3.4.2. Saltmarsh and mudflat restoration

WHAT IS IT?

The restoration of intertidal habitats such as mudflats and saltmarsh to create space to dissipate wave and tidal energy.

Saltmarsh vegetation consists of a limited number of salt tolerant species that are adapted to regular immersion by the tides. A natural saltmarsh system shows clear zonation according to the frequency of inundation (Table 3.4). There are approximately 40 species of higher plants found in British saltmarshes, but individual marshes generally have between 10 to 20 species[89].

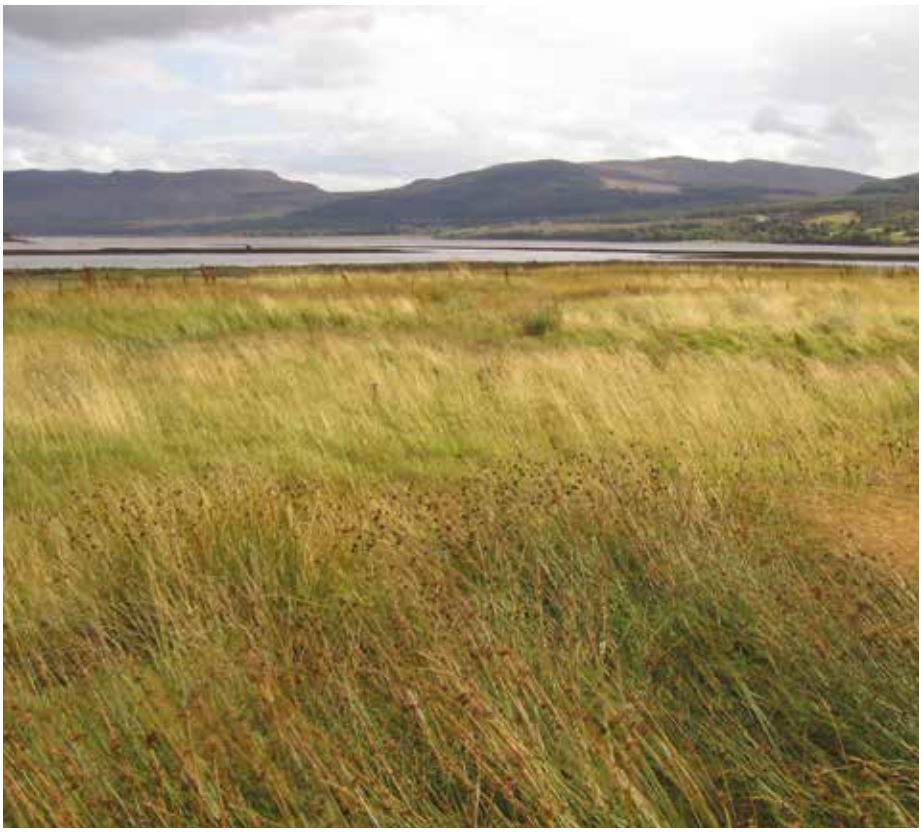

Figure 3.13. Saltmarsh at Bonar Bridge on the Dornoch Firth estuary, Sutherland: The saltmarsh provides space for wave and tidal energy to dissipate.

Table 3.4. Zonation of intertidal habitats and types of species found in each type of habitat (adapted from Boorman et al.[94] and Nottage and Robertson[87]).

Inundations (per year)	Habitat zones	Tidal zone	Plant community composition
450	Mudflat	Up to mean high water neap tides	None
300-450	Pioneer marsh	Centred around mean high water neap tides; above lowest neap tides	Open communities with one or more of Spartina spp., *Salicornia* spp. or *Aster tripolium*
Less than 300	Low marsh	Centred around mean high water; inundated by most tides	Generally closed communities with *Puccinellia maritima* and *Atriplex portulacoides* (and previous species)
	Middle marsh	Only inundated by spring tides	Generally closed communities with *Limonium* spp. and/or *Plantago* (and previous species)
	High/ Upper marsh	Only inundated by the highest spring tides	Generally closed communities with one or more of *Festuca rubra, Armeria maritima* or *Elytrigia* spp. (and previous species)
	Transitional marsh	Inundated occasionally by tidal surges during extreme storm events	Vegetation intermediate between high marsh and non salt-tolerant species

Saltmarsh and saltmarsh creeks can contribute to flood risk management by dissipating wave and tidal energy (Figures 3.12 and 3.13). A study of wave attenuation over a 180m wide salt marsh in Norfolk compared to a 197m wide sand flat, for example, found that the saltmarsh dissipated total wave energy by an average of 82%, while the un-vegetated sand flat only dissipated an average of 29% of total wave energy[90,91]. A recent controlled experiment in a wave flume estimated that up to 60% of observed wave reduction was due to the presence of saltmarsh vegetation. Although waves progressively flatten and break vegetation stems, reducing dissipation, the marsh substrate remains stable and resistant to surface erosion, creating a sustainable defence[92]. Even a small width of fronting saltmarsh can significantly reduce the height of sea walls required to achieve the same level of protection and thus initial construction costs (Table 3.5). It will also significantly reduce maintenance costs due to the reduced exposure to wave and tidal energy.

3.4.2.1. Technical considerations

Where is restoration of saltmarsh appropriate?

Saltmarsh and mudflats are generally located together; with mudflats fronting saltmarsh. To form these habitats, fine grained sediments (silts and clays) need to settle out of the water column, which will only occur at very low water speeds (less than 0.0002cm/s^{-1}). As such saltmarsh will generally only form in areas with a wind fetch distance of less than 2,000m[93]. Therefore, saltmarsh is usually found in estuaries or sheltered areas such as bays or at the head of sea lochs. The overall shape of the estuary or bay determines the location and extent of saltmarsh versus mudflat. The four elements to allow colonisation of a mudflat and growth of saltmarsh are[94]:

- relatively stable (slowly accreting) area of sediment exposed to the air for more time than it is inundated by the tide;
- suitable suspended sediments present in the water during the inundation period;
- sufficiently low water speeds to allow some of this sediment to settle out; and
- a supply of appropriate seeds or propagules to establish vegetation cover.

For initial colonisation of mudflat, it is important that pioneer species seeds are present. It has been shown that there should be sufficient suspended sediment in the water to allow an accretion rate of 3-10mm per year, but an accretion rate greater than 150mm per year can smother new vegetation[93]. Development of mature saltmarsh typically takes between 40 to 80 years[94]. However, this will not be possible in all locations, particularly where existing protection structures restrict the establishment of higher zones.

It can be difficult to determine if conditions are favourable for the establishment of saltmarsh. In addition to favourable physical processes, the presence of nutrients and/or chemical pollutants can also affect whether saltmarsh can colonise mudflat. Therefore, it is generally better to increase the extent or facilitate the relative stability of existing saltmarsh, rather than attempt to establish this habitat in new areas where it has not been present historically. In Scotland, there are a large number of areas with relatively small areas of saltmarsh (75% of sites have an area of less than 10ha)[94]. Where new structures are being installed as part of port activities or flood or coastal protection schemes, this may create new areas where saltmarsh can be established.

Restoring saltmarsh

The tidal range will largely determine the extent of saltmarsh habitat that can be established. To increase the space available for saltmarsh, mudflat can be extended seawards or a managed realignment approach can be taken, moving existing coastal structures landwards (see Section 3.4.1). To extend mudflat seawards, it may be necessary to undertake trickle or rainbow charging (see Section 3.4.5). Mudflats, because they are cohesive and composed of fine sediments, take longer to dewater, consolidate and develop an infauna of microorganisms. Therefore recharged sediment will need some protection from the waves and tides to allow it to settle[95].

Sediment can be placed at various levels in the morphological profile:

- a thin layer of sediment can be sprayed over existing habitat to increase existing intertidal elevation; or
- sediment can be placed in the intertidal zone to artificially increase the intertidal area; or
- sediment can be placed in the sub-tidal zone to reduce erosion from intertidal margins.

To encourage sediment to settle and saltmarsh to establish the following techniques can be used:

- **Brushwood fascines/groynes:** Small wooden posts erected in parallel rows and in-filled with brushwood to create a small fence. Other materials can be used but brushwood has been found to be the most durable. The best orientation is generally at right angles to the foreshore[96].

Table 3.5. The value of fronting saltmarsh in reducing the cost of seawall construction (adapted from Nottage and Robertson[87]).

Width of saltmarsh fronting seawall	Height of seawall required	Cost (£ c. 1994) per metre of seawall
0	12	5,000
6	6	1,500
30	5	800
60	4	500
80	3	400

- **Polders:** Brushwood fences or fascines are erected that enclose a width of mature marsh with a similar sized seaward extent of mudflat. Ditches are dug to collect deposited sediment, which is then piled onto banks between the ditches[96].

Saltmarsh can be left to naturally colonise the mudflats. However, unless there are good natural sources of local seeds, planting or sowing will be needed (Figure 3.14). Planting has generally been shown to be more effective than sowing[94]. Other key influences to saltmarsh successfully establishing are outlined in Table 3.6.

Table 3.6. Influences on the successful establishment of saltmarsh.

Negative Influences	Positive Influences
• Trampling	• Cutting or grazing of vegetation to encourage growth
• Invasive species	
• Unsuitable soils e.g. non-saline arable soils (if managed realignment)	
• Waves generated by ferry or boat wash	
• Pollution or disease	

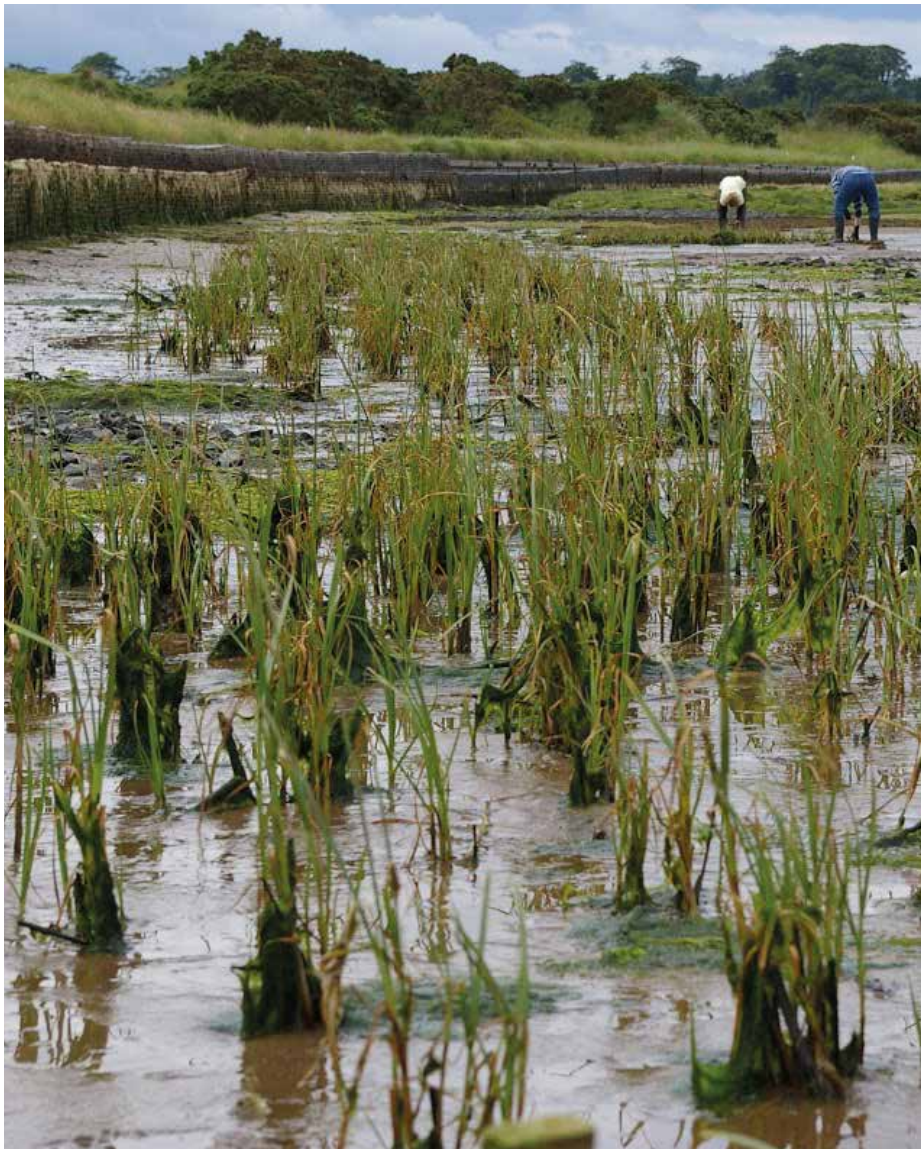

Figure 3.14. Saltmarsh restoration on the Eden estuary, Fife: This project was undertaken to help protect the coastline from erosion and benefit wildlife (© C. Maynard).

3.4.2.2. Cost

The majority of the costs associated with establishing saltmarsh will be the associated costs of recharge (Section 3.4.5) or managed realignment (Section 3.4.1) required. If polders are used, the costs of establishing and maintaining these can also be significant. A number of options are available in the Scottish Rural Development Programme to assist with the restoration of intertidal habitats.

Further reading and guidance

ADNITT, C., BREW, D., COTTLE, R., HARDWICK, M., JOHN, S., LEGGETT, D., MCNULTY, S., MEAKINS, N., and STANILAND, R. (2007). Saltmarsh management manual: R and D Technical Report SC030220. Bristol: Environment Agency.

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