Improving the science base: design and evolution of creek networks in restored coastal wetlands

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

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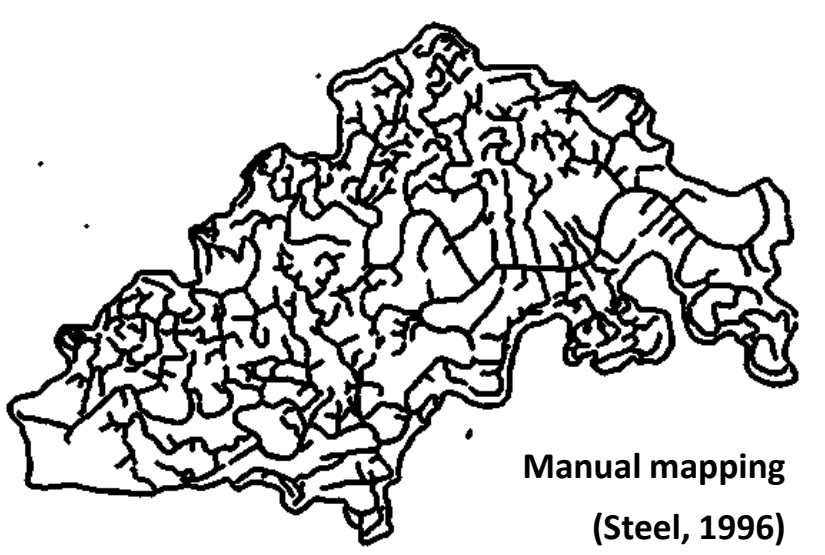
Creek networks

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



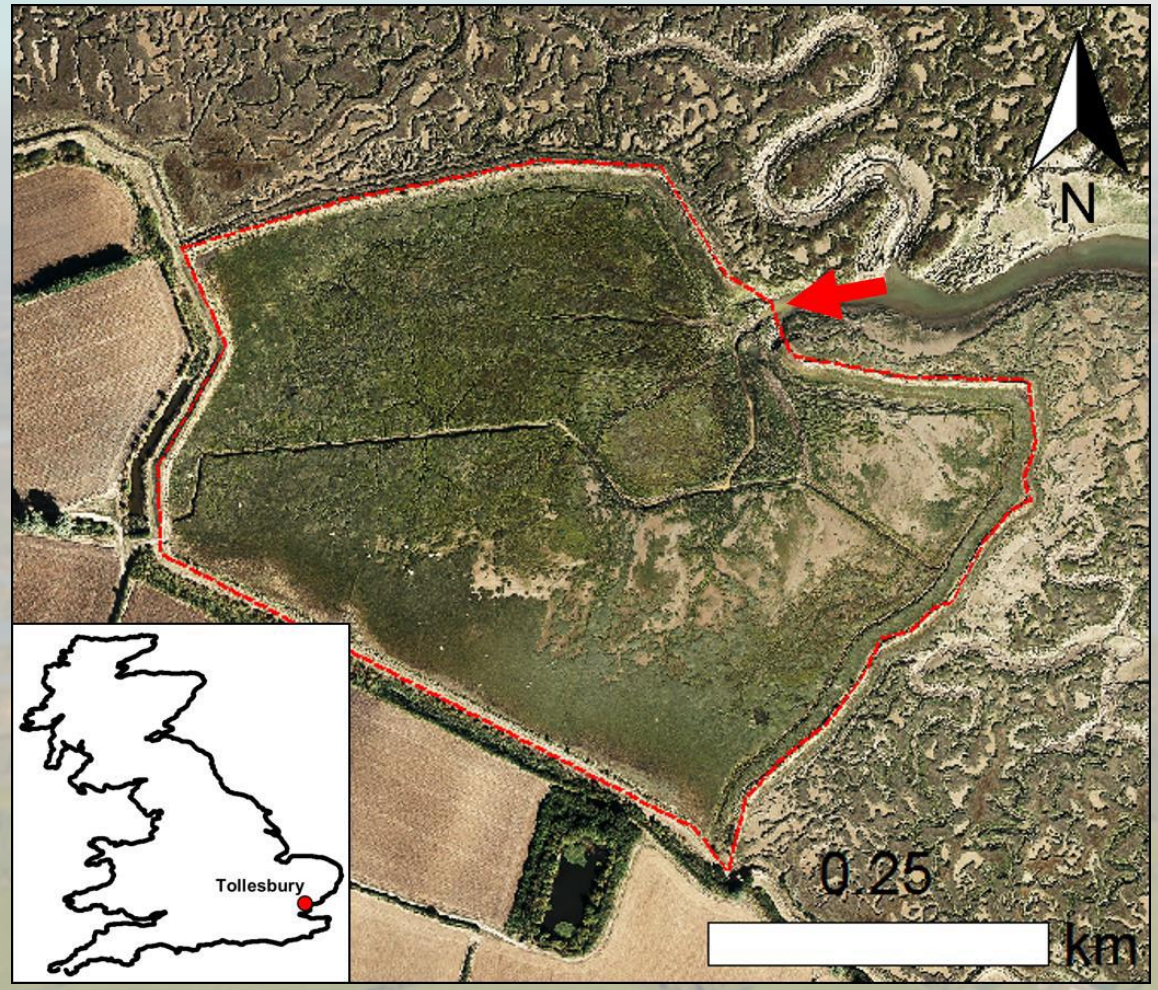
Manual mapping

(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…

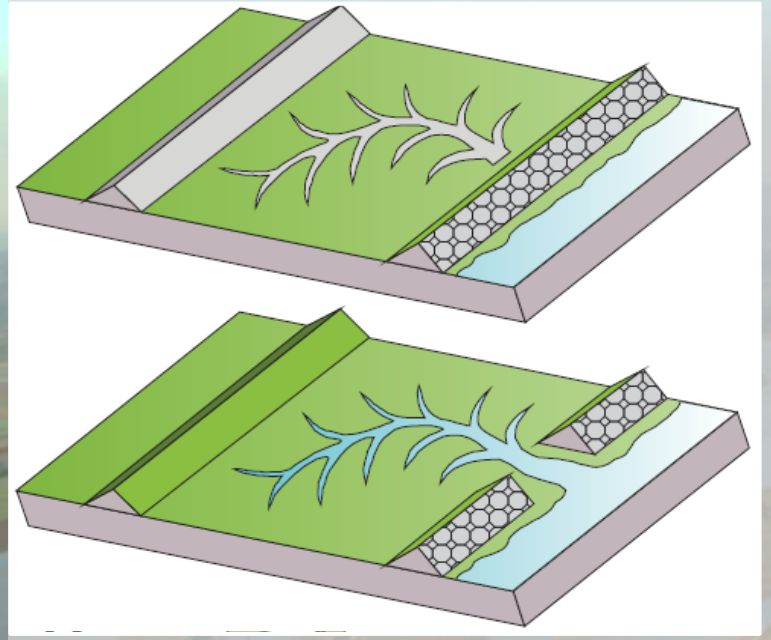


Restoring saltmarshes

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

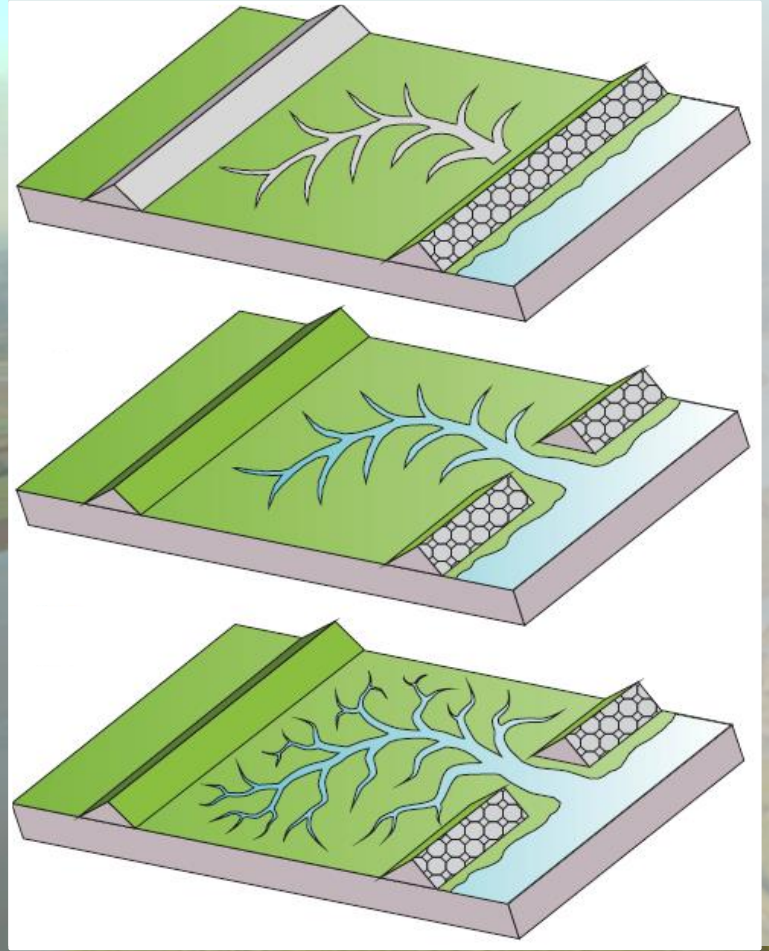
Steart Managed Realignment scheme, September 2014
Photo: Sacha Dent, WWT

Expected evolution toward mature state



MR sites are generally implemented with a simplified initial creek template

Expected evolution toward mature state



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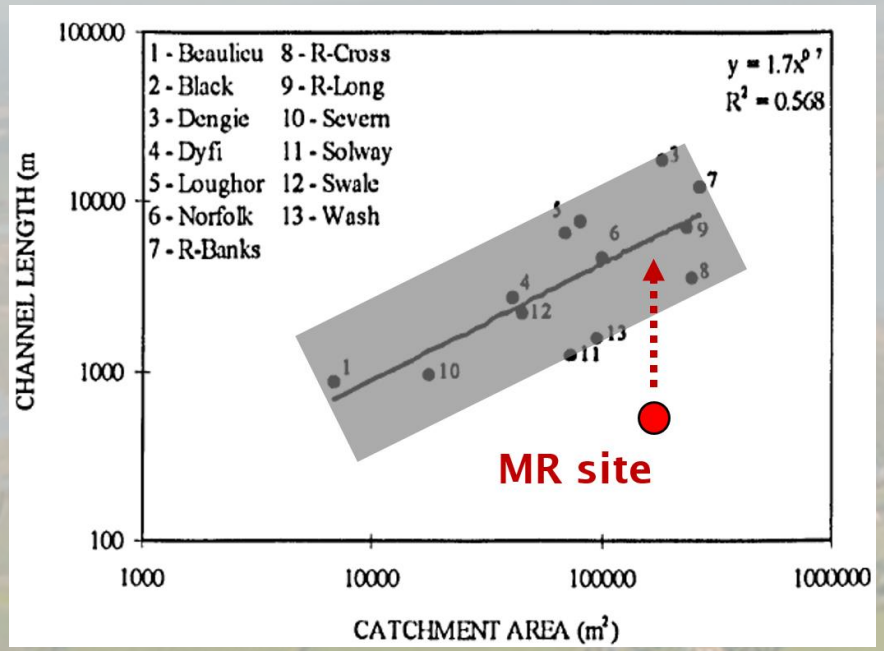


(Modified from Steel & Pye, 1997)

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

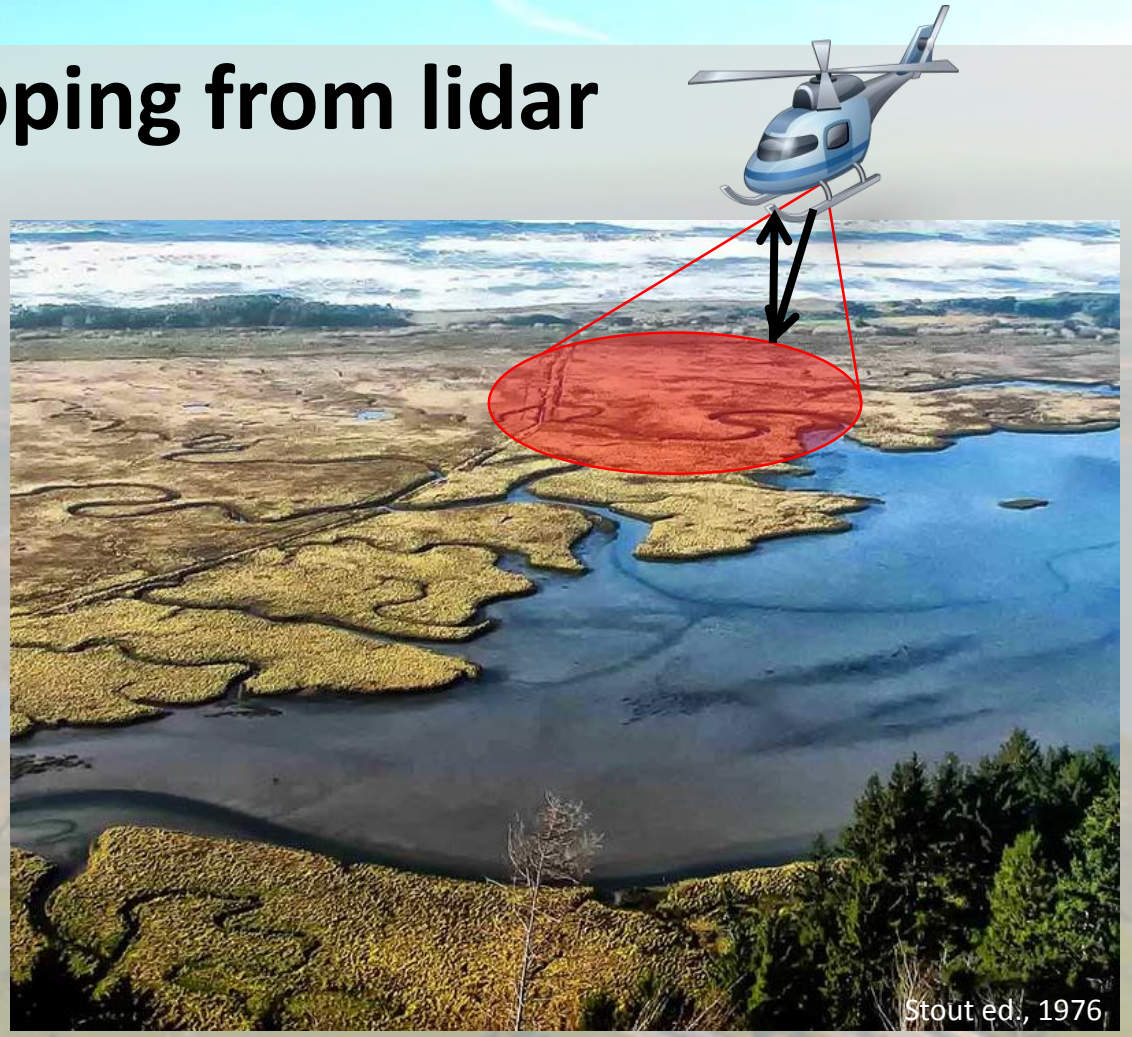
Creek network mapping from lidar

Data type: airborne lidar elevation maps (DSM)

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

Resolution: 1m horizontal and 0.15m vertical resolution

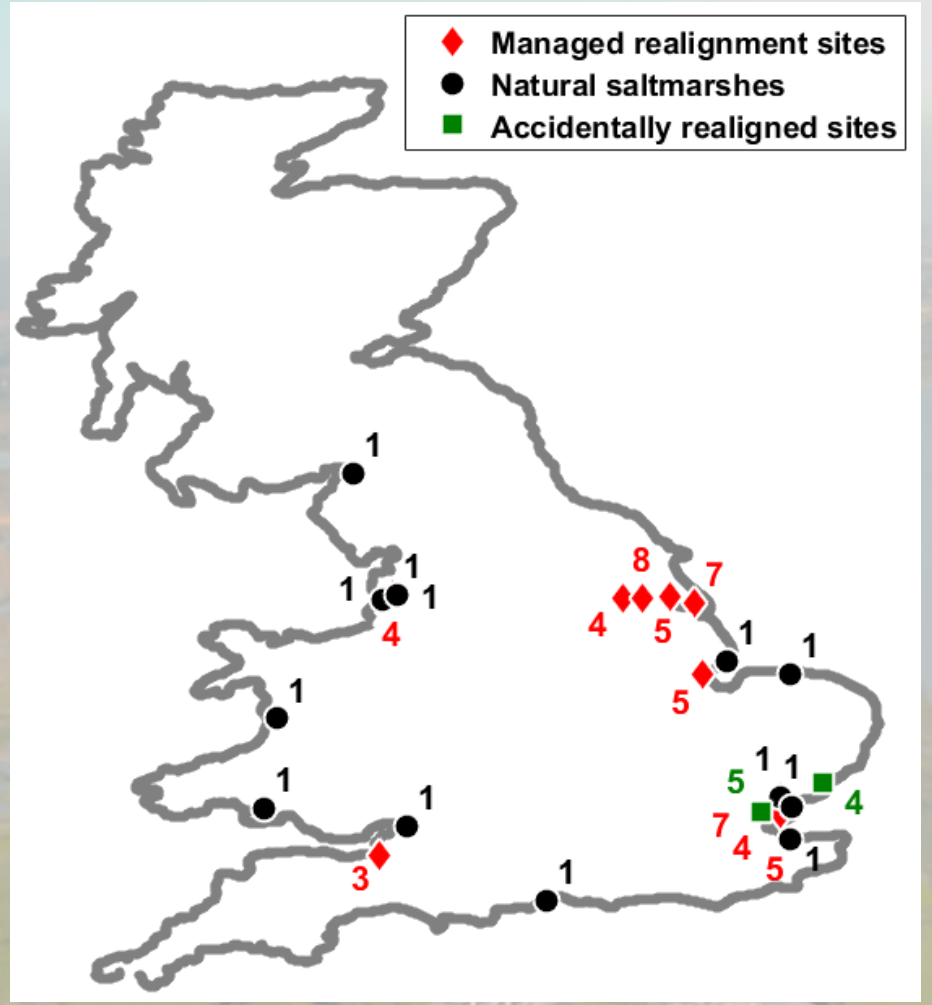
Frequency: every 2-5 years since 2002



Study sites

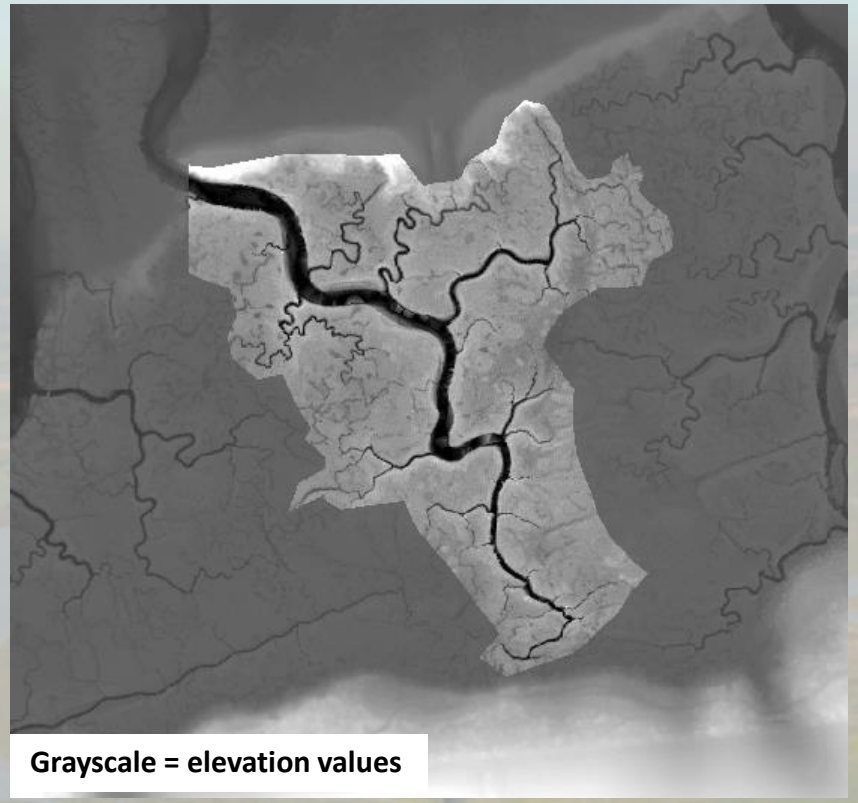
- 10 MR sites implemented between 1995 and 2014
- 13 mature saltmarshes used as reference
- 2 century-old accidentally realigned sites used to predict the long-term MR evolution

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



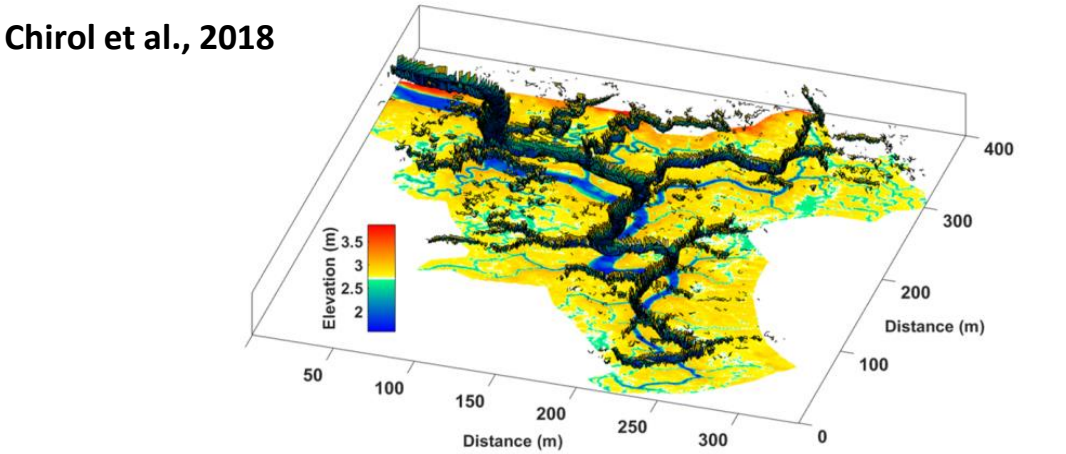
Site location (numbers = number of lidar datasets for each site)

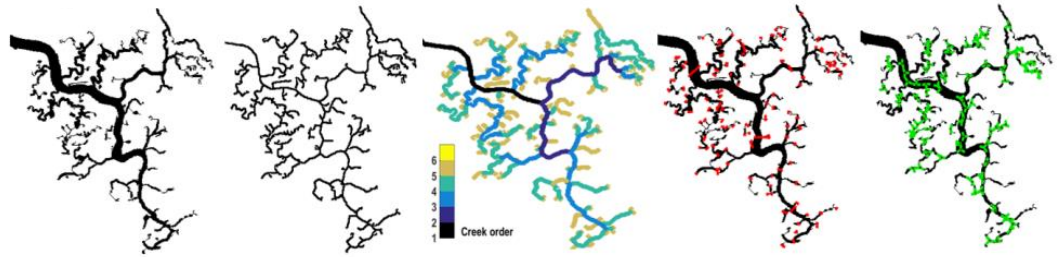
Creek parametrisation algorithm



Grayscale = elevation values

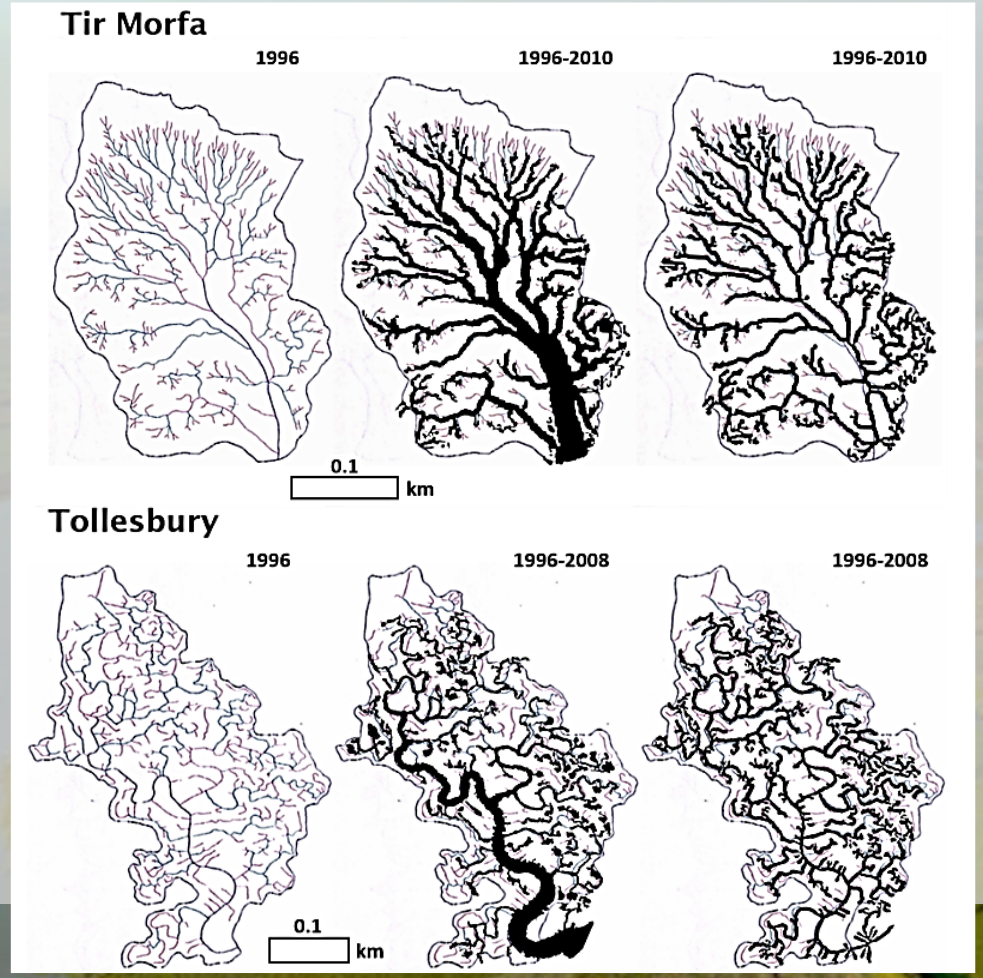
Chirol et al., 2018

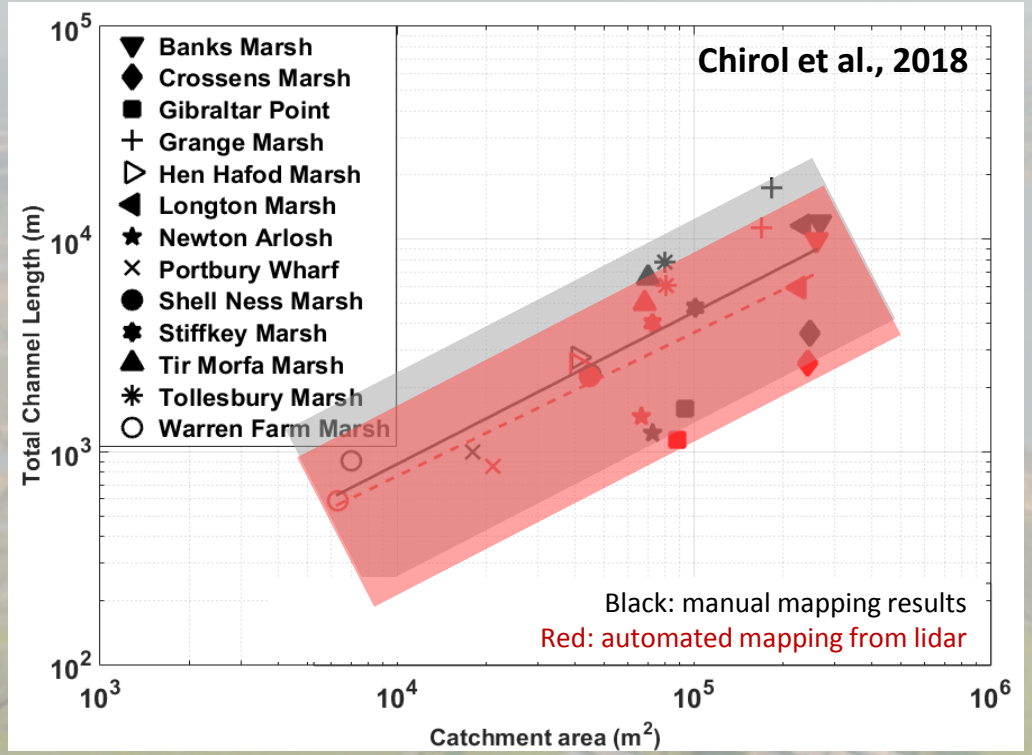




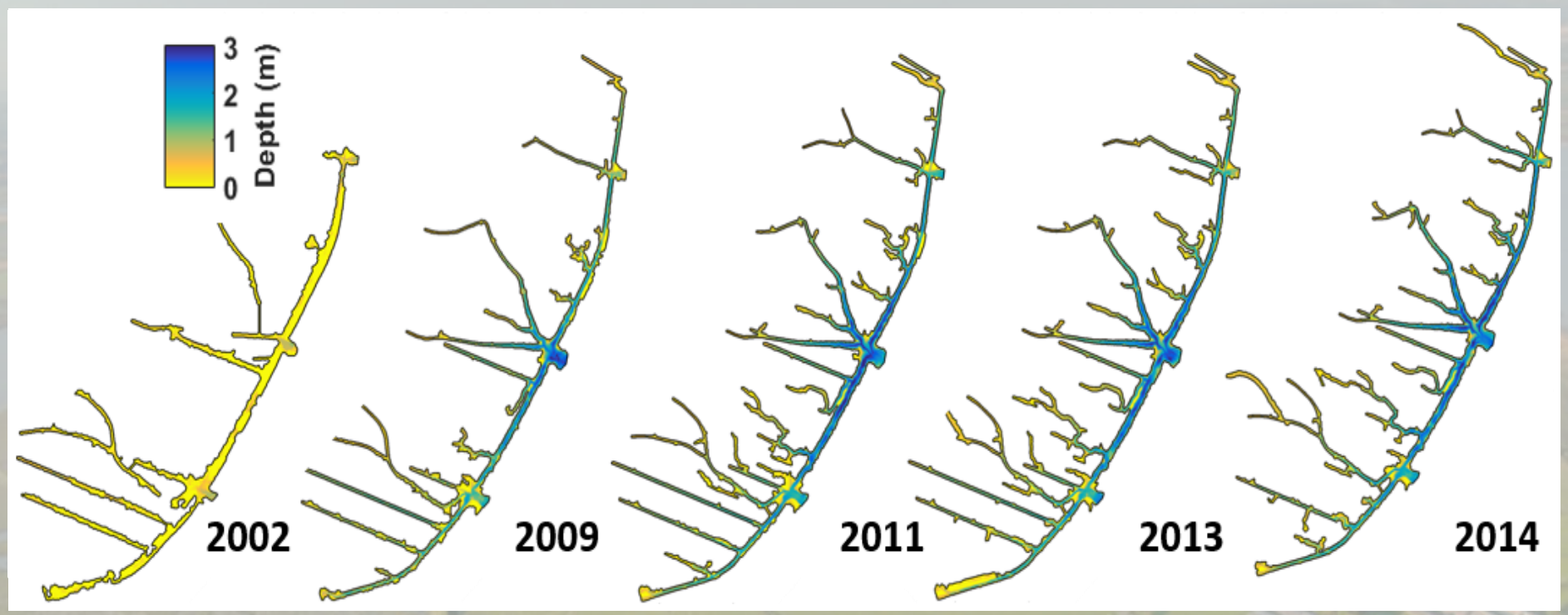
Semi-automated algorithm developed to extract key shape parameters of saltmarsh creeks

Algorithm tested on 13 mature saltmarshes in the UK

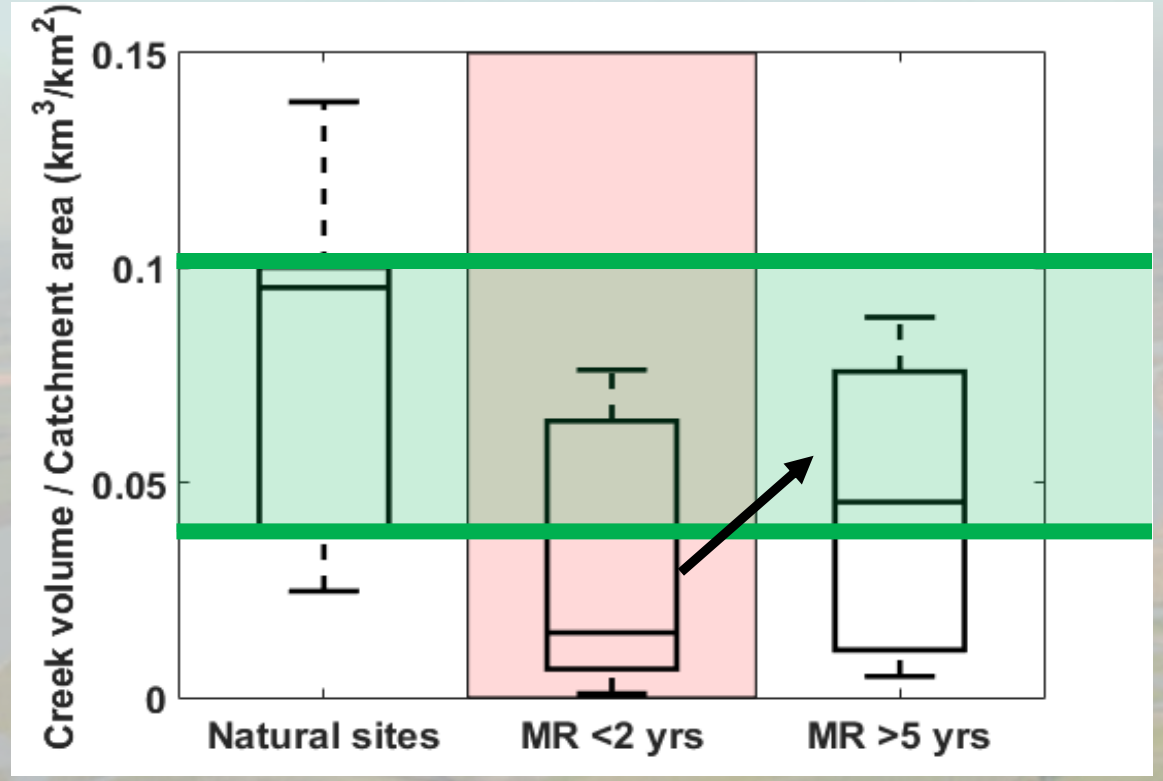




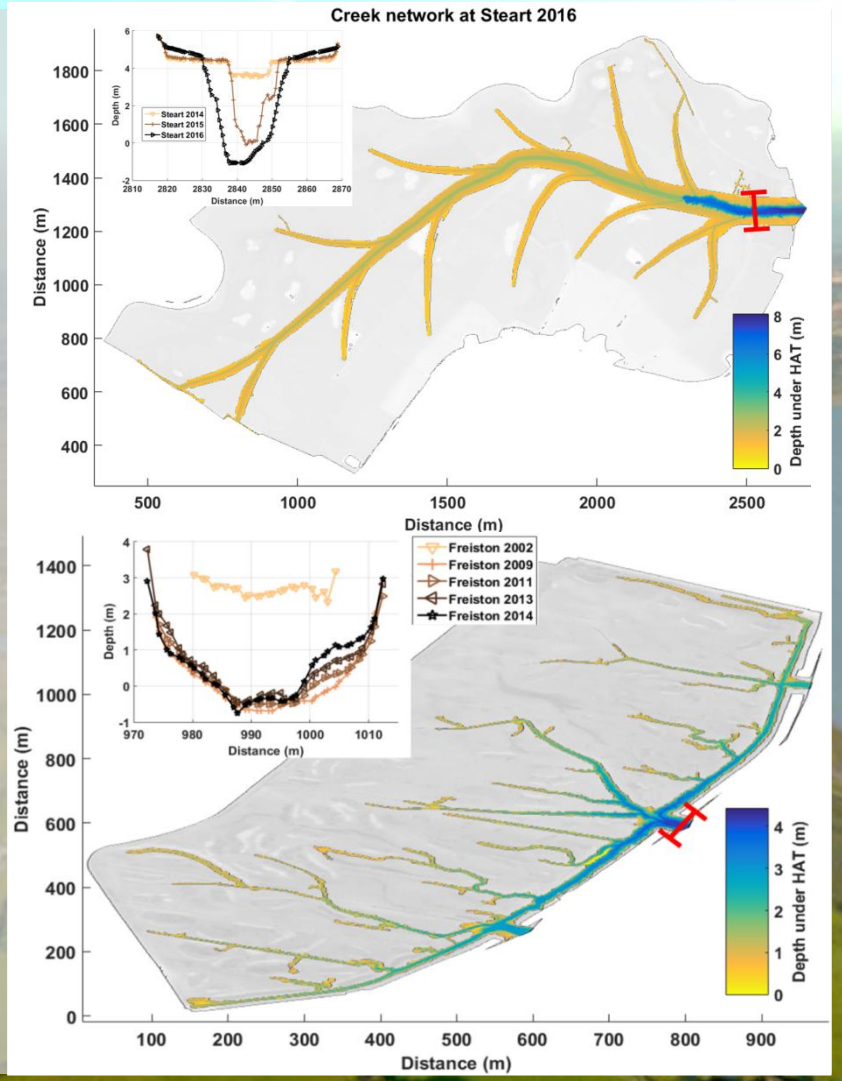
MR creek evolution: volume, length and distribution



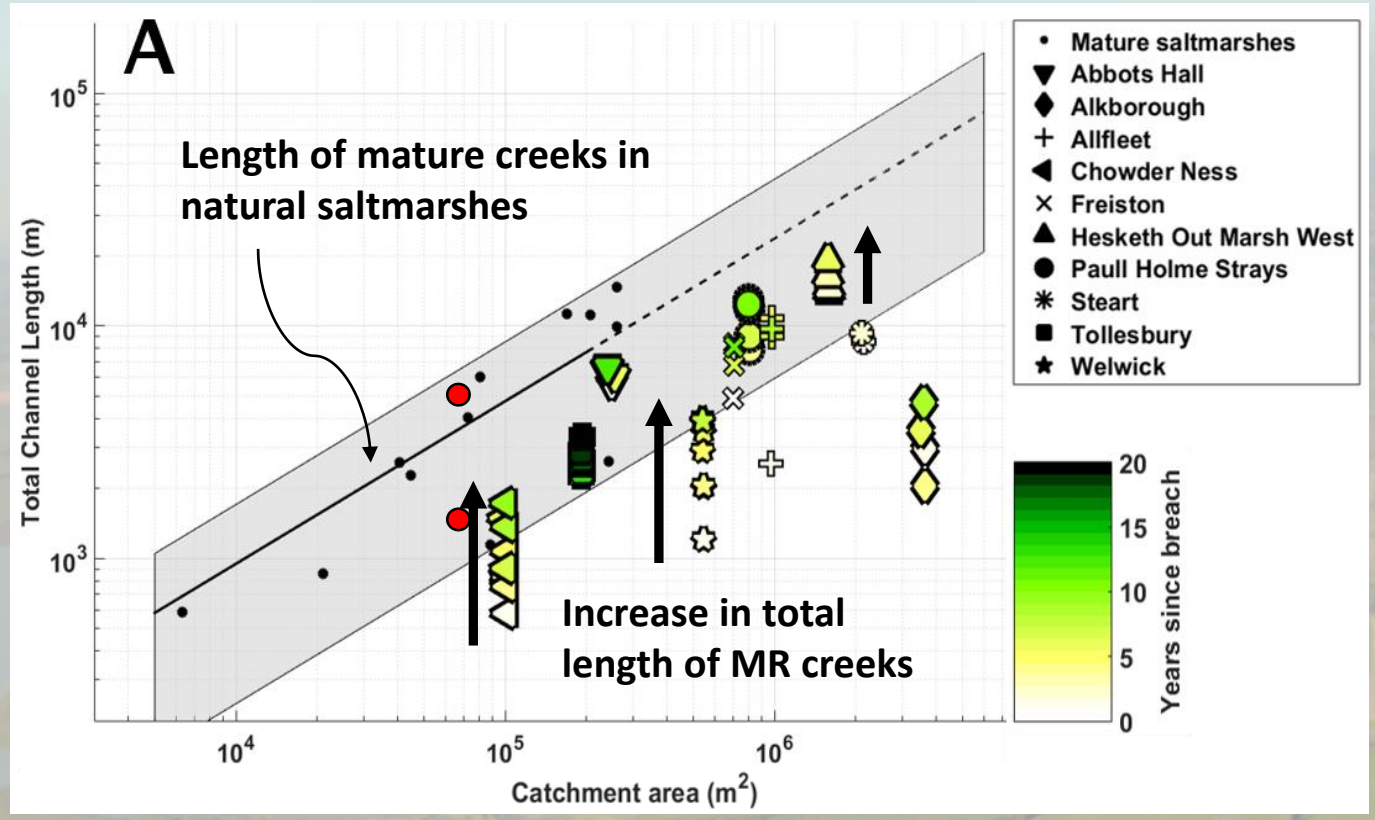
Volume evolution of MR creeks



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

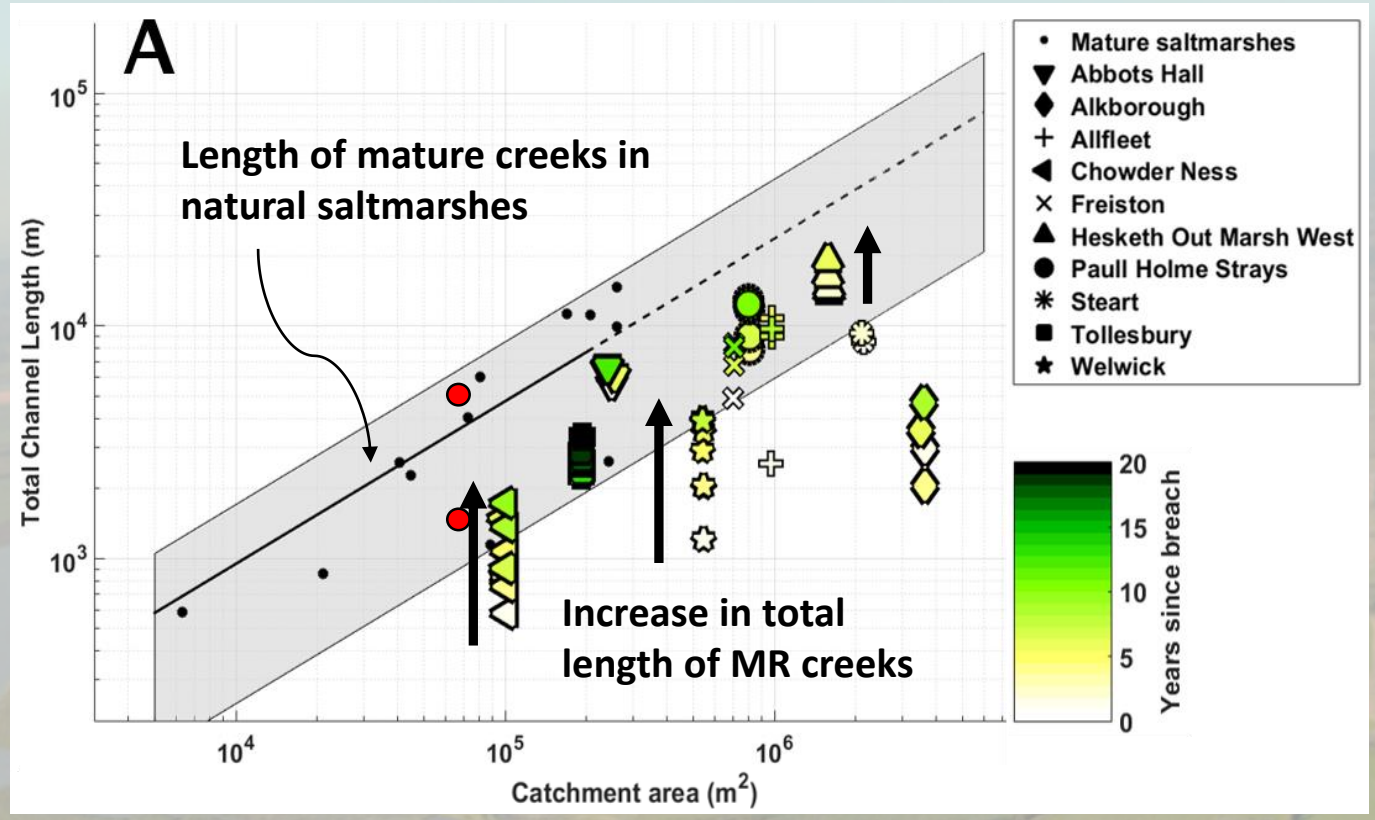


- **Evolution of total creek length**

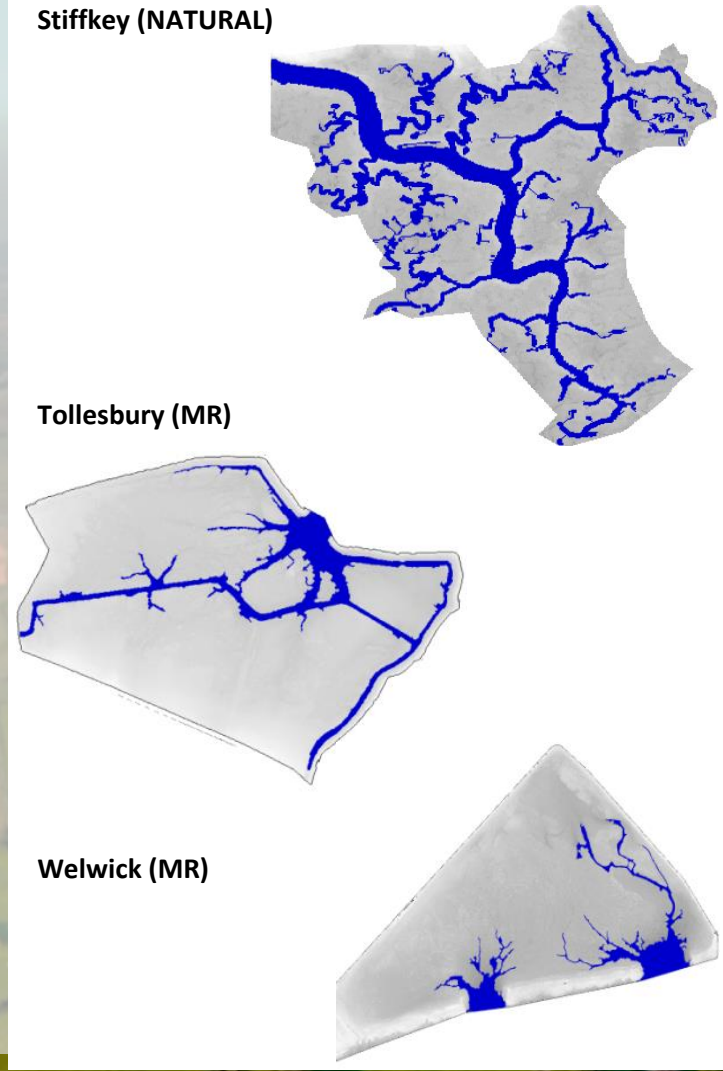


- Increase in total channel length for all sites considered

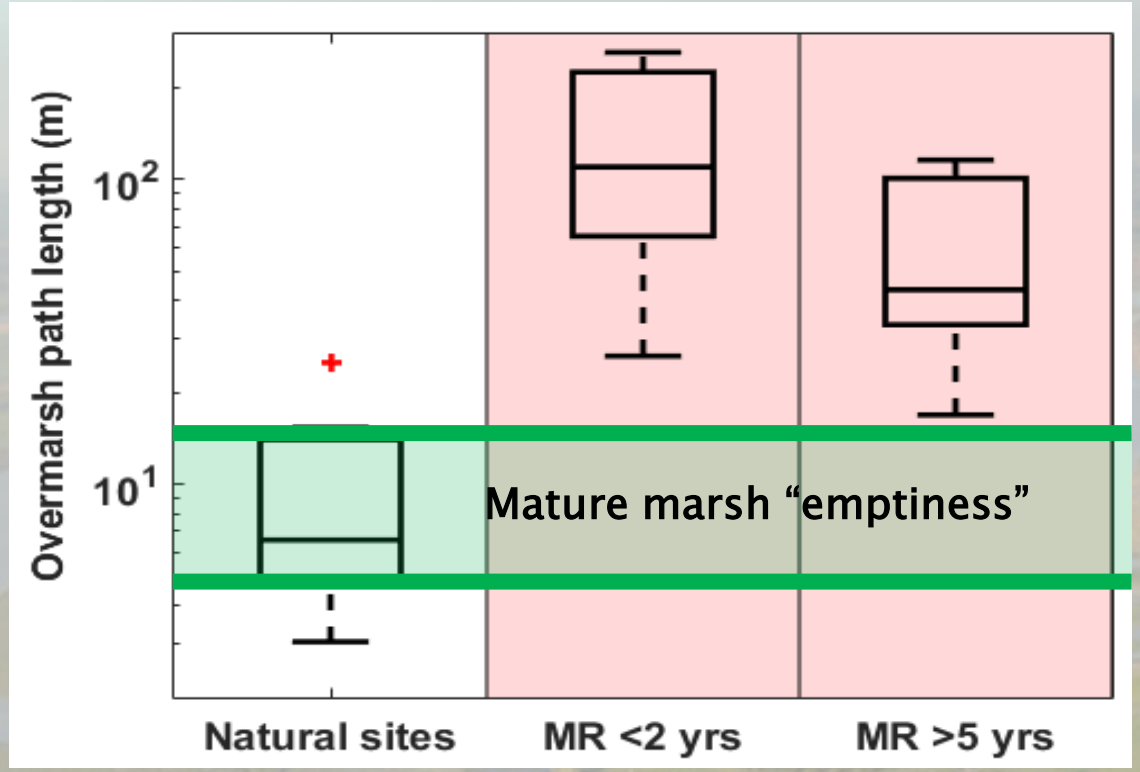
- **Evolution of total creek length**



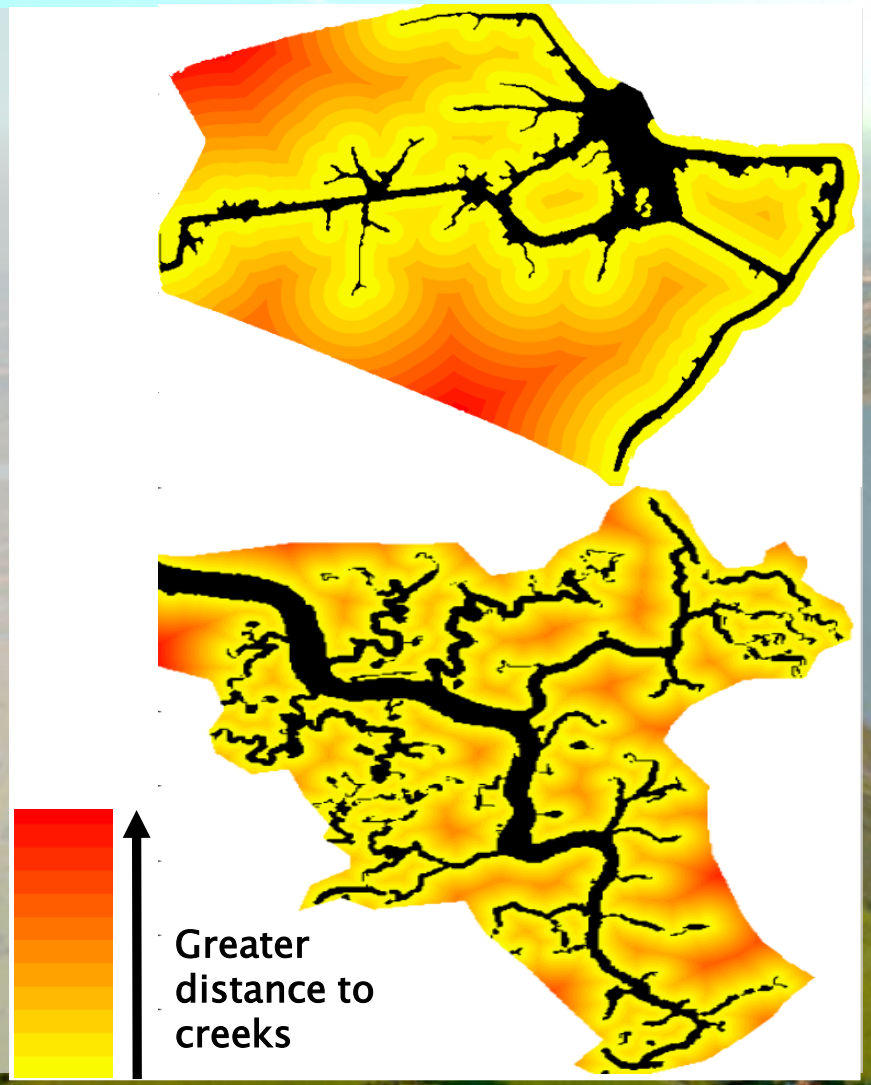
- New creeks tend to form in clusters around the breach area, while furthest parts of site remain empty



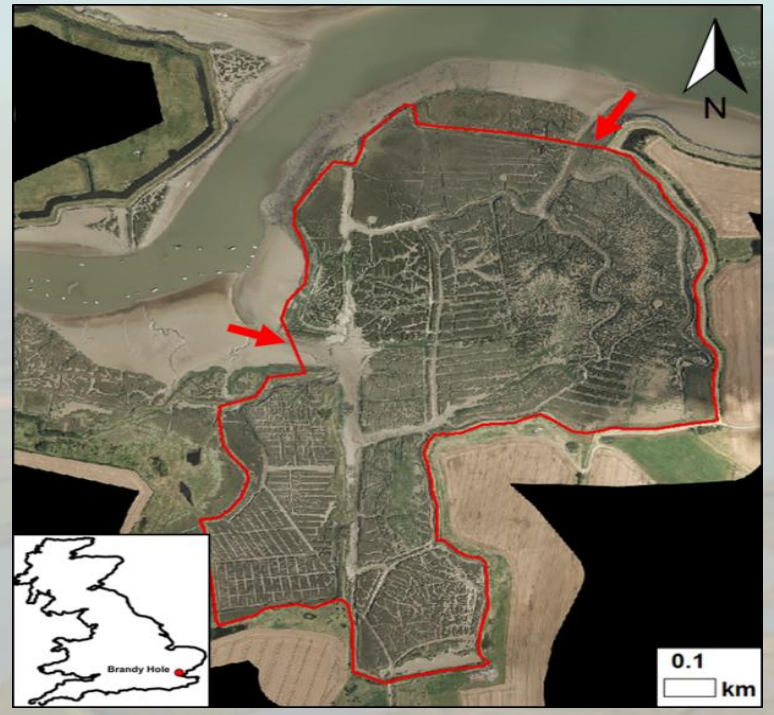
- "Emptiness": Mean distance necessary to reach a creek (creek distribution)



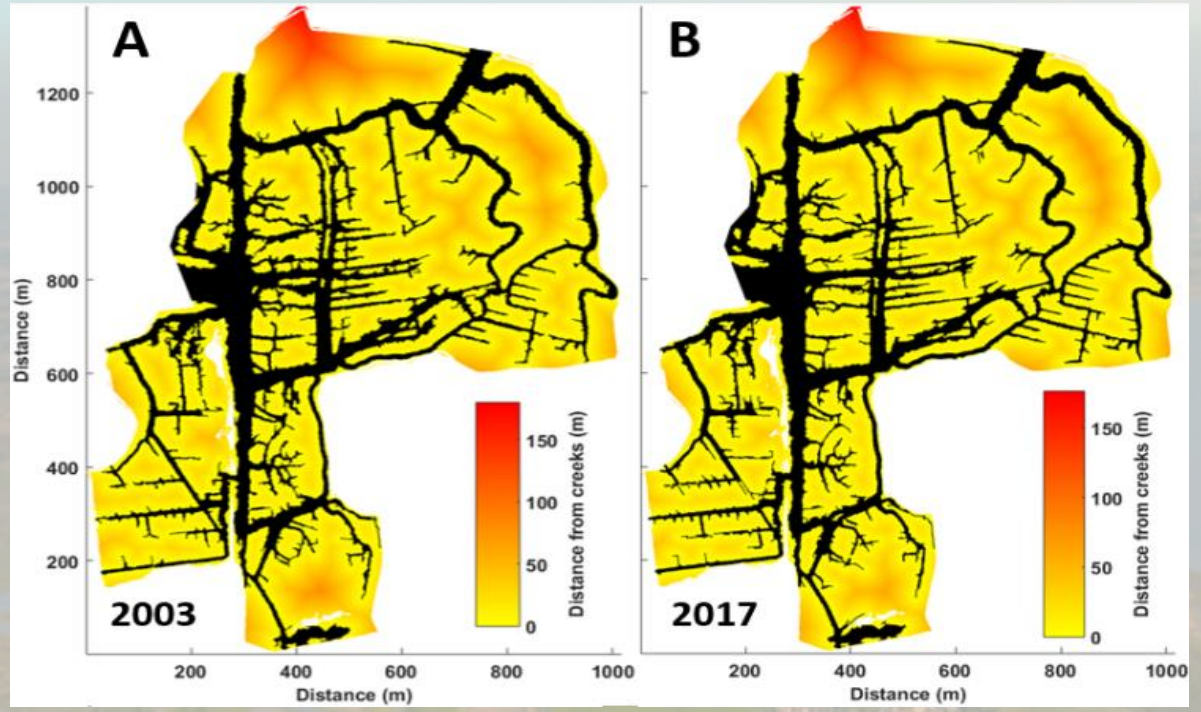
MR creeks remain sparser and straighter than in natural systems



Long-term evolution

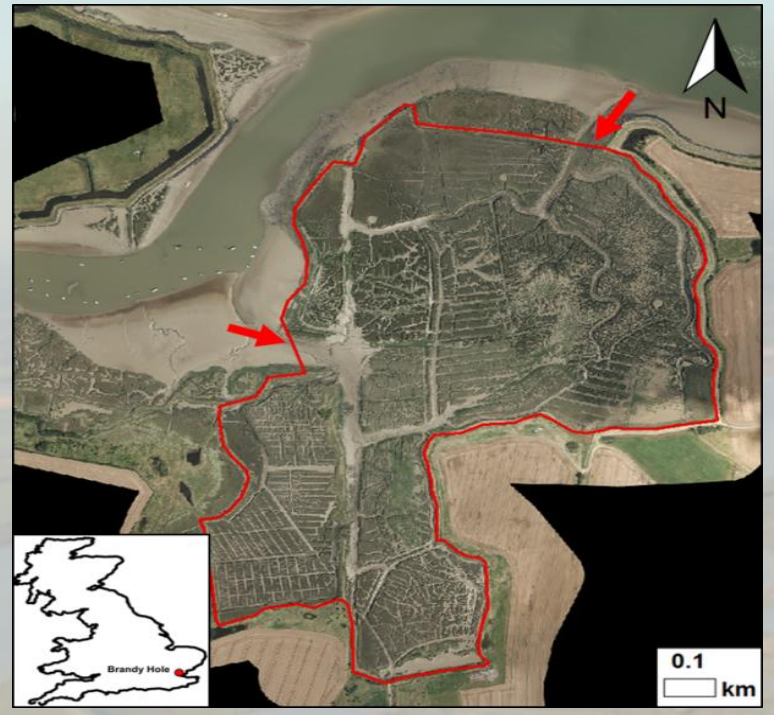


Brandy Hole, pasture/arable, storm-breached in 1897



- 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



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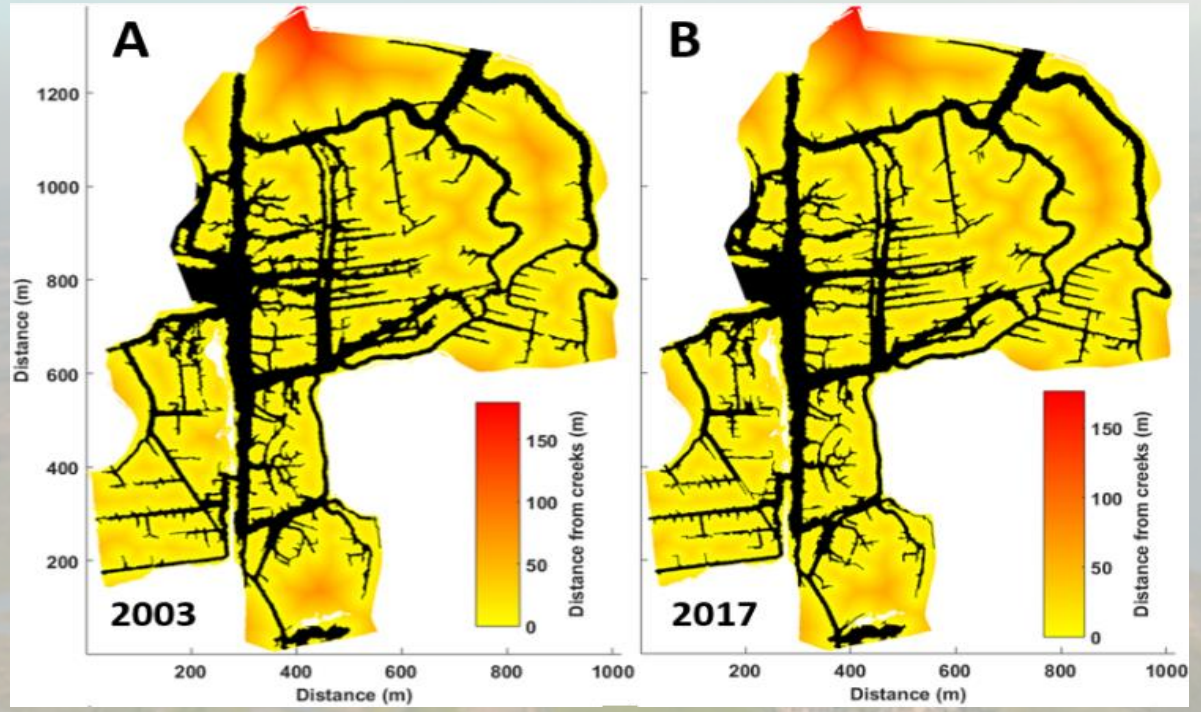
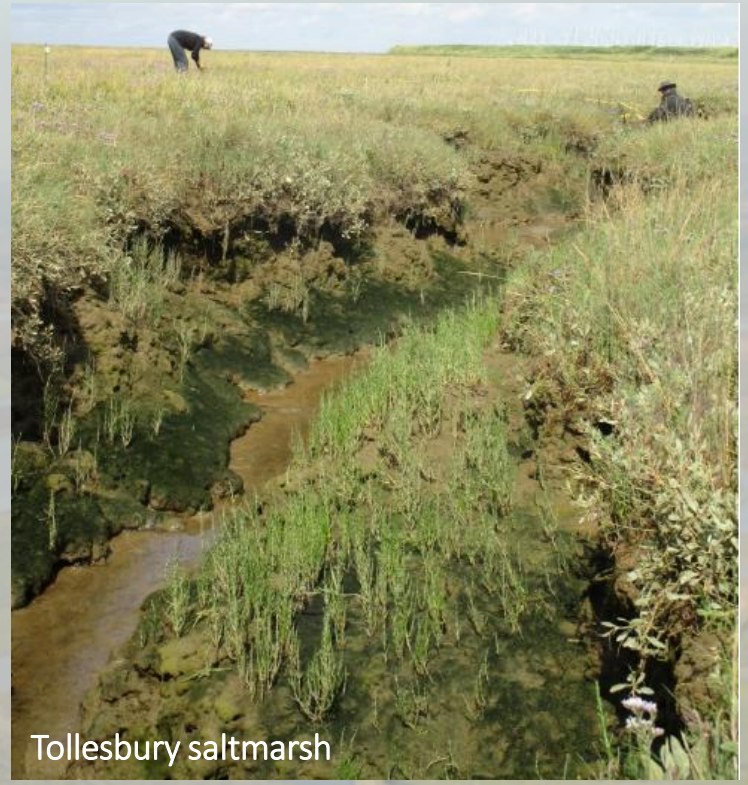


MR creeks evolve towards a mature state that is very different from that found in natural saltmarshes

How can we improve future MR schemes?

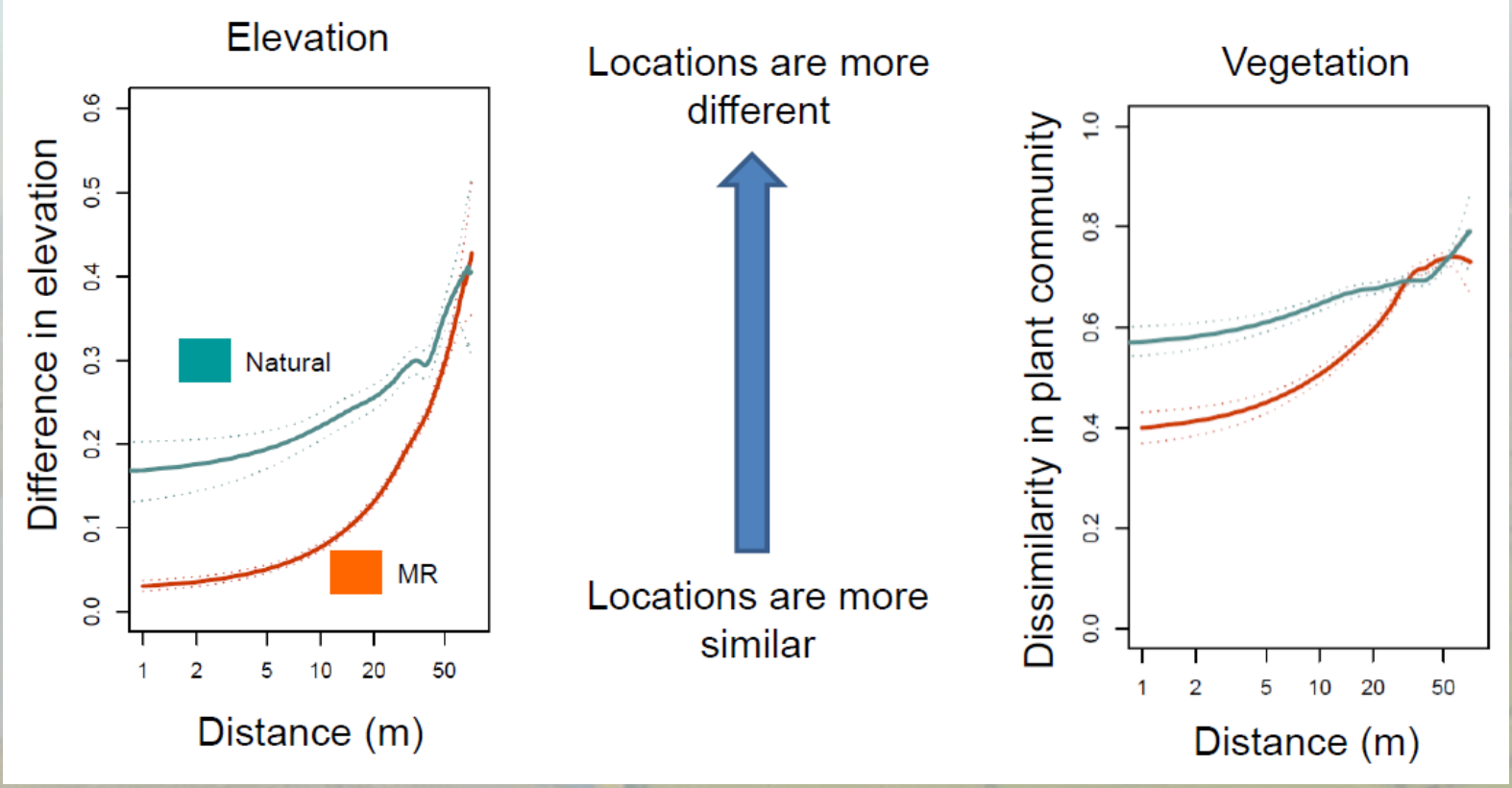

Tollesbury saltmarsh

Natural saltmarsh


Tollesbury managed realignment

MR site

Importance of initial template: MR lack topography



But post-breach manipulation can increase plant diversity

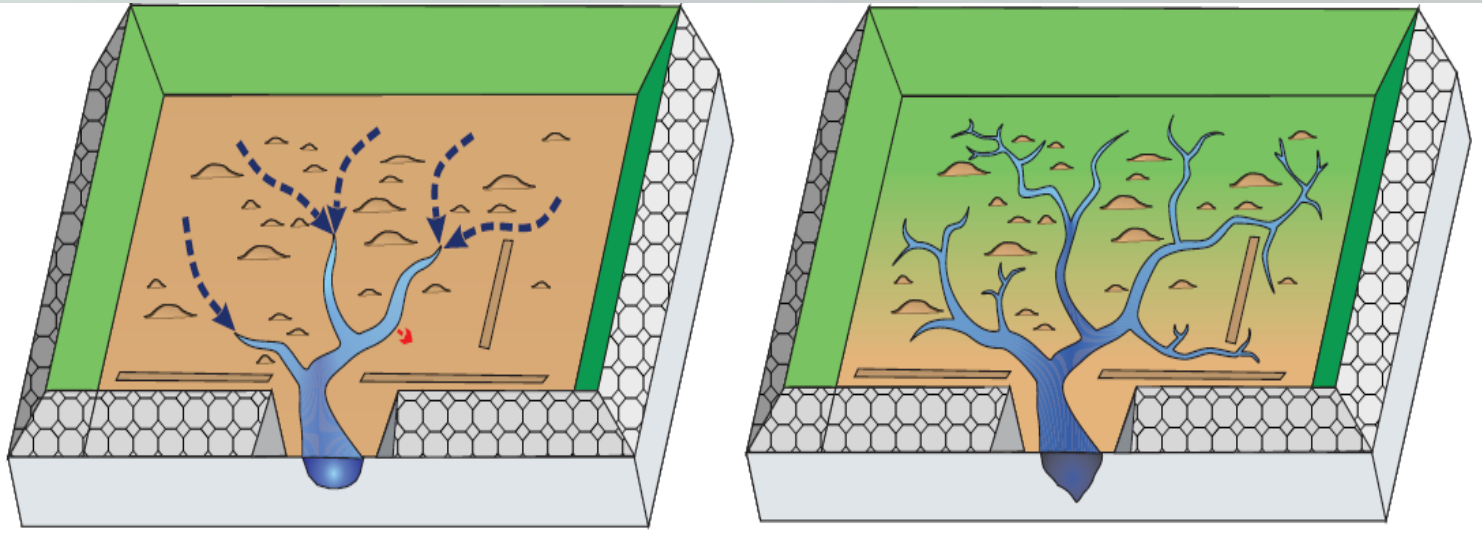

RSPB Freiston trial management

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

Manchester Metropolitan University

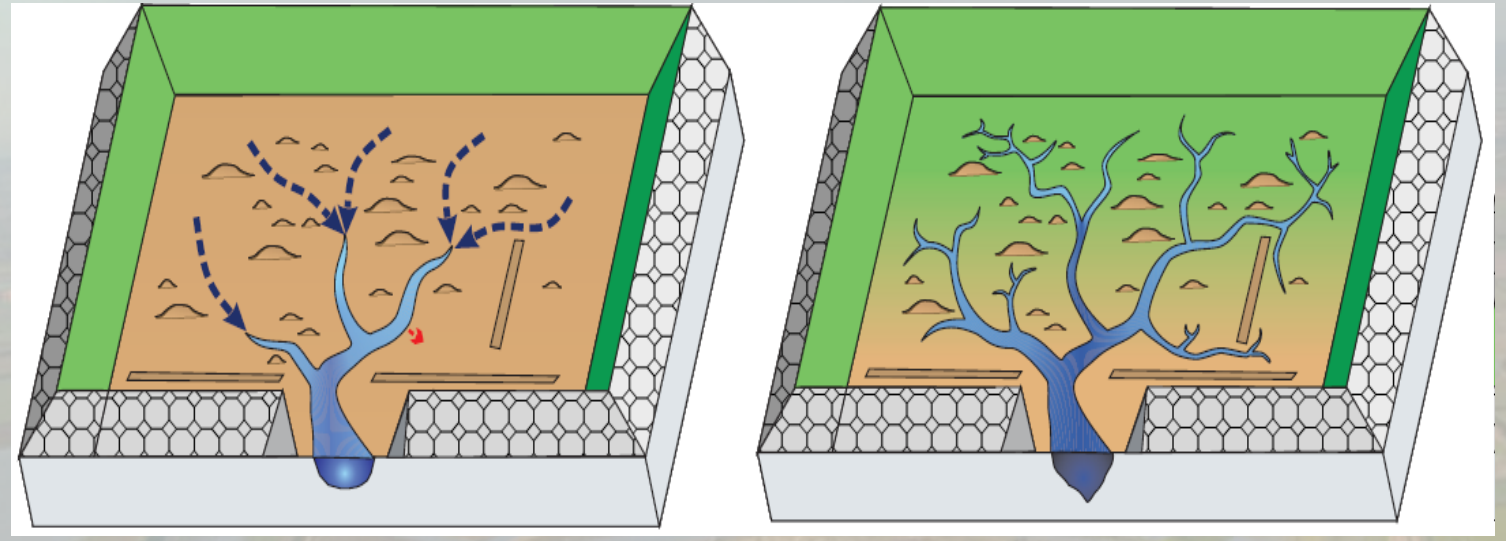
Research conducted by Hannah Mossman, Peter Lawrence. Contact h.mossman@mmu.ac.uk

Importance of initial template: MR lack topography

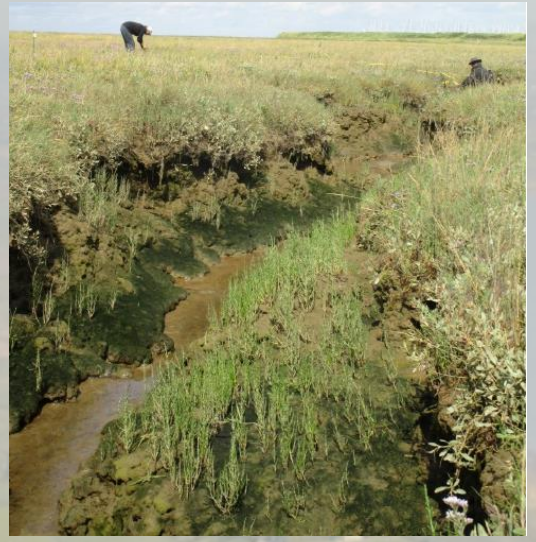


Small-scale topography also focuses run-off into preferential flow paths and promotes creek development into more sinuous, natural-looking shapes…

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…



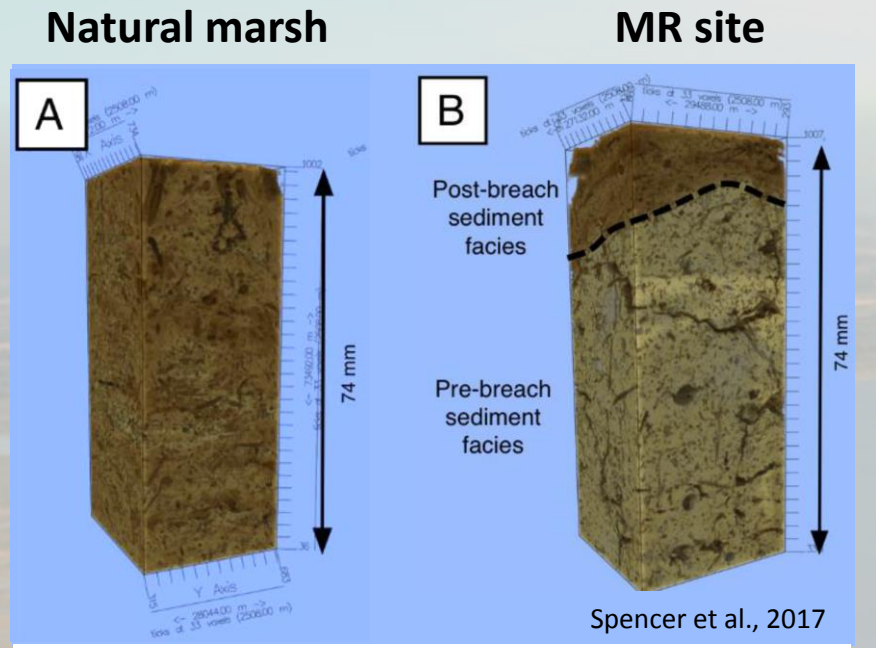
…that will also provide niche habitats and increase biodiversity

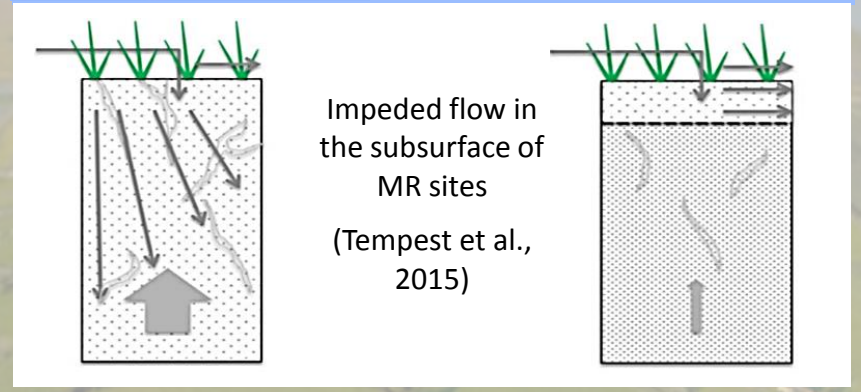
Belowground influence on creek growth and marsh health

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





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

Special thanks to

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Jacobs™ for providing funding and expertise during the PhD project

Dr Hannah Mossman and Dr Peter Lawrence for contributing their slides on MR topography and plant diversity

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

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