Restoration Trajectories in Peatland Surface Motion using Satellite Radar

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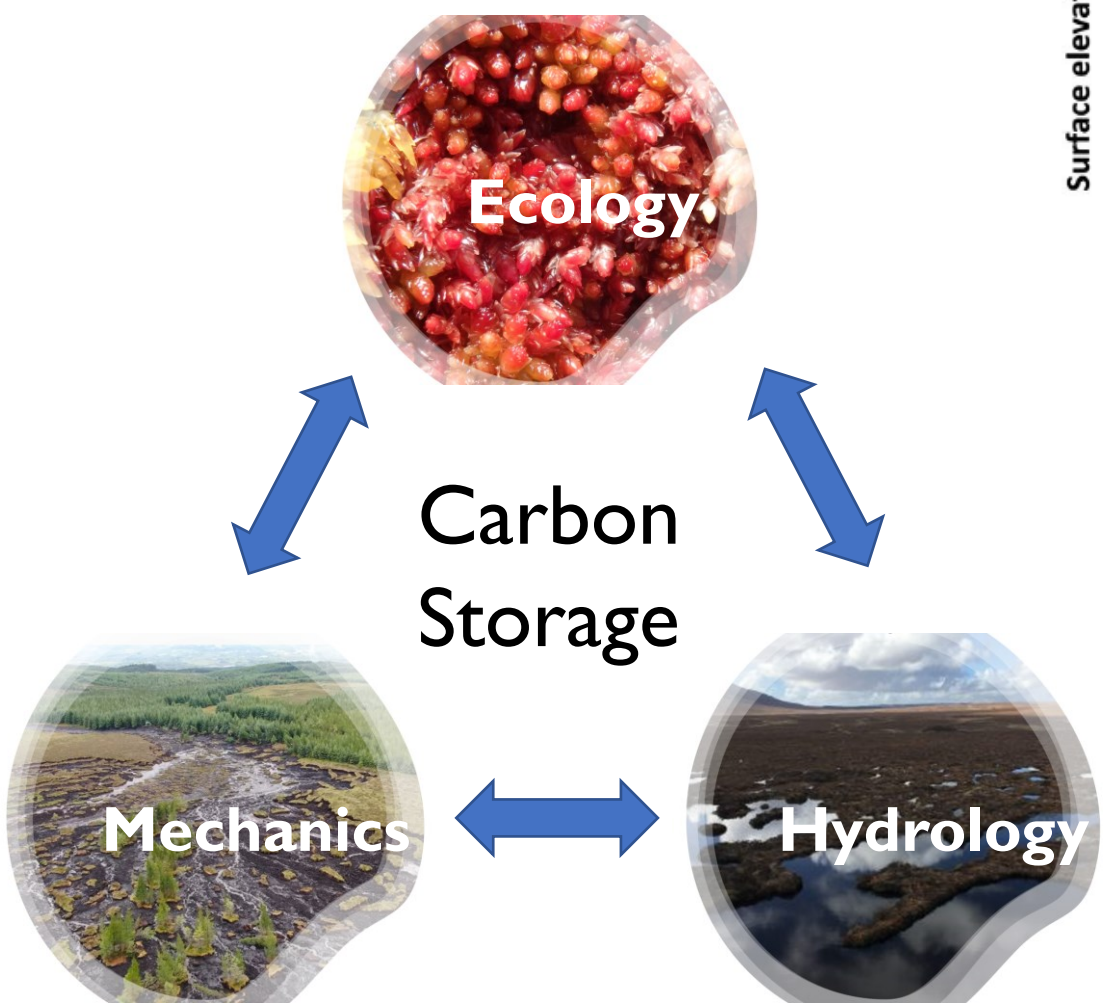
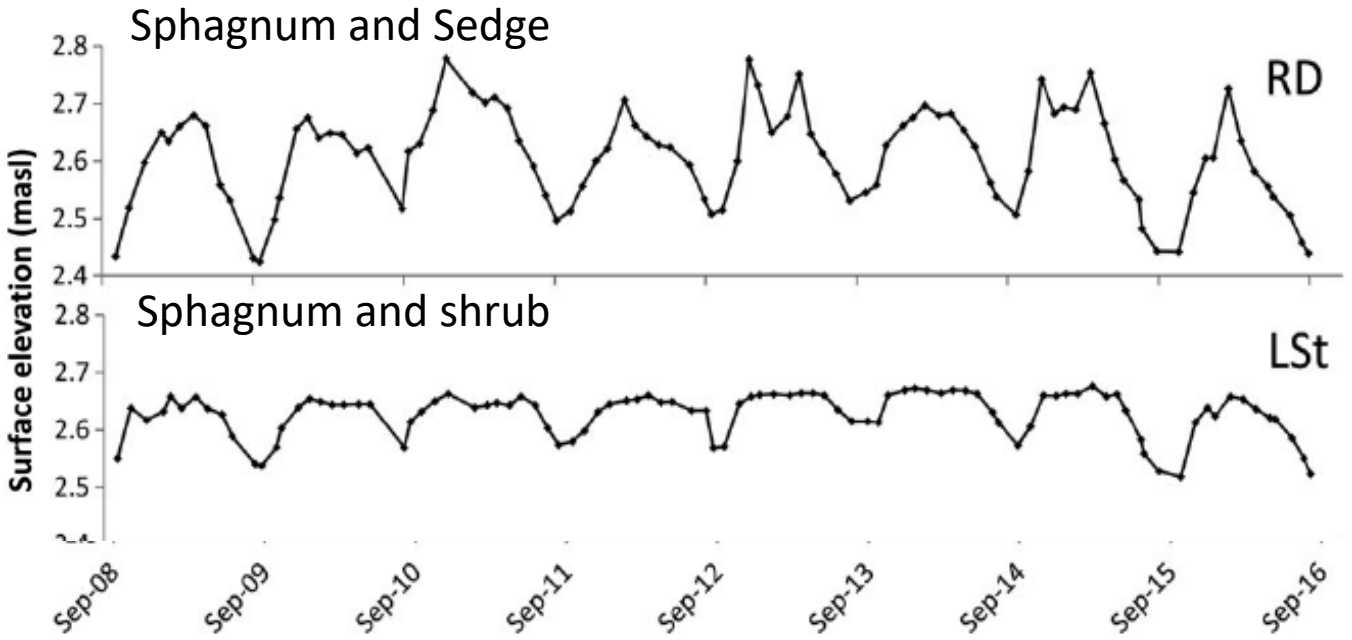
What is Peatland Condition?



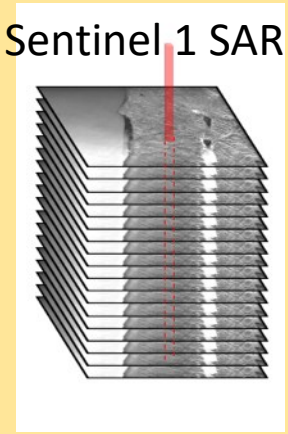


Howie and Hebda (2018)

How peat swells and shrinks in response to changes in water content is a measure of condition.

This movement can be measured using InSAR (interferometric satellite RADAR)

ESA Sentinel 1 SAR Data

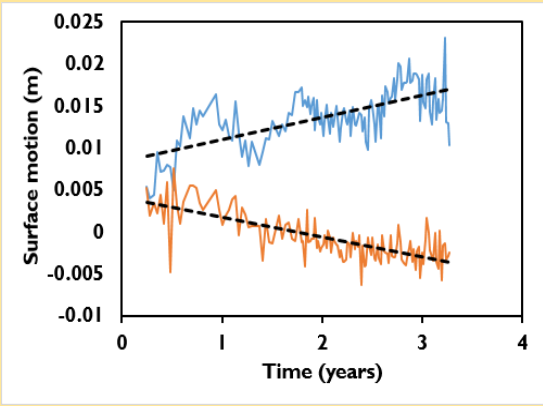


Every 6-12 days

APSIS
InSAR Processing
Technique*

Terra Motion

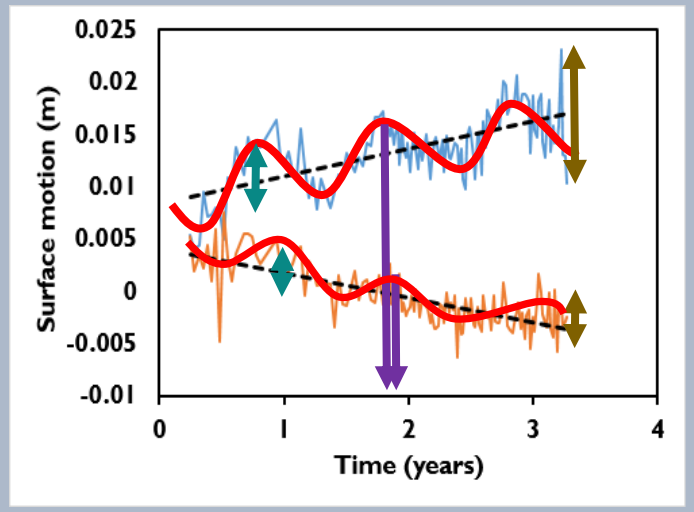
Time series/long term velocity



Per 20m or 90m pixel

Time series analysis

Extract and classify surface motion metrics



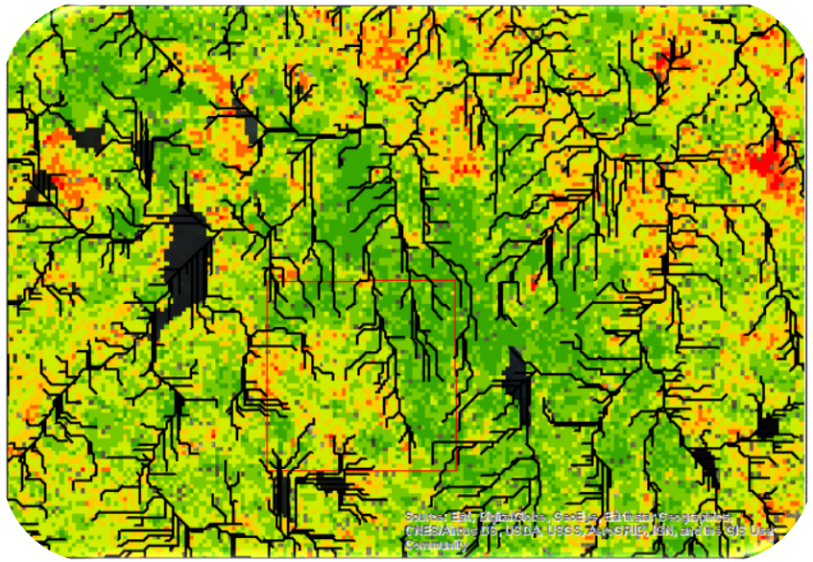
- Trend
- Seasonal Oscillations
  1. Amplitude
  2. Timing
  3. Regularity
  4. Shape
- Variance

Validation

Spatial distribution of metrics
vs
Field Observations
(Ecology, Hydrology, Levelling)

Application

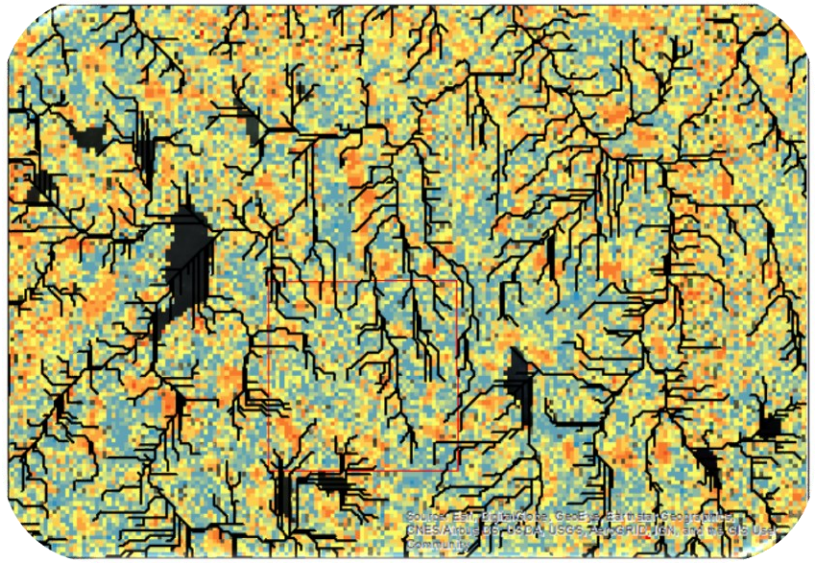
Three key variables



VELOCITY

Multi-annual trend of surface motion

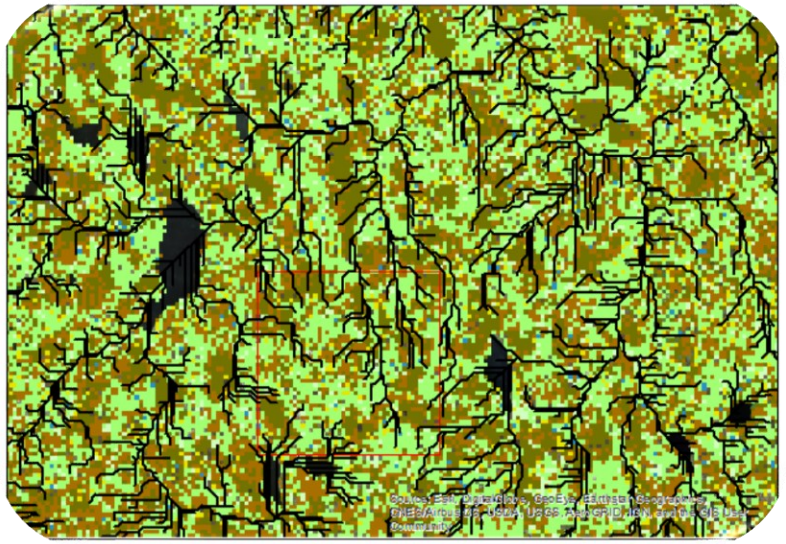
Accumulation / consolidation



AMPLITUDE

Amplitude of the seasonal annual peak.

Poro-elastic response to water storage



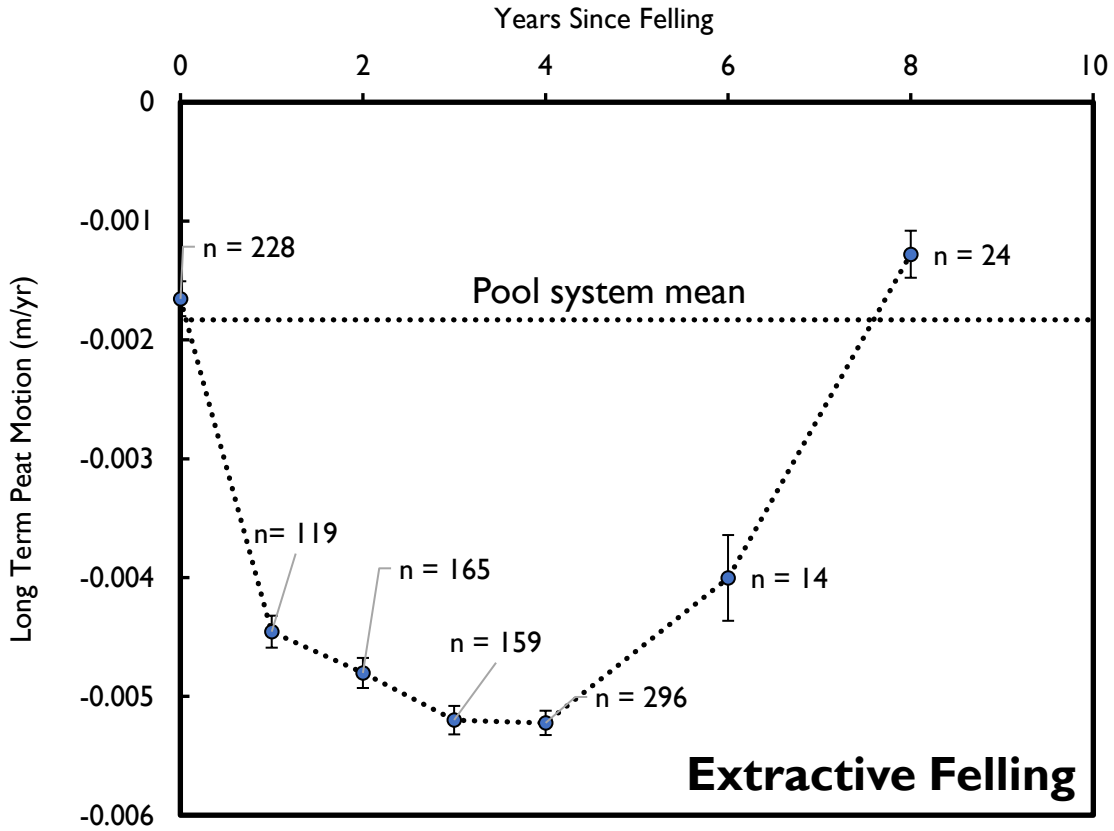
TIMING

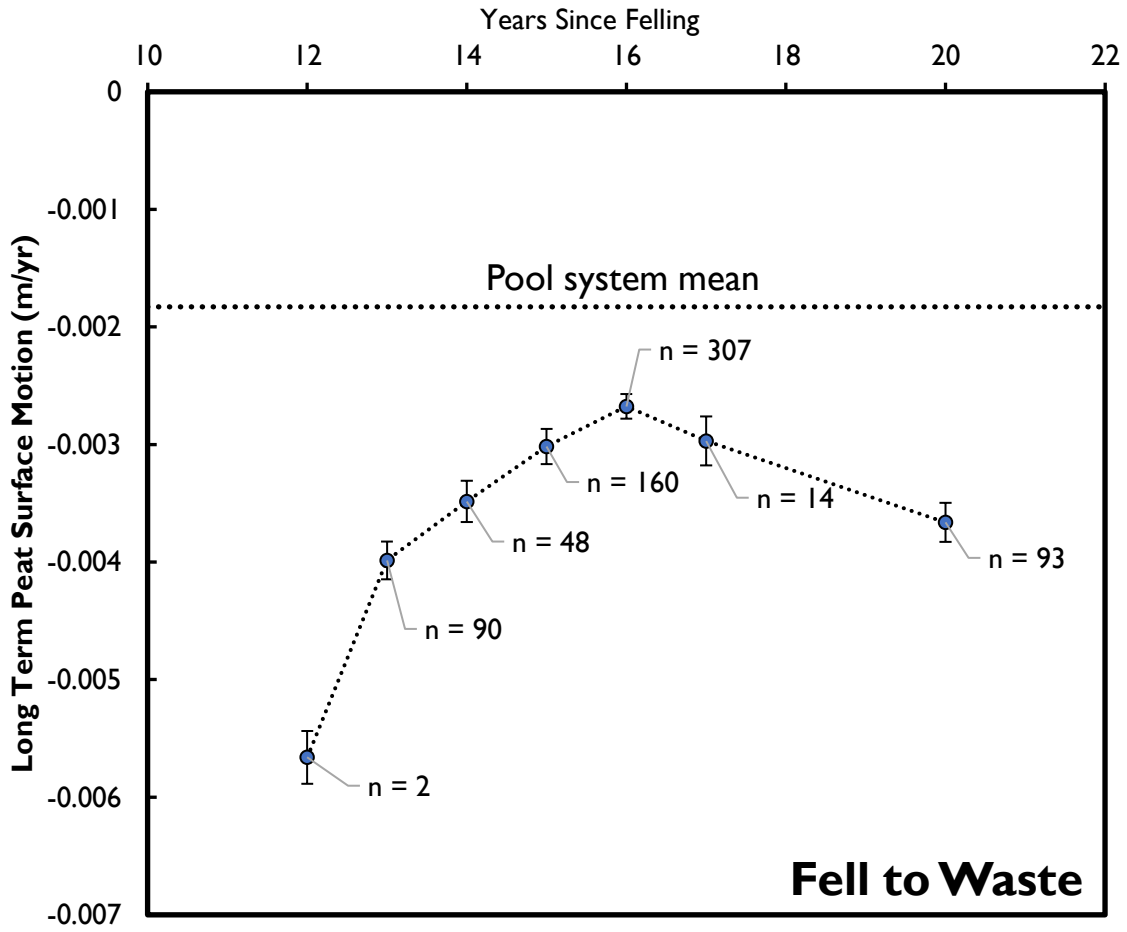
Date of the seasonal peak

Plant functional type/ecohydrology, landscape position

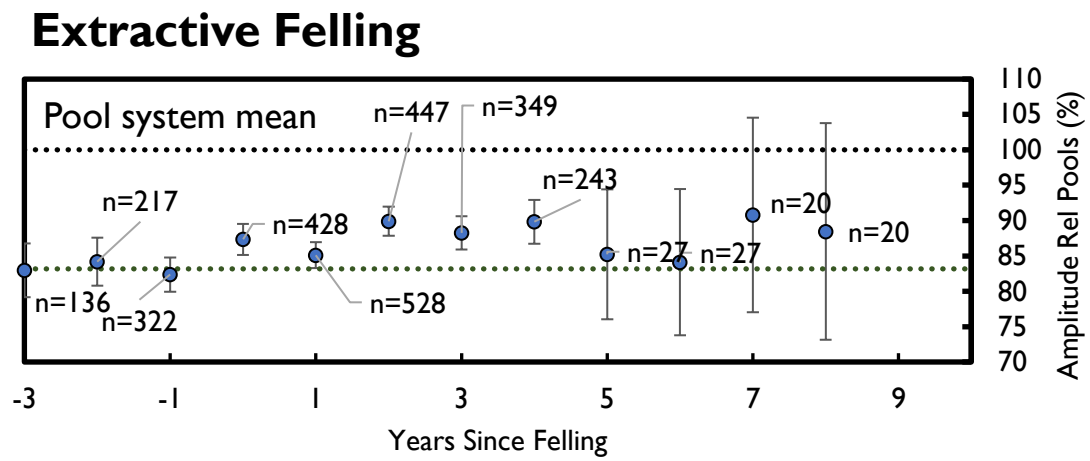
Restoration Trajectory – Velocity (Compaction)

- Compaction from extractive felling and restoration less and recovery faster than fell to waste
- Secondary Interventions lead to secondary compaction events

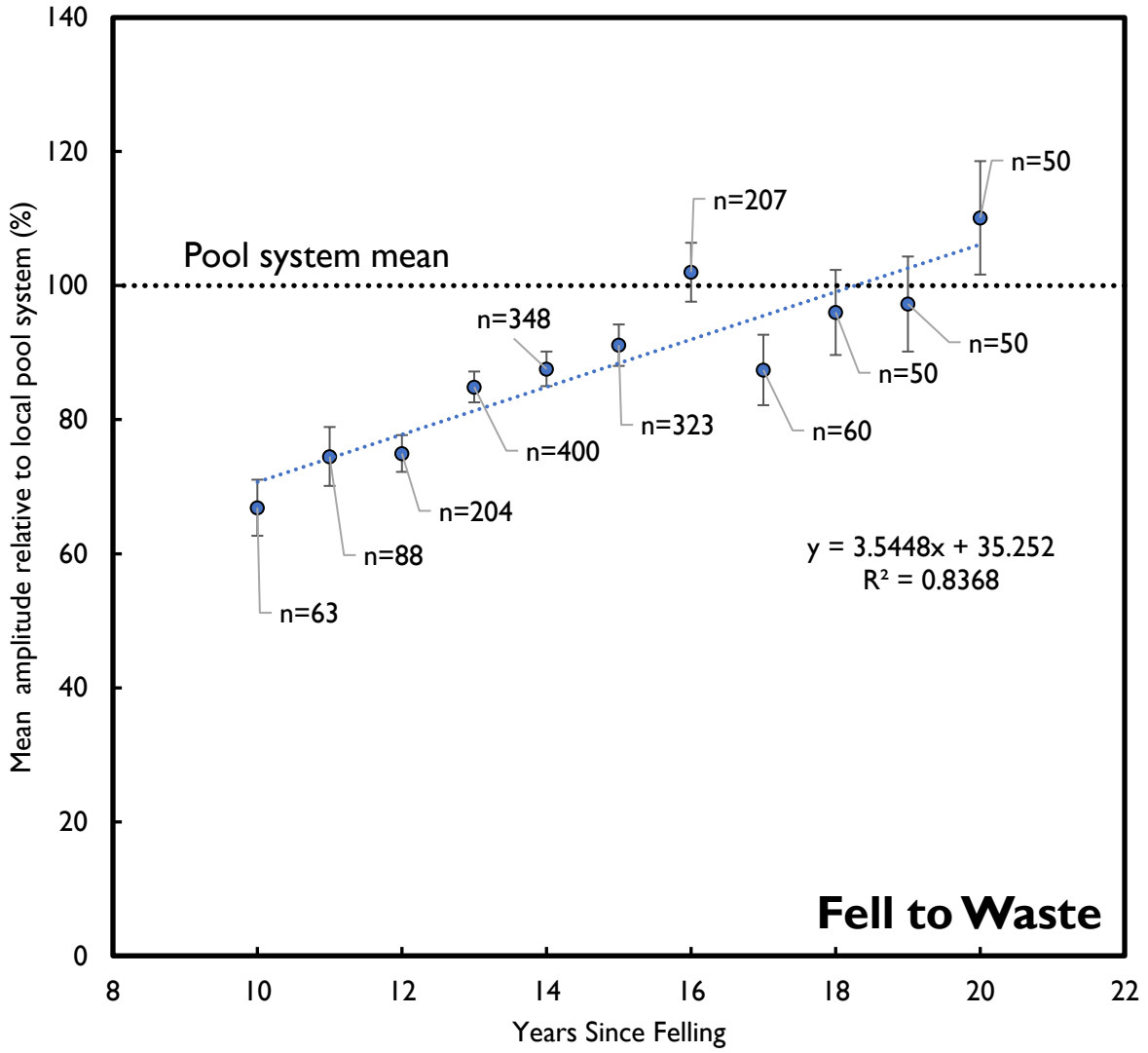




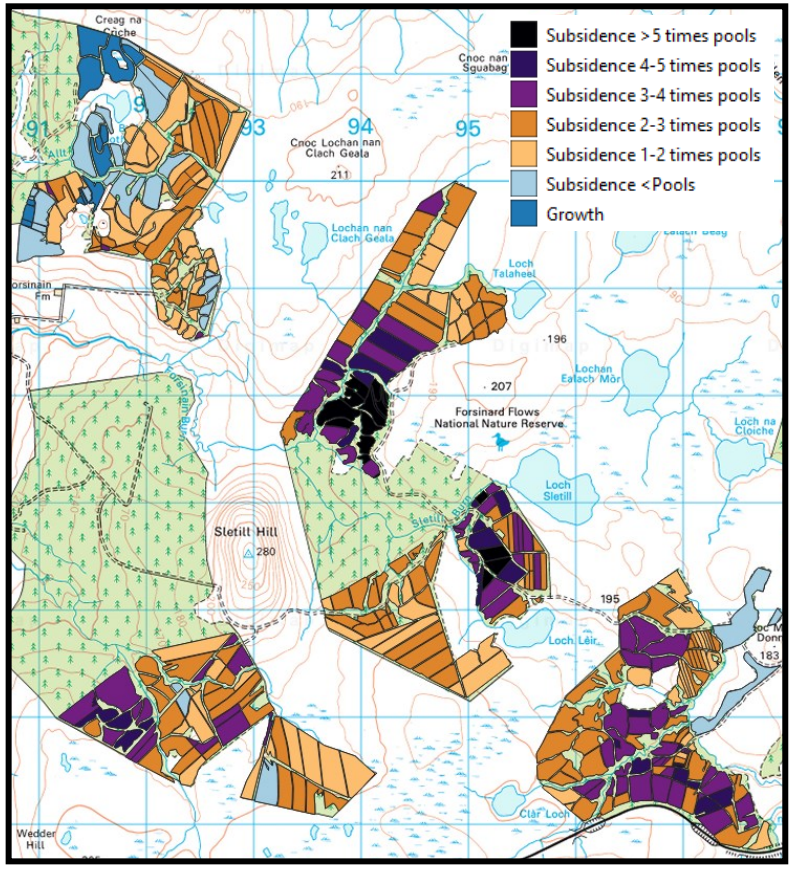
Restoration Trajectory – Amplitude (Surface Dynamism)

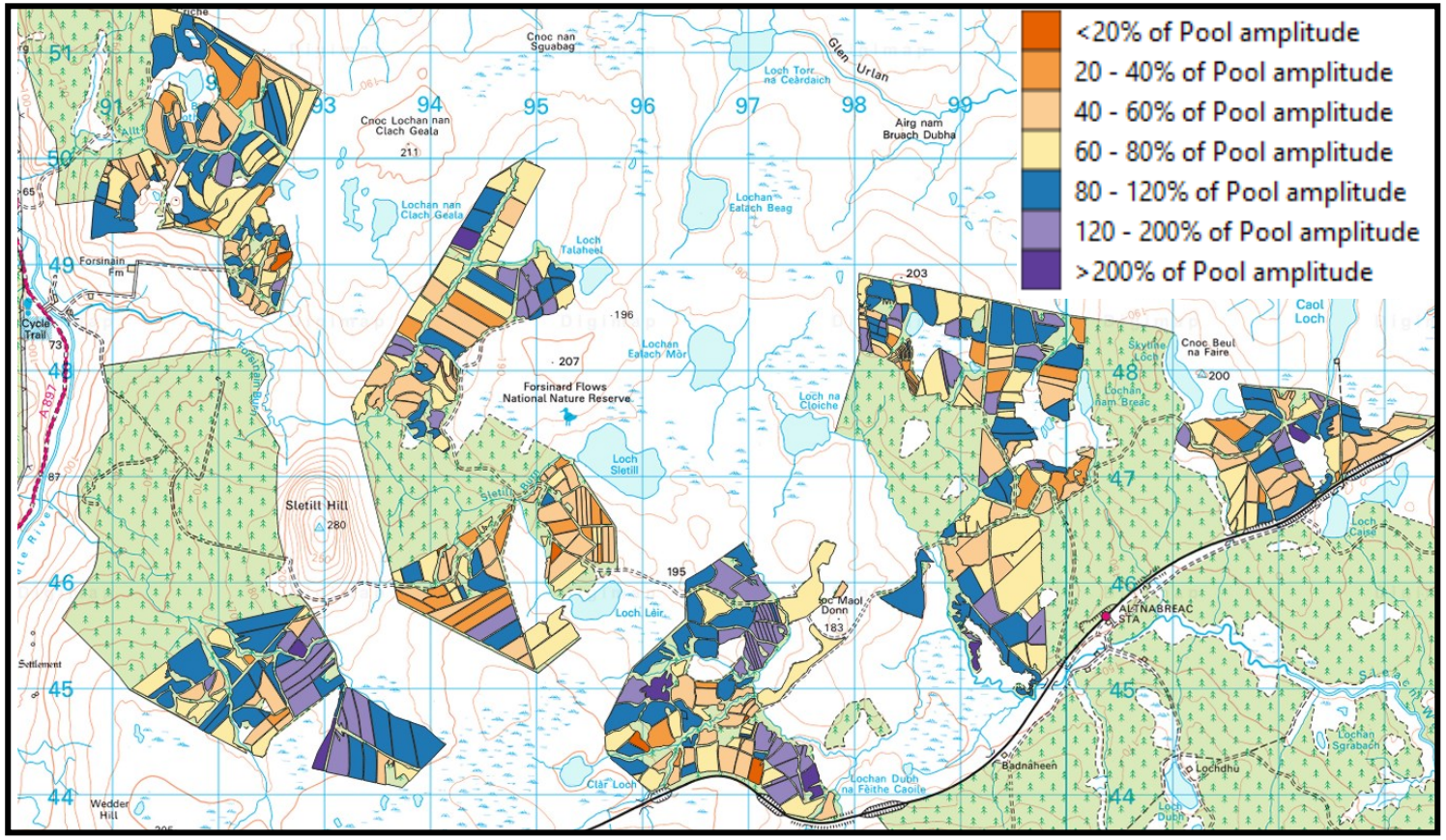


- Peat surface dynamism is higher post felling but slower to recover using extractive felling
- Clear trajectory of increasing surface dynamism in fell to waste sites



Mapping Restoration Trajectory



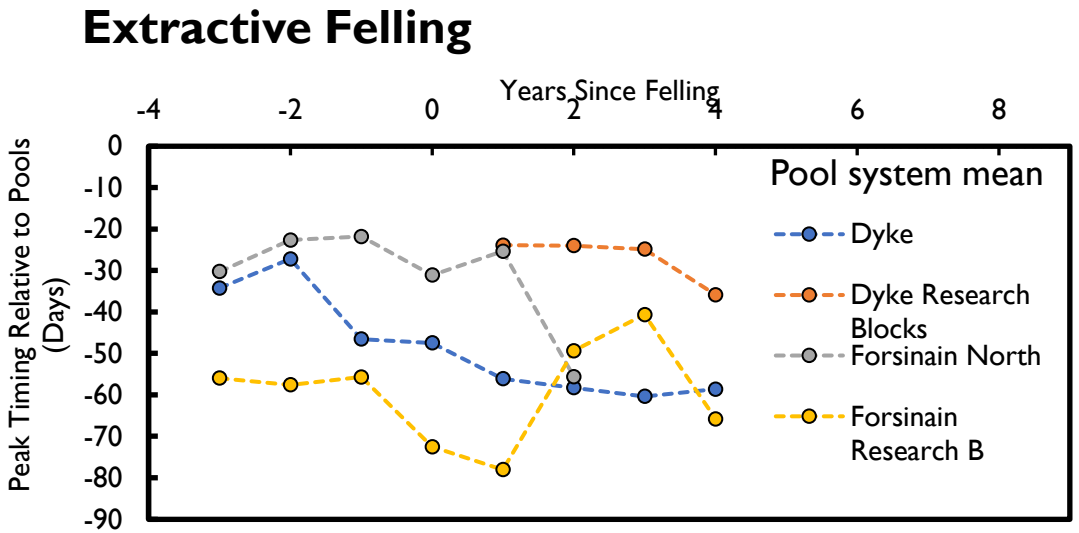


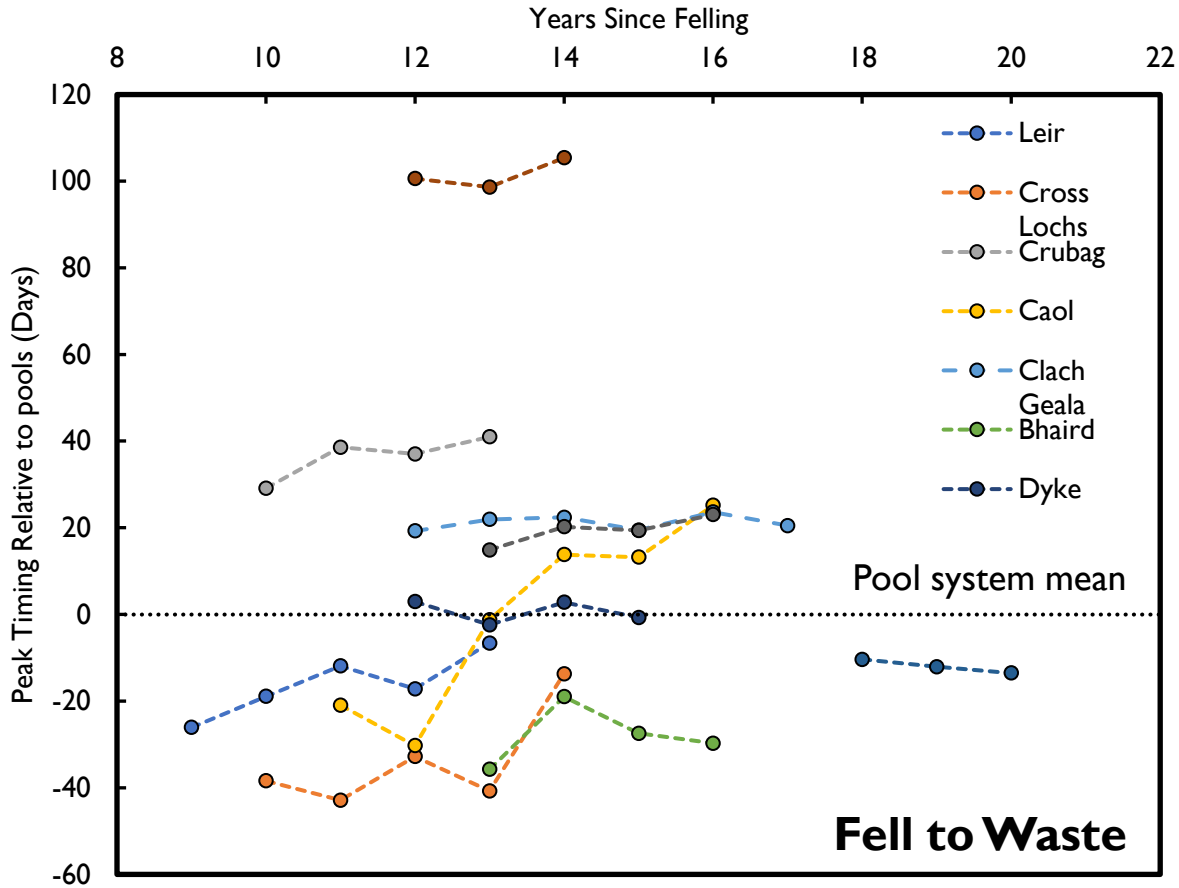
Velocity – mapping by forest block identifies hotspots of long term growth and subsidence

Amplitude associated with peatland resilience mapping by forest block allows high and low amplitude areas to be monitored. Very high amplitude – bog burst risk?

Restoration Trajectory? – Peak Timing

- Peat timing shows no trend with time since restoration
- Seems to be predetermined by forest block location
- End point indicator?

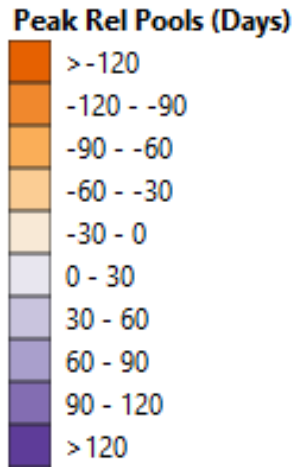


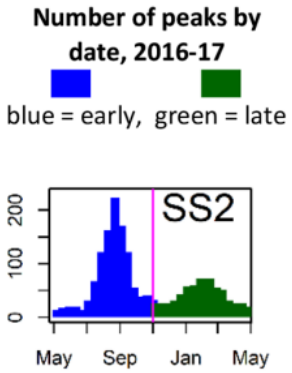


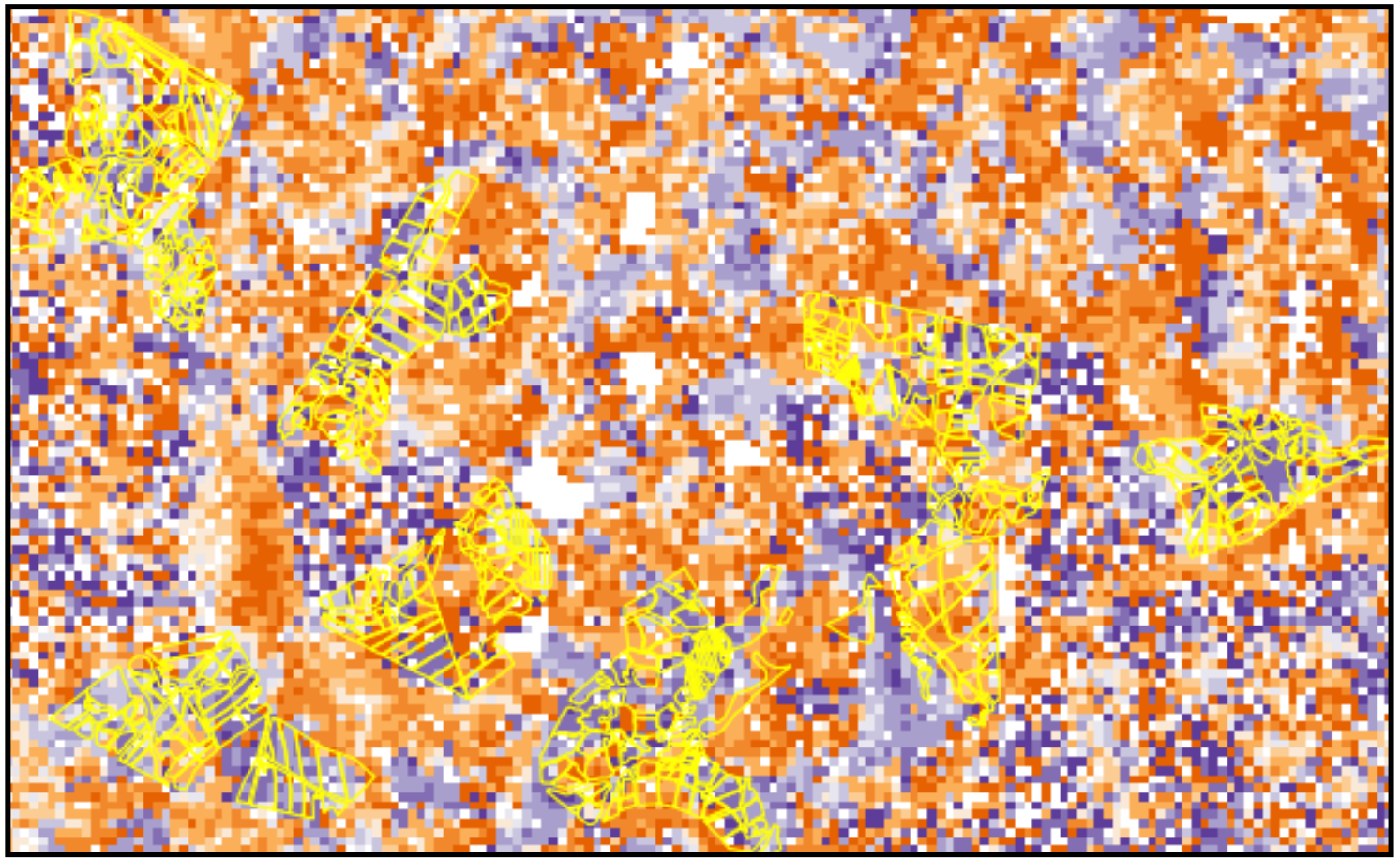
Restoration Trajectory? – Peak Timing

‘Shrub Dominated’

‘Sphagnum Dominated’

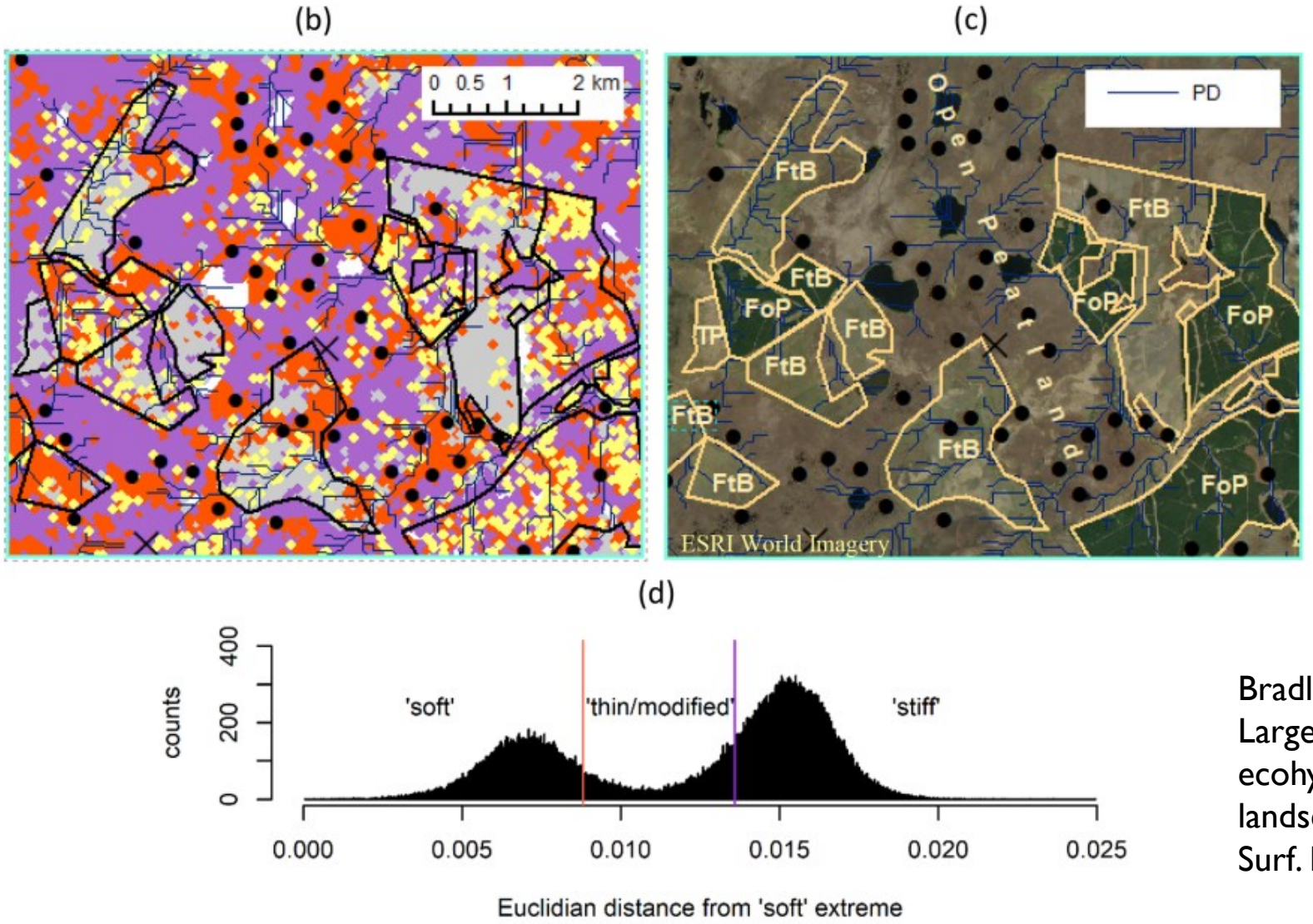






- Maximum peak timing will be a result of both landscape position and plant functional type and the coupling between the two (i.e. under near natural conditions, flatter wetter areas are more likely to have sphagnum which in turn has a high capacity for water storage)

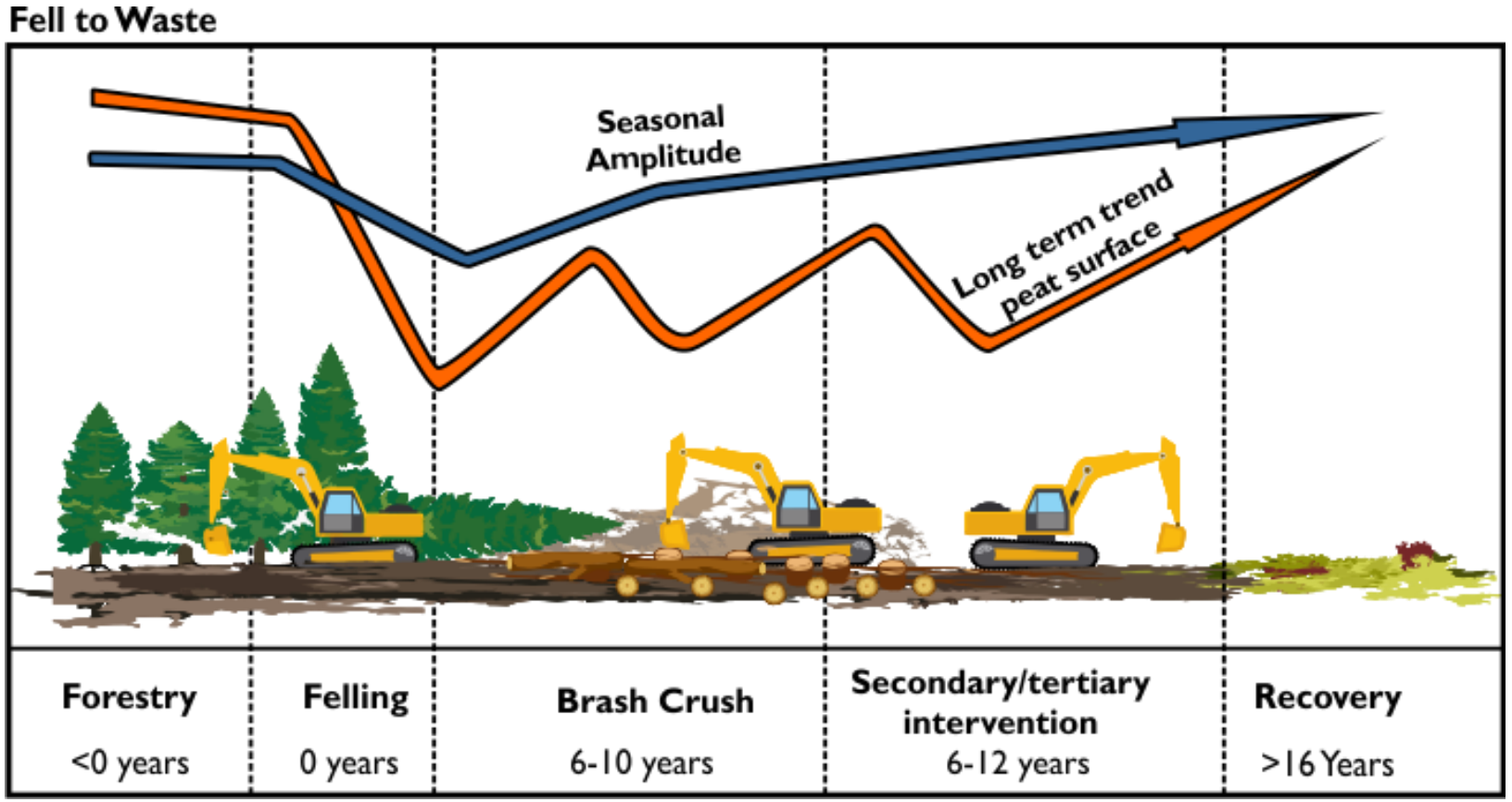
Combining Parameters



- Using all three parameters together to give a holistic assessment of restoration progress in a particular year

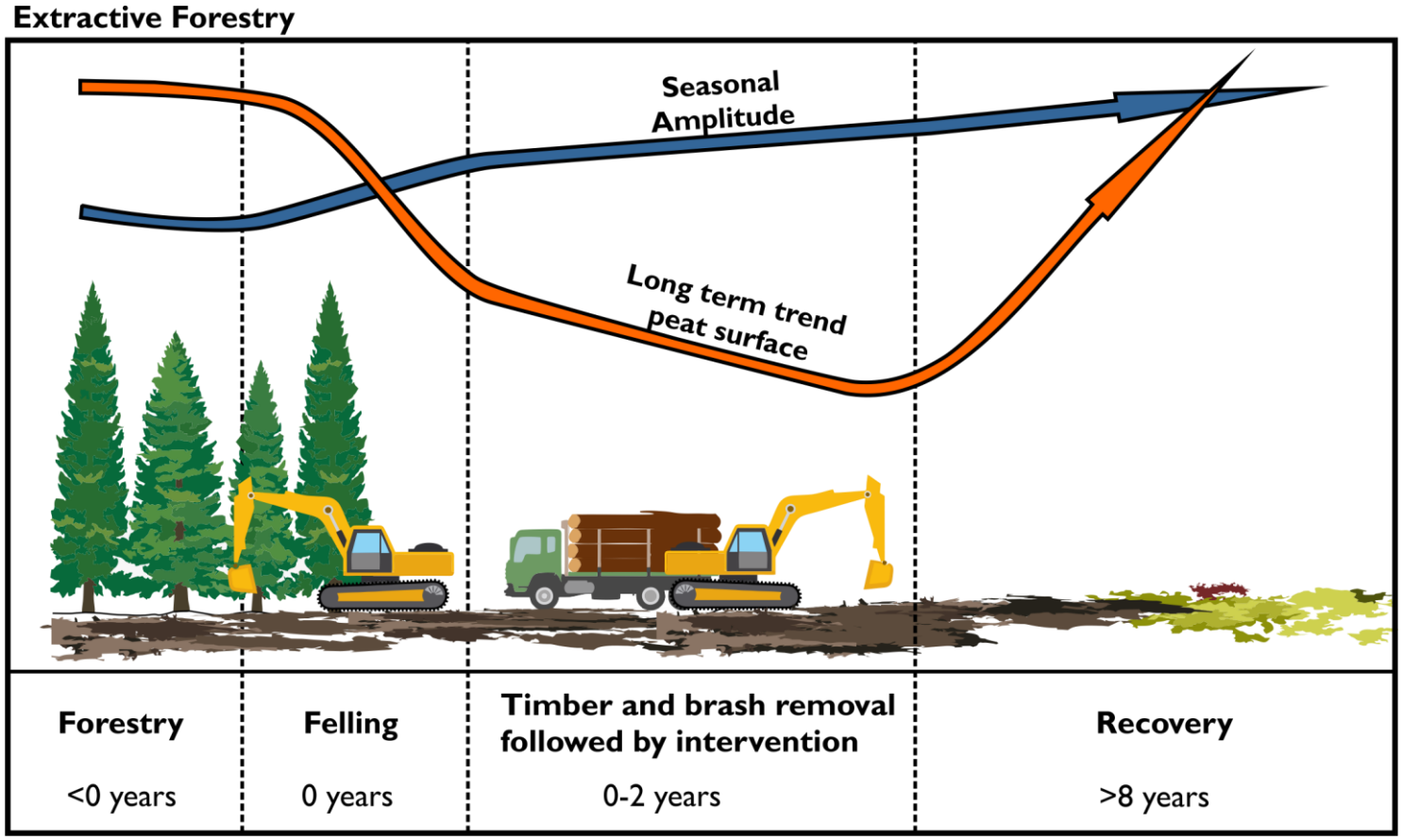
Bradley, A.V., Andersen, R., Marshall, C., Sowter, A., Large, D.J., 2022. Identification of typical ecohydrological behaviours using InSAR allows landscape-scale mapping of peatland condition. Earth Surf. Dynam. 10, 261-277

Summary– Fell to Waste



1) Fell to Waste appears to take approx 16+ years to be comparable with adjacent 'near natural pools
2) Requirement to wait for brash crush and repeated interventions delays recovery

Summary– Extractive Forestry



1) Extractive Forestry and more intense interventions initially have more impact but have more rapid recovery rates from compaction and more dynamic peat
2) At Forsinard – saves approx. 8 years in recovery from compaction