Survey and Mapping

AVON ESTUARY RESEARCH PROJECT
SALT MARSH SURVEY

For
South Devon AONB

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Notice

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Summary

Atkins was commissioned by the South Devon AONB Authority to undertake a survey of the salt marsh habitats within the River Avon, Devon. The survey is a part of the wider Avon Sediment Research Study, being undertaken by Plymouth University. The methodology used was based on the JNCC's 'Common Standards Monitoring Guidance' for saltmarsh habitats (August 2004).

The survey was partially initiated in response to local concerns about changes in the distribution of the salt marsh habitats within the Devon Avon. The results should form part of an established baseline against which future changes are monitored. The JNCCs CSM guidance indicates that a basic six-yearly monitoring cycle should be used, but with more frequent visits if this is feasible.

The key conclusions of the survey were:

- The Devon Avon salt marshes are naturally constrained by the topography and geology of the river valley.
- The salt marshes surveyed are largely limited to pioneer vegetation, with a narrower band of low to mid marsh species and small areas of mid-upper marsh species.
- Upper salt marsh vegetation is not found within the key salt marsh areas surveyed adjacent to the main river channel, but may be found along some of the tributaries that flow into the channel, which were not included in the survey.
- The marshes are likely to be vulnerable to future sea level rise and coastal squeeze due to the constraints placed upon them by the valley sides.

The main factors impacting on the marshes at present are:

- Fluvial erosion along part of Unit 1, possibly exacerbated by use of the marsh edge as a footpath by local walkers.
- Anecdotal evidence that samphire (glasswort) collection is occurring on Unit 3 further downstream, for use by local hotels and restaurants.

1 Introduction and Methodology

1.1 Introduction

Atkins was commissioned by the South Devon AONB Authority to undertake a survey of the salt marsh habitats within the River Avon, Devon. The survey is a part of the wider Avon Sediment Research Study, being undertaken by Plymouth University. The methodology is based on the JNCC's 'Common Standards Monitoring Guidance' for saltmarsh habitats (August 2004).

The Common Standards Monitoring Guidance for saltmarsh lists five key attributes that are required to set conservation objectives or produce management plans for salt marsh interest features. These attributes are intended to be used as part of the conservation objectives or management plan for designated areas where salt marsh is an interest feature. The attributes are:

- Habitat extent
- Physical structure: Creeks and pans
- Vegetation structure: zonation, sward structure
- Vegetation composition: characteristic species, indicator of negative trend
- Other negative indicators

Whilst the survey methodology was based on the JNCC guidance, the aim of the survey was not to collect data relating to the full range of attributes listed in the guidance, but to provide a characterisation of the salt marsh at the present time. This will provide a baseline for the AONB authority to develop future management and monitoring of the estuary, and also aid in developing a technique that can be used and applied to other estuaries within the region.

1.1.1 Survey location

The extent of the survey was the vegetation of three key areas of salt marsh in the River Avon (Devon). These areas of salt marsh were identified during a topographical survey carried out in March/April 2005, and run from the approximate OS grid references E268231, N46584 to E267630, N46120 on the right (north) bank (referred to as **Unit 1** within this report), E268455, N46484 to E268188, N46194 (referred to as **Unit 2**) and E267763, N45976 to E267680, N45393 on the left (south) bank (referred to as **Unit 3**).

1.2 Survey methodology for salt marsh attributes

1.2.1 Habitat extent

The extent of salt marsh within the Avon estuary was mapped as part of the topographical survey undertaken in April 2005. In addition to the information provided within these maps, the field survey made observations of factors which could have future effects on the marshes, or where impacts on the salt marsh are already taking place. These factors are listed below:

1) Presence/absence of coastal defences

Sea level rise is recognised as a threat to salt marsh habitats in the UK. Loss of salt marsh habitat occurs as sea levels rise and 'drown' the marshes. Although salt marshes would naturally readjust their position relative to the tidal frame through landward transgression, if they are constrained by man made structures such as sea walls or embankments this landward movement will not be possible. The field survey therefore recorded whether any structures are present which are likely to impede this landward movement.

2) Erosion – Cycles of erosion and accretion

In addition to sea level rise, the increased storminess that is predicted to occur with climate change may also accelerate levels of erosion on salt marshes. Although within the context of this report (as a baseline study) it was not possible to determine whether the salt marshes are eroding, accreting or in equilibrium, any clear signs of erosion or accretion were recorded and photographed as part of the field survey. Future monitoring of the estuary can then record any observed changes from this baseline.

The following erosion signs were recorded as part of the survey:

- Mud-mound topography
- Marsh edge 'cliffing' with toppled cliff blocks with live or dying vegetation
- Marsh edge 'cliffing' with rotational slides
- Marsh edge 'cliffing' with overhanging (cantilever) blocks

The following accretion signs were recorded as part of the survey:

- Seaward marsh edges have an accretional ramp upon which pioneer and low-marsh vegetation can become established.

1.2.2 Physical Structure: Creeks and pans

The network of creeks (location and size) and pans was recorded as part of the topographical mapping. No further recording of the creek network was therefore undertaken as the baseline for future monitoring had already been established.

1.2.3 Vegetation Structure and Vegetation Composition

1) Sward Structure: structured walk

Vegetation structure and composition were assessed by undertaking a structured walk on salt marsh Unit 1 and Unit 2. This consisted of a 'W'-shaped walk over the areas of salt marsh, stopping at a minimum of 10 pre-selected locations along the route to record the vegetation. Exact stopping locations were recorded in the field using a GPS.

At each stopping location the vegetation was recorded from a 2X2m quadrat. Each quadrat was aligned using a compass so that one edge of the quadrat ran east to west. A permanent marker (in the form of a 50cm metal rod) was then driven into the ground at the north-west corner of each quadrat. This will allow the exact relocation of the quadrats, should this be required on future visits. To reduce the health and safety risks to walkers associated with leaving the pins in the salt marsh, only the top 5-10cm of the pins were left above the surface of the mud and marked with orange enamel spray paint to aid visual relocation.

In order to test the level of accuracy of the hand held GPS, two quadrats were relocated on the salt marsh during the second day of field work. The marker pins were successfully relocated using the GPS coordinates and by eye.

Due to time constraints in the field, it was not possible to undertake a structured walk on Unit 3. However, a walkover determined that the salt marsh unit in this area consisted of two distinct areas of vegetation. In order to enable some future monitoring of vegetation of these areas to be carried out, two permanent quadrats were located in each of these discrete units; one using a permanent marker base station (E267619.501, N45791.909), and the second to the north of the base station at E267703, N45921.

Recording was undertaken using visual estimates of percentage cover of each species. Photographs of the quadrats were also taken and the height of the vegetation sward in centimetres was also recorded.

Following the completion of the structured walk, the results from the sampling stops was used to make a quantitative assessment of frequency, using the adapted DAFOR scale shown in the CSM Guidance. The classifications within the DAFOR scale are as follows:

D – Dominant (the species appears at most (>60%) stops and it covers more than50% of each sampling unit)

A – Abundant (species occurs regularly throughout a stand, at most (>60%) stops and its cover is less than 50% of each sampling unit)

F – Frequent (species recorded from 41-60% of stops)

O – Occasional (species recorded from 21-40% of stops)

R – Rare (species recorded from up to 1-20% of stops)

2) Salt marsh zonation: transects

The zonation of the salt marsh units was surveyed and assessed according to the general definitions within the JNCC Guidance as follows:

- Pioneer marsh (*Salicornia* spp., *Suaeda maritima*, *Aster tripolium* with bare mud and sand)
- Low-mid marsh (Continuous cover with *Puccinellia maritima* or *Atriplex portulacoides* often dominant)
- Mid-upper marsh (*Festuca rubra*, *Limonium vulgare*, *Armeria maritima*, *Plantago maritima* often dominant)

The full list of typical species for each zone is shown in Table 1-1 below.

Table 1-1: Species list for salt marsh zones

Pioneer zone	**Low-mid marsh**	**Mid-upper marsh**
Salicornia spp. *Suaeda maritima* *Puccinellia maritima* *Aster tripolium*	*Puccinellia maritima* *Triglochin maritima* *Plantago maritima* *Atriplex portulacoides* *Aster tripolium* *Spergularia maritima* *Suaeda maritima* *Salicornia* spp. turf fucoids	*Festuca rubra* *Juncus gerardii* *Armeria maritima* *Agrostis stolonifera* *Limonium vulgare* *Glaux maritima* *Seriphidium maritimum* *Plantago maritima* *Aster tripolium* *Juncus maritimus* *Triglochin maritima* *Blysmus rufus* *Eleocharis uniglumis* *Artemisia maritima* *Leontodon autumnalis* *Carex flacca* *Carex extensa* turf fucoids

Source: JNCC, 2004

The assessment was made using transects across the marsh units, with transition points between zones marked using a hand-held GPS. Transects were undertaken at intervals of 30m, which was an upward revision from that originally estimated for the field work, as there were fewer zones present on the Avon salt marshes than was anticipated.

A total of twenty transects were undertaken on Unit 1, and nine transects were undertaken on Unit 2. This exceeded the minimum requirement of 5 transects per unit defined in the JNCC Guidance. Rather than pre-selecting the transects from aerial photographs, the relatively small size of the units of salt marsh allowed transects to be taken across the whole of the two units.

The GPS coordinates of the transects were downloaded and transferred to the project GIS, and an assessment of the zonation of the salt marsh units along the estuary was digitised between these points. Due to time constraints during field work, and limitations in the resolution of the data that can be gained from the transects, zonation data presented on the maps has also been interpolated using field observations where necessary.

As mentioned above, a walkover of Unit 3 revealed that the salt marsh comprised two distinct areas of vegetation. It was therefore felt by the surveyors that undertaking transects would provide little benefit in the time available, and instead the boundaries of the two zones was walked and mapped using GPS points. This allowed the extent of the salt marsh vegetation to be mapped rapidly and relatively accurately. The GPS points were transferred to the project GIS and are included in the zonation maps in Appendix B.

Future monitoring visits can be used to detect any changes in the observed zonation of the salt marshes from the time of the baseline study by overlaying subsequent transects on the existing GIS layer.

1.2.4 Other negative indicators

As listed within the CSM Guidance, any other negative indicators (such as visual pollution or vehicle damage or trampling) observed in the field were also recorded.

2 Survey Results

2.1 Vegetation Structure and Vegetation Composition

2.1.1 Sward Structure: structured walk

The plant species, their percentage cover and sward heights recorded from individual quadrats are listed in full in Appendix A. From this data, a species list for each salt marsh unit on the Avon has been produced, and a quantitative definition of their frequency within that unit has been allocated based on the adapted DAFOR scale described in Section 2. These are shown in Table 2-1 below.

As only two quadrats were located on Unit 3, the results have not been included in Table 2-1. However, the species recorded from these quadrats are shown in Appendix A.

Table 2-1: Summary quadrat results for salt marsh Units 1 and 2

	Unit 1	**Unit 2**
Species recorded	**Frequency**	**Frequency**
Atriplex portulacoides	**F**	**O**
Spartina anglica	**A**	**A**
Aster tripolium	**A**	**F**
Enteromorpha	**A**	**A**
Salicornia spp.	**F**	**R**
Puccinellia maritima	**O**	**O**
Fucus sp.	**F**	**O**
Plantago maritima	**R**	**R**
Triglochin maritima	**Not recorded**	**R**
Glaux maritima	**Not recorded**	**R**
Festuca rubra	**Not recorded**	**R**
Spergularia media	**O**	**R**

As it can be seen from the table, the most frequently occurring salt marsh species in the Avon estuary were the pioneer species *Spartina anglica* and *Aster tripolium*. The survey also recorded a relatively high cover of the green algae *Enteromorpha*. Other commonly occurring species on the marshes were *Atriplex portulacoides* and *Salicornia* spp.

No nationally rare or scarce salt marsh species were recorded from any of the quadrats, and none were observed over the course of the baseline survey in any of the salt marsh units studied.

The location of all of the quadrats is shown on Figure 6 in Appendix B.

Sward heights

Average sward heights recorded on both Unit 1 and Unit 2 were 27cm, which reflects the fact that the salt marshes on the Avon are ungrazed. Sward heights for each quadrat are shown in Appendix A.

2.1.2 Salt marsh zonation: transects

The zonation derived from the transect surveys is shown on Figures 1-4 (Appendix B), and the location of the transect points is shown on Figure 5 in Appendix B. It can be seen from the maps that the salt marsh vegetation on Unit 1 is largely restricted to two zones; pioneer marsh (which forms the majority of the salt marsh in the surveyed units), with a restricted low-mid marsh zone. This supports the results of the quadrat surveys, which indicated a high proportion of pioneer species in the Avon.

On Unit 2, a small area of mid-upper marsh was observed and recorded during the transect surveys. This zone is shown on the maps in Appendix B.

Transects were not carried out on Unit 3 due to time constraints, and also because observations made in the field showed that the whole unit comprised two discrete 'blocks' of salt marsh vegetation. These were a stand of almost continuous cover of *Salicornia* spp. with *Spartina anglica* to the south of the unit, and at the northern end a block of low-mid marsh vegetation fronted by a narrow zone of *Salicornia* spp. These two zones were therefore mapped using the GPS, and are shown on the maps in Appendix B.

The limited salt marsh zonation observed in the Avon is a natural result of the local topography of the estuary (see Section 2.2). The steep sides of the valley and the height of the valley floor restricts the salt marsh zones within the estuary to the pioneer and low-mid marsh zones, and there is not sufficient space to allow a full progression from pioneer salt marsh through to terrestrial habitats. Further upstream around the tidal road, small areas of middle-upper salt marsh (supporting stands of *Glaux maritima* and *Armeria maritima*) can be observed, and where smaller tributary watercourses flow into the Avon estuary the sides of these watercourses were observed to be fringed with stands of *Scirpus maritimus,* a species more typically associated with upper salt marshes and freshwater influence.

2.2 Habitat extent

1) Presence/absence of coastal defences

The topography of the river valley poses a natural constriction on the extent of the salt marshes. The Avon flows through a steep-sided valley which ends in near-vertical rock walls. Therefore although there are no man-made structures currently restricting the development of the salt marshes, any landward transgression of the salt marsh habitats will be still prevented, and the salt marsh habitats in the Avon are likely to be vulnerable to future coastal squeeze.

2) Erosion and accretion

Erosion of a long section of the seaward marsh edge on Unit 1 was observed (between approximate grid references E268193, N46547 to E268074, N46247). The edge of the marsh shows cantilever failures, with blocks of overhanging and collapsed salt marsh vegetation. Discussion with a fluvial geomorphologist from Atkins has indicated that the main cause of the erosion is likely to be fluvial scour from the river channel, but other factors may also be exacerbating the problem, such as wash from passing boats and trampling effects (see Section 2.3 below). The erosion along this section is shown in Photo 1 below.

Photo 1: Cantilever failures of the seaward edge of the northern part of salt marsh Unit 1

Towards the southern end of Unit 1, the eroding of the marsh edge ends and the pioneer zone appears to be stable with a gentle, shallow slope at the seaward edge.

There were no signs of erosion within Unit 2. The seaward edge of the marsh forms a gentle slope with established pioneer vegetation which then grades into low-marsh vegetation. This is shown in Photo 2 below.

Photo 2: Stable accreting edge of Unit 2.

Unit 3 also appears to have a largely stable seaward edge, with established pioneer and low-marsh vegetation. Some minor erosion of the edge of the marsh was visible in the middle section of the salt marsh unit, and is shown in Photo 3 below.

Photo 3: Slight cliffing visible along middle section of salt marsh Unit 3

2.3 Other negative indicators

Trampling

A well-used footpath runs along the landward edge of Unit 1. Some trampling effects on the salt marsh are evident around the path in some locations along the salt marsh. However, the marsh itself is also regularly accessed by members of the public at low tide, who walk along the river channel. This has resulted in a path being worn through the vegetation along the eroding edge adjacent to the channel of the northern section of Unit 1. This section of the marsh is showing clear signs of erosion, as described in Section 2.2 above. Although this use of the path may not be directly causing the erosion along the river channel on this unit, it is likely to be a contributing factor. Plant root systems bind sediments and help to reduce their susceptibility to erosion, therefore trampling of the plants, especially at this vulnerable location, can de-stabilise the marsh. The path and marsh edge cliffing are shown in Photo 4 below.

Unit 2 is relatively inaccessible, there are no footpaths along this side of the river and the marsh can only be accessed by boat or by crossing the channel at low tide. There were no obvious signs of trampling or other disturbance.

Photo 4: Use of the marsh by walkers has trampled a path through the vegetation along the eroding edge of Unit 1.

Collection of *Salicornia* plants

Unit 3 is also relatively inaccessible by foot, but there is anecdotal evidence that local hotels and restaurants may be having an impact on this salt marsh through collection of the *Salicornia* (for culinary use, where it is often called Samphire). It is reported that the plants are collected by boat from this section of the channel. As the scale and frequency of this harvesting is not known, it is difficult to make an assessment of what impact this is having on the extent of the marsh along this section of the river. Large scale collection of the plants could have a negative impact through loss of the seed bank and a reduction in the colonisation of the mud and sand flats in the estuary. The downstream section of this salt marsh unit largely comprises stands of *Salicornia* and *Spartina*, and is

therefore an attractive point for collecting these plants. At present there is no clear visual evidence of damage to the marsh, and the seaward edge appears to be a stable slope (refer to Photo 5).

Photo 5: Stable edge of marsh at southern end of Unit 3

Proliferation of green algae

John Peters (pers com.) of the Aune Conservation Association has noted that in recent years the amount of green algae present in the estuary (e.g. caught on anchor chains or mooring lines) appeared to have increased. During the survey it was also noted that in places quantities of green algae were also stranded on the marsh at high tide, which resulted in the salt marsh being blanketed along the tide mark. However, at this stage this is merely an observation, and there is no evidence to suggest that the stranding of this algae is adversely affecting the salt marshes within the estuary.

3 Conclusions & Recommendations

3.1 Conclusions

- The Devon Avon salt marshes are naturally constrained by the topography and geology of the river valley.
- The salt marshes surveyed are largely limited to pioneer vegetation, with a narrower band of low to mid marsh species and small areas of mid-upper marsh species.
- Upper salt marsh vegetation is not found within the key salt marsh areas surveyed adjacent to the main river channel, but may be found along some of the tributaries that flow into the channel, which were not included in the survey.
- The marshes are likely to be vulnerable to future sea level rise and coastal squeeze due to the constraints placed upon them by the valley sides.

The main factors impacting on the marshes at present are:

- Fluvial erosion along part of Unit 1, possibly exacerbated by use of the marsh edge as a footpath by local walkers.
- Anecdotal evidence that samphire (glasswort) collection is occurring on Unit 3 further downstream, for use by local hotels and restaurants.

3.2 Recommendations for future monitoring work

The survey has partially been initiated in response to local concerns about changes in the distribution of the salt marsh habitats within the Devon Avon. The results should form part of an established baseline against which future changes are monitored. The JNCCs CSM guidance indicates that a basic six-yearly monitoring cycle should be used, but with more frequent visits if this is feasible.

The extent of the salt marshes surveyed will need to be monitored through repeat visits. This habitat extent monitoring could simply take the form of revisiting the site and mapping the edge of the pioneer zone. As the marshes are naturally constrained to the rear, this would be sufficient to show whether the marsh edge advances or retreats from the baseline established in 2005.

Sections of the marsh edge that have been identified as either eroding or stable/accreting should be specifically checked at each monitoring visit to look for changes in the current situation.

Changes to the creek network should also be monitored, as these changes (such as creek enlargement and dissection) can be indicative of major marsh erosion. The most cost effective means of doing this would be to obtain recent aerial photography at the time of the monitoring visit and compare this to the baseline maps produced as part of the topographical survey in 2005.

The transects should be revisited (using the recorded GPS points) as part of the repeat surveys. This will establish whether the marshes are accreting or eroding (i.e. expansion or reduction of the pioneer zone respectively), and also help to establish whether any reversed zonation (i.e. reversion of the low and mid marsh zones to pioneer vegetation) is occurring, which may be indicative of coastal squeeze effects.

The marked quadrats should also be revisited to look for structural changes in the vegetation composition at the site. Comparison of the results can be made using the adapted DAFOR scale used in this report. If management objectives or targets are to be set for the estuary, it may be necessary to take into account the fact that the salt marsh zones in the Avon are naturally reduced. Due to the limited amount of middle or upper marsh vegetation, typical targets given for frequency and abundance of plant species above the pioneer zone in the CSM Guidance may not be suitable for this location.

It would be useful to collect additional information with regard to the scale and frequency of glasswort collection within the estuary. Some limited collection of plants by hand picking may be sustainable, but if large scale commercial collections using machinery are involved this is likely to result in damage to the salt marsh habitats on the Avon. There is no evidence to suggest that machines are currently used to collect plants, but any additional information that can be obtained would be useful to help determine whether this activity could require future management.

3.3 Recommendations for application to future survey work

3.3.1 General limitations

The key limitation of this methodology is that it will not produce the same results as a detailed National Vegetation Classification survey – it will not provide maps showing exactly what salt marsh communities are present, or their distribution. The surveys will provide an overview of the main species present on the marsh, and the features of the salt marshes (i.e. physical features and zonation). It is therefore a rapid assessment of saltmarsh botany, and can be done relatively quickly and cost-effectively.

Studies such as this will be useful to provide a baseline to show the extent of the salt marsh and its key features (i.e. zones), and to allow future monitoring for long term changes. However, it is not likely to be suitable as a means of collecting detailed botanical data for ecological assessment.

3.3.2 Habitat extent and physical structure (creeks and pans):

The habitat extent of the Avon salt marshes was undertaken as part of a separate topographical survey, and therefore a significant amount of time was saved in undertaking the assessment of habitat extent. It is recognised that commissioning such a detailed topographical survey is not likely to be possible for all estuaries within the South Devon AONB area in the future. The most cost effective way of determining habitat extent and the location of creeks on the salt marsh is likely to be through the study of up to date aerial photographs, which can be geo-referenced using a GIS and overlaid over Ordnance Survey or other base maps. The key limitations of this technique are likely to be:

- The availability and cost of up to date aerial photography of a suitable quality
- Any additional costs associated with the licence required for the use of Ordnance Survey map data and GIS software.

If aerial photographs are not available, an alternative method may be to simply map the salt marsh habitats on the ground using a hand held GPS and walking around the outer edge of the pioneer zone to obtain the seaward extent and the boundary of the terrestrial transitional zone to determine the landward extent. Major creeks would also have to be mapped in this way. The GPS points can then be transferred to a GIS or to paper maps (although this is likely to very be labour intensive) to map the extent of the salt marsh habitats and major creeks within the estuary. The practicality of using this technique is likely to depend on the size of the estuary being studied and the amount of salt marsh present; and would need to be determined on a case by case basis. If a large area needs to be surveyed it is likely to be worth the additional expenditure incurred in obtaining aerial photography and an OS licence when considered against the time and cost of mapping GPS points by hand on paper maps.

3.3.3 Zonation

The use of transects to provide an indication of the extent of zonation on the marsh is a rapid and cost effective means of building up a general overview of the vegetation patterns on the salt marshes. The main limitation of using these kinds of transects is that they can fail to highlight smaller scale internal variations in topography on the salt marsh and therefore provide a somewhat simplistic view of the structure of the marsh. For example, small raised areas within the low-mid marsh on Unit 1 were observed to support mid-upper marsh vegetation, but as these were smaller discrete areas rather than actual zones, it was not possible to include them on the zonation maps without making the maps overly complex.

Despite this limitation, in terms of providing a baseline against which future changes can be monitored, the use of transects (particularly if the locations of the transects are recorded and revisited over future monitoring cycles) is a useful tool with which to monitor changes to the extent and structure of the salt marshes from an established baseline.

3.3.4 Vegetation structure and composition

The quadrat data obtained as part of the structured walk were not intended to be statistically analysed, but to provide an overview of the vegetation present on the salt marsh. Again, the quadrats are a rapid and cost-effective way of obtaining information about the vegetation structure present on the marsh, and the permanent markings may enable the quadrats to be revisited. This will allow direct comparison between the vegetation structure between monitoring visits. The success of the marker pins will need to be tested at the next monitoring cycle, as Dalby (1987) has previously noted that the relocation of markers in a dynamic salt marsh environment (particularly in the lower zones) can have only limited success due to their burial or loss.

4 References

Joint Nature Conservation Committee, 2004. *Common Standards Monitoring Guidance for Saltmarsh Habitats*. Version August 2004, Updated from (February 2004).

Dalby, D.H., 1987. Salt Marshes. In: Baker, J.M. and Wolff, W. (eds). *Biological Surveys of Estuaries and Coasts*. Cambridge. Cambridge University Press. 1987

Appendix A: QUADRAT DATA AND PHOTOGRAPHS

Salt Marsh Unit 1

Quadrat 1			
Species	**% cover**	**Sward height (cm)**	**NGR (accuracy in m), Notes/observations**
Atriplex portulacoides	95	35	SX68015, 46379 (10m)
Bare ground	5		Some evidence of trampling from the adjacent footpath No photo

Quadrat 2			
Species	**% cover**	**Sward height (cm)**	**NGR (accuracy in m), Notes/observations**
Spartina anglica	40	30-35	SX68036, 46277 (4m)
Aster tripolium	8		Photo A1
Atriplex portulacoides	10		
Puccinellia maritima	10		
Salicornia sp.	1		
Enteromorpha	40		
Fucus sp.	5		

PHOTO A1

Quadrat 3			
Species	**% cover**	**Sward height (cm)**	**NGR (accuracy in m), Notes/observations**
Aster tripolium	20	25	SX68045, 46233 (4m)
Spartina anglica	10		Eastern edge of quadrat fell partly over a new creek that is forming
Atriplex portulacoides	5		Photo A2
Puccinellia maritima	10		
Salicornia sp.	1		
Enteromorpha	30		
Fucus sp.	20		
Bare mud	5		

PHOTO A2

Quadrat 4			
Species	**% cover**	**Sward height (cm)**	**NGR (accuracy in m), Notes/observations**
Spartina anglica	40	30-35	SX68007, 46258 (4m)
Aster tripolium	15		Photo A3
Atriplex portulacoides	10		
Puccinellia maritima	5		
Enteromorpha	30		

PHOTO A3

Quadrat 5			
Species	**% cover**	**Sward height (cm)**	**NGR (accuracy in m), Notes/observations**
Atriplex portulacoides	95	35	SX67951, 46291 (5m)
Spartina anglica	1		Photo A4
Enteromorpha	10		
Aster tripolium	0.5		

PHOTO A4

Quadrat 6			
Species	**% cover**	**Sward height (cm)**	**NGR (accuracy in m), Notes/observations**
Spartina anglica	60	30	SX67932, 46247 (6m)
Enteromorpha	25		Photo A5
Fucus sp.	80		

PHOTO A5

Quadrat 7			
Species	**% cover**	**Sward height (cm)**	**NGR (accuracy in m), Notes/observations**
Spartina anglica	15	26	SX67928, 46212 (5)
Plantago maritima	20		Photo A6
Fucus sp.	70		
Enteromorpha	10		
Aster tripolium	1		

PHOTO A6

Quadrat 8			
Species	**% cover**	**Sward height (cm)**	**NGR (accuracy in m), Notes/observations**
Salicornia sp.	25	17	SX67925, 46195 (5m)
Spergularia media	1		Photo A7
Aster tripolium	3		
Enteromorpha	95		
Mud/sand	10		

PHOTO A7

Quadrat 9			
Species	**% cover**	**Sward height (cm)**	**NGR (accuracy in m), Notes/observations**
Spartina anglica	10	10	SX67906, 46204 (5m)
Salicornia sp.	15		Photo A8
Spergularia media	3		
Aster tripolium	1		
Enteromorpha	70		
Fucus sp.	4		
Mud/sand	10		

PHOTO A8

Quadrat 10			
Species	**% cover**	**Sward height (cm)**	**NGR (accuracy in m), Notes/observations**
Enteromorpha	30	30	SX67832, 46245 (6m) (Waypoint 346)
Spartina anglica	40		Photo A9
Atriplex portulacoides	35		
Aster tripolium	1		
Salicornia sp.	1		
Spergularia media	0.5		

PHOTO A9

Salt Marsh Unit 2

Quadrat 1			
Species	**% cover**	**Sward height (cm)**	**NGR (accuracy in m), Notes/observations**
Atriplex portulacoides	80	32	SX68404, 46445 (4m
Spartina anglica	5		Photo A10
Aster tripolium	3		
Enteromorpha	20		
Puccinellia maritima	2		

PHOTO A10

Quadrat 2			
Species	**% cover**	**Sward height (cm)**	**NGR (accuracy in m), Notes/observations**
Spartina anglica	45	40	SX68383, 46452 (5m)
Enteromorpha	30		Photo A11
Mud	25		

PHOTO A11

Quadrat 3			
Species	**% cover**	**Sward height (cm)**	**NGR (accuracy in m), Notes/observations**
Atriplex portulacoides	40	25	SX8323, 46479 (5m)
Aster tripolium	25		Photo A12
Spartina anglica	5		
Puccinellia maritima	20		
Enteromorpha	10		

PHOTO A12

Quadrat 4			
Species	**% cover**	**Sward height (cm)**	**NGR (accuracy in m), Notes/observations**
Salicornia sp.	30	17	SX68283,46475 (4)
Enteromorpha	90		Photo A13
Mud/sand	5		

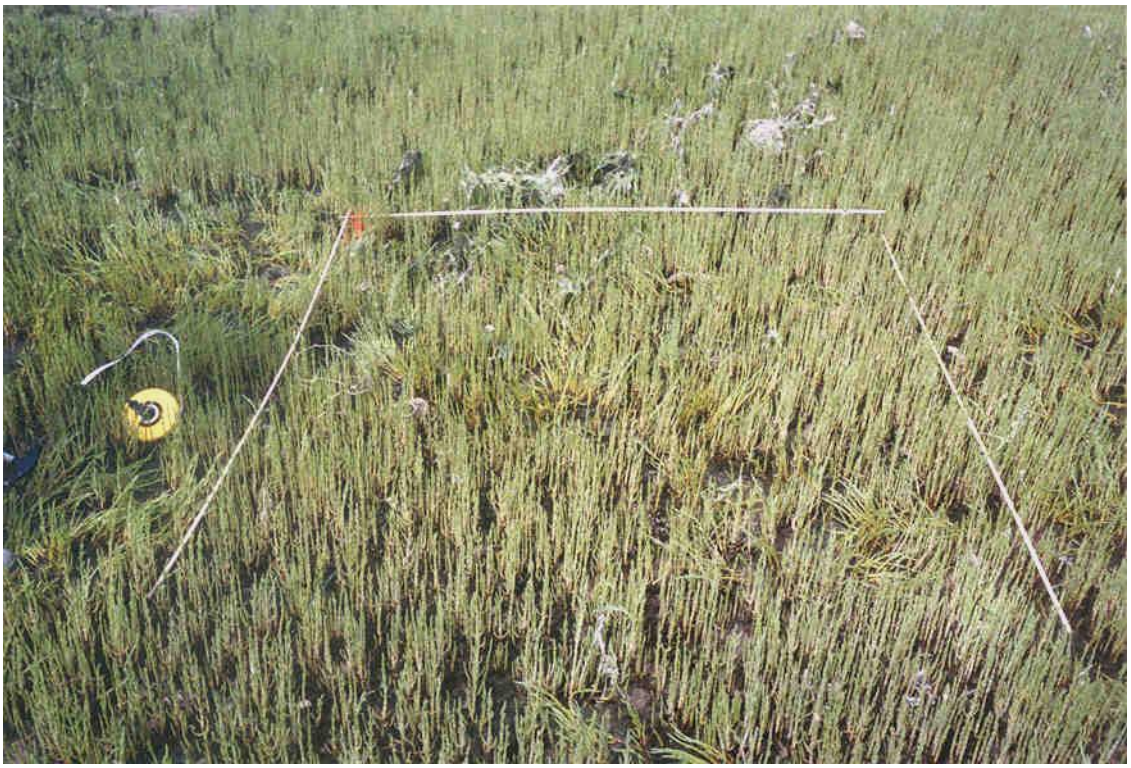

PHOTO A13

Quadrat 5			
Species	**% cover**	**Sward height (cm)**	**NGR (accuracy in m), Notes/observations**
Aster tripolium	20	25	SX68315, 46419 (4m)
Puccinellia maritima	40		Photo A14
Enteromorpha	30		
Spartina anglica	10		
Mud	5		
Fucus sp.	5		

PHOTO A14

Quadrat 6			
Species	**% cover**	**Sward height (cm)**	**NGR (accuracy in m), Notes/observations**
Atriplex portulacoides	60	37	Photo A15
Spartina anglica	5		
Plantago maritima	40		
Triglochin maritima	5		
Glaux maritima	3		
Festuca rubra	10		

PHOTO A15

Quadrat 7			
Species	**% cover**	**Sward height (cm)**	**NGR (accuracy in m), Notes/observations**
Atriplex portulacoides	80	40	SX68313, 46356 (5m)
Triglochin maritima	10		Photo missing
Aster tripolium	3		
Spartina anglica	2		
Plantago maritima	1		
Puccinellia maritima	5		
Spergularia media	0.5		

Quadrat 8			
Species	**% cover**	**Sward height (cm)**	**NGR (accuracy in m), Notes/observations**
Spartina anglica	40	25	SX68265, 46345 (4m)
Enteromorpha	15		Photo A16
Fucus sp.	40		
Aster tripolium	1		

PHOTO A16

Quadrat 9			
Species	**% cover**	**Sward height (cm)**	**NGR (accuracy in m), Notes/observations**
Fucus sp.	45	12	SX68259, 46322 (4m)
Enteromorpha	35		Photo A17
Aster tripolium	15		
Salicornia sp.	5		

PHOTO A17

Quadrat 10			
Species	**% cover**	**Sward height (cm)**	**NGR (accuracy in m), Notes/observations**
Spartina anglica	75	24	SX68256, 46282 (4m)
Enteromorpha	20		Photo A18
Fucus sp.	5		

PHOTO A18

Salt Marsh Unit 3

Quadrat 1 – Base station			
Species	**% cover**	**Sward height (cm)**	**NGR (accuracy in m), Notes/observations**
Salicornia sp.	40	17	SX67622, 45799 (5m)
Spartina anglica	5		Photo A19
Enteromorpha	55		
Fucus sp.	2		
Puccinellia maritima	4		

PHOTO A19

Quadrat 2			
Species	**% cover**	**Sward height (cm)**	**NGR (accuracy in m), Notes/observations**
Puccinellia maritima	65	18	SX67703, 45921 (4m)
Aster tripolium	30		No photo
Salicornia sp.	10		
Triglochin martitima	1		
Spergularia media	10		

Appendix B: MAPS