

## Appendix A8.1: Detailed Saltmarsh Baseline

### 1 Purpose of Appendix

- 1.1 This appendix provides detailed results of the saltmarsh survey conducted around the Kincardine Bridge in 2018 which is discussed in Chapter 8 (Marine Ecology) and shown on Figure 8.2 (Saltmarsh Survey Results). It also presents a summary of the previous survey conducted by Northern Ecological Services (NES) prior to construction of the Clackmannanshire Bridge. This baseline data from these surveys was used to inform the Ecological Impact Assessment (EclA) for the A985 Kincardine Bridge Refurbishment: Piled Viaduct Replacement scheme (hereafter referred to as the proposed scheme).

### 2 Previous Survey

- 2.1 To inform the Environmental Statement (ES) for the Upper Forth Crossing project (hereafter referred to as the 2003 ES) (Scottish Executive 2003) a National Vegetation Classification (NVC) survey was undertaken in August 2000 on the saltmarsh either side of the Kincardine Bridge and the area now associated with the Clackmannanshire Bridge (Northern Ecological Services (NES) 2003).
- 2.2 The saltmarsh was described as being close to the accepted limit of MHWN (mean high water neaps), occupying the entire extent of available habitat. It was determined to be stable on the downstream side of the Kincardine Bridge but with active erosion noted on the upstream side.
- 2.3 Downstream of the Kincardine Bridge, NES (2003) recorded a narrow band of dense *Aster* habitat along the estuarine edge of the marsh. This community did not fit any specific NVC classification but had affinities with SM11 *Aster tripolium* var. *discoideus* and SM12 rayed *Aster tripolium* on saltmarshes communities, and as such was classified as SM11/SM12. The majority of the remaining area downstream of the bridge consisted of SM13 *Puccinellia maritima* saltmarsh community (low marsh) and SM16 *Festuca rubra* saltmarsh community (mid marsh). A narrow band of SM28 *Elymus repens* saltmarsh community (high marsh) was recorded along the inland edge of the marsh. Small patches of SM8 annual *Salicornia* saltmarsh community (pioneer low marsh) and SM10 transitional low-marsh vegetation with *Puccinellia maritima*, annual *Salicornia* species and *Suaeda maritima* (transitional low marsh) were recorded on lower edge of the marsh, downstream of the bridge where the marsh narrows.
- 2.4 SM13 and SM16 were also the dominant communities upstream of the Kincardine Bridge. Obvious differences between the upstream and downstream areas were the lack of any SM8 or SM10 low marsh communities upstream of the bridge, and the restriction of the SM11/SM12 community to the network of creeks rather than along the leading edge of the marsh as seen downstream. At the time of survey, the hardcore ramp, constructed in the 1980s, was still present, occupying a large area of the saltmarsh upstream of the bridge.
- 2.5 Overall the area of saltmarsh around the Kincardine Bridge was dominated by low and mid marsh communities (SM13 and SM16) and was considered to be typical of those within the Firth of Forth with vegetation communities that were common or relatively common within the Forth Estuary. The vegetation communities were of low species diversity with the well-developed creeks in the area creating localised diversity increases.

### 3 2018 Saltmarsh Survey

#### Methods

- 3.1 In June 2018 a site survey was conducted by Jacobs ecologists of the saltmarsh habitat on the southern shore of the estuary to a minimum of 100m either side of the Kincardine Bridge (Figure 8.2). The purpose was to update the surveys which informed the 2003 ES (Scottish Executive 2003).

- 3.2 The site survey methodology was based on guidance provided within the NVC user's handbook (JNCC 2006). Firstly, homogenous habitats were identified within the study area. Subsequently, five 1m x 1m quadrats were surveyed within each habitat unit, recording the percentage cover of all vegetation species present. Percentage cover was converted to the Domin scale (a standard scale which assigns a value of 1-10 according to percentage ground cover ranging from 1 for <4% cover to 10 for 91-100% cover) to classify the area according to the NVC (Rodwell 2000). Where habitats were small in extent (only a few m<sup>2</sup>) or consisted predominantly of non-saltmarsh vegetation, quadrat surveys were not conducted but a simple species list was produced.

### Results

- 3.3 Three main areas of homogenous saltmarsh habitat were observed upstream of the Kincardine Bridge. Area 1 covered the low/mid marsh, Area 2 covered the section under the previous hardcore ramp and Area 3 covered the upper marsh around a ponded area (Figure 8.2, Photograph 1).



**Photograph 1: Saltmarsh Upstream of the Kincardine Bridge (Areas 1-3)**

- 3.4 Two areas of homogenous saltmarsh habitat were observed downstream of the Kincardine Bridge. Area 4 consisted of the low/mid marsh and Area 5 the upper marsh. (Figure 8.2, Photograph 2).



**Photograph 2: Saltmarsh Downstream of the Kincardine Bridge (Areas 4 and 5)**

3.5 The species lists and their percentage coverage for each area of homogenous saltmarsh are given in Table 1. The dominant cover type/species are shown in bold and frequency given in brackets.

**Table 1: Average Percentage Cover within Each Area Calculated from Quadrat Data**

Scientific Name	Common Name	Area 1	Area 2	Area 3	Area 4	Area 5
<i>Agrostis stolonifera</i>	Creeping bent	-	-	3.0 (1)	-	-
<i>Festuca rubra</i>	Red fescue	-	-	<b>59.0 (5)</b>	-	17.3 (5)
<i>Juncus gerardii</i>	Saltmarsh rush	-	-	<b>30.7 (3)</b>	-	<b>52.5 (4)</b>
<i>Juncus maritimus</i>	Sea rush	-	-	-	-	<b>30.0 (2)</b>
<i>Triglochin maritima</i>	Sea arrowgrass	<b>29.0 (5)</b>	3.0 (3)	7.0 (4)	<b>23.8 (5)</b>	7.2 (5)
<i>Armeria maritima</i>	Sea thrift	8.4 (5)	3.0 (2)	1.0 (1)	5 (5)	2.2 (3)
<i>Aster tripolium</i>	Sea aster	3.5 (3)	7.0 (5)		0.9 (4)	0.8 (2)
<i>Atriplex prostrata</i>	Spear-leaved orache	-	-	-	-	0.6 (2)
<i>Cochlearia officinalis</i>	Common scurvygrass	5.8 (4)	17.2 (5)	0.2 (5)	1.5 (5)	1.5 (3)
<i>Lysimachia maritima</i>	Sea milk-wort	-	-	2.6 (5)	-	-
<i>Plantago maritima</i>	Sea plantain	<b>36.0 (5)</b>	<b>36.0 (5)</b>	3.8 (4)	<b>57.0 (5)</b>	3.3 (4)
<i>Puccinellia maritima</i>	Common saltmarsh-grass	1.4 (5)	14.6 (5)	-	10.6 (5)	-
<i>Salicornia</i> agg.	Glasswort	-	0.1 (1)	-	-	-
<i>Spergularia media</i>	Greater sea-spurrey	0.4 (5)	1.0 (4)	-	0.5 (3)	-
<i>Spergularia</i> sp.	Sea-spurrey	-	-	-	1.0 (1)	-
<i>Melilotus</i> sp.	Melilot	-	-	0.1 (1)	-	-
<i>Elymus repens</i>	Common couch	-	-	0.5 (1)	-	-
n/a	Algal mat	3.0 (1)	1.1 (2)	-	1.0 (1)	-
n/a	Bare ground	19.0 (5)	<b>23.6 (5)</b>	1.3 (4)	9.0 (5)	9.3 (4)
n/a	Litter	-	-	12.4 (5)	-	6.3 (3)
<b>NVC Community</b>		<b>SM13</b>	<b>SM13</b>	<b>SM16</b>	<b>SM13</b>	<b>SM16</b>

- 3.6 The results of the quadrat surveys show that Areas 1, 2 and 4 have almost identical species lists (Table 1) with all three areas being classified as SM13 *Puccinellia maritima* saltmarsh community. In Area 2, previously covered by a hardcore ramp, although the species list was identical to the other areas, the proportion of species was found to differ. The main difference being the low abundance of sea arrowgrass (*Triglochin maritima*) in Area 2, which was the second most dominant species in Areas 1 and 4. Sea arrowgrass is a relatively conspicuous grass species and as a result there was a marked difference in appearance between these areas (Photograph 3). In contrast, Area 2 had a slightly higher proportion of bare ground and higher abundances of common saltmarsh-grass (*Puccinellia maritima*) and common scurvy-grass (*Cochlearia officinalis*).
- 3.7 These SM13 communities extended to the seaward limit of the saltmarsh in the survey area, with no pioneer/low marsh communities observed at the marsh edge, which is marked by a vertical 'cliff' of up to 1m in height (Photograph 4).



Photograph 3: Boundary Between Area 1 (left) and Area 2 (right)



**Photograph 4: View of Marsh Edge on Downstream Side of Kincardine Bridge**

3.8 Areas 3 and 5 in the mid to upper marsh contained similar species lists, dominated by rushes and grasses (*Juncus* sp. and *Festuca rubra*), and were both classified as SM16 *Festuca rubra* saltmarsh community. The main difference between these two areas was the absence of sea rush (*Juncus maritimus*) in Area 3, which had an average percentage cover of 30% in Area 5, although only recorded in two of the five quadrats (Table 1). The slight differences in species recorded in these two areas may be related to the presence of a ponded area in Area 3 (Photograph 5).

3.9 These upper marsh areas, more so on the downstream side of the Kincardine Bridge, have formed a hummock and hollow topography, which NES (2003) attributed to past grazing pressures.



**Photograph 5: Ponded Area in Area 3**

3.10 A well-developed network of creeks was present throughout the marsh on both sides of the Kincardine Bridge which, as also noted by NES (2003), resulted in localised increases in diversity (Photograph 6).

One species which was notably less abundant than expected throughout the site was sea milk-wort (*Lysimachia maritima*). According to Rodwell (2000), this species is a constant of the SM16 community and present in most of the SM13 sub-communities, however sea milk-wort was recorded only from Area 3 with an average cover of just 2.6%. This species was also noticeably absent from the 2000 survey (NES 2003).



**Photograph 6: Example of Community Around Creeks**

- 3.11 No significant areas of SM8 or SM10 *Salicornia* communities were recorded in 2018. A small patch of sparse glasswort (*Salicornia*) habitat was observed directly under the existing viaduct (Photograph 7), however this patch was considered too small to be surveyed in the same level of detail as the rest of the saltmarsh and as such was not classified under NVC. Annual glasswort species form pioneer communities (SM8) on open mudflats, generally seaward of the perennial vegetation but also in any areas, such as depressions or pans, where the perennial vegetation is unable to become established (Adnitt, Brew, Cottle, Hardwick, John, Leggett, McNulty, Meakins and Staniland 2007). These stands are ephemeral often containing no other species (Rodwell 2000). Under the Kincardine Bridge, the glasswort stands varied from being extremely sparse, where shading from the existing viaduct section was high to areas co-dominant with sea aster (*Aster tripolium*).



Photograph 7: Glasswort Vegetation with Sea Aster under the Existing Viaduct

#### Additional Areas

- 3.12 Species lists were created for two areas at the transition of the road verge into the saltmarsh (Table 2). NVC surveys were not undertaken in these areas as quantitative information was not required and the species list and abundance according to the DAFOR scale, (D–dominant, A–abundant, F–frequent, O–occasional, R–rare, LA–locally abundant), were considered sufficient to show that these areas are not continuation of saltmarsh habitat.

**Table 2: Species List for Areas 6 and 7**

Scientific Name	Common Name	Area 6	Area 7
<i>Agrostis stolonifera</i>	Creeping bent	F	-
<i>Arrhenatherum elatius</i>	False oat-grass	F	F
<i>Carex otrubae</i>	False fox-sedge	O	F (LA)
<i>Cirsium arvense</i>	Creeping thistle	F (LA)	F
<i>Cochleaeria officinalis</i>	Common scurvy grass	O	-
<i>Dactylis glomerata</i>	Cock's-foot	F	F
<i>Elymus repens</i>	Common couch	F	O
<i>Epilobium hirsutum</i>	Great willowherb	-	O
<i>Equisetum arvense</i>	Field horsetail	F (LA)	F (LA)
<i>Festuca rubra</i>	Red fescue	F	-
<i>Heracleum sphondylium</i>	Hogweed	O	-
<i>Holcus lanatus</i>	Yorkshire-fog	F	-
<i>Lathyrus pratensis</i>	Meadow vetchling	F	F
<i>Melilotus sp.</i>	Melilot sp.	F	-
<i>Plantago lanceolata</i>	Ribwort plantain	R	-
<i>Rubus fruticosus</i>	Bramble	-	O
<i>Taraxacum officinale</i>	Dandelion	O	-
<i>Triglochin maritima</i>	Sea arrowgrass	O	-

Scientific Name	Common Name	Area 6	Area 7
<i>Urtica dioica</i>	Common nettle	-	0
<i>Vicia cracca</i>	Tufted vetch	-	0

3.13 Area 6 was a patch of rough/tall ruderal grassland on the upstream side of the Kincardine Bridge (Figure 8.2, Photograph 8). Area 7, on the southern side of the Kincardine Bridge, was an area of tall/rough ruderal grassland on the embankment (Figure 8.2, Photograph 9). With the exception of the species already listed in Areas 1-5, all species recorded were typical of rank/unmanaged road verge vegetation.



Photograph 8: Area 6



Photograph 9: Area 7



## 4 Discussion

- 4.1 Overall there appears to have been little change in the saltmarsh around the Kincardine Bridge since the 2000 survey. The area is still dominated by SM13 and SM16 mid-marsh communities. Although no SM8 or SM13 communities were recorded by the 2018 survey, this does not represent a loss of these habitats but is a factor of the reduced survey area in the later survey. Small patches of glasswort habitat were noted at the downstream 'corner' of the marsh in 2018, where the SM10 community was recorded in 2000, but this was outside the 2018 NVC survey extent.
- 4.2 The saltmarsh around Kincardine Bridge is species poor, as was highlighted in previous surveys (NES 2003) and is typical of saltmarsh in the Firth of Forth (Proctor 1987). When compared to corresponding quadrat data from 2000, the species lists were similar across both surveys. In 2018, two additional species were recorded that were not noted in 2000, sea rush and melilot (*Melilotus* sp.), a non-native species. There were no species recorded in 2000 that were absent in 2018, however the cover values for common saltmarsh-grass appeared to be somewhat lower in the 2018 data. When combined with information from Taubert and Murphy (2012), which compared data from Skinflats in 2006 and 2011, it appears that the abundances of common saltmarsh-grass and sea plantain (*Plantago maritima*) vary seasonally and possibly between years in this area.
- 4.3 As the NVC class of the vegetation in the area of the hardcore ramp is the same as that outwith the area, it would be reasonable to conclude that the saltmarsh has recovered from removal of the hardcore ramp. Although the proportion of species differs, all species recorded in the surrounding areas are present in Area 2, with the noticeable difference due to lower abundance of sea arrowgrass. Sea arrowgrass is a slow-growing species (Brooke, Landin, Meakins and Adnitt 1999) and it has been shown that it is poor at natural recolonisation and would benefit from artificial seed reintroduction at restoration sites (Erfanzadeh, Garbutt, Petillion, Maelfait and Hoffman 2010). Therefore, it is not unexpected that this species takes a long time to achieve the same level of dominance in the area of the removed hardcore ramp as in the undisturbed areas. The saltmarsh will continue to develop and it is likely that the abundance of sea arrowgrass will increase over time.

## 5 References

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