

Saltmarsh processes and climate change – a new approach



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MASTS ASM 2 November 2018

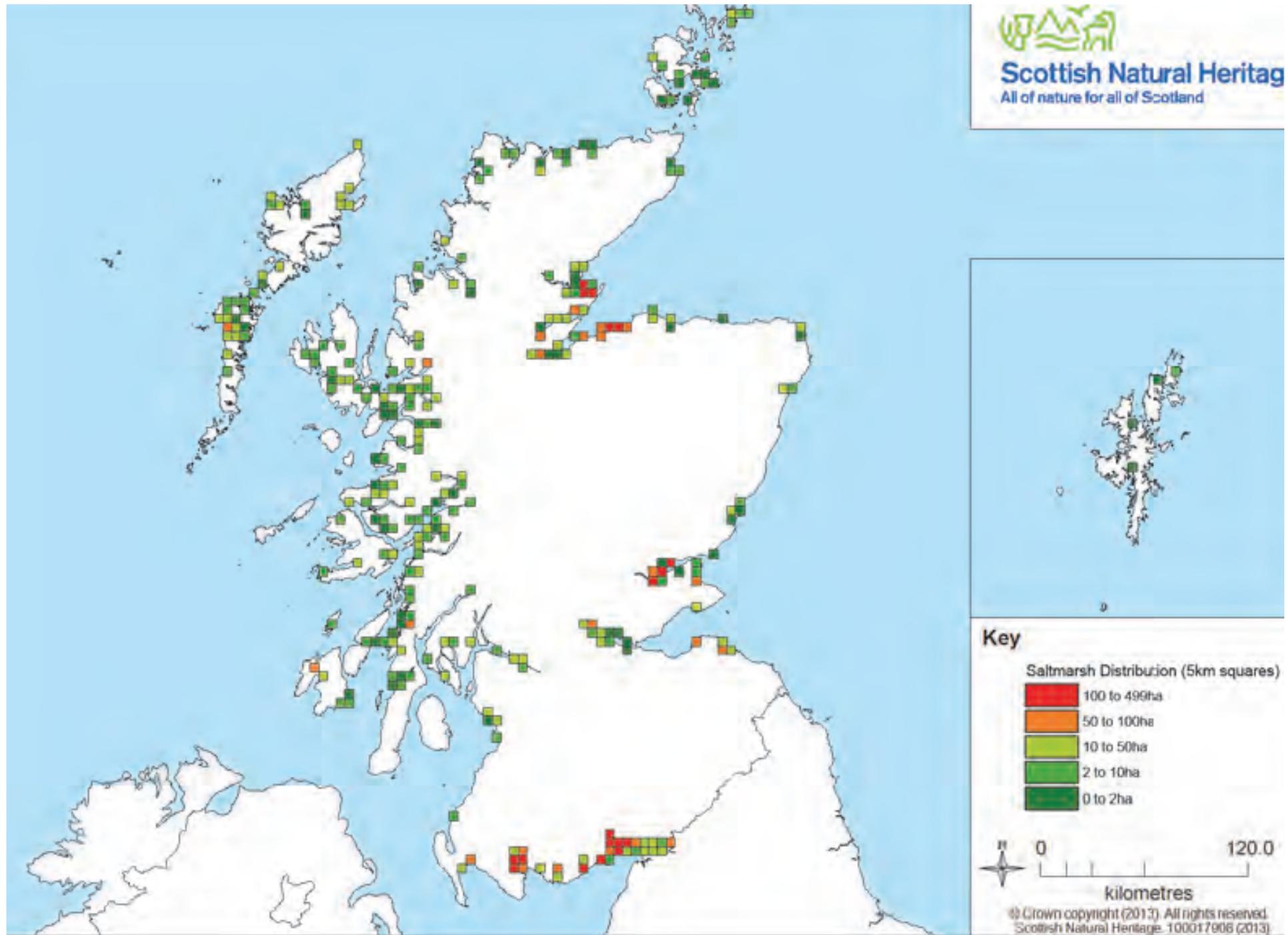
Saltmarsh Survey of Scotland

Total saltmarsh:	7721	
SSSI	5974	77.37%
SAC	3413	44.21%
SPA	4621	59.85%
SSSI+SAC+SPA	6019	77.95%

Thanks to Susi Hodgson



Scottish Natural Heritage
All of nature for all of Scotland

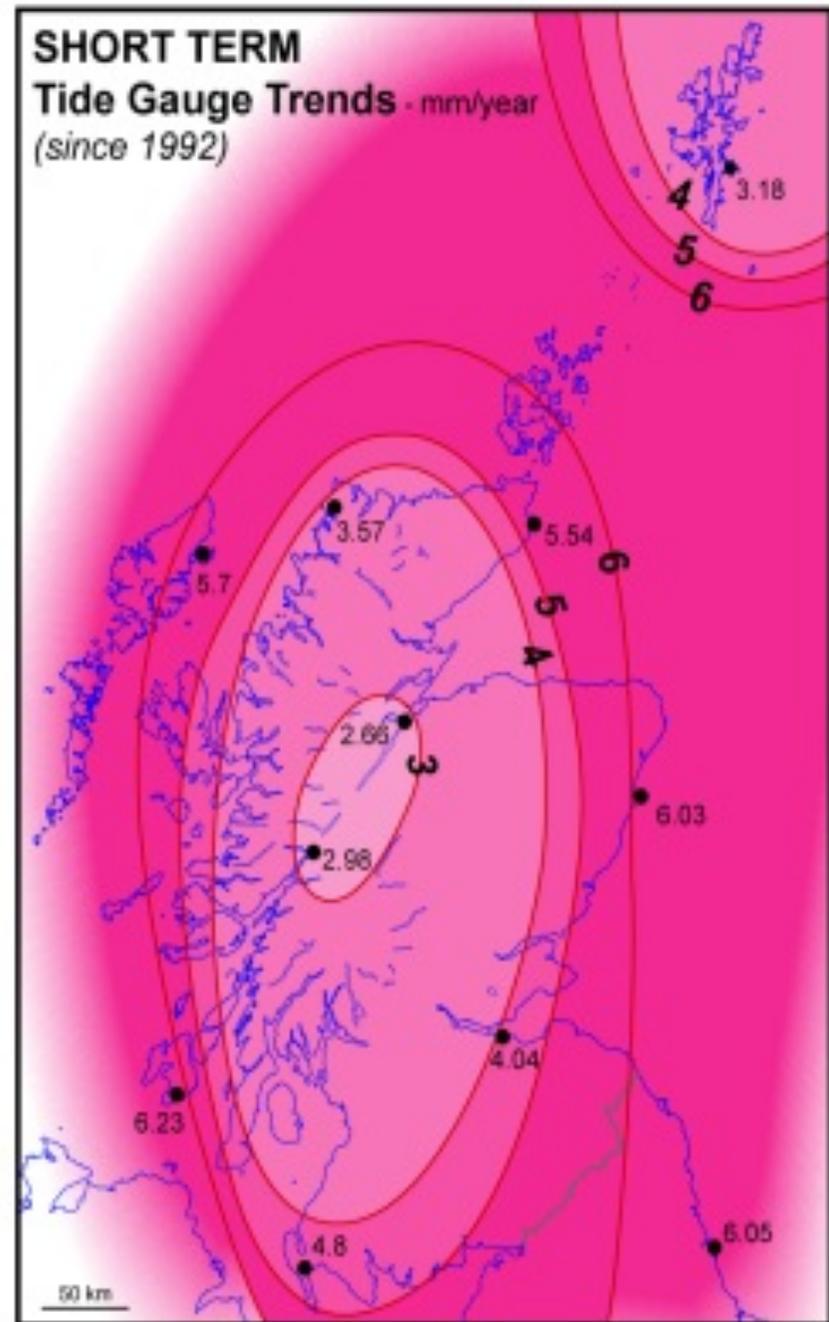
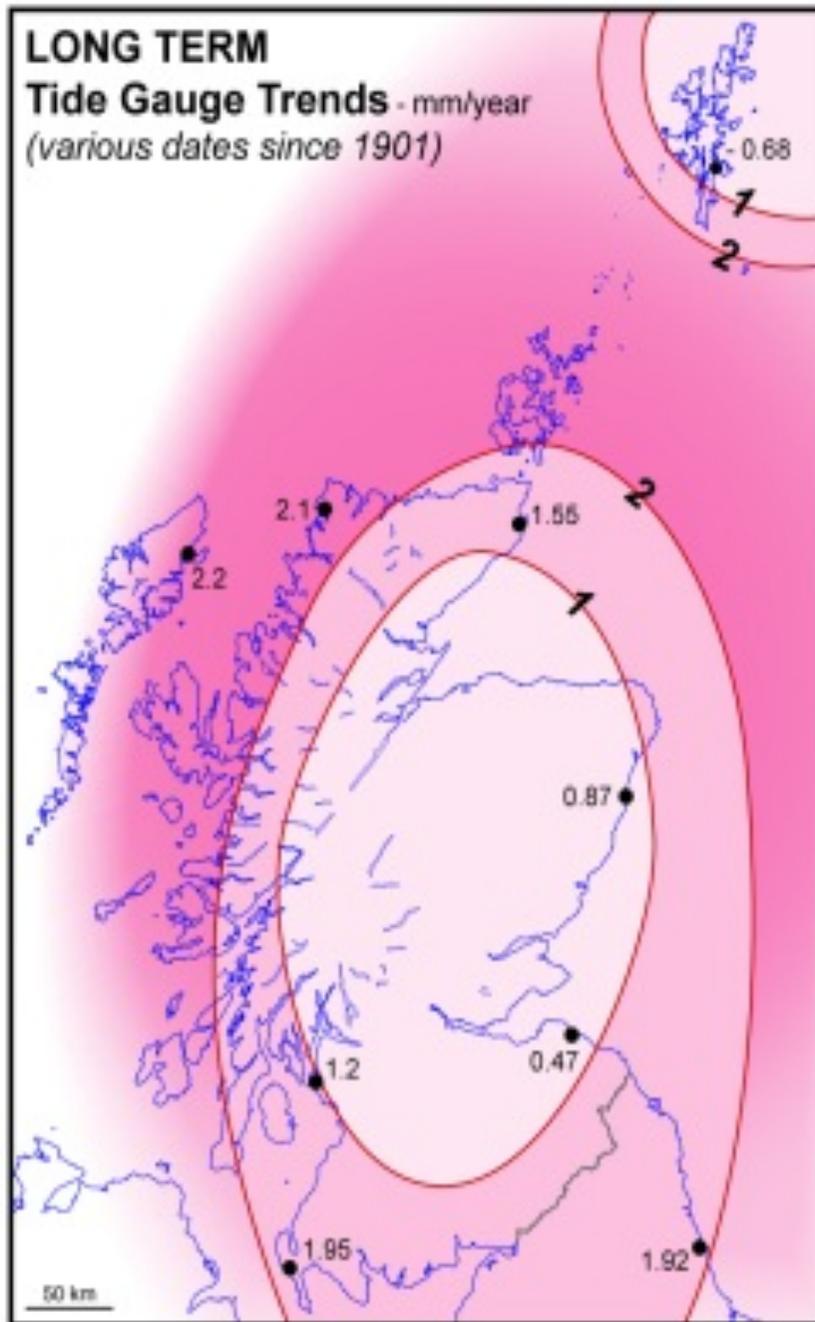


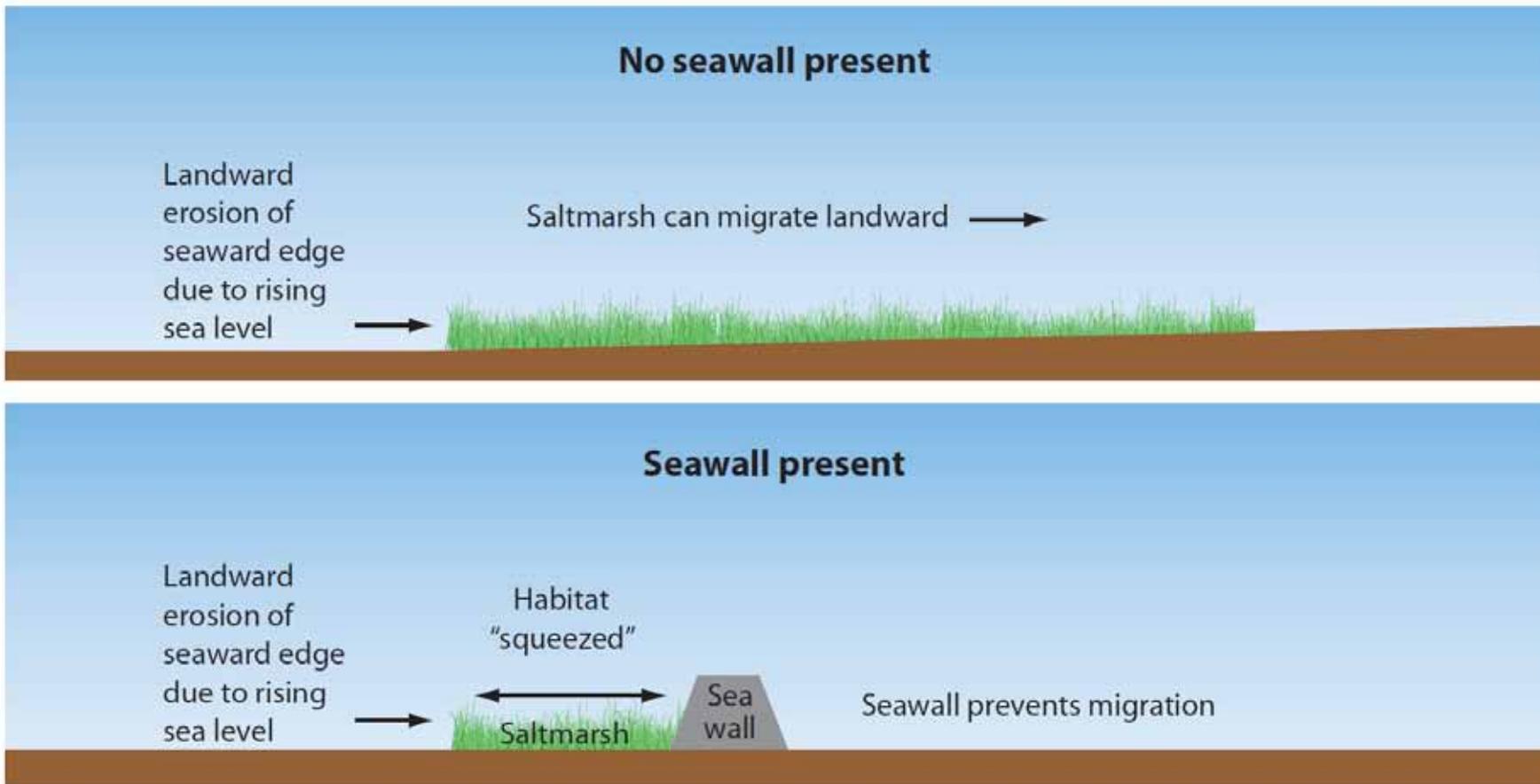
Saltmarsh ecosystem services

- reduction of wave-induced shoreline erosion
- attenuation of storm surges
- biogeochemical filtering of pollutants
- provision of nursery areas for commercial fish and shellfish
- grazing
- biodiversity
- carbon sequestration

Sources: Wang & Temmerman (2013), Fagherazzi *et al.* (2013)

Source: Rennie & Hansom 2011





Source: Pontee (2013)

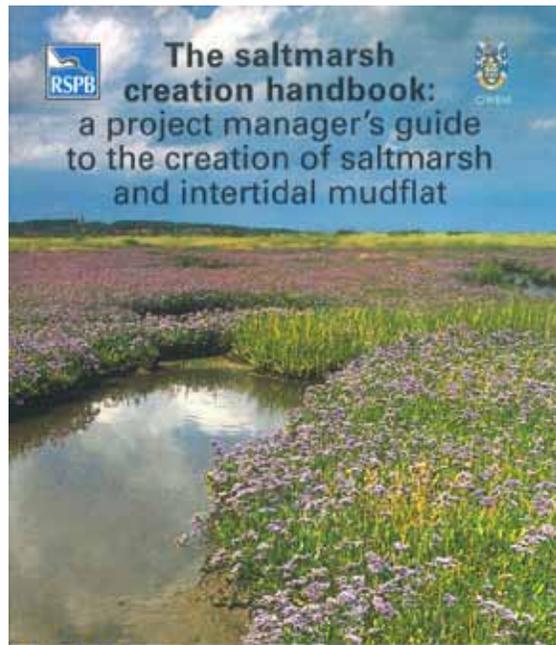
Bruun Rule

Beaches will respond to sea-level rise by moving the profile upward and landward while maintaining its initial morphology (landward migration)

RSLR → landward migration

Dominates UK Government, and some agency and NGO policy

This is despite a less than obvious audit trail of the idea in the literature



Sustainable Shores

Technical Report

February 2010



Report Number
710

Coastal squeeze, saltmarsh loss and
Special Protection Areas

English Nature Research Reports



UK 2012 Climate Change Risk Assessment

(Defra project code GA0204)

A climate change risk assessment for Scotland

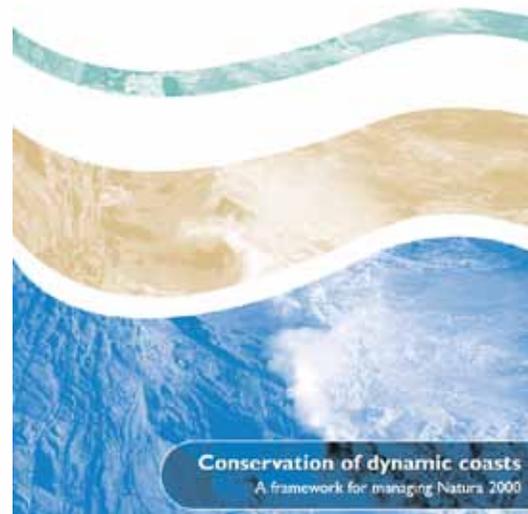
January 2012

Contractors:
HR Wallingford
AMEC Environment & Infrastructure UK Ltd
(formerly Entec UK Ltd)
The Met Office
Collingwood Environmental Planning
Alexander Ballard Ltd
Frost Wildess Associates
Mormonconomics

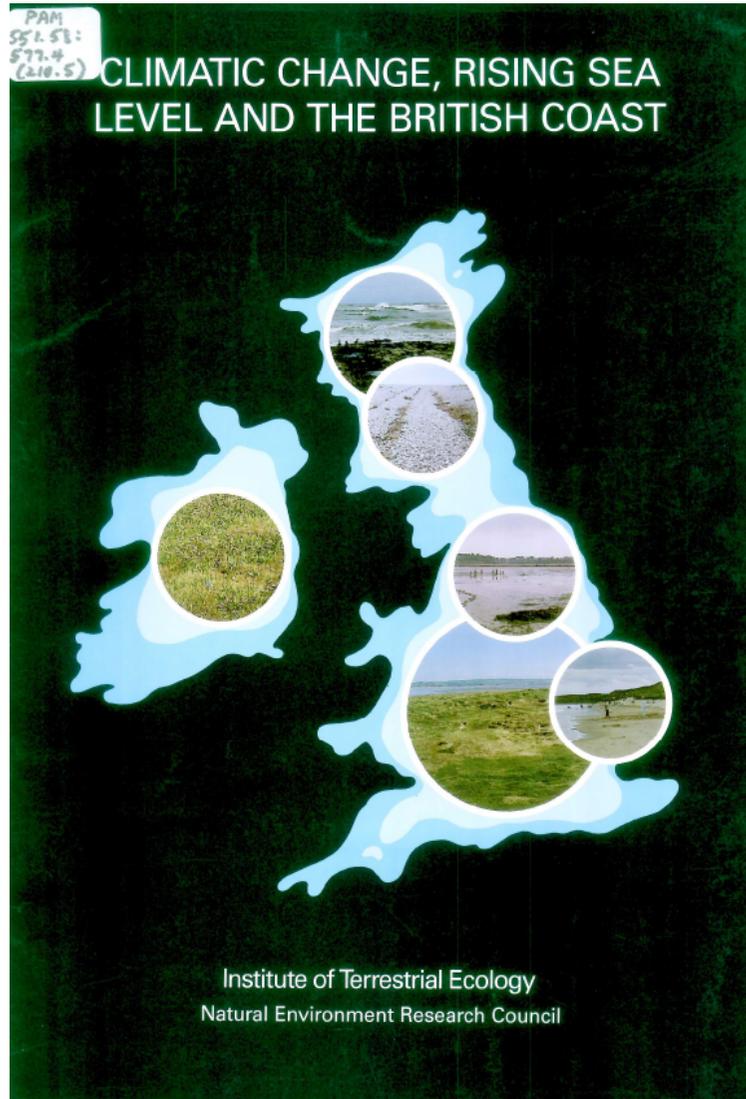
A UK-wide review of



working today
for nature tomorrow



Boorman *et al.* 1989



A rise in sea level would result in increased erosion, but such erosion can usually release enough sediments into circulation to allow the coast to reform more or less unchanged, the classic 'sea level transgression'.

Variables (11)

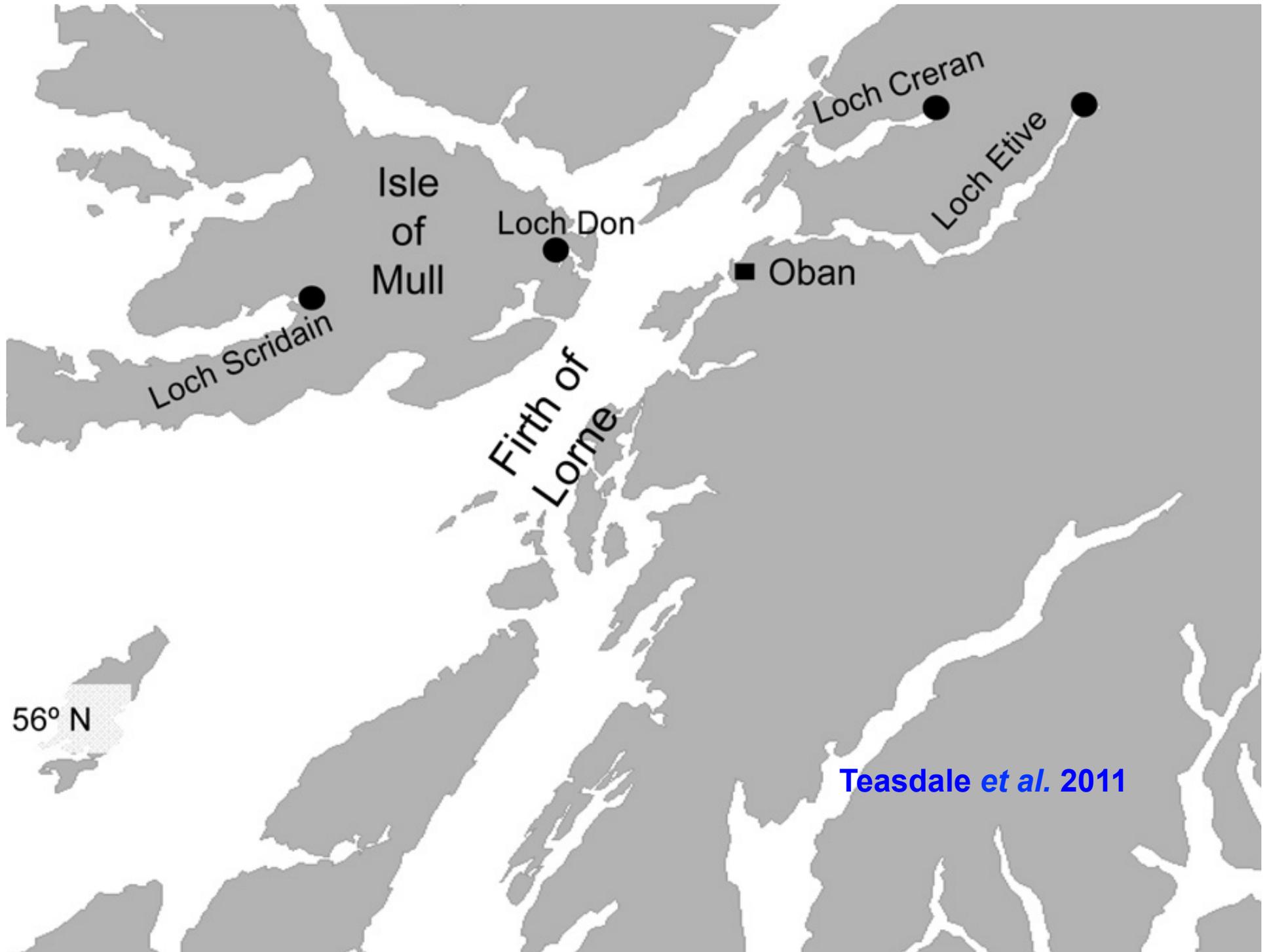
- Waves
- Winds
- Currents
- Tides
- Freshwater forcing
- Sediment supply
- Vegetation structure
- RSLR
- Human intervention
- Adjacent habitat
- Ecogeomorphic feedback (including bioturbation)

Base of saltmarsh

- Adjoins mudflats (or sandflats)
- Mudflat/pioneer relationship complex, e.g. bioturbation
- Pioneer is being displaced by lower Atlantic saltmarsh (*Puccinellia*)

Base of saltmarsh

- Where eroding (e.g. SE England) this is primarily due to wave action, not RSLR
- Most UK saltmarsh is accreting at lower levels



Pioneer *Salicornia* saltmarsh, Caerlaverock,
1998





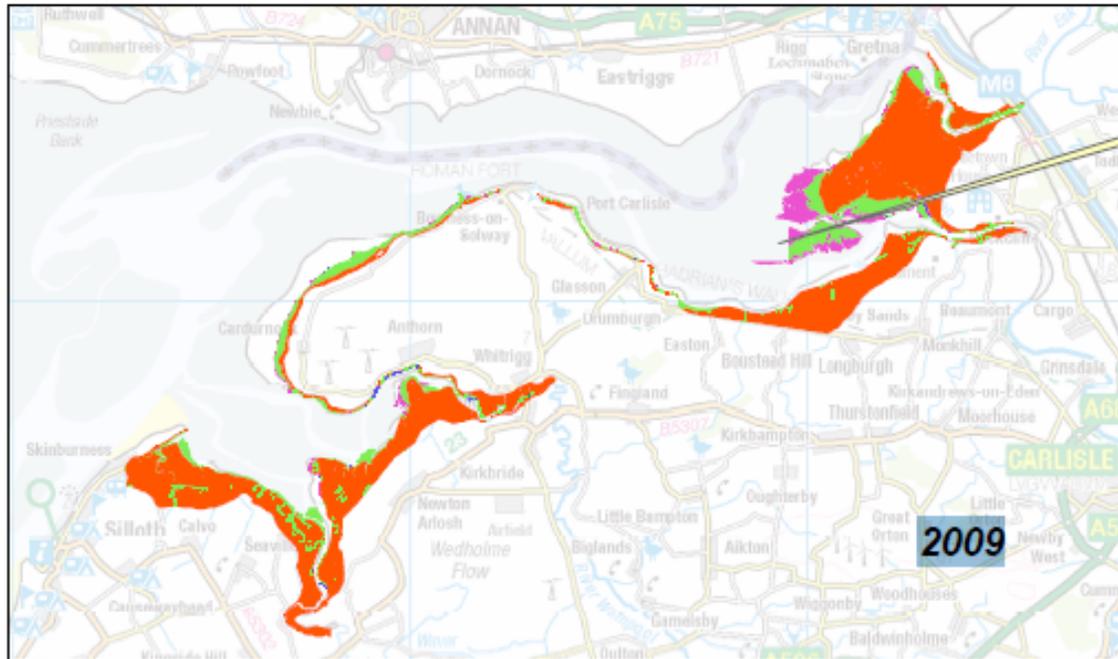
Caerlaverock 2012 – pioneer saltmarsh displaced by lower saltmarsh



15/08/2012 22:34:27 (+0.0 hrs) Lat=54.9632 Lon=-3.49992 WGS 1984

Area not mapped

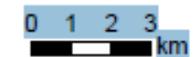
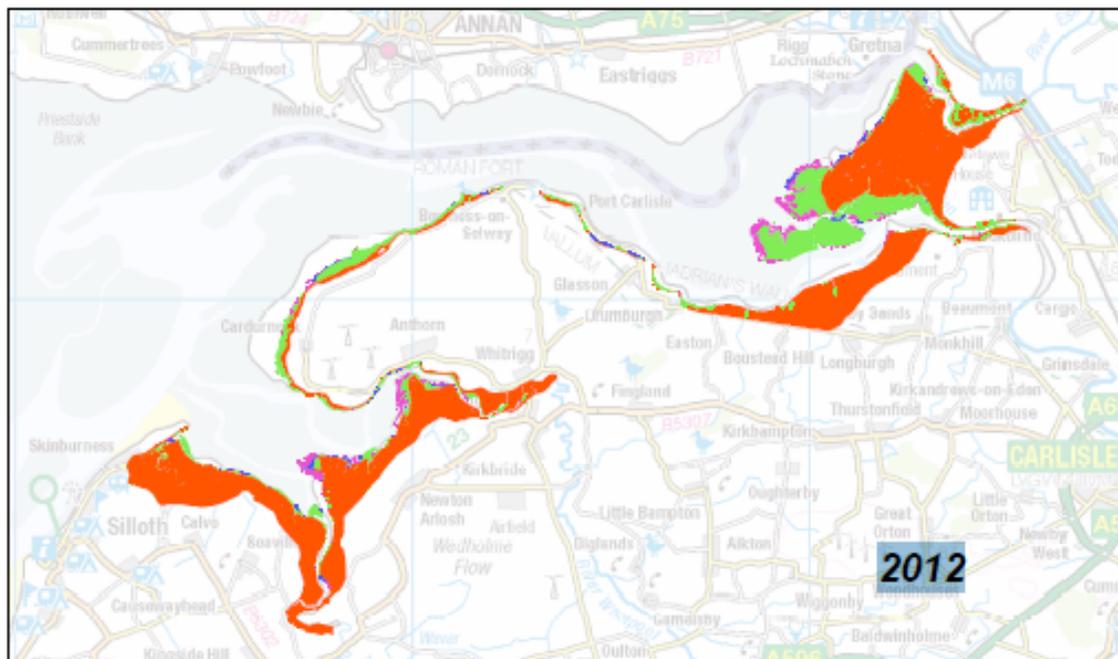
EA Solway Saltmarsh Zonation



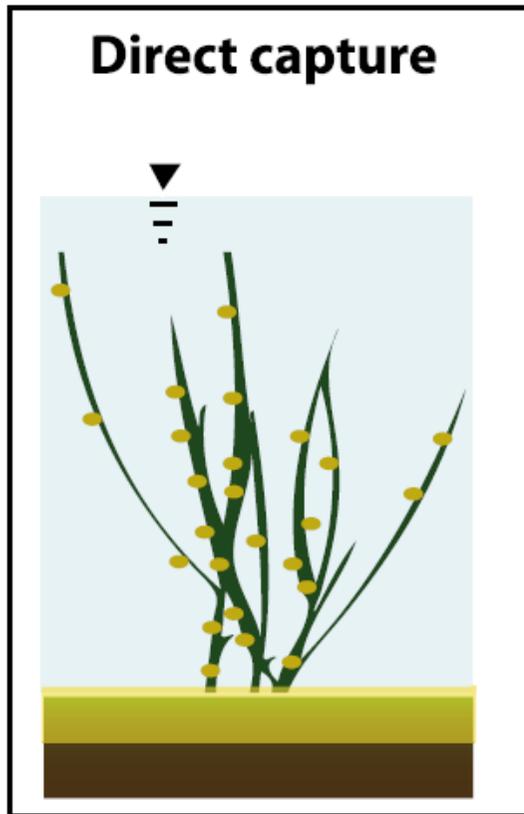
Surveillance_SM_zonation

Classific

- HIGH MARSH
- MID-LOW
- NOT SALT MARSH
- PIONEER
- REED BEDS
- SPARTINA

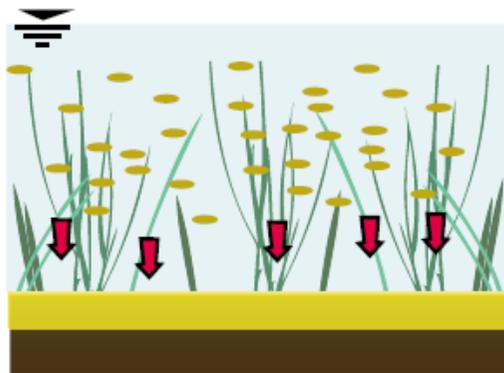


Ecogeomorphic feedback



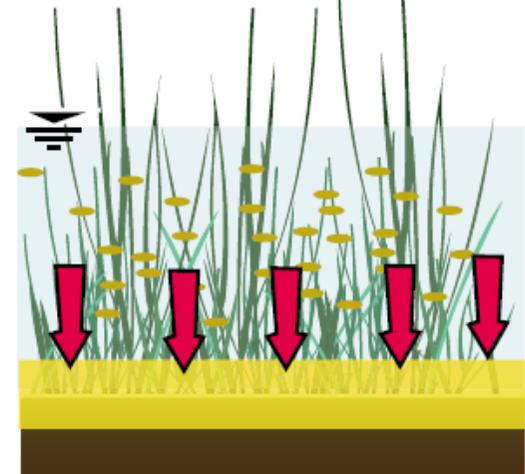
Plant modulated settling

Less biomass = faster flow,
more turbulence, lower
effective settling velocity
Less sedimentation



Plant modulated settling

More biomass = slower flow,
less turbulence, higher
effective settling velocity
More sedimentation





Vegetation can also influence erosion



26/06/2012 09:44:45 (+0.0 hrs) Lat=56.7582 Lon=-5.85402 WGS 1984



27/06/2012 14:35:47 (+0.0 hrs) Lat=56.75135 Lon=-5.8454 WGS 1984

Question

Why is RSLR resulting in sediment accumulating only in the lower saltmarsh?

Question

Why is RSLR resulting in sediment accumulating only in the lower saltmarsh?

- Lower saltmarsh covered by sea for longer
- Vegetation on lower saltmarsh may have intercepted most of sediment

But

Two main study areas for RSLR

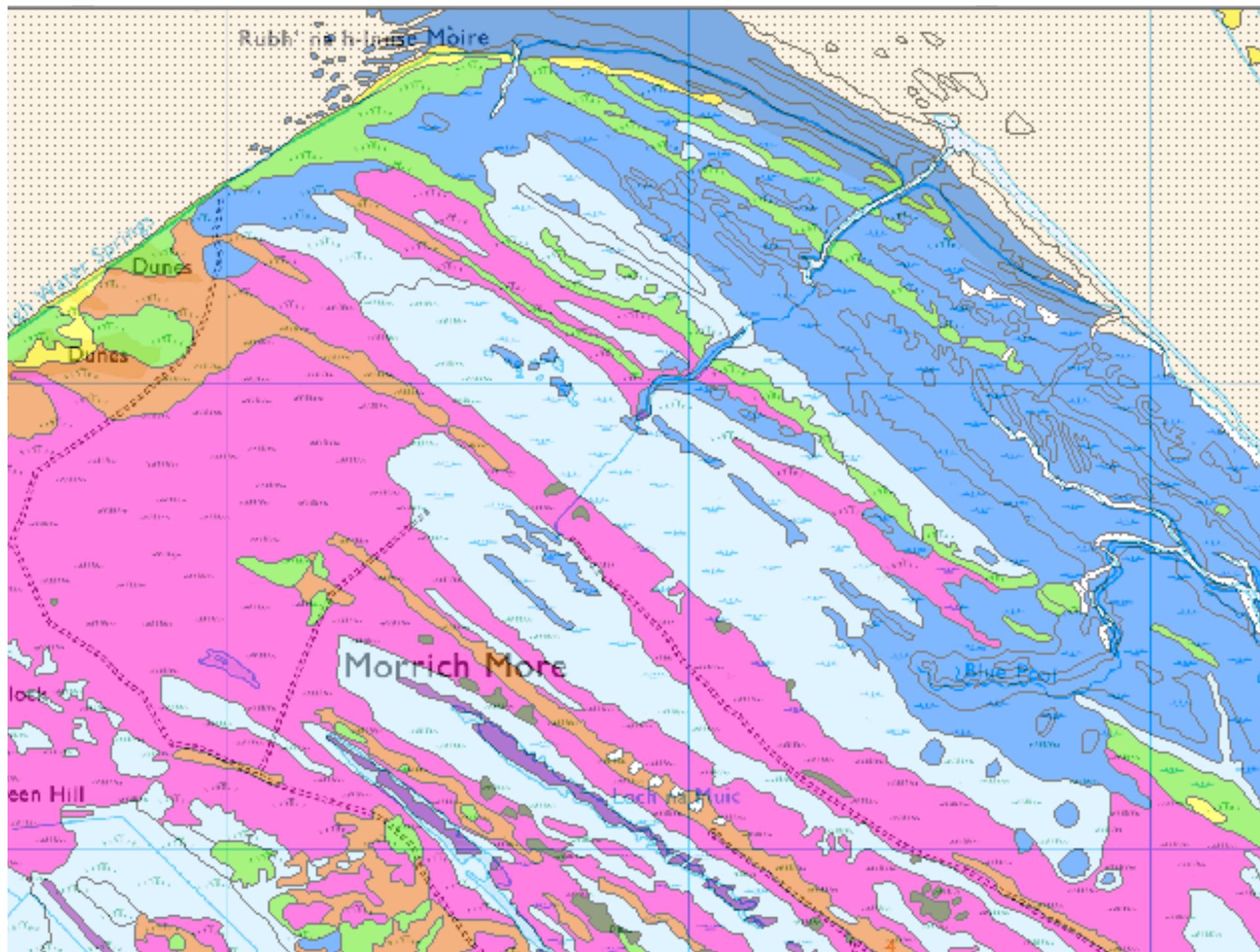
- Uists – long history of sinking. Machair, saline lagoons, lochs, dunes
- Morrich More – long history of emergence and progradation. Recent ‘switch’ to sinking suggested – looking for evidence. Dunes, saltmarsh, sandflats

Dargie Report

T. Dargie (2016). Morrich More
Coastal Change Analysis 1987 to
2015

*Scottish Natural Heritage
Commissioned Report No. 927*









Dargie Report

- Data matrix covering 1279 quadrats, 54 species over 27 years
- SNH asked him to find evidence of RSLR

Dargie Report

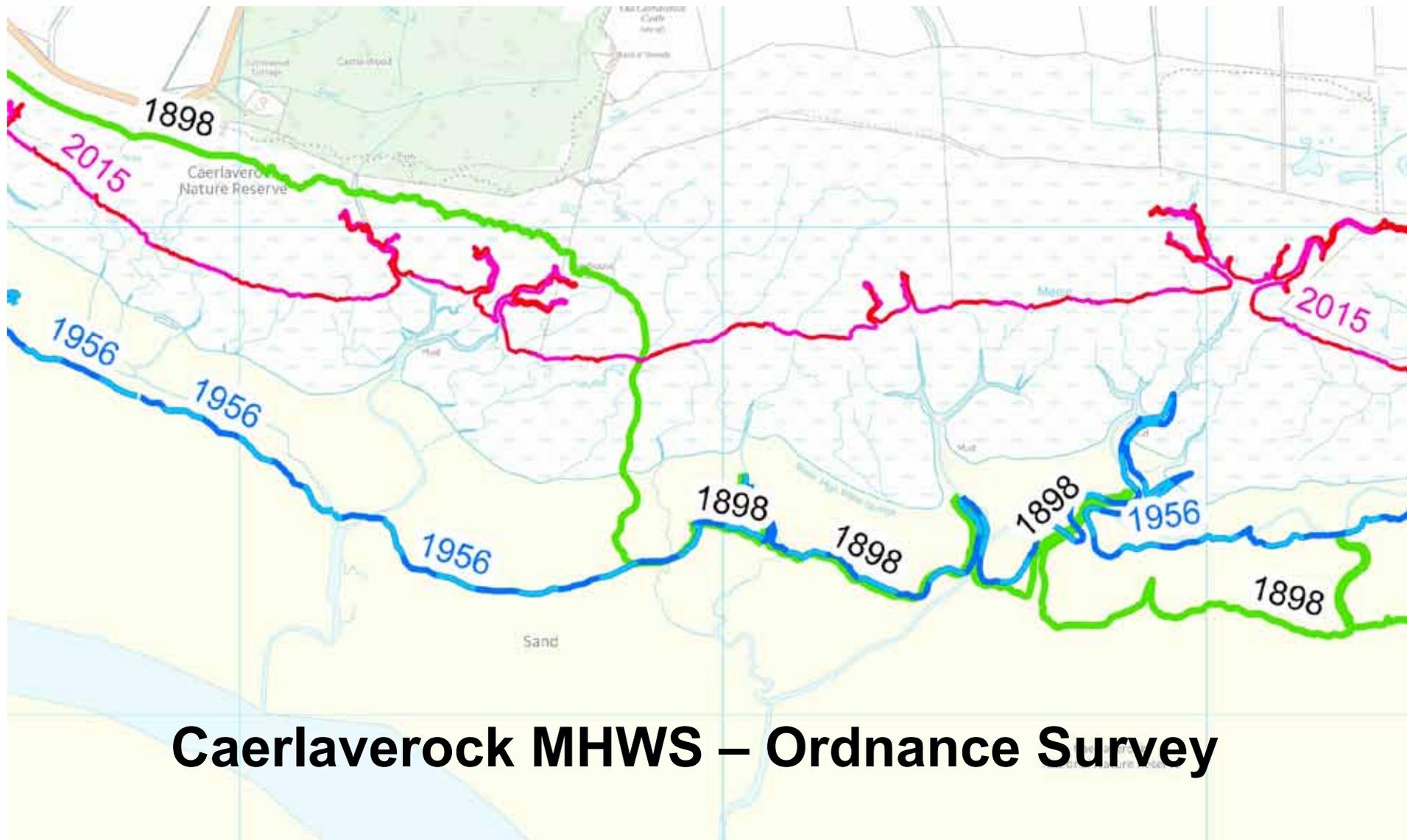
- Tidal modelling suggests that the 18.61-year lunar nodal cycle is responsible for most recent sea-level change at Morrich More. Models adjusted to include eustatic sea level rise and isostatic fall modify the lunar nodal cycle signal slightly, but it remains the strongest component of sea level change.
- The lunar nodal cycle signal has been detected as a major response of vegetation within permanent quadrat data. It is a clear signal over time within strong elevation and wetness gradients which structure Morrich More saltmarsh. This is the first time that a lunar nodal signal has been identified in UK and European saltmarsh vegetation science. Its strength suggests that this factor is much more important in saltmarsh development and change than its contribution to tidal range would indicate.

Landward migration of saltmarsh

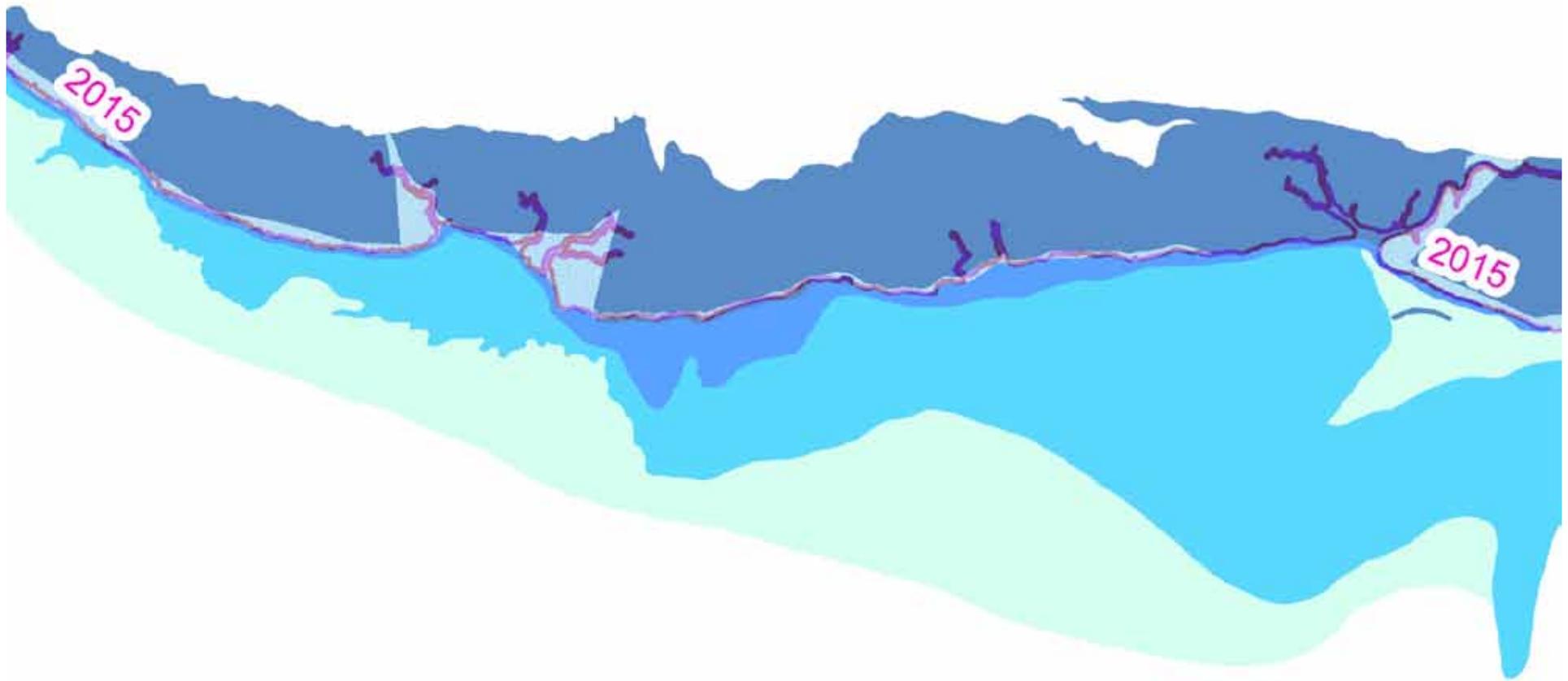
Recorded on both coasts of N America. Only one known case in UK – Lower Test (Hampshire) but could be due to management for fisheries, not to RSLR

Evidence of absence or just absence of evidence?

Upper margin is complex



Caerlaverock MHWs – Ordnance Survey



- Dark purple – *Festuca rubra* upper saltmarsh SM16
- Royal blue & turquoise - *Puccinellia maritima* lower saltmarsh SM13
- Pale green - *Salicornia* pioneer saltmarsh SM8
- Pale blue stipple – *Elymus repens* saltmarsh SM28

Intertidal saltmarsh

58.6% of saltmarsh (classed as SM by National Vegetation Classification) in Scotland is above MHWS so if intertidal is defined as MLWS-MHWS only 41.4% of saltmarsh is intertidal.

Analysis by Carmen Mayo (SNH)

No landward migration of saltmarsh

Evidence of absence or just absence of evidence?

If RSLR operates on a gentle gradient, surely saltmarsh **MUST** be advancing landwards?

This assumes that the landward margin is passive

Morrich More and Dargie again

No landward migration of saltmarsh

Evidence of absence or just absence of evidence?

If RSLR operates on a gentle gradient, surely
saltmarsh **MUST** be advancing landwards?

High tides only twice a day for 1-2 hours

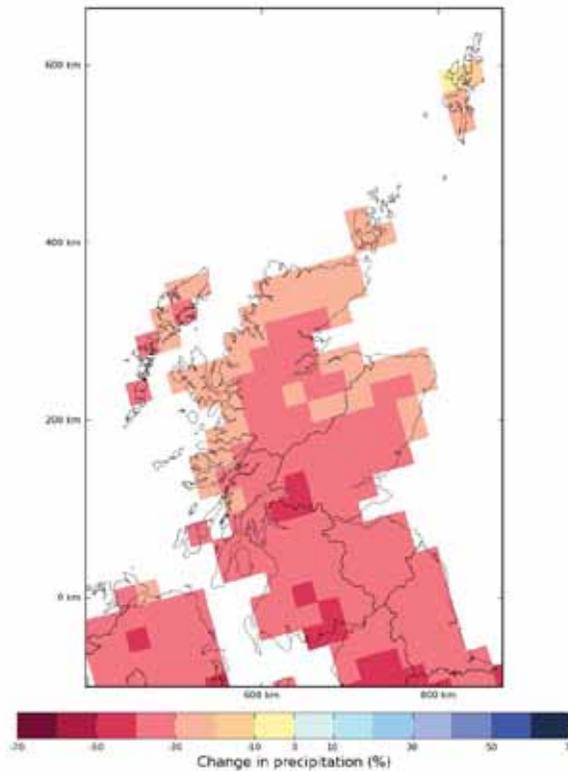
Freshwater forcing is constant – Dargie

Why no landward migration?

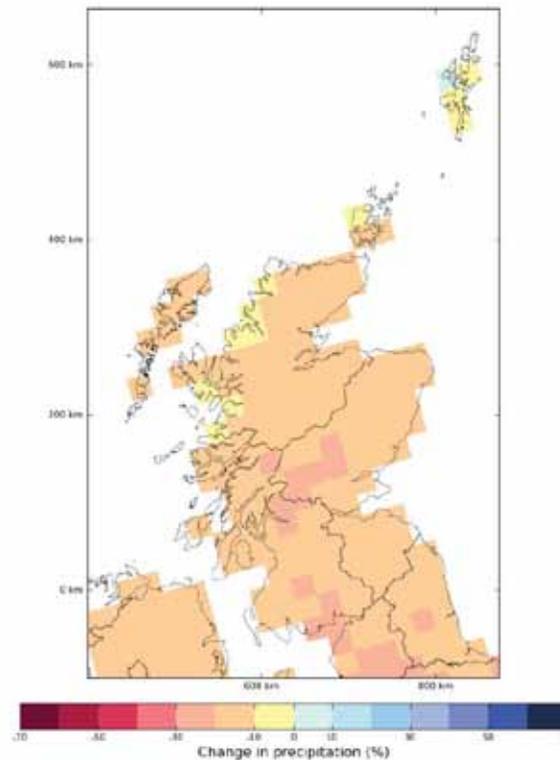
- High tide (salt water) only for 1-2 hours twice a day
- Groundwater forcing (as seaward flow) from terrestrial water table is constant
- Upper saltmarsh boundary thus held stable in 'dynamic equilibrium'
- With increased RSLR, surely the equilibrium point will shift inland?



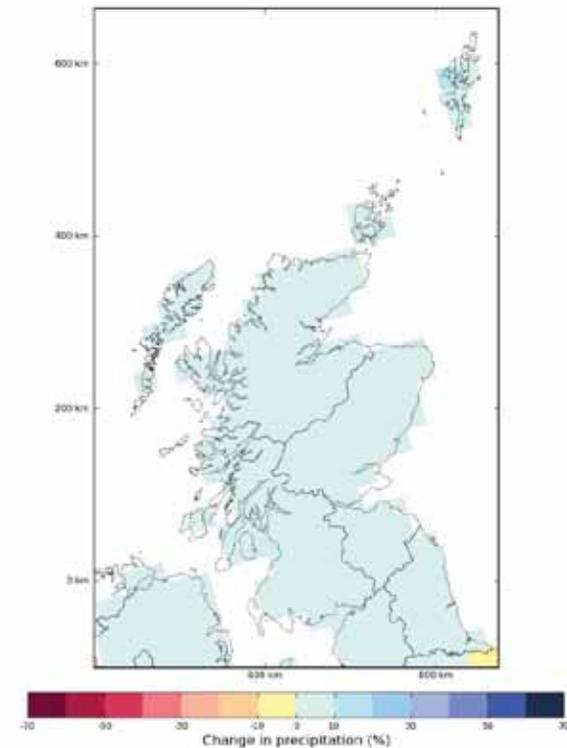
UKCP09 estimates of the percentage change in summer mean precipitation, for the 2080s under the Medium emissions scenario, at 3 probability levels



10%



50%



90%

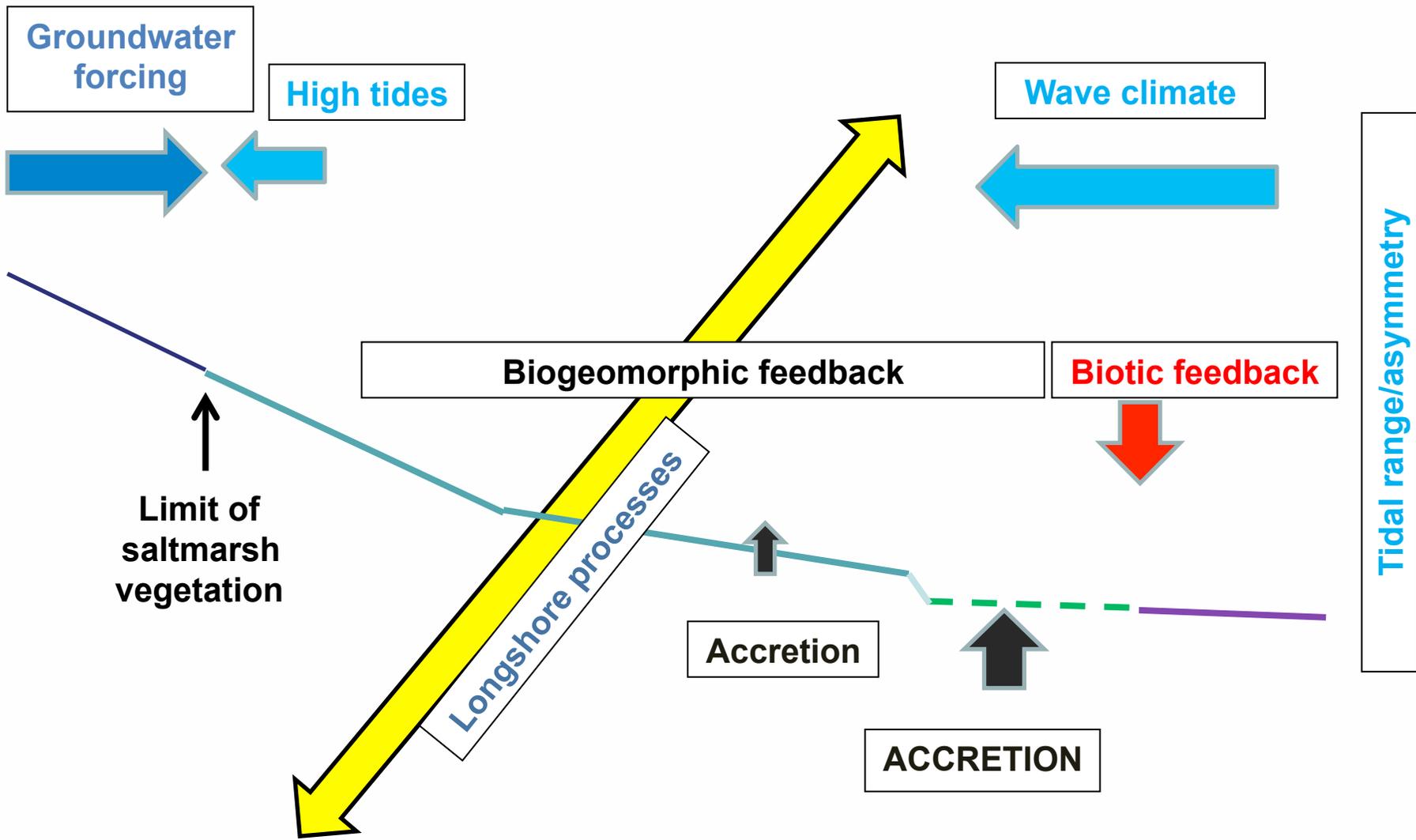
Why no landward migration?

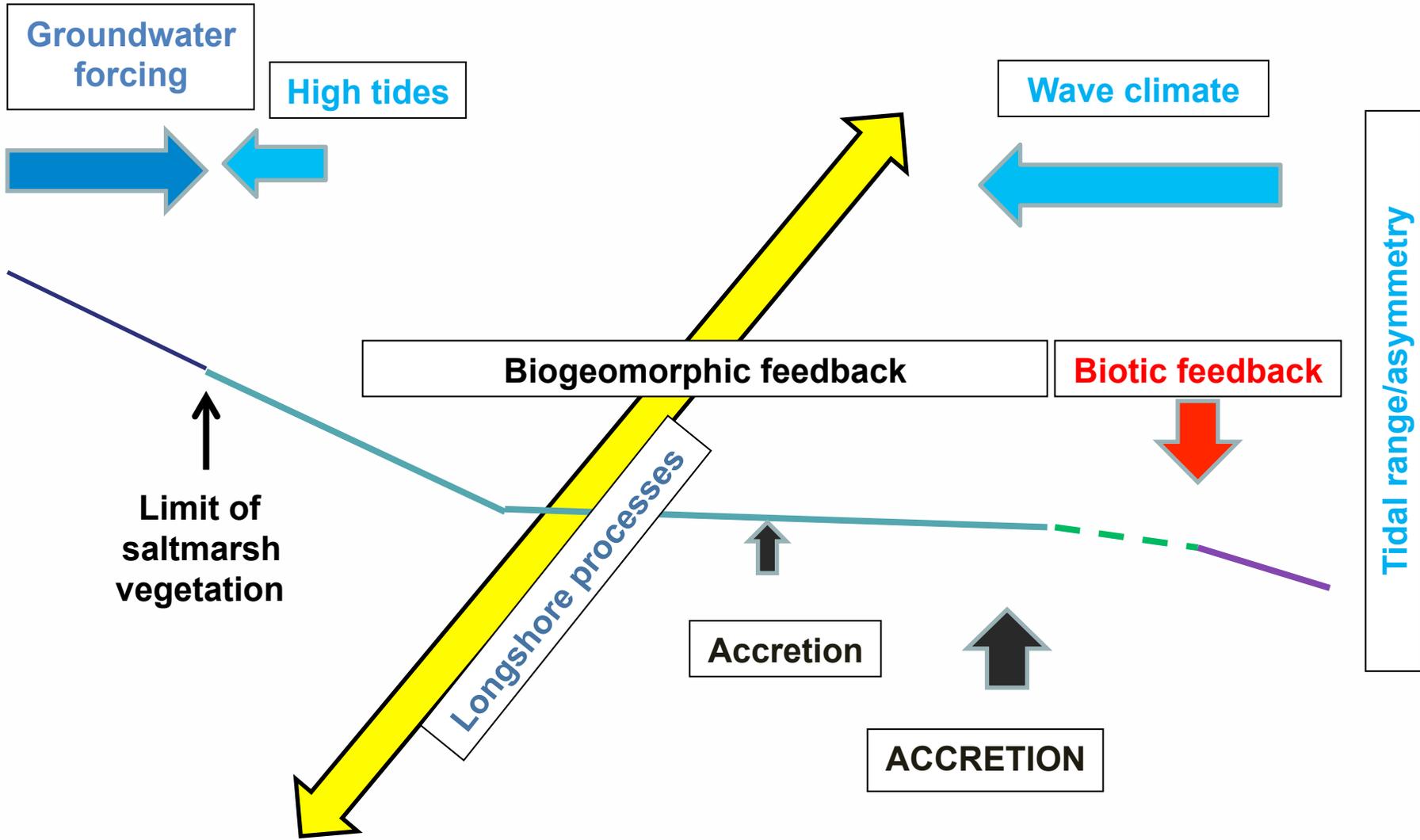
- High tide (salt water) only for 1-2 hours twice a day
- Groundwater forcing from terrestrial water table is constant
- RSLR will tend to push saltmarsh landwards as it will keep increasing
- Groundwater forcing also likely to increase due to increases in rainfall but seasonality and lag might affect influence on saltmarsh



Saltmarsh and climate change

- Complex of abiotic and biotic processes
- Saltmarsh interacts with marine and terrestrial processes
- Operate on saltmarsh expanse, at upper and lower margins, and alongshore
- Model specifically excludes landward migration (though it might operate on a very small number of sites)





Thanks to:

Alistair Rennie (SNH), Carmen Mayo (SNH) and Susi Hodgson (SNH)