

Gene Expression – Phenotype Relationships in a Field Study of Photorespiration-Suppressed Transgenic Poplars

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Oregon State University
College of Forestry



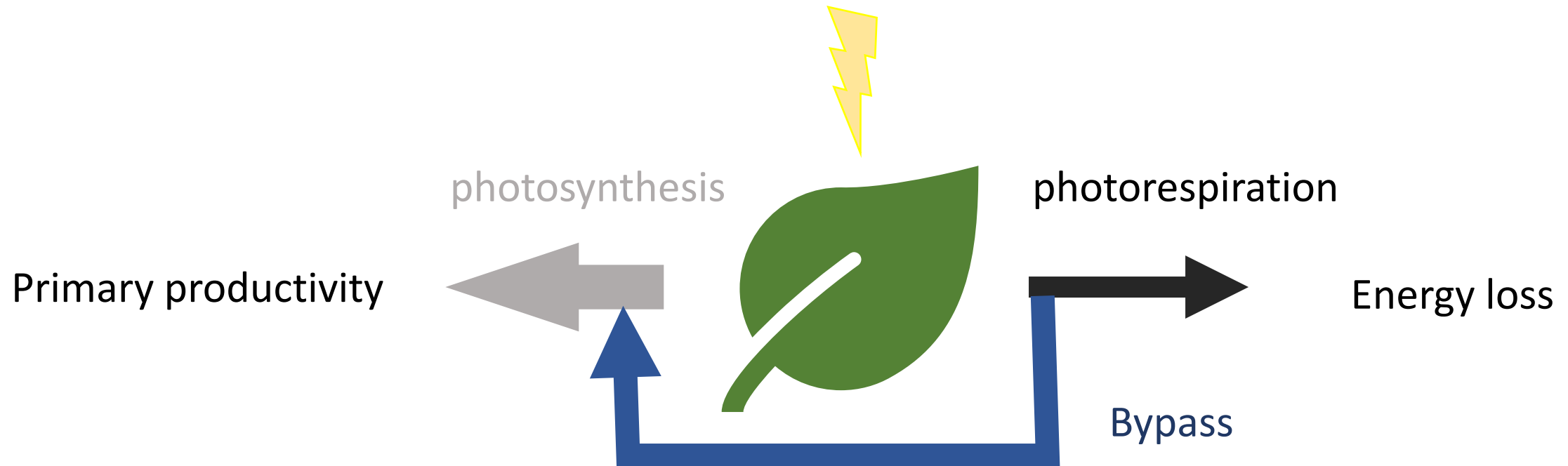
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Introduction

Photorespiration bypass

Photorespiration



Photorespiration

Science

Synthetic glycolate metabolism pathways stimulate crop growth and productivity in the field

Paul F. South^{1,2}, Amanda P. Cavanagh², Helen W. Liu^{3*}, Donald R. Ort^{1,2,3,4†}

Genetically modified 'shortcut' boosts plant growth by 40%

BBC

NEWS



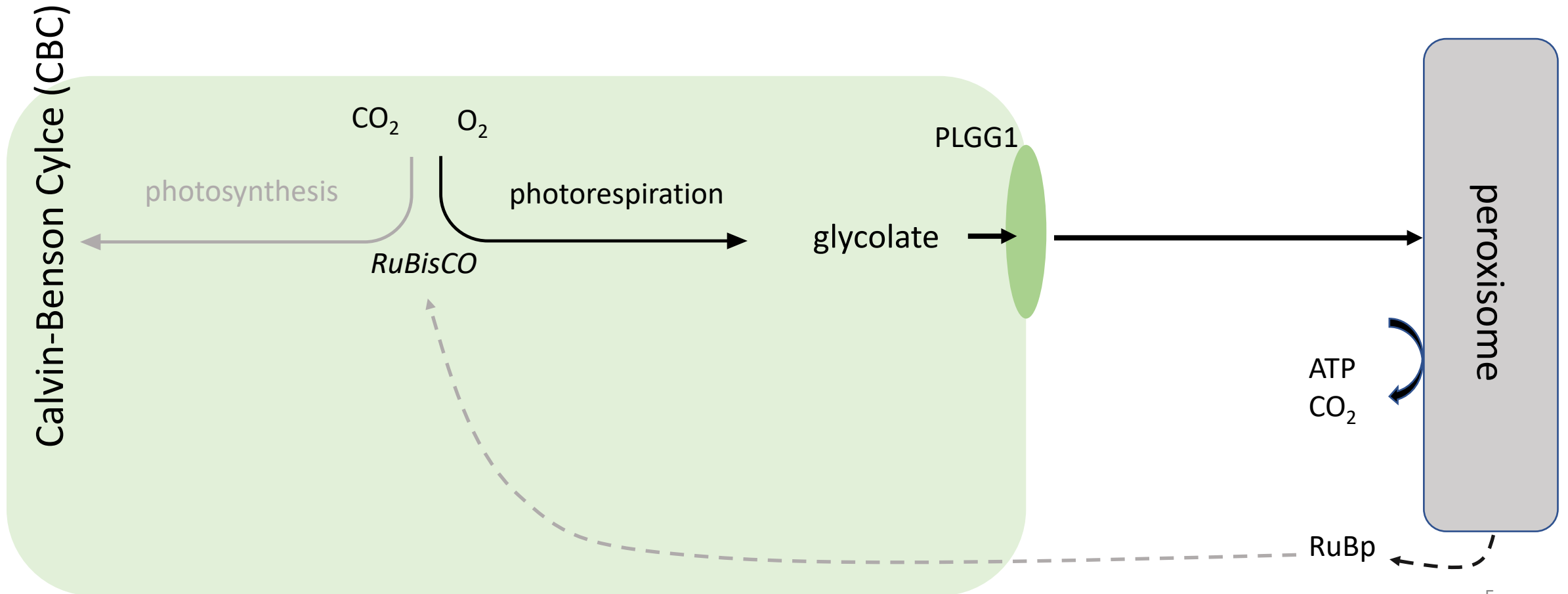
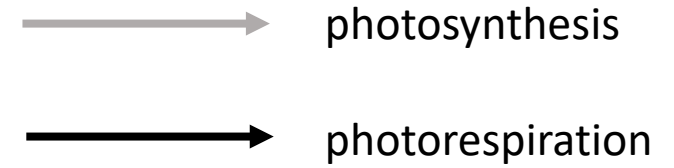
RIPE project

Breakthrough in plant engineering could boost productivity, feed millions more

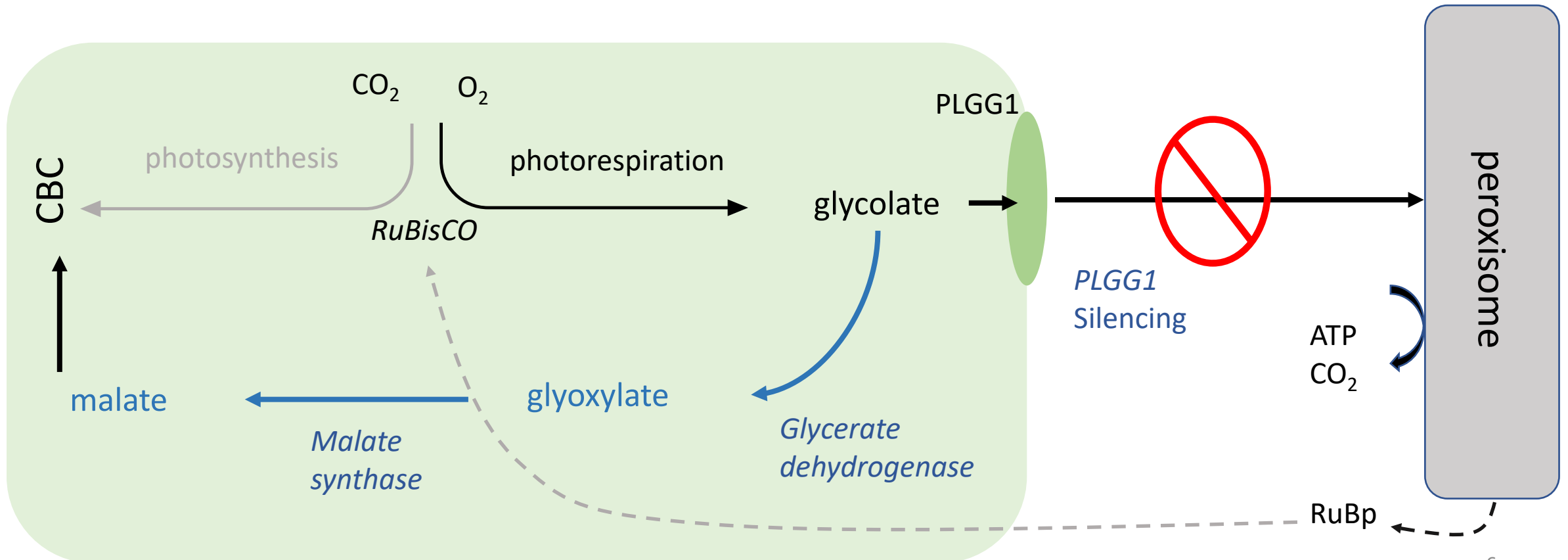
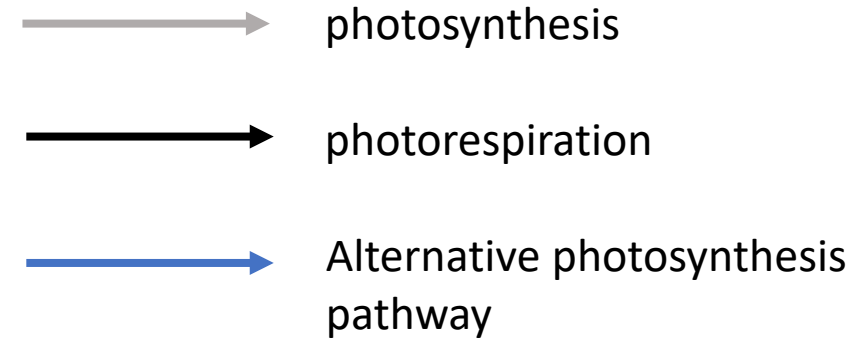


REUTERS

How does this bypass work?



How does this bypass work?



Why trees?

- Carbon potential
- Plantation efficiency



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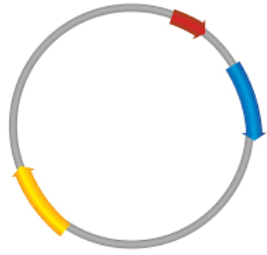
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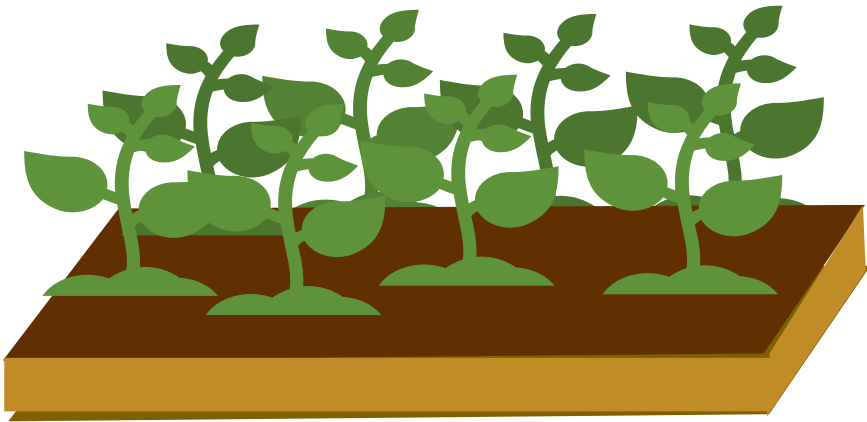


Methods

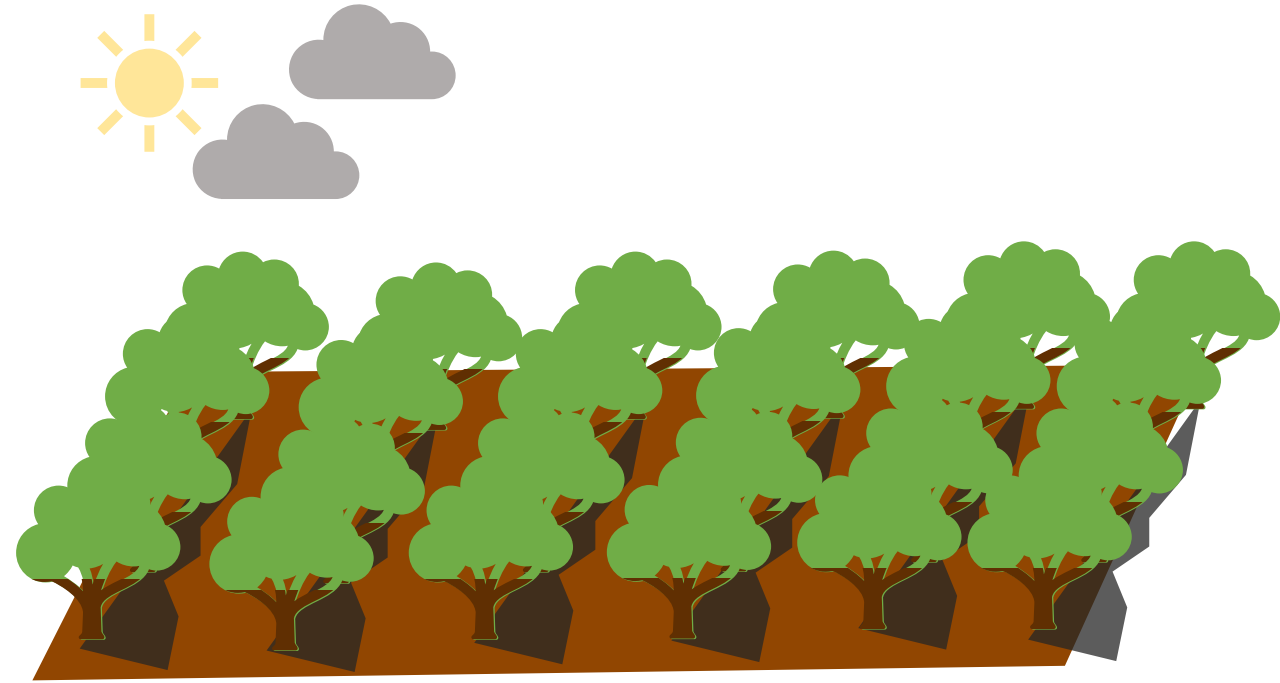
Methods Overview



Transformation in
Populus tremula x
alba 717

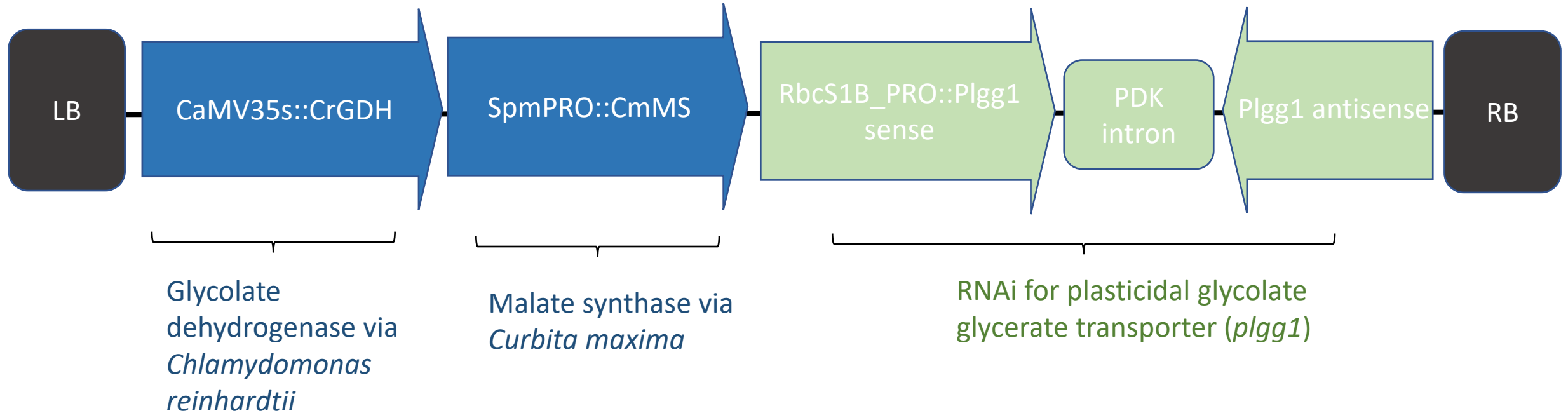


Tissue culture propagation: 8 insertion events + controls



- Planted July 2021
- 30-40 ramets per event
- Randomized within 2 blocks
- Irrigation + fertilization

Schematic of construct



- RT-qPCR Field leaves
- PLGG1 2021-22
 - GDH 11 trees/event
 - MS

All genes w/ chloroplast-targeted transporter



A. Goddard



C. Hart



A. Goddard

What we measured— Relative stem volume

Cumulative measurement
(September 2022)

- Diameter (at 6 in.)
- Height


Stem Volume index:

$$V = h * diam^2$$





Analysis and results

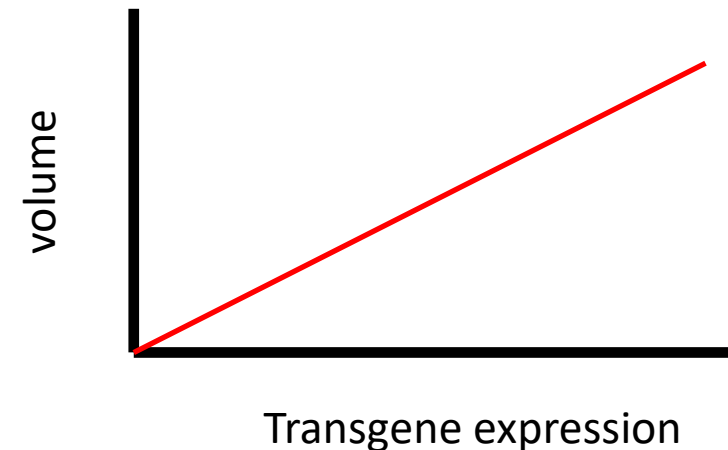
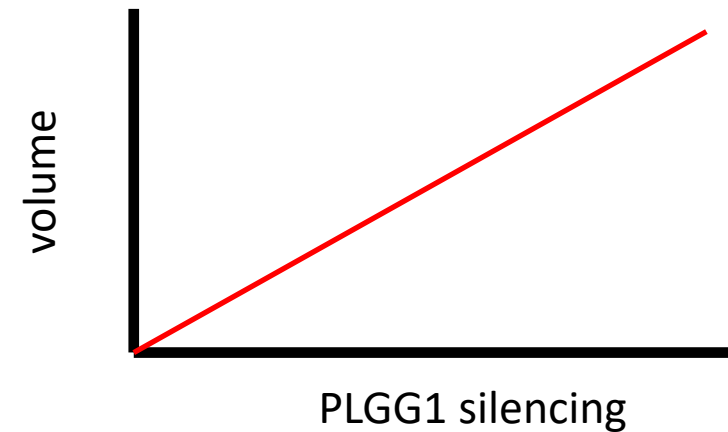
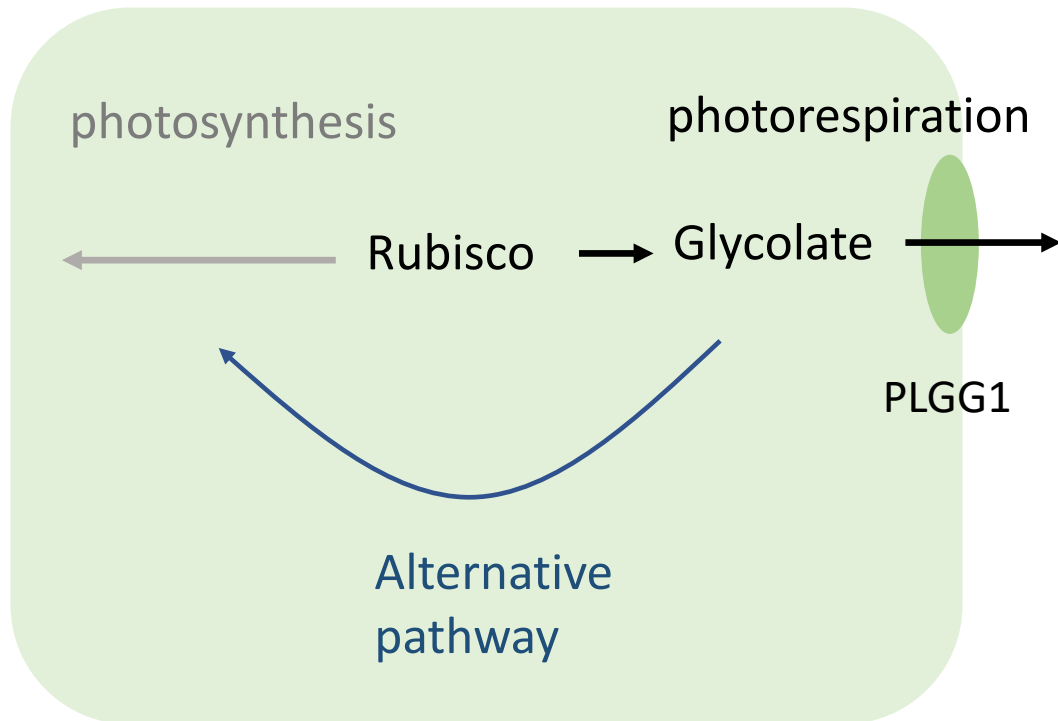


Construct
genotype –
phenotype
relationship

What is the relationship between construct gene expression and cumulative volume in transgenic events?



Model of relationship between construct activity and cumulative field volume

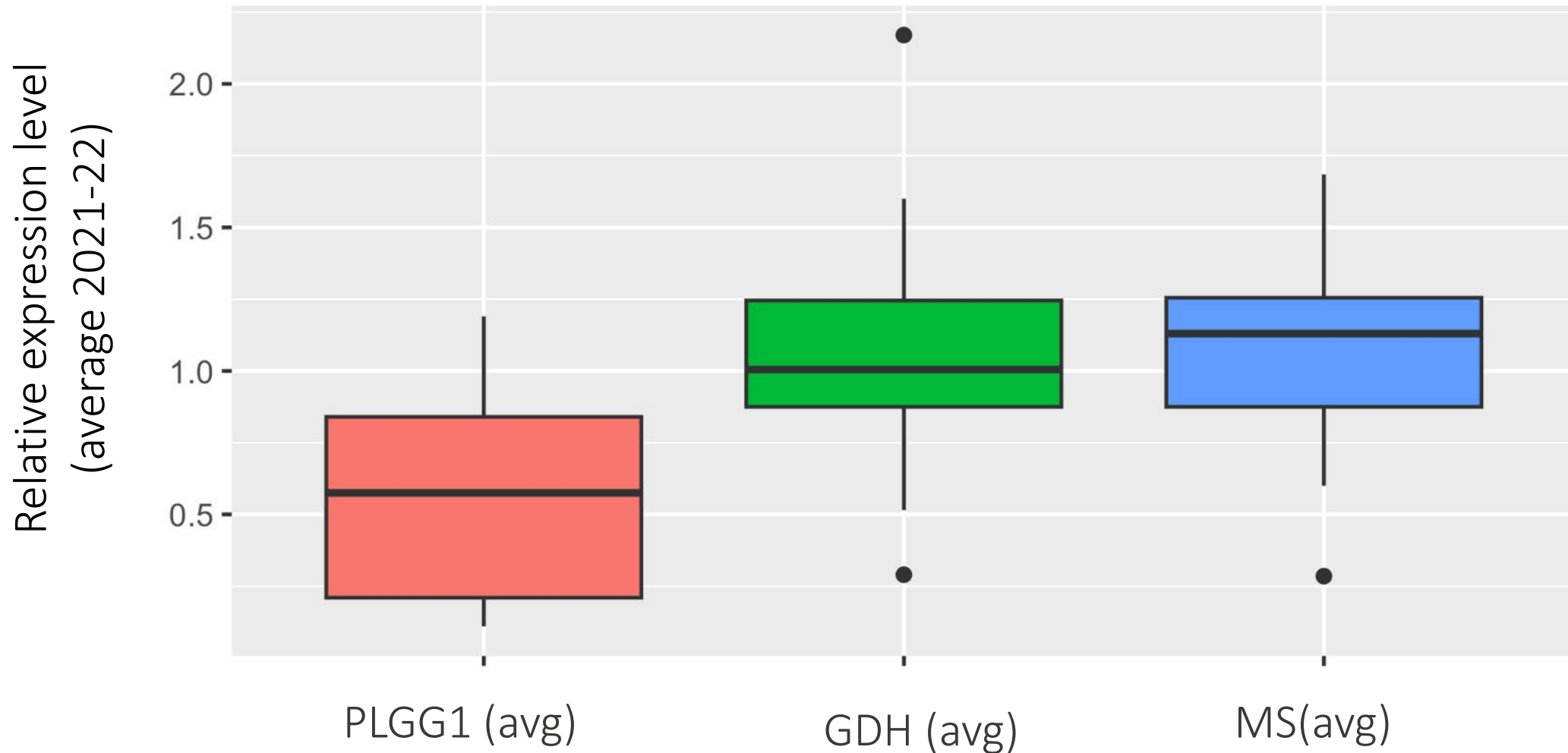




Approach

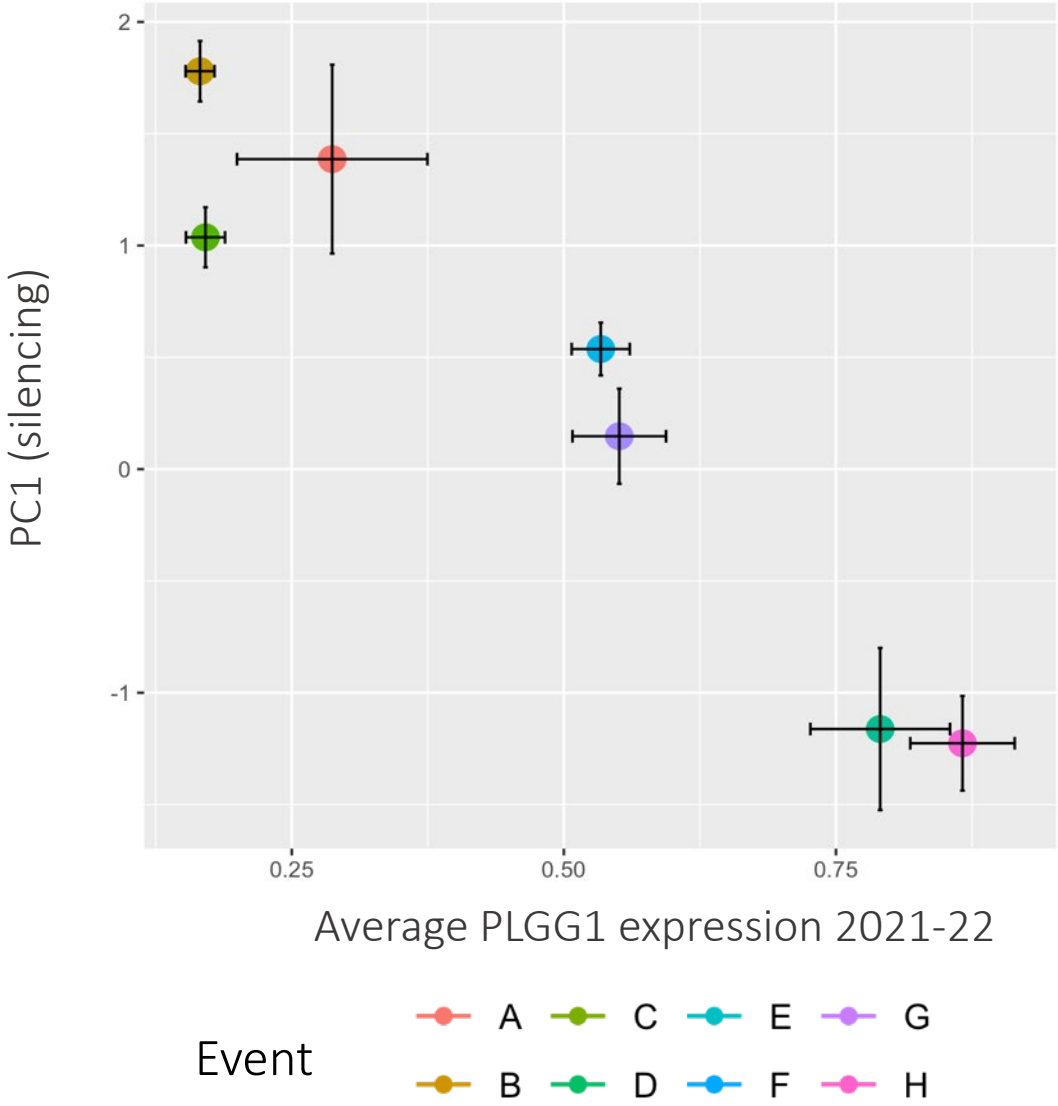
- Use principal components analysis to summarize differences in construct activity between events
- Correlate principal components with cumulative growth

Variance between events is greater in PLGG1 than in transgenes



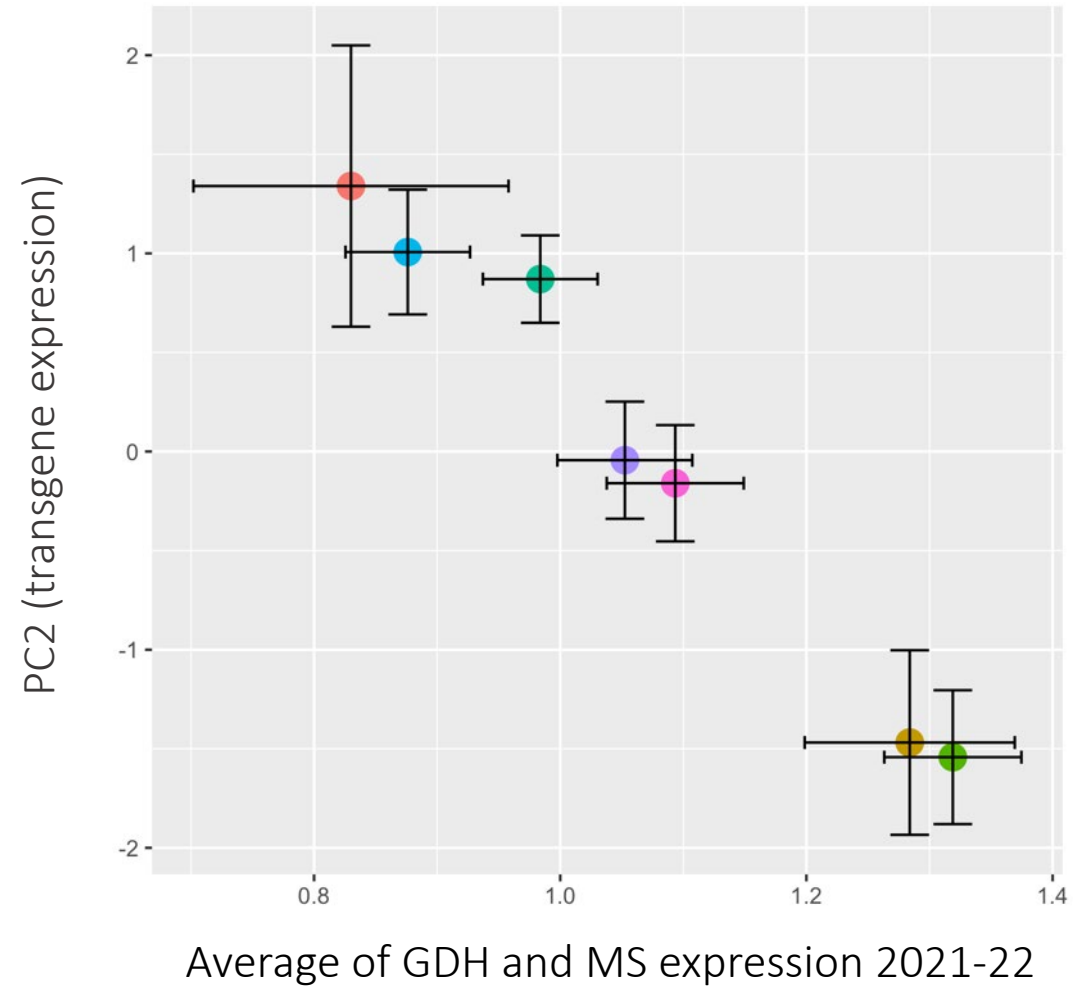
Principal component 1 summarizes differences in silencing of PLGG1

	PC1 loading
PLGG1 2022	-0.64
<i>PLGG1 2021</i>	<i>-0.60</i>
MS 2022	-0.37
<i>MS 2021</i>	-0.17
GDH 2022	-0.05
<i>GDH 2021</i>	0.25

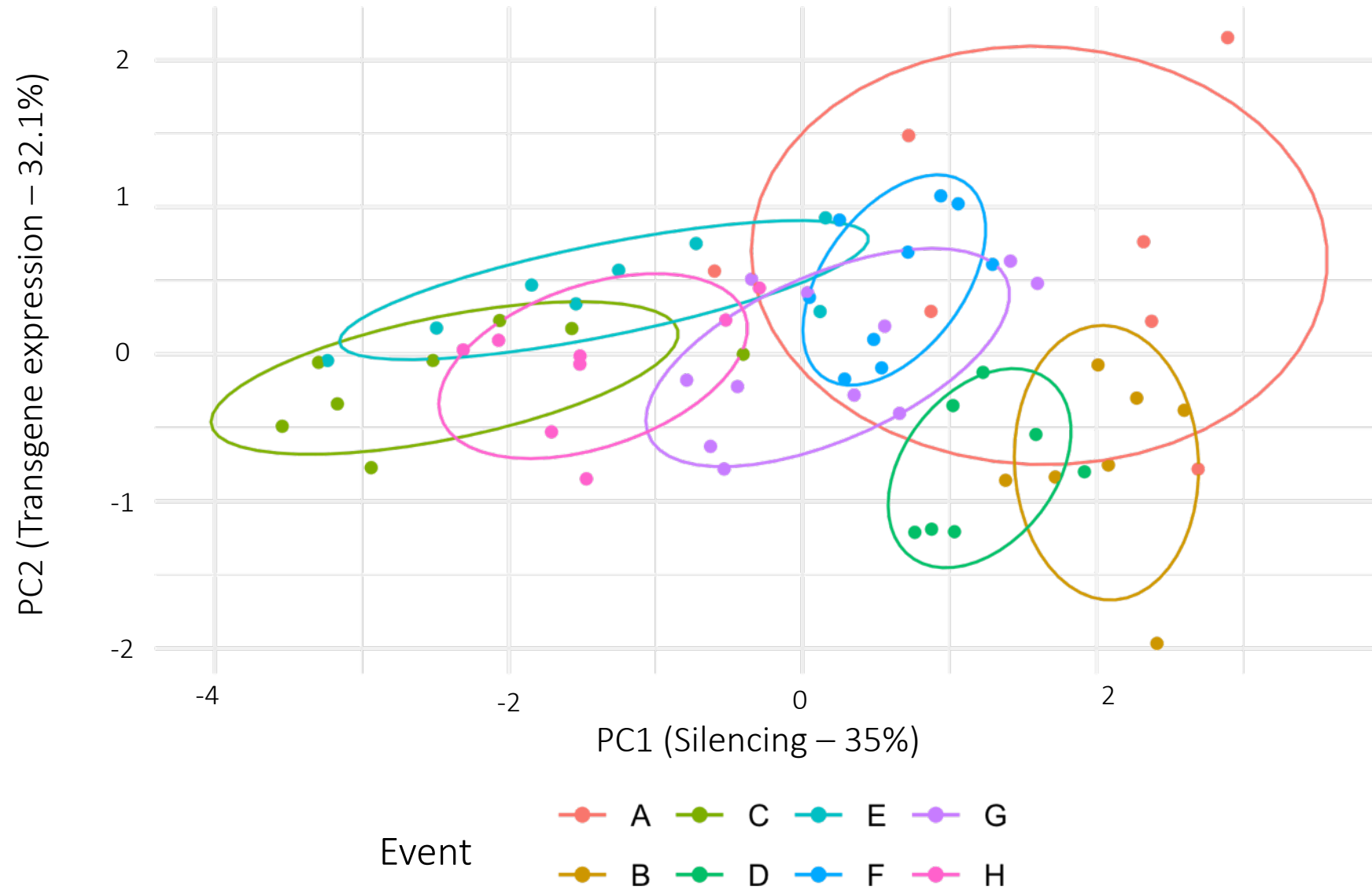


Principal component 2 captures expression of GDH and MS

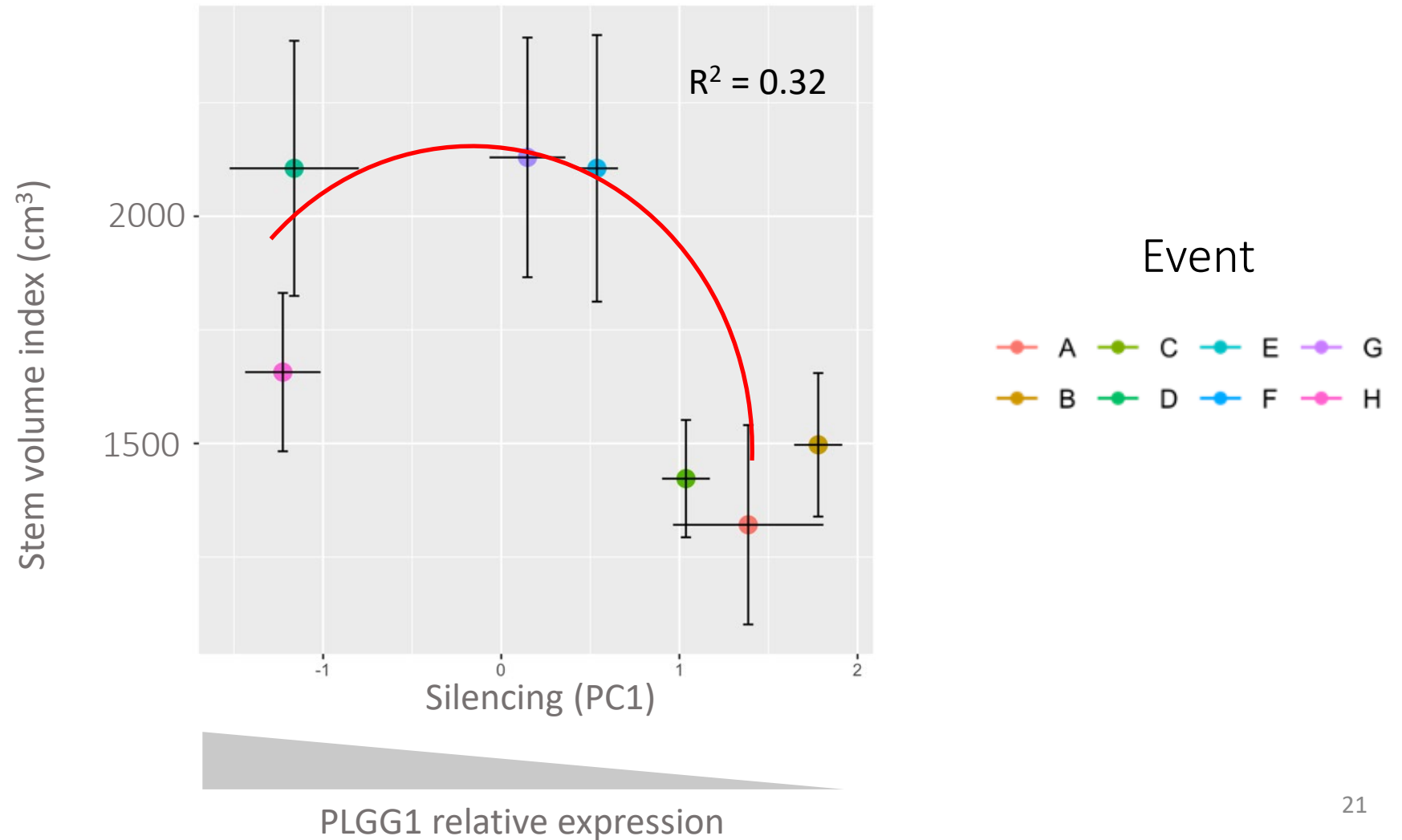
	PC2 loading
PLGG1 2022	0.048
PLGG1 2021	0.115
MS 2022	-0.32
MS 2021	-0.54
GDH 2022	-0.50
GDH 2021	-0.58



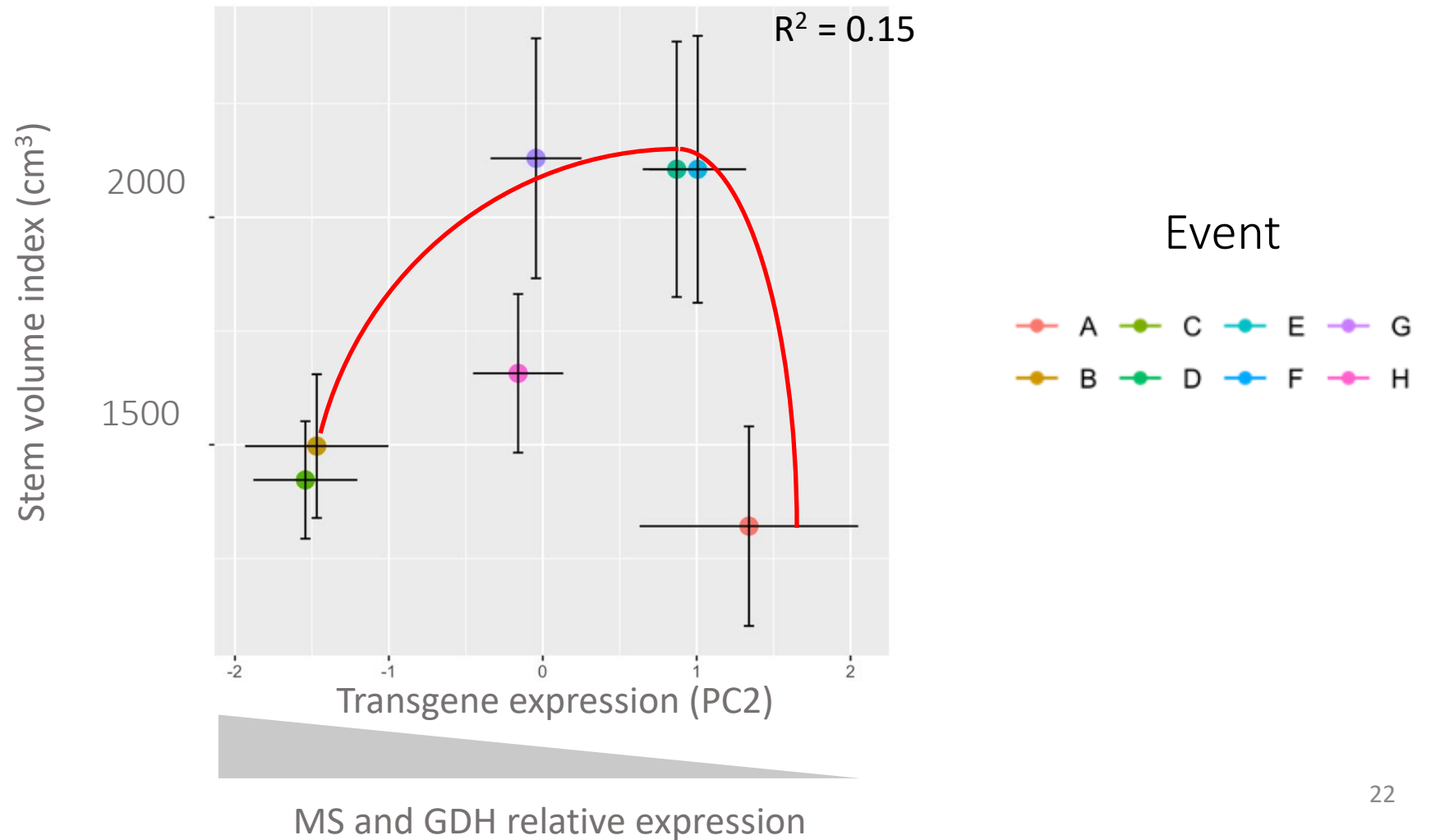
Principal components summarize differences in construct activity between events



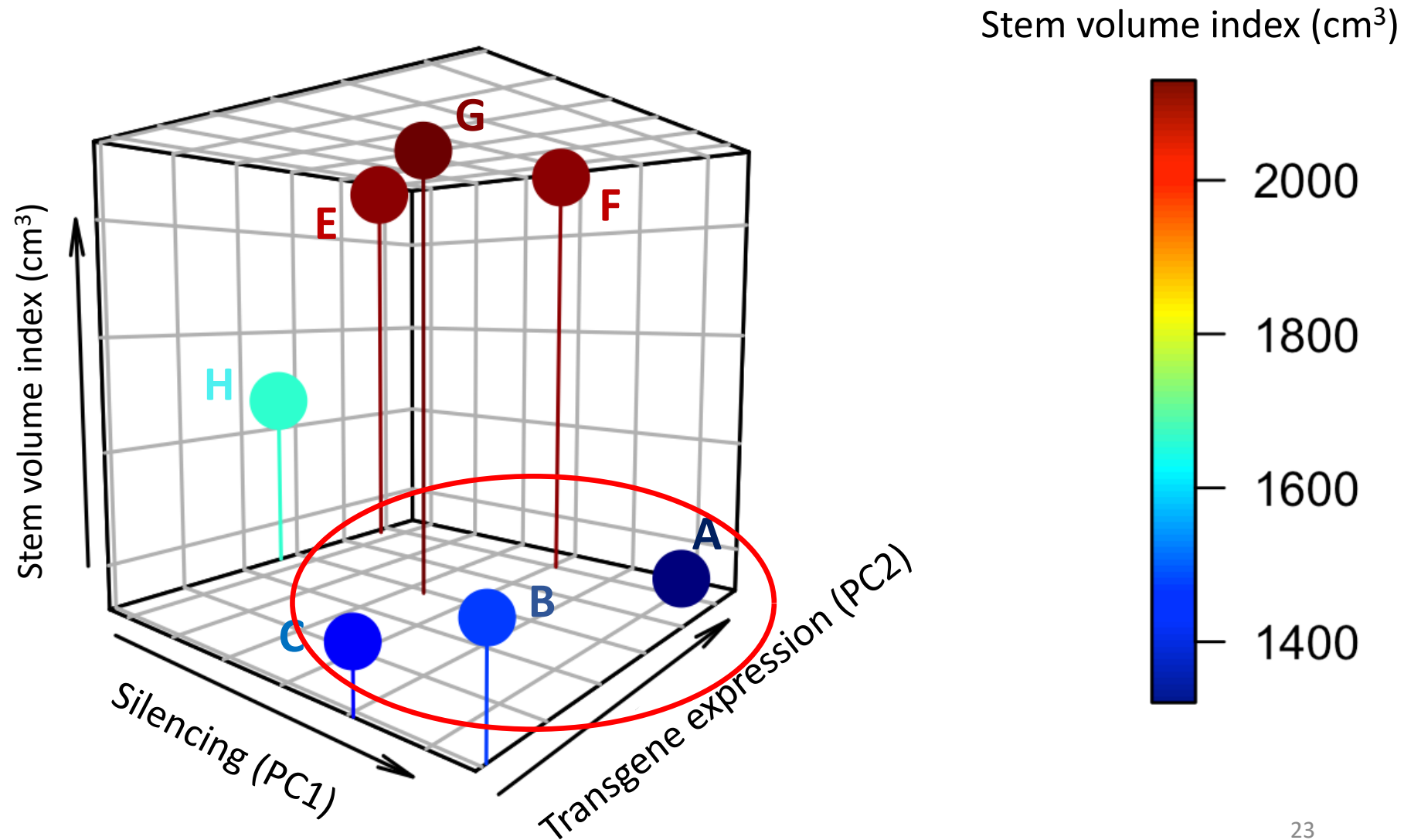
Optimum volume at intermediate silencing levels



Optimum volume at intermediate transgene expression levels



Interaction between silencing and transgene expression influence volume



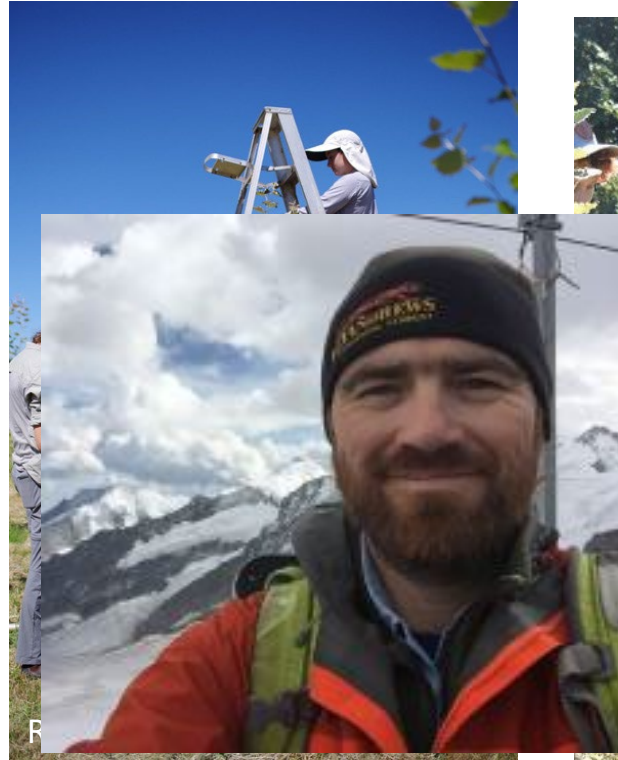
Conclusions

- Translating construct activity to phenotype: Goldilocks zone
 - Event refinement
- Future research
 - 2023 field season
 - Controls
 - Physiology
 - Biomass



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- Strauss lab
- Still lab



Questions

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