Relationships between biotic & abiotic conditions on Clara Bog (Ireland)

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- Backgrounds
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- Hydrologic concepts
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Irish-Dutch Raised Bog Study (1989-2001)

- Functioning bogs in Ireland and
- Conservation & regeneration experience in The Netherlands
- Topics
  - – Geology, hydrology, vegetation
  - – Hydrology: regional → *bog system*
  - – Vegetation: community → *ecotope*

Position of Clara Bog

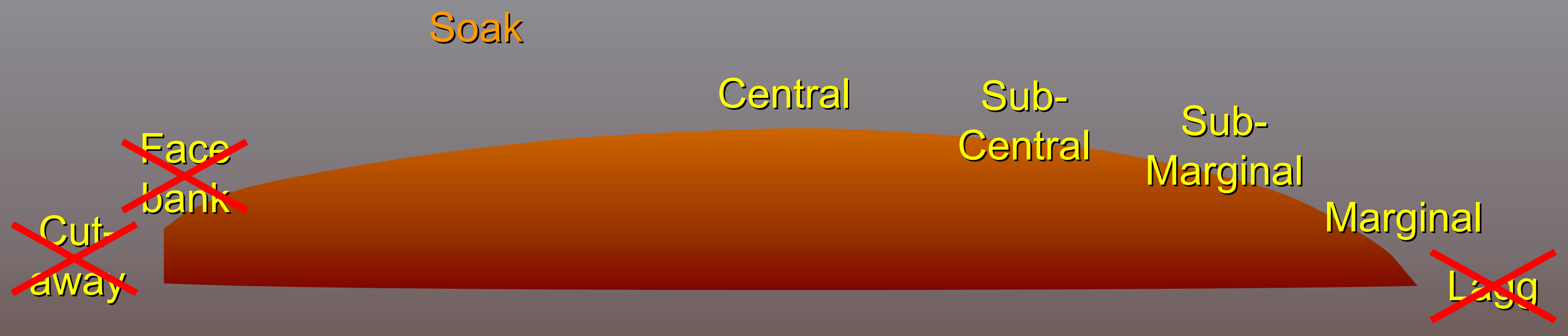
Clara Bog (500 ha)

- Backgrounds
- Ecotopes
- Hydrologic concepts
- Results & conclusions

Ecotopes

- Based on supposed position on an idealised bog dome
- Defined by abiotic conditions:
  - Hummock-hollow
  - Mean water level & fluctuation
- Resulting in a differentiation by species composition

Ecotope positions



Central ecotope

- Hummocks, hollows & pools
- Water level fluctuations: $\leq$ 20 cm
- Acrotelm well developed
- *Sphagnum cuspidatum* in hollows & pools

Central ecotope (summer)

Central ecotope (winter)

Marginal ecotope

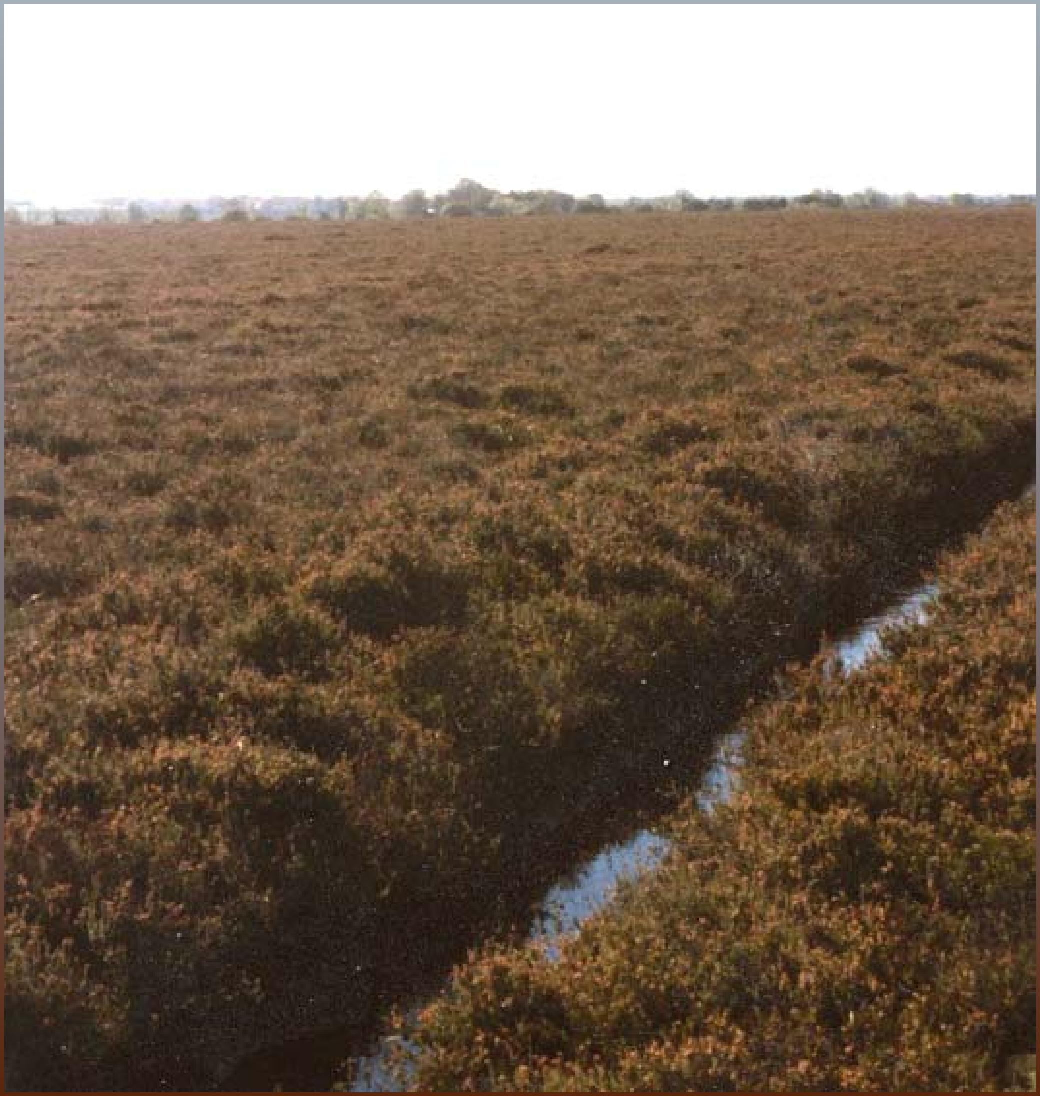
- No hummocks & hollows
- Water level fluctuation 30-40 cm, mean 10-40 cm below surface
- Acrotelm: absent or poorly developed
- Dominated by *Calluna vulgaris* and *Scirpus caespitosus*

Sub-central & sub-marginal ecotopes

- Transitional between central and marginal
- Sub-marginal: *Sphagnum tenellum and Narthecium ossifragum* in hollows
- Sub-central: Hummock-hollow & *Sphagnum magellanicum* dominated lawns

Mostly sub-central ecotope

Sub-marginal ecotope



Soak ecotopes

- Wet to extremely wet
- Lawns and/or flat hummock-hollow microtopography
- Species which indicate slightly more minerotrophic conditions
- Discussed soaks are rheotrophic

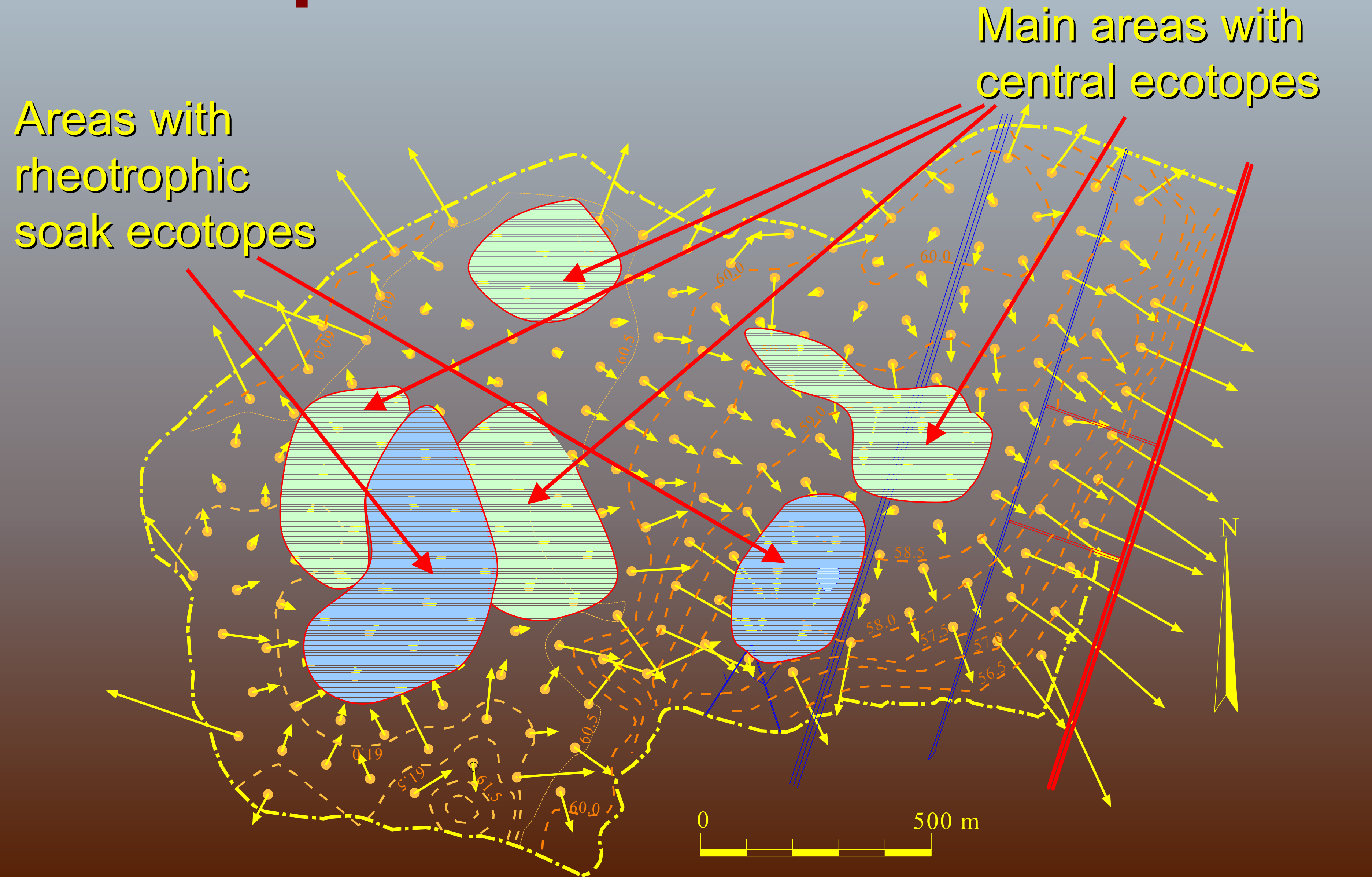
Soak on Clara Bog (1)

Soak on Clara Bog (2)

Deviations from positional concept (1)

- Road with associated drains has caused unequal subsidence
- “Central” and “sub-central” are not always in the centre anymore
- “Marginal” is still at the margin
- “Sub-marginal” could be anywhere

Flow pattern after subsidence



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Diplotelmic approach

- Acrotelm is the only aquifer
- Darcy’s law is assumed to apply
- Hydraulic gradient ≈ surface slope
- The surface slope is approximately constant over the seasons

Acrotelm transmissivity T_a

- T_a is related to flux q_a $[L^2T^{-1}]$ and hydraulic gradient by Darcy's law:

$$q_a = -T_a \frac{dH}{ds}$$

- The hydraulic gradient dH/ds is approximately equal to surface slope I
- I is approximately constant in time
- Main relationship is $q_a \Leftrightarrow T_a$
- Not $q_a \Leftrightarrow dH/ds$

Consequences

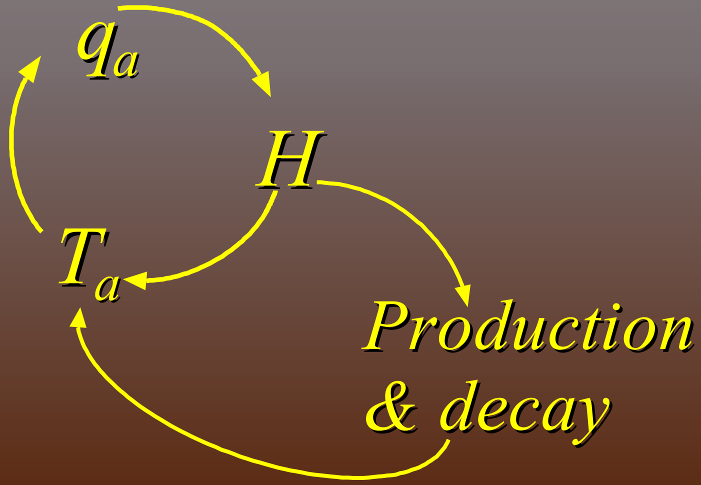
- In an undisturbed bog:
  - effective T_a adjusts itself to accommodate q_a
  - surface flow occurs only at peak discharges when hollows and pools interconnect
- In a disturbed bog:
  - surface flow compensates for a low attainable T_a already at relatively small discharges

How does it work?

- The acrotelm is a result of production and decay of organic matter
- Production and decay rates
  - affect pore size and hydraulic conductivity
  - are controlled by hydrological conditions
- Feedback loop of hydrology and production ecology

Regulation loop $q_a \Leftrightarrow T_a$

- Pore size decreases downwards (decay)
- Hydraulic conductivity is proportional to the square of pore size (Poiseuille's law)
- T_a depends on phreatic level H and H on q_a



Estimating q_a

- Define a flow path from surface levels
- q_a follows from specific discharge v_a [LT^{-1}], upstream area A_u and flowpath width w:

$$q_a \approx \frac{A_u v_a}{w}$$

- Simpler: use flow path length L_u instead of A_u & w and correct for flow pattern

Potential T_a is estimated from

$$T_a \approx \frac{-q_a}{I} \approx \frac{-A_u v_a}{w\,I} \approx \frac{-L_u v_a}{f\,I}$$

- f is a correction factor for flow pattern
  - Parallel flow → $f=1$
  - Radially diverging flow → $f=2$
  - Converging flow → $0<f<1$

Assessing ecological potential

- By a single value quantity provisionally called *potential acrotelm capacity* $\tau_a = T_a/v_a$ [L]

$$\tau_a = \frac{T_a}{v_a} \approx \frac{-A_u}{w\,I} \approx \frac{-L_u}{f\,I}$$

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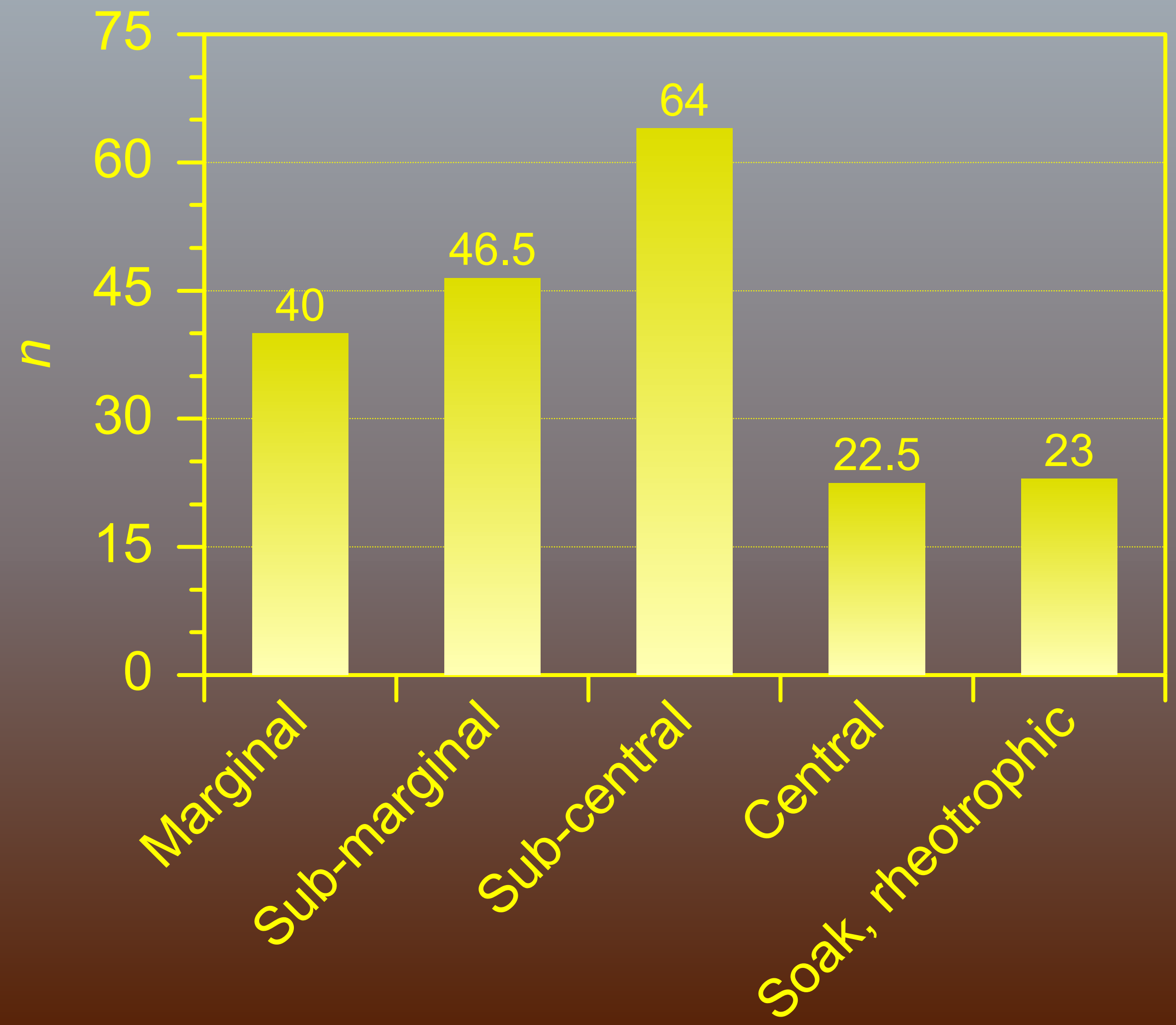
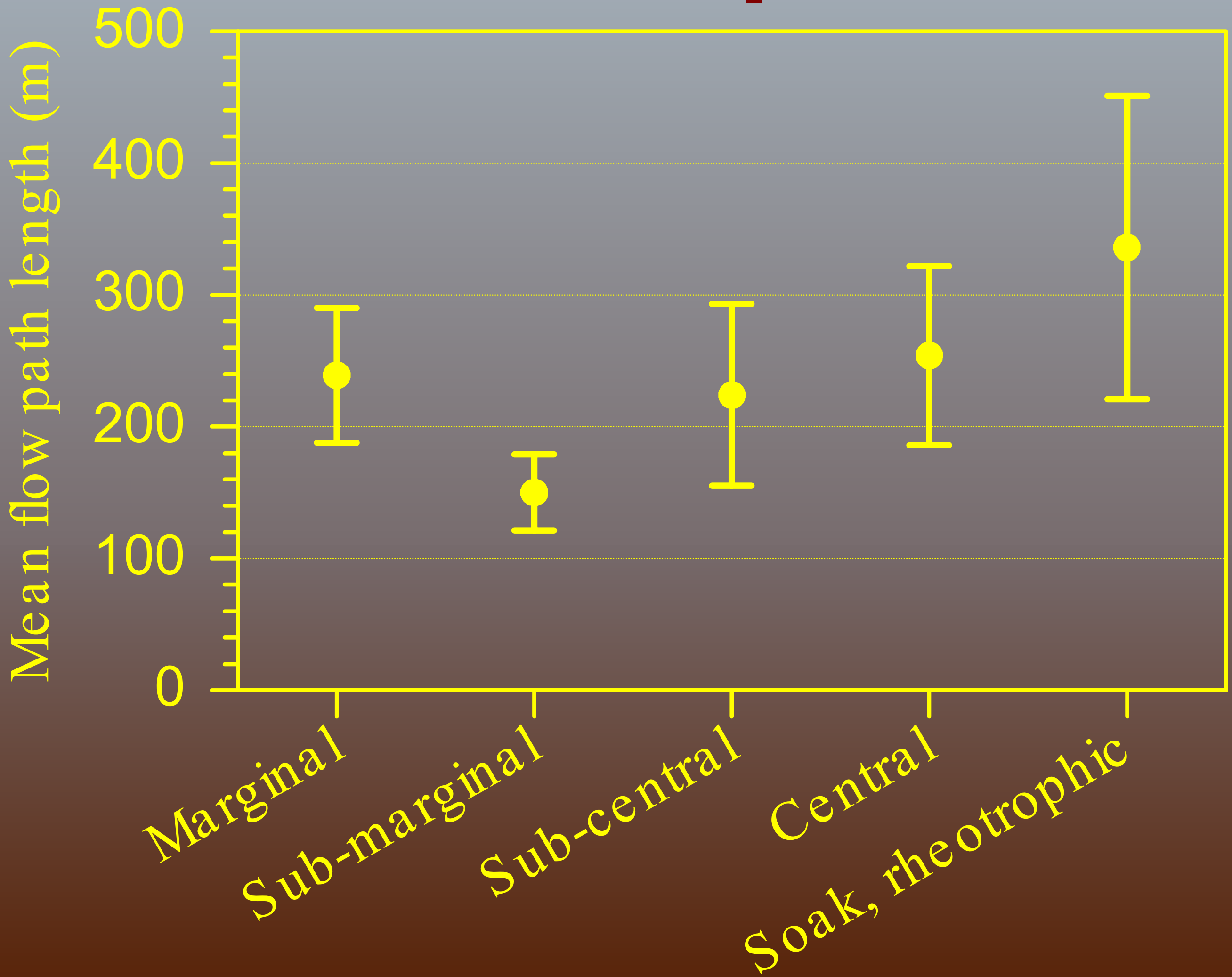
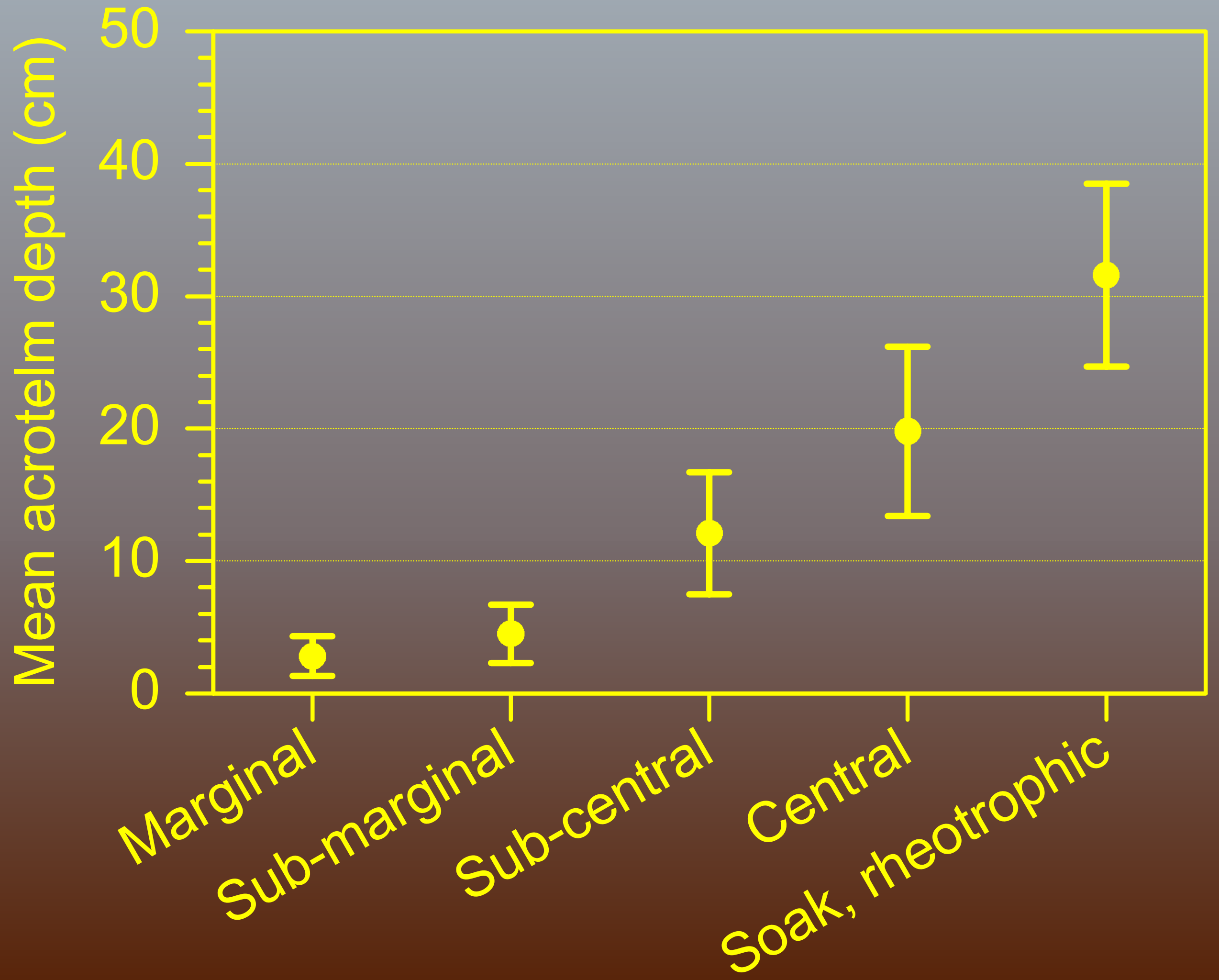
Number of data points per ecotope



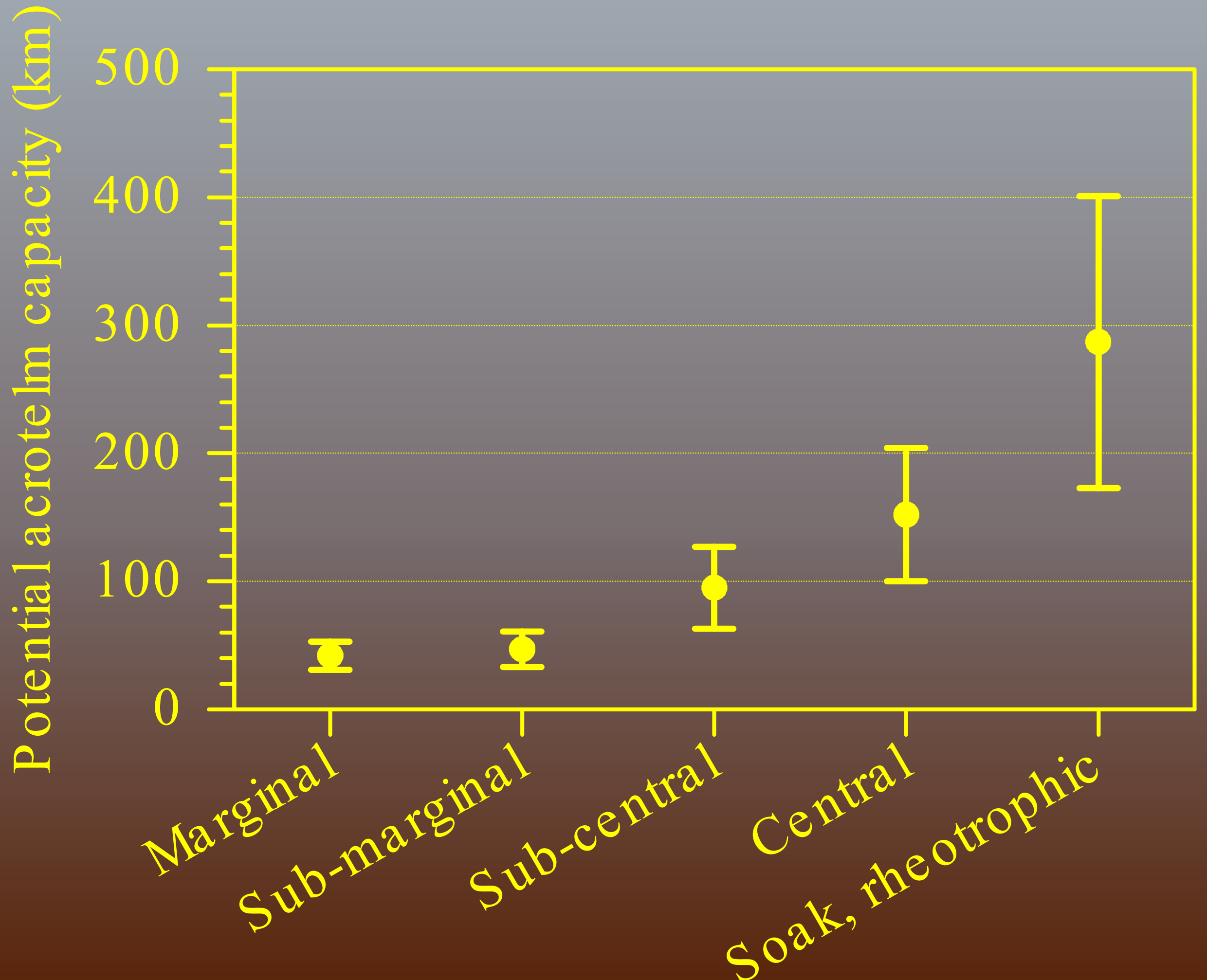
Flow path lengths per ecotope



Acrotelm depth per ecotope (≤ H3)



Potential acrotelm capacity per ecotope



Conclusions

- For Atlantic raised bogs with a usually limited differentiation in microtopes, the concept of *potential acrotelm capacity* gives a useful link between ecotopes and hydrology
- The concept is probably useful in predicting the ecological potential of bog remnants

Points for further research

- What are critical levels for τ_a?
- To what extent do they differ by climatic region?
- To what extent should the concept be modified to be useful in bogs with more patterning and pool systems?

Example: Männikjärve Bog (Estonia)

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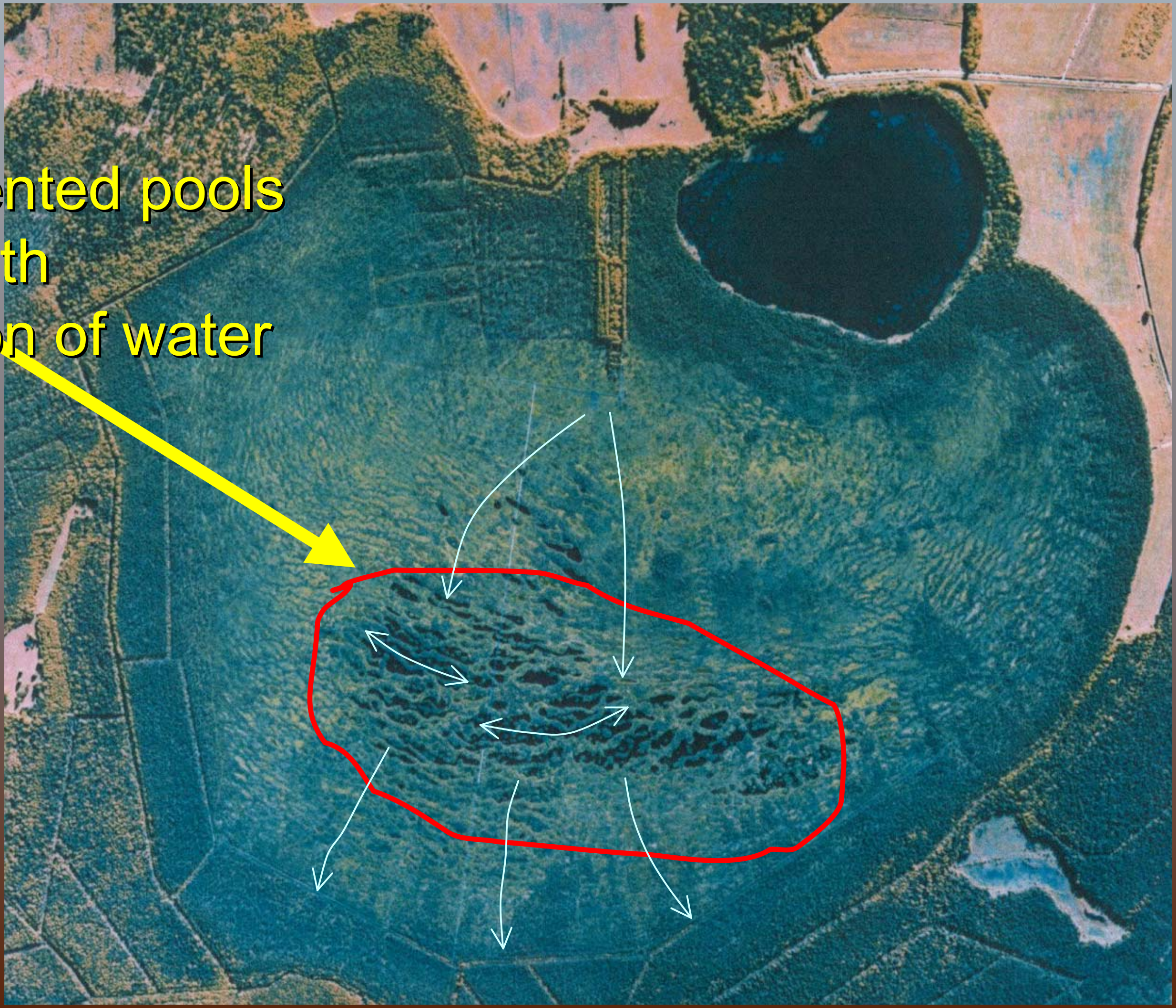
Area of oriented pools & strings with redistribution of water



Thank you for your attention