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PLANTS RESPONSE TO ESTUARINE CONSTRAINTS: A STUDY OF CONTROLLED SALINITY AND INUNDATION



Markus Neupert¹, Michaël Aubert¹, Estelle Langlois¹

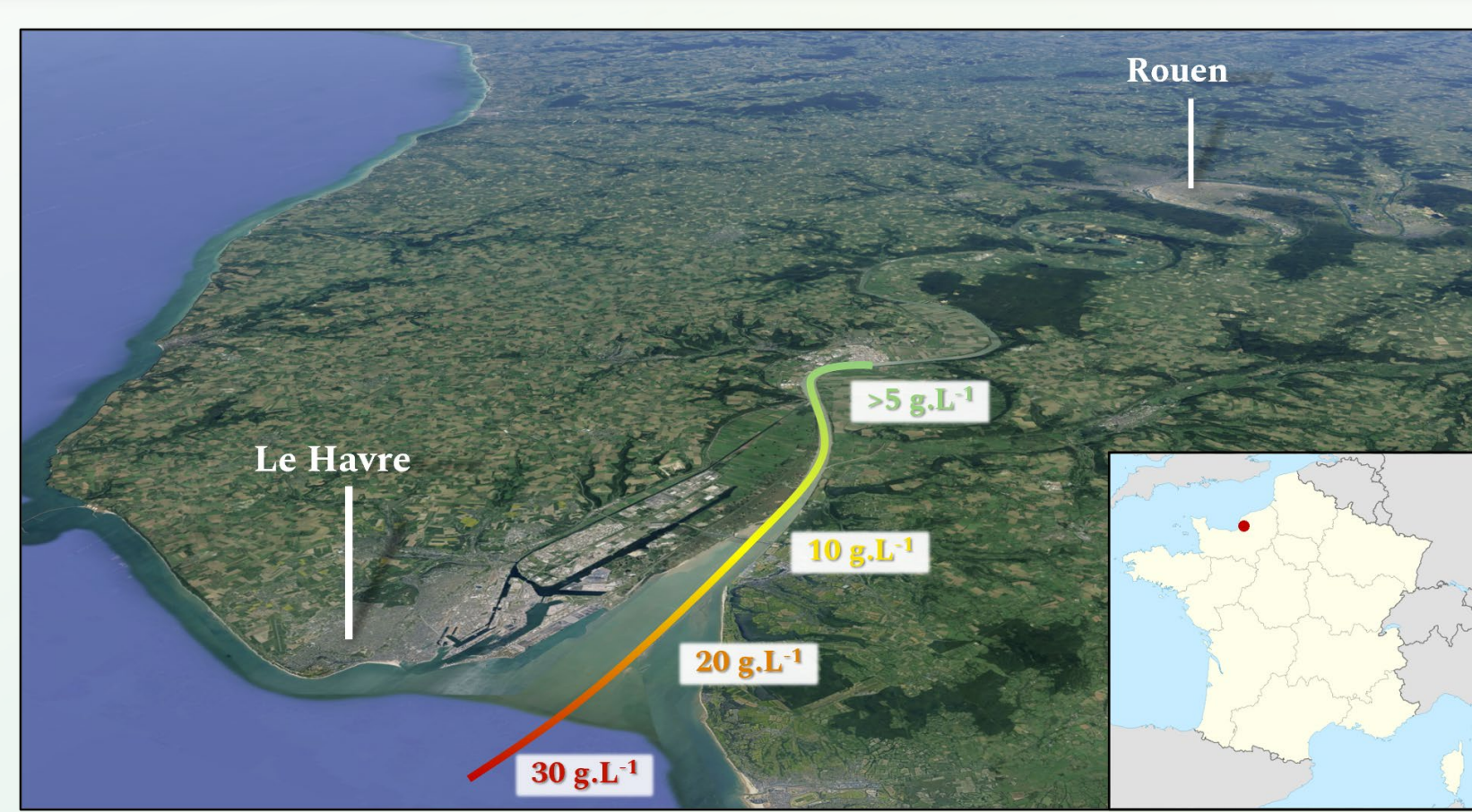
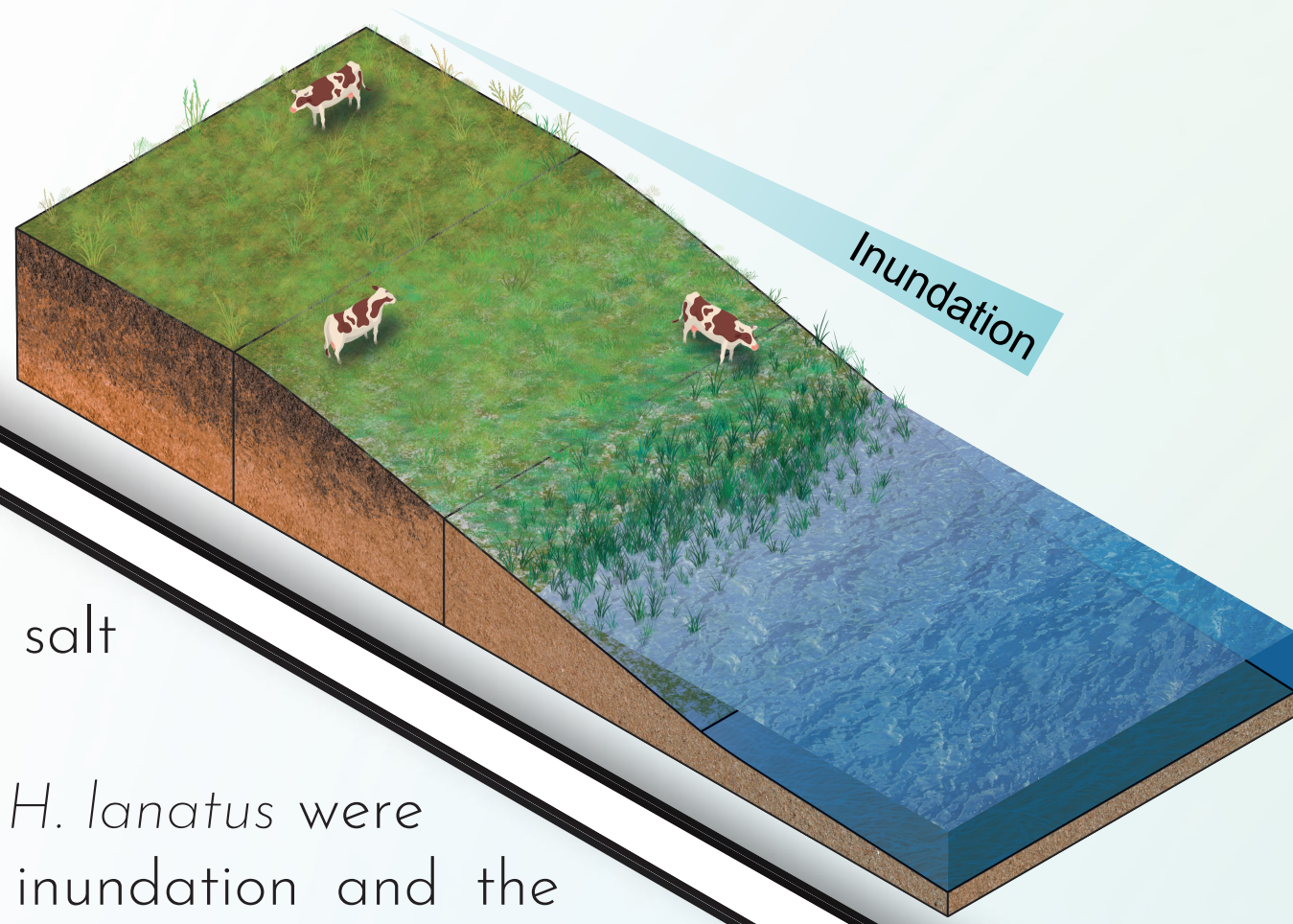
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- Inbetween terrestrial, marine and freshwater ecosystems, estuarine wetlands are shaped by strong environmental constraints, including tidal cycles, varying salt concentrations, and erosion/sedimentation dynamics (Perillo et al., 2019).
- Vegetation community composition is strongly driven by the salinity and inundation gradients (Silvestri et al., 2005), which impact growth performance and select species with fitting functional traits (Keddy et al., 1992).

- F. arundinacea* responded positively to increased salt concentrations.
- A. geniculatus* and *H. lanatus* were more affected by inundation and the compound effect of salt+inundation than salinity alone.



The salt gradient of the Seine estuary as a reference.

- In a context of human-made climate change, the current salinities and inundation frequencies are bound to change (IPCC, 2022). How do plant growth and resource allocation of estuarine wetland plants respond to them?

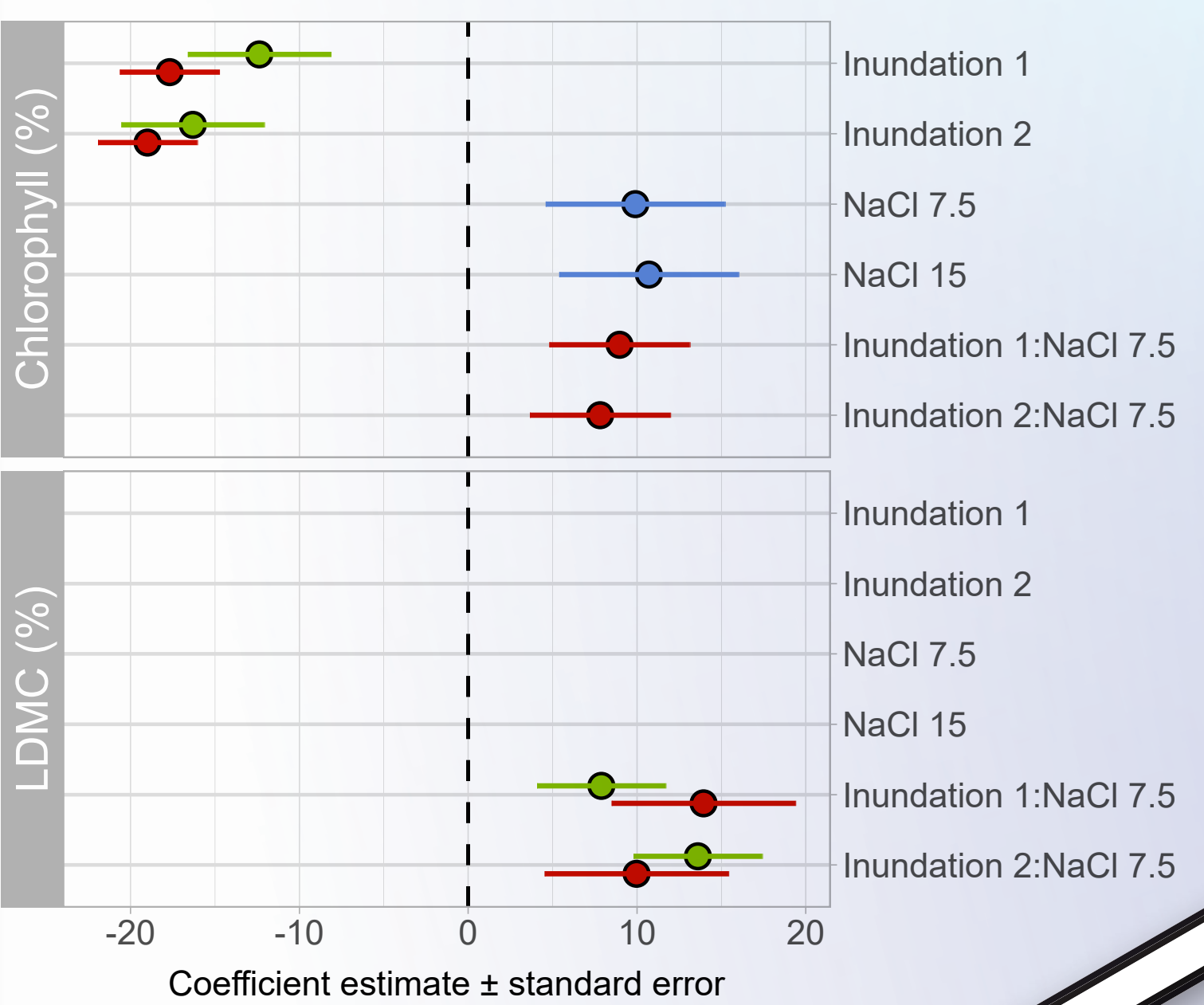
Working hypotheses:

- Disturbance gradients of salinity and inundation impact plant survival and functional traits at the species level.
- Productivity is related to disturbance intensity and frequency.

LINEAR MODEL COEFFICIENTS OF LEAF TRAIT RESPONSE

Formula: Trait ~ Inundation * Salinity
Only most significant coefficients shown (p<0.07)

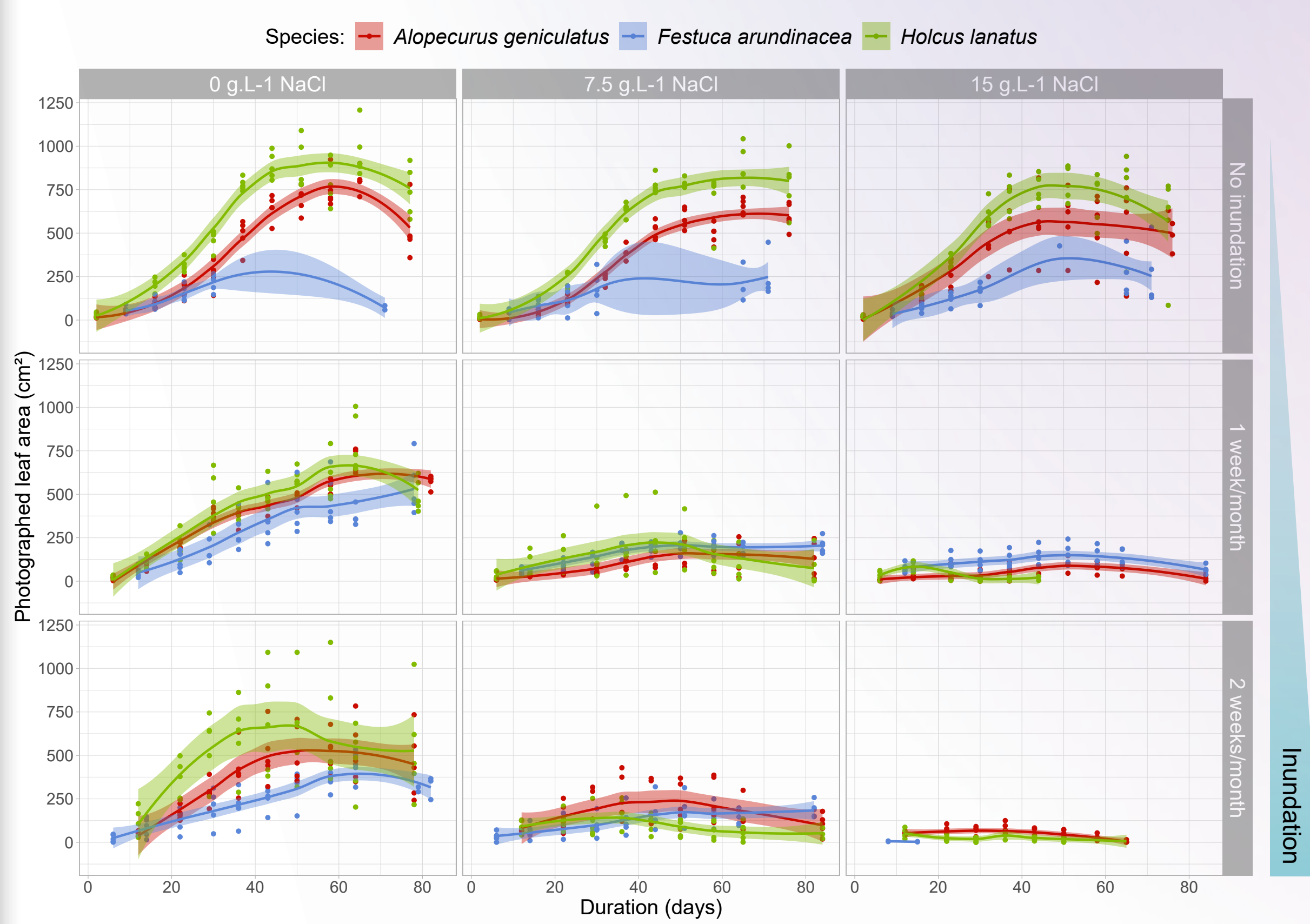
Species: ● *Alopecurus geniculatus* ● *Festuca arundinacea* ● *Holcus lanatus*



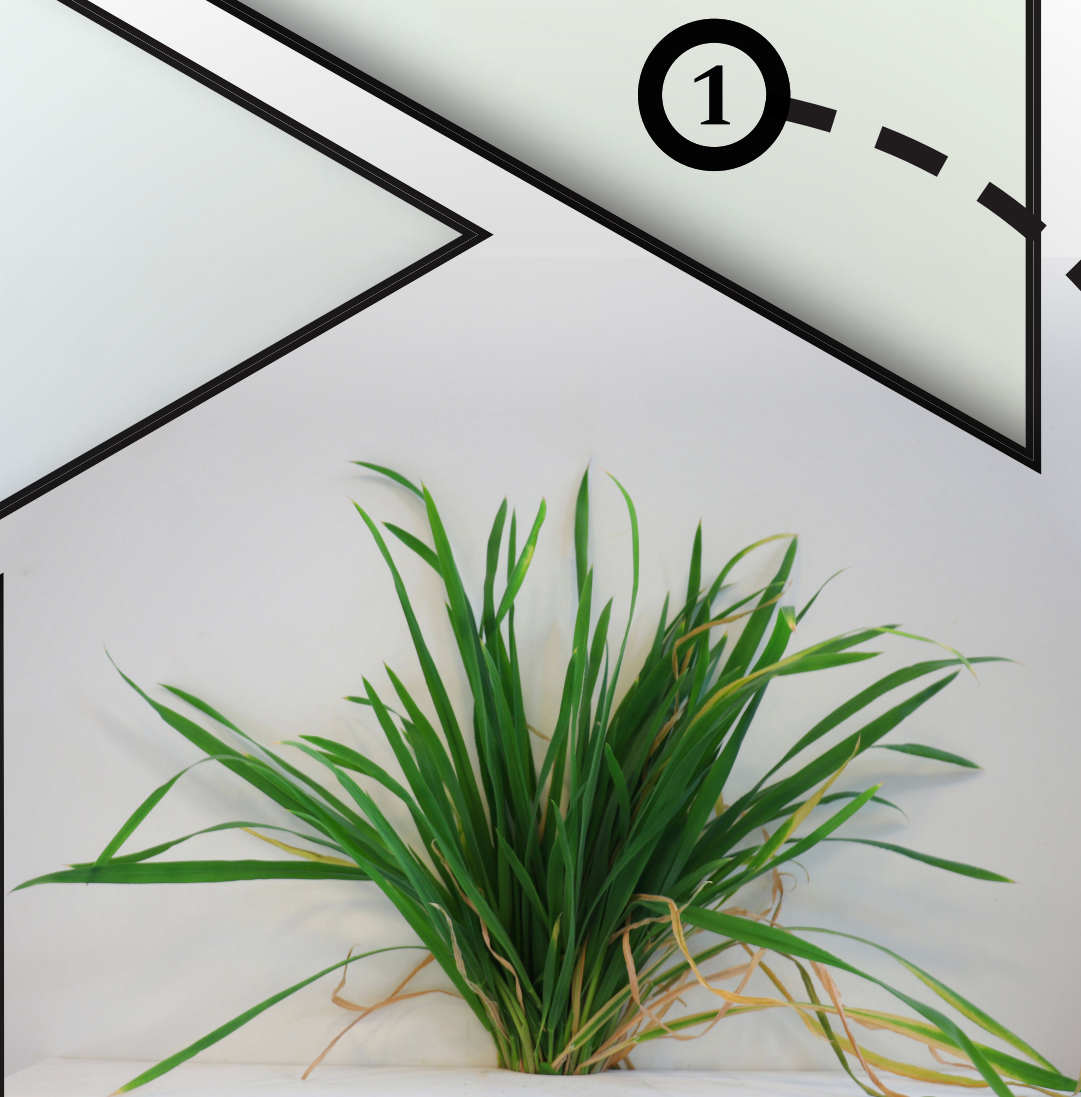
- Across the gradients of inundation and salinity, there is evidence for different responses of traits between species, related to their life strategies.

- With approx. 5000 photographs taken over the course of the experiment, we found an important synergy of the effects of inundation and salinity on plant survival and growth performance.
- Given the linear increase of leaf overlap, the photographic data can be corrected to estimate total leaf area.

PHOTOGRAPHED LEAF AREA OVER THE COURSE OF THE EXPERIMENT (not adjusted for leaf overlap)



CONTEXT



EXPERIMENTAL SETUP

- 1 seedling per pot filled with 4 litres of soil from the Seine estuary.
- 3 salt concentrations, spanning the gradient observed in the Seine estuary.
- 3 automated flood cycles mimicking distance from the riverbed and the 6h tidal cycle:
 - No tidal cycle, pots watered weekly with 250 ml by hand;
 - 12h tidal cycle every 4th week;
 - 12h tidal cycle every 2nd week.
- 3 characteristic species of the oligohaline marshes of the Seine estuary:
 - Alopecurus geniculatus* L.
 - Festuca arundinacea* Schreb.
 - Holcus lanatus* L.

Measured plant traits	
Specific Leaf Area	Destructive
Leaf Dry Matter Content	
Chlorophyll content	
Biomass	Non-destructive
Growth	

FIRST RESULTS: TRAITS

FIRST RESULTS: GROWTH

PROOF OF CONCEPT

- A preliminary experiment with 4 different plant species was used to develop the photoanalysis algorithm and test its use case under benign growth conditions.
- The average leaf area values from 4 photographs per individual allowed for the most accurate estimations of leaf area and plant height.
- Compared to destructive leaf area scans, photography underestimated the total leaf area due to increasing leaf overlap with plant size.
- Photographed leaf area is a good estimator of dry biomass ($R^2=0.93$), except for *J. gerardii*, whose thin leaves were not detected as well ($R^2=0.46$).

PHOTOANALYSIS

- Photographic growth monitoring is cost-effective, time saving and allows for repeated measures on the same individuals.
- Various applications: vegetation cover estimation, N content estimation, phenological analyses, biomass estimation.
- The custom algorithm calculates leaf area in few seconds, simplifying batch analyses.

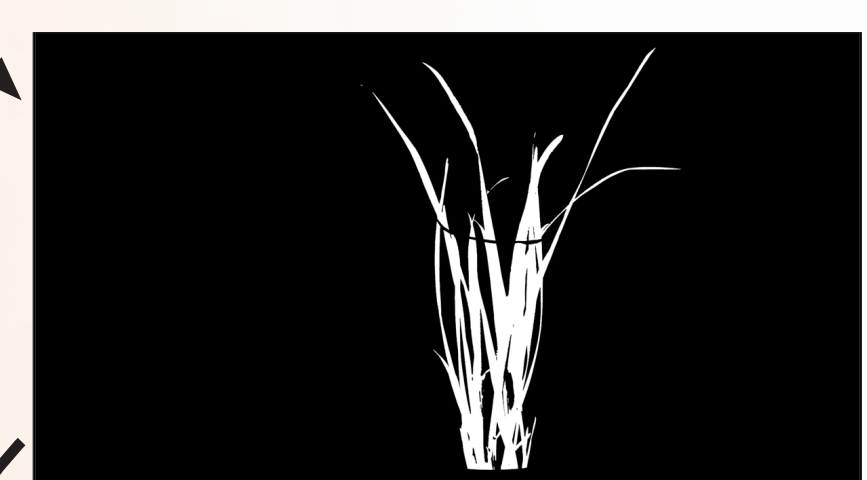
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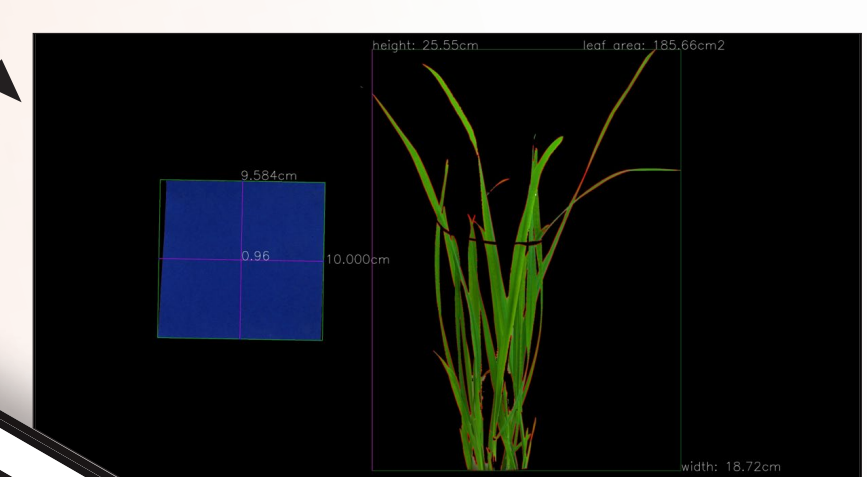
Color Adjustment



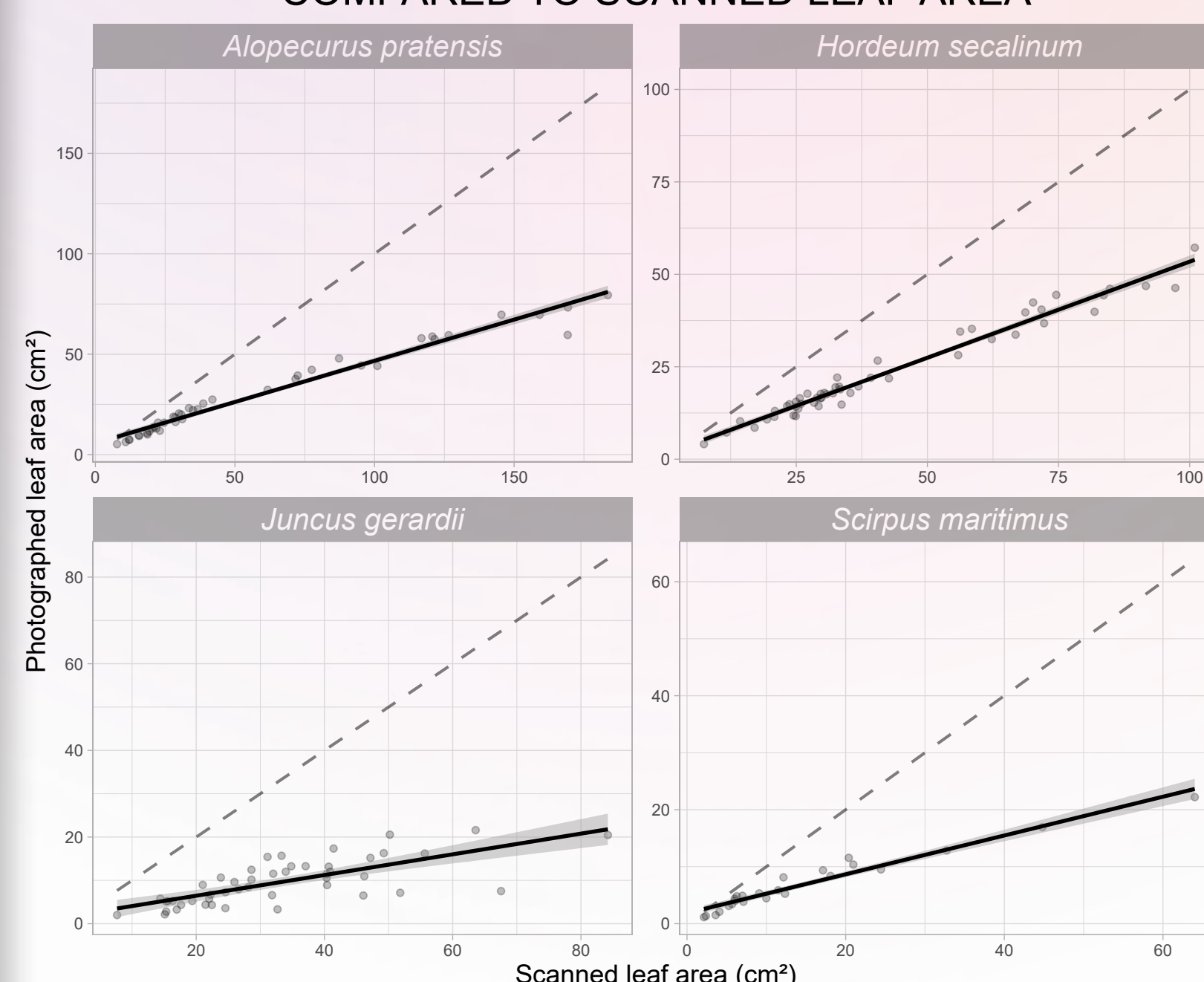
Thresholding



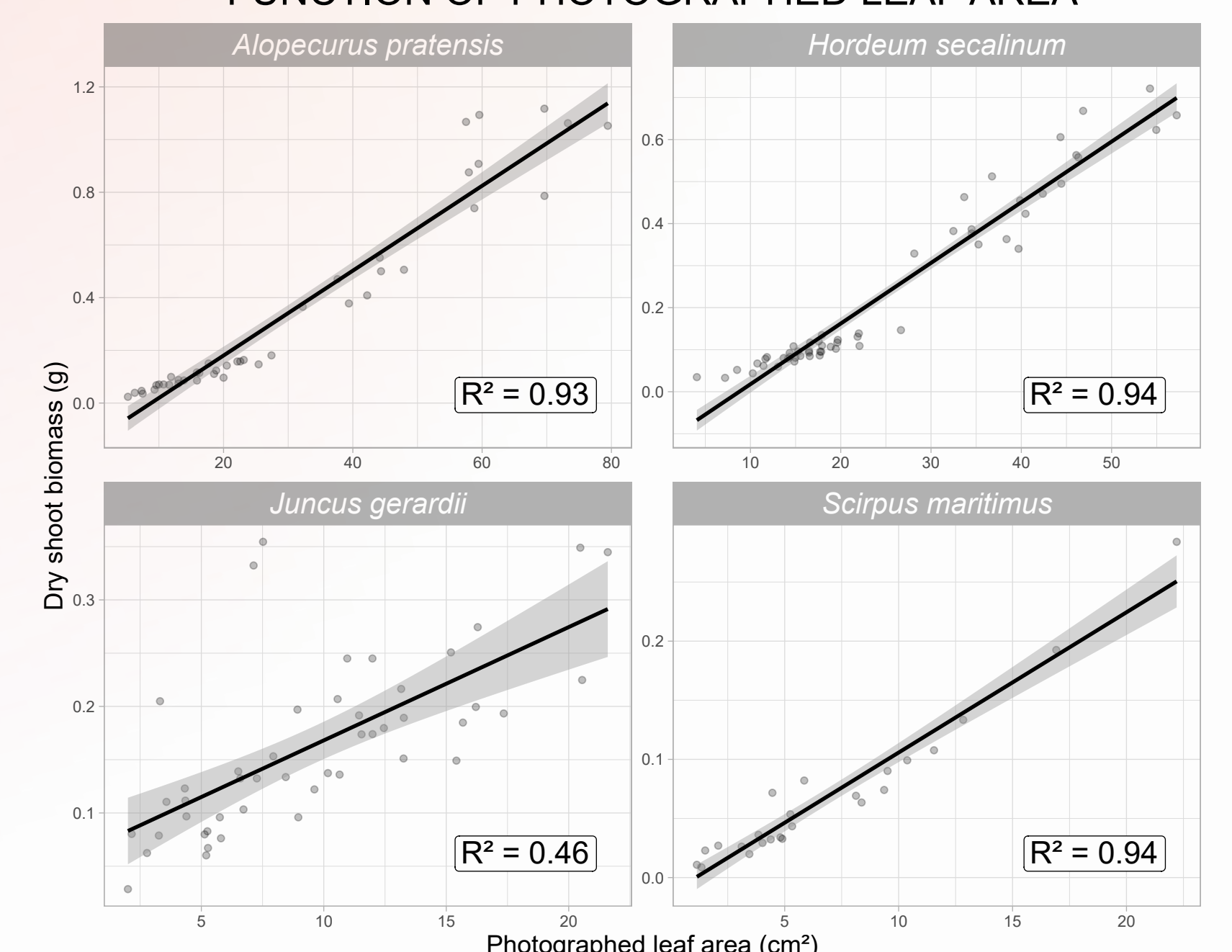
Pixel to surface conversion



PHOTOGRAPHED LEAF AREA COMPARED TO SCANNED LEAF AREA



DRY SHOOT BIOMASS AS A LINEAR FUNCTION OF PHOTOGRAPHED LEAF AREA



Abstract n°53
Submission 49-PO8

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