Plant selection for paludiculture:

water and nutrient level optima differ among Typha species

Why Typha paludiculture?

- Highly productive wetland species: 2.2 – 22.1 t ha^{-1} a^{-1} dry matter (Wichtmann & Joosten 2007; Dubbe, Garver & Pratt 1988)

- Benefits at cultivation site:
  - Nutrient removal (Vroom et al. 2018; Grosshans 2014; IISD 2013; Ciria, Solano & Soriano 2005)
  - GHG mitigation (Vroom et al. 2018; Grosshans 2014; IISD 2013)
  - Habitat improvement (Grosshans 2014; IISD 2013)

- Biomass
  - Bioenery (e.g. pellets, bioethanol) (Rebaque et al. 2017; Grosshans 2014; IISD 2013; Ciria, Solano & Soriano 2005; Dubbe, Garver & Pratt 1988)
  - Insulation & building material (Colbers et al. 2017; Georgiev et al. 2014; Krus et al. 2014; Wichtmann & Joosten 2007)

Paludi-PRMIA project

PALUDI CULTURE

Paludi-PRIMA

Main goals (Universität Greifswald & LFA MV 2018)

- Optimal yield and biomass quality
  - suitable clones (*Phragmites*) or species (*Typha*)?
  - cultivation method, harvest method, harvest timing?
  - water level & nutrient availability?
- Costs and profits
- Legal framework

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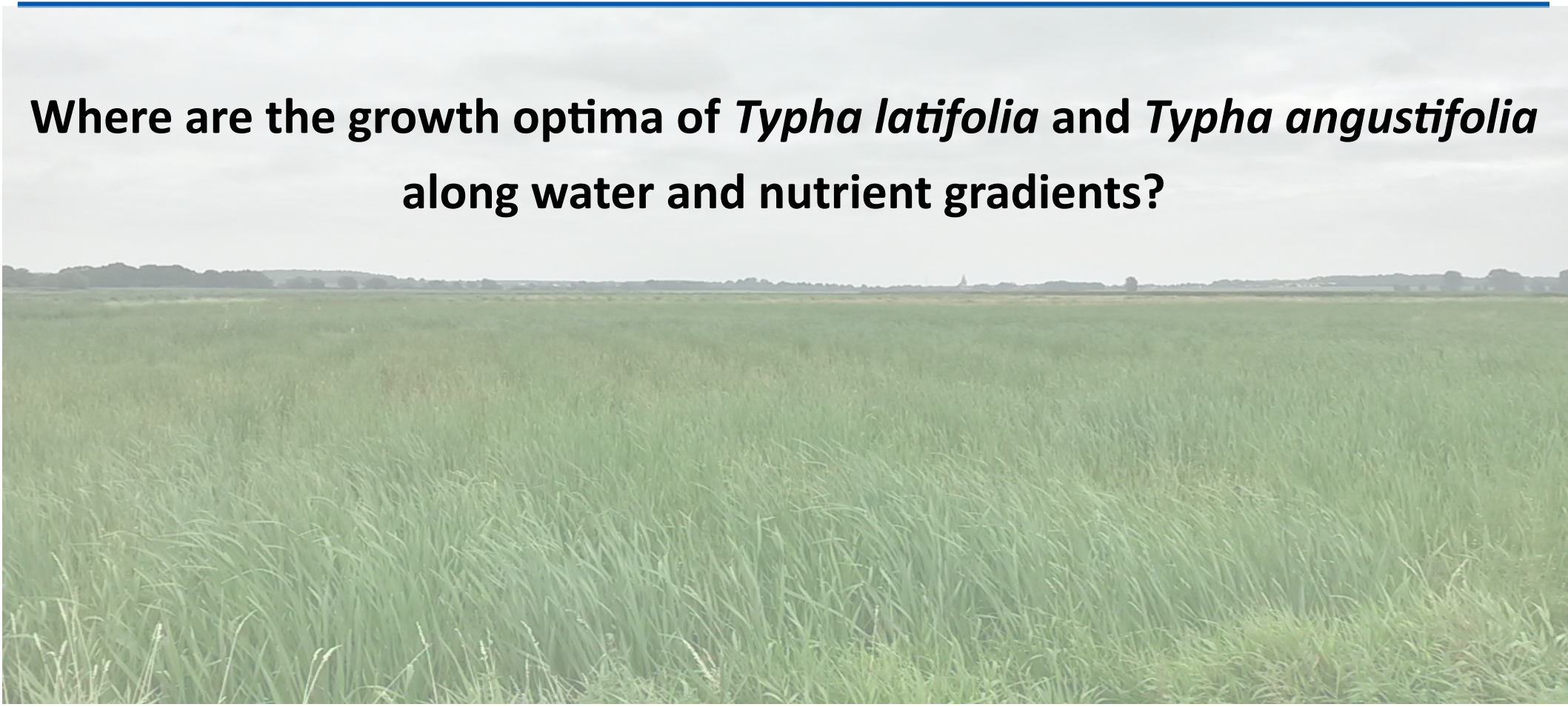
Research question

Where are the growth optima of *Typha latifolia* and *Typha angustifolia* along water and nutrient gradients?

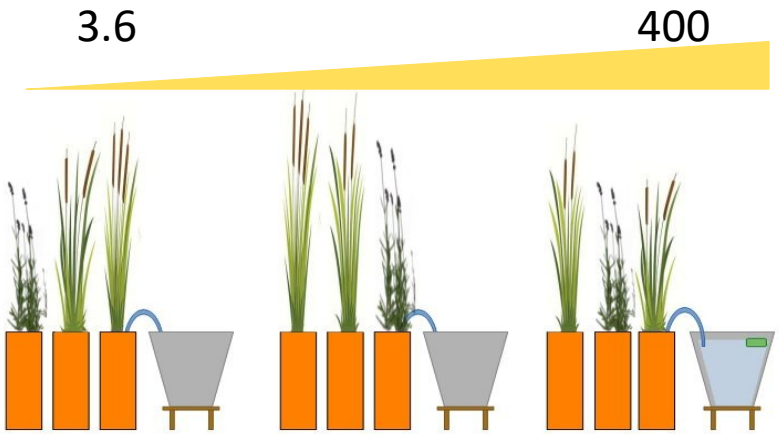


Experimental setup

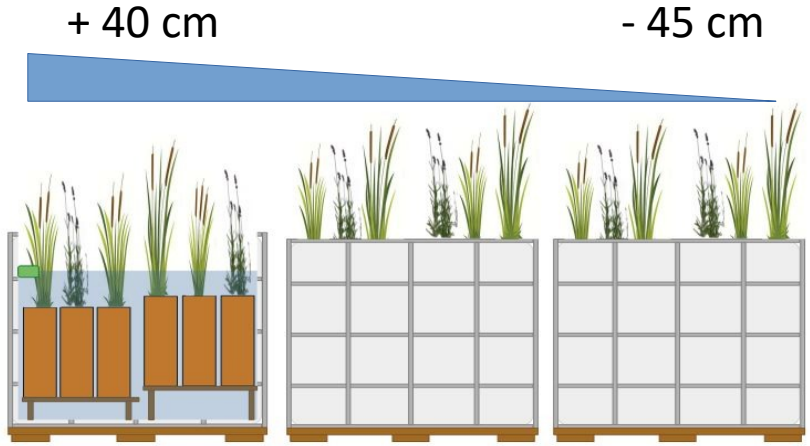
Mesocosm experiment

- May 2019 to February 2020
- *T. angustifolia* & *T. latifolia*
- Gradient design, 15 levels in each gradient, no replications

Fertilization [kg N ha^{-1} a^{-1}]



Water level



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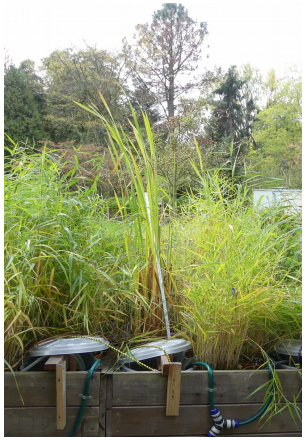
Measurements



- Growth (weekly)
  - height
  - no. shoots
  - no. leaves per shoot
- Photosynthetic rate
- Biomass yield
  - Aboveground
  - Roots
  - Rhizomes

Gradient design

- Environmental gradient, not different treatment groups
- Nonlinear ecological responses → shape of response pattern (Kreyling et al. 2018)

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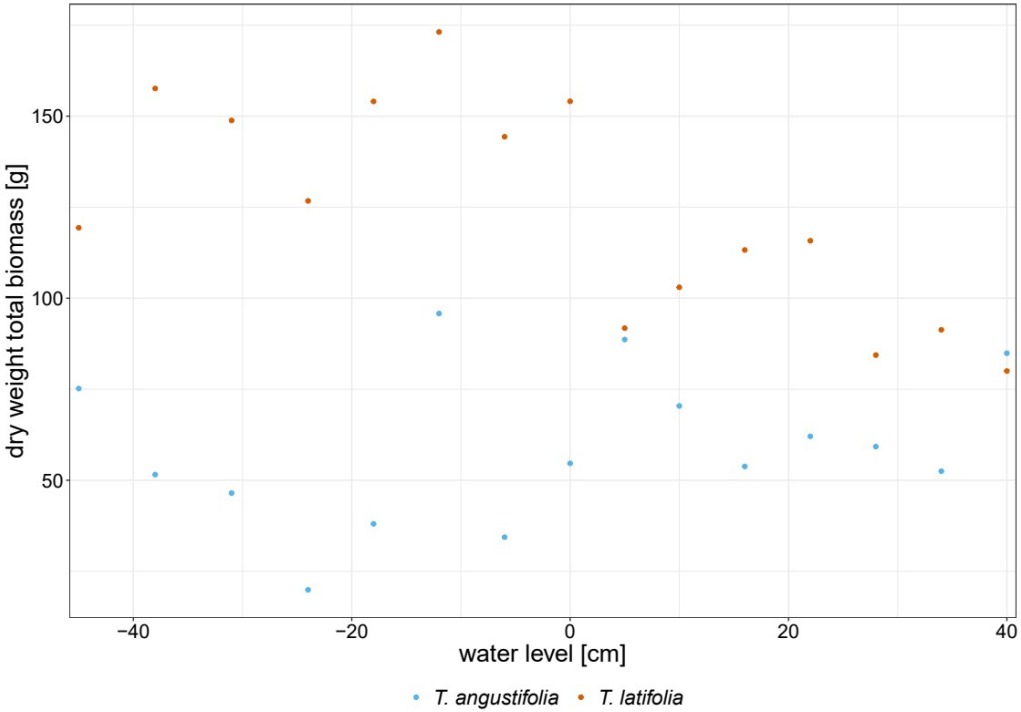

- Graphical analysis:

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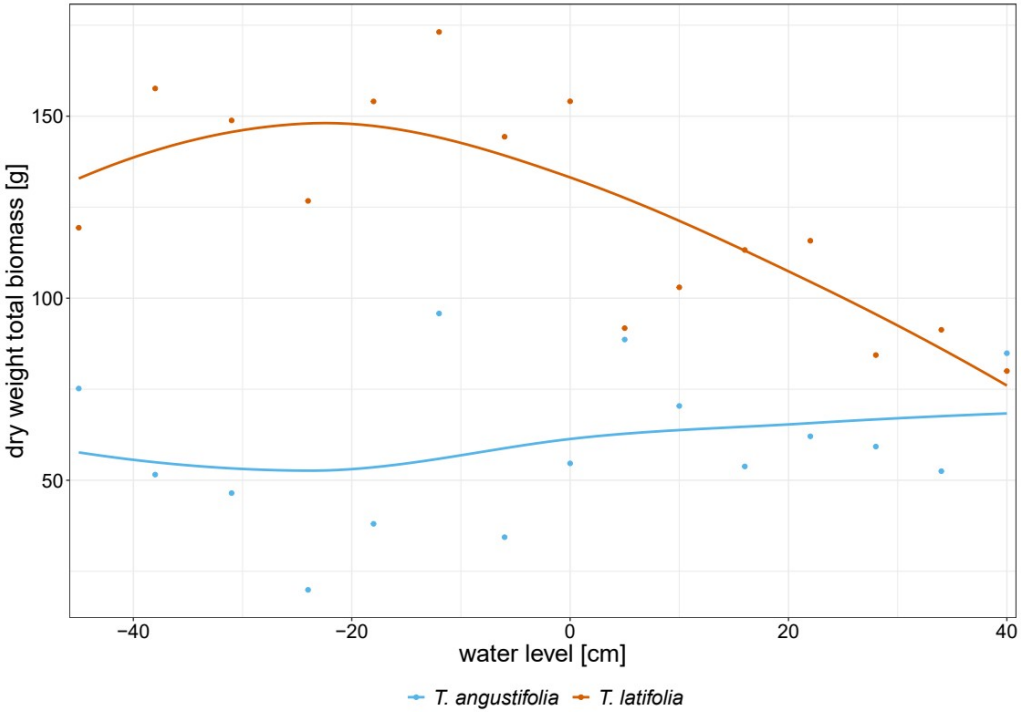

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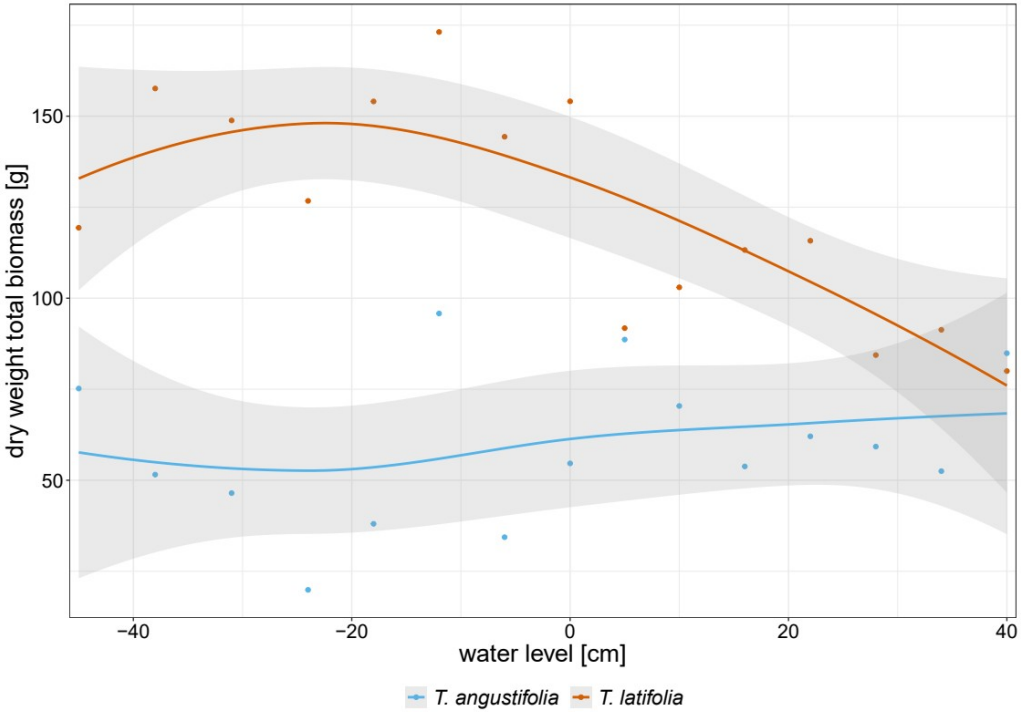

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  - Significant effect of environmental driver on one species (α = 5%):
    95% Confidence interval (grey)

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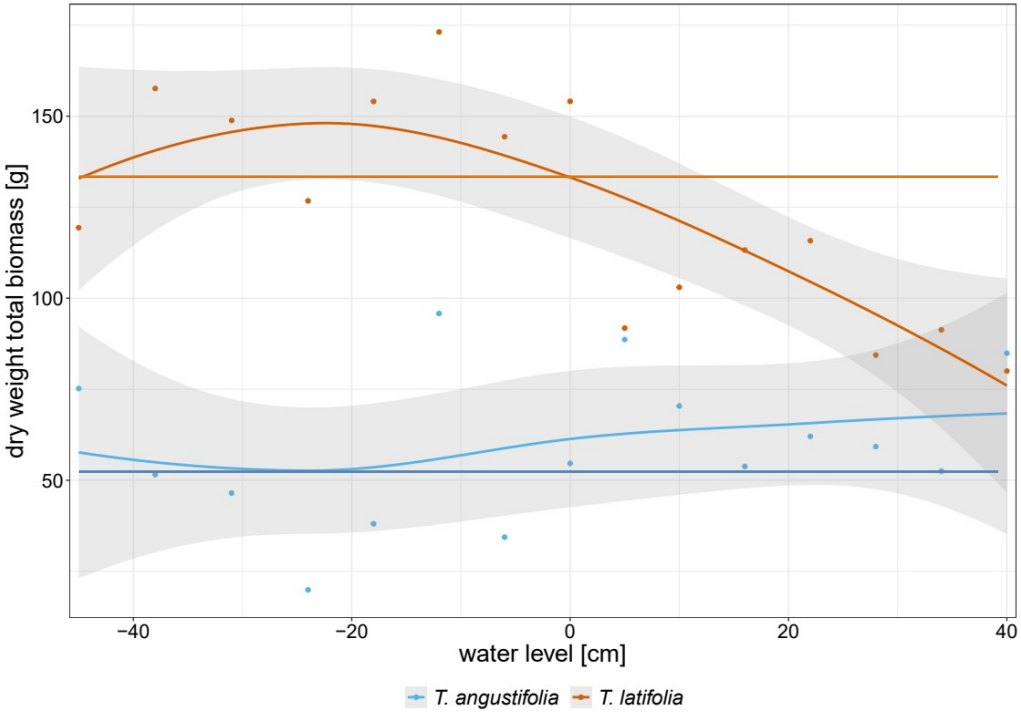

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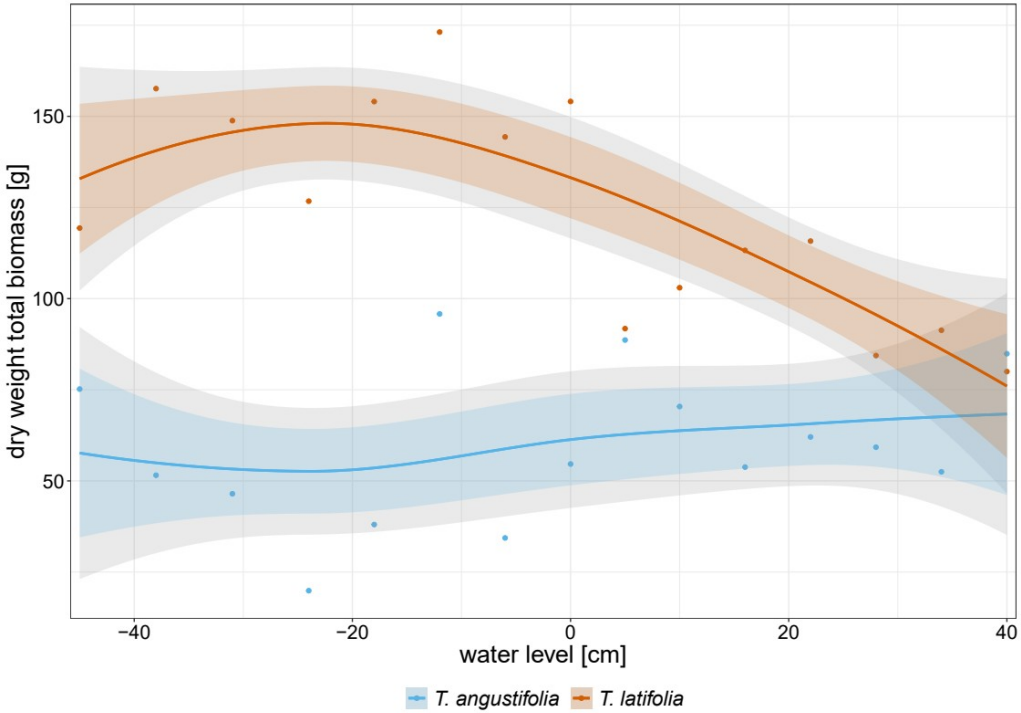

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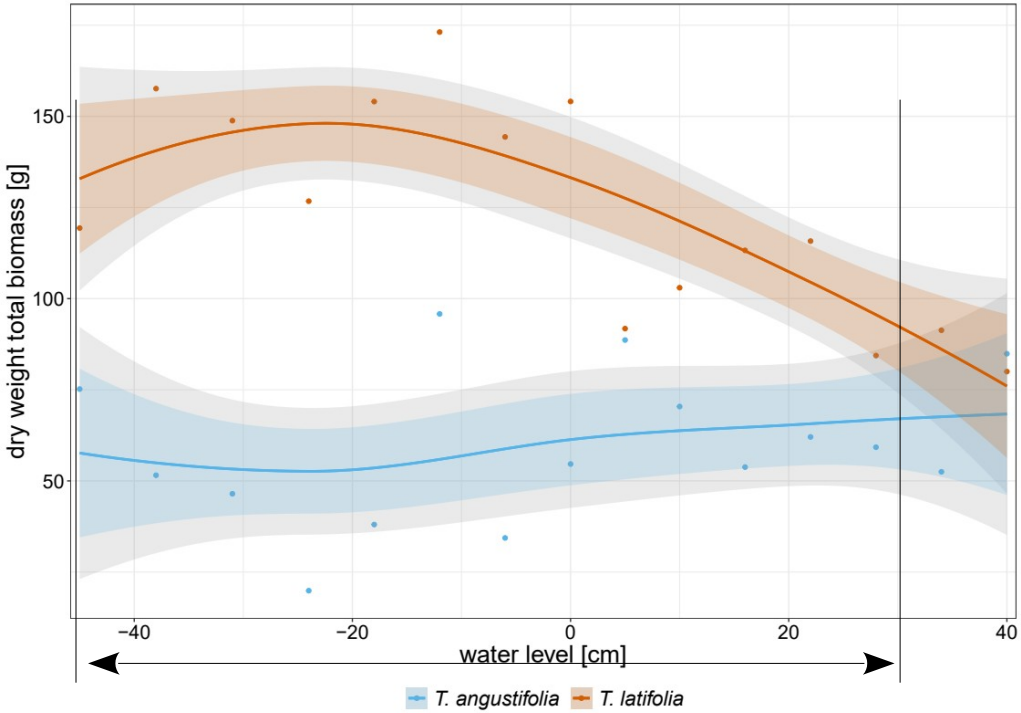

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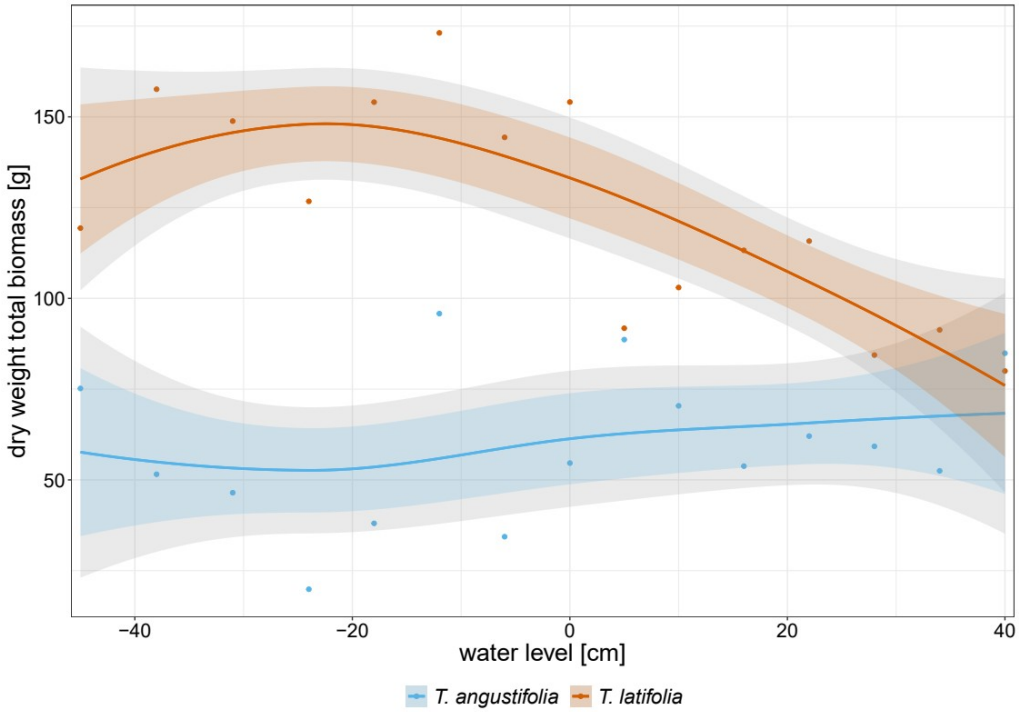
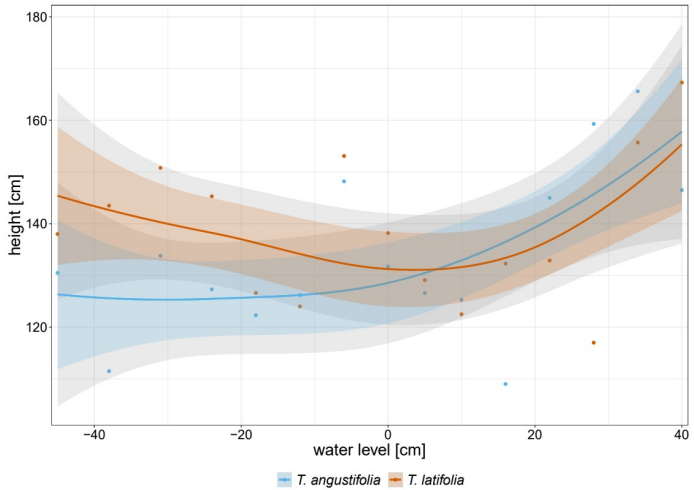
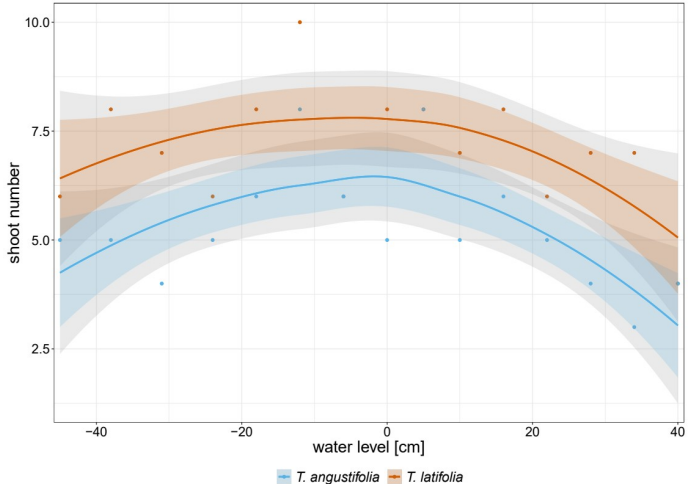
Water levels

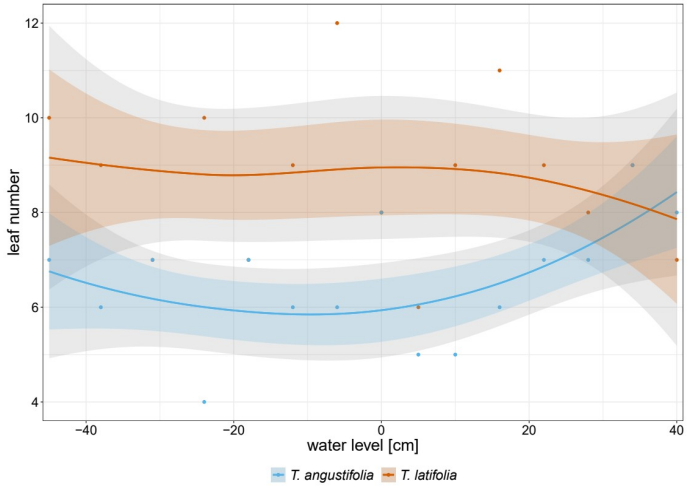


- *T. angustifolia*:
  - no change in biomass production over water level gradient
- *T. latifolia:*
  - more biomass at water levels below ground than under flooding
  - more biomass than *T. angustifolia* at all water levels except flooding > 30 cm

Water levels

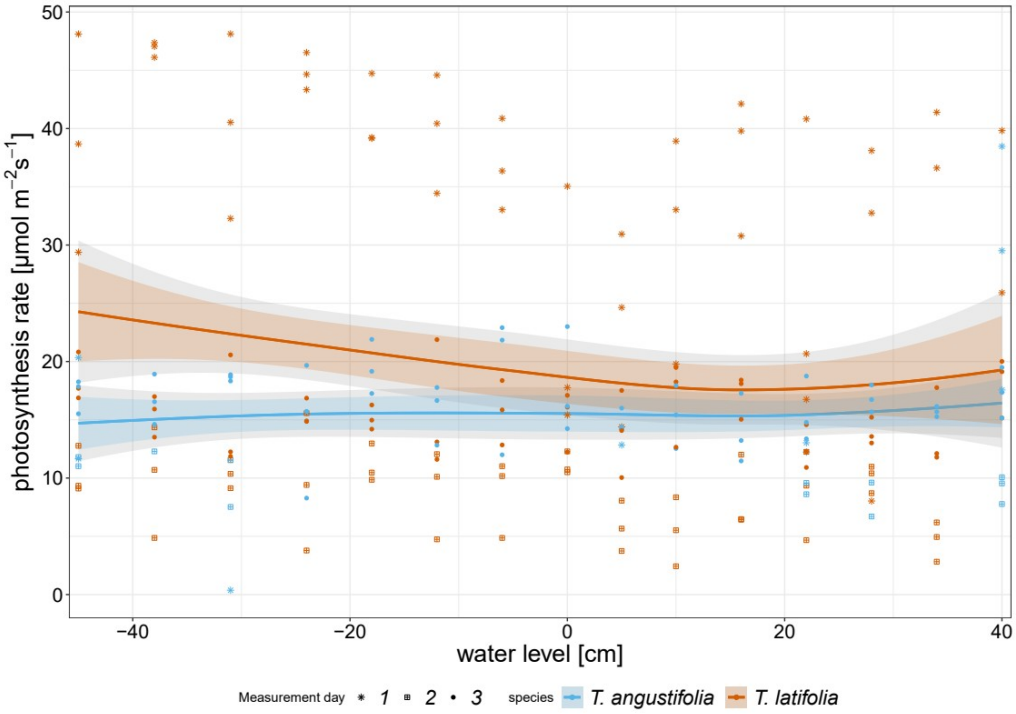






- *T. angustifolia*:
  - under flooding taller but less shoots
- *T. latifolia*:
  - no significant effect of water level on growth parameters
  - more leaves per plant at wide range of water levels, not at extremes (- 36 cm - + 25 cm)
  - partly more shoots than *T. angustifolia* (- 41 cm to - 4 cm & + 3 cm to + 36 cm)

Water levels - Photosynthesis

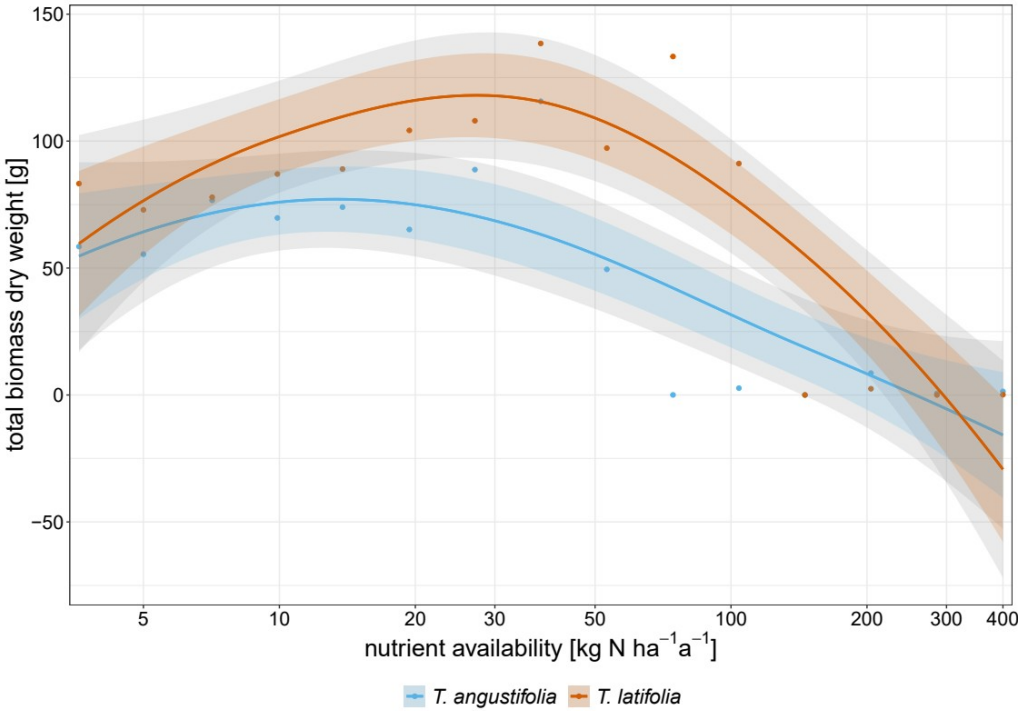


- Both species:
  - no significant change in photosynthetic rate of either species along water level gradient
- *T. latifolia:*
  - higher photosynthetic rate under dry conditions (- 45 cm - -6 cm)

Conclusion water level gradient

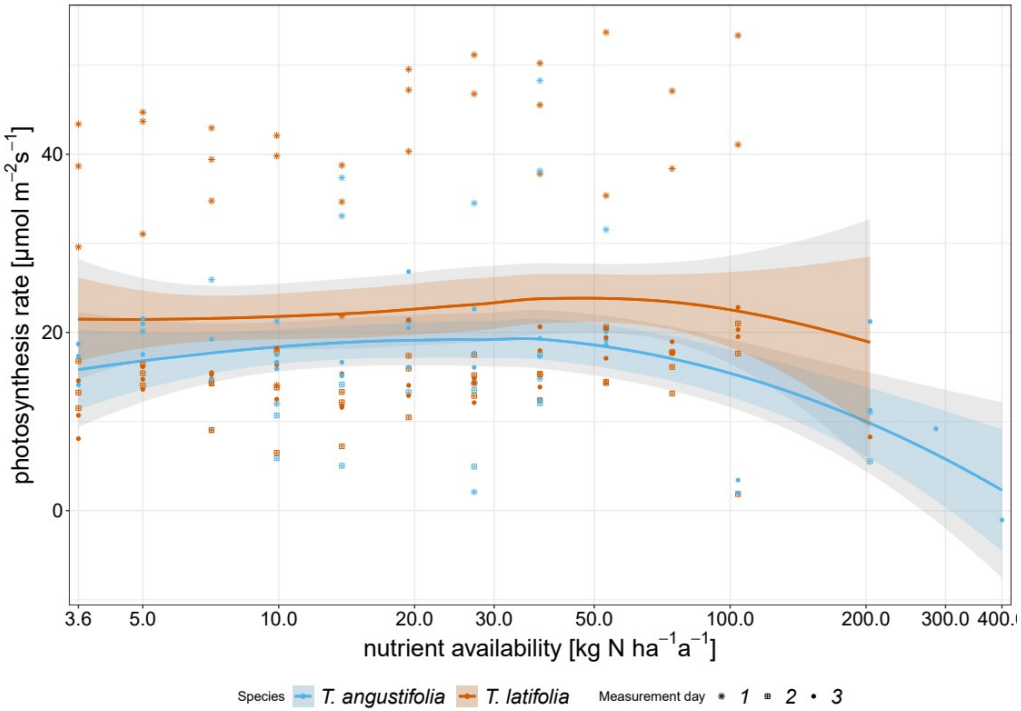
- *T. latifolia* better producer than *T. angustifolia* regarding biomass over large part of water level gradient
- Similar pattern in photosynthetic rate and no. leaves per plant

Nutrients - Biomass



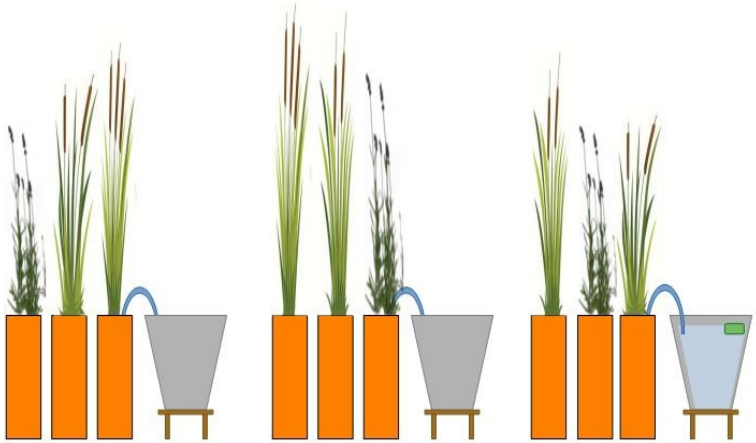
- Both species:
  - No significant change at low and intermediate nutrient availability
  - Significant decrease with increasing nutrient availability
- *T. latifolia:*
  - more biomass than *T. angustifolia* at intermediate nutrient availability (~ 12 – 180 kg N ha^{-1} a^{-1})

Nutrients - Photosynthesis



- *T. latifolia*:
  - no significant change in photosynthetic rate along nutrient gradient
- *T. angustifolia*:
  - decrease in photosynthetic rate with increasing nutrient availability
- No significant difference between species

Conclusion nutrient gradient



- Decrease of biomass with increasing nutrient availability unusual (Ren et al. 2019, Geurts & Fritz (eds.) 2018) → most likely ammonia (NH_3) poisoning
- *T. latifolia* better producer at ~ 12 – 180 kg N ha^{-1} a^{-1} regarding biomass
- Pattern of biomass production and growth along nutrient gradient reflected in photosynthetic performance

What does it mean for paludiculture?!

- Biomass production: *T. latifolia* preferrable over *T. angustifolia* under most nutrient and water level conditions
- Biomass production still good under low nutrient availability → perspective of long-term unfertilised *Typha* paludiculture
- Biomass production of *T. latifolia* higher under dry conditions → consider other aspects of paludiculture: climate goals, peat conservation, competing vegetation
- *Typha* can continue to produce biomass even under dry conditions, lack of irrigation water

Looking forward to your questions

Today, 13:30 :
Virtual excursion
"Field-scale Typha paludiculture in NE Germany"