Improving the science-base: design and evolution of creek networks in restored saltmarshes

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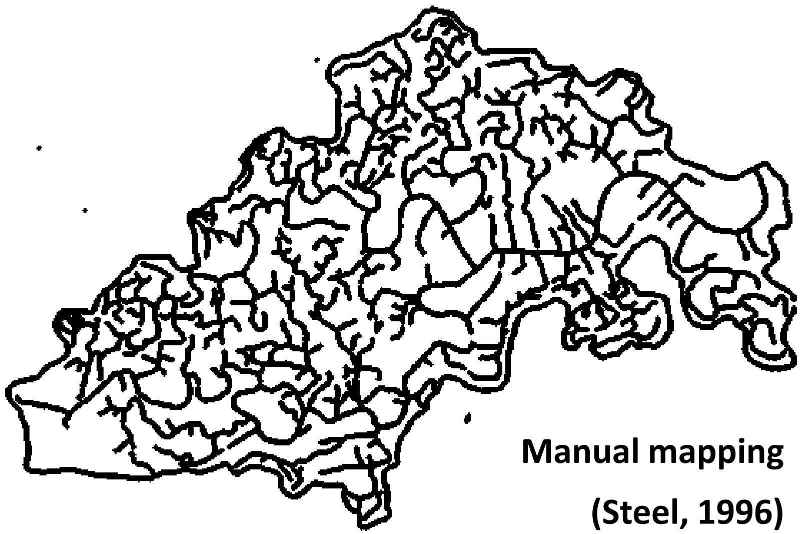
Creek networks

- Are integral to the health of saltmarshes
- Act as an interface between the water and the land: control distribution of sediment, nutrients and seeds

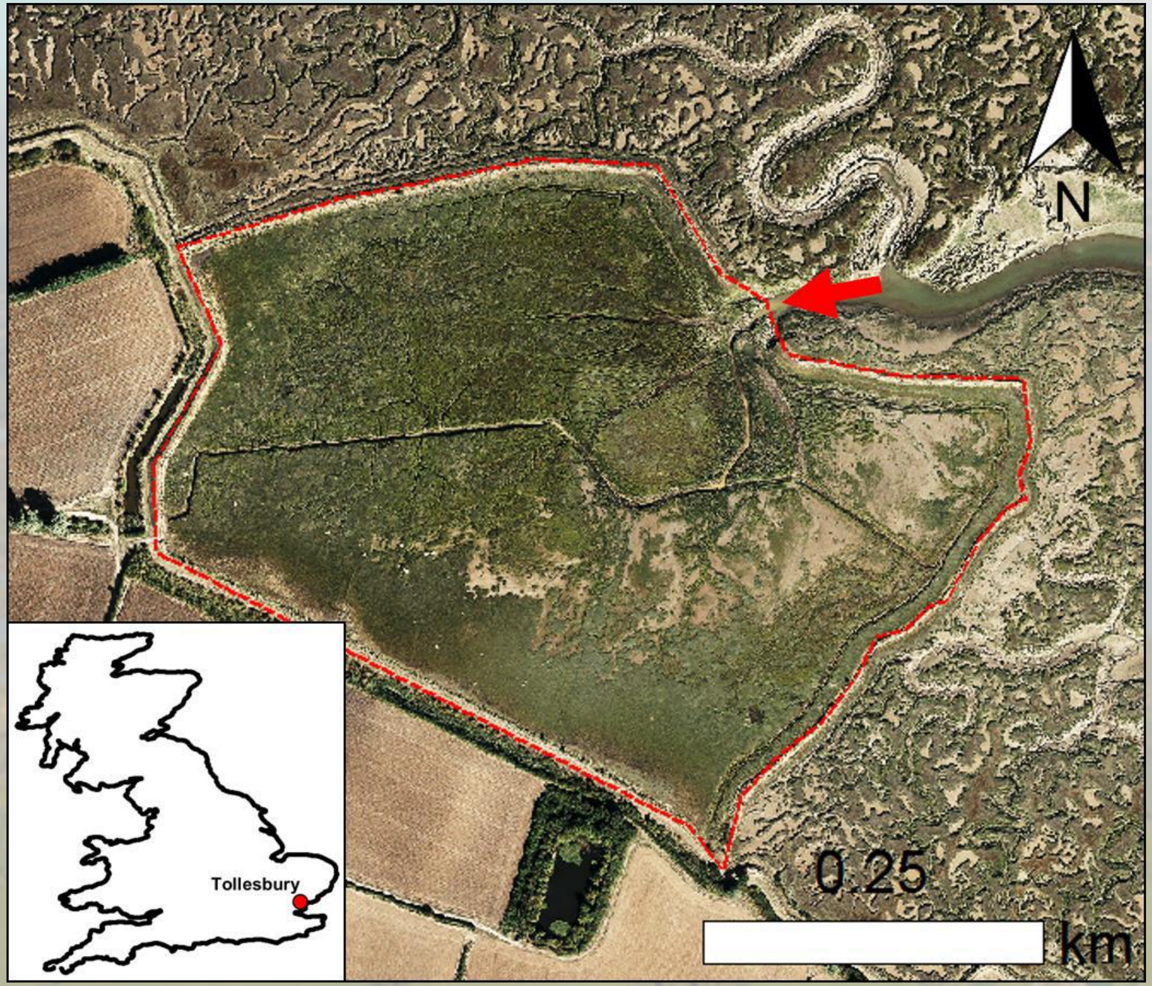


Manual mapping
(Steel, 1996)

- **Assume various complex shapes: difficult and time-consuming to map and monitor**
- **How should they look like in a MR site?**

Restoring saltmarshes

Early sites re-use drainage ditches...

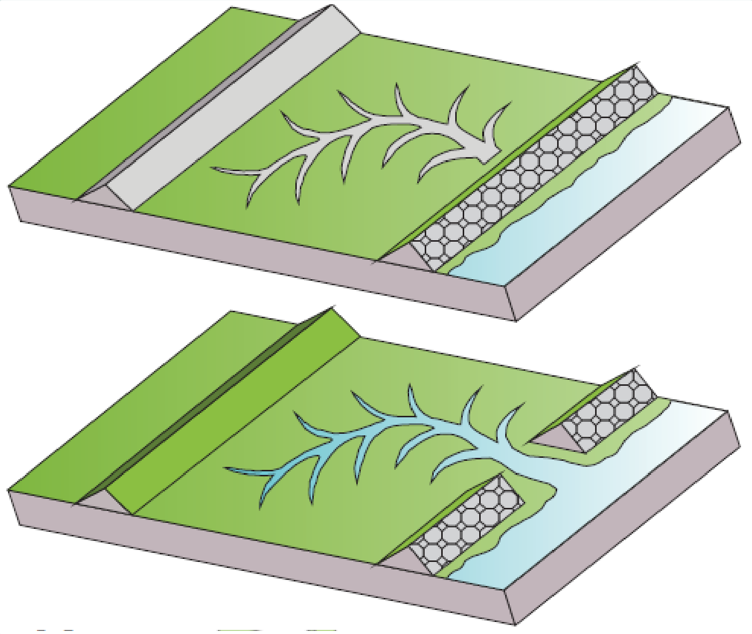


Restoring saltmarshes

In more recent schemes, creek design is becoming more complex in an attempt to encourage natural evolution

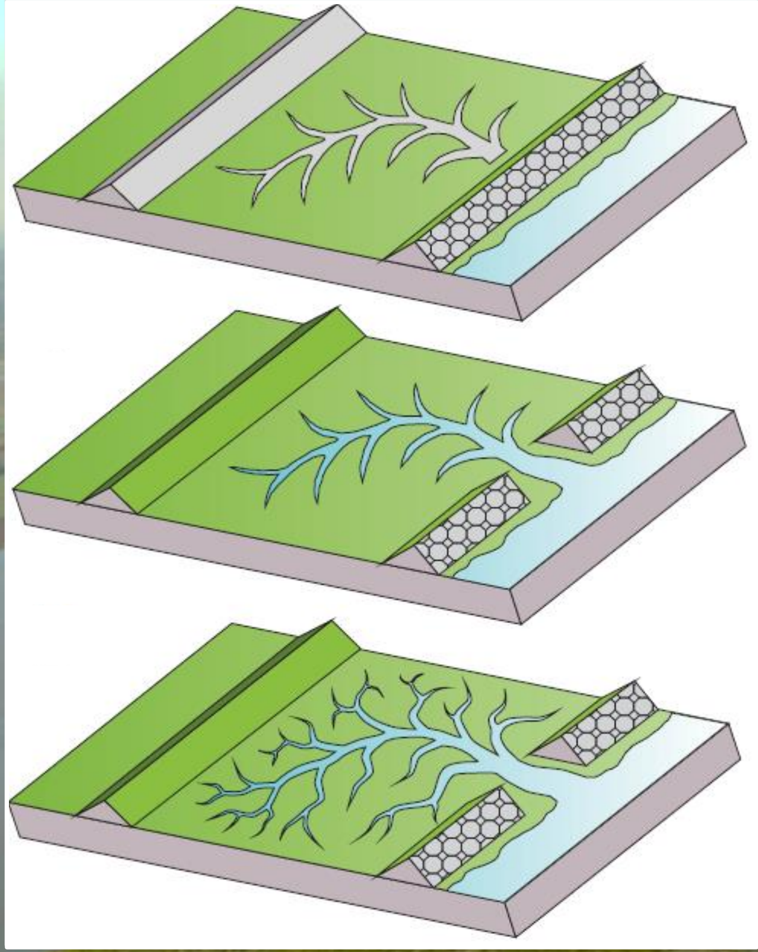

Steart Managed Realignment scheme, September 2014
Photo: Sacha Dent, WWT

Expected evolution toward mature state

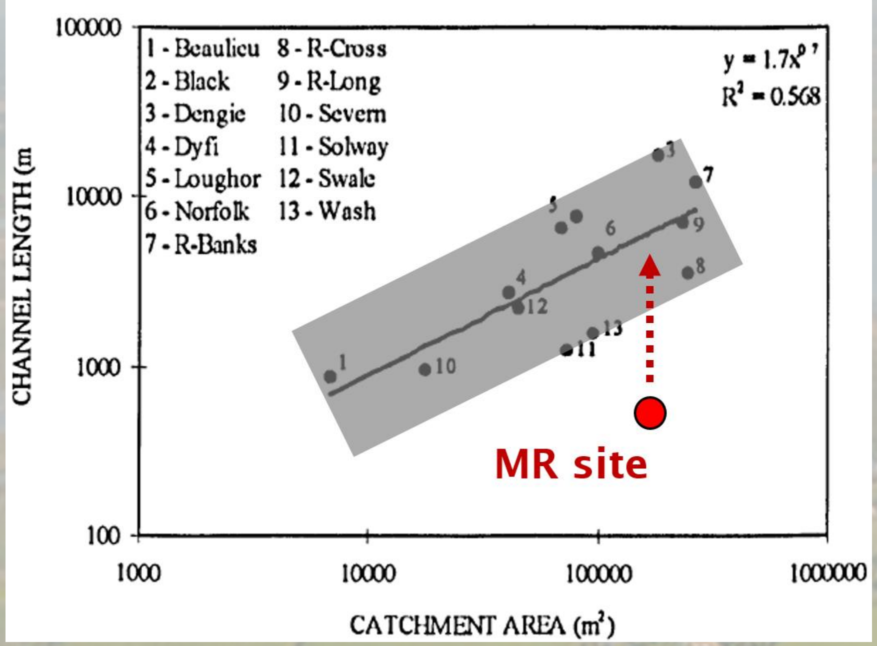


MR sites are generally implemented with a simplified initial creek template

Expected evolution toward mature state



MR sites are generally implemented with a simplified initial creek template



(Modified from Steel & Pye, 1997)

Can they evolve towards a volume, length and distribution similar to natural systems?

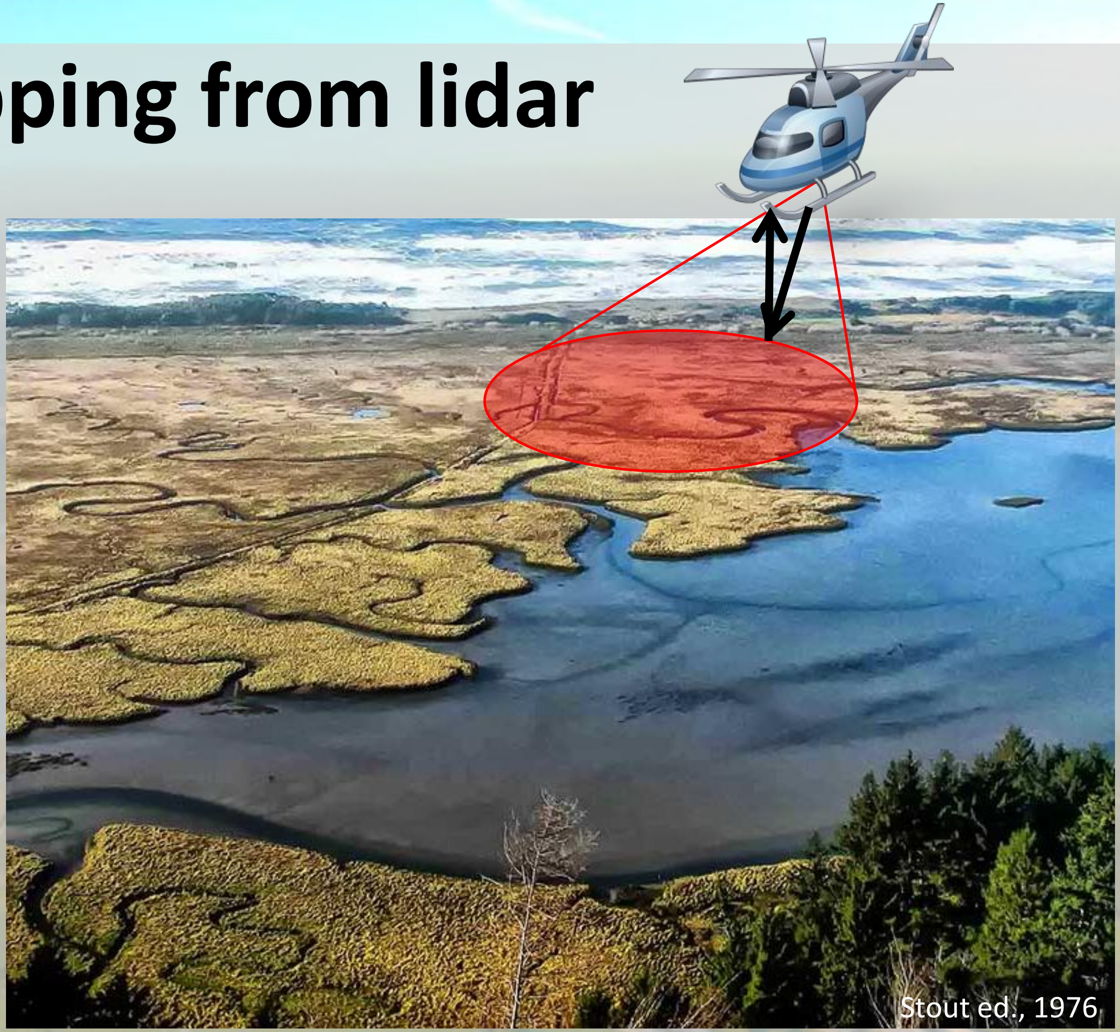
Creek network mapping from lidar

Data type: airborne lidar elevation maps (DSM)

Source: Environment Agency (https://environment.data.gov.uk/)

Resolution: 1m horizontal and 0.15m vertical resolution

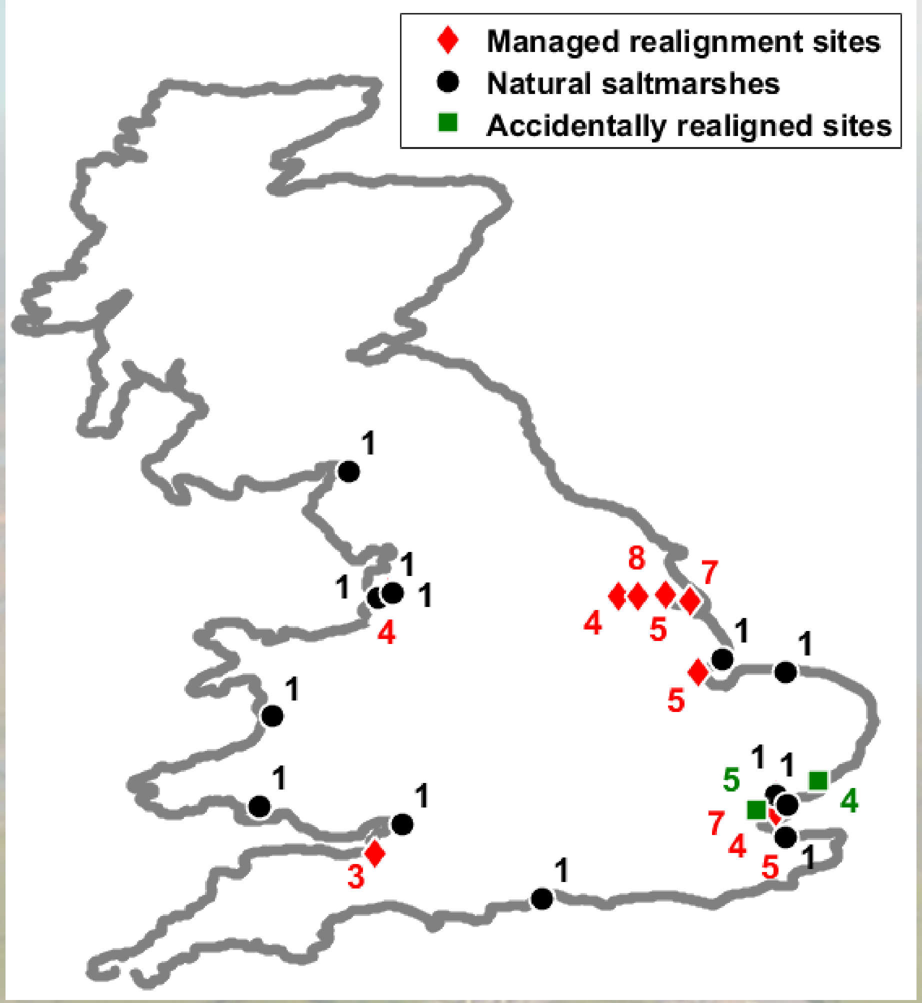
Frequency: every 2-5 years since 2002



Study sites

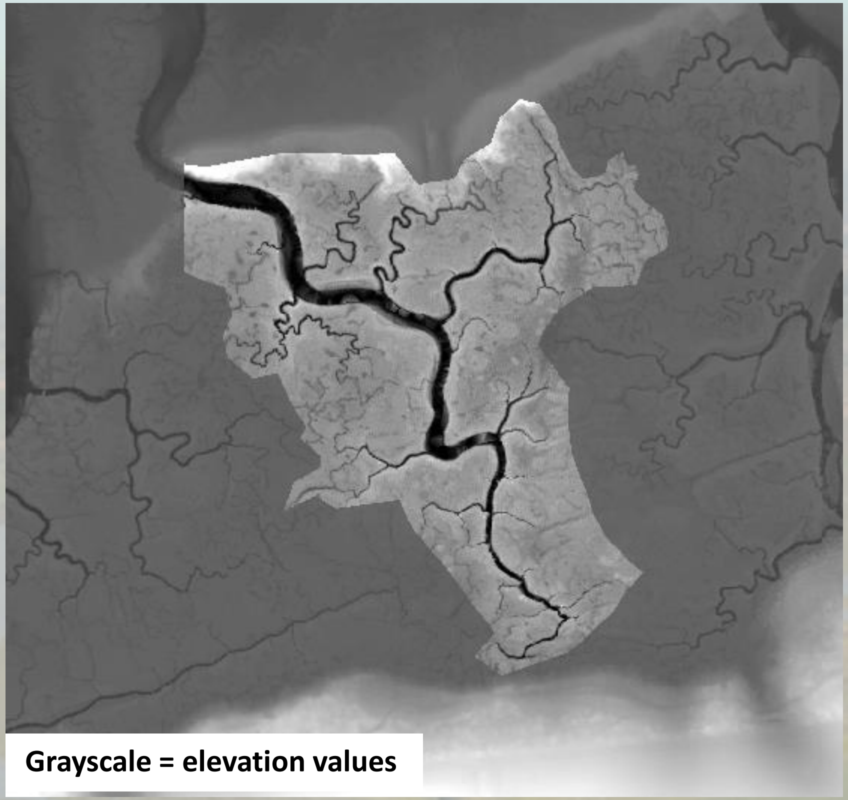
- 10 MR sites implemented between 1995 and 2014
- 13 mature saltmarshes used as reference
- 2 century-old accidentally realigned sites used to predict the long-term MR evolution

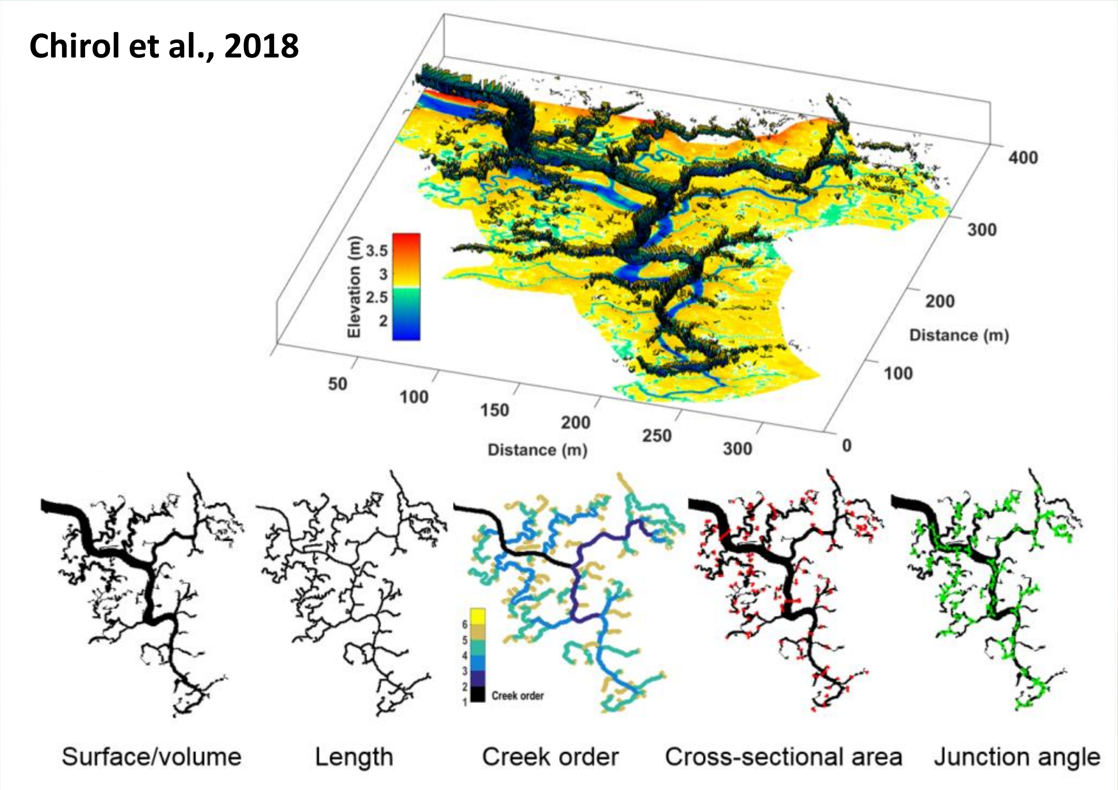
Objective: Explore design choices and subsequent evolution of creek networks in MR schemes



Site location (numbers = number of lidar datasets for each site)

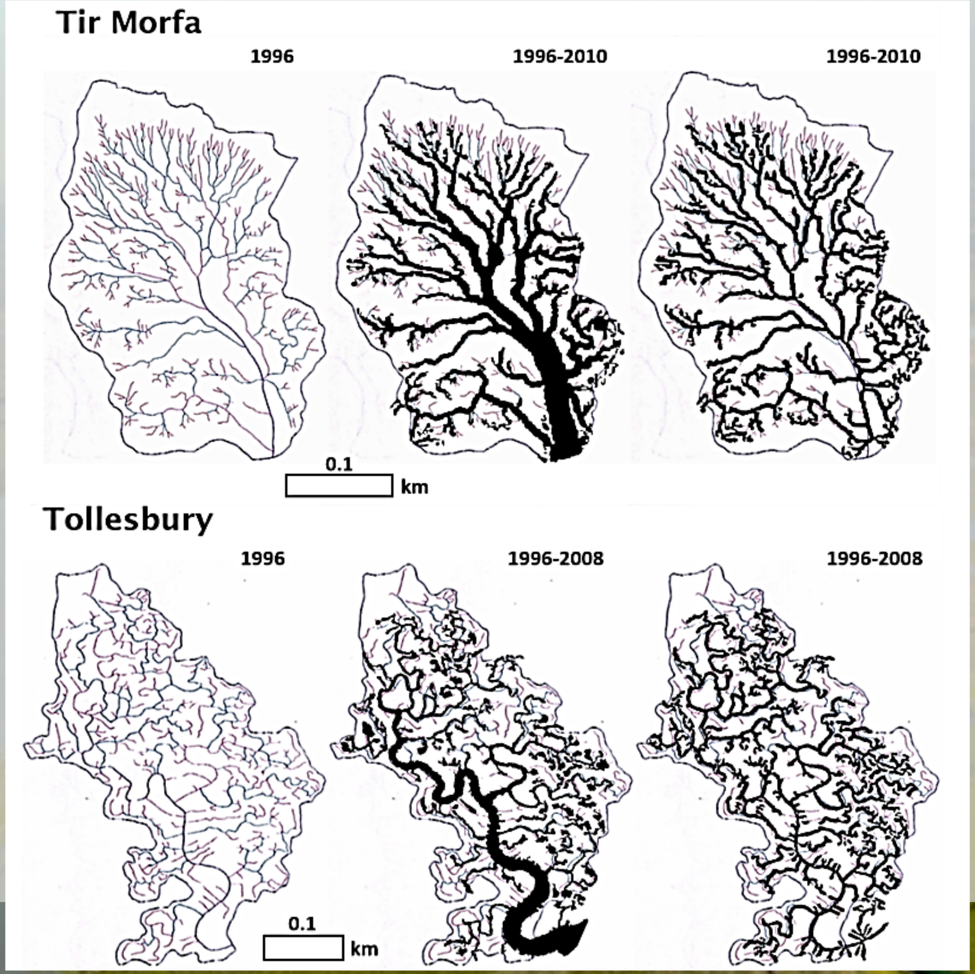
Creek parametrisation algorithm

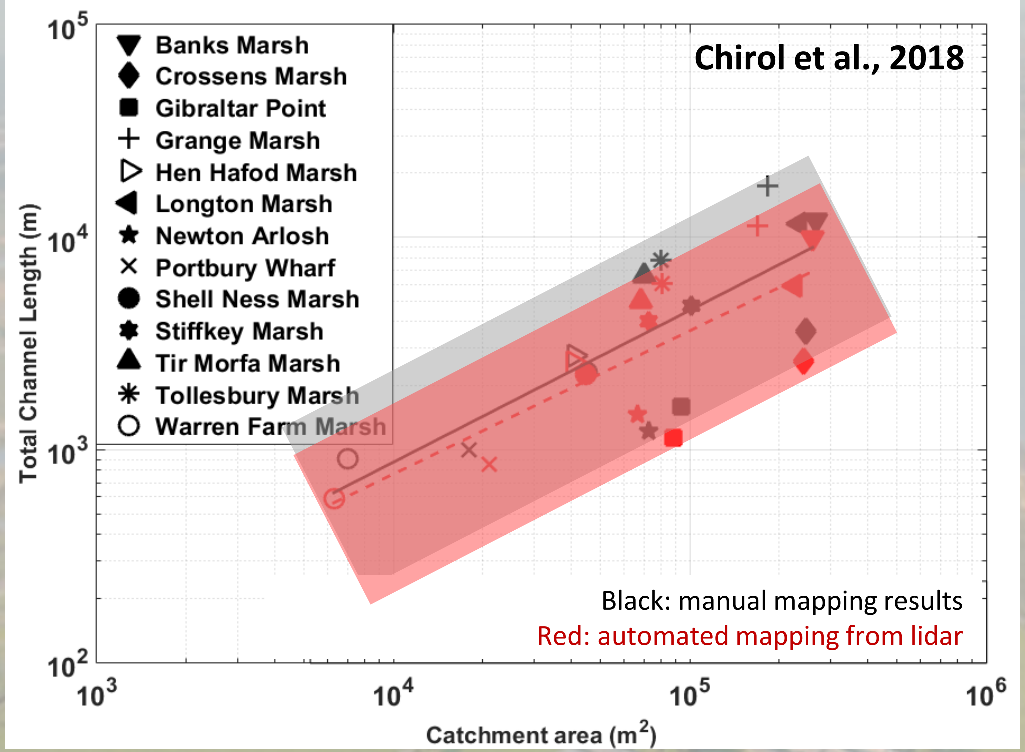




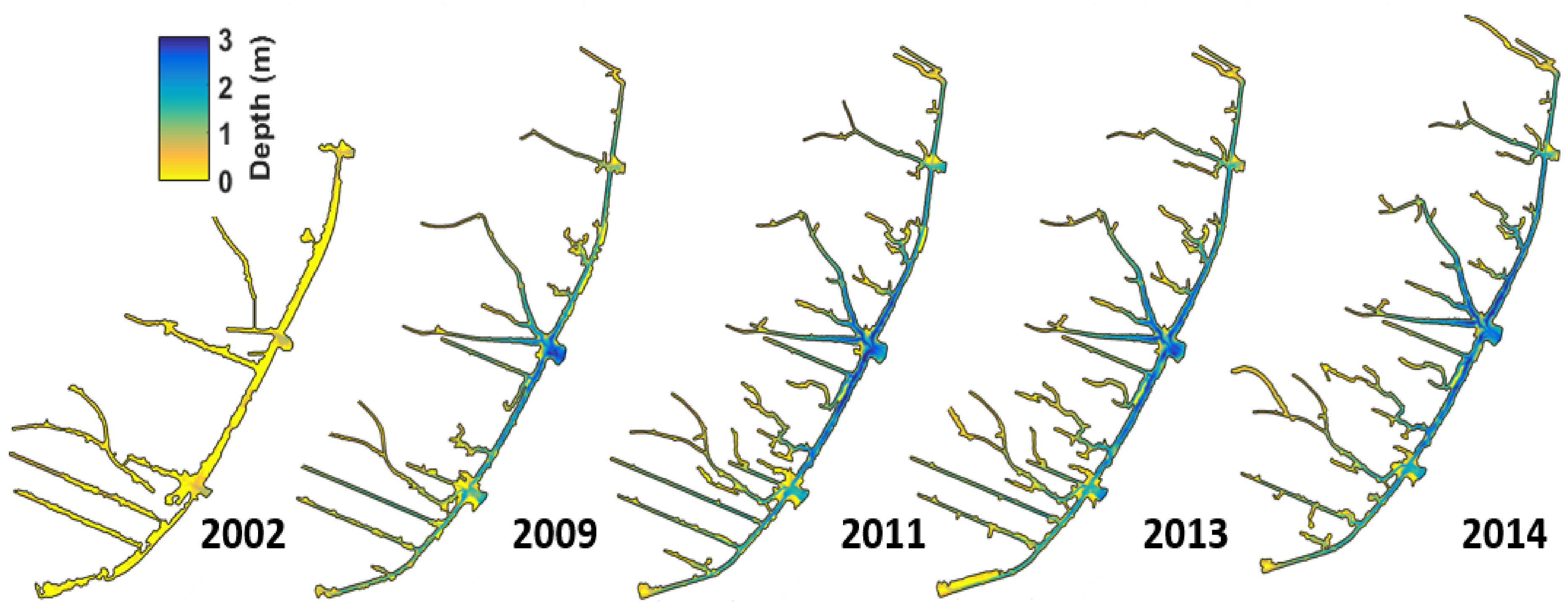
Semi-automated algorithm developed to extract key shape parameters of saltmarsh creeks

Algorithm tested on 13 mature saltmarshes in the UK

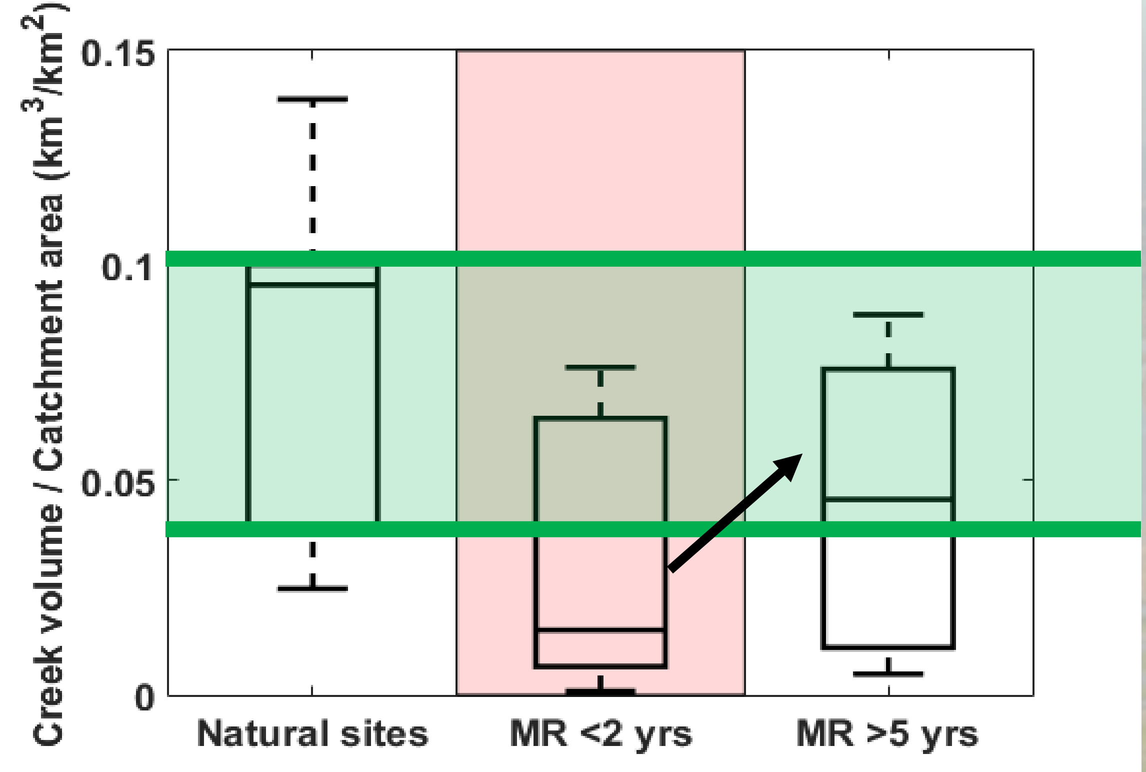




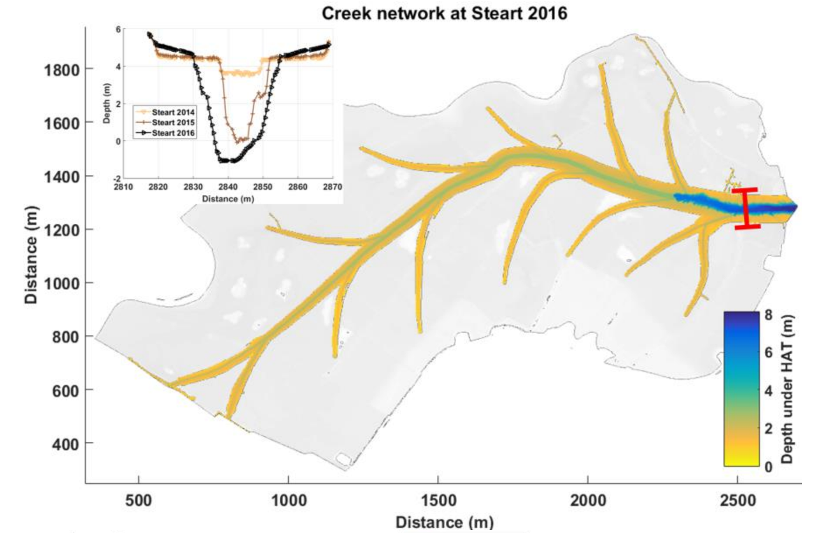
MR creek evolution: volume, length and distribution

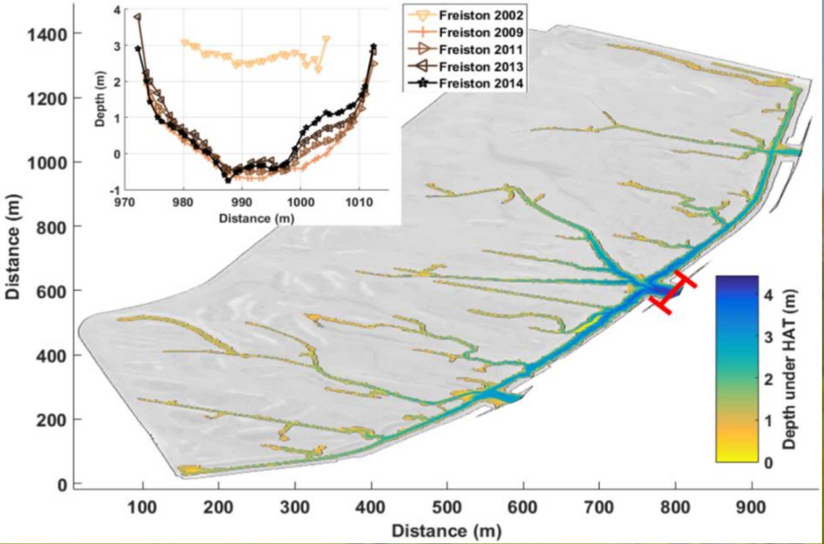


Volume evolution of MR creeks

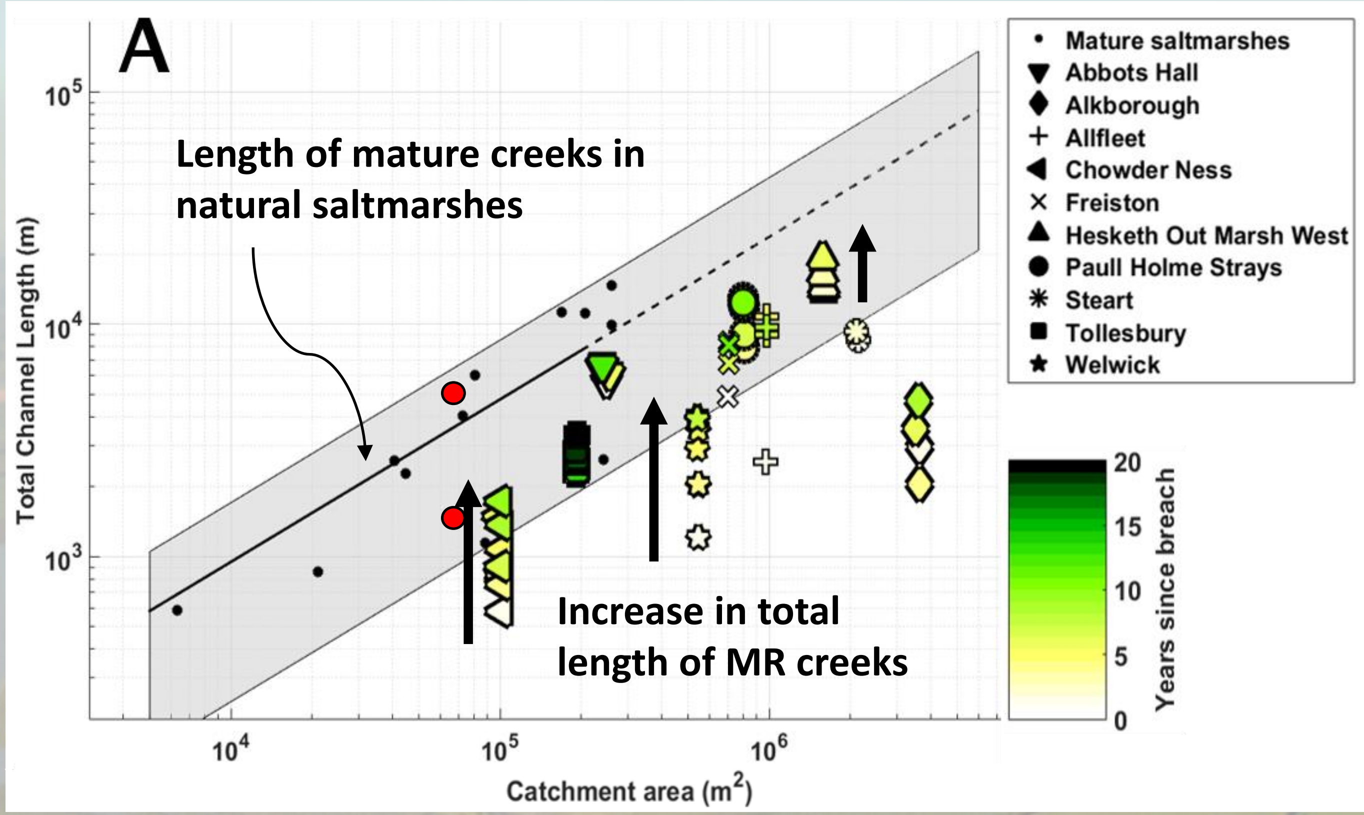


MR creeks deepen to the volume of natural mature creeks: mostly linked to wide, high-energy entry channel



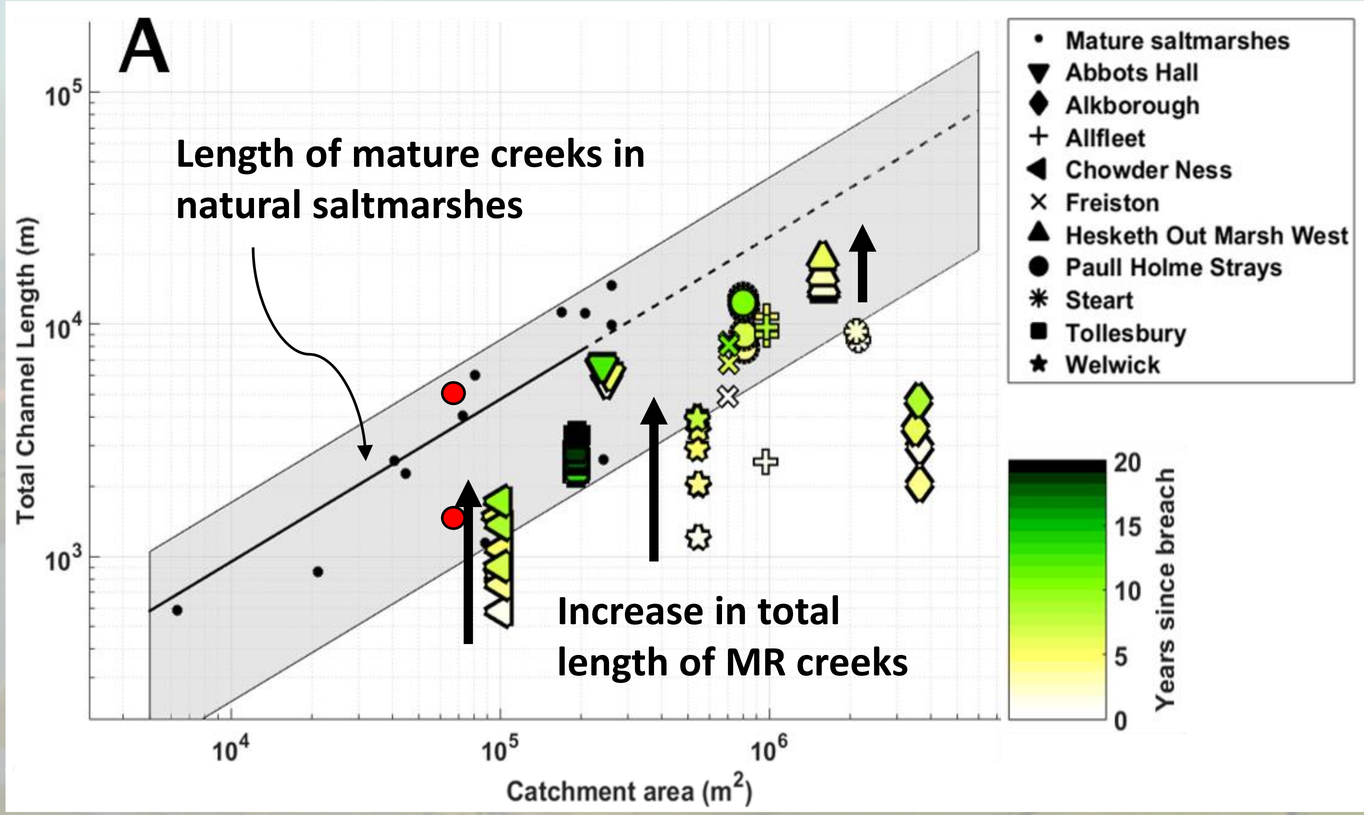


- **Evolution of total creek length**

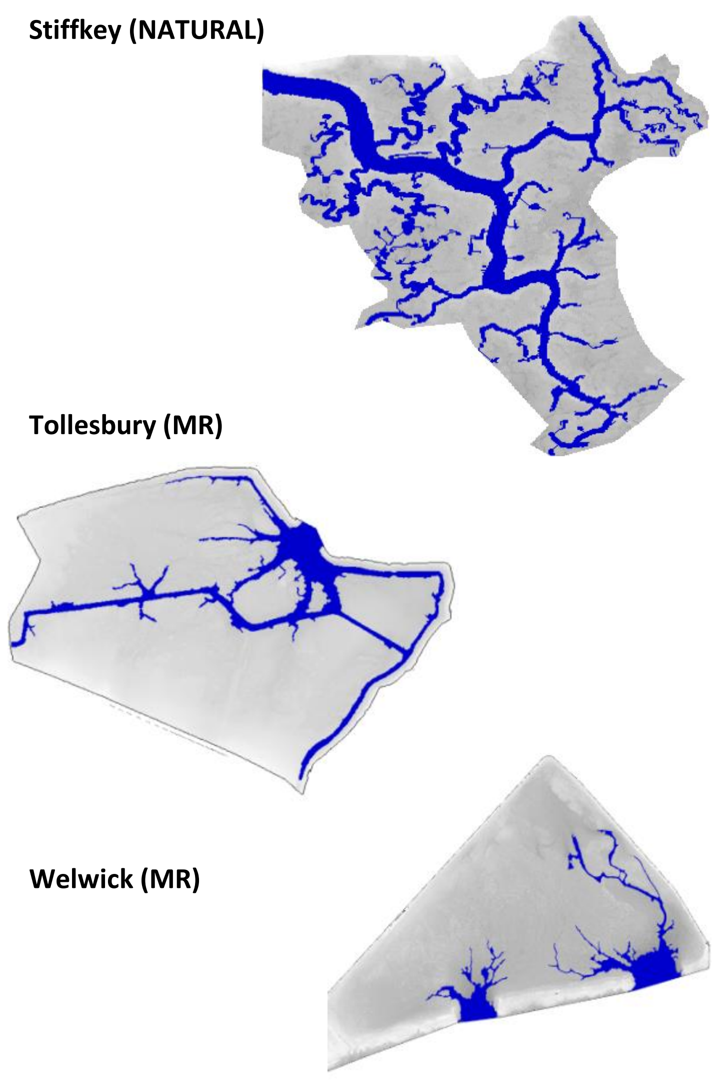


- Increase in total channel length for all sites considered

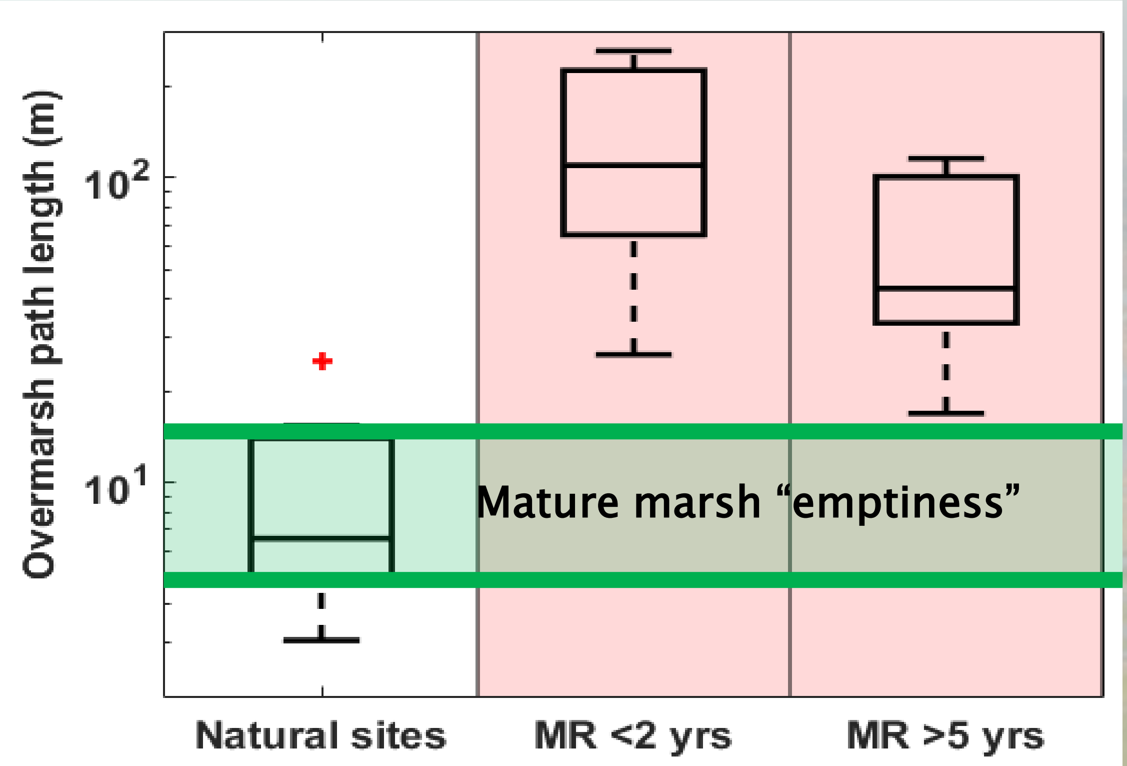
- **Evolution of total creek length**



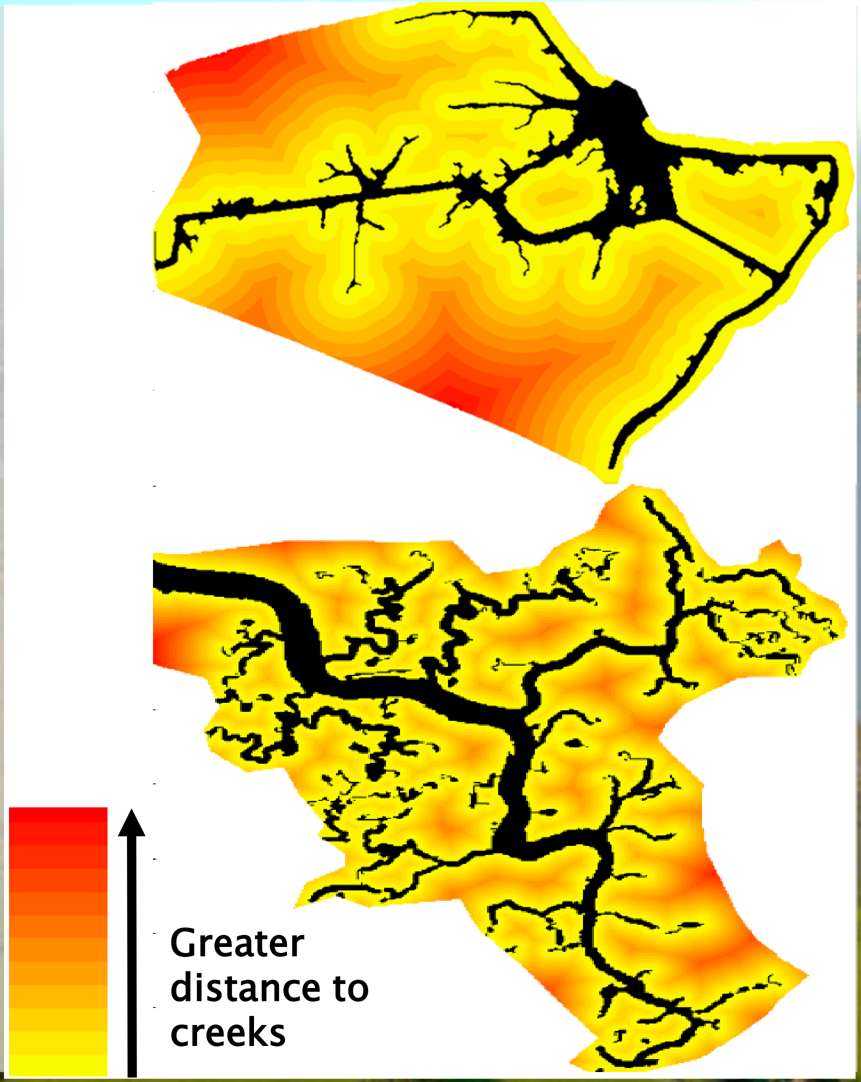
- New creeks tend to form in clusters around the breach area, while furthest parts of site remain empty



- "Emptiness": Mean distance necessary to reach a creek (creek distribution)

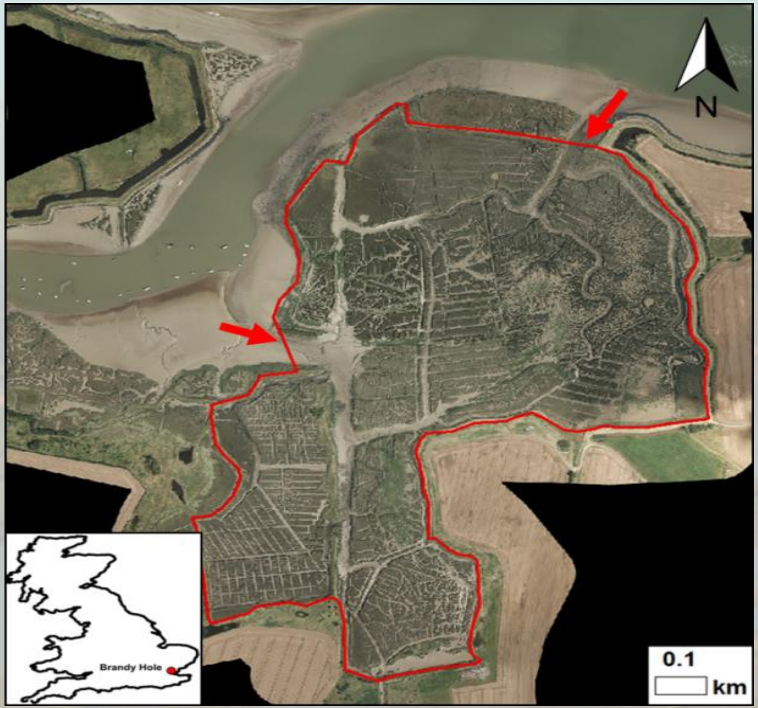


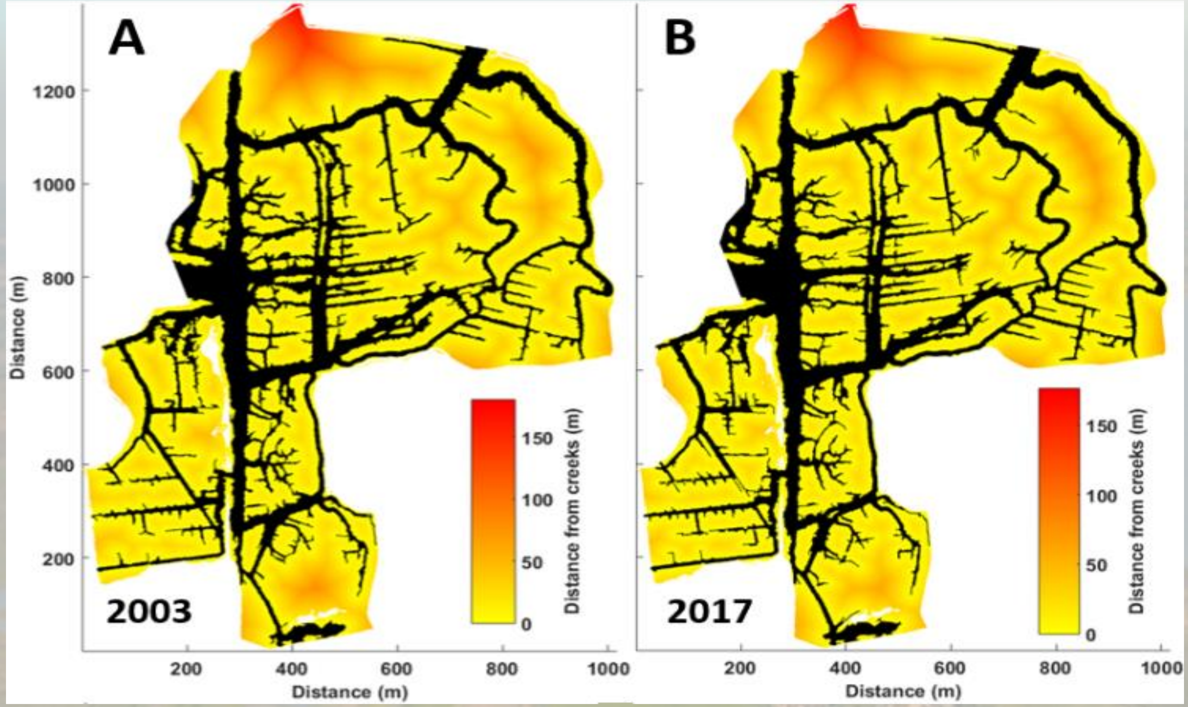
MR creeks remain sparser and straighter than in natural systems



Long-term evolution

Brandy Hole, pasture/arable, storm-breached in 1897

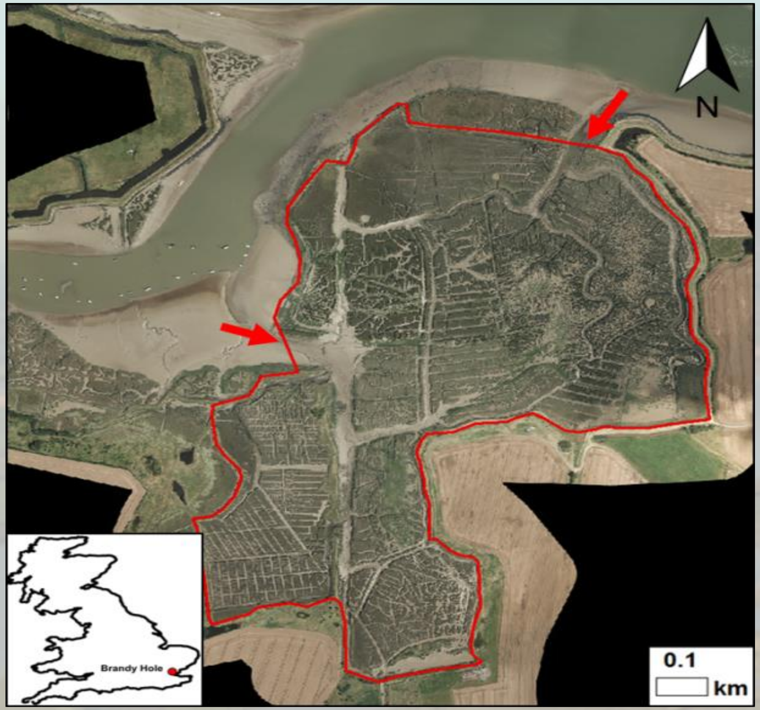


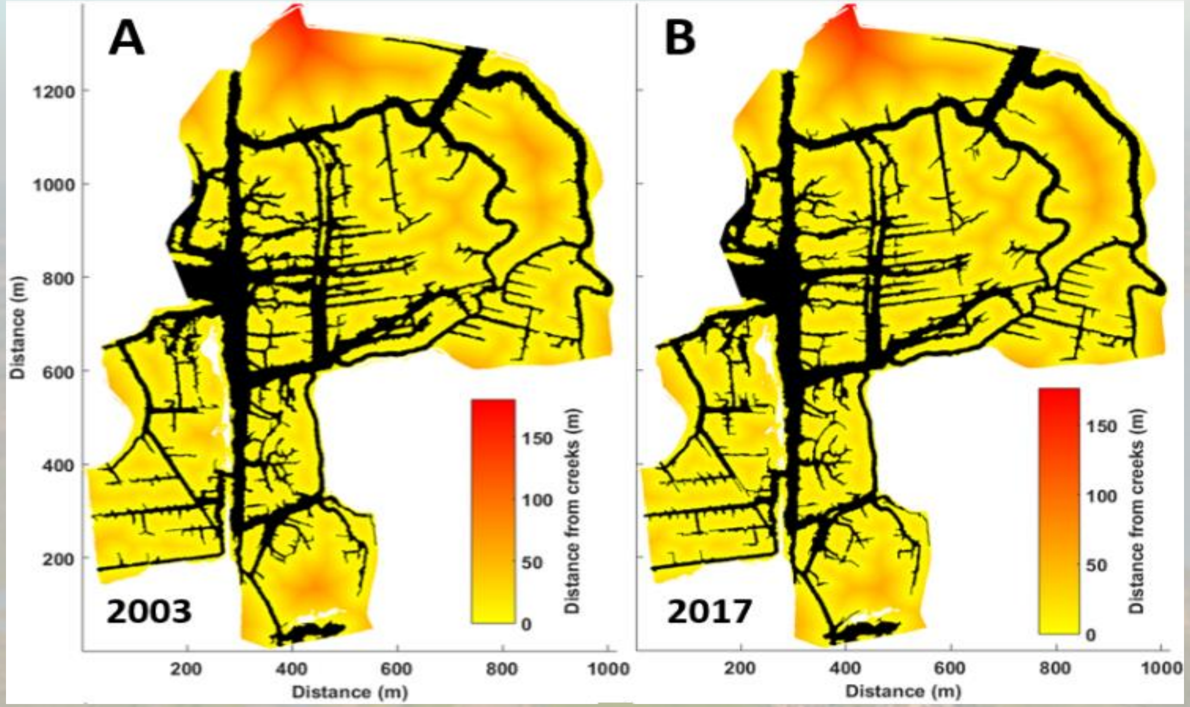


- No change in creek extent between 2003 and 2017: stabilised
- Straight drainage ditches remain clearly visible
- Creeks mainly found in clusters near the breach, leaving some areas empty

Long-term evolution

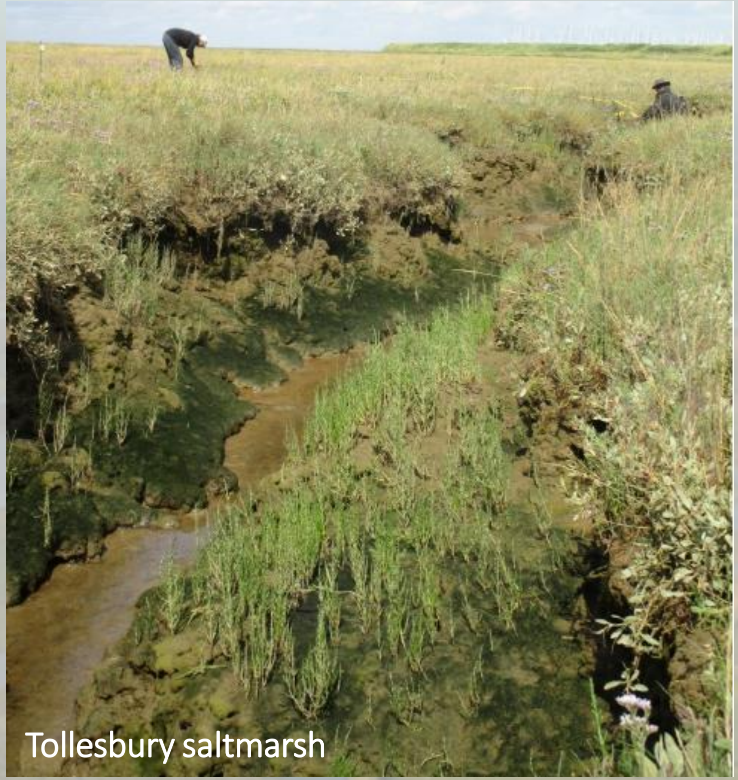
Brandy Hole, pasture/arable, storm-breached in 1897





MR creeks evolve towards a mature state that is very different from that found in natural saltmarshes

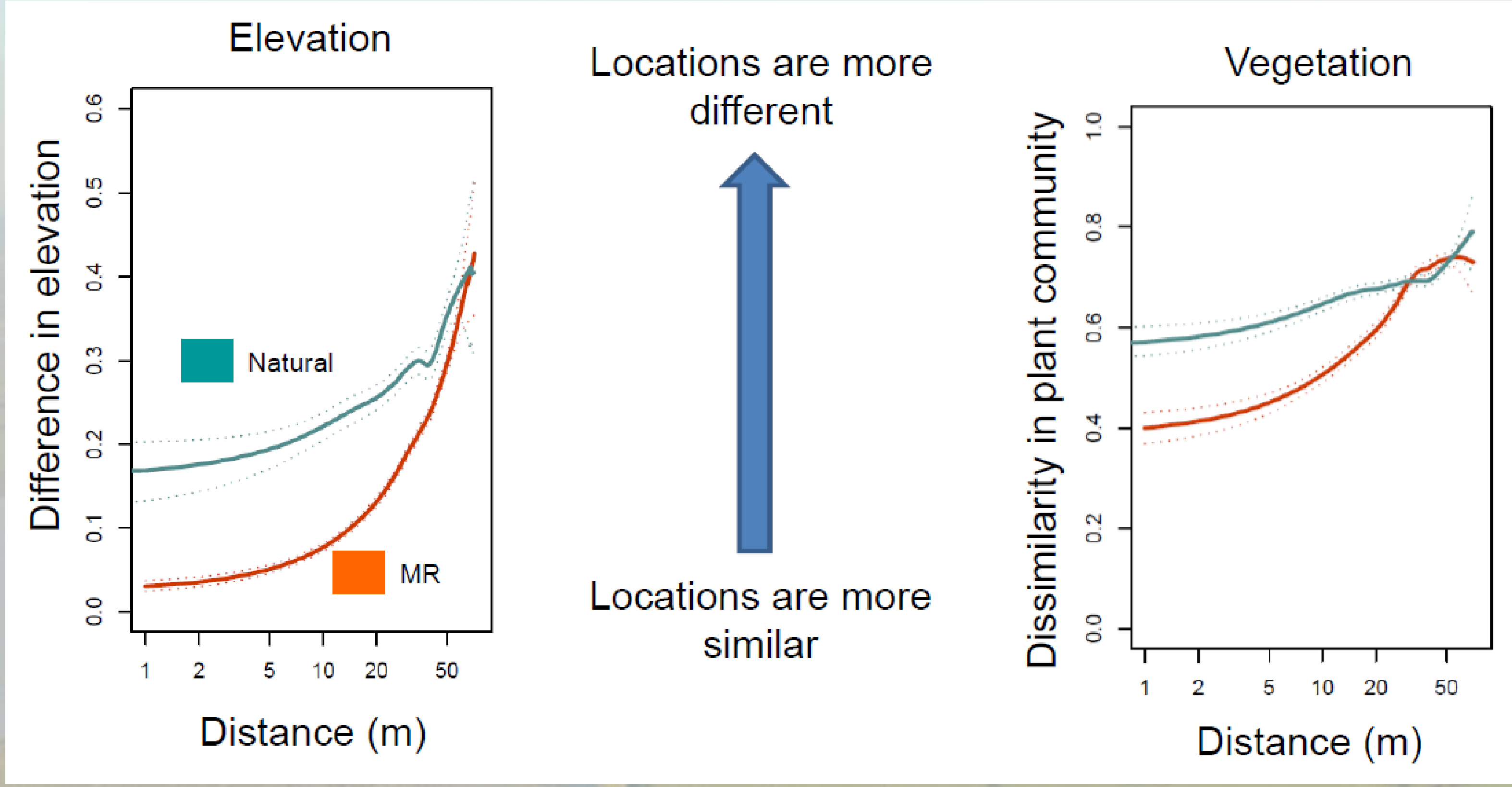
How can we improve future MR schemes?



Natural saltmarsh

MR site

Importance of initial template: MR lack topography



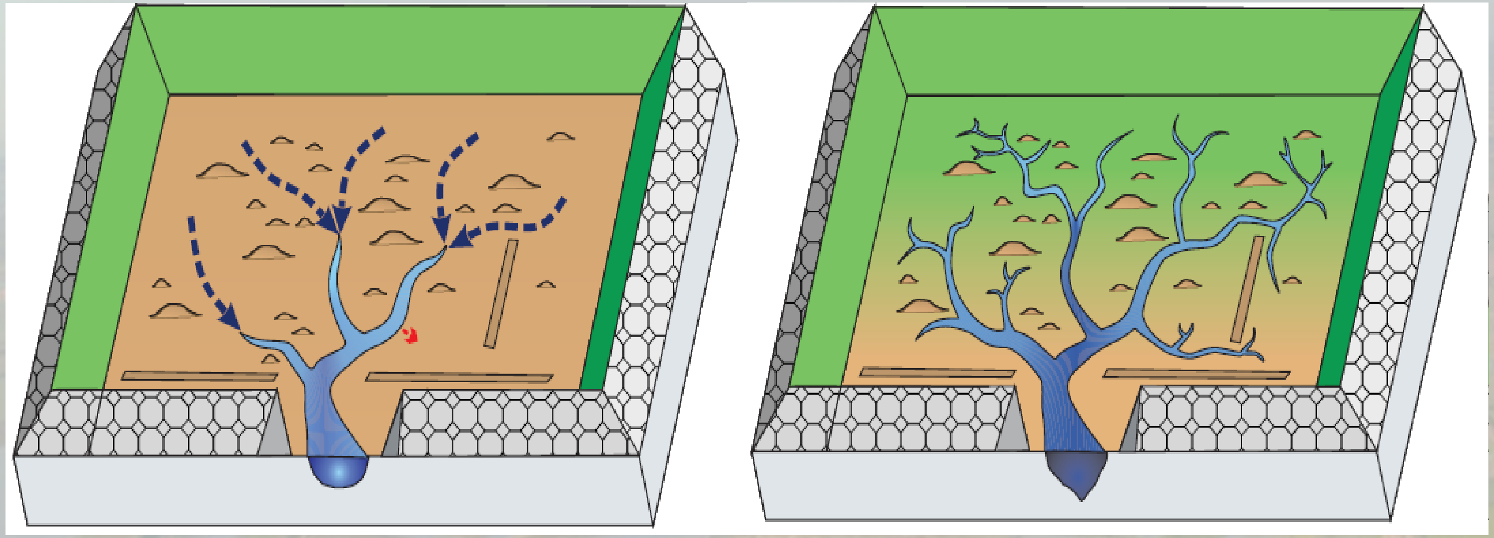
But post-breach manipulation can increase plant diversity

Mossman et al. in press Journal of Ecology; Lawrence et al in prep; Brooks et al (2015) Estuaries & Coasts

Manchester Metropolitan University

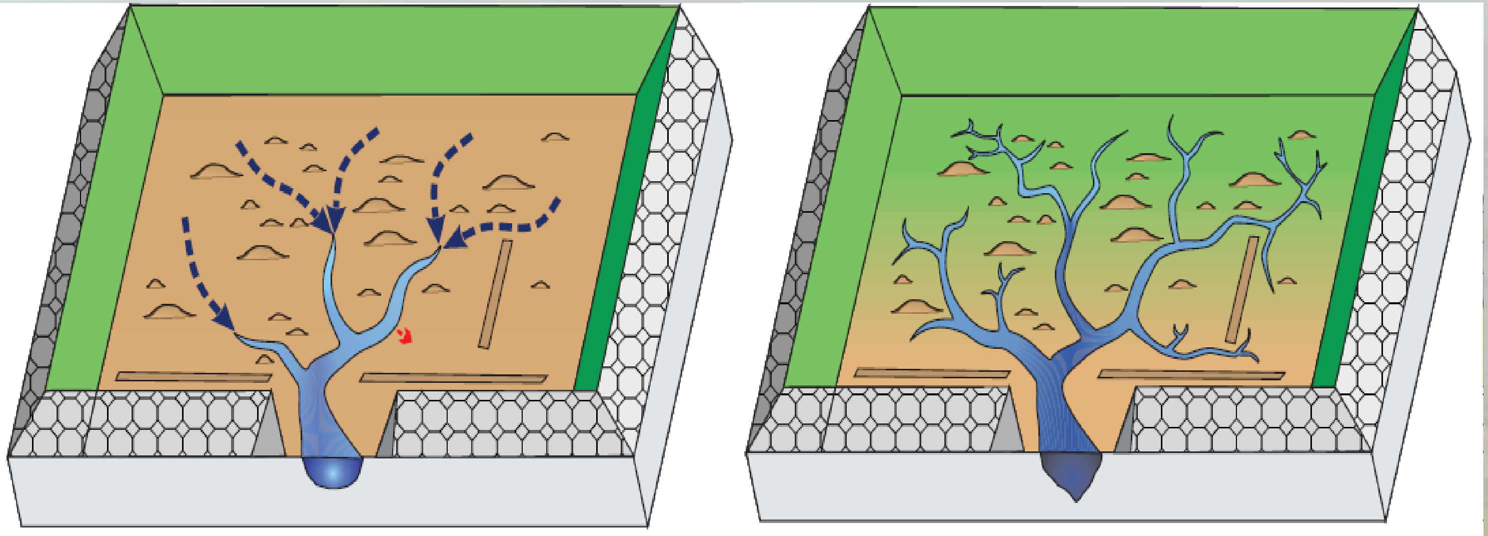
Research conducted by Hannah Mossman, Peter Lawrence. Contact h.mossman@mmu.ac.uk

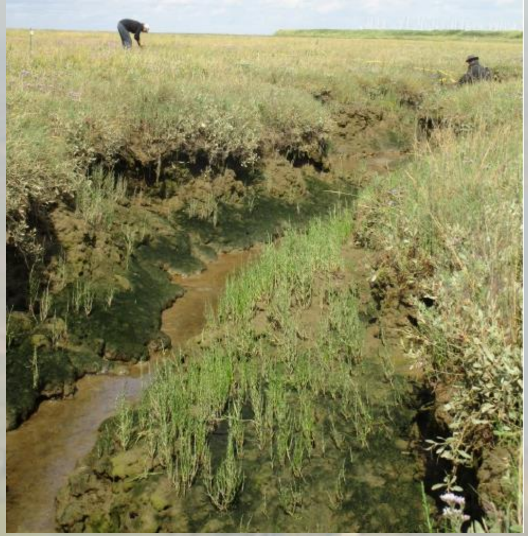
Importance of initial template: MR lack topography



Small-scale topography also focuses run-off into preferential flow paths and promotes creek development into more sinuous, natural-looking shapes…

Importance of initial template: MR lack topography





Small-scale topography also focuses run-off into preferential flow paths and promotes creek development into more sinuous, natural-looking shapes…

…that will also provide niche habitats and increase biodiversity

Belowground influence on creek growth and marsh health

Soil in MR sites altered during the agricultural phase

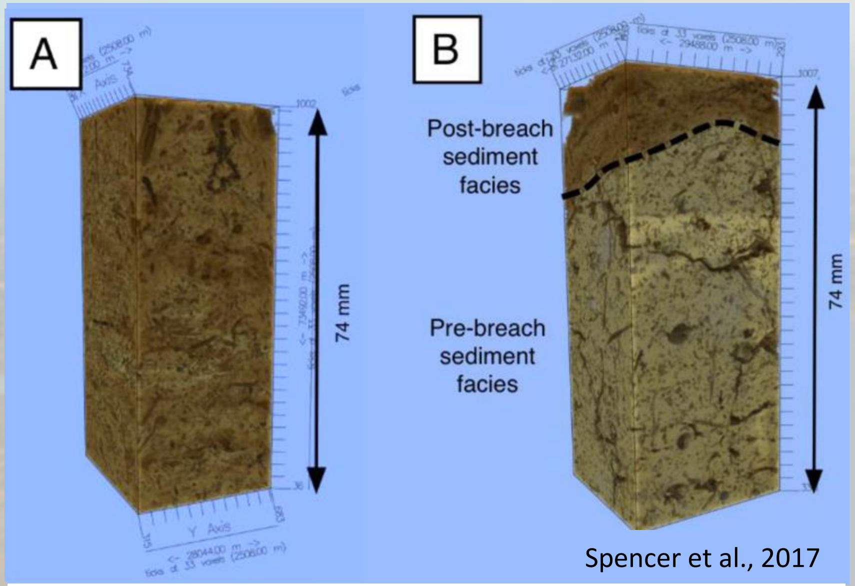
↓

Over-compacted substrate may prevent water circulation, root penetration within the soil, and erosional processes

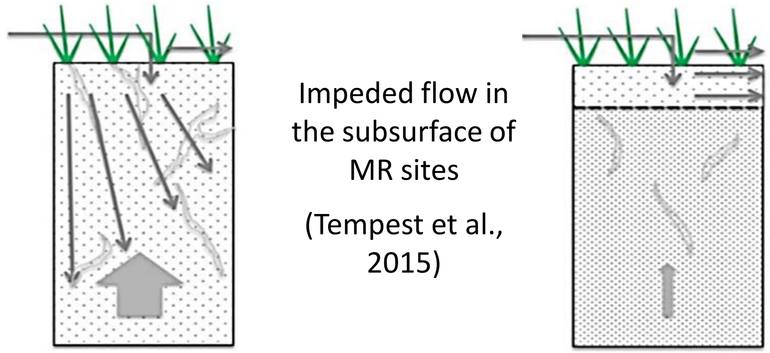
↓

MR sites with altered sediment will struggle to develop natural-looking creeks, and to support diverse plant communities

Natural marsh | MR site



Spencer et al., 2017



Impeded flow in the subsurface of MR sites

(Tempest et al., 2015)

Conclusions

Despite progress in design, MR schemes:

-are **flatter** than natural saltmarshes

-have a **poorer creek distribution**

-have **more homogeneous plant distribution**

Future schemes would be improved by the addition of small-scale topography features: greater variety of ecological niches, better biodeiversity, may promote drainage and creek formation

However creek incision is likely to be hindered by over-compacted substrate: necessity to look into below-ground processes

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Alys Laver and volunteers for facilitating field work at Steart, and Sacha Dent for background aerial photography

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