Fluvial processes feedback to Salicaceae

Description, thresholds and responses

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Foreword: what & why Salicaceae?

- Willows and poplars
- Ubiquitous along river Northern hemisphere, invasive elsewhere
- Pioneer species: keystone succession element
- Ecosystem engineers
- Depend on natural flow regime → decline with flow alteration

Presentation topics

- Fluvial processes feedback to Salicaceae
- How these processes work and what are their thresholds
- Processes-thresholds-timescales conceptual framework

Source

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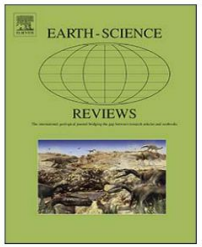

Invited review

Feedbacks between the riparian Salicaceae and hydrogeomorphic processes: A quantitative review

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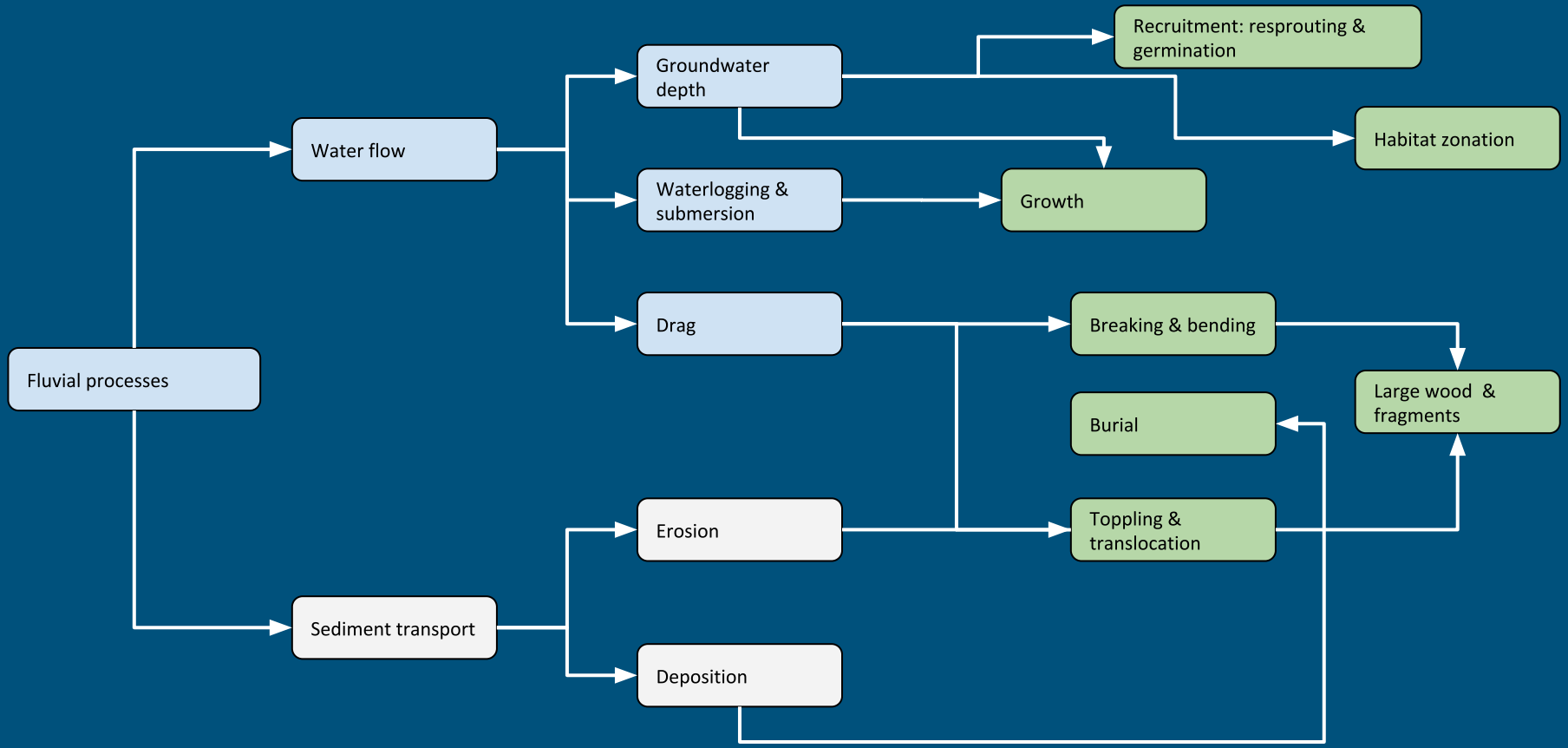
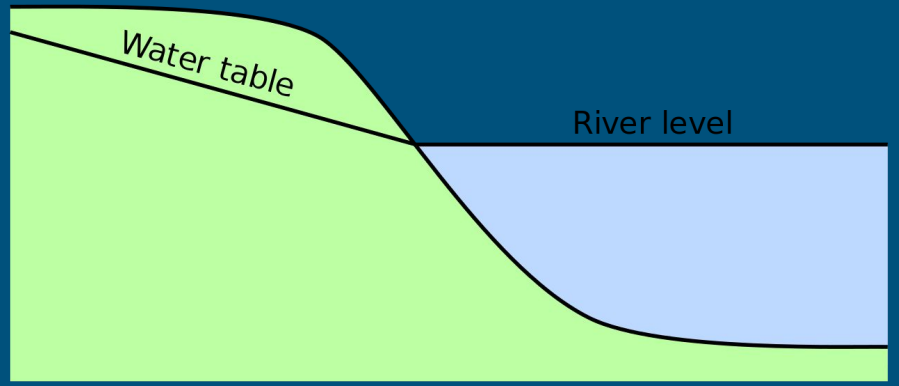
Fluvial processes feedback to Salicaceae



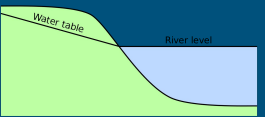
Groundwater related processes

- Seed recruitment
- Large Wood (LW) resprouting
- Growth
- Habitat segmentation



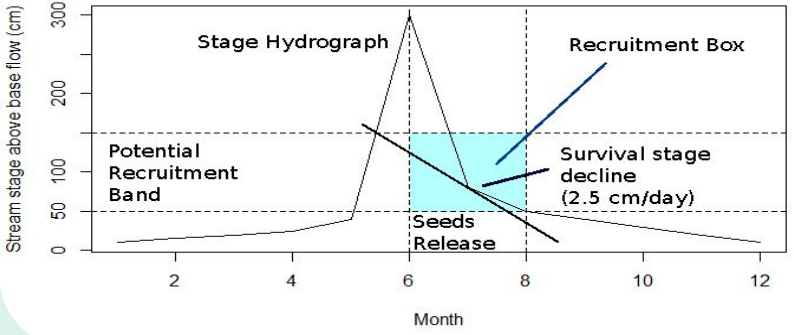
Seed recruitment: process

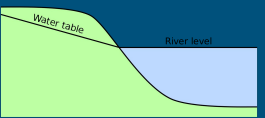
- Requires bare ground (Salicaceae are heliophilous)
- Seeds dispersal sync with annual peak
  - Floods create bare nursery sites
  - Receding wave provides moisture
  - Seeds require immediately for moisture (viability ~ 20 days)



Seed recruitment: thresholds

- Roots track peak declining stage
  - Max decline 2 - 3 cm/day
  - Max root growth 1.5 - 1.7 cm/day
- Recruitment box model (Mahoney & Rood '98)

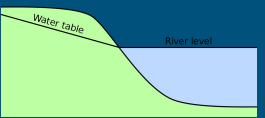




Mahoney, J.M., Rood, S.B., 1998. Streamflow Requirements for Cottonwood Seedling Recruitment An Integrative Model. Wetlands 18, 634–645.

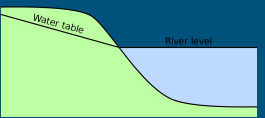
LW survival & resprouting: process

- LW created & deposited by floods
- Key regeneration process (most in highly dynamic rivers)
- Create the “green core” of islands



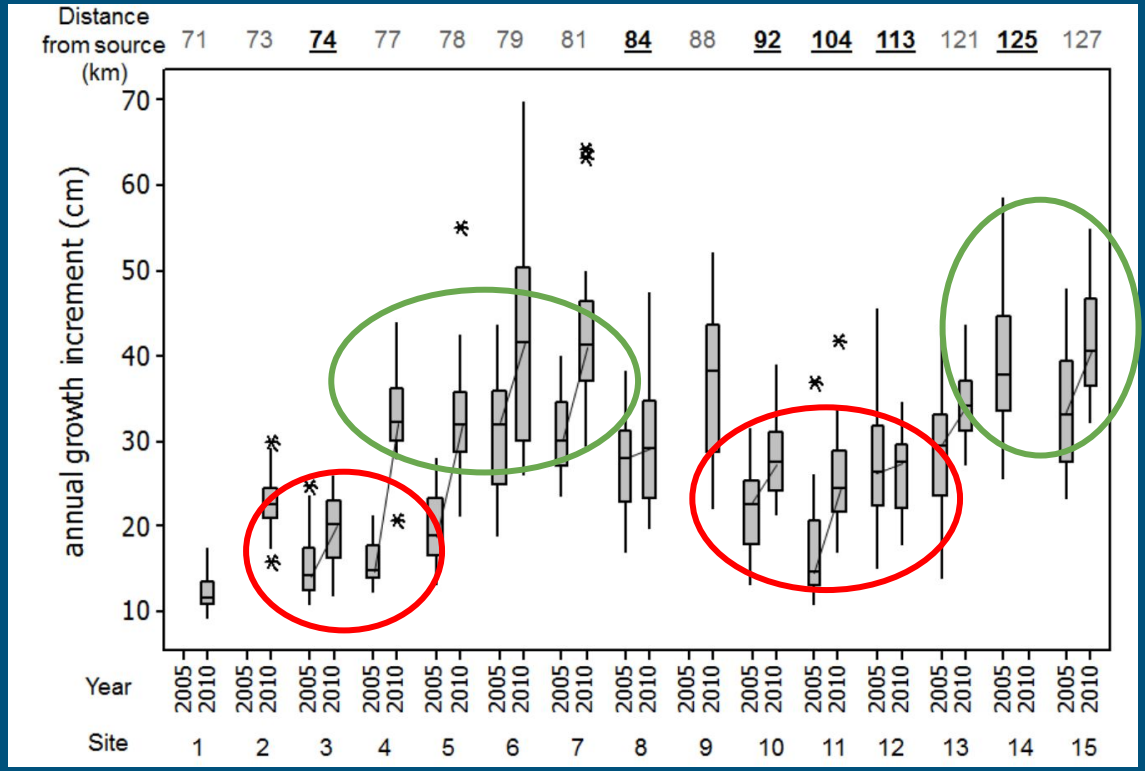
LW survival & resprouting: threshold

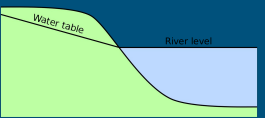
- Favourable locations:
  - Low enough to provide moisture
  - High enough to prevent re-mobilization by subsequent floods
  - Approximately 0.5 - 1 m above mean bed elevation



Groundwater and growth

- Gaining reach: + growth rate
- Losing reach - growth rate
- More important in unconfined rivers

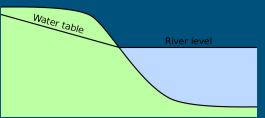




GURNELL AM (2016) . Trees, wood and river morphodynamics: results from 15 years research on the Tagliamento River, Italy.River Science: Research and Management for the 21st Century, Editors: Gilvear, DJ, Greenwood, MT, Thoms, MC, John Wiley and Sons Ltd (Chichester)

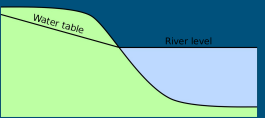
Habitat zonation: process

- Salicaceae are phreatophytes
- Do not tolerate deep water table
- Roots depth is a plastic trait
- Do not tolerate within year large water table oscillations



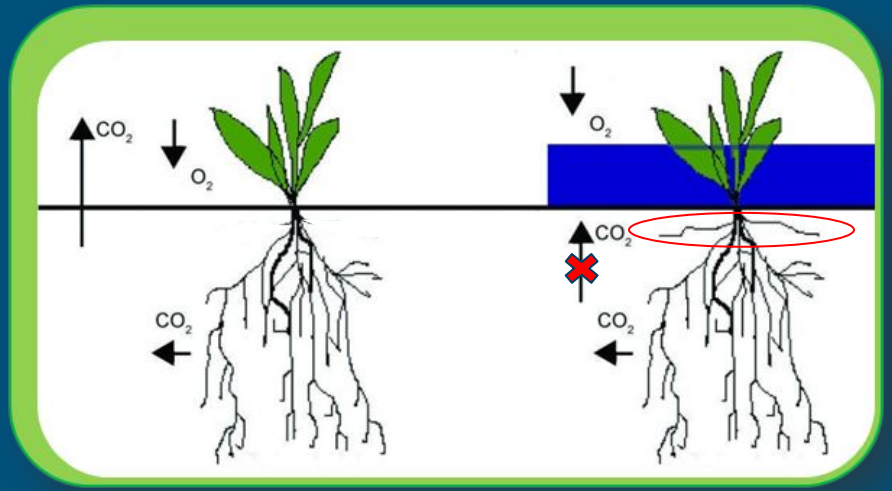
Habitat zonation: thresholds

- Maximum documented root depth 4 - 5 m
- Within year oscillation < 0.5 - 0.8 m shape optimal habitat
- Between years groundwater decline > 1/1.5 m:
  - Growth season timescale: reduced growth
  - Permanent: stand decline/senescence



Waterlogging: process

- Cause soil anoxia
- Responses:
  - Adventitious roots
  - Aerenchymatous tissues
  - Lenticels
  - Reduced leaf area
  - Reduced shoot and root weight
- Salix more tolerant
- Females more tolerant

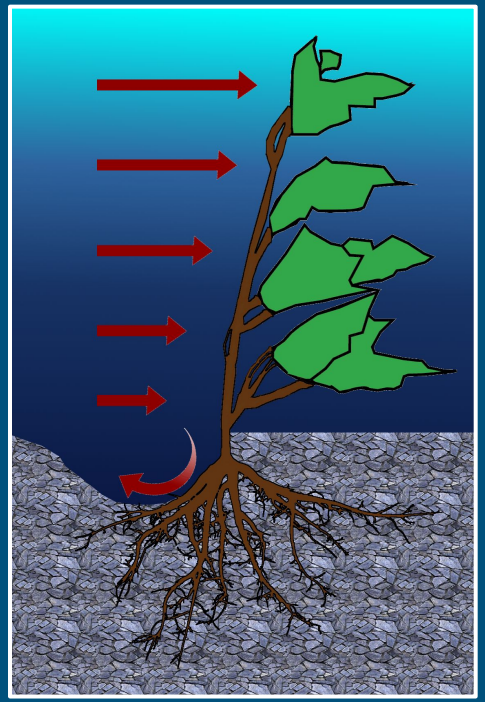


Waterlogging: thresholds

- Critical over the growing-season time scale
- High survival rates

Drag & erosion: process

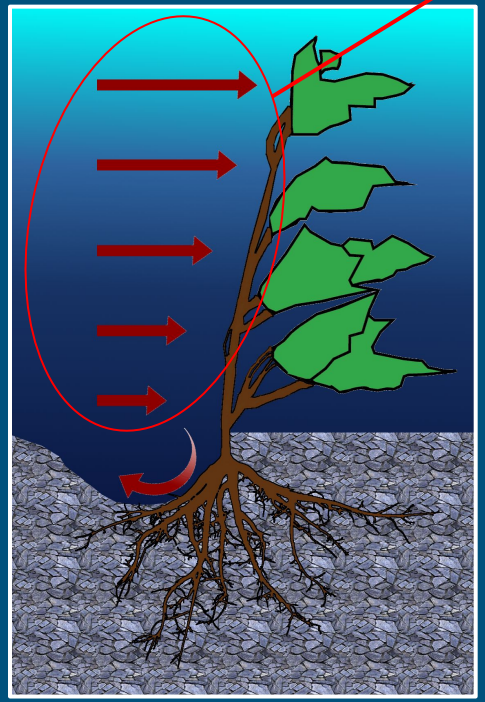
Surface erosion



Bank/side erosion

Drag & erosion: process

Surface erosion



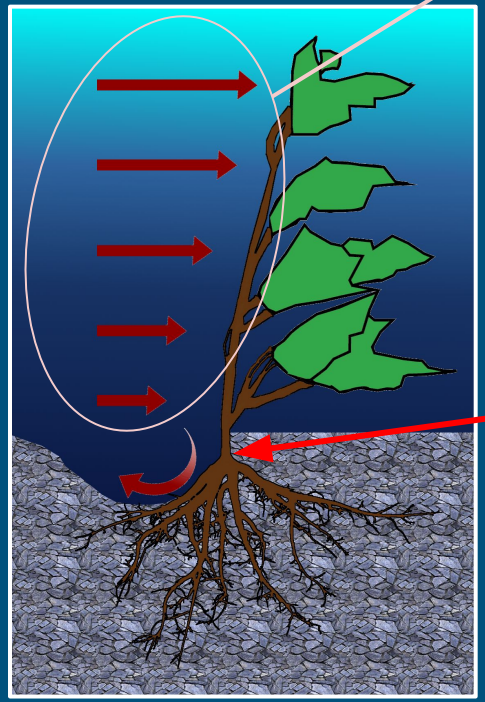
Drag

- Pull-out (if short/exposed roots)
- Plastic bending
- Trunk breakage

Bank/side erosion

Drag & erosion: process

Surface erosion



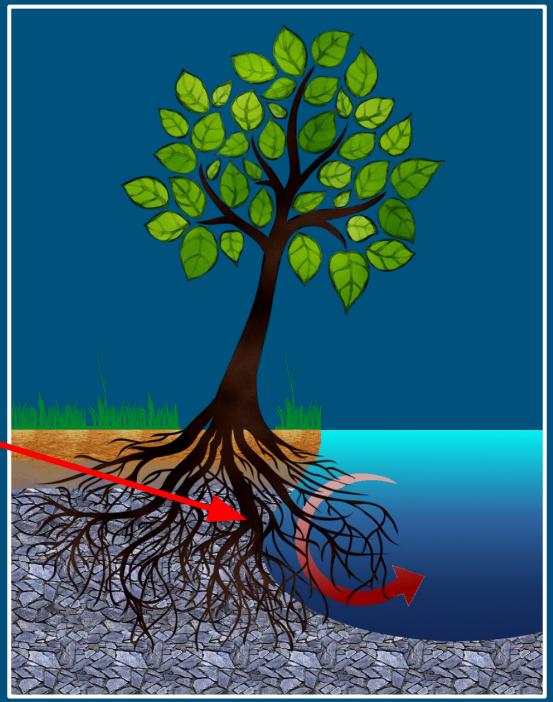
Drag

- Pull-out (if short/exposed roots)
- Plastic bending
- Trunk breakage

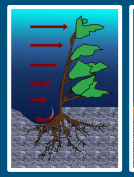
Roots exposure

- Favours toppling/pull-out

Bank/side erosion



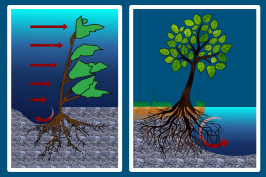
Drag & erosion: process, in real



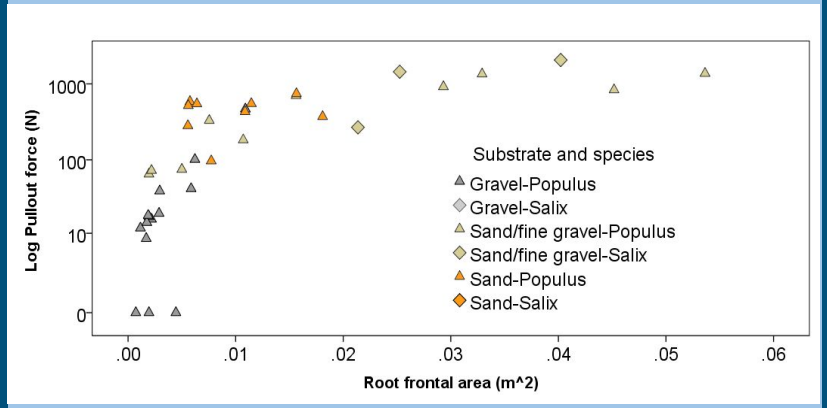
Surface erosion

Bank/side erosion

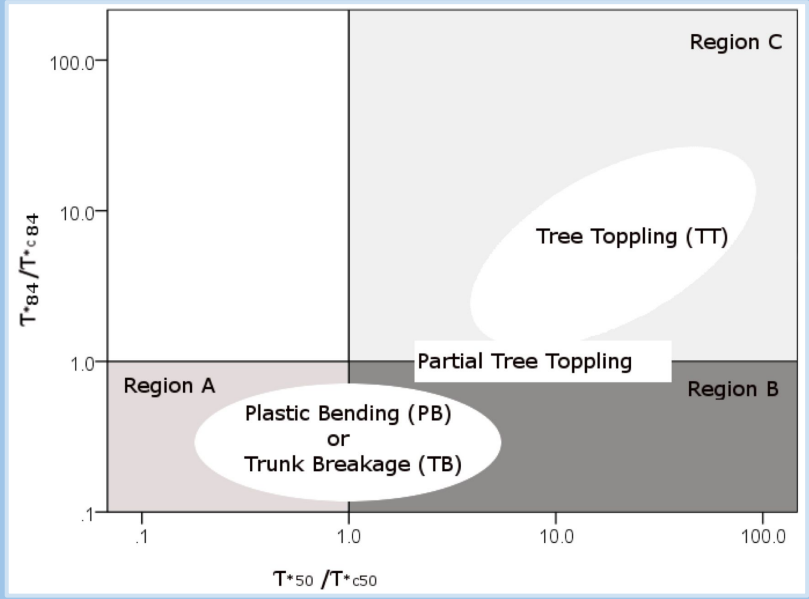
Drag & erosion: thresholds



Pullout

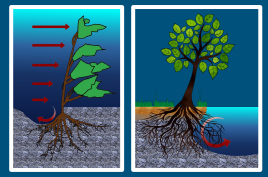


Bending - breakage - toppling

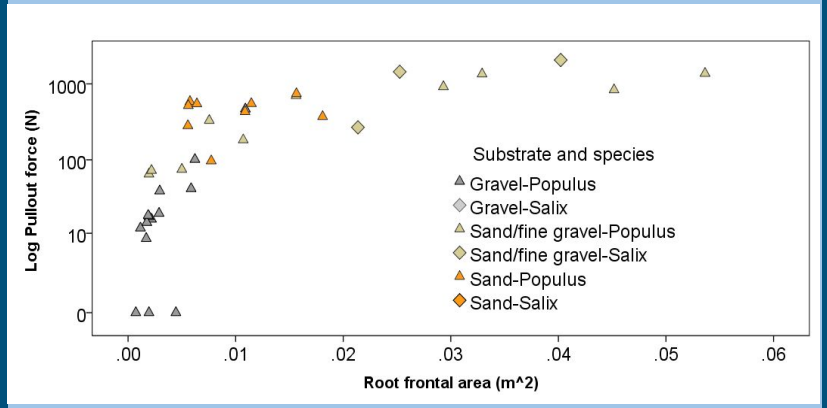


Kui, L., Stella, J.C., 2016. Fluvial sediment burial increases mortality of young riparian trees but induces compensatory growth response in survivors. For. Ecol. Manage. 366, 32–40.
Tanaka, N., Yagisawa, J., 2009. Effects of tree characteristics and substrate condition on critical breaking moment of trees due to heavy flooding. Landsc. Ecol. Eng. 5, 59–70.

Drag & erosion: thresholds



Pullout



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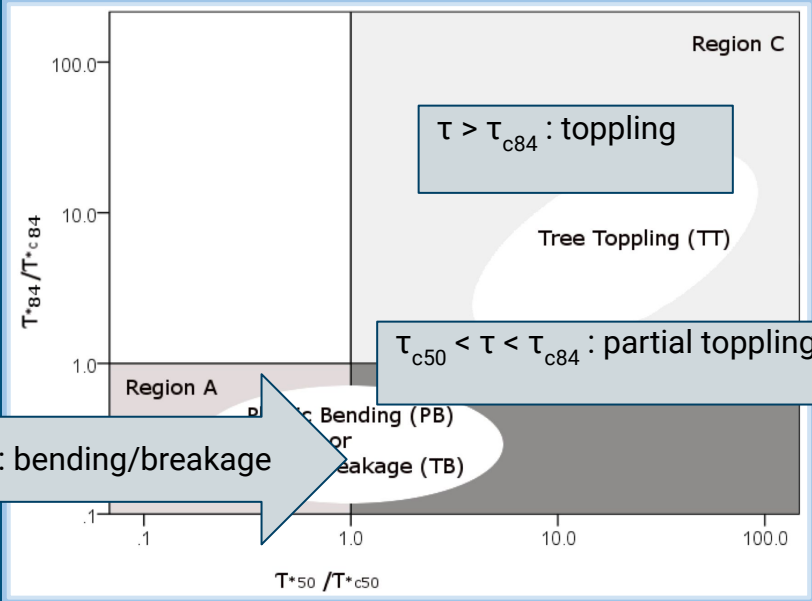

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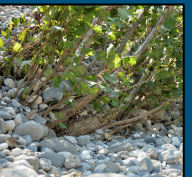
Deposition: process

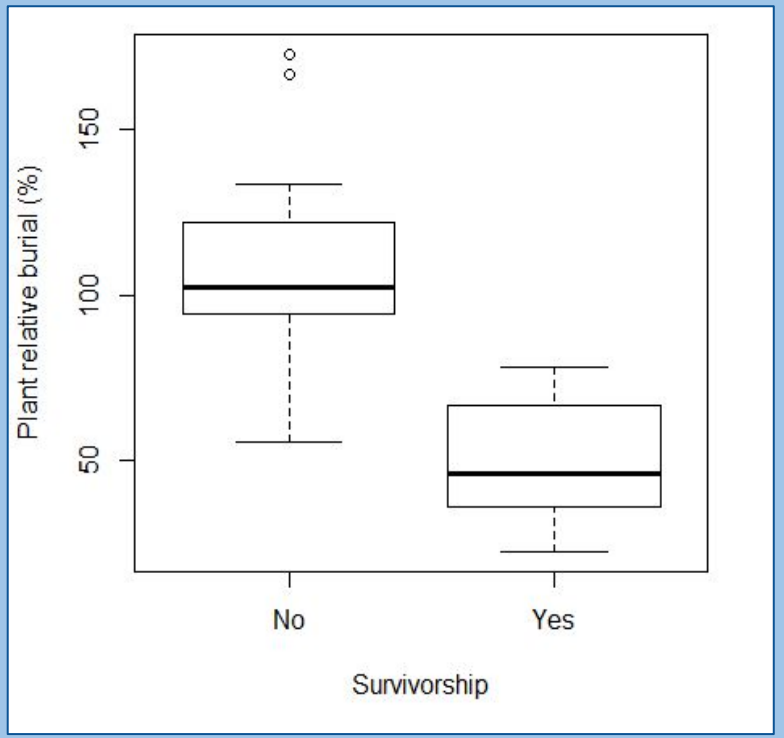
- Occurs during floods
- Anoxia
- Physical damage
- Stimulates adventitious roots development
- Buried stems turn into root (increase substrate cohesion)

Deposition: thresholds

- Death with > 50% burial
- Otherwise resprout



Survival vs relative deposition



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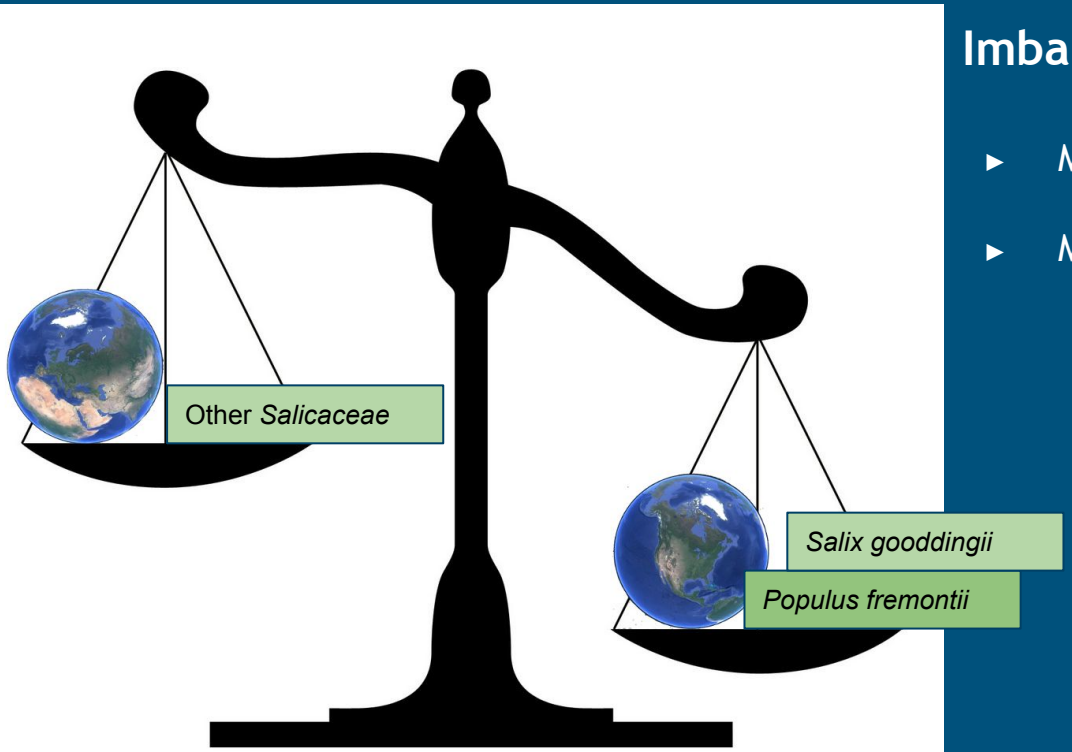
Review conclusions

Imbalance I

- More studies from North America than Eurasia

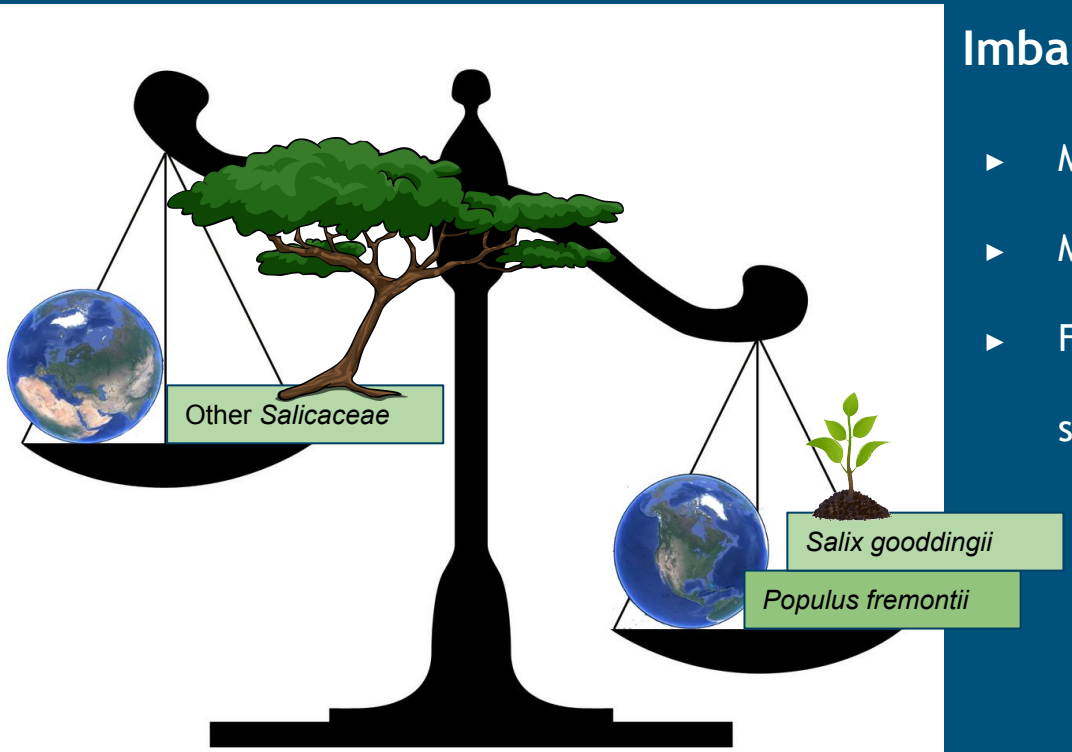
Review conclusions



Imbalance II

- More studies from North America than Eurasia
- Mainly for P. fremontii & S. gooddingii species

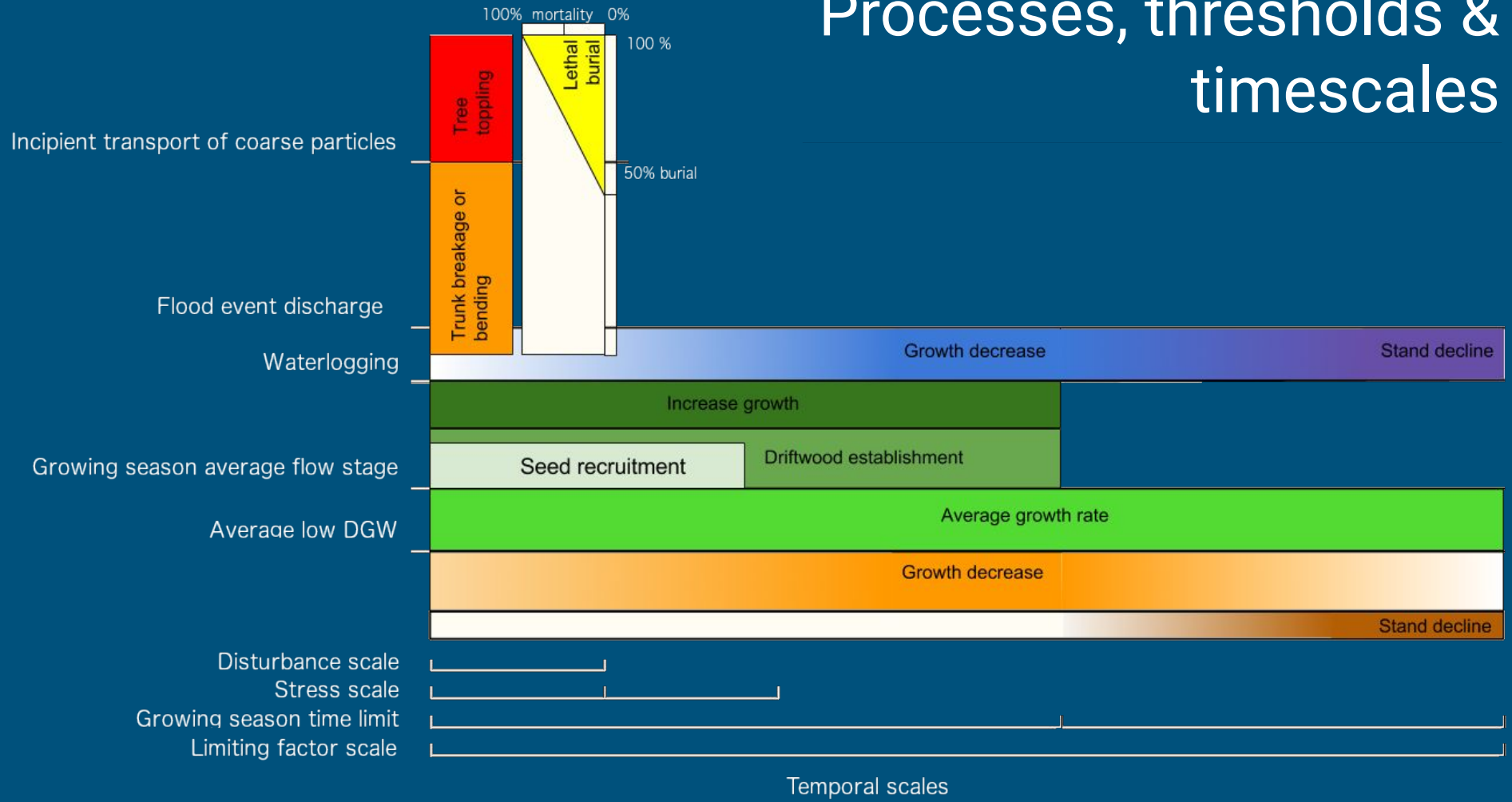
Review conclusions



Imbalance III

- More studies from North America than Eurasia
- Mainly for P. fremontii & S. gooddingii species
- Focus of fluvial disturbances effects on seedlings

Processes, thresholds & timescales




Questions?