Competition mediates CO_2 fertilization of plant growth

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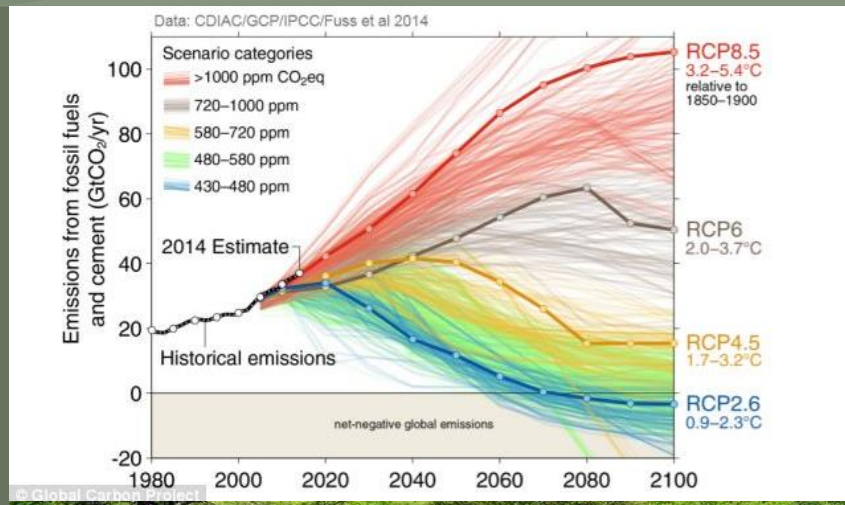
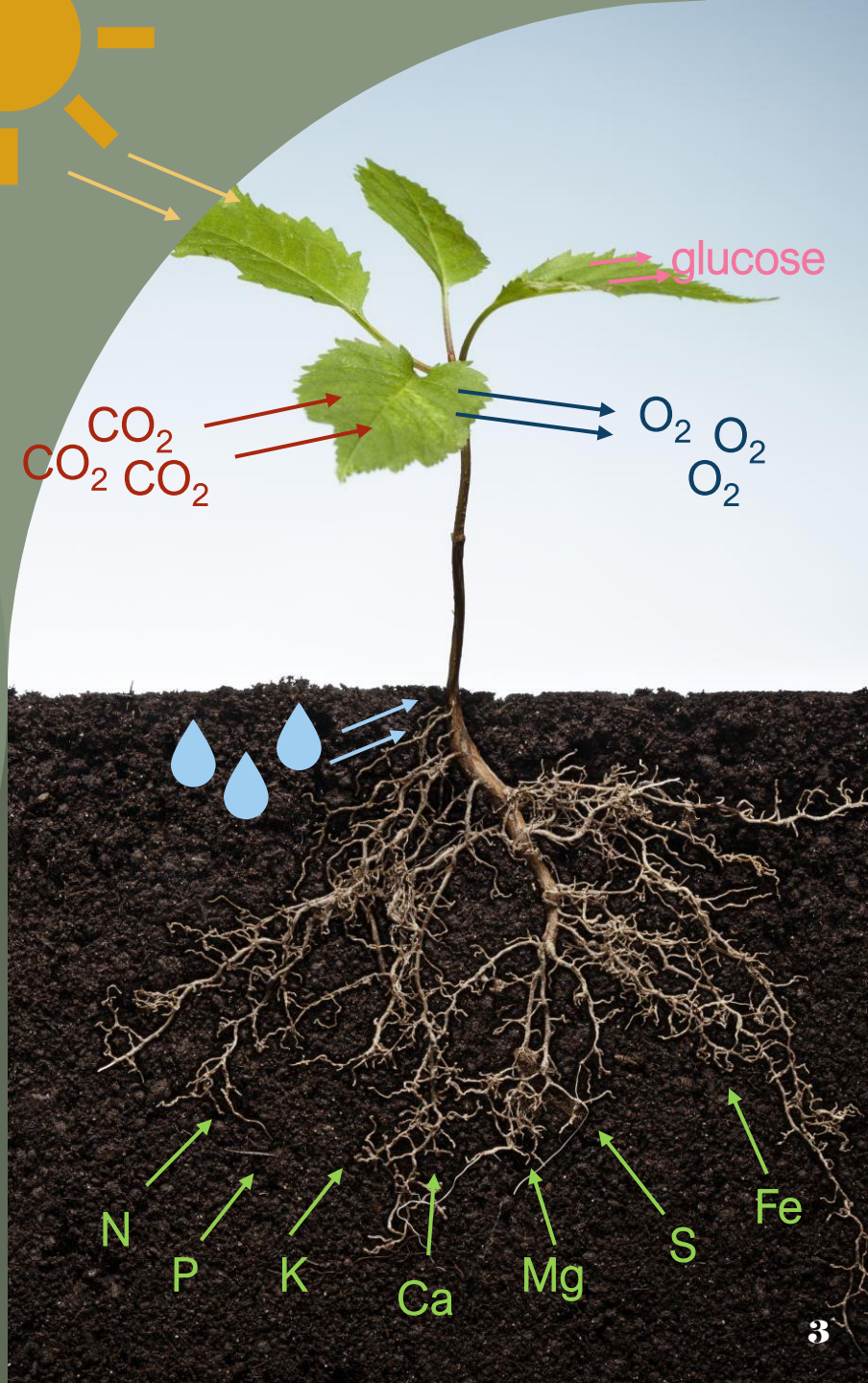
Why do we care about CO_2 effects on plants?

- Drives Plant Growth
- Shifts Species Composition
- Alters Plant Interactions
- Impacts Carbon Storage



How does CO_2 influence **plant growth?**

$CO_2 + H_2O + \text{light energy} \rightarrow \text{glucose} + O_2$

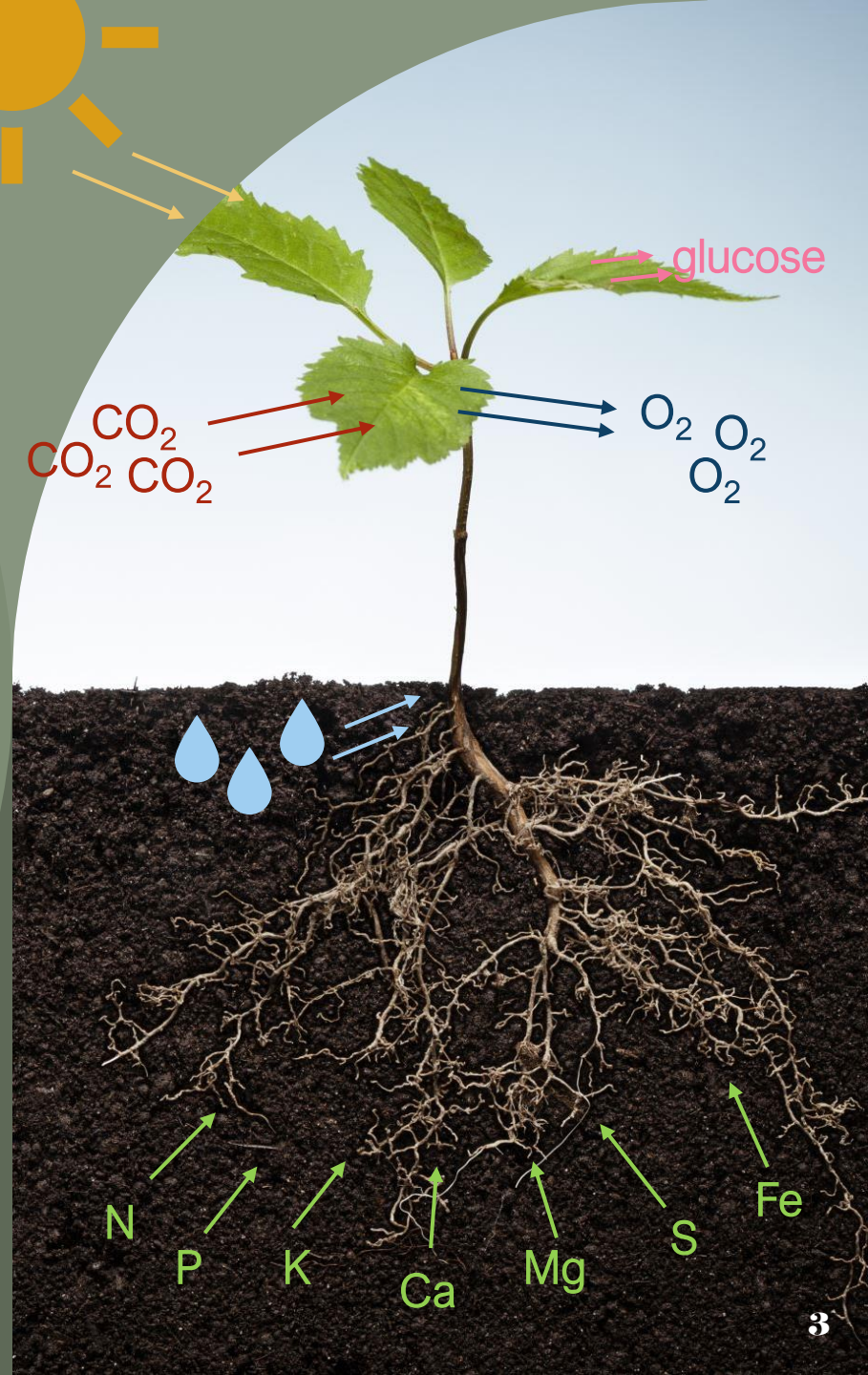


How does CO_2 influence **plant growth?**

* In an ideal scenario *

↑ Growth

Low CO_2 High CO_2



How does CO_2 influence **plant growth?**

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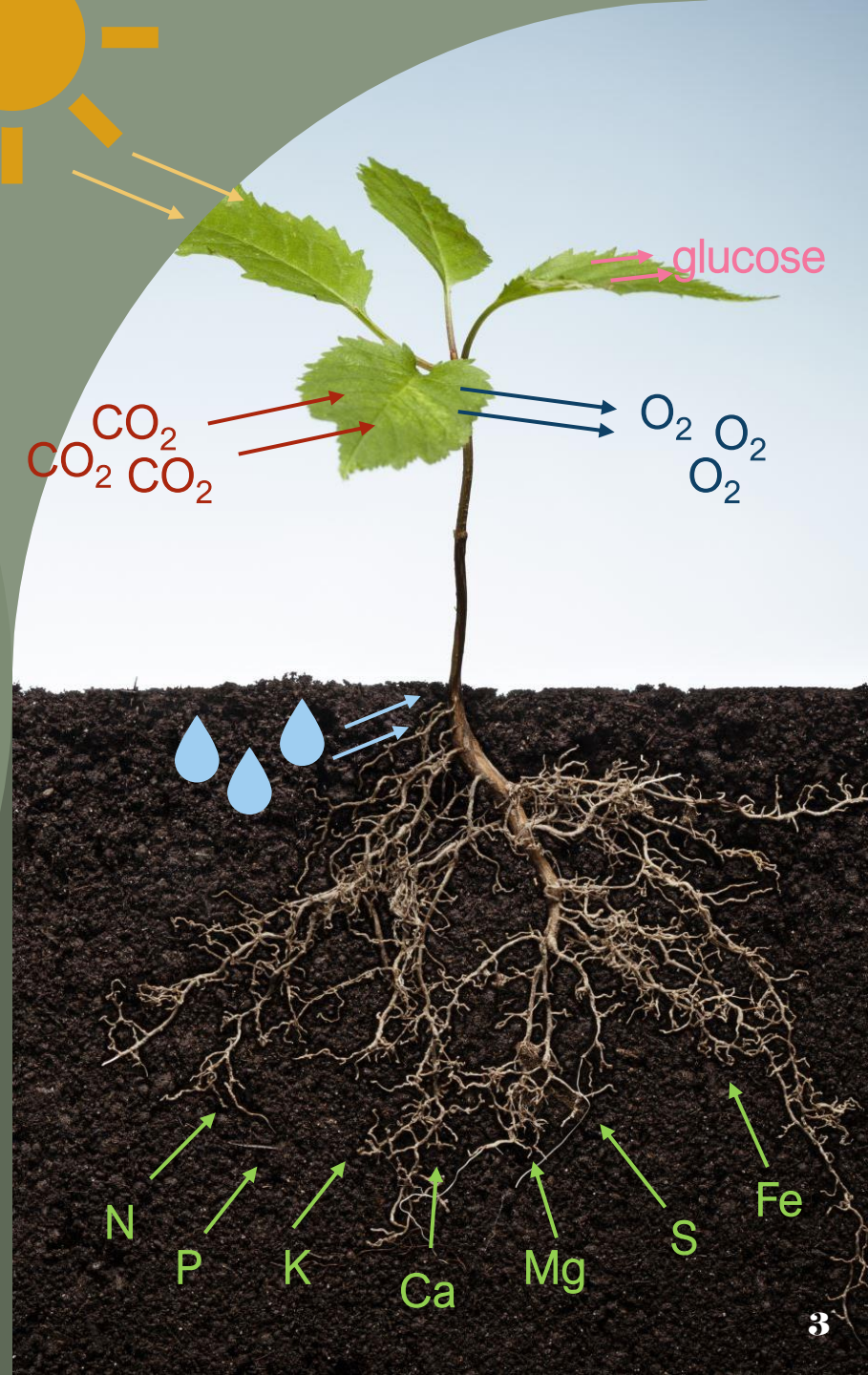
↑ Growth
↑ Water Use Efficiency

Low CO_2 High CO_2

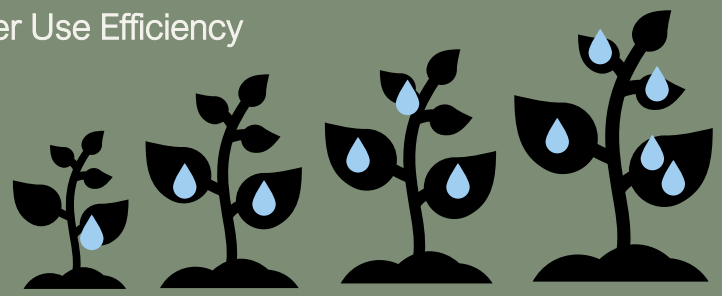


How does CO_2 influence **plant growth?**

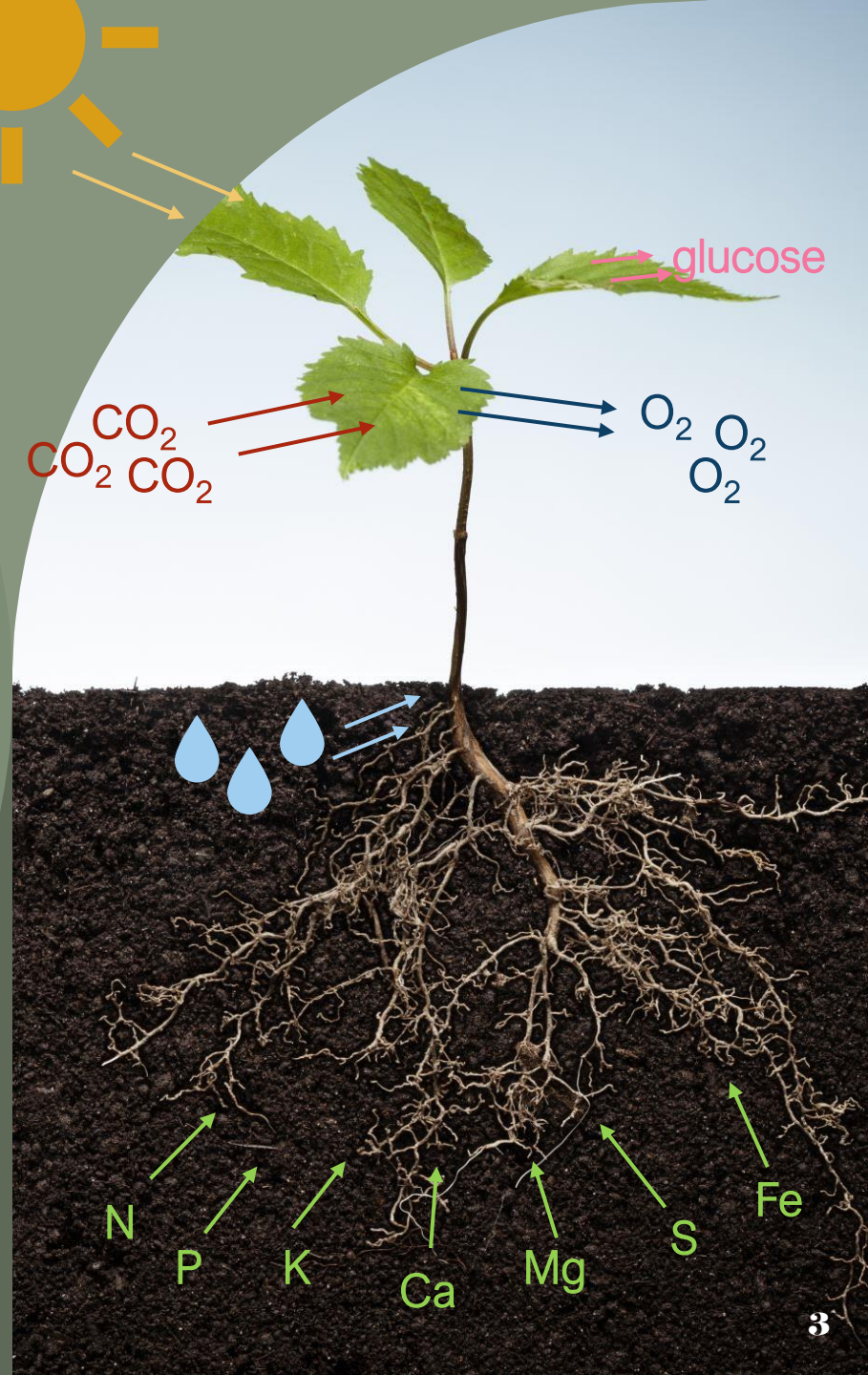
BUT, eCO_2 stimulation is inconsistent across species and systems

* In an ideal scenario *

↑ Growth
↑ Water Use Efficiency



Low CO_2 High CO_2

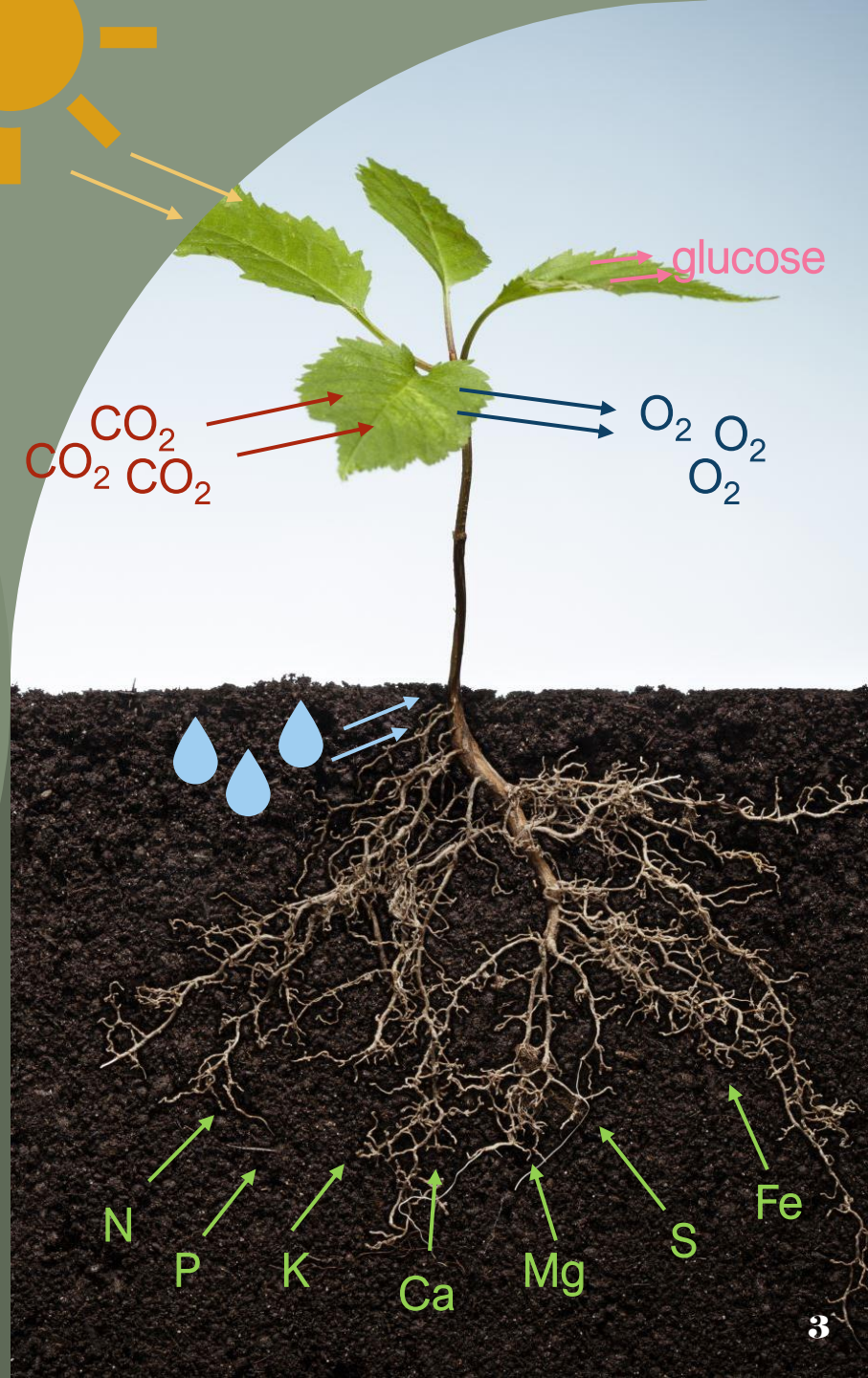


How does CO_2 influence **plant growth?**

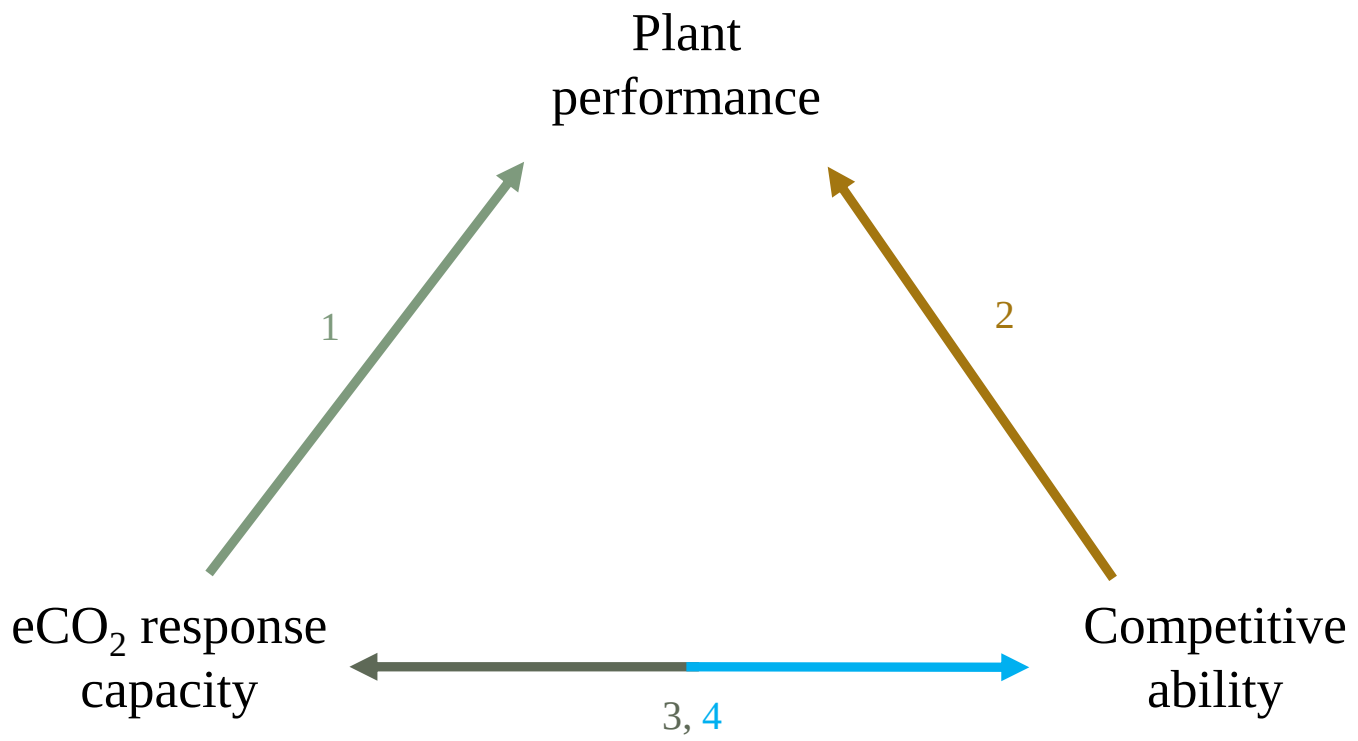
"the **growth** of an organism (such as a plant) is **limited by the scarcest essential resource**, even if all other necessary factors are in abundance"

- Liebig's Law of the Minimum

Competition for resources will be important.



Predicting future plant community interactions



Predicting future grassy ecosystem community interactions

Meta-analysis

Criteria:

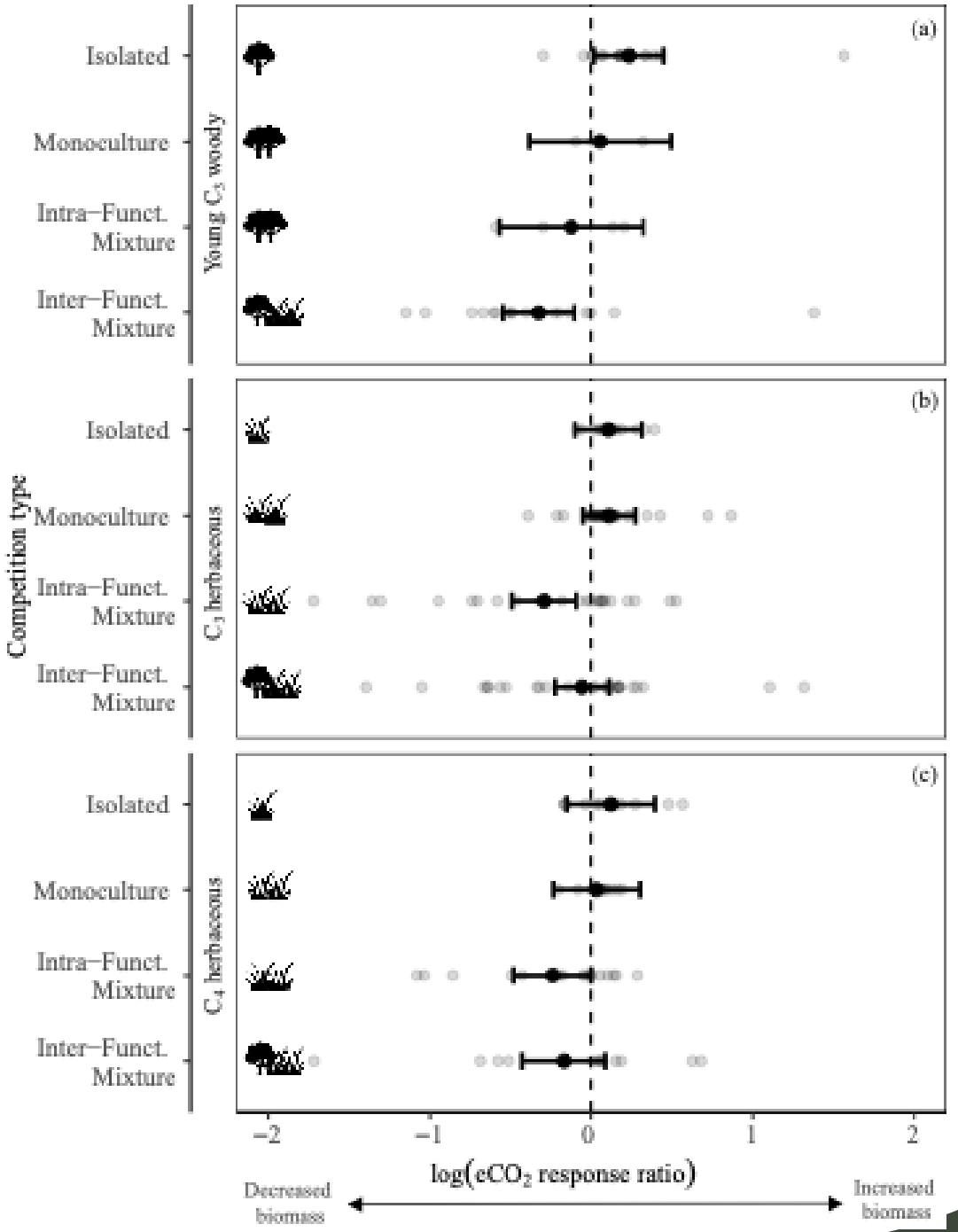
- **elevated** CO_2 (eCO_2) **vs ambient** CO_2 (aCO_2)
- **competition comparison**
- **grassy biome** (grassland, savanna, woodland with a continuous grass layer)

=

97 species from 20 studies

(23 C_3 woody species, 49 C_3 herbaceous species, and 23 C_4 herbaceous species).

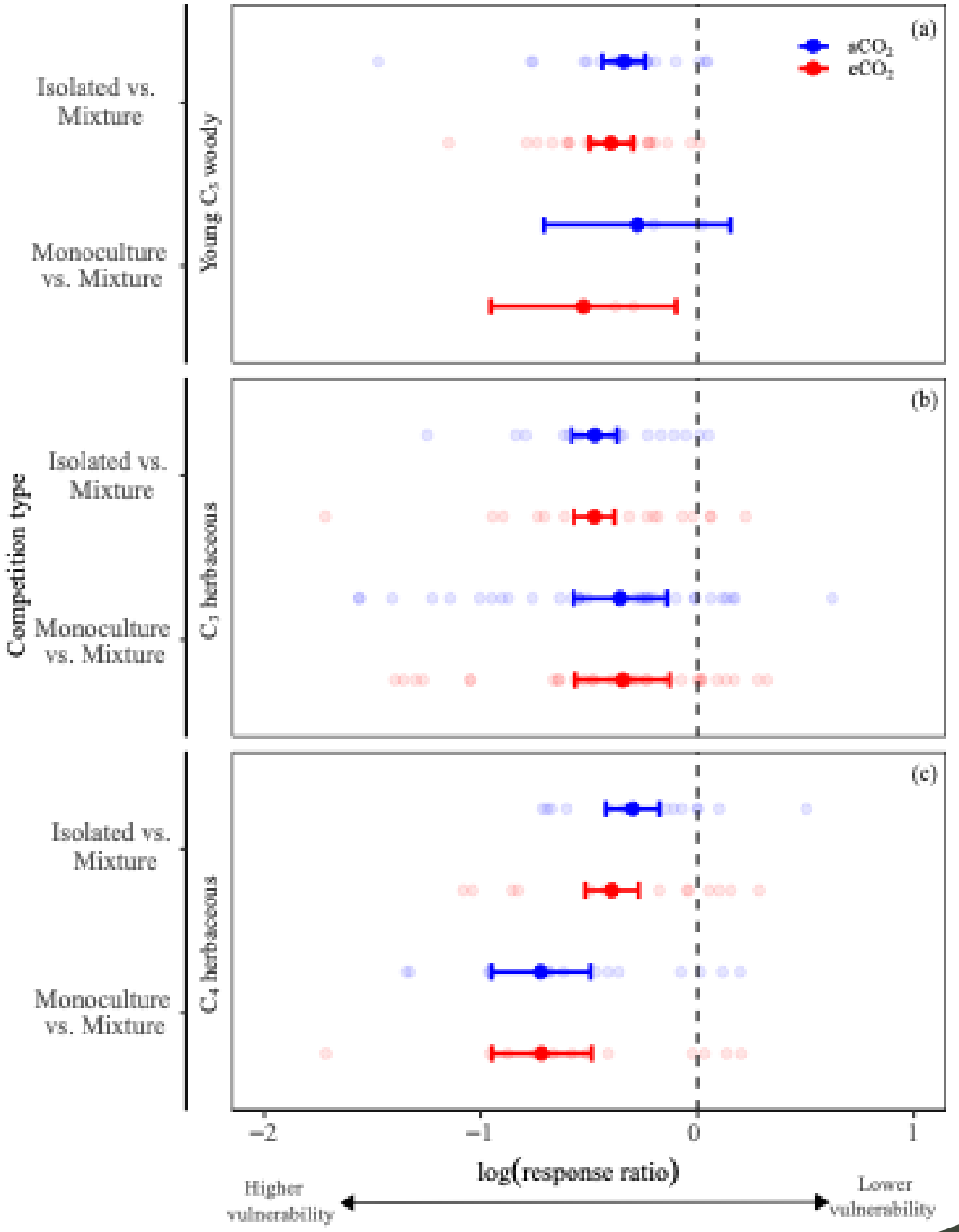
Elevated CO_2 Responses



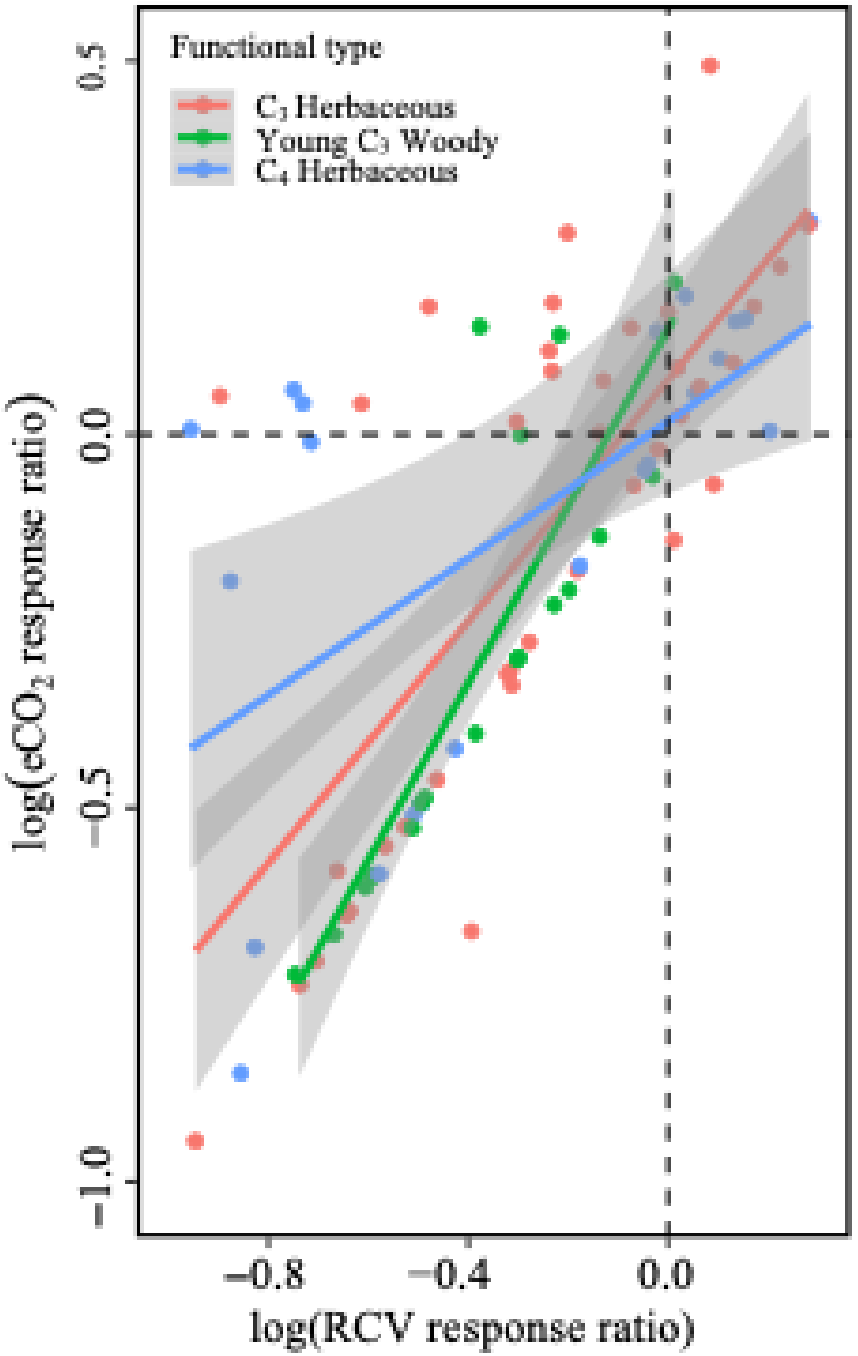
Competition & diversity effects

Competition vulnerability
=
Isolated vs Mixture

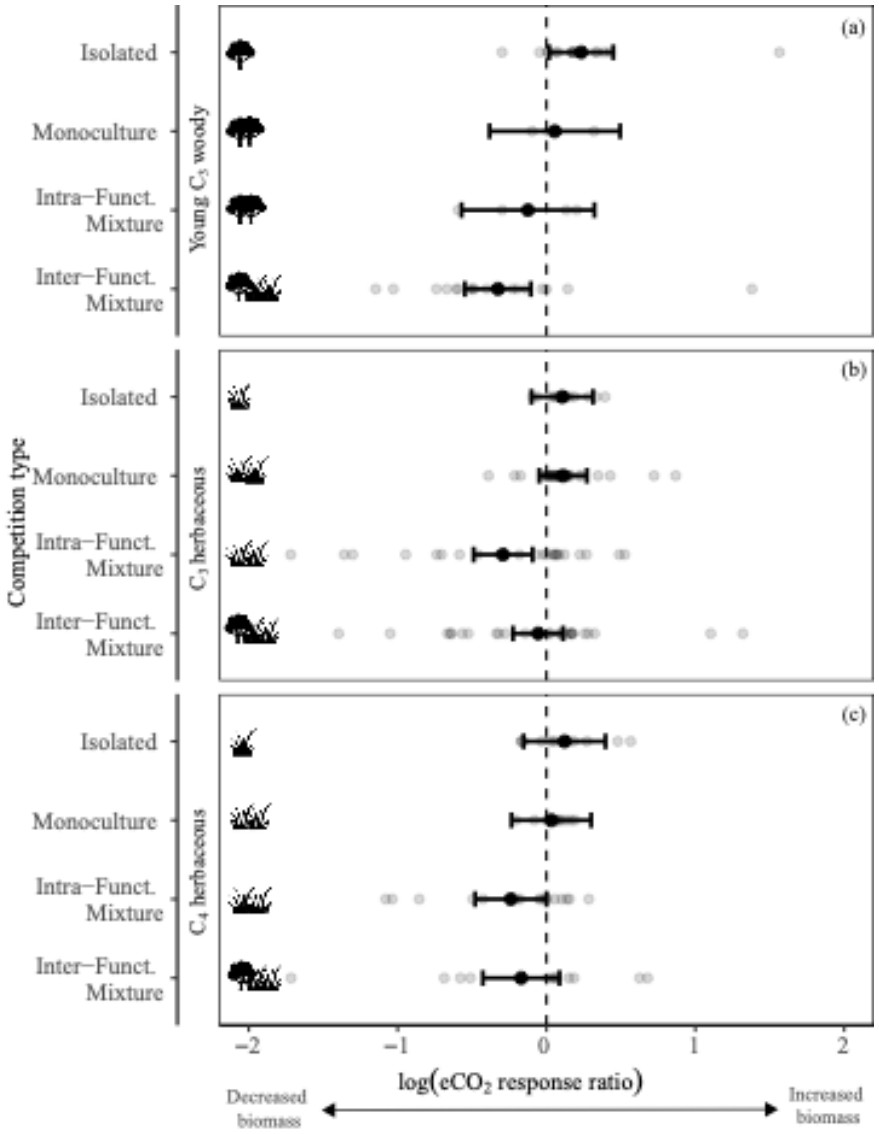
Diversity vulnerability
=
Monoculture vs Mixture

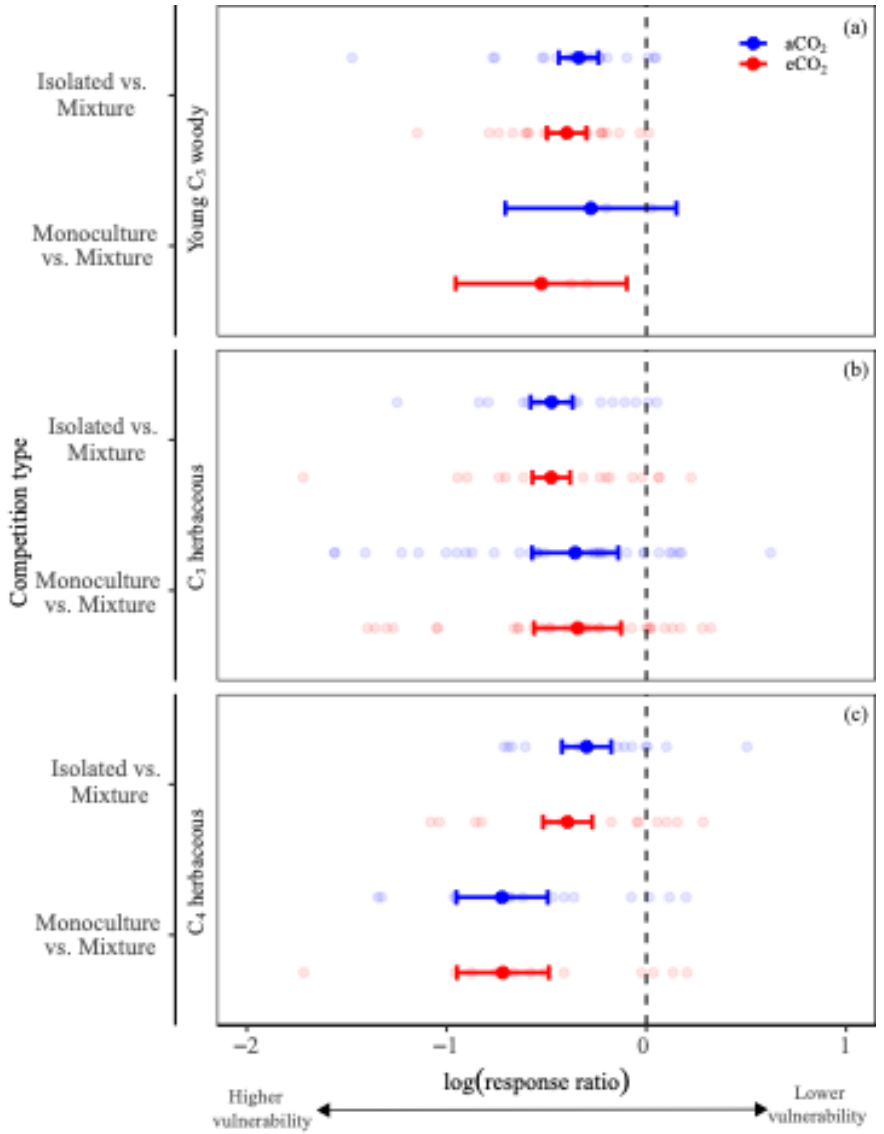


eCO_2 response and competitive vulnerability are correlated.



Does competitive ability affect CO_2 stimulation, or vice versa?





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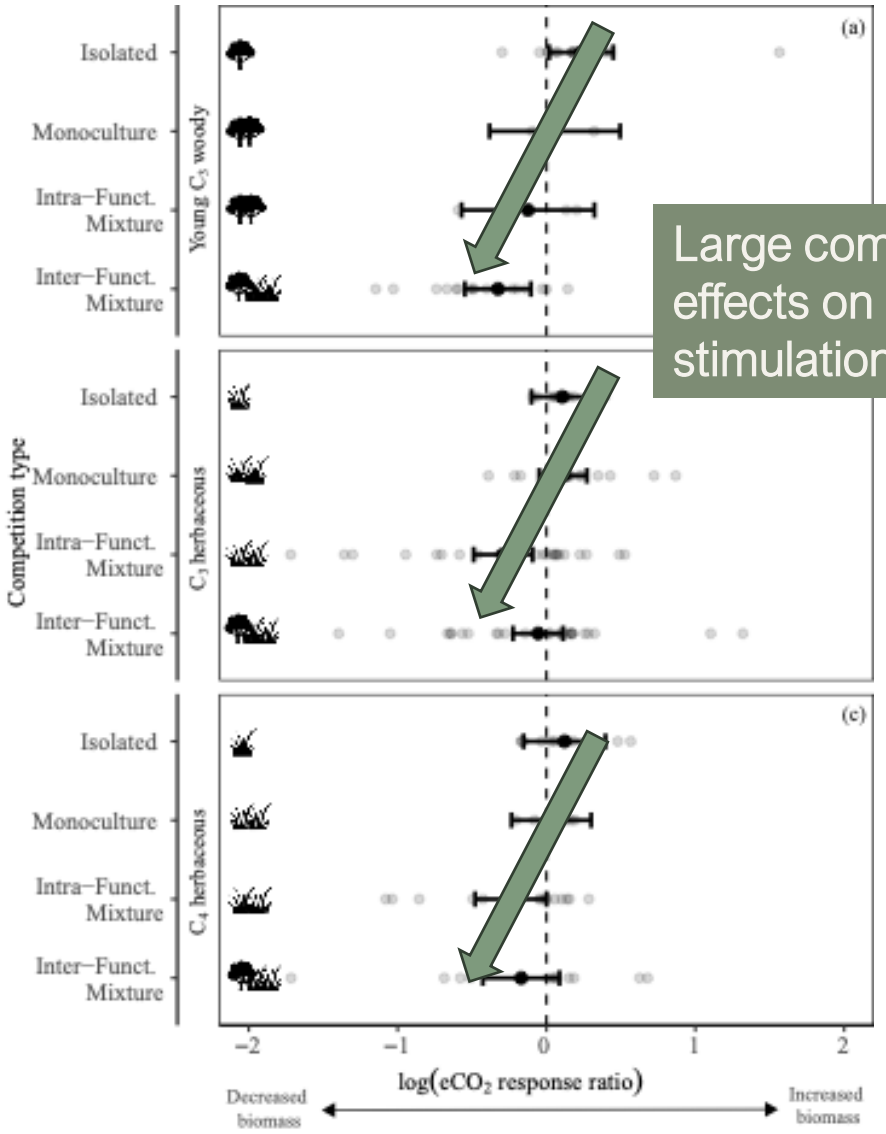
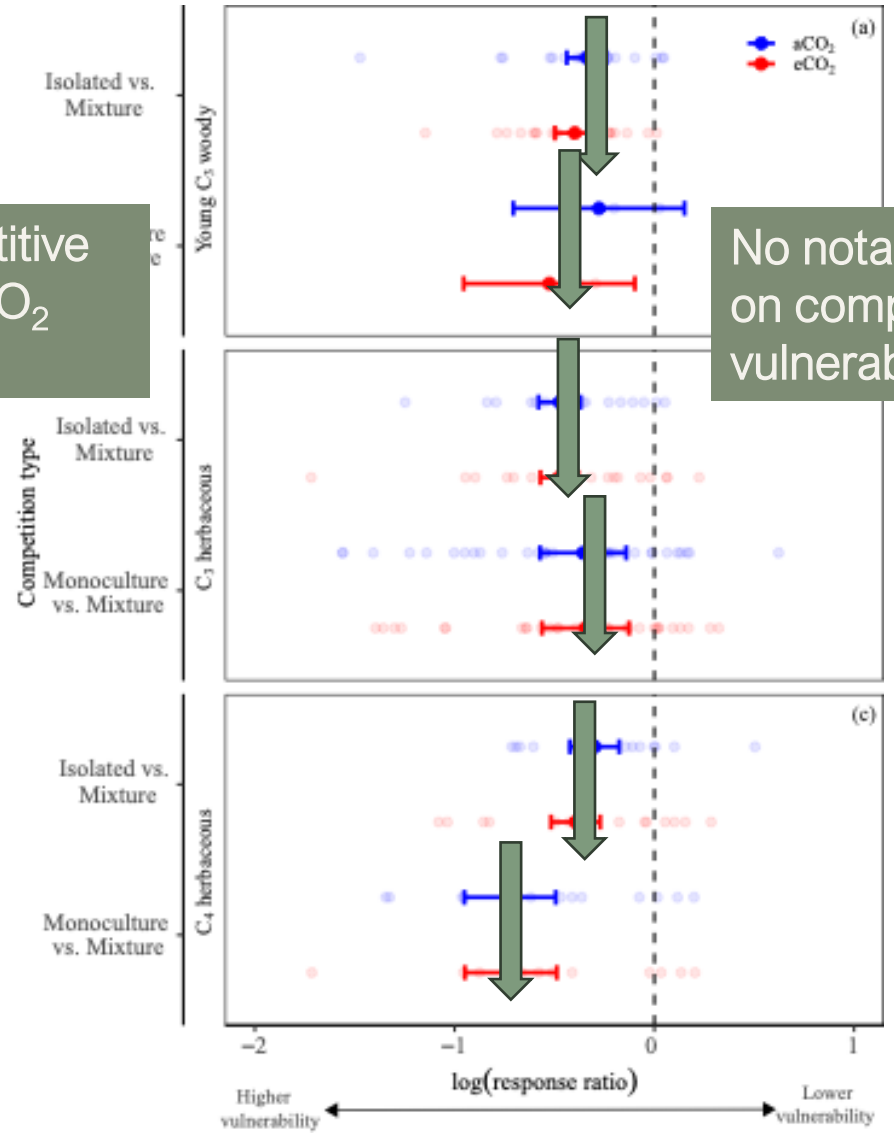


Large competitive effects on eCO_2 stimulation



No notable eCO_2 effects on competitive vulnerability

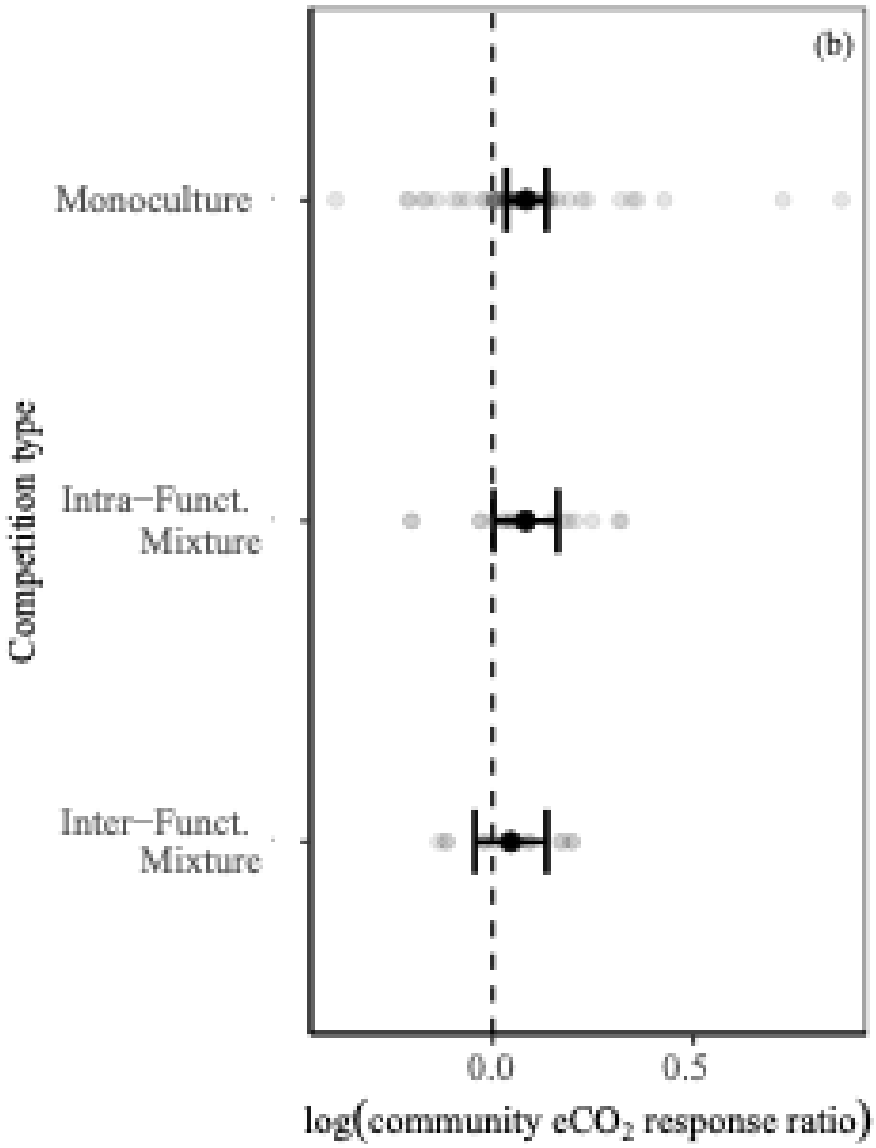
Which traits are associated with success?

↑ Leaf Nitrogen
↑ Leaf Area
↓ Specific Stem Density
↓ Leaf Thickness
↓ Life span

Acquisitive Strategies

* 96% of ‘winners’ have been classified as **invasive** somewhere in the world

Community level responses



- Positive eCO_2 responses in **dominant species** outweigh negative responses in rarer species
- But, **community eCO_2 stimulation is modest** compared to that used in many predictive models.

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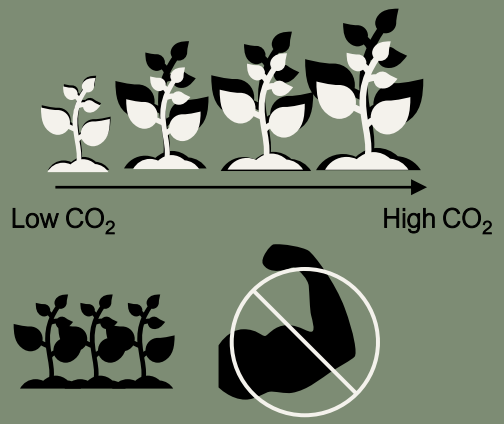

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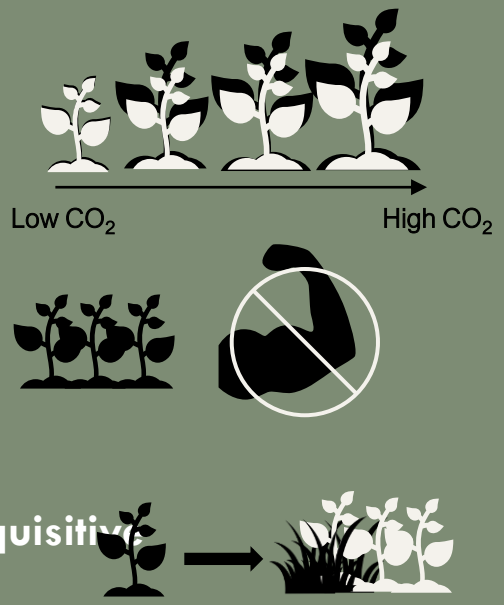
- eCO_2 does not ameliorate competitive effects
- The better competitors in the future are likely to have acquisitive and invasive strategies



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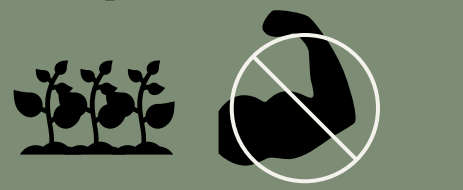
- We can't ignore competitive effects when modeling future plant growth!



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- We can't ignore competitive effects when modeling future plant growth!

- Big changes (e.g. bush encroachment) linked to eCO_2 are likely to occur via <u>accrual of benefit</u> in times/places where resources and competition are <u>not limiting</u>.

Thank you!

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