to walk on the sides but the beds were often very soft (knee-deep mud), and had to be navigated to a point where surveyors could step across the bed without entering it.
- 2.6. Information on the abundance and distribution of Canada geese was collected to inform an assessment of their impact on the suitability of the saltmarsh to support the SPA features.



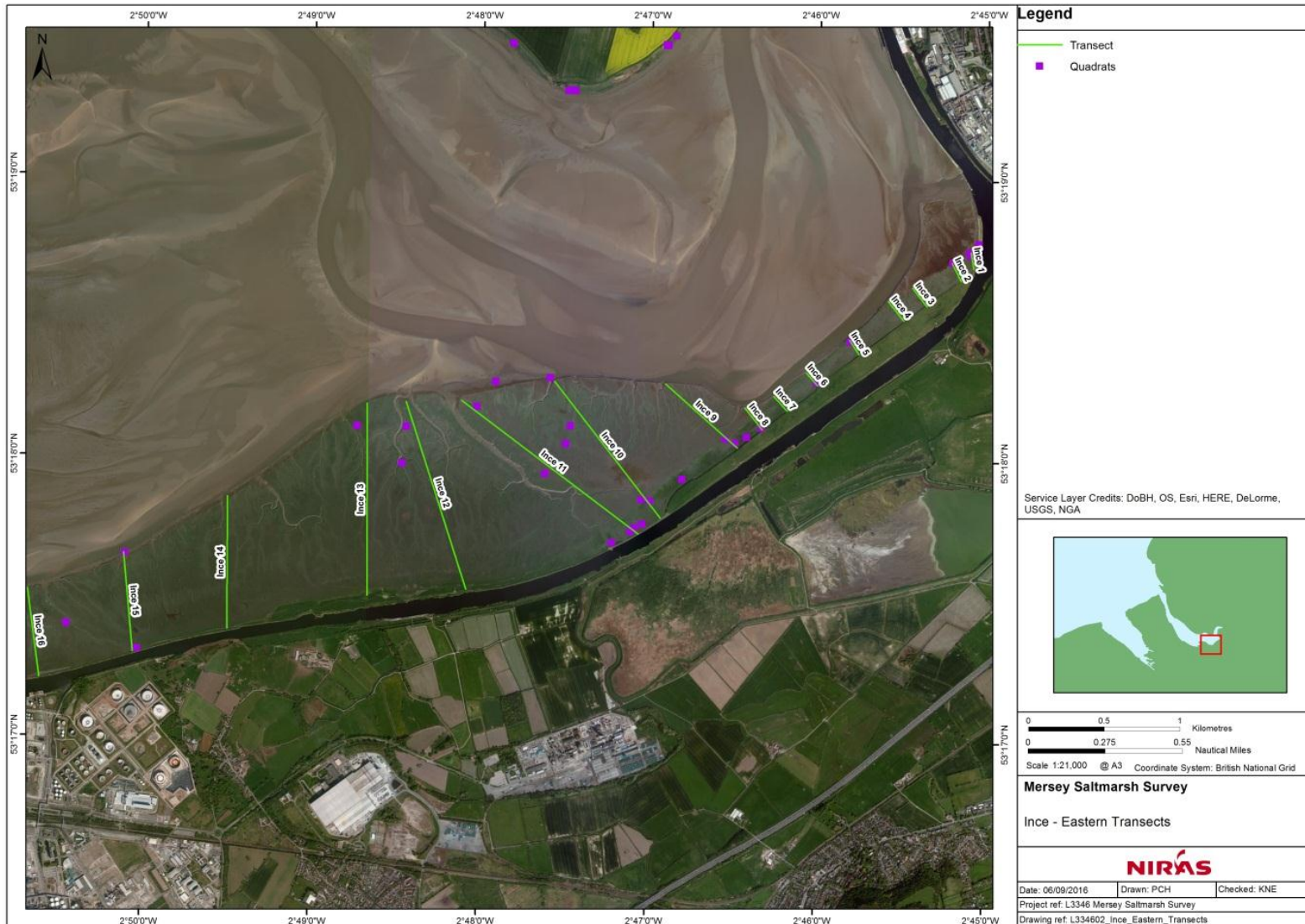


Figure 2.1. Survey transects on Frodsham Score and Ince Banks. Quadrats from the previous survey (Skelcher, 2003) are also shown.

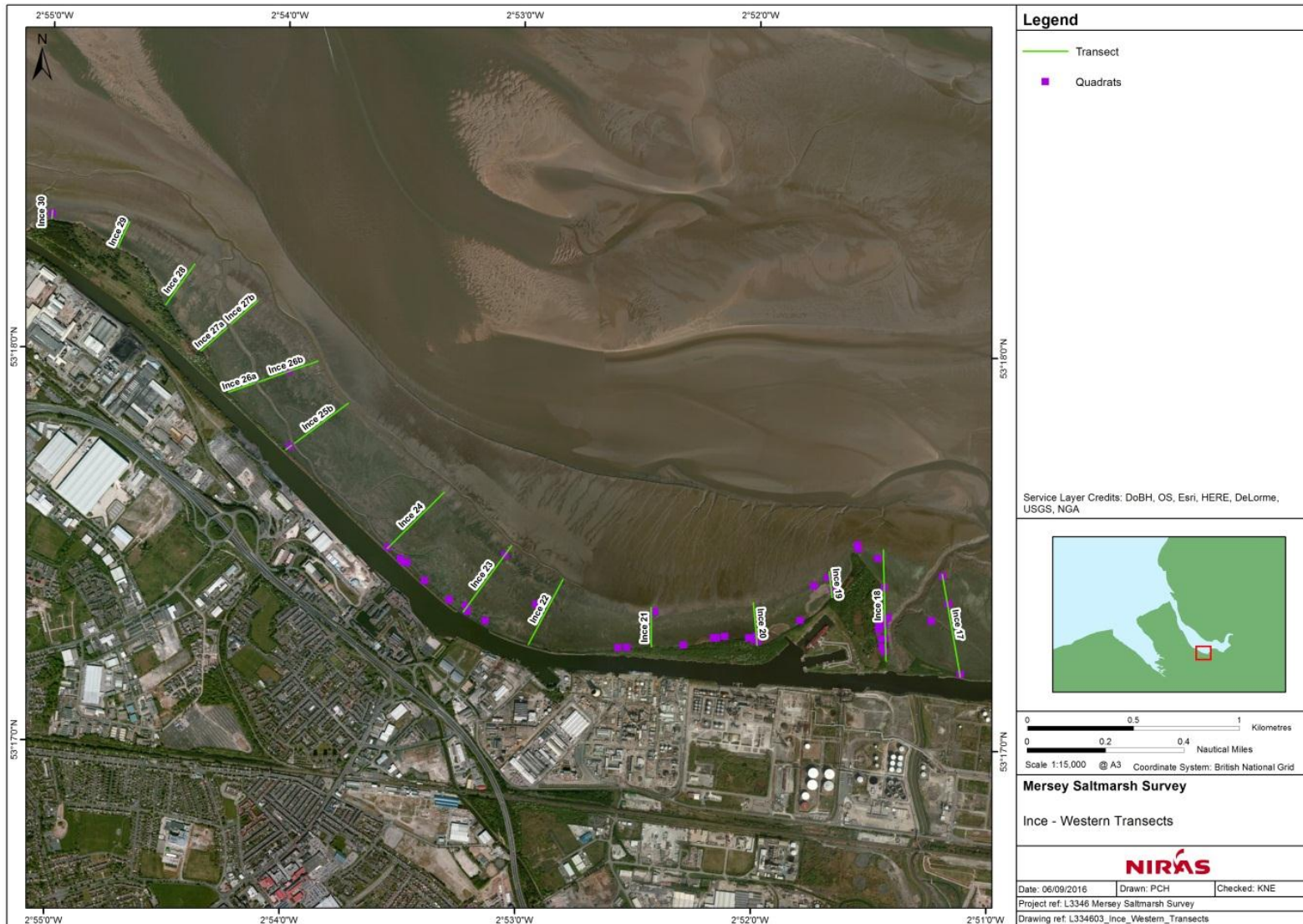


Figure 2.2. Survey transects in the Stanlow Banks to Mount Manisty area. Quadrats from the previous survey (Skelcher, 2003) are also shown.

### 3. Results

Field notes from the survey are provided in Appendix 1. All surveys were carried out by Dr Ken Neal from NIRAS Consulting and Steven Weber from Landscape Science Consultancy.

- 3.1. Surveys were carried out from 8<sup>th</sup> to 11<sup>th</sup> September inclusive; details of tides are given in Table 3-1 below. Most of the transects were surveyed from the upper marsh to the lower marsh as planned but in two cases the transects were surveyed from the lower marsh to the upper marsh. This was because traversing between transects on the lower marsh was less arduous than returning to the upper shore to start the next transect, thus saving time.
- 3.2. The planned survey transects were a straight line across the marsh but the actual survey lines deviated from this somewhat owing to the surveyors being drawn offline by creeks and dense vegetation, but also to carry out repeats of quadrats from the previous survey.

**Table 3-1. Details of tides and daylight on each of the survey days.**

Date	LW (Eastham Lock)	Amplitude (Height above datum)	Sunrise (BST)	Sunset (BST)
8 <sup>th</sup> September 2016	10:27	2.3m	06:34	19:43
9 <sup>th</sup> September 2016	11:12	2.9m	06:36	19:41
10 <sup>th</sup> September 2016	12:18	3.4m	06:38	19:38
11 <sup>th</sup> September 2016	13:55	3.5m	06:40	19:36

#### Transect descriptions, saltmarsh zonation and NVC communities

- 3.3. Transects 1-3 (Figure 3.1): At the top of these transects there was an embankment which gradually increased in height to the west and supported an MG1 community; common nettle *Urtica dioica*, creeping thistle *Cirsium arvense*, common mouse-ear *Cerastium fontanum*, silverweed *Potentilla anserina*, soft brome *Bromus hordeaceus*, Yorkshire-fog *Holcus lanatus*, false oat grass *Arrhenatherum elatius*, red fescue *Festuca rubra*, perennial rye-grass *Lolium perenne*, dandelion *Taraxacum* sp. and spear thistle *Cirsium vulgare*. On the marsh itself, the vegetation was heavily grazed by both livestock and wildfowl (the latter apparent from the density and freshness of droppings rather than actually observing birds grazing on this part of the marsh) and therefore was a low sward (1-2cm) with a turf-like appearance (see Plate 1). The flora at the top of the marsh was made up of creeping bent *Agrostis stolonifera*, red fescue and sea milkwort *Glaux maritima* (SM16). Towards the bottom of the marsh there has been noticeable erosion, with some recolonization below the eroding face by *Glaux maritima* (dominant) with some common saltmarsh grass *Puccinellia maritima* (SM13).
- 3.4. Transect 4 (Figure 3.1): The flora on this transect was much as Transects 1-3 (MG1 on the embankment above the marsh with SM16 on the marsh itself) but lacked the common saltmarsh grass and denser sea milkwort on the lower shore owing to the erosion that had occurred there (see Plate 2).
- 3.5. Transects 5-7 (Figure 3.1 and Figure 3.2): Above the upper limit of the marsh was the embankment with the MG1 community as described previously (though with fewer species and dominated by creeping thistle and false oat grass). At the base of the embankment the vegetation community was dominated by perennial rye-grass with some meadow barley *Hordeum secalinum*. On the upper saltmarsh, red fescue and creeping bent became dominant with some sea milkwort and sea barley *Hordeum marinum* in the middle marsh mainly around creek edges (SM16). This community continued



to the bottom of the marsh on transects 5 and 7 where there was an eroding edge<sup>1</sup>. On Transect 6 there was a small area of MG11a community where creeping bent was the dominant species.

- 3.6. Transect 8 (Figure 3.2): Above the upper limit of the marsh, at the base of the embankment was a terrestrial fringe community of silverweed and Yorkshire-fog with some meadow barley, perennial rye-grass and creeping bent (MG1). Lower down the marsh, this changed to the more typical marsh community of creeping bent, red fescue with some sea milkwort (SM16). Approximately half way down the marsh there was a step-change in elevation by approximately 50cm where erosion had previously been occurring (see Plate 3). Below this decrease in elevation the sediment has been recolonised by common cord grass *Spartina anglica* and common saltmarsh grass with some lesser sea-spurrey *Spergularia marina* and sea milkwort, a community that continued to the bottom of the marsh but with common cord grass becoming gradually more dominant seaward (SM6).
- 3.7. Transect 9 (Figure 3.2): The upper limit of this part of the marsh was very similar to the top of Transect 8 with a silverweed and perennial rye-grass community (MG1) at the top followed by a community of red fescue and creeping bent (MG11a) down to a location of previous erosion where there was a 50cm drop in elevation to a low marsh community. The upper marsh on this transect was less heavily grazed compared to Transects 1-7 and had a slightly higher sward (20cm) which also included saltmarsh rush *Juncus gerardii*. The low marsh was much more extensive on this transect than on Transects 1-8 and consisted mainly of a low turf of common saltmarsh grass with spear-leaved orache near creeks (SM13) and isolated stands of common cord grass (SM6). The bottom of the marsh showed some bare areas and evidence of grazing by wildfowl (see Plate 4).
- 3.8. Transect 10 (Figure 3.2): The flora at the top of the marsh was made up of red fescue and sea barley (SM16) which extended to an abrupt change in community, demarked by a noticeable drop in elevation, to one of common saltmarsh grass, sea milkwort and lesser sea-spurrey (SM13) all of which were heavily grazed to a low turf. In the middle of the marsh, there was a relatively extensive area of poaching where grazing and trampling had revealed bare mud (see Plate 5). Below this poached area, the saltmarsh community changed to one made up of common cord grass, sea aster, common saltmarsh grass and spear-leaved orache (but was still classified as SM13) which had all been cropped by livestock. At the bottom of the marsh there was a patchwork of areas dominated by spear-leaved orache and areas of a short turf of common saltmarsh grass. There was evidence of wildfowl grazing here and the saltmarsh was also eroding at its lower extremity; a quadrat from the previous survey in 2002 is now 100 metres out into the sandflats and mudflats of the estuary.
- 3.9. Transect 11 (Figure 3.2): The top of the marsh here was more diverse than to the east, probably as a result of lighter grazing and was principally made up of red fescue, creeping bent, sea barley and perennial rye-grass but also contained knotgrass and sea aster (SM16 and SM16a). Lower down on the marsh the community changed to one of common saltmarsh grass and spear-leaved orache (SM13) with ground cover of each species varying along the transect length (Plate 6). On the low marsh, common cord grass and annual sea-blite were abundant in places, and the lowest extremity of the marsh was the low sward of common saltmarsh grass that showed evidence of grazing by wildfowl.
- 3.10. Transect 12 (Figure 3.3): The embankment at the upper limit of the marsh here supported an MG1 community as elsewhere to the east, below which the sward was dominated by spear-leaved orache but this was a relatively narrow area that changed to a community dominated by red fescue with

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<sup>1</sup> Note that the aerial imagery used in the maps is the most recent available but that in some places the marsh has eroded since the pictures were taken, hence the discrepancy between the edge of the marsh and the end of the transects in certain figures.

creeping bent and spear-leaved orache lower down (SM16 and SM16a). On the middle marsh where there appeared to be little grazing, the flora was mainly of common saltmarsh grass, sea aster and spear-leaved orache, with some common cord grass towards the bottom of the marsh (SM13a). Occasional monospecific stands of sea couch grass *Elytrigia pycnanthus* were encountered in the mid-marsh (SM24). At the bottom of the marsh there were areas dominated by common cord grass (SM6), also with spear-leaved orache, but the majority of the ground supported a community of common saltmarsh grass and sea aster (SM13), which had a much lower sward height than higher up the marsh.

- 3.11. Transect 13 (Figure 3.3): The top of the marsh was dominated by creeping bent but with some red fescue, Yorkshire-fog and spear-leaved orache (SM16). Below this was a grazed community of common saltmarsh grass and spear-leaved orache (Plate 7) which increased in diversity lower down where grazing pressure was less and included sea plantain, sea aster and sea arrowgrass *Triglochin maritimum* (SM13). At the bottom of the marsh, it was evident there was less grazing (or none) compared to transects to the east as the sward was much higher (10cm as compared to 1-2cm further east) and more diverse with sea aster, annual sea-blite, common scurvygrass *Cochlearia officinalis*, lesser sea-spurrey, sea milkwort and spear-leaved orache amongst the common saltmarsh grass (SM13).
- 3.12. Transect 14 (Figure 3.3): Above the top of the marsh on this transect, the face of the embankment for the ship canal was made up of placed stone which, in the gaps between stones, supported a community of perennial rye-grass, common couch grass *Elytrigia repens*, knotgrass, creeping bent, common mouse-ear, perennial sow-thistle *Sonchus arvensis*, common ragwort *Senecio jacobaea*, dandelion and spear-leaved orache. The upper marsh community consisted of creeping bent, red fescue, spear-leaved orache, common saltmarsh grass and sea aster with grazing pressure either minimal or absent (SM13a). In the middle marsh, the community was less diverse, being dominated by sea aster and common saltmarsh grass with spear-leaved orache (Plate 8). This community continued to the bottom of the marsh but with patches of common cord grass on the low marsh and possible indication of grazing (most likely by wildfowl) as the sward height was much lower than in the mid marsh (SM13).
- 3.13. Transects 15-17 (Figure 3.3 and Figure 3.4): These transects were very similar with an upper shore community of couch grass, red fescue and creeping bent grass (SM24 or SM28). Below this the community was typically of sea aster, common saltmarsh grass and spear-leaved orache which continued from the middle down to the bottom of the marsh where there were also patches of common cord grass. The middle and lower marsh was mainly classified as SM13 or SM13a except for a small area on Transect 16 that was dominated by sea aster and therefore classified as SM12.
- 3.14. Transect 18 (Figure 3.4): This transect ran along the western side of the creek created by an outfall from the ship canal (which is assumed to allow the River Gowy to drain into the Mersey Estuary). For this reason, zonation of the marsh was not necessarily linear in a south to north (upper marsh to lower marsh) direction as with other transects but was also likely influenced by the tides in the creek. The southern end of the transect was mainly Yorkshire-fog and sea milkwort with some red fescue, sea aster, spear-leaved orache, perennial sow-thistle and curled dock *Rumex crispus* (SM16). This community also contained sea club-rush in places. In the middle of the transect, common couch grass and sea aster became dominant but with most of the community components from the southern end still present (SM28). At the northern end of the transect, the principal community was one of common saltmarsh grass, sea aster and sea plantain with some sea purslane *Atriplex portulacoides* and common cord grass (SM13). At the end of the transect, there was a remnant eroding edge with a pioneer marsh of common cord grass and glasswort below it (Plate 9), which was classified as SM6.
- 3.15. Transect 19 (Figure 3.4): The embankment at the top of marsh mainly supported a scrub of hawthorn and elder, below which there was a fringe community of sea mayweed, curled dock, couch grass and

false fox sedge. This occupied only a 2-3m wide band at the top of the marsh, below which there was a similarly narrow band of sea plantain, sea aster and sea milkwort which was apparently grazed, most likely by rabbits. The mid marsh consisted of alternating areas of two communities; the first was of spear-leaved orache, sea aster, common cord grass and sea milkwort, which alternated with slight depressions dominated by common cord grass with few other plants (SM12 and SM6). Alternation between these two communities continued until the low marsh where the community changed to one of common saltmarsh grass, common cord grass and spear-leaved orache (SM13) until the very bottom of the marsh where glasswort became the dominant plant (SM8).

- 3.16. Transect 20 (Figure 3.4): In the vicinity of the top of this transect there were a number of shallow pools and the upper portion of the marsh here was dominated by stands of common reed *Phragmites australis* (S4). Below this was a flora of sea arrowgrass, sea plantain with some sea aster and common cord grass which was much lower in height than elsewhere on the marsh (SM12). The middle marsh was mainly sea aster, annual sea-blite, common saltmarsh grass, creeping bent grass with some sea arrowgrass and spear-leaved orache (SM13). Towards the lower marsh patches of common cord grass began to appear which then consolidated into continuous areas (SM6) but this was not the dominant species as there was also common saltmarsh grass and spear-leaved orache and therefore represented a gradation in community from those that are less inundation-tolerant to those with a greater tolerance to inundation by saltwater. At the very bottom of the marsh the principal species was glasswort but with some common cord grass as well as annual sea-blite and common saltmarsh grass (Plate 10), and was classified as SM8.
- 3.17. Transect 21 (Figure 3.4): Landward of the upper limit of the marsh on this transect, there was the MG1 community made up of false oat grass, perennial sow-thistle, common nettle and lesser burdock *Arctium minus*. The top of the marsh was made up of a relatively small area of sea sea club-rush *Bolboschoenus maritimus* (S21), below which was the typical mid-marsh community of sea aster and common saltmarsh grass with some spear-leaved orache and sea arrowgrass (SM13). Lower down on the marsh, spear-leaved orache became more abundant and sea aster became dominant leading to a change in community classification (SM14). On the lower marsh, common cord grass became gradually more abundant into the estuary until it was the dominant community component with some common saltmarsh grass and annual sea-blite (SM6). In the middle of the common cord grass community there was an area of bare mud with small patches of vegetation (Plate 11), which then reverted to full vegetation lower down (SM10) and graded into a glasswort-dominated community (SM8) at the lowest extent of the marsh.
- 3.18. Transect 22 (Figure 3.8): The upper marsh here represented a change in vegetation and community compared to the upper marsh to the east of this transect; the predominant taxa was couch grass (a mixture of common couch, sea couch and their hybrid) with spear-leaved orache, sea aster and perennial sow-thistle (SM24). Lower down the marsh, sea aster became the dominant taxon but couch grass and spear-leaved orache remained components of the community (SM13-SM24). Lower down again, sea aster remained dominant but common saltmarsh grass, sea plantain and sea arrowgrass became components of the community along with patches of common cord grass (Plate 12), which was classified as SM13. On the lower marsh, sea aster became a less important component of the community but common saltmarsh grass and spear-leaved orache became the dominant components also with some common cord grass (SM13). The community at the bottom of the marsh was glasswort with some common cord grass (SM8).
- 3.19. Transect 23 (Figure 3.8): The top of the marsh on this transect was less terrestrial-influenced than transects to the east and the community was mainly couch grass and spear-leaved orache (SM24). Below this was a community of sea aster, common saltmarsh grass and spear-leaved orache (SM12)

which then alternated with a patch of couch grass in the middle shore (SM24) before returning to a mainly sea aster community but with some common cord grass and then common saltmarsh grass and spear-leaved orache (SM13). Common cord grass became more prevalent amongst the common saltmarsh grass on the lower marsh with some annual sea-blite, but there was no lower marsh glasswort community owing to a deep and wide creek that cut across the shore and formed the lower boundary of the marsh.

- 3.20. Transect 24 (Figure 3.8): A creek draining the marsh came very close to the top of the marsh on this transect and influenced the floral communities somewhat. The very top of the shore was a couch grass community (SM24) as for Transect 23 but below this on both sides of the creek was a spear-leaved orache dominated community. This community ran parallel with the creek and extended a few metres from it on either side. Seaward of the creek and below the spear-leaved orache, the flora returned to a couch grass community which then changed to a community of sea aster, common saltmarsh grass and spear-leaved orache (SM13) which continued to the bottom of the marsh where there were some patches of common cord grass and some glasswort.
- 3.21. Transect 25 (Figure 3.8): This transect was divided into two halves by a large creek (as were 26 and 27) above which the community was mainly grasses such as couch, Yorkshire-fog and creeping bent (SM28) with sea aster and spear-leaved orache towards the creek (SM13a). Below the creek, the community changed to the typical middle marsh community of sea aster, common saltmarsh grass and spear-leaved orache (SM12), which continued to the bottom of the marsh but with an increasing proportion of common cord grass until it was the dominant component of the community (SM6).
- 3.22. Transect 26 (Figure 3.8): The top of the marsh on this transect supported a terrestrial fringe community of couch grass, spear-leaved orache, perennial sow-thistle, curled dock, sea aster and silverweed which changed seaward to an upper marsh community of sea plantain, sea aster, sea arrowgrass, Yorkshire-fog, common saltmarsh grass, sea milkwort and spear-leaved orache (SM28). Lower down the shore towards the creek, the community became less diverse and was made up of spear-leaved orache, common saltmarsh grass and sea aster in approximately equal proportions (SM12), but with some annual sea-blite at the edges of the creek (SM13). This community continued seaward of the creek but with patches of common cord grass (SM6) alternating until the lower part of the marsh where common cord grass became the dominant component of the marsh community.
- 3.23. Transect 27 (Figure 3.9): The upper shore on this transect was made up of a common reed swamp (S4), below which was a relatively rich community of sea aster, sea arrowgrass and spear-leaved orache with some common saltmarsh grass, sea plantain and annual sea-blite (SM12). Below the creek, the community of sea aster, common saltmarsh grass and spear-leaved orache (SM13) continued but with some common cord grass (Plate 13) that gradually became the dominant component on the lower marsh (SM6). At the seaward edge of the marsh there was an area of glasswort (SM8).
- 3.24. Transect 28 (Figure 3.9): Above the marsh on this transect there was a high embankment which amongst native flora supported the invasive species Himalayan balsam *Impatiens glandulifera* and sycamore *Acer pseudoplatanus*. The upper marsh supported mainly grass, principally couch grass and red fescue (SM28), but the community also contained silverweed, sea plantain, greater plantain, Yorkshire-fog, sea aster, curled dock, common ragwort and spear-leaved orache. Lower down on the marsh the community changed to mainly Yorkshire-fog but with some creeping bent and sea aster. This then changed to a mid-marsh type community of sea aster, sea milkwort, sea arrowgrass, spear-leaved orache and common saltmarsh grass but still with some Yorkshire-fog (SM12). On the mid to lower marsh common cord grass gradually became the dominant component of the community until there monospecific stands of this species on the lower edge of the marsh (SM6).



- 3.25. Transect 29 (Figure 3.9): The upper marsh here had been cropped by rabbits and the community was made up of Yorkshire-fog, sea milkwort and sea aster. Beyond the extent of the grazing down the transect, the community changed to one of common saltmarsh grass, sea aster, sea milkwort, spear-leaved orache and sea plantain but still with some Yorkshire-fog (SM13). Lower down on the marsh the community became less diverse and was mainly made up of common saltmarsh grass and spear-leaved orache with some common cord grass. On the lower marsh common cord grass was the dominant community component with some annual sea-blite and sea aster as well as small discrete patches of common saltmarsh grass (SM6).
- 3.26. Transect 30 (Figure 3.9): Compared to the rest of the marsh, there was a very limited stand of vegetation with a barren upper shore of cobble and sand. Below this was a marsh community which was made up of greater sea-spurrey, sea aster, common saltmarsh grass and annual sea-blite with some glasswort (SM13). On the lower marsh common cord grass became dominant with some sea aster, glasswort and common saltmarsh grass (Plate 14), which was classified as SM6.



Figure 3.1. NVC communities on transects 1 to 6.

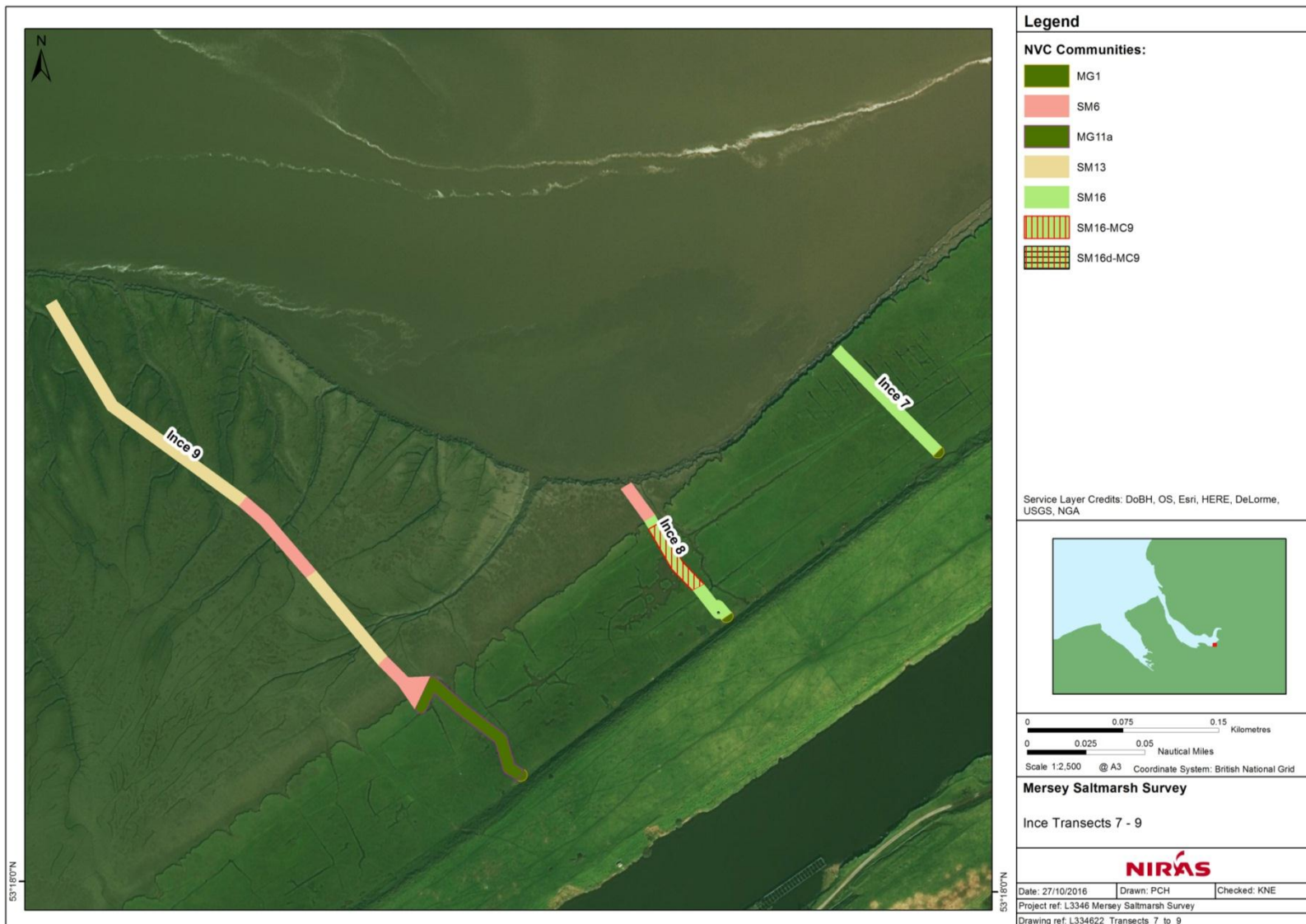


Figure 3.2. NVC communities on transects 7 to 9.



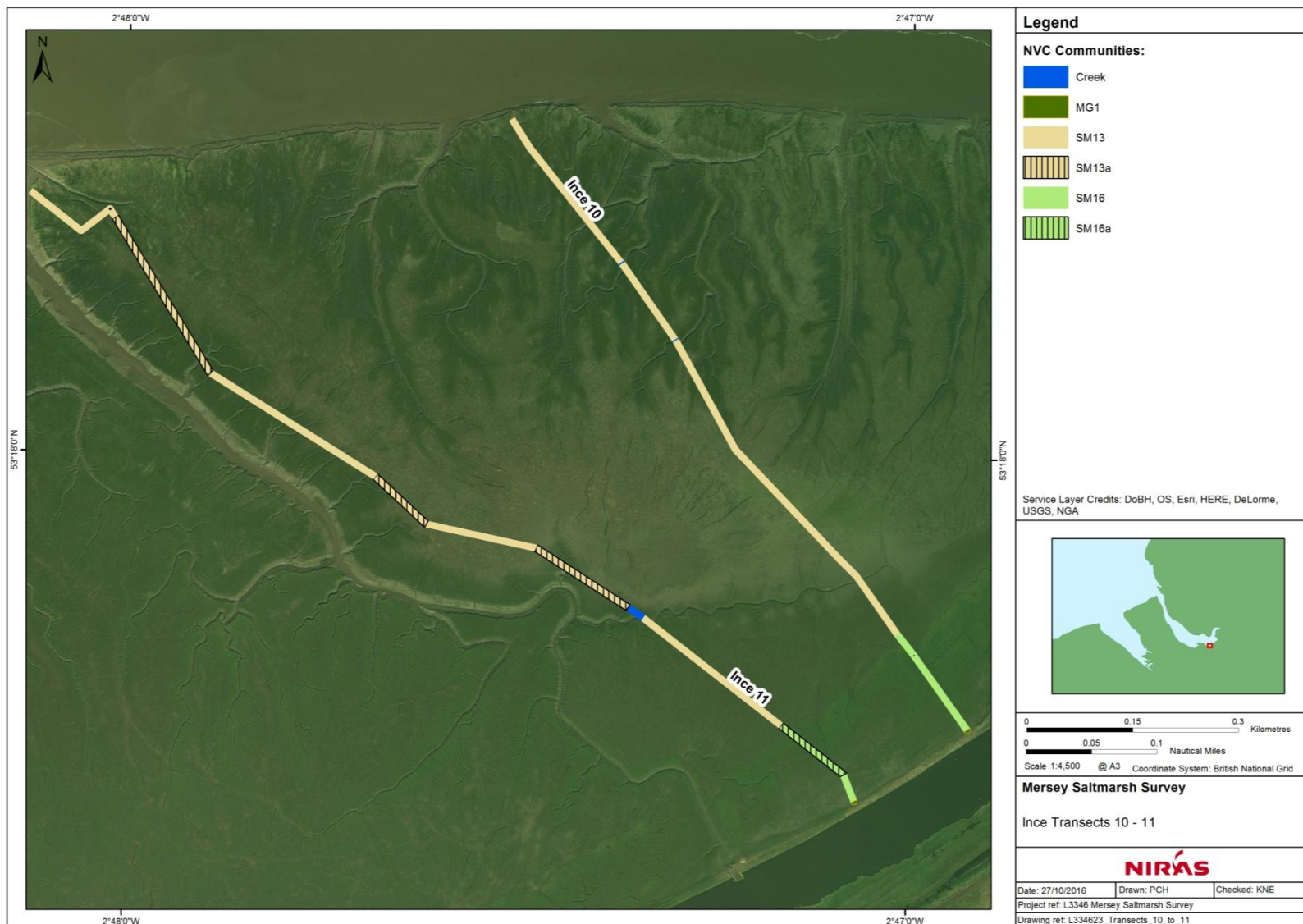


Figure 3.3. NVC communities on transects 10 and 11.

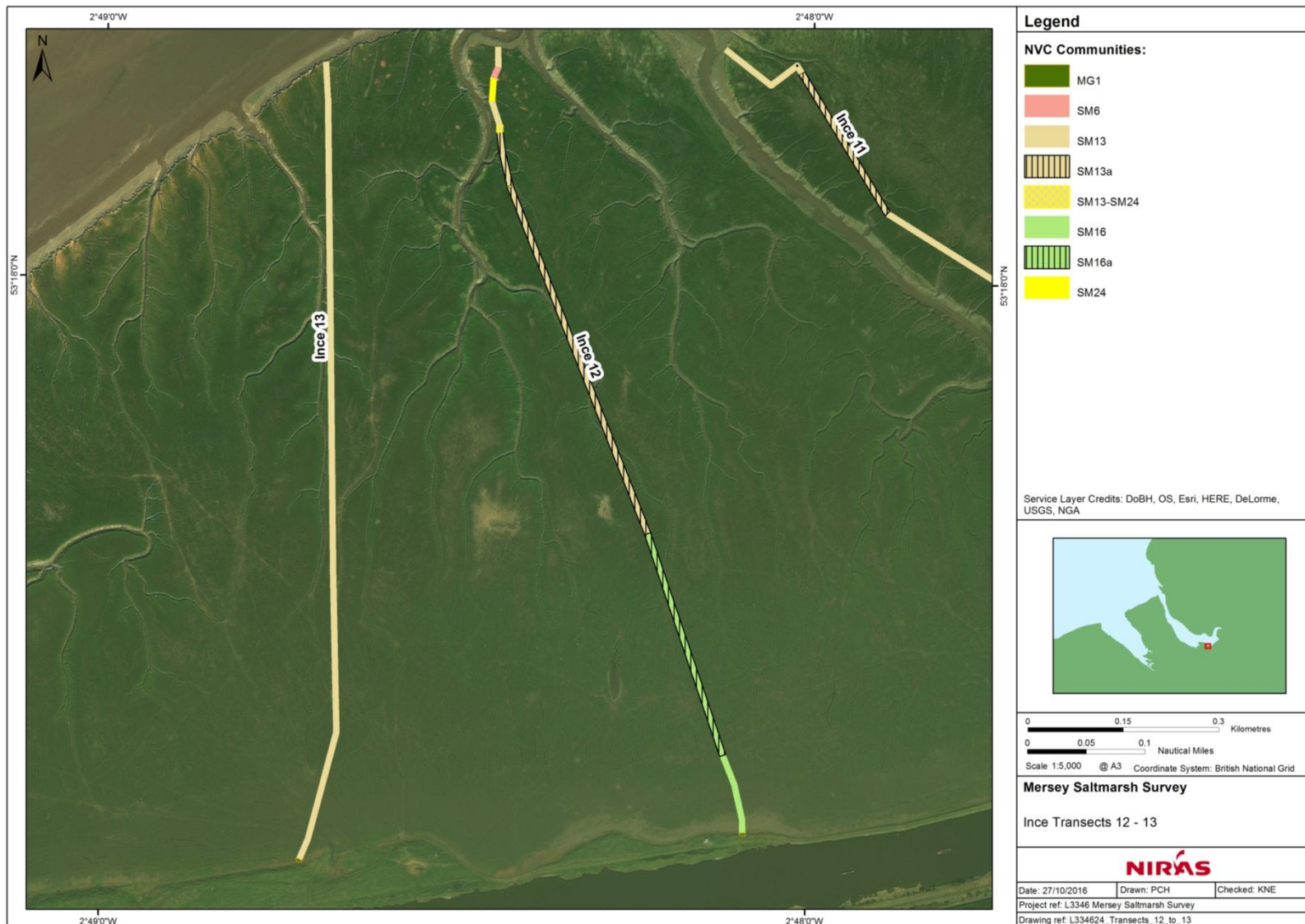


Figure 3.4. NVC communities on transects 12 and 13.

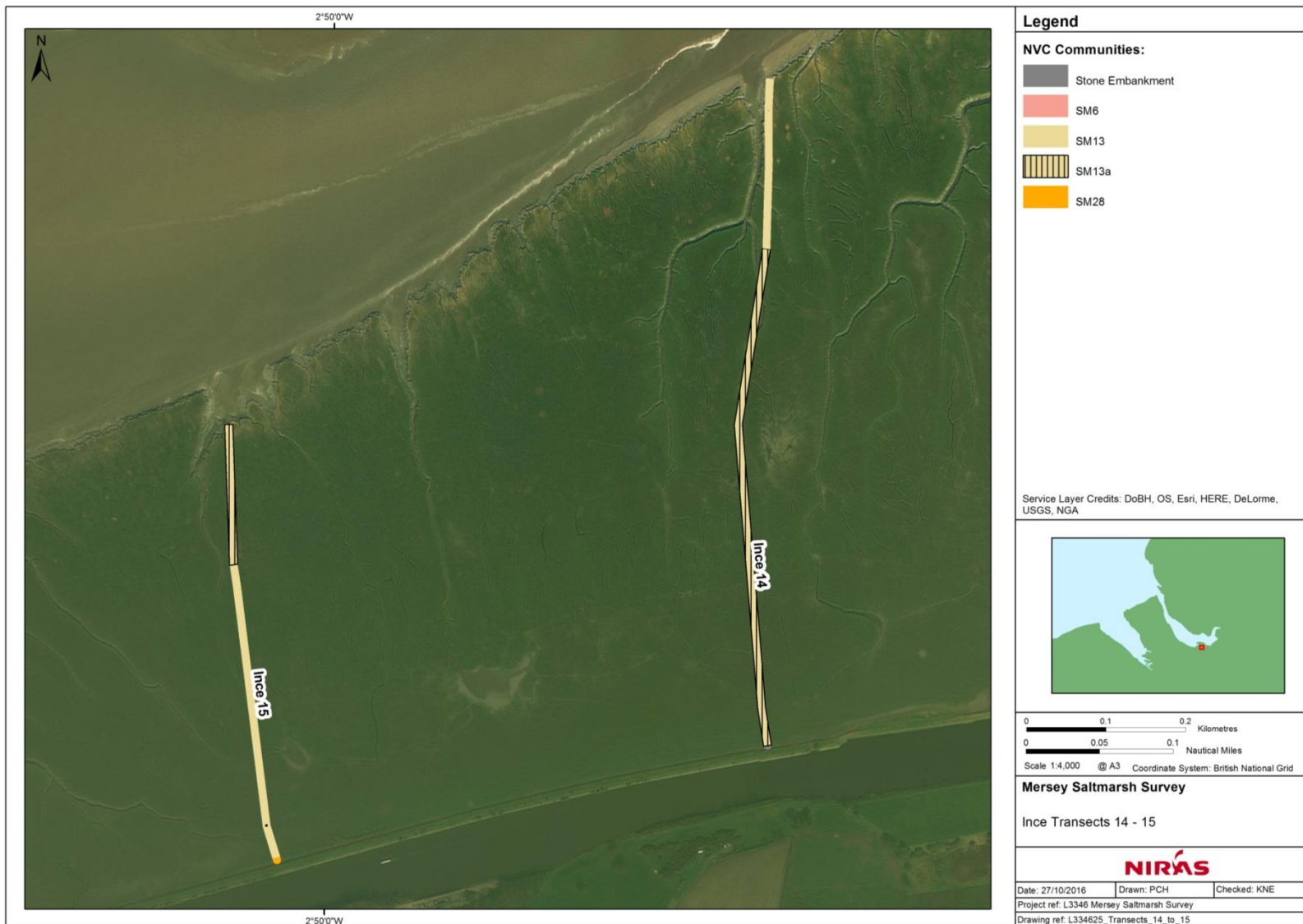


Figure 3.5. NVC communities on transects 14 and 15.





Figure 3.6. NVC communities on transects 16 to 18.





Figure 3.7. NVC communities on transects 19 to 21 .

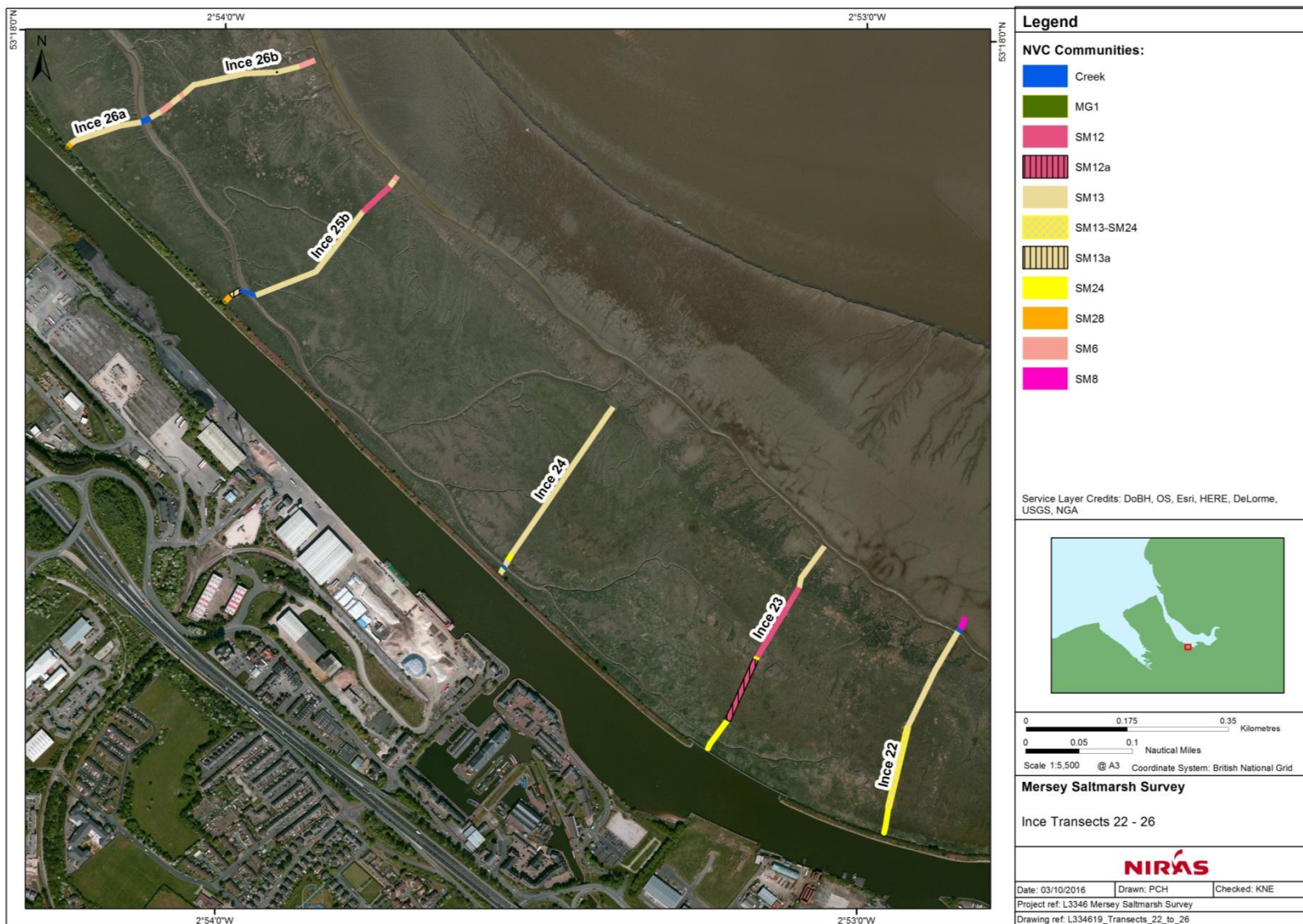


Figure 3.8. NVC communities on transects 22 to 26.



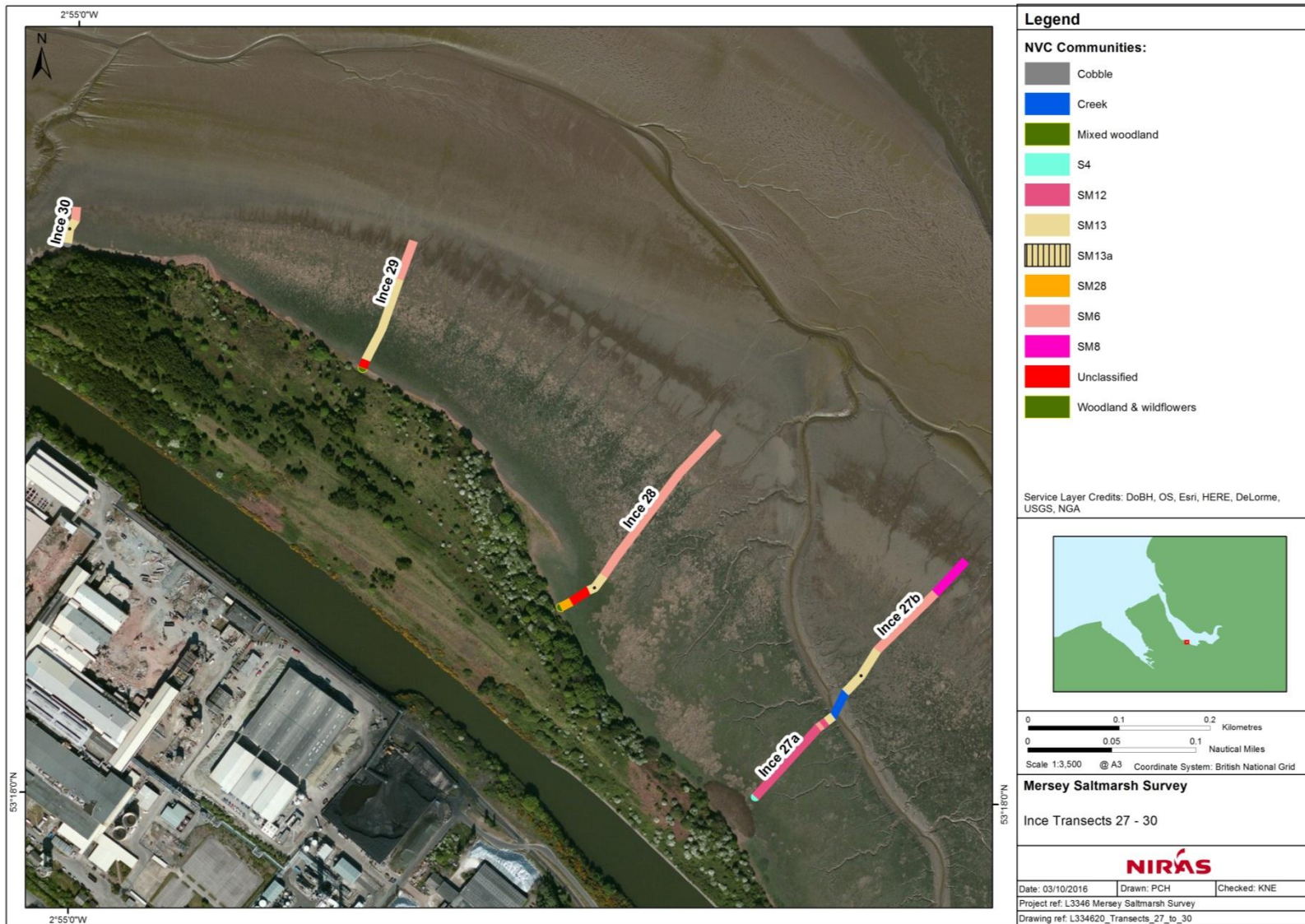


Figure 3.9. NVC communities on transects 27 to 30.

### Quadrats

2016 quadrat data is provided in Appendix 2, comparative data from 2002 (reported in Skelcher, 2003) and 2016 is provided in Appendix 3.

- 3.27. A total of fifty two quadrats were carried out during the survey of which eighteen were repeats from a previous survey (Skelcher, 2003). A total of twenty six taxa were recorded from the quadrats although individual sampling locations were generally species poor with no more than six separate taxa recorded in a single quadrat and three species or less (minimum two species) recorded in a third of the quadrats (Figure 3.10). Diversity did not show any apparent trends: quadrats from the grazed area were as likely to contain six taxa as quadrats from the ungrazed areas; there also did not appear to be a consistent trend of number of taxa between different parts (i.e. lower, middle and upper) of the marsh.
- 3.28. The taxa most frequently recorded in the quadrats were spear-leaved orache, sea aster and common saltmarsh grass but red fescue, creeping bent grass, common cord grass and annual sea-blite were also regularly encountered.
- 3.29. Comparison of saltmarsh communities in quadrats first surveyed in 2003 and repeated in 2016 indicated that there had been nominal improvement at seven of the eighteen repeated quadrats as the dominant community components had not changed but diversity had increased. Common cord grass, a negative indicator, remained absent in quadrats where it had not been found before and had become absent from two quadrats between 2003 and 2016. The absence of common cord grass between surveys should not necessarily be considered as a decrease in distribution however, as the limits of GPS accuracy do mean that quadrats will not be placed in exactly the same place and therefore patches of a certain plant may be missed or included in different surveys. At three quadrats there had been no appreciable change in floral community between 2003 and 2016, at four quadrats there had been some change between years (e.g. the species recorded were similar between years but there had been changes in dominance) and at four quadrats there had been large changes in community between years. All of the repeated quadrats in the Stanlow Banks area had changed to some extent but changes were not restricted to ungrazed areas with several changed quadrats on the upper shore in the Ince Banks area (Figure 3.11). Indeed, many of the quadrats in the grazed areas of the marsh had either remained broadly the same or shown an increase in diversity between 2003 and 2016.



Figure 3.10. Number of floral taxa in each quadrat.



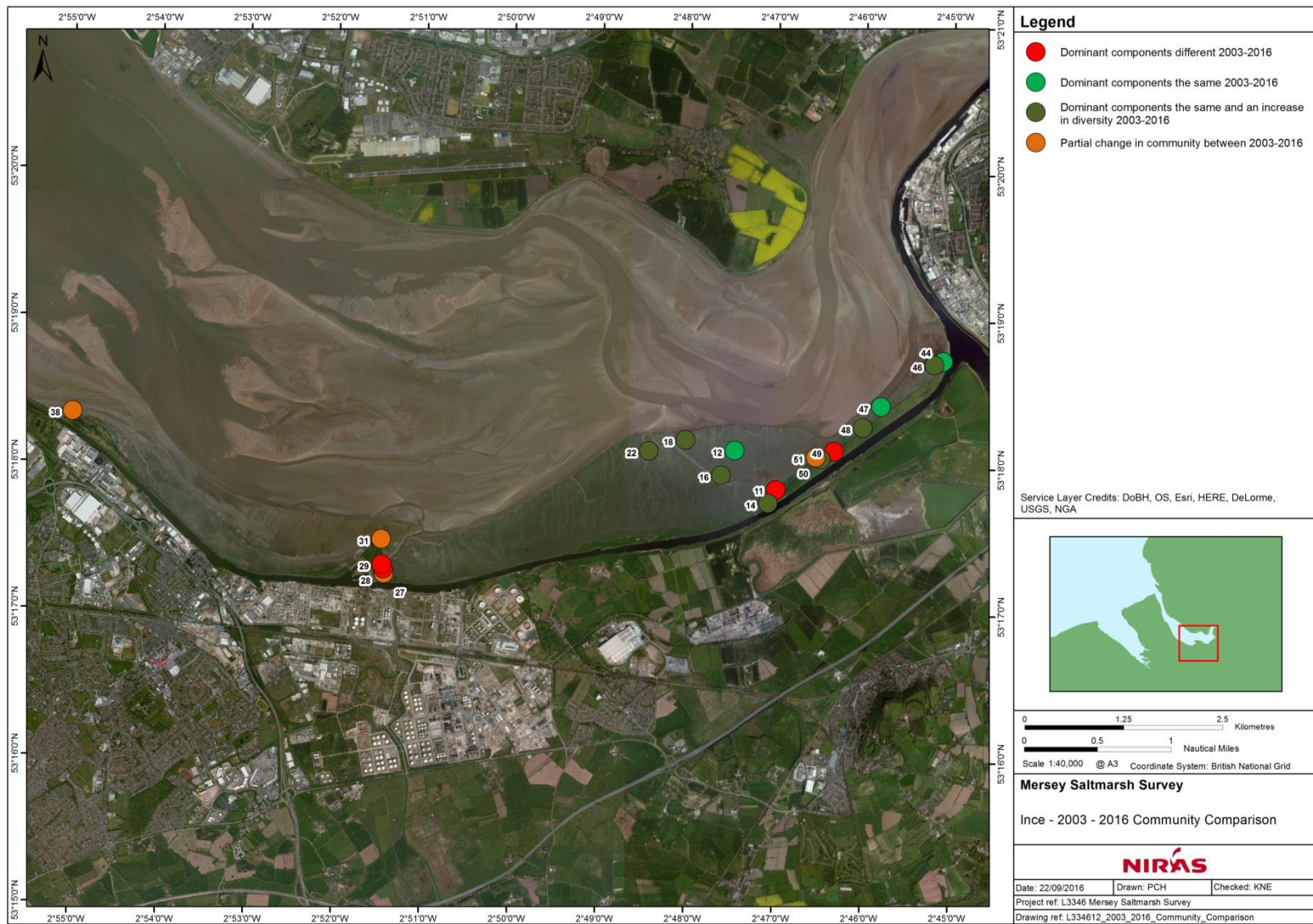


Figure 3.11. Illustration of changes to floral community on quadrats surveyed in 2003 and 2016.

### **Sward height**

Grazing kept the sward short (generally 1-10cm) on the eastern side of the marsh but with occasional peaks of 40-80cm on transects 8 to 12 (Figure 3.12 and Figure 3.13) where there were areas of common cord grass which were generally subject to less grazing than other saltmarsh flora. Sward height increased to 10-30cm the west of Transect 13 as grazing became less prevalent and from Transect 18 westwards the vegetation was generally over 20cm (Figure 3.14 and Figure 3.15) and often higher, especially where common cord grass or common reed were prevalent.





Figure 3.12. Sward heights on transects on Ince Bank saltmarsh.



Figure 3.13. Sward heights on transects on Ince Bank saltmarsh.



Figure 3.14. Sward heights on transects on Ince and Stanlow Bank saltmarsh.





Figure 3.15. Sward heights on transects on Stanlow Bank saltmarsh

### Canada geese

- 3.30. Canada geese *Branta canadensis* were observed directly either on the marsh or in the estuary in the area between Transect 5 and Transect 12. The greatest number was recorded on 11<sup>th</sup> September when approximately 650 Canada geese were recorded; 100 on the marsh near the top of transects 10 and 11 plus another 550 which were loafing on the ship canal but were flushed by the surveyors and alighted on the marsh with the other 100 individuals. The presence of these geese is represented by the two large circles at the top of the marsh near Transect 11 in Figure 3.16. This large group of geese were recorded while the surveyors were transiting to transects 1-9 and they also observed two large groups while returning to the ferry, with approximately 300 geese on the ship canal and a further 600 on the top 100m of the marsh in the area between the two larger circles in the figure.
- 3.31. Further smaller groups of Canada geese were recorded during the surveys including a group grazing on the lower marsh to the east of Transect 12 on September 9<sup>th</sup> and a group on the sandflat below the marsh on September 11<sup>th</sup>.
- 3.32. In addition, notes were taken on evidence of goose presence including droppings and grazed areas that livestock did not appear to have access to, mainly owing to creeks across the marsh, and these indicators were used to map out an area that is likely to be frequented by geese (hatched area in Figure 3.16).



Figure 3.16. Location of Canada geese *Branta canadensis* on the days of survey and an indicative area used by the geese.



## 4. Discussion

### Comparison of 2002 and 2016 saltmarsh communities

- 4.1. Unit 7 Frodsham Score: The communities found in 2016 were in broad agreement with those of the 2002 survey (Skelcher, 2003) with a predominance of SM16 *Festuca rubra* community across the area. The principal difference between 2002 and 2016 was the presence of the SM13 *Puccinellia maritima* community which was forming on the lower marsh at the eastern end of this unit.
- 4.2. Units 8 and 9 Ince Banks: In 2002 the large majority of this area supported an SM13 community with patches of SM6 *Spartina anglica* community and this remained the case in 2016. Differences between the 2002 and 2016 data included the loss of SM6 and SM8 *Salicornia* sp. pioneer marsh at the eastern end and a change on some parts of the upper marsh at the western end from SM13a to SM24 *Elytrigia pycnanthus* and SM28 *Elytrigia repens* communities.
- 4.3. Units 10 and 11 Stanlow Banks: In common with the 2002 survey, the 2016 survey found a greater variety of saltmarsh communities on Stanlow Banks in comparison to the Ince and Frodsham saltmarsh areas. Just to the west of the Gowy, the major communities were much the same between 2002 and 2016 with an upper marsh of SM16 and low-mid marsh of SM13. In 2016, the S21 *Bolboschoenus (Scirpus) maritimus* swamp was also observed (but was not recorded as it was not on the transect line) but the S12 *Typha latifolia* community appeared to be absent. The SM9 *Suaeda maritima* community was also not recorded on this transect or elsewhere to the west; it is possible that the common saltmarsh grass and common cord grass components of this community have become more dominant with time and are now classified as SM13. On the lower marsh just to the west of the Gowy, SM6 pioneer marsh has developed between 2002 and 2016. In the area around transects 19 to 21, the marsh communities were very similar in 2016 to that of 2002 but there was less SM6 which may have developed into SM10 transitional low marsh vegetation in the intervening period. Patches of SM8 were also recorded in this area in 2016 but not in 2002. On transects 23 to 28 some areas previously classified as SM13 in 2002 was classified as SM12 owing to dominance by sea aster over common saltmarsh grass. The upper and lower shore communities in the central part of the Stanlow Banks marsh was much the same in 2016 as it was in 2002 with S4 and S21 swamp communities and couch grass communities still present. At the Western end of this area the SM9 community had become SM13 – there were generally few records of *Suaeda maritima* on the open marsh, it was mainly noted at the edges of creeks and other disturbed areas. *Spartina anglica* was the dominant lower shore species on the western side of Stanlow Banks in both 2002 and 2016.

### Common Standards Monitoring assessment

- 4.4. Vegetation structure: zonation. For the majority of the marsh, there was a clear zonation as defined in the Common Standards Monitoring (JNCC, 2004) with a transition to mesotrophic grassland along much of the very upper marsh, and typical mid-upper marsh, low-mid marsh and pioneer marsh zonation in a seaward direction. Pioneer marsh was, however, absent for much of the Ince Bank and Frodsham Score marsh where a shift of channels in the estuary have eroded much of the lower margin of the marsh and is apparently yet to stabilise and allow typical zonation to form.

Condition: Favourable (Stanlow-Manisty) but declining at Ince Banks and Frodsham Score.

- 4.5. Vegetation structure: sward height. This was highly variable across the survey area from heavy grazing on the eastern end of the survey area, then moderate grazing in a westerly direction and then

abandoned grazing on the western side of the Ince Banks. The low sward height on the eastern Frodsham Score (Unit 7) could be expected to be attractive for roosting waders and wildfowl but with little orache for them to feed on. The western side of Unit 7, Unit 8 and the eastern half of Unit 9 is expected to be attractive to roosting birds owing to the unobstructed view offered by the low sward and also beneficial for grazing wildfowl with abundant orache, but glasswort was lacking in this area due to erosion at the face of the marsh. On the western side of Unit 9 and in Units 10 and 11, orache was also abundant in this area, as was glasswort, but the vegetation in general was under-grazed and the sward height was relatively high (generally 20 cm or more). As a result, these areas are likely to be of limited appeal to grazing and roosting waders and wildfowl (with the exception of snipe, see below), owing to the potential for ambush from the tall vegetation by predators.

Tracks of both fox and badger were seen in the mud on the Stanlow Banks and in front of Mount Manisty, and a young peregrine was seen repeatedly flying low over the saltmarsh in this area towards the sandflats in an attempt to surprise the waders foraging there.

It is unclear whether or not the marsh on Stanlow-Manisty area has ever been grazed but the limited access suggests not.

The taller sward on the Stanlow-Manisty area was certainly beneficial for invertebrates; while fauna were not a focus of the survey, amphipods were regularly observed amongst the vegetation, spiders such as wolf spiders (Lycosidae) were prevalent amongst the upper marsh grasses, crickets (probably bush crickets Tettigoniidae) and the orb weaver *Araneus quadratus* were both observed on the sea aster as were various bees and butterflies on the flowers. The taller sward height was also good for some bird species including snipe *Gallinago gallinago*, skylark *Alauda arvensis* and meadow pipit *Anthus pratensis* which were all flushed by the surveyors as they traversed the marsh.

Condition: Favourable.

- 4.6. Vegetation composition: characteristic species. The saltmarsh Frodsham Score and Mount Manisty supported all of the typical pioneer and low-mid marsh species as well as approximately half of the typical mid-upper marsh species listed in the Common Standards Monitoring Guidance (JNCC, 2004). In addition, the large majority of the marsh showed a transition zone to terrestrial plant communities.

Condition: Favourable.

- 4.7. Vegetation composition: negative indicator species *Spartina anglica*. Surveying the marsh with a series of transects rather than traversing all of the marsh makes assessment of this attribute somewhat problematical. Comparison of the distribution of saltmarsh communities along the transects surveyed in 2016 with the distribution maps in Skelcher (2003) appear to indicate that there has been no increase in *Spartina anglica* cover in the pioneer zone. Indeed, it appears that there has been an overall decrease in the expanse of *Spartina anglica* cover owing to the recent erosion on the Ince Bank marsh.

Condition: Favourable.

- 4.8. Other negative indicators. No artificial drainage channels were observed on the marsh (the channel between transects 17 and 18 is assumed to maintain drainage of the River Gowry into the Mersey) and vehicle use on the marsh is likely to be limited to occasional visits by farmers to check their livestock. With the exception of some litter on strandlines, there were no obvious signs of pollution on the marsh and while there were some bare areas owing to poaching by livestock, these amounted to an area that was far below the threshold of <25% in the Common Standards Monitoring (JNCC, 2004).

Condition: Favourable.

- 4.9. Physical structure: creeks and pans. Guidance (JNCC, 2004) suggests that this attribute is assessed by examination of aerial photographs or remote sensing but the surveys undertaken to create this report did not see any indications of internal dissection of the marsh or formation of mud basins. It was noted, however that there had been apparent dredging in the top of a creek near Transect 11, as sediment had been piled up on the marsh adjacent to the creek which was assumed to be its source.

#### **Canada goose (*Branta canadensis*)**

- 4.10. The impact of Canada geese on the saltmarsh was not immediately apparent as these birds tended to frequent areas that were already grazed (in some places heavily) by cattle and sheep and therefore only the in-combination effects of grazing could be observed. The exceptions to this were areas on the lower marsh in the vicinity of Transects 10, 11 and 12 where the marsh appeared to be grazed only by geese which had apparently cropped the sward to a low turf. Relative to the area of marsh grazed by all species, however, the area apparently grazed exclusively by Canada geese was very small. In a study on an Alaskan saltmarsh, Canada geese were found to feed mainly on species of *Triglochin*, *Puccinellia* as well as *Carex* (Zacheis *et al.*, 2001) and therefore do not necessarily compete with teal, wigeon and pintail for food which mainly feed on benthic invertebrates along with some plant material (Dessborn *et al.*, 2011). Whether or not Canada geese physically exclude other wildfowl from the areas they occupy is not known and may need to be studied.

#### **Recommendations for future surveys**

- 4.11. The assumption in the planning surveys of personnel travelling at an average of 1 mile per hour were broadly met although transit times on foot from the ferry landing to the eastern and western extremes of the marsh were long (up to five miles each way plus transect distances) and in future it might be worth considering accessing the saltmarsh to the west of the River Gowry from the seaward side using a small flat-bottomed boat or a hovercraft. To access saltmarsh to the east of the Gowry, it would be worth commissioning a small boat to ferry surveyors up the ship canal to minimise transit times and distance on foot, potentially allowing more area of saltmarsh to be surveyed. Alternatively, all-terrain bikes could be used by the surveyors which could easily cope with the tracks at the top of the marsh to the east of the Gowry and would considerably reduce effort and time expended by surveyors in transiting to Frodsham Score.
- 4.12. Survey personnel could potentially carry a collapsible ladder or similar to facilitate crossing creeks, although this may need a third person to prevent over-burdening a single surveyor with equipment.
- 4.13. Up to date aerial photography provided prior to survey panning would assist with determination of transect locations and subsequent assessment of habitat extent.
- 4.14. A survey in early summer to establish the condition of the marsh in the middle of the growing season.

## 5. References

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## Appendices

### Appendix 1: Field notes

Waypoint	Transect	Target note	Photos
212	Ince 1	Top of marsh. Above this is a low bank supporting common nettle, creeping thistle, common mouse-ear, silverweed, soft brome, Yorkshire-fog, false oat grass, red fescue, perennial rye grass, dandelion, spear thistle. (MG1 community). Below this is dominated by creeping bent and red fescue, heavily grazed. Sea milkwort also present but rare. Bare ground in shallow channels. Much goose dung on this part of marsh	224
214		Eroding cliff of marsh. Change in dominance to sea milkwort with some common saltmarsh grass.	
215		Seaward edge of marsh. Sea milkwort dominant.	225
216	Ince 2	Top of marsh. Above this is low embankment with community as described for Ince 1. MG1 also with meadow barley. Below this is creeping bent and red fescue with some sea milkwort.	
217		Quadrat. Note density of goose droppings prevalent over much of marsh here.	226
218		Bottom of marsh. Community of red fescue here but with some common saltmarsh grass and sea milkwort.	
220	Ince 3	Top of marsh. Perennial rye grass, meadow barley, smooth meadow grass and creeping thistle on embankment. First photo of embankment, second photo looking down shore.	227, 228
221		Community changes here to red fescue and creeping bent with small patches of sea arrowgrass. Slightly less grazed here.	
222		Change to common saltmarsh grass and sea milkwort where marsh has eroded and slumped.	229
223		Bottom of marsh	
224	Ince 4	Top of marsh. Mostly perennial rye grass here with some meadow barley. Creeping thistle and common nettle up embankment	
225		Change to creeping bent, red fescue with some sea milkwort	
226		Lower edge of marsh, eroding cliff face. Community as above, still a great deal of goose dung on mid and lower marsh. Photo across shore to show lumps of mud on lower marsh. Creeks on lower shore have very occasional sea aster, common cord grass and common scurvygrass (presumably where grazing is lighter)	230
227	Ince 5	Top of marsh. Above this point dominated by silverweed for a few metres to base of embankment (dominated by creeping thistle, false oat grass). Below waypoint is mainly perennial rye with some meadow barley. Photo looking downshore.	231
228		Change to creeping bent, red fescue, sea milkwort community	
229		As above but addition of sea barley (mainly on creek edges)	
230		Quadrat. Some goose dung here but less than on	



Waypoint	Transect	Target note	Photos	
		Transects 1-4.		
231		Bottom of marsh. Mainly red fescue here. Circa 150 Canada geese on sandflat across channel from here.		
232	Ince 6	Embankment with typical creeping thistle community. Top of marsh here is perennial rye and meadow barley.		
234		Some sea barley coming into community, no sea milkwort. Still dominated by red fescue and creeping bent. Little goose dung here.		
235		Lower edge of marsh. Photo looking east	232	
236	Ince 7	Above here is mainly silverweed and perennial rye grass. Below this is creeping bent and red fescue and sea rush community. Some sea milkwort.		
237		Bottom of marsh: no change in community from top to bottom.		
238	Ince 8	Bottom of embankment – silverweed and Yorkshire-fog, meadow barley, perennial rye, creeping bent.		
239		Change to creeping bent, red fescue with some sea milkwort. Sea rush in middle marsh.		
241		Slight change in community – addition of sea barley and more sea milkwort.		
242		Eastern edge of bare patch. See photo.	233	
243		Edge of red fescue-creeping bent community. ~50cm drop in elevation to next community of common saltmarsh grass and common cord grass with lesser sea-spurrey and sea milkwort. Photo looking west.	234	
244		Edge of saltmarsh, almost complete coverage by common cord grass here. Photo looking west. This is near enough the eastern edge of the common cord grass marsh.	235	
245		Ince 9	Bottom of embankment: creeping thistle community. Below this is silver weed, perennial rye, Yorkshire-fog and false oat grass.	
246			Change to creeping bent, red fescue and saltmarsh rush also sea barley and Yorkshire-fog.	
248	Community as above but with added sea barley (frequent)			
249	End of red fescue-creeping bent-sea barley community. 50cm drop in elevation to common cord grass and common saltmarsh grass.			
252	Common cord grass becomes patchy amongst a low turf of common saltmarsh grass with some spear-leaved orache.		240	
253	Start of dense stand of common cord grass 100% cover.			
254	End of common cord grass. Back to common saltmarsh grass with patches of common cord grass.			
255	Start of dense stand of common cord grass 100% cover.			
256	End of common cord grass. Back to common saltmarsh grass with patches of common cord grass.			
257	Common cord grass absent almost 100% cover of common saltmarsh grass, some spear-leaved orache, particularly near creeks. Some linear bare patches of mud – very shallow channels or pools.			
258		Much goose dung on bottom of marsh. First photo looking up shore, second looking along cliffs.	242, 243	

Waypoint	Transect	Target note	Photos	
79	Ince 10	Bottom of low embankment which supports common nettle, silverweed, common couch grass, perennial rye, creeping thistle, perennial sow-thistle, knotgrass.	177	
80		Quadrat. Photo looking seaward note bare area near sheep and also heavy grazing.	178	
81		Bottom of red fescue-sea barley community and start of heavily grazed turf of common saltmarsh grass, sea milkwort and lesser sea-spurrey. Some spear-leaved orache near creeks.		
82		Heavily poached area with much bare ground; vegetation here is patchy common saltmarsh grass	179	
83		Poached area made up of cropped common cord grass, sea aster, common saltmarsh grass and spear-leaved orache.		
84		End of poached area and a change to dominance by common saltmarsh grass and spear-leaved orache	180	
85		Two metre deep creek. Sides support common scurvygrass, sea aster, spear-leaved orache and annual sea-blite. Much more spear-leaved orache downshore of creek than upshore of it.		
86		As above but also with some common cord grass	181	
87		≈150m <sup>2</sup> area of short turf of common saltmarsh grass = result of grazing? Marsh is much more dominated by spear-leaved orache around this area.	182	
88		Lower edge of saltmarsh. Eroding mud cliff. Skelcher's quadrat 19 is now 100m into estuary. First photo of saltmarsh and goose dung, second photo is of eroding mud face.	183, 184	
90		Ince 11	Start of transect see quadrats for details of communities	
92			Change from dominance of creeping bent to common saltmarsh grass, lesser sea-spurrey and sea barley	185
93			Large creek, below which abrupt change to dominance by spear-leaved orache with common saltmarsh grass	186
95	Cropped common cord grass appearing here and it is as abundant as spear-leaved orache and common saltmarsh grass.		187	
97	Back to dominance by spear-leaved orache and common saltmarsh grass. No common cord grass.			
98	Quadrat with photo of general marsh		188	
99	Quadrat but note this community is not typical for this part of the marsh: the rest is closely cropped common saltmarsh grass turf.			
100	Change to short turf of mainly common saltmarsh grass. Very stunted spear-leaved orache and annual sea-blite. Some patches of bare mud. Patches of sea milkwort lower down marsh.		189	
101	Bottom of marsh. Much goose dung here. 1 <sup>st</sup> photo looking up creek, second photo looking down creek.		190, 191	
102	Ince 12		Bottom of embankment which supports common nettle, perennial rye, couch grass, creeping thistle, marsh thistle, smooth meadow grass. MG1 community.	
103		Change of dominance from spear-leaved orache to red fescue but also with creeping bent and spear-leaved		

Waypoint	Transect	Target note	Photos
		orache.	
104		Bottom of red fescue. Creeping bent much more common in here also sea aster appearing as well as sea arrowgrass.	
106		Sea aster much more abundant here with common saltmarsh grass. Some spear-leaved orache and occasional clumps of common cord grass.	
107		10m <sup>2</sup> patch of monospecific sea couch grass.	193
109		Less common saltmarsh grass here, understory (below sea aster) is mainly creeping bent and sea couch grass	
110		Back to sea aster-common saltmarsh grass community	
111		5m <sup>2</sup> patch of sea couch grass with some sea aster	
112		Patch of ≈100m <sup>2</sup> dominated by common cord grass and spear-leaved orache with some sea aster	
113		Back to sea aster and common saltmarsh grass but with a sward height of 10cm.	
114		Edge of saltmarsh of eroding mud cliff. Photo of 200+ Canada geese approximately 100m to east of this waypoint.	194
115	Ince 13	Bottom of marsh. Mixture of common saltmarsh grass with sea aster, annual sea-blite, common scurvygrass, lesser sea-spurrey as well as spear-leaved orache and sea milkwort.	195
116		Less diverse from here upwards with no sea-spurrey, milkwort or scurvygrass	
117		Grazing becoming more obvious; common saltmarsh grass more dominant but still some cover of sea aster (stunted) and spear-leaved orache.	196
118		Community change to common saltmarsh grass, sea plantain, spear-leaved orache with some sea aster and sea arrowgrass.	
120		Community changes to grazed common saltmarsh grass and spear-leaved orache.	
121		Top of shore just below embankment. Upwards from here is 2-3m dominated by creeping bent with some Yorkshire-fog, red fescue and spear-leaved orache. Above that is the embankment which is nettle-thistle dominated, MG-1 community.	
122	Ince 14	Start of transect. Placed stone embankment upshore from this point. Embankment supports ragwort, perennial rye, common couch grass, knotgrass, creeping bent, common bent, dandelion, perennial sow-thistle, common mouse-ear and spear-leaved orache. Below this is the upper marsh with a community of spear-leaved orache, creeping bent, red fescue, common saltmarsh grass and sea aster	
123		Quadrat	197
124		Community much as for quadrat (at WP123) but with addition of sea milkwort.	
125		Sea aster, common saltmarsh grass, spear-leaved orache. Slight increase in sward height.	
126		Patches of common cord grass appearing from here down the marsh but the community is still mainly sea aster and common saltmarsh grass. Sward height has	

Waypoint	Transect	Target note	Photos
		steadily increased along transect as grazing pressure has decreased.	
127		Patch of common cord grass with sea aster and spear-leaved orache and some common saltmarsh grass.	
128		Bottom of marsh. Possibly goose-grazed. Mainly common saltmarsh grass and sea aster but with some sea arrowgrass. Photo looking up creek.	198
131	Ince 15	Top of marsh of common couch grass, spear-leaved orache and perennial rye.	
132		Change to common saltmarsh grass, sea aster, spear-leaved orache, sea plantain, annual sea-blite, some sea milkwort and creeping bent	
134		Sea aster becoming more prevalent but with common saltmarsh grass and spear-leaved orache as before. A few scattered patches of common cord grass.	
135		Quadrat	200
136		Bottom of marsh. Community as for quadrat at WP135 (but annual sea-blite is more abundant here)	
137	Ince 16	Top of shore. Couch grass, spear-leaved orache, sea plantain as well as sea aster, red fescue, sea arrowgrass and, around a pool, common cord grass.	201
138		Quadrat	202
139		25m <sup>2</sup> patch of common cord grass	
140		Seaward edge of marsh community the same as the quadrat but with some sea milkwort	
141	Ince 17	Top of transect, bottom of low embankment which supports sea mayweed, couch grass (dominant), spear-leaved orache and ragwort. Below this is the saltmarsh with a community of sea milkwort, creeping bent, red fescue, sea plantain, sea arrowgrass, spear-leaved orache and sea aster.	
142		Changes to dominance by sea aster and common saltmarsh grass and creeping bent. Some spear-leaved orache, sea arrowgrass, sea plantain and patches of sea milkwort.	
143		Edge of deep creek with much water at high tide. On other side the community appears to be the same sea aster and grass community as recorded higher up.	
144	Ince 18	Top of marsh. Mainly Yorkshire-fog and sea milkwort with red fescue, sea aster, spear-leaved orache, perennial sow-thistle, curled leaf dock further down.	
145		To west of transect is sea sea club-rush but only for about 5m along transect. To east is grass community as above.	
147		Sea sea club-rush in amongst Yorkshire-fog and red fescue with spear-leaved orache.	
148		Quadrat	205
149		End of sea club-rush	
150		Quadrat	206
151		Taller sea aster starting to appear, common couch grass, Yorkshire-fog, spear-leaved orache, some milkwort and sea plantain.	207
153		Change of community: still seeing sea aster and some Yorkshire-fog but also common saltmarsh grass more	

Waypoint	Transect	Target note	Photos
		sea milkwort and sea plantain. Sea purslane around creeks.	
154		Quadrat. Greater sea-spurrey rare just outside quadrat	208
155		Sea purslane just outside quadrat	
156		Sea purslane and common cord grass amongst common saltmarsh grass-sea plantain-sea aster community.	209
157		Eroding edge of mid-marsh with pioneer common cord grass below it. Much greater sea-spurrey at eroding marsh edge.	
158		Lower edge of pioneer common cord grass which also contains glasswort. First photo along edge of marsh, second looking across estuary.	210, 211
24	Ince 19	Top of narrow band of sea may weed (90% cover), curled dock, sea milkwort, couch grass and false fox sedge	
25		Top of narrow band of sea plantain, sea aster and sea milkwort (about equal cover) – cropped by rabbits.	
26		Top of broad area of spear-leaved orache, sea aster, common cord grass, sea milkwort	
27		Change in dominance from orache to common cord grass	
28		Back to dominance by orache with common cord grass mixed in.	
29		Change to sea aster, sea plantain (dominant) and common saltmarsh grass (latter mainly next to drainage creeks)	
30		Change to dominance. Community of common saltmarsh grass and common cord grass with some spear-leaved orache, sea aster with some annual sea-blite lower down. Common cord grass becomes dominant lower down.	
31		Boundary between common cord grass and glasswort. Odd sea aster.	
32		Bottom of glasswort and bottom of saltmarsh.	
33	Ince 20	Bottom of common reed swamp. Photo looking up shore.	157
34		Bottom of sea arrowgrass and sea plantain with some sea aster and stunted common cord grass. Top of community of sea aster, annual sea-blite, common saltmarsh grass, creeping bent grass occasional sea arrowgrass, spear-leaved orache.	
35		Lower down patches of common cord grass appear plus sea milkwort.	
36		Top of common saltmarsh grass-common cord grass community with spear-leaved orache.	
37		Change to glasswort, with some common cord grass ≈20%, also some annual sea-blite, sea aster and common saltmarsh grass <5% cover each.	158, 159
38		Bottom of glasswort	
39	Ince 21	Top of a small area ≈50m <sup>2</sup> of sea sea club-rush. Above this is MG1 type habitat dominated by false oat grass, perennial sow-thistle, nettle and lesser burdock (this is embankment above marsh). Photo looking up shore.	160



Waypoint	Transect	Target note	Photos
40		Bottom of sea club-rush, start of sea aster, sea arrowgrass, creeping bent grass, common saltmarsh grass.	
43		Change to dominance by sea purslane with some sea aster, sea plantain, also common saltmarsh grass.	
44		Start of clumps of common cord grass amongst spear-leaved orache, common common saltmarsh grass, some sea aster. Common cord grass becomes dominant lower down.	
47		Dominant common cord grass with common saltmarsh grass and annual sea-blite.	
48		Break in saltmarsh – open mud with clumps of common cord grass, common saltmarsh grass and glasswort	163
49		Back to full coverage of marsh – glasswort annual sea-blite, common cord grass and common saltmarsh grass.	
52		Start of glasswort.	
53		Bottom on glasswort.	
54	Ince 22	Top of shore community dominated by common couch grass, with spear-leaved orache, sea aster and perennial sow-thistle.	
55		Bottom of couch grass. Top of community of sea aster, spear-leaved orache, common couch grass in about equal coverage.	164
56		As above but starting to see some sea plantain, sea arrowgrass and common saltmarsh grass.	
57		As above but with patches of common cord grass appearing. More dominance by common saltmarsh grass.	165
58		Top of community dominated by spear-leaved orache and common saltmarsh grass, much less sea aster here than higher up. Patches of common cord grass lower down.	166
59		Edge of deep, wide creek. Community here is mainly sea aster, annual sea-blite, spear-leaved orache.	167
60		Top of glasswort with some common cord grass	168
61		Bottom of glasswort <5% cover	
63	Ince 23	Top of couch grass dominated community with spear-leaved orache.	
64		Bottom of couch grass community. Top of sea aster, common saltmarsh grass and some spear-leaved orache.	
66		≈100m <sup>2</sup> area with little sea aster, more couch grass (see quadrat at WP67).	173
68		Sea aster dominated community with common cord grass patches	
69		Change to spear-leaved orache and common saltmarsh grass community with patches of common cord grass, some sea aster and some sea purslane.	
71		Seaward edge of saltmarsh and edge of deep , wide creek. More common cord grass plus annual sea-blite	174
72	Ince 24	Lower edge of creek. Spear-leaved orache dominated community with common saltmarsh grass. This is 4-5m wide and runs along the creek. Above the creek there	

Waypoint	Transect	Target note	Photos
		is another band of spear-leaved orache ≈2m with couch grass landward of this.	
73		Bottom of spear-leaved orache, top of couch grass	
74		Sea aster, spear-leaved orache, common saltmarsh grass. About equal coverage of each.	
75		Change to mainly common saltmarsh grass but with sea purslane, sea aster (less than higher up), spear-leaved orache and annual sea-blite.	
76		Patches of common cord grass amongst common saltmarsh grass with some spear-leaved orache. Some glasswort lower down.	
159	Ince 25a	Top of marsh backed by embankment which supports bramble, dog rose, bracken, hawthorn, sycamore, nettle, ragwort, elder, gorse, perennial sow-thistle, sea mugweed, red fescue and false oat grass. Ragwort, common mugwort and wood sage also present. Below this is tall spear-leaved orache, sea aster, sea/common couch (probably hybridising), creeping bent and Yorkshire-fog.	
160		Quadrat	212
161		Top edge of creek: no change in community from top of marsh to here.	
203	Ince 25b	Bottom of marsh. Dominated by common cord grass	
205		Change to common saltmarsh grass and sea aster. Some annual sea-blite and spear-leaved orache.	
206		10m <sup>2</sup> patch of common cord grass	
208		Lower edge of creek. Community here is common saltmarsh grass, spear-leaved orache and sea aster.	
162	Ince 26a	Top of marsh. Bottom of embankment with flora much as for the top of Ince 25a. Below waypoint is dominated by couch grass, spear-leaved orache, perennial sow-thistle, curled dock, sea aster and silverweed	
163		Flora changes to sea plantain, sea aster, sea arrowgrass, Yorkshire-fog, common saltmarsh grass, sea milkwort with some spear-leaved orache.	
164		Quadrat	213
165		Change in community to more spear-leaved orache, sea aster and common saltmarsh grass (in equal quantities but no other species)	
166		Edge of wide creek. Some annual sea-blite here amongst community as above.	
193	Ince 26b	Lower edge of creek which has glasswort at the lip and annual sea-blite at creek edges. Saltmarsh community: common saltmarsh grass and spear-leaved orache with some sea aster.	
194		Community changes to common cord grass and spear-leaved orache in equal amounts with some sea aster and common saltmarsh grass.	
195		Back to sea aster, common saltmarsh grass and spear-leaved orache.	
196		Back to common cord grass again	
197		And back to sea aster-spear-leaved orache-common saltmarsh grass community	

Waypoint	Transect	Target note	Photos
198		Quadrat	221
199		Start of patchy common cord grass amongst common saltmarsh grass, sea aster and spear-leaved orache. Scurvygrass and annual sea-blite on creek edges.	222
201		Common cord grass becomes dominant with some sea aster, common saltmarsh grass and glasswort.	
202		Bottom of common cord grass and bottom of marsh. Creek here prevents glasswort establishing. Photo looking east.	223
167	Ince 27a	Bottom of S4 common reed swamp – very dense and surveyors did not enter it. Below this is a community of sea aster, sea arrowgrass, spear-leaved orache, some common saltmarsh grass and occasional sea plantain and sea-blite.	
168		50m <sup>2</sup> area of common cord grass amongst community described above	
169		Edge of creek. Photo looking up shore.	214
188	Ince 27b	Lower edge of creek. Saltmarsh here is a mix of common cord grass, common saltmarsh grass, annual sea-blite and spear-leaved orache. Photo looking down shore.	219
190		Common cord grass becomes dominant here, also more annual sea-blite but less common saltmarsh grass (patchy). Low abundance of sea aster and spear-leaved orache.	
191		End of common cord grass and start of glasswort which is restricted to creek edges, see photo.	220
192		Seaward edge of glasswort.	
170	Ince 28	Top of marsh. Above this is mixed woodland of sycamore, hawthorn, elder and goat willow with rosebay willowherb, teasle, Himalayan balsam and nettle. Below waypoint is grassy area with mainly couch grass, red fescue, but also some silverweed, sea plantain, greater plantain, Yorkshire-fog, sea aster, curled dock, common ragwort and spear-leaved orache.	
171		Change to mostly Yorkshire-fog with some creeping bent and sea aster.	
172		Change in community: sea aster, sea milkwort, sea arrowgrass, spear-leaved orache, Yorkshire-fog, common saltmarsh grass	215
174		Common cord grass dominated area, spear-leaved orache some sea aster and common saltmarsh grass	
176		100% common cord grass from here down marsh	
177		Bottom of marsh, common cord grass is patchy for last few metres	
178	Ince 29	Top of marsh. Above this is steep embankments supporting ash, hawthorn and a variety of wildflowers including st. John's wort, vetches, false oat grass, woodsage, rosebay willowherb, yellow wort and bramble. Below this is a cropped area (by rabbits) of Yorkshire-fog, sea milkwort and sea aster.	
179		Cropped area ends, still some Yorkshire-fog but mainly common saltmarsh grass with sea aster, sea milkwort,	

Waypoint	Transect	Target note	Photos
		spear-leaved orache and sea plantain.	
180		Common cord grass amongst spear-leaved orache and common saltmarsh grass. Photo looking downshore.	216
181		Dense common cord grass with annual sea-blite, sea aster and patches (<math><1\text{m}^2</math>) of common saltmarsh grass.	
182		Edge of saltmarsh, bottom of common cord grass. Photo looking up shore.	217
183	Ince 30	Top of marsh, cobble above this. Greater sea-spurrey, sea aster, common saltmarsh grass, annual sea-blite, some glasswort.	218
186		Top of common cord grass community with sea aster, glasswort and common saltmarsh grass.	
187		Bottom edge of marsh.	
77		≈130 Canada geese here	
78		≈140 Canada geese here	
209		100 Canada geese approximately 150m down onto marsh from here	
210-211		≈550 Canada geese on the ship canal between these two points.	
		On the walk back to the ferry, there were ≈300 Canada geese on the ship canal between WP210&211. In addition there were ≈600 Canada geese on top 100m of marsh between transect 10 and the area just over the creek to the west of transect 11.	



**Appendix 2: Quadrat data**

Quadrat number	1		2		3		4		5		6		7		
Repeat of (2002 quadrat)															
NVC community	Sm13a		SM12a		SM13a		SM13		SM13		SM6		SM24		
Vernacular	Species	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin
Sea barley	<i>Hordeum marinum</i>														
White clover	<i>Trifolium repens</i>														
Red fescue	<i>Festuca rubra</i> agg.														
Sea milkwort	<i>Glaux maritima</i>														
Sea aster	<i>Aster tripolium</i>	f	6	a	9	r	1					r	1		
Spear-leaved orache	<i>Atriplex prostrata</i>	r	1	f	7	f	5					r	1	f	5
Common saltmarsh grass	<i>Puccinellia maritima</i>	a	8	f	4	d	10	d	10	d	10	o	4		
Common scurvygrass	<i>Cochlearia officinalis</i>														
Knotgrass	<i>Polygonum</i> sp.														
Perennial rye-grass	<i>Lolium perenne</i>														
Creeping bent	<i>Agrostis stolonifera</i>														
Sea arrowgrass	<i>Triglochin maritimum</i>	o	1												
Common cord grass	<i>Spartina anglica</i>					r	2	a	6	o	5	f	6		
Annual sea-blite	<i>Suaeda maritima</i>			r	1					o	2	f	5		
Couch grass	<i>Elytrigia</i> sp.													d	10
Sea plantain	<i>Plantago maritima</i>														
Lesser sea-spurrey	<i>Spergularia marina</i>														
Glasswort	<i>Salicornia</i> sp.									o	2	a	7		
Yorkshire-fog	<i>Holcus lanatus</i>														
Tufted hair-grass	<i>Deschampsia cespitosa</i>														
perennial sow-thistle	<i>Sonchus arvensis</i>														
Sea club-rush	<i>Bolboschoenus maritimus</i>														
Umbellifer (indet.)															
Greater sea-spurrey	<i>Spergularia media</i>														
Silverweed	<i>Potentilla anserina</i>														
Saltmarsh rush	<i>Juncus gerardii</i>														

Quadrat	8		9		10		11		12		13		14		
Repeat of (2002 quadrat)							153		59				152		
NVC community	SM12		SM24		SM13		SM16e		SM13a		SM16		SM16a		
Vernacular	Species	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin
Sea barley	<i>Hordeum marinum</i>							f	6			o	5		
White clover	<i>Trifolium repens</i>							f	6						
Red fescue	<i>Festuca rubra</i>							d	10			a	8	f	6
Sea milkwort	<i>Glaux maritima</i>							r	2					o	3
Sea aster	<i>Aster tripolium</i>	d	10	o	5			r	1			r	1		
Spear-leaved orache	<i>Atriplex prostrata</i>	o	3	a	9	a	8			a	6			r	1
Common saltmarsh grass	<i>Puccinellia maritima</i>					d	10			d	10				
Common scurvygrass	<i>Cochlearia officinalis</i>									o	3				
Knotgrass	<i>Polygonum sp.</i>											o	3		
Perennial rye-grass	<i>Lolium perenne</i>											f	6		
Creeping bent	<i>Agrostis stolonifera</i>											o	6	d	10
Sea arrowgrass	<i>Triglochin maritimum</i>													r	1
Common cord grass	<i>Spartina anglica</i>														
Annual sea-blite	<i>Suaeda maritima</i>														
Couch grass	<i>Elytrigia sp.</i>			a	8										
Sea plantain	<i>Plantago maritima</i>														
Lesser sea-spurrey	<i>Spergularia marina</i>														
Glasswort	<i>Salicornia sp.</i>														
Yorkshire-fog	<i>Holcus lanatus</i>														
Tufted hair-grass	<i>Deschampsia cespitosa</i>														
perennial sow-thistle	<i>Sonchus arvensis</i>														
Sea club-rush	<i>Bolboschoenus maritimus</i>														
Umbellifer (indet.)															
Greater sea-spurrey	<i>Spergularia media</i>														
Silverweed	<i>Potentilla anserina</i>														
Saltmarsh rush	<i>Juncus gerardii</i>														

Quadrat	15		16		17		18		19		20		21		
Repeat of (2002 quadrat)			10				52								
NVC community	SM13a		SM13a		SM13a		SM13a		SM16c		SM16a		SM13a		
Vernacular	Species	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin
Sea barley	<i>Hordeum marinum</i>														
White clover	<i>Trifolium repens</i>														
Red fescue	<i>Festuca rubra</i>									a	8	d	10		
Sea milkwort	<i>Glaux maritima</i>														
Sea aster	<i>Aster tripolium</i>			r	1			r	1			o	4	f	5
Spear-leaved orache	<i>Atriplex prostrata</i>	d	8	f	4	a	8	a	8	d	10	f	6	r	1
Common saltmarsh grass	<i>Puccinellia maritima</i>	d	8	d	10	a	8	a	8					d	10
Common scurvygrass	<i>Cochlearia officinalis</i>					r	1	r	1						
Knotgrass	<i>Polygonum sp.</i>														
Perennial rye-grass	<i>Lolium perenne</i>									r	2				
Creeping bent	<i>Agrostis stolonifera</i>									o	4	o	4		
Sea arrowgrass	<i>Triglochin maritimum</i>														
Common cord grass	<i>Spartina anglica</i>			f	5	o	2								
Annual sea-blite	<i>Suaeda maritima</i>									r	1				
Couch grass	<i>Elytrigia sp.</i>									r	1				
Sea plantain	<i>Plantago maritima</i>											r	1		
Lesser sea-spurrey	<i>Spergularia marina</i>											r	1		
Glasswort	<i>Salicornia sp.</i>														
Yorkshire-fog	<i>Holcus lanatus</i>														
Tufted hair-grass	<i>Deschampsia cespitosa</i>														
perennial sow-thistle	<i>Sonchus arvensis</i>														
Sea club-rush	<i>Bolboschoenus maritimus</i>														
Umbellifer (indet.)															
Greater sea-spurrey	<i>Spergularia media</i>														
Silverweed	<i>Potentilla anserina</i>														
Saltmarsh rush	<i>Juncus gerardii</i>														

Quadrat	22		23		24		25		26		27		28		
Repeat of (2002 quadrat)	48										109		166		
NVC community	SM13a		SM13a		Sm13a		SM13a		SM13a		SM16d		SM16		
Vernacular	Species		DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	
Sea barley	<i>Hordeum marinum</i>														
White clover	<i>Trifolium repens</i>														
Red fescue	<i>Festuca rubra</i>										a	8	a	8	
Sea milkwort	<i>Glaux maritima</i>										o	4			
Sea aster	<i>Aster tripolium</i>		a	6	o	4	f	5	f	6	f	4	r	1	
Spear-leaved orache	<i>Atriplex prostrata</i>		f	5	f	5	f	5	o	4	f	4	r	1	
Common saltmarsh grass	<i>Puccinellia maritima</i>		d	8	d	10	d	10	d	9	a	8			
Common scurvygrass	<i>Cochlearia officinalis</i>														
Knotgrass	<i>Polygonum sp.</i>														
Perennial rye-grass	<i>Lolium perenne</i>														
Creeping bent	<i>Agrostis stolonifera</i>				r	1	r	2							
Sea arrowgrass	<i>Triglochin maritimum</i>									r	1	r	1		
Common cord grass	<i>Spartina anglica</i>														
Annual sea-blite	<i>Suaeda maritima</i>				o	3	o	4	r	1	f	5			
Couch grass	<i>Elytrigia sp.</i>														
Sea plantain	<i>Plantago maritima</i>														
Lesser sea-spurrey	<i>Spergularia marina</i>														
Glasswort	<i>Salicornia sp.</i>									r	1				
Yorkshire-fog	<i>Holcus lanatus</i>											d	10	a	8
Tufted hair-grass	<i>Deschampsia cespitosa</i>													o	4
perennial sow-thistle	<i>Sonchus arvensis</i>													o	4
Sea club-rush	<i>Bolboschoenus maritimus</i>													f	4
Umbellifer (indet.)															
Greater sea-spurrey	<i>Spergularia media</i>														
Silverweed	<i>Potentilla anserina</i>														
Saltmarsh rush	<i>Juncus gerardii</i>														



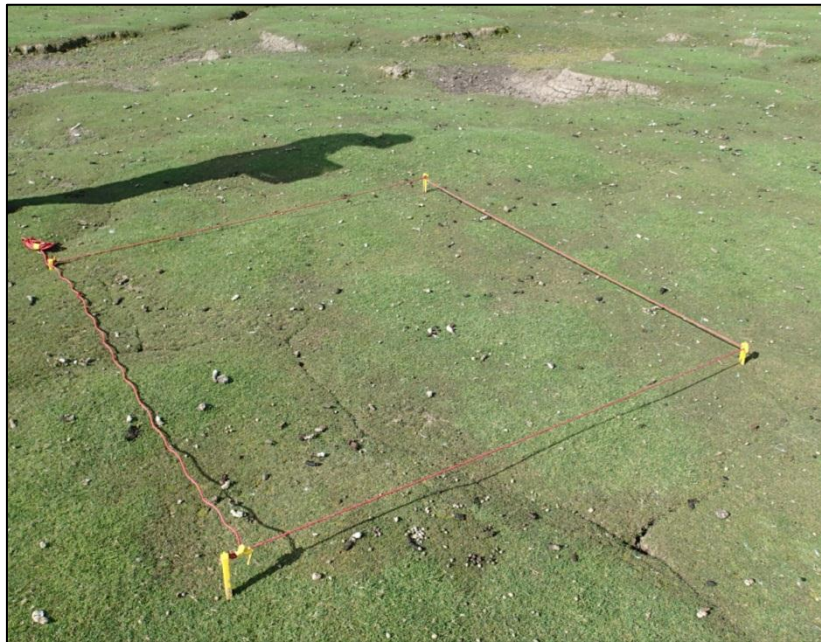
Quadrat	29		30		31		32		33		34		35		
Repeat of (2002 quadrat)	163				21										
NVC community	SM16		SM28		SM13a		SM13		SM13a		SM12		SM13a		
Vernacular	Species	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin
Sea barley	<i>Hordeum marinum</i>														
White clover	<i>Trifolium repens</i>														
Red fescue	<i>Festuca rubra</i>	a	8												
Sea milkwort	<i>Glaux maritima</i>					r	1					o	4	o	4
Sea aster	<i>Aster tripolium</i>			o	4	o	1	a	7	a	6	d	10	f	5
Spear-leaved orache	<i>Atriplex prostrata</i>	o	4	o	4	a	7	f	4	f	5	r	3	f	5
Common saltmarsh grass	<i>Puccinellia maritima</i>					a	8	f	5	a	8	o	4	a	9
Common scurvygrass	<i>Cochlearia officinalis</i>														
Knotgrass	<i>Polygonum sp.</i>														
Perennial rye-grass	<i>Lolium perenne</i>														
Creeping bent	<i>Agrostis stolonifera</i>									r	2				
Sea arrowgrass	<i>Triglochin maritimum</i>					o	4					r	2		
Common cord grass	<i>Spartina anglica</i>														
Annual sea-blite	<i>Suaeda maritima</i>														
Couch grass	<i>Elytrigia sp.</i>														
Sea plantain	<i>Plantago maritima</i>							a	5						
Lesser sea-spurrey	<i>Spergularia marina</i>														
Glasswort	<i>Salicornia sp.</i>														
Yorkshire-fog	<i>Holcus lanatus</i>	d	9	d	10										
Tufted hair-grass	<i>Deschampsia cespitosa</i>														
perennial sow-thistle	<i>Sonchus arvensis</i>	r	1												
Sea club-rush	<i>Bolboschoenus maritimus</i>														
Umbellifer (indet.)		r	1												
Greater sea-spurrey	<i>Spergularia media</i>														
Silverweed	<i>Potentilla anserina</i>														
Saltmarsh rush	<i>Juncus gerardii</i>														

Quadrat	36		37		38		39		40		41		42	
Repeat of (2002 quadrat)					20									
NVC community	SM6		SM13a		SM13a		SM13a		SM13		SM13a		SM6	
Vernacular	Species		DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin
Sea barley	<i>Hordeum marinum</i>													
White clover	<i>Trifolium repens</i>													
Red fescue	<i>Festuca rubra</i>													
Sea milkwort	<i>Glaux maritima</i>													
Sea aster	<i>Aster tripolium</i>		o	4	o	4	f	6	r	1	o	4	o	4
Spear-leaved orache	<i>Atriplex prostrata</i>		a	7	f	4			f	6	a	8		r
Common saltmarsh grass	<i>Puccinellia maritima</i>				d	10	a	8	d	8	f	6	a	8
Common scurvygrass	<i>Cochlearia officinalis</i>													
Knotgrass	<i>Polygonum sp.</i>													
Perennial rye-grass	<i>Lolium perenne</i>													
Creeping bent	<i>Agrostis stolonifera</i>													
Sea arrowgrass	<i>Triglochin maritimum</i>													
Common cord grass	<i>Spartina anglica</i>		d	9			a	5	f	4			o	4
Annual sea-blite	<i>Suaeda maritima</i>				o	3	r	1	r	1			f	5
Couch grass	<i>Elytrigia sp.</i>													
Sea plantain	<i>Plantago maritima</i>													
Lesser sea-spurrey	<i>Spergularia marina</i>													
Glasswort	<i>Salicornia sp.</i>				o	4	o	4						
Yorkshire-fog	<i>Holcus lanatus</i>													
Tufted hair-grass	<i>Deschampsia cespitosa</i>													
perennial sow-thistle	<i>Sonchus arvensis</i>													
Sea club-rush	<i>Bolboschoenus maritimus</i>													
Umbellifer (indet.)														
Greater sea-spurrey	<i>Spergularia media</i>				r	1								
Silverweed	<i>Potentilla anserina</i>													
Saltmarsh rush	<i>Juncus gerardii</i>													

Quadrat	43		44		45		46		47		48		49		
Repeat of (2002 quadrat)			82				77		155		83		176		
NVC community	SM13		SM16		SM16		SM16		SM16		SM16		SM16d - MC9		
Vernacular	Species	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin
Sea barley	<i>Hordeum marinum</i>							f	6						
White clover	<i>Trifolium repens</i>														
Red fescue	<i>Festuca rubra</i>			a	7	a	7	a	7	a	8	a	8	a	8
Sea milkwort	<i>Glaux maritima</i>			f	6			f	4	r	2	o	3		
Sea aster	<i>Aster tripolium</i>	a	8												
Spear-leaved orache	<i>Atriplex prostrata</i>	f	6												
Common saltmarsh grass	<i>Puccinellia maritima</i>	f	6					o	4			a	4		
Common scurvygrass	<i>Cochlearia officinalis</i>														
Knotgrass	<i>Polygonum sp.</i>														
Perennial rye-grass	<i>Lolium perenne</i>														
Creeping bent	<i>Agrostis stolonifera</i>			a	7	a	7	a	7	o	5	a	7	o	4
Sea arrowgrass	<i>Triglochin maritimum</i>							o	3						
Common cord grass	<i>Spartina anglica</i>														
Annual sea-blite	<i>Suaeda maritima</i>														
Couch grass	<i>Elytrigia sp.</i>														
Sea plantain	<i>Plantago maritima</i>														
Lesser sea-spurrey	<i>Spergularia marina</i>									r	1				
Glasswort	<i>Salicornia sp.</i>														
Yorkshire-fog	<i>Holcus lanatus</i>													o	3
Tufted hair-grass	<i>Deschampsia cespitosa</i>														
perennial sow-thistle	<i>Sonchus arvensis</i>														
Sea club-rush	<i>Bolboschoenus maritimus</i>														
Umbellifer (indet.)															
Greater sea-spurrey	<i>Spergularia media</i>														
Silverweed	<i>Potentilla anserina</i>													a	6
Saltmarsh rush	<i>Juncus gerardii</i>														

Quadrat		50		51		52	
Repeat of (2002 quadrat)		75		154			
NVC community		MG11a		MG11a		SM6	
Vernacular	Species	DAFOR	Domin	DAFOR	Domin	DAFOR	Domin
Sea barley	<i>Hordeum marinum</i>			a	8		
White clover	<i>Trifolium repens</i>						
Red fescue	<i>Festuca rubra</i>	a	8	a	8		
Sea milkwort	<i>Glaux maritima</i>	f	5				
Sea aster	<i>Aster tripolium</i>						
Spear-leaved orache	<i>Atriplex prostrata</i>						
Common saltmarsh grass	<i>Puccinellia maritima</i>					f	7
Common scurvygrass	<i>Cochlearia officinalis</i>						
Knotgrass	<i>Polygonum sp.</i>						
Perennial rye-grass	<i>Lolium perenne</i>						
Creeping bent	<i>Agrostis stolonifera</i>	f	7				
Sea arrowgrass	<i>Triglochin maritimum</i>						
Common cord grass	<i>Spartina anglica</i>					a	8
Annual sea-blite	<i>Suaeda maritima</i>						
Couch grass	<i>Elytrigia sp.</i>						
Sea plantain	<i>Plantago maritima</i>						
Lesser sea-spurrey	<i>Spergularia marina</i>						
Glasswort	<i>Salicornia sp.</i>						
Yorkshire-fog	<i>Holcus lanatus</i>						
Tufted hair-grass	<i>Deschampsia cespitosa</i>						
perennial sow-thistle	<i>Sonchus arvensis</i>						
Sea club-rush	<i>Bolboschoenus maritimus</i>						
Umbellifer (indet.)							
Greater sea-spurrey	<i>Spergularia media</i>						
Silverweed	<i>Potentilla anserina</i>	f	6				
Saltmarsh rush	<i>Juncus gerardii</i>						

**Appendix 3: Colour plates.**



**Plate 1. Quadrat on Transect 2. Note low sward height and dung from geese and livestock.**



**Plate 2. Lower edge of Transect 4 showing erosion by wave action, and effects of livestock grazing. in the middle ground lumps of mud can be seen which appear to have been thrown up onto the marsh from the eroding edge by wave action.**





**Plate 3. Drop in marsh elevation on Transect 8 with creeping bent and red fescue community above and common cord grass and common saltmarsh grass community below.**



**Plate 4. A view up the marsh from the bottom of Transect 9. Note bare patches, low sward height and goose droppings in the foreground. The embankment protecting the ship canal can be seen in the distance.**



**Plate 5. Heavily poached area in the middle of Transect 10. Grazing sheep can be seen in the distance.**



**Plate 6. A creek on Transect 11 with a change in dominance between sides. On the left, common saltmarsh grass is dominant whereas on the right spear-leaved orache is dominant.**





**Plate 7. Grazed marsh on Transect 13. This area was mainly grazed by cattle and shows a cropped turf of common saltmarsh grass, spear-leaved orache and sea aster.**



**Plate 8. SM13a saltmarsh on Transect 16 characterised by tall sea aster with an understory of common saltmarsh grass and spear-leaved orache. This community was typical of the mid to lower marsh where grazing pressure was absent (All transects from 16 to 30). Note small patch of common cord grass centre-right.**





**Plate 9. Bottom of the marsh on Transect 18. Pioneer common cord grass and glasswort saltmarsh can be seen on the right with a common saltmarsh grass, sea aster and sea plantain community above the eroded marsh edge.**



**Plate 10. Glasswort *Salicornia* sp. community on the lower shore of Transect 20.**





**Plate 11. Bare area in Transect 21. There is no grazing in this part of the marsh and therefore the lack of vegetation was assumed to be the result of more frequent inundation relative to the remainder of the marsh.**



**Plate 12. Tall sea aster community with a patch of common cord grass on Transect 22.**





**Plate 13. Common saltmarsh grass and sea aster community with common cord grass on the middle marsh on Transect 27.**



**Plate 14. Looking down marsh on Transect 30. In the foreground there is a community of sea-spurrey, sea aster and common saltmarsh grass. Below this there is a common cord grass dominated community on the lower marsh.**



**Plate 15. Canada geese on the lower marsh near to the bottom of Transect 12.**