Creating species-rich reedfen

Introduction

Over the past five years, the Lower Ure Conservation Trust has trialled the creation of several different types of fen habitat at Nosterfield Quarry, a working sand and gravel quarry in the North Yorkshire lowlands near Ripon. Our trial site, Flasks Fen, comprises a gently sloping beach of silt: fine mineral sediment pumped back after sand and gravel are extracted below water level. Water conditions are moderately eutrophic (nutrient-rich) and alkaline, with a pH between 7 and 8. Trials have had to take account of grazing pressure from Greylag Geese, Rabbits (which are present in large numbers) and, to a lesser extent, deer. Wave wash, strongly fluctuating water levels, sediment deposition and invasive New Zealand Pygmyweed *Crassula helmsii* present ongoing challenges.

This report summarises our current knowledge of establishing species-rich reedfen based on the results of planting trials between 2018 and 2023. Every site will present different challenges and opportunities, so not all our findings will apply to other wetland creation projects.

Our fen creation trials have been based on planting key species because observations from a number of mineral extraction sites indicated that natural colonisation either didn't occur or was sparse and slow. This is probably because some keystone plants are poor colonists, especially on isolated sites set in a predominantly arable landscape. In other locations, initial protection from grazing to allow natural regeneration of fen vegetation might be more successful.

All our work focuses on re-creating habitats which are authentic to the local landscape because this is likely to be the most effective way to establish 'stepping stones' reconnecting the few remaining pockets of semi-natural wetland in the surrounding countryside. To this end, we've researched the environmental archaeology and landscape history of our wider project area (the lower Swale and Ure valleys), delved into a rich archive of botanical records and surveyed remaining habitats. Plants are grown in our volunteer-run nursery from seeds and cuttings obtained from local wetlands, so that we maintain local genetic characteristics.

What is species-rich reedfen?

This habitat comprises mixtures of wetland vegetation, with a varied structure incorporating low-growing plants, tussocks and understorey beneath an open canopy of Common Reed *Phragmites australis* or similar plants. By contrast, reedbeds tend to be overwhelmingly dominated by Common Reed and have a much more uniform structure.

Two plant communities representing species-rich reedfen are described in the National Vegetation Classification (NVC). Common Reed – Milk Parsley tall-herb fen is coded S24 in the NVC and most data on this community comes from its strongholds in East Anglia. However, analogous vegetation occurs in scattered locations elsewhere in the English lowlands and it was almost certainly more widespread in the past. The handful of Yorkshire sites are characterised by open or patchy *Phragmites* with tall forbs such as Purple Loosestrife *Lythrum salicaria*, Yellow Loosestrife *Lysimachia vulgaris*, Water Mint *Mentha aquatica* and Skullcap

Scutellaria galericulata, sometimes with an understorey of Purple Small-reed *Calamagrostis canescens*. The best examples also feature Great Fen Sedge *Cladium mariscus*, Tufted Sedge *Carex elata*, Blunt-flowered Rush *Juncus subnodulosus* and Great Water Dock *Rumex hydrolapathum*. In East Anglia, this community is associated with winter-flooded fens which dry out in summer but where the water level remains close below the surface.

Common Reed – Hemp Agrimony tall-herb fen (NVC S25) is more widely, if very locally, distributed. It can occur as linear stands along ditches or beside watercourses, or as a component of more extensive floodplain habitats. Water levels are normally below the surface, at least in summer, although hydrological parameters are poorly known. An abundance of Hemp Agrimony *Eupatoria cannabinum* with varying amounts of Common Reed is characteristic of this community but there are usually other tall-herbs such as Wild Angelica *Angelica sylvestris*, Valerian *Valeriana officinalis* and Yellow Flag *Iris pseudacorus*.

Species-rich reedfens do not necessarily conform closely to the NVC communities S24/S25 and can occur in varying habitats including shallow or seasonally exposed lake margins, mineral extraction sites and floodplains. This habitat can also intergrade with swamps where single species are more dominant: at Flasks Fen, species-rich reedfen has been planted in mosaics with NVC S1 Tufted Sedge swamp, S2 Great Fen Sedge swamp, S4 *Phragmites* reedbed and S9 Bottle Sedge *Carex rostrata* swamp.

In addition to their floristic interest, species-rich reedfens may be used by mammals such as Otter, Water Vole and Water Shrew and by birds including herons, crakes, nesting waterfowl and wetland songbirds. Long-established examples are often exceptionally rich invertebrate habitats. Our own examples support a range of wetland moths while breeding birds include Moorhen, Reed Bunting and Sedge Warbler; Cetti's Warbler is regular in winter.

Photo 1: Northern version of species-rich reedfen near Doncaster, with Great Water Dock, Blunt-flowered Rush, Greater Pond-sedge; Great Fen-sedge, Purple Small-reed, Tufted Sedge, Skullcap & Purple Loosestrife occur in surrounding vegetation.

Figure 1: Illustration of species-rich reedfen showing the complex vegetation structure, with bryophytes in field layer, short herbs, tussocks, mid-height layer and tall 'reeds'. Drawing by Jon Graham.

Planting trials

Our initial trial plots comprised enclosures (to protect against grazing animals) made of mesh panels supported by road pins and secured with re-useable cable ties: although materials are initially expensive, they can be reused and fencing can be erected and moved quickly by volunteers. Some fencing has since been removed but off-shore and on-shore barriers are currently maintained to deter geese. In time, grazing animals will become part of the dynamic management of Flasks Fen.

Initially, hazard tape was strung across the tops of enclosures in a zig-zag pattern to deter geese from flying in. The benefits of this are unclear.

Planting grids were designed to form a mixed structure of tall, lower and tussock-forming species, planted as 1 litre pots or large plugs at 50 cm spacings. Account was taken of water level preferences, with 'wetter' species concentrated lower down the transect and vice-versa for those less tolerant of prolonged inundation. This basic design has worked well. Planting is much easier on exposed sediment than beneath the water, so control over water levels is useful.

Our plots are elongated rectangles, extending from about 50 cm deep water to exposed shore in summer. Summer water levels from around 30 cm deep to 10 cm below the surface seem most favourable to the development of species-rich reedfen: some species such as Purple Small-reed prefer situations where shallow flooding is limited to the winter months while others such as tussock-forming sedges grow best where shallow water stands well into spring.

In summary, favourable sites are likely to have ankle-deep to welly-deep water in winter and spring with wetter zones remaining shallow-flooded in summer. Summer-dry zones should have a high enough water table to ensure that the root zone remains permanently wet. On-site observations are important because soil characteristics as well as water supply mechanisms will help identify which areas are hydrologically suitable. Contrary to common misconception, fen habitats are not confined to peat and can develop on mineral soils, as is the case at Flasks Fen.

To date, management has been limited to manually removing willow saplings and small-scale weed-wiping of Greater Reedmace *Typha latifolia*. The latter is a natural and valuable component of most lowland fens but we decided it needed to be controlled during the early stages of development. In the fifth year of our trials (2023), it became increasingly apparent that Common Reed was forming dense stands in the wettest zones, so that species-rich reedfen is becoming replaced by monodominant reedbed in these areas (see below).

We see development of species-rich reedfen as a dynamic process, as different plants adapt (or fail to adapt) to prevailing conditions. Several species disappeared within a year of planting and we have not attempted to replace these. Establishment of a 'self-organising' plant community can be seen as a measure of success.

Results

Our trial plots took on a recognisable structure after two to three years and began to form cohesive habitats, e.g. with wetland birds nesting and key plant species flowering and/or showing vegetative spread. Within five years, a distinctive habitat with a characteristic vegetation structure is well established (Figure 1).

A number of smaller and less competitive plants disappeared early on, as might be expected. Rosette-leaved forbs (broad-leaved plants) and those which disappear below the surface over-winter were generally unsuccessful, probably due to competition from *Crassula helmsii* and the smothering effect of *Crassula* debris[1]. *Crassula* appears to have little effect on taller monocotyledons planted as mature plants. One more recent trial area suffered from inwash of fine sediment from quarrying operations during the winter months. Overall, however, the tall or tussock-forming monocotyledons which form the core structural components of species-rich reedfen have performed well. Survival of individual plants was monitored in one 'wet' (lake-edge) plot for four years[2] with the following results (Figure 2).

Figure 2: Survival of individual plants, 2018-22

Species	*English name*	*No. planted*	*No. Yr 4*	*% survival*
Cladium mariscus	Great Fen Sedge	20	20	100
Caltha palustris	Kingcup	5	5	100
Mentha aquatica	Water Mint	20	19	95
Carex elata	Tufted Sedge	19	18	95
Phragmites australis	Common Reed	14	12	86
Iris pseudacorus	Yellow Flag Iris	7	6	86
Juncus subnodulosus	Blunt-flowered Rush	27	20	74
Calamagrostis canescens	Purple Small-reed	8	4	50
Molinia caerulea	Purple Moor-grass	9	3	33
Succisa pratensis	Devil's-bit Scabious	8	2	25
Valeriana dioica	Marsh Valerian	4	1	25
Filipendula ulmaria	Meadowsweet	19	4	21
Eupatoria cannabinum	Hemp Agrimony	23	0	0
Carex panicea	Carnation Sedge	4	0	0
Thelypteris palustris	Marsh Fern	3	0	0

This demonstrates very high rates of successful establishment by key reedfen plants including Great Fen Sedge, Tufted Sedge and Blunt-flowered Rush. The latter may not persist indefinitely where the reed canopy consolidates but Great Fen Sedge continues to form expanding

[1] Marked changes in water level were likely an additional factor.
[2] Monitoring was discontinued because it was becoming impossible to distinguish original plants from subsequent growth.

flowering stands while large tussocks of Tufted Sedge have developed. Water Mint and Kingcup were successful forbs, though the latter was only planted in small amounts.

Photo 2: Five year old reedfen plot, June 2023

A small plot at the edge of the winter flood zone was planted in 2000 (Photo 3). Winter inundation is very shallow (<10 cm) but the water table remains close to the surface in summer. This plot is more species-rich than the 'wet' transects, with 44 vascular plant species present in 20 square metres in August 2023. Intermediate and low vegetation layers are much better developed than in the wetter plots. The former is represented by Blunt-flowered Rush, Purple Small-reed and Purple Moor-grass; the latter by Carnation Sedge *Carex panicea*, Marsh Valerian *Valeriana dioica* and patchy bryophytes. An interesting though as yet unexplained phenomenon in this plot is the decreasing cover of invasive *Crassula*.

Photo 3: 'Dry' reedfen plot, June 2022

Managing Common Reed

Common Reed is a successful species in all the trial plots but has colonised other enclosures naturally. In Year 5 of the trials, water levels were stablised at a relatively high level during the summer months. This has promoted the growth of Great Fen Sedge and aquatic *Carex* species but in water over 30 cm deep, Common Reed has grown particularly vigorously. As a result, the wetter sections of our trial plots increasingly resemble NVC S4 *Phragmites* reedwamp rather than species-rich reedfen. The literature suggests that *Phragmites* benefits from high, stable water levels and is likely to outcompete other fen species in such conditions but maturation may also be a factor.

With hindsight, it was a mistake to include Common Reed in the initial planting and we would now advise against this. It may be best to treat *Phragmites* as overly invasive during the early years of fen creation, and to weed-wipe or cut naturally colonising plants as we have done with Greater Reedmace.

An outer fringe of dense S4 reedswamp is not an unfavourable outcome and is likely to benefit some species such as Reed Warbler and Bittern as well as buffering wave wash and silt deposition. However, preventing an over-abundance of Common Reed in shallow water and seasonally-exposed plots is now our main management challenge. Traditional advice is to cut Reed in summer then flood over-winter, removing the hollow stems which conduct air to the submerged rhizomes.

Having lowered water levels, we have recently (September 2023) cut broad swathes of Common Reed before raising the level again, with the aim of pushing back the inshore boundary of S4 reedswamp. We are combining this with manual cutting of reed stems below the water line in shallow areas. Results will be monitored over the next few years.

In the medium term, our ambition is to lightly graze Flasks Fen with cattle and/or ponies in late summer and autumn when water levels are low. Since *Phragmites* is relatively palatable, this will hopefully reduce its abundance in more accessible areas.

Key species

Great Fen Sedge

Evidence shows that *Cladium* was an important component of North Yorkshire wetlands from early post-glacial through to late medieval times. We obtained seeds from two remaining sites within our project area and another in the Vale of York.

Great Fen Sedge is one of our best-performing species, flowering and producing vegetative spread within two years of planting. In the long-term it's likely to become a locally-dominant plant, which should be borne in mind when planting. Although robust once established, competition from the taller and faster-growing Common Reed will need managing.

We have planted single-species stands of Great Fen Sedge between our reedfen trial plots to create a mosaic of fen communities. We have produced separate guidelines for this habitat.

In our experience, Great Fen Sedge tolerates a broader range of water levels than the literature suggests, from around 50 cm deep water to summer-dry locations where water remains close below the surface. Young plants need protecting from grazing.

Guidance on growing Great Fen Sedge from seed can be found at:

https://www.luct.org.uk/plant-propagation

Tufted Sedge

This tussock-forming sedge has been described as a 'restoration super-plant'. The large tussocks provide great invertebrate habitat and can be colonised by bryophytes and small herbs; they sequester carbon and nutrients; and they help form specialised micro-habitats such as shaded pools between tussocks.

In our trials, Tufted Sedge has been among the most successful species. It's probably best planted in clusters to create groups of tussocks but spacings of about a metre between plants are needed to allow formation of large tussocks. Tussock formation is favoured by shallow, fluctuating water with summer levels in the range of 0-30 cm, and can be 'headstarted' by growing young plants in alternating deep/shallow water.

If Tufted Sedge is not a locally-native species in your area, other tussock-forming sedges could be considered. Greater Tussock Sedge *Carex paniculata* is widespread in the British lowlands and can form spectacular hummocks. This species can be grown from seed, which germinates best when it's very fresh or after storing in a fridge mixed with a little compost until seeds begin to chit.

Guidance on growing Tufted Sedge from seed can be found at:

https://www.luct.org.uk/plant-propagation

Tufted Sedge has produced abundant self-sown seedlings in one plot where it was planted on recently-exposed silt.

Blunt-flowered Rush

This rush is characteristic of base-rich fens in the southern half of Britain, and can be grown from seed or by splitting rhizomes. It tolerates a range of water depths, from around +30 cm to – 20 cm but is likely to be shaded out eventually by taller plants in wetter situations. Blunt-flowered Rush is often an important understorey species in species-rich reedfen where water levels are below the surface during the growing season.

Purple Small-reed

This is a characteristic grass of drier types of species-rich reedfen, though it struggles where water stands in summer. Although slow to establish, it can become vigorous after a few years and vegetation management will be needed to prevent it smothering smaller herbs. Fresh seed germinates on damp compost, or it can be propagated by splitting rhizomes.

Yellow Flag

A very widespread wetland plant over most of the British lowlands. Like Water Mint, Yellow Flag is likely to be a reliable species on more challenging sites with high nutrient levels and herbivore pressure. It can be grown easily from seed (soaking in water then chilling over winter improves its germination rate) and is one of the few fen species which establishes well from direct sowing onto bare silt.

Great Water Dock

An imposing plant, Great Water Dock is one of the 'tall herbs' characteristic of species-rich reedfen in shallow water or waterside situations. The seeds are eaten by waterfowl. We didn't include this species in our initial trials but it has established well in subsequent plantings. This is a widespread but local wetland plant, mainly in the southern half of Britain. It grows well from seed, usually germinating in spring after an autumn sowing.

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