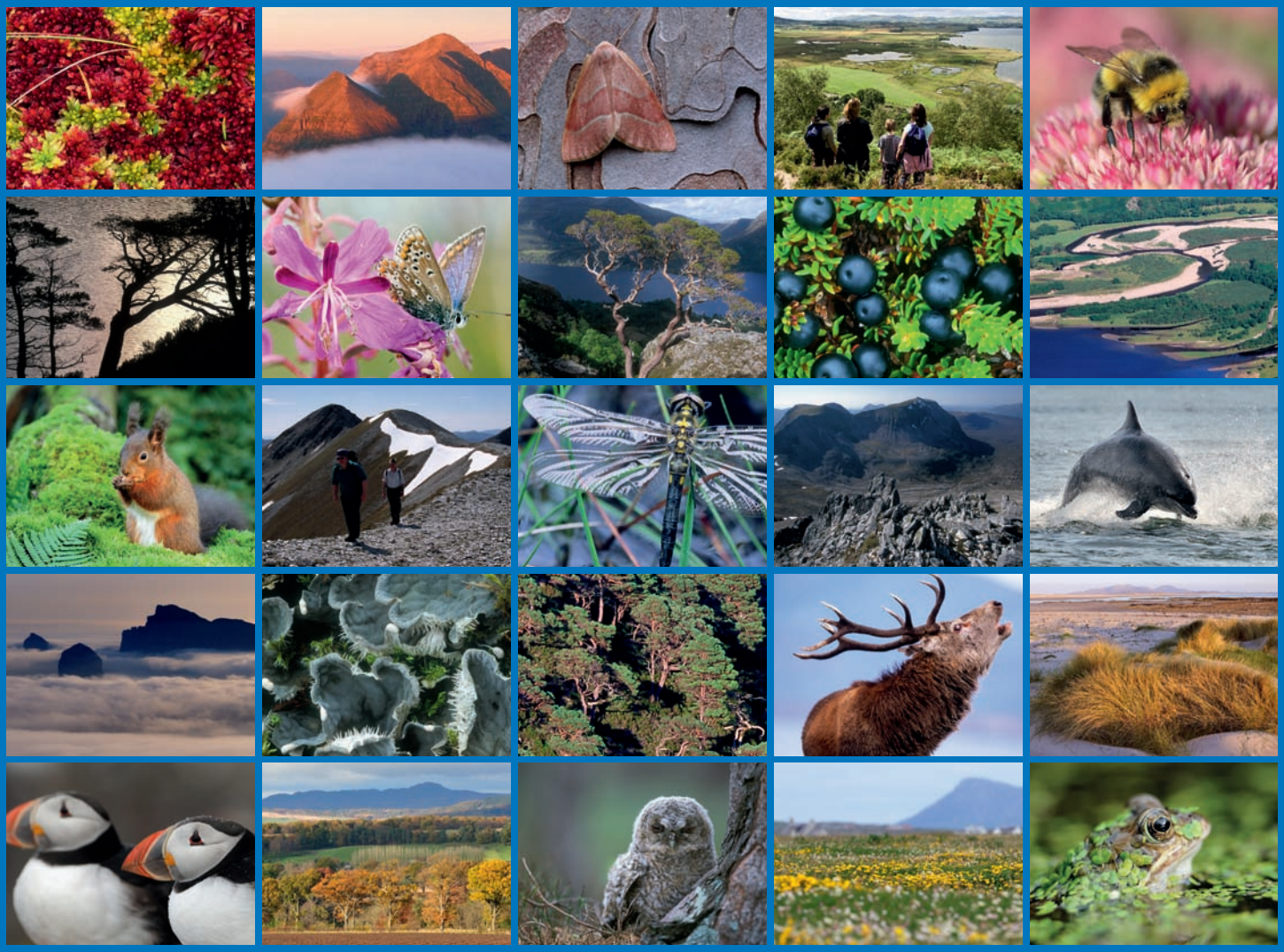
Scottish Natural Heritage
Research Report No. 1186

Saltmarsh survey and assessment of current herbivore impacts for Kentra Bay and Moss Site of Special Scientific Interest



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RESEARCH REPORT

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RESEARCH REPORT

Summary

Saltmarsh survey and assessment of current herbivore impacts for Kentra Bay and Moss Site of Special Scientific Interest

Research Report No. 1186
Project No: 117136
Contractor: Ian M. Strachan
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Keywords

Claish Moss and Kentra Moss SAC; saltmarsh; sheep; turf fucoids; Ardnamurchan DMG.

Background

Kentra Bay and Moss SSSI is a large area of intertidal flats, saltmarsh, blanket bog and woodland near Acharacle, in west Lochaber. Kentra Bay holds one of the largest and best-developed saltmarshes in Lochaber, with extensive mid- and upper marsh development and varied morphology. Mid-marsh with abundant turf fucoids, and with *Salicornia* locally frequent, is particularly well represented.

This report describes the findings of a herbivore impact assessment of the saltmarsh feature. The objective of the survey was to obtain information that would allow SNH and land managers to monitor progress towards conservation and condition objectives for the SSSI.

Main findings

- Fifty 2 x 2 m stratified random saltmarsh plots were examined and photographed. The following were recorded for each plot: saltmarsh zone, NVC type, sward height, structure/level of grazing, % bare ground due to poaching, cover of turf fucoids and frequency of flowering/fruiting of saltmarsh plants.
- 62% of plots were on upper marsh and 38% on mid-marsh. One mid-marsh plot included a fringe of low marsh. Sheep grazing was noted throughout the site but deer may also graze the saltmarsh.
- The mean sward height for middle marsh was 1.9 cm, for upper marsh was 4.2 cm, and for all plots was 3.3 cm (range 1-30 cm). Overall, 44 plots (88%) were in the range 1-5 cm and 5 plots (10%) in the range 6-10 cm. Only one plot, dominated by the unpalatable rush *J. maritimus,* had a taller sward (30 cm). None of the middle marsh plots had a mean sward height above 4 cm.
- Based on mean sward height, grazing pressure was assessed as ‘heavy’ on 88% of plots and ‘moderately heavy’ on 10% of plots, with no obvious pattern of variation across the site. Despite this, flowering or fruiting of saltmarsh plants was frequent throughout the saltmarsh, varying from abundant to sparse.

- The main flowering/fruiting saltmarsh species were *Armeria maritima* and *Plantago maritima* with a range of other species recorded, including new localities for *Centaurium littorale* and *Aster tripolium.*
- The mean cover of poached bare ground across all 50 plots was 7.6%. However, the proportion was very variable. It was much higher in mid-marsh (12.9%) than upper marsh (4.4%). 63% of mid-marsh plots had at least 10% bare ground due to poaching, compared to 19% of upper marsh plots. Four plots (8%) had more than 25% bare ground, which is the upper target threshold for SCM.
- Continued heavy grazing by sheep and associated trampling is likely to result in a loss of saltmarsh cover in certain areas, especially of mid-marsh, including loss of turf-fucoids. It seems likely that a moderate reduction in stock levels would be beneficial, reducing the risk of poaching damage and creating a more diverse sward structure, whilst maintaining the characteristic turf-fucoid saltmarsh vegetation and allowing its recovery in places.

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Acknowledgements

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1. INTRODUCTION

Kentra Bay and Moss SSSI is a large area of intertidal flats, saltmarsh, blanket bog and woodland near Acharacle in west Lochaber (Figure 1). One of the qualifying interests is saltmarsh, which was surveyed in 2012 as part of the Scottish Saltmarsh Survey (Strachan, 2012a). The distribution of saltmarsh is shown in Figures 2 and 3. It was described as follows:

> Kentra Bay is a large, semi-enclosed tidal bay, 2 km west of Acharacle in the west of Lochaber. Saltmarsh is distributed around the eastern half of Kentra Bay in a diversity of situations. Saltmarsh has developed on deposits which are predominantly of sand and muddy sand, with frequent rock outcrops, and muddier deposits locally at stream mouths. Some stands occur on small tidal islands, and others extend up winding watercourses.
>
> This is one of the largest and best-developed saltmarshes in Lochaber, with extensive mid- and upper marsh development and varied morphology. Mid-marsh with abundant turf fucoids and *Salicornia* locally frequent is particularly well represented. Other features of note include SM18 near its northern limit on the west coast, well-developed transitions to heath and bog with *Molinia*-rich forms of SM16 and SM18, large pans with SM23, and several sites for *Centaurium littorale. Euphrasia heslop-harrisonii* is also present though was not surveyed.

This report describes the findings of a herbivore impact assessment of the saltmarsh feature, as commissioned by SNH. The objective of the survey was stated as being 'to obtain information that would allow SNH and land managers to monitor progress towards conservation and condition objectives at the SSSI'.

Figure 1. Eilean an Eididh (Kentra Bay north), showing transition from bog and wet heath to saltmarsh and intertidal sandflats. © Ian Strachan

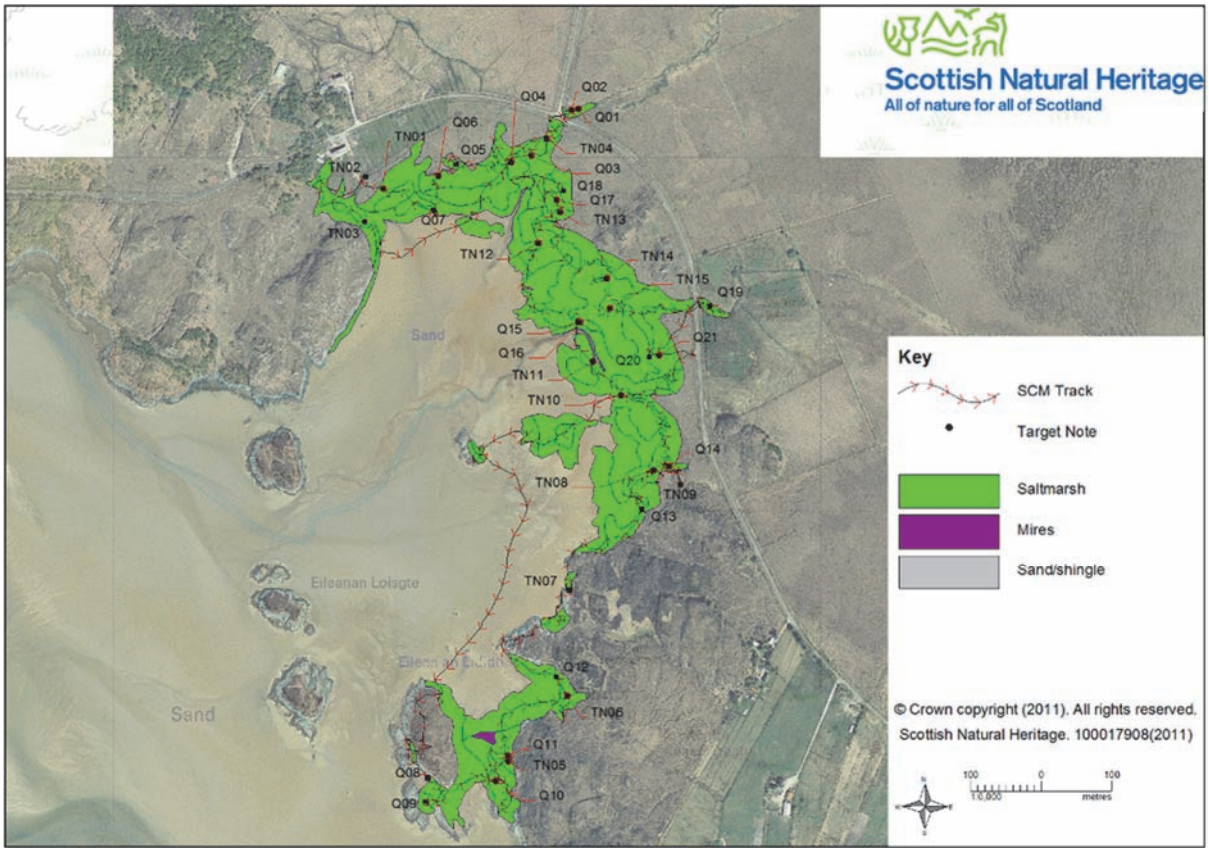

Figure 2. Kentra Bay (north) showing the distribution of saltmarsh. From: Strachan (2012a).

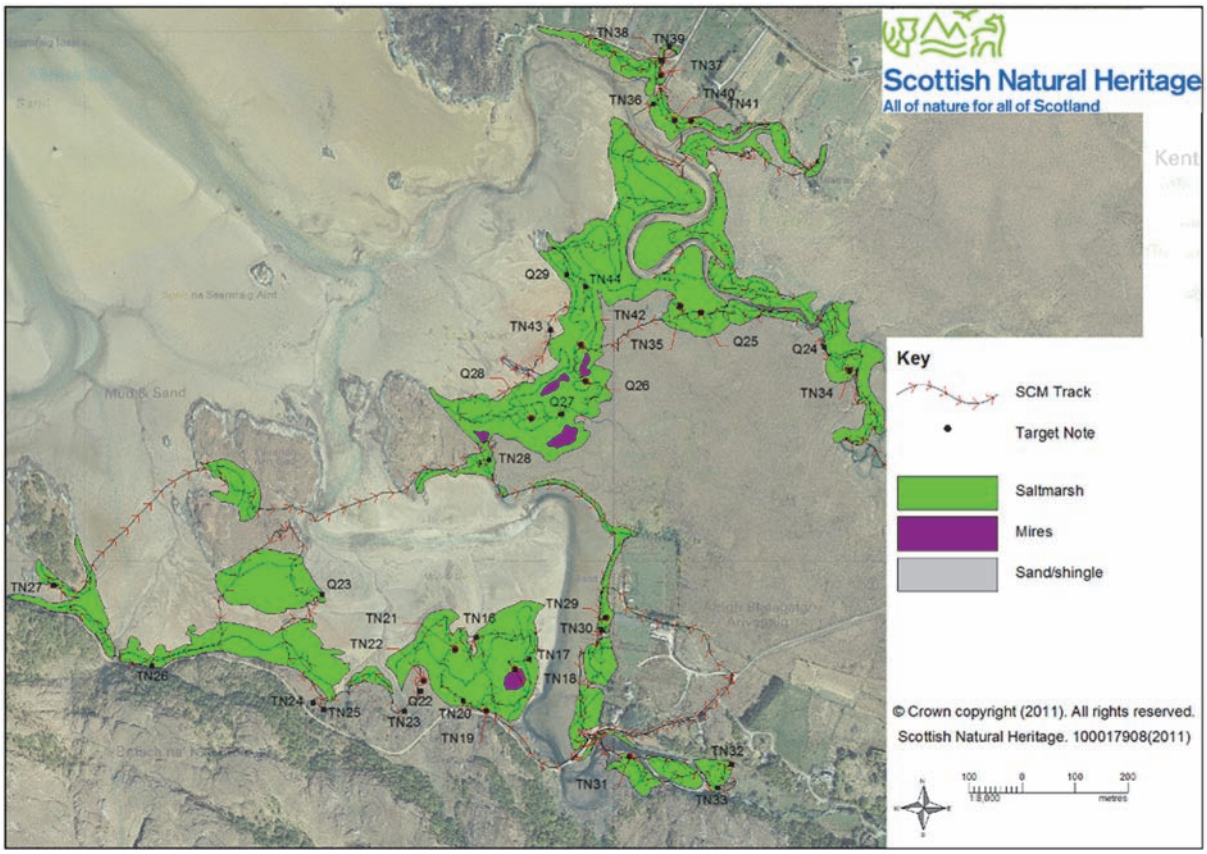

Figure 3. Kentra Bay (south) showing the distribution of saltmarsh. From: Strachan (2012a).

1.1 Previous monitoring

Site Condition Monitoring (SCM) of the saltmarsh feature was first carried out in 2002. The feature failed one target, for frequency of flowering/fruiting, with the following comment (Hutcheon Bros, 2002):

> The saltmarsh at Kentra Bay North and Kentra Bay East has high grazing impact, slightly less so at Kentra Bay South although this is still borderline for the target being met. The saltmarsh has a very short sward (~1 cm tall), with a bowling green like appearance, low growing and unpalatable species are predominant. There was very little flowering of herbs or monocotyledons. There was some sparse and infrequent flowering of the relatively unpalatable flowers of *Plantago maritima*, *Armeria maritima* and more rarely *Leontodon autumnalis*. Sheep dung was prominent on the saltmarsh. On the other hand, such short sward did make the site notably good for the abundance of turf fucoids in the swards.

As part of the 2012 survey, SCM was also carried out for the Kentra Bay saltmarsh (Strachan, 2012b). It again failed to meet the flowering/fruiting target, with the following comment:

> As highlighted in the 2002 SCM report, the turf is very short across most of the site due to heavy grazing. In particular the sward for SM13 and SM16 is typically very low, with longer growth and flowering often limited to creek sides.

It also failed the target for poaching damage, with the following comment:

> Poaching damage by sheep is widespread across the site, with significant exposure of bare ground especially in mid-marsh. Damage is most severely in the southern part, where bare ground sometimes exceeds 25%.

It failed three other targets due to damage from excavation and track construction. The report concluded that 'The site would benefit from reduced grazing pressure from sheep, and further damage from turf cutting, excavation etc should be prevented.'

2. METHODS

Fifty quadrats of dimensions 2 x 2 m were sampled between 23 June and 6 July 2018 (Figure 5). There is very little pioneer saltmarsh at Kentra and so the survey focused on lower, middle and upper Atlantic saltmarsh. Individual plot locations were generated by SNH GIS Unit in order to sample systematically the saltmarsh NVC types identified by Strachan (2012a). Where the habitat type expected at a plot location was different from that found on the ground, the plot location was relocated to the nearest suitable habitat.

At each point the following information was collected, as per the contract specification:

a. Saltmarsh zone (lower, middle and upper saltmarsh, plus the saltmarsh strandline and transitions to other habitats).
b. Average sward height (ignoring flowering heads).
c. Sward structure/ level of grazing as defined by the standing crop:
    - light grazing - most of the standing crop is not removed
    - moderate grazing - standing crop almost completely removed
    - heavy grazing - height < 10 cm, all standing crop removed
    - abandoned grazing - matted vegetation, no standing crop removed
d. Percentage bare ground due to poaching (algal mat also recorded).
e. Abundance of turf fucoids.
f. Abundance of flowering and fruiting of saltmarsh species.
g. Main herbivore or herbivores present.
h. Digital photographs of the plot illustrating the life-class structure and current herbivore impacts. One image was taken showing the whole plot (looking north) and one overhead image was taken of the centre of the plot (from 1 m height).
i. Any other negative indicators (other than issues already picked up in the 2012 Scottish Saltmarsh Survey).

In addition, the NVC type was recorded and compared with the map in the 2012 survey.

For e and f, use of the DAFOR scale was stipulated. However, this is difficult to apply at the individual plot level, being more appropriate across plots, as used in Site Condition Monitoring (JNCC, 2004). For turf fucoids, % cover in each plot was recorded instead; for flowering and fruiting of saltmarsh species, a modified subjective version of DAFOR was used within each plot (Abundant, Frequent, Occasional, Sparse, None) and the main species were noted.

Notes were also made of any features within each plot e.g. pans, creeks/channels, transitions. Where bare pans or creeks occurred, these were excluded when estimating d, e and f above.

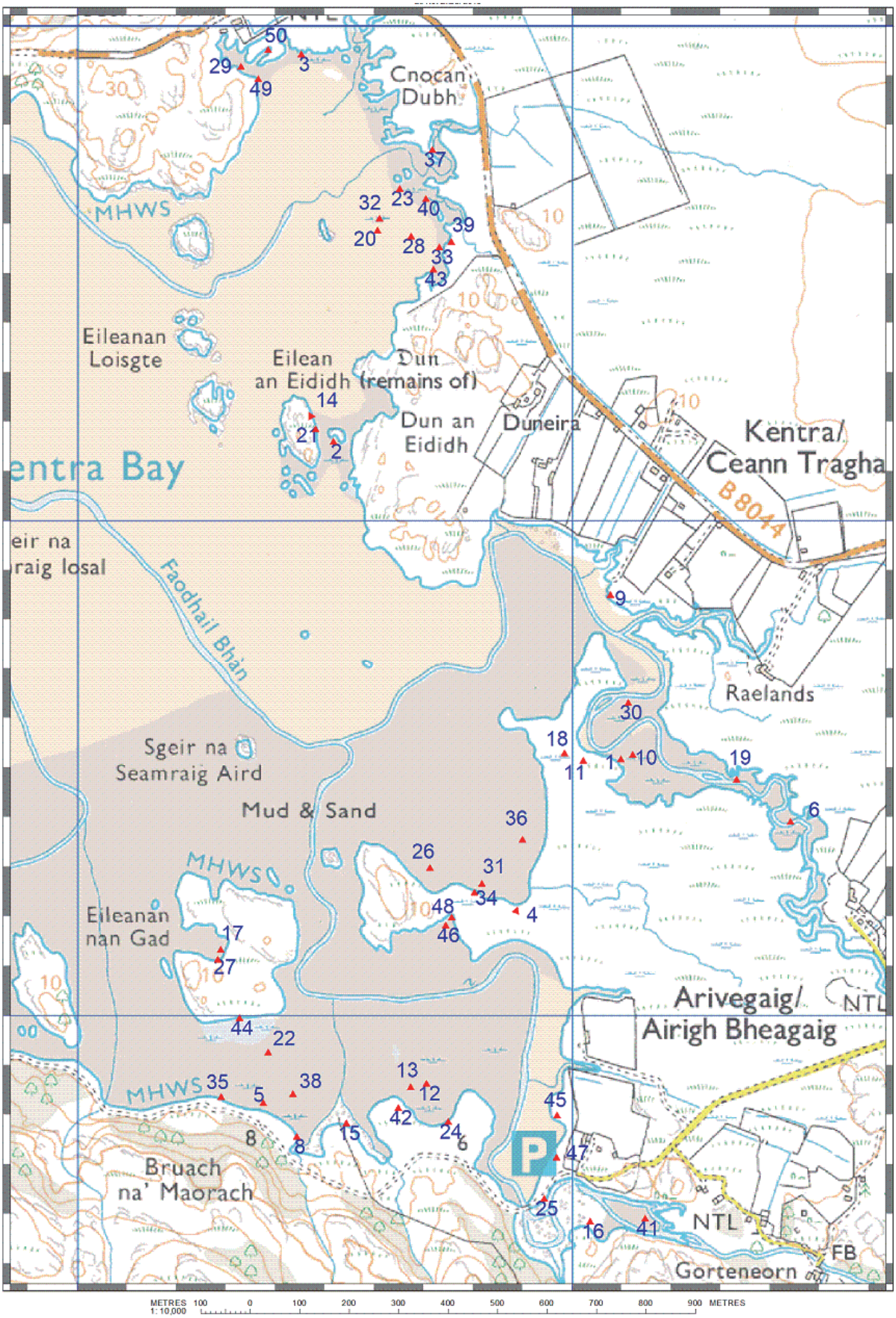

Figure 3. Kentra Bay saltmarsh sample plot locations (numbered red triangles). The plot numbers correspond to the tables in Annex 1. © Crown copyright and database right 2018 Ordnance Survey 100017908.

3. RESULTS

The data collected from the 50 saltmarsh plots are given in Annexes 1 and 2 and summarised below. Photographs (supplied separately) of the plots, notable species and other views are listed in Annex 3. The relevant image codes are also included in Annex 1.

3.1 Saltmarsh zones and vegetation types

The NVC types for each plot (Rodwell, 2000) are given in Annex 1, and include the following:

- SM13 (*Puccinellia maritima* saltmarsh)
  - SM13a (*Puccinellia maritima* sub-community)
  - SM13d (*Plantago maritima-Armeria maritima* sub-community)
  - SM13e (*Puccinellia maritima*-turf fucoid sub-community)
- SM16 (*Festuca rubra* saltmarsh)
  - SM16a (*Puccinellia maritima* sub-community)
  - SM16b (*Juncus gerardii* sub-community)
  - SM16c (*Festuca rubra-Glaux maritima* sub-community)
  - SM16e (*Leontodon autumnalis* sub-community)
  - SM16f (*Carex flacca* sub-community)
  - SM16x (proposed *Molinia caerulea* sub-community)
- SM18 (*Juncus maritimus* saltmarsh community)
  - SM18a (*Plantago maritima* sub-community)
- SM19 (*Blysmus rufus* community)
- SM20 (*Eleocharis uniglumis* saltmarsh)

Of the 50 plots, the majority (62%) were in upper marsh (mostly SM16, with minor representation of SM18, SM19 and SM20). The remainder (38%) were in middle marsh (mostly SM13e, with a few SM13d). Low marsh is widespread but scarce at Kentra Bay, mostly restricted to a very narrow zone of SM13a on the outer edge of the middle marsh zone. It occurred as a minor component in just one plot (28). The proportions of the three saltmarsh zones sampled corresponds well to the extents as mapped in 2012 (61% upper, 38% middle and <1% lower).

Three plots had to be slightly relocated, each by only a few metres, as follows:

- Plot 4 was moved from blanket bog to upper marsh in the nearby creek.
- Plot 28 was moved from bare sand onto the adjacent low/middle marsh.
- Plot 47 was moved from wet heath onto the nearby upper marsh-wet heath transition.

The revised grid references for these plots are given in Annex 1.

The NVC types observed in 2018 corresponded to those mapped in Strachan (2012) except in the vicinity of plots 14 and 21 where an area of SM16 upper marsh had been incorrectly labelled as SM13 mid-marsh.

3.2 Sward structure and grazing

All the plots showed evidence of grazing by sheep, based on sightings of animals, dung and small hoof-prints (MacDonald *et al*, 1998) (Figure 4); deer are also likely to graze the saltmarsh, though similar evidence of deer was not seen during the survey, and it was thus concluded that impacts were overwhelmingly due to sheep. Mean sward height was mostly very short (Table 1, Figures 5 and 6). The mean sward height for middle marsh was 1.9 cm (range 1-4 cm) and for upper marsh was 4.2 cm (range 1-30 cm). The mean sward height across all 50 plots was 3.3 cm (range 1-30 cm). Overall 44 plots (88%) were in the range 1-5

cm and 5 plots (10%) in the range 6-10 cm. Only one plot had a taller sward (30 cm); this was the upper marsh type SM18 *Juncus maritimus* saltmarsh dominated by the very unpalatable rush *J. maritimus.* Even here the associated flora had a mean height of only 5 cm. None of the middle marsh plots had a mean sward height above 4 cm.

Based on the classification provided (see Methods) all but one of the plots should be assessed as having 'heavy grazing' because the sward height was below 10 cm. However, this does not reflect the variation in grazing pressure observed, and so an additional category of 'moderately heavy' grazing has been used in Annex 1 for those swards between 6 and 10 cm tall. Five plots fell into this category; these were scattered across the north, east and south parts of the bay i.e. there was no obvious pattern to their distribution.

Table 1. Sward height distribution, with number of plots in mid-marsh, upper marsh and combined. The final column gives the overall % of plots in each height range.

mean sward height	Mid-marsh plots	Upper marsh plots	All plots	%
1-5 cm	19	25	44	88
6-10 cm	0	5	5	10
11-15 cm	0	0	0	0
16-20 cm	0	0	0	0
21-25 cm	0	0	0	0
26-30 cm	0	1	1	2
total	19	31	50	

Figure 4. Sheep grazing on saltmarsh west of Arivegaig. © Ian Strachan

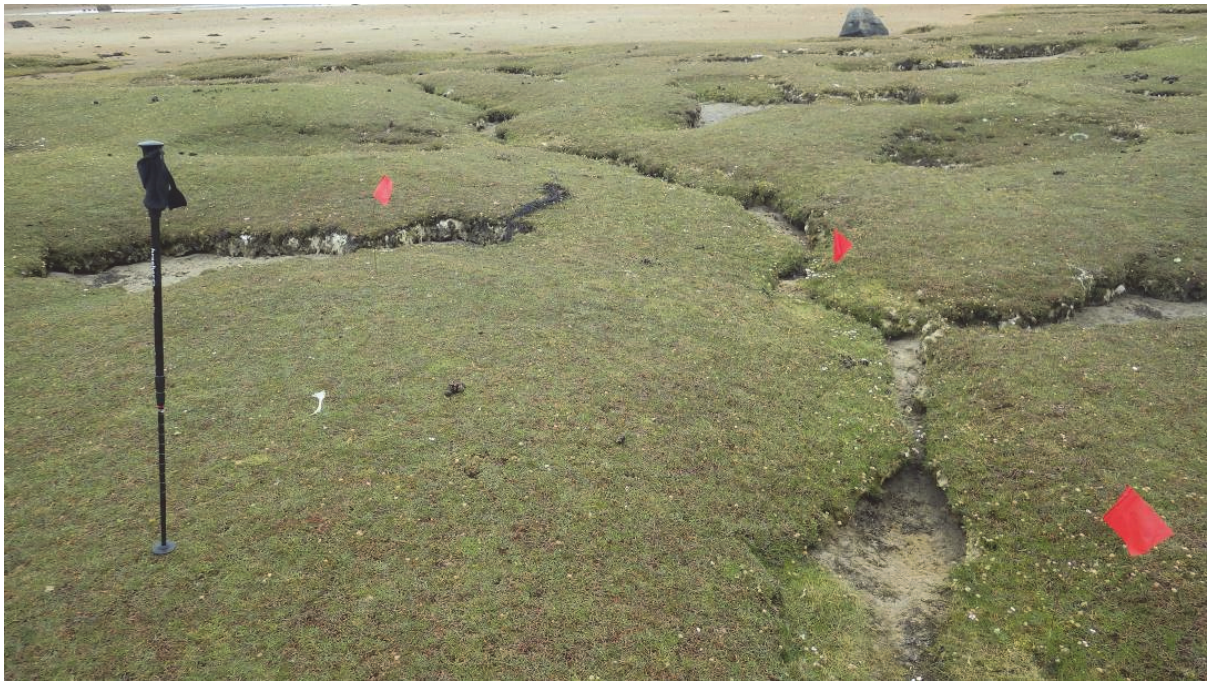

Figure 5. Typical heavily sheep-grazed saltmarsh sward (SM13e, plot 32).

Figure 6. Overhead view of typical short turf (SM16a, plot 2).

3.3 Flowering/fruiting of saltmarsh species

Flowering/fruiting of saltmarsh species was recorded in every plot but varied from abundant to sparse (Figures 7 and 8). There was no clear correlation between sward height and abundance of flowering/fruiting, and abundant or frequent flowering was recorded in some very short swards. *Armeria maritima*, which has flowers that are relatively unpalatable to sheep (Chatters, 2017), was the most abundant flowering/fruiting species, followed by *Plantago maritima, Puccinellia maritima* (in middle marsh) and *Juncus gerardii* (in upper marsh). More palatable species such as *Triglochin maritima* and *Aster tripolium* were absent or rare.

Figure 7. Abundant flowering of Armeria maritima *and* Plantago maritima *in short mid-marsh turf (SM13e, plot 22).*

Figure 8. Sparse flowering of saltmarsh species in short upper-marsh turf (SM16c, plot 24).

Flowering specimens of *Centaurium littorale* (Figure 9), typically less than 2 cm high, were recorded on the upper saltmarsh in several places, including one of the monitoring plots (plot 14). The eyebright *Euphrasia heslop-harrisonii* was found in plot 34, and near plot 26. Both species are Nationally Scarce, and form part of the Vascular Plant Assemblage feature of the SSSI; these records represent new records/populations. A miniature flowering specimen of *Aster tripolium* was also found at one locality (Figure 10), apparently the first known record for this common but grazing sensitive species in Kentra Bay for 40 years (BSBI Distribution Database). The locations and counts of notable species found are listed in Table 2.

Figure 9. Flowering seaside centaury Centaurium littorale *in SM16f saltmarsh, plot 34.*

Figure 10. Flowering sea aster Aster tripolium, *just 1 cm tall, in close-grazed saltmarsh turf.*

Table 2. Location and abundance of notable species recorded

Grid reference	date	species	flowers	extent
NM 64390 67820	25/06/2018	*Centaurium littorale*	20	5x2m
NM 65460 68360	06/07/2018	*Centaurium littorale*	20+	10m+
NM 65440 68360	06/07/2018	*Centaurium littorale*		
NM 65208 68512	06/07/2018	*Centaurium littorale*	2	
NM 65203 68595	06/07/2018	*Centaurium littorale*	4	
NM 64796 68262	06/07/2018	*Centaurium littorale*	60	10X10m
NM 64809 68252	06/07/2018	*Centaurium littorale*	5	
NM 64884 68215	06/07/2018	*Centaurium littorale*	30+	
NM 64886 68213	06/07/2018	*Centaurium littorale*		
NM 64809 68252	06/07/2018	*Euphrasia heslop-harrisonii*		
NM 64991 68533	06/07/2018	*Aster tripolium*	1	

3.4 Poached bare ground

Recording bare ground due to poaching is not always straightforward, since bare substrate can be a natural feature of saltmarshes, particularly in low marsh. Channels and pans, which are naturally unvegetated, were excluded from consideration. Otherwise the decision was generally based on the presence of animal footprints, although these can be 'blurred' by the tide. In some areas, bare substrate was covered with an algal mat, which often develops on intertidal mud and muddy sand in summer, and which may or may not be covering poached ground; a judgement had to be made in each case. However, because of this uncertainty the algal mat cover was recorded in addition to the estimate of poached ground (Figure 10).

Poaching appeared to be mostly if not entirely due to sheep, based on the small size of hoof-prints. The mean cover of poached bare ground across all 50 plots was 7.6%. However, the proportion was very variable. In terms of zonation it was much higher in mid-marsh (12.9%) than upper marsh (4.4%). 63% of mid-marsh plots had at least 10% bare ground due to poaching, compared to 19% of upper marsh plots. The mean cover of bare ground was somewhat higher in the plots on the northern side of the bay compared to the east and south, but this largely reflects the greater proportion of mid-marsh in that part of the site. Four plots (8%) had more than 25% bare ground, which is the upper target threshold for SCM (JNCC, 2004) (Figure 11). These occurred in the north, east and south i.e. there was no obvious pattern to the distribution of heavy poaching.

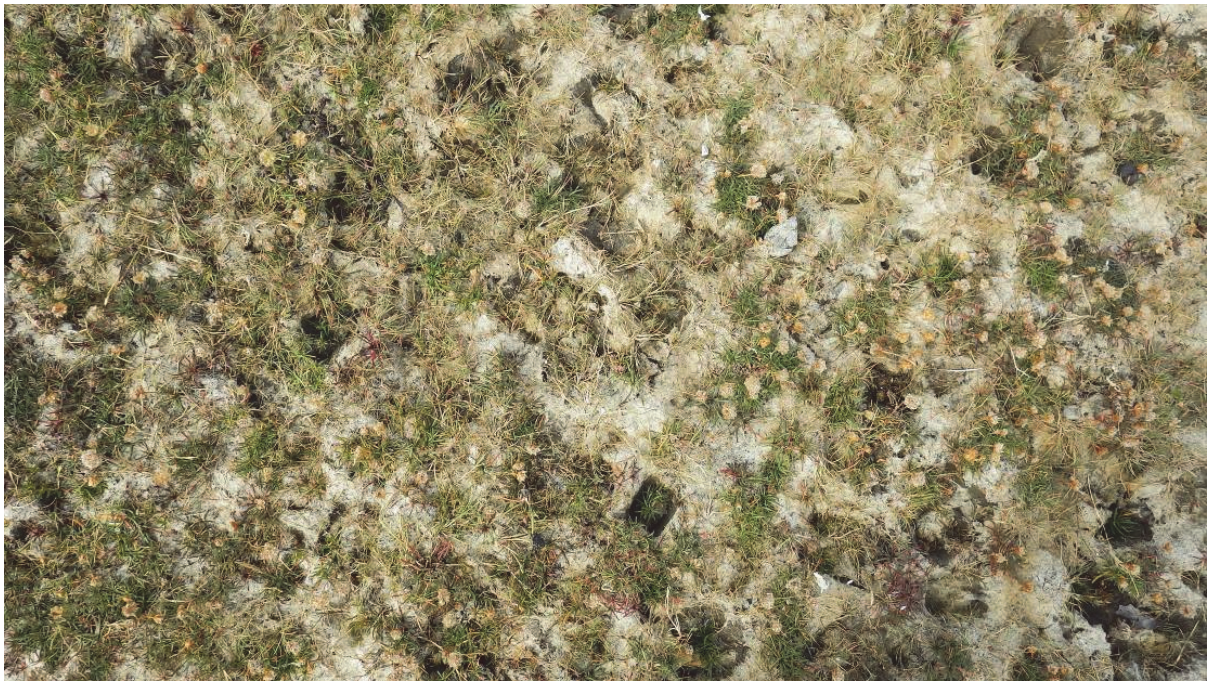

Figure 10. Sheep-poached saltmarsh with mat of filamentous algae (SM13d, plot 31).

Figure 11. Severe poaching damage by sheep to mid-marsh (SM13d, plot 29).

3.5 Turf fucoids

Turf fucoids are a distinctive feature of grazed saltmarshes in western Scotland and Ireland. They are most abundant in the mid-marsh NVC type SM13e, forming an extensive dense understorey (Rodwell, 2000). Turf fucoids also occur in upper marsh but much less frequently. Kentra Bay is an important site for saltmarsh with turf fucoids, having 13.8 ha of SM13e, representing 96% of mid-marsh and 36% of total saltmarsh present (Strachan, 2012a). In the current survey, turf fucoid cover in mid-marsh plots averaged 30.9%, with 7 of 19 plots (37%) having at least 50% cover (Figure 12). However, seven plots (37%) had 10% cover or less.

Figure 12. SM13e saltmarsh with abundant orange-brown turf-fucoids (plot 38).

3.6 Other negative indicators

No evidence was noted of negative indicators additional to those recorded by Strachan (2012b).

4. CONCLUSIONS

The saltmarshes in Kentra Bay continue to be intensively grazed by sheep, as reported in previous survey and monitoring of this feature (Scott, 1984; Hutcheon Bros., 2002; Strachan, 2012b). Deer are probably adding to this, but from the lack of direct evidence in 2018 their contribution is judged to be minor. The site has undoubtedly been grazed relatively heavily for a long period, and the vegetational and floristic interests may reflect this to some extent. SM13e with abundant turf fucoids is a notable feature of Kentra Bay, and this sub-community is typically grazed in western Scotland; Haynes (2016) observed that 'SM13e appears able to cope with intensive sheep grazing (unlike SM13a and SM13d), and may form as a response to such grazing on some sites.' However, excessive poaching by stock in combination with heavy grazing is likely to eliminate the turf fucoids, and appears be a factor in their low cover on some areas at Kentra Bay. The scarcity of SM13a low-marsh at Kentra may also be a consequence of grazing pressure, although Haynes (2016) observed that SM13a is often only found as a narrow fringing zone on Scottish saltmarshes, and may be replaced to some extent by forms of SM13e.

Flowering/fruiting of saltmarsh plants seemed to be more frequent than reported previously, although was not seen for more sensitive/taller species such as *Triglochin maritima*.

Continued heavy grazing by sheep and associated trampling is likely to result in a loss of saltmarsh cover in certain areas, especially of mid-marsh, including loss of turf-fucoids, and may be a cause of the scarcity of low marsh. A moderate reduction in stock levels would be likely to be beneficial in reducing the risk of poaching damage and creating a more diverse sward structure whilst maintaining the characteristic turf-fucoid saltmarsh vegetation and allowing its recovery locally.

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ANNEX 1: DATA FOR SAMPLE PLOTS 1-50

Key: Part of bay: N north, E east, S south; Grazing pressure: H heavy, MH moderately heavy, L light; Flowering/fruiting A abundant, F frequent, O occasional, S sparse. Photo numbers should all be preceded by RIMG.'% bare ground poached' means % cover of bare ground caused by poaching. Flowering/fruiting species codes: *Ags Agrostis stolonifera, Arm Armeria maritima, Cen Centaurium littorale, Cex Carex extensa, Cf Carex flacca, Cn, Carex nigra, Coe Carex oederi, Eq Eleocharis quinqueflora, Eun Eleocharis uniglumis, Eup Euphrasia sp, Fru Festuca rubra, Gm Glaux maritima, Hla Holcus lanatus, Jar Juncus articulates, Jg Juncus gerardii, Jma Juncus maritimus, Mol Molinia caerulea, Plc Plantago coronopus, Plm Plantago maritima, Puc Puccinellia maritima, Sau Scorzoneroides autumnalis, Trep Trifolium repens.*

UID	X	Y	Part of bay	Photo view north	Photo over-head	NVC	Salt marsh zone	sward height cm	Grazing pressure	% bare ground poached	% algal mat	% cover of turf fucoids	flower/ fruiting	Flowering/ fruiting species
1	165105	768521	E	2172	2173	SM16x	upper	6	MH	0		0	F	*Jg Plm Mol Hla Cn*
2	164524	769164	N	2024	2025	SM16a	upper	2	H	10		0	F	*Arm Plm Puc*
3	164459	769947	N	2039	2040	SM16c	upper	1	H	2	5	0	OF	*Arm Plm*
4	164895	768214	E	2197	2198	SM20	upper	6	MH	5		0	O	*Eun Plm Ags Jg Coe*
5	164382	767828	S	2100	2101	SM16c	upper	3	H	30		0	F	*Arm Plm Jg Fru*
6	165448	768395	E	2163	2164	SM16e	upper	5	H	0		0	A	*Arm Plm Jg Ags Gm*
7	164613	770023	N	2037	2038	SM16c	upper	2	H	20		0	F	*Arm Plm Cex*
8	164450	767760	S	2104	2105	SM16c	upper	2	H	3		0	F	*Arm Plm Fru Jg*
9	165084	768854	E	2047	2048	SM16c	upper	1	H	5		0	OF	*Arm Plm Jg*
10	165129	768530	E	2170	2171	SM16fx	upper	5	H	0		0	F	*Jg Plm Mo Cf Ags*
11	165029	768518	E	2174	2175	SM16e	upper	1	H	1		0	OF	*Arm Plm Jg*
12	164712	767867	S	2094	2095	SM13e	mid	1	H	1		50	F	*Arm Plm*
13	164680	767860	S	2096	2097	SM13e	mid	2	H	15		10	F	*Arm Plm*
14	164475	769219	N	2020	2021	SM16fe	upper	2	H	1		0	O	*Arm Plm Fru*
15	164550	767787	S	2119	2120	SM16f	upper	2	H	10		0	O	*Arm Plm Jg*
16	165043	767589	S	2202	2203	SM16c	upper	8	MH	0		0	A	*Arm Jg Plm Ags*
17	164296	768137	S	2112	2113	SM13d	mid	1	H	30		10	F	*Arm Plm*
18	164991	768533	E	2176	2177	SM16c	upper	2	H	5		0	A	*Arm Plm*
19	165339	768480	E	2166	2167	SM16c	upper	5	H	5		0	A	*Arm Plm Jg Ags Fru*
20	164613	769591	N	2012	2013	SM13de	mid	1	H	1	30	20	F	*Arm Plm Puc*
21	164488	769189	N	2022	2023	SM16fe	upper	2	H	1		0	F	*Jg Plm Coe Fru*
22	164392	767930	S	2114	2115	SM13e	mid	2	H	5		50	A	*Arm Plm*
23	164658	769675	N	2008	2009	SM13e	mid	2	H	5		70	F	*Arm Plm*
24	164756	767790	S	2092	2093	SM16c	upper	3	H	0		0	F	*Arm Jg Fru*
25	164950	767635	S	2086	2087	SM16c	upper	3	H	0		0	F	*Jg Plm Ags*

UID	X	Y	Part of bay	Photo view north	Photo over-head	NVC	Salt marsh zone	sward height cm	Grazing pressure	% bare ground poached	% algal mat	% cover of turf fucoids	flower/ fruiting	Flowering/ fruiting species
26	164719	768302	E	2184	2185	SM13e	mid	2	H	20		20	A	*Arm Puc*
27	164290	768117	S	2110	2111	SM13e	mid	2	H	5		30	A	*Arm Plm Puc*
28	164681	769579	N	2014	2015	SM13de	mid	3	H	5		50	A	*Arm Plm Gm*
29	164337	769922	N	2043	2044	SM13d	mid	2	H	50		0	OF	*Arm Plm Puc*
30	165120	768635	E	2168	2169	SM13e	mid	1	H	10		50	F	*Arm Plm*
31	164824	768270	E	2186	2187	SM13d	mid	2	H	10	50	2	OF	*Arm*
32	164617	769615	N	2010	2011	SM13e	mid	1	H	3		70	F	*Arm Plm*
33	164738	769557	N	2029	2030	SM13d	mid	4	H	10		5	F	*Arm Plm Puc*
34	164809	768252	E	2188	2189	SM16f	upper	3	H	0		0	F	*Arm Jg Eup Cen Jar*
35	164297	767840	S	2106	2107	SM16c	upper	4	H	10		5	A	*Arm Plm Jg Fru*
36	164906	768359	E	2180	2181	SM16f	upper	3	H	0		0	F	*Jg Cn Coe Ags Fru Plc*
37	164724	769754	N	2035	2036	SM16c	upper	1	H	10	10	0	F	*Arm Plm Puc*
38	164442	767846	S	2116	2117	SM13e	mid	2	H	15		50	A	*Arm Plm Puc*
39	164762	769568	N	2031	2032	SM20/16e	upper	6	MH	10		0	F	*Eun Arm Coe Plm*
40	164711	769655	N	2006	2007	SM13a	mid	2	H	10		60	F	*Arm Plm*
41	165154	767595	S	2204	2205	SM18	upper	5/30	L/H	0		0	A	*Jma Sau*
42	164655	767818	S	2098	2099	SM16f	upper	4	H	0		0	F	*Jg Fru Coe Cf*
43	164726	769512	N	2027	2028	SM13de	mid	2	H	5		10	F	*Arm Plm Puc*
44	164334	767999	S	2108	2109	SM16e	upper	1	H	1		0	OF	*Arm Plm Jg Fru*
45	164976	767803	S	2090	2091	SM16c	upper	3	H	5		0	F	*Arm Jg Cex Plm*
46	164751	768186	E	2195	2196	SM13d	mid	3	H	30		0	F	*Arm Plm Puc*
47	164975	767718	S	2088	2089	SM16f	upper	8	MH	0		0	F	*Jg Hla Cf Cn Trep*
48	164763	768202	E	2193	2194	SM16f	upper	3	H	0		0	F	*Jg Mol Jar Cf Eq*
49	164372	769897	N	2045	2046	SM13e	mid	1	H	15		30	F	*Arm Plm Puc*
50	164392	769956	N	2041	2042	SM16c	upper	2	H	1		0	F	*Arm Plm Jg*

ANNEX 2: SAMPLE PLOTS: FURTHER NOTES

UID	plot features/notes
1	edge of pan, varied sward height
2	
3	
4	narrow creek in M17. *Eleocharis* 50% grazed
5	eroded
6	taller sward to W
7	W bank of stream, eroded
8	small pan and channel
9	2 deep pans
10	transition to M15, varied sward height
11	mossy
12	
13	small pan
14	10% bryophytes, transition to M17. mapping error (SM13)
15	
16	J gerardii ungrazed, others short
17	channels
18	Aster tripolium
19	
20	
21	channel with SM19. mapping error (SM13)
22	small pan
23	pool in middle, erosion on edge
24	
25	
26	30% bare gravel
27	channel
28	narrow fringe of Puccinellia SM13a. original GR on sand
29	shallow channel across
30	
31	dried algae over most of plot. *Salicornia* occasional
32	pool on edge. original GR in pool
33	bare channel
34	pan on edge
35	also SM13e present
36	on shingle, adjacent to wet heath
37	steep eroded bank
38	channels
39	in wide channel with bare substrate, pan at corner. varied sward height
40	
41	upper sward height is *Juncus maritimus*
42	
43	small pool
44	
45	
46	sandy pans.
47	transition to U4
48	transition to M15
49	small pan
50	channel with *J gerardii*

ANNEX 3: LIST OF IMAGES (SUPPLIED SEPARATELY)

For plot locations see Annex 1 and Figure 3.

photo code	date	plot ID	description
RIMG2006	23/06/2018	40	view north across plot
RIMG2007	23/06/2018	40	vertical view of plot centre
RIMG2008	23/06/2018	23	view north across plot
RIMG2009	23/06/2018	23	vertical view of plot centre
RIMG2010	23/06/2018	32	view north across plot
RIMG2011	23/06/2018	32	vertical view of plot centre
RIMG2012	23/06/2018	20	view north across plot
RIMG2013	23/06/2018	20	vertical view of plot centre
RIMG2014	23/06/2018	28	view north across plot
RIMG2015	23/06/2018	28	vertical view of plot centre
RIMG2016	23/06/2018	14	poaching detail
RIMG2017	23/06/2018	14	*Carex oederi* fruiting
RIMG2018	23/06/2018	14	view SE transition to bog
RIMG2019	23/06/2018	14	view NW transition to bog
RIMG2020	23/06/2018	14	view north across plot
RIMG2021	23/06/2018	14	vertical view of plot centre
RIMG2022	23/06/2018	21	view north across plot
RIMG2023	23/06/2018	21	vertical view of plot centre
RIMG2024	23/06/2018	2	view north across plot
RIMG2025	23/06/2018	2	vertical view of plot centre
RIMG2026	23/06/2018		poaching near plot 2
RIMG2027	23/06/2018	43	view north across plot
RIMG2028	23/06/2018	43	vertical view of plot centre
RIMG2029	23/06/2018	33	view north across plot
RIMG2030	23/06/2018	33	vertical view of plot centre
RIMG2031	23/06/2018	39	view north across plot
RIMG2032	23/06/2018	39	vertical view of plot centre
RIMG2033	23/06/2018	39	view east across plot
RIMG2035	23/06/2018	37	view north across plot
RIMG2036	23/06/2018	37	vertical view of plot centre
RIMG2037	23/06/2018	7	view north across plot
RIMG2038	23/06/2018	7	vertical view of plot centre
RIMG2039	23/06/2018	3	view north across plot
RIMG2040	23/06/2018	3	vertical view of plot centre
RIMG2041	23/06/2018	50	view north across plot
RIMG2042	23/06/2018	50	vertical view of plot centre
RIMG2043	23/06/2018	29	view north across plot
RIMG2044	23/06/2018	29	vertical view of plot centre
RIMG2045	23/06/2018	49	view north across plot
RIMG2046	23/06/2018	49	vertical view of plot centre
RIMG2047	23/06/2018	9	view north across plot
RIMG2048	23/06/2018	9	vertical view of plot centre
RIMG2086	25/06/2018	25	view north across plot
RIMG2087	25/06/2018	25	vertical view of plot centre
RIMG2088	25/06/2018	47	view north across plot
RIMG2089	25/06/2018	47	vertical view of plot centre
RIMG2090	25/06/2018	45	view north across plot
RIMG2091	25/06/2018	45	vertical view of plot centre
RIMG2092	25/06/2018	24	view north across plot
RIMG2093	25/06/2018	24	vertical view of plot centre
RIMG2094	25/06/2018	12	view north across plot
RIMG2095	25/06/2018	12	vertical view of plot centre

photo code	date	plot ID	description
RIMG2096	25/06/2018	13	view north across plot
RIMG2097	25/06/2018	13	vertical view of plot centre
RIMG2098	25/06/2018	42	view north across plot
RIMG2099	25/06/2018	42	vertical view of plot centre
RIMG2100	25/06/2018	5	view north across plot
RIMG2101	25/06/2018	5	vertical view of plot centre
RIMG2102	25/06/2018		*Centaurium littorale* near plot 5
RIMG2103	25/06/2018		*Centaurium littorale* near plot 5
RIMG2104	25/06/2018	8	view north across plot
RIMG2105	25/06/2018	8	vertical view of plot centre
RIMG2106	25/06/2018	35	view north across plot
RIMG2107	25/06/2018	35	vertical view of plot centre
RIMG2108	25/06/2018	44	view north across plot
RIMG2109	25/06/2018	44	vertical view of plot centre
RIMG2110	25/06/2018	27	view north across plot
RIMG2111	25/06/2018	27	vertical view of plot centre
RIMG2112	25/06/2018	17	view north across plot
RIMG2113	25/06/2018	17	vertical view of plot centre
RIMG2114	25/06/2018	22	view north across plot
RIMG2115	25/06/2018	22	vertical view of plot centre
RIMG2116	25/06/2018	38	view north across plot
RIMG2117	25/06/2018	38	vertical view of plot centre
RIMG2118	25/06/2018		*Salicornia* in SM13 turf near plot 38
RIMG2119	25/06/2018	15	view north across plot
RIMG2120	25/06/2018	15	vertical view of plot centre
RIMG2161	06/07/2018		*Centaurium littorale* near plot 6
RIMG2162	06/07/2018		view NW along Dig Bhan showing SM16f
RIMG2163	06/07/2018	6	view north across plot
RIMG2164	06/07/2018	6	vertical view of plot centre
RIMG2165	06/07/2018	6	view west across plot
RIMG2166	06/07/2018	19	view north across plot
RIMG2167	06/07/2018	19	vertical view of plot centre
RIMG2168	06/07/2018	30	view north across plot
RIMG2169	06/07/2018	30	vertical view of plot centre
RIMG2170	06/07/2018	10	view north across plot
RIMG2171	06/07/2018	10	vertical view of plot centre
RIMG2172	06/07/2018	1	view north across plot
RIMG2173	06/07/2018	1	vertical view of plot centre
RIMG2174	06/07/2018	11	view north across plot
RIMG2175	06/07/2018	11	vertical view of plot centre
RIMG2176	06/07/2018	18	view north across plot
RIMG2177	06/07/2018	18	vertical view of plot centre
RIMG2178	06/07/2018		*Aster tripolium* flowering near plot 18
RIMG2179	06/07/2018		view S with sheep grazing near plot 36
RIMG2180	06/07/2018	36	view north across plot
RIMG2181	06/07/2018	36	vertical view of plot centre
RIMG2182	06/07/2018		*Euphrasia heslop-harrisonii* near plot 26
RIMG2183	06/07/2018		*Euphrasia heslop-harrisonii* near plot 26
RIMG2184	06/07/2018	26	view north across plot
RIMG2185	06/07/2018	26	vertical view of plot centre
RIMG2186	06/07/2018	31	view north across plot
RIMG2187	06/07/2018	31	vertical view of plot centre
RIMG2188	06/07/2018	34	view north across plot
RIMG2189	06/07/2018	34	vertical view of plot centre
RIMG2193	06/07/2018	48	view north across plot
RIMG2194	06/07/2018	48	vertical view of plot centre
RIMG2195	06/07/2018	46	view north across plot

photo code	date	plot ID	description
RIMG2196	06/07/2018	46	vertical view of plot centre
RIMG2197	06/07/2018	4	view north across plot
RIMG2198	06/07/2018	4	vertical view of plot centre
RIMG2199	06/07/2018	4	view west across plot
RIMG2202	06/07/2018	16	view north across plot
RIMG2203	06/07/2018	16	vertical view of plot centre
RIMG2204	06/07/2018	41	view north across plot
RIMG2205	06/07/2018	41	vertical view of plot centre
RIMG2206	06/07/2018		view east up Allt Beithe from near plot 26

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