

Determinants of legacy effects in pine trees

















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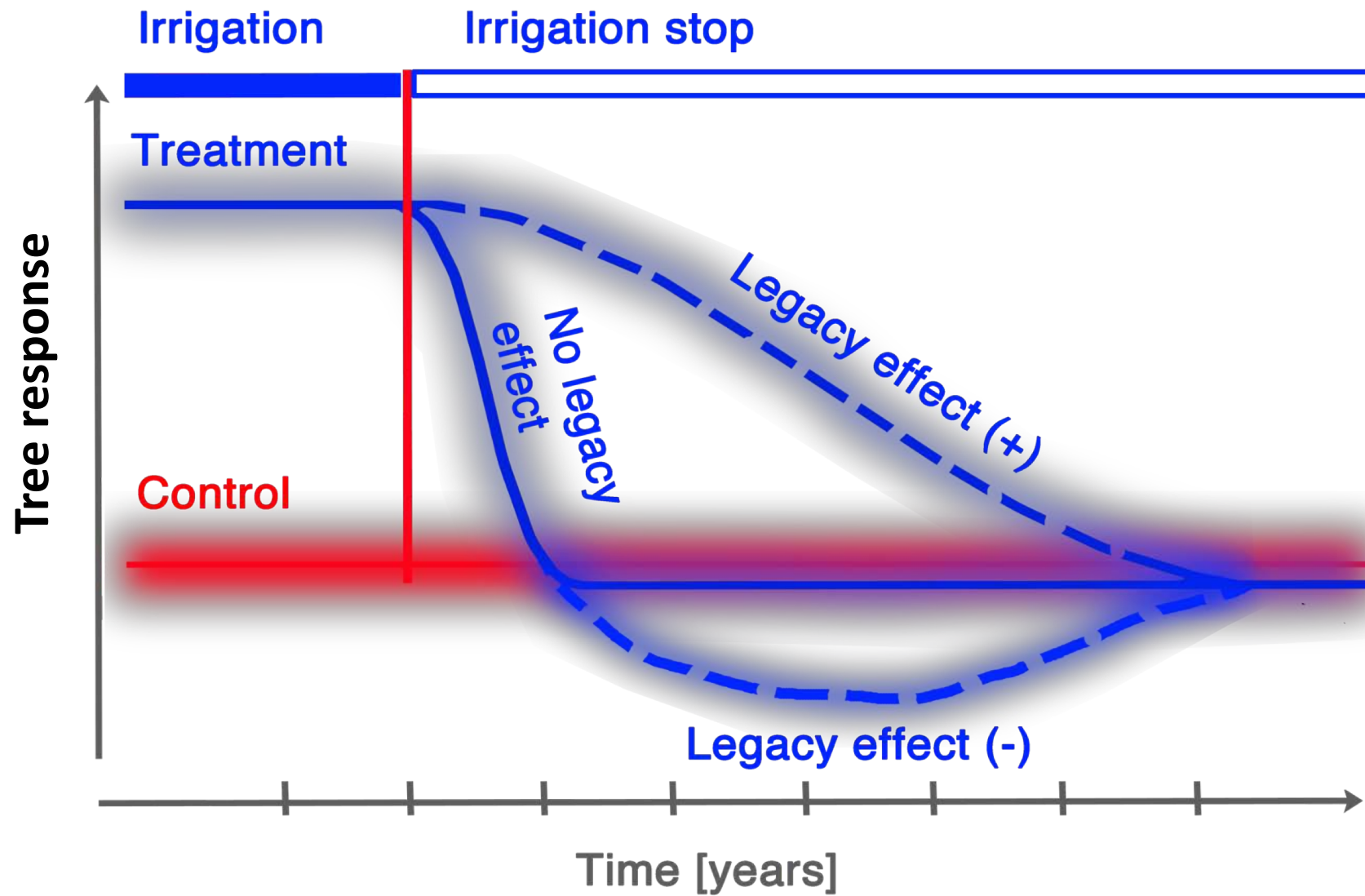


Determinants of legacy effects in pine trees – implications from an irrigation-stop experiment

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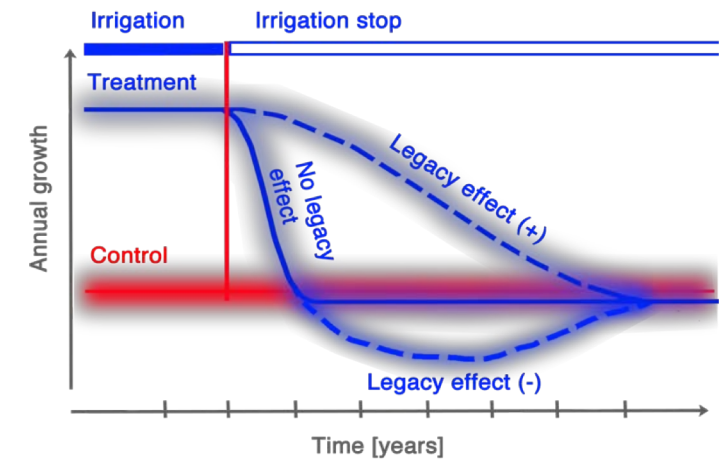
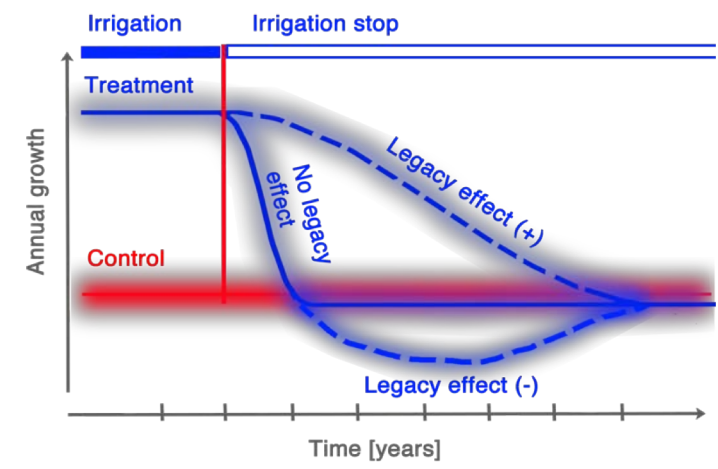
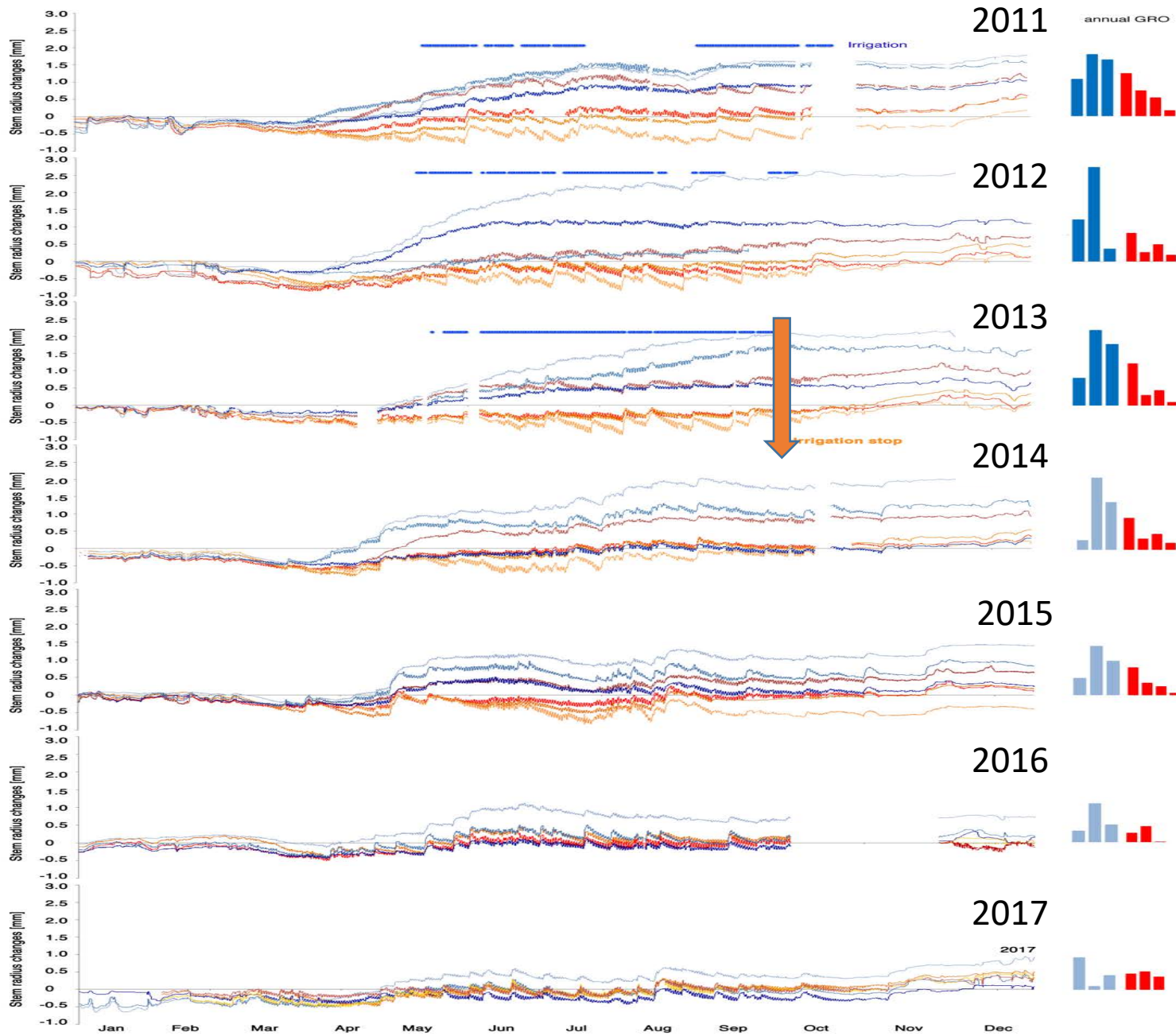


Table 2 Responsiveness of annual means of Scots pine responses after stopping the irrigation.

	SAP	TWD	NL	SL	CT	GRO
First strong response (yr)	1	1	1	2	Gradual	Gradual
Matching control level (yr)	> 4	4	1	> 4	4	4
Legacy type	Negative (but see intraseasonal responses)	Negative (but see intraseasonal responses)	Negative	Negative with 1 yr delay	Positive	Positive

Listed are the number of years after the irrigation stop in 2013 when the measured variables returned to the level of the control trees. Measurements refer to sap flow (SAP), tree water deficit (TWD), needle length (NL), shoot length (SL), crown transparency (CT), and radial stem growth (GRO). CT and GRO did not show a strong response but were more of a gradual nature. The legacy type refers to the scheme in Fig. 1.



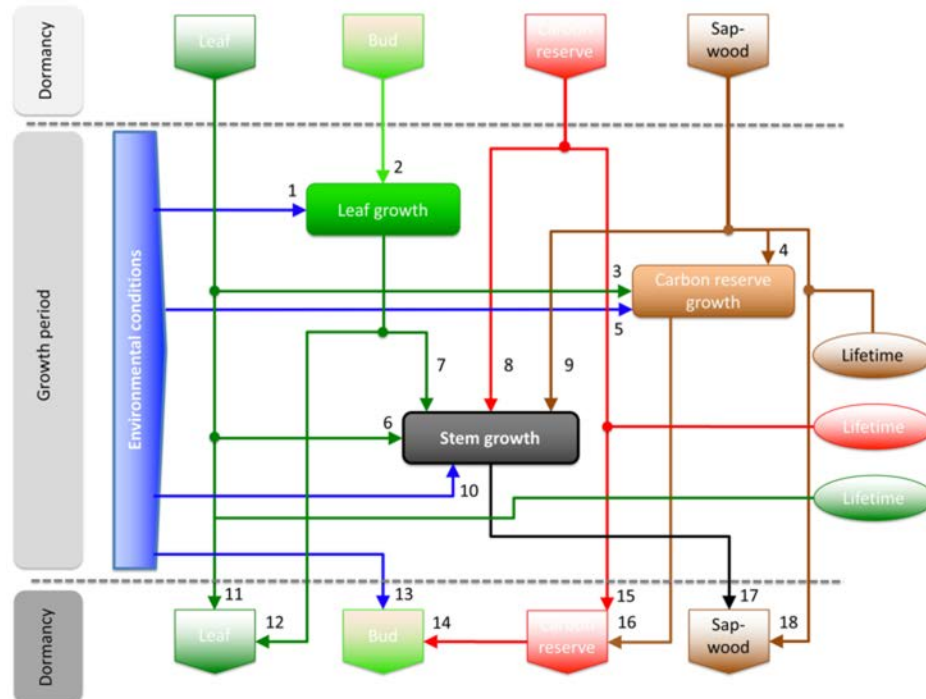
Irrigation stop

A Conceptual Tree Model Explaining Legacy Effects on Stem Growth

Roman Zweifel^{1*} and Frank Sterck²

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Requirement

- Past conditions need to be stored in a tree to affect today's physiology

Idea

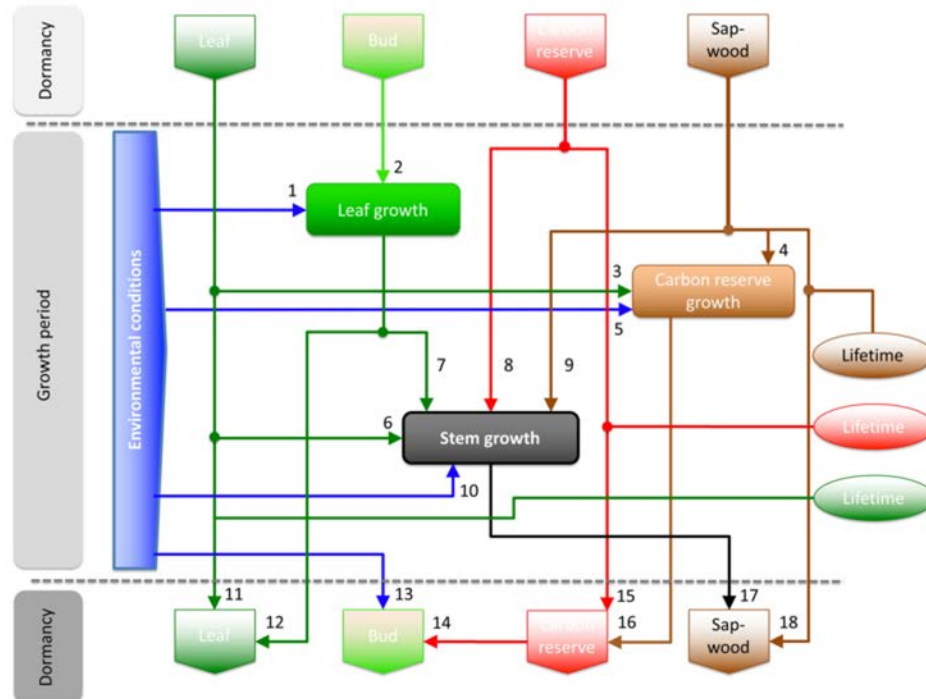
- Functional organs and reserves that are built up over several years are the 'ecological memory'

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Ecological memory

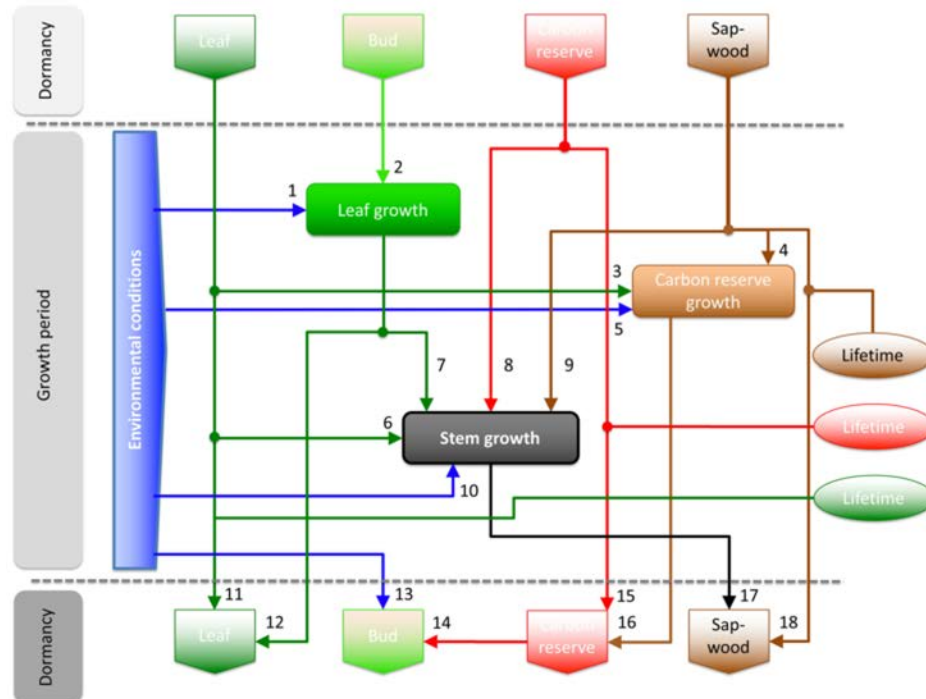
- Crown: patchwork of needles from several years
- Sapwood: Collection of tree rings built over many years
- Carbon storage: Accumulated and depleted over decades
- Buds: predisposed in the year before

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Today's functionality depends on conditions of many years back in time

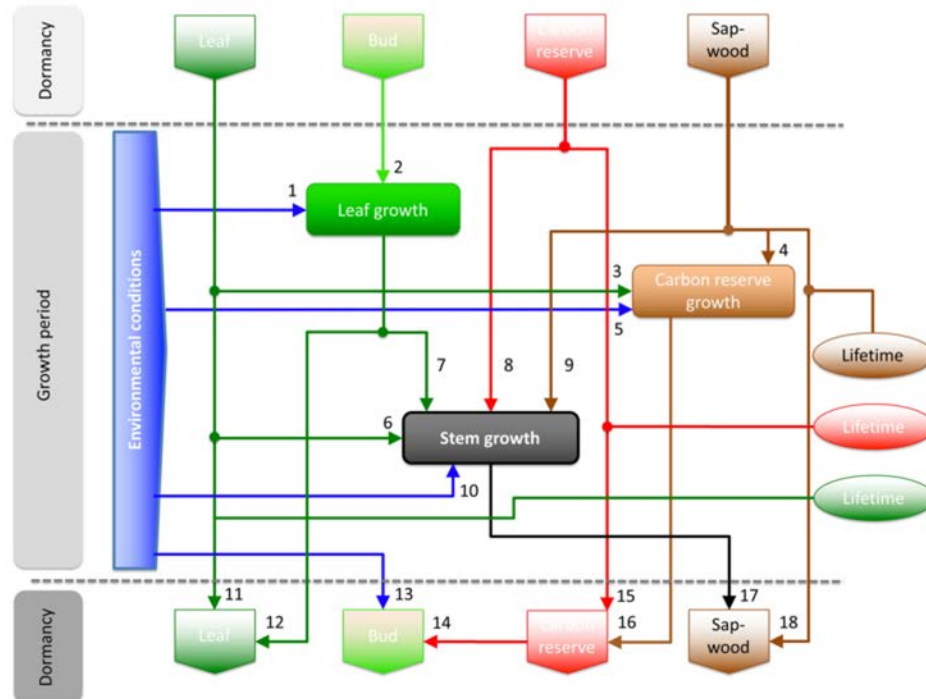
- Crown: needle size/shape changes with conditions
- Sapwood: a tree ring of a dry year is different from a tree ring of a wet year -> different hydraulic properties
- etc.

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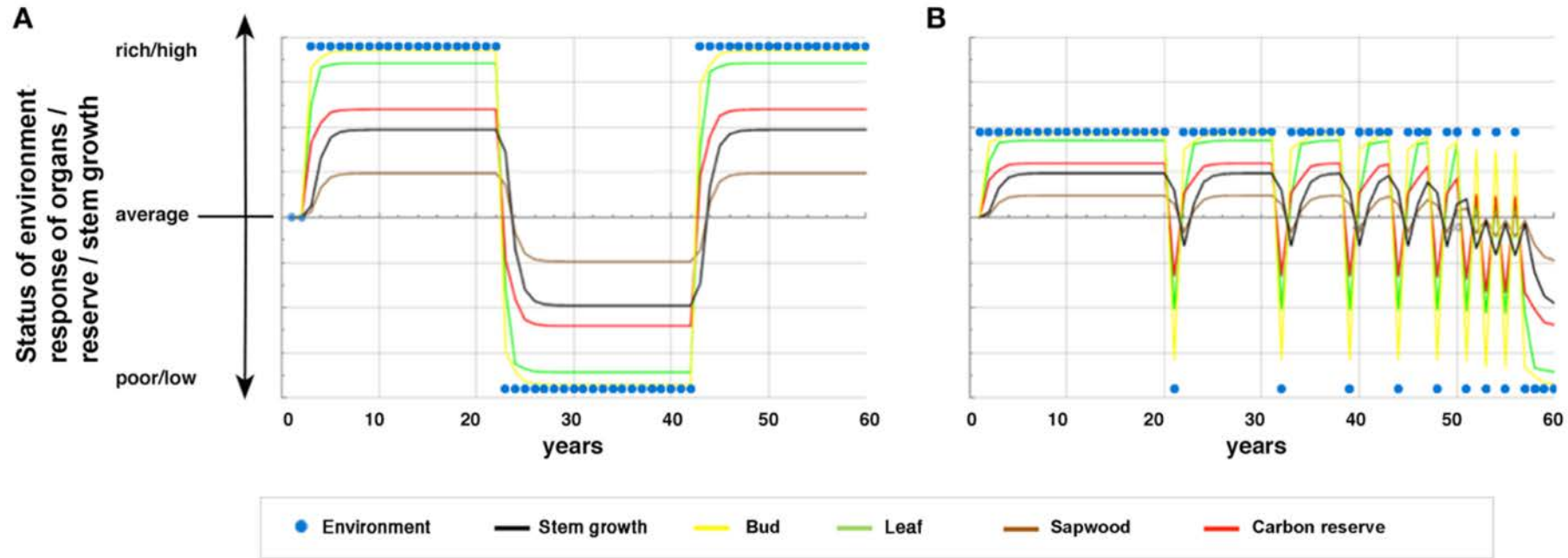
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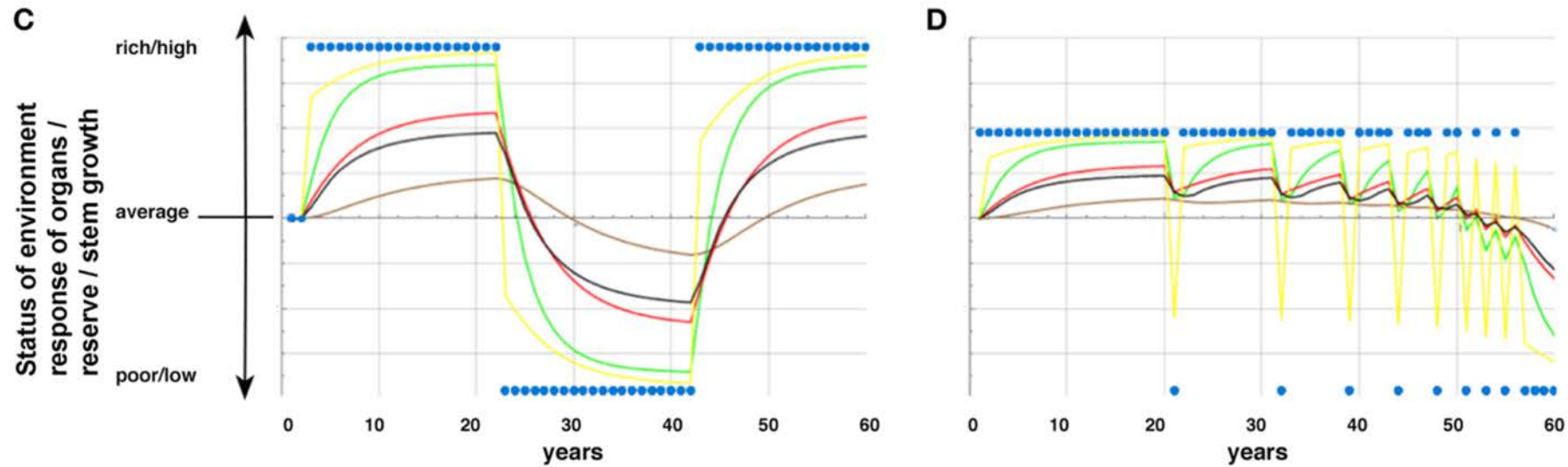
Conclusion

- In such an approach a good/poor year keeps its effect on future physiological responses as long as the structure that was built in this year is kept functional.
- KEY is lifetime/turnover rate of organs and reserves

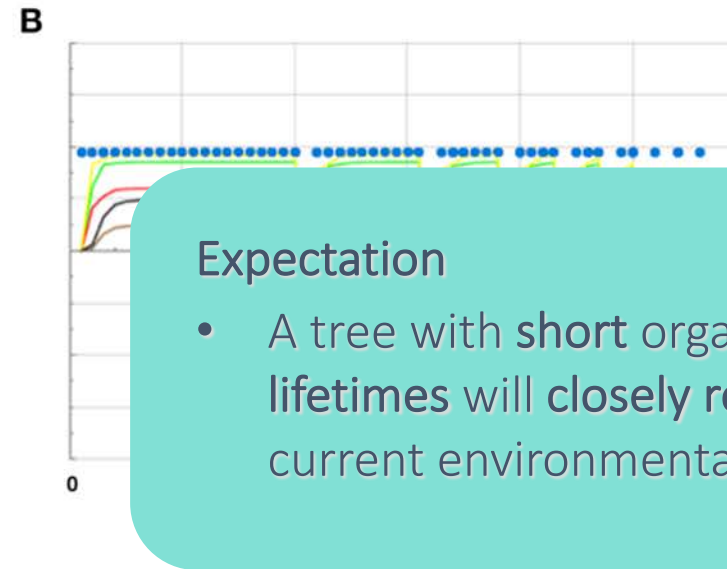
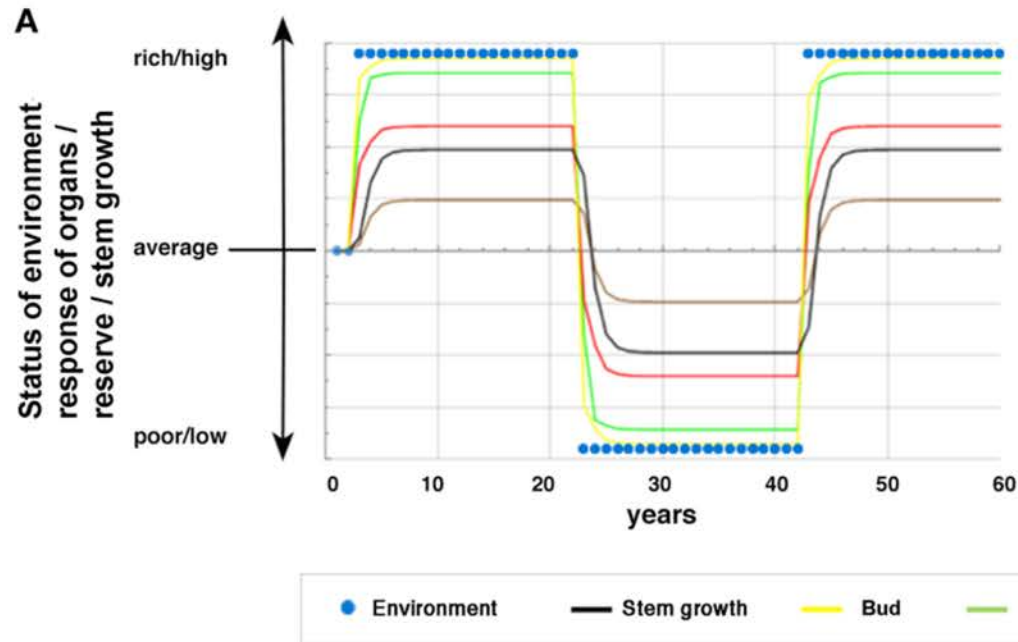
Short organ and reserve lifetimes (acquisitive species)



Long organ and reserve lifetimes (conservative species)



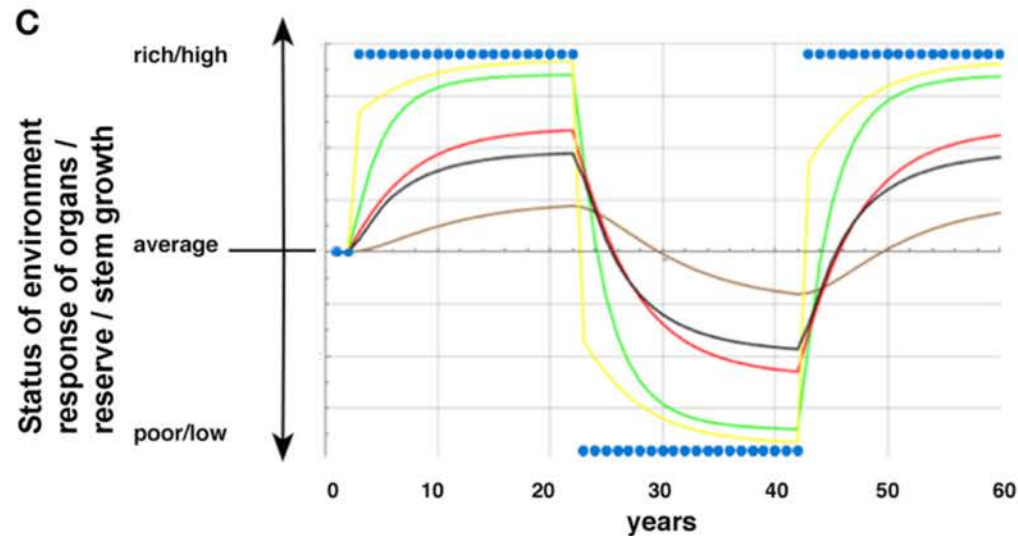
Short organ and reserve lifetimes (acquisitive species)



Expectation

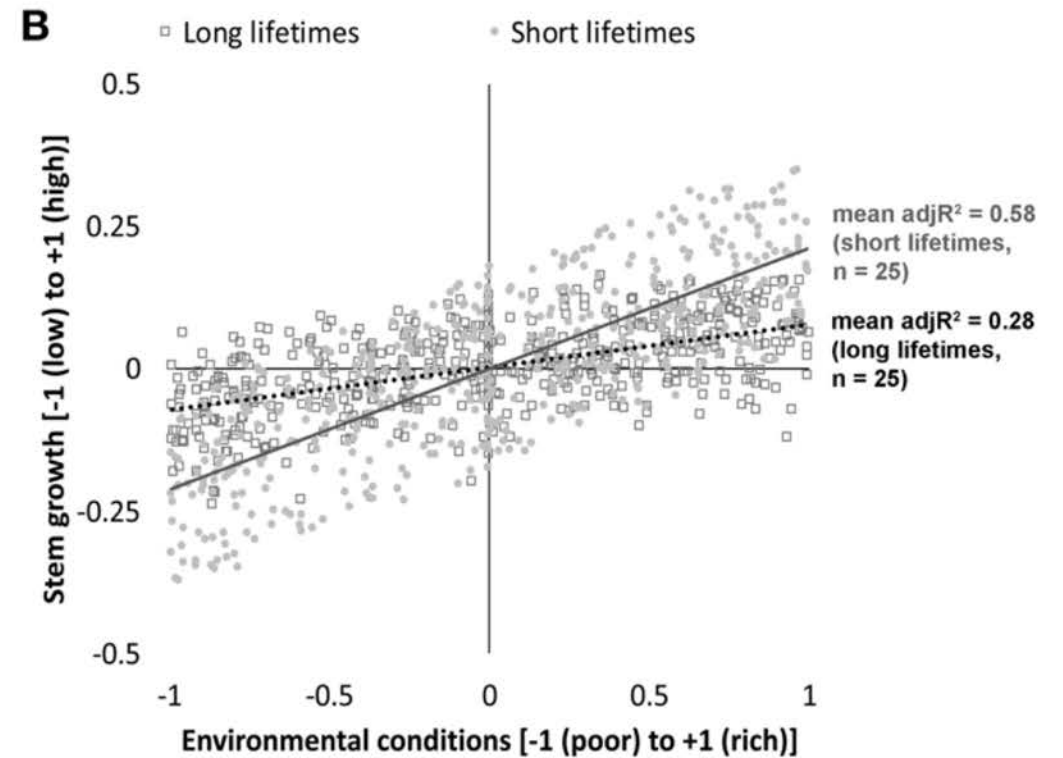
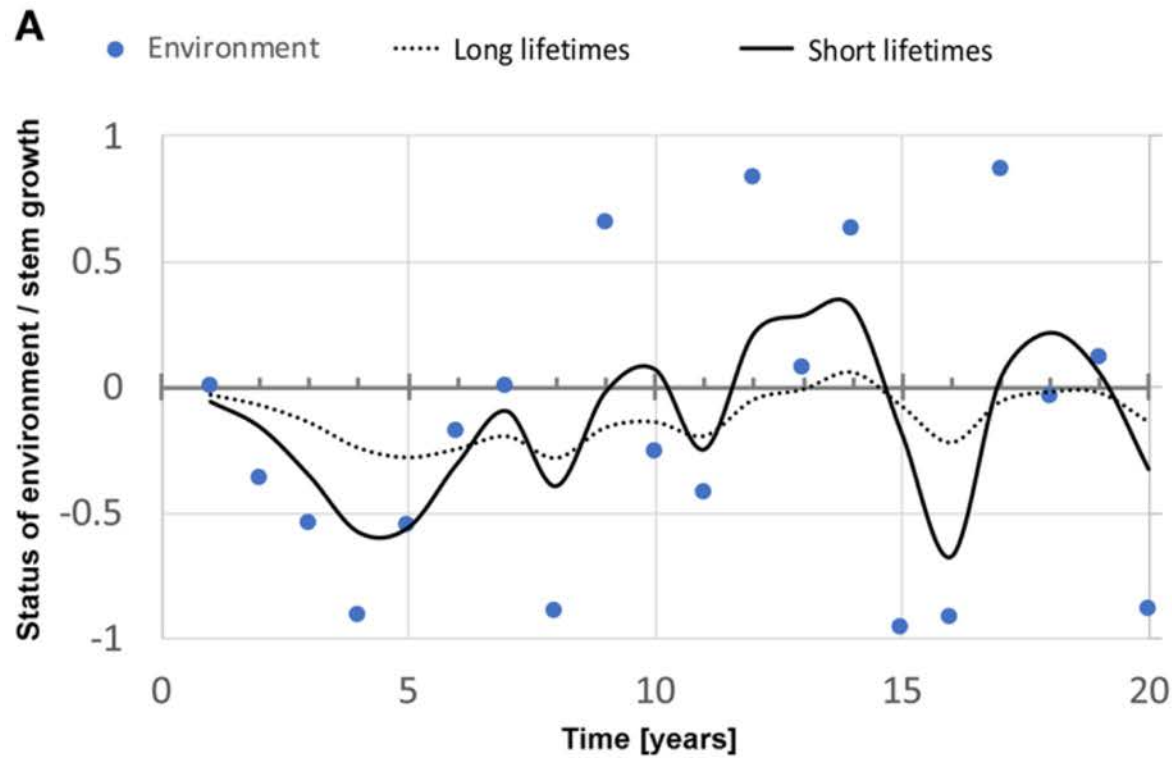
- A tree with **short organ/reserve lifetimes** will closely respond to current environmental conditions

Long organ and reserve lifetimes (conservative species)



Expectation

- A tree with **long organ/reserve lifetimes** will respond with delay to current environmental conditions

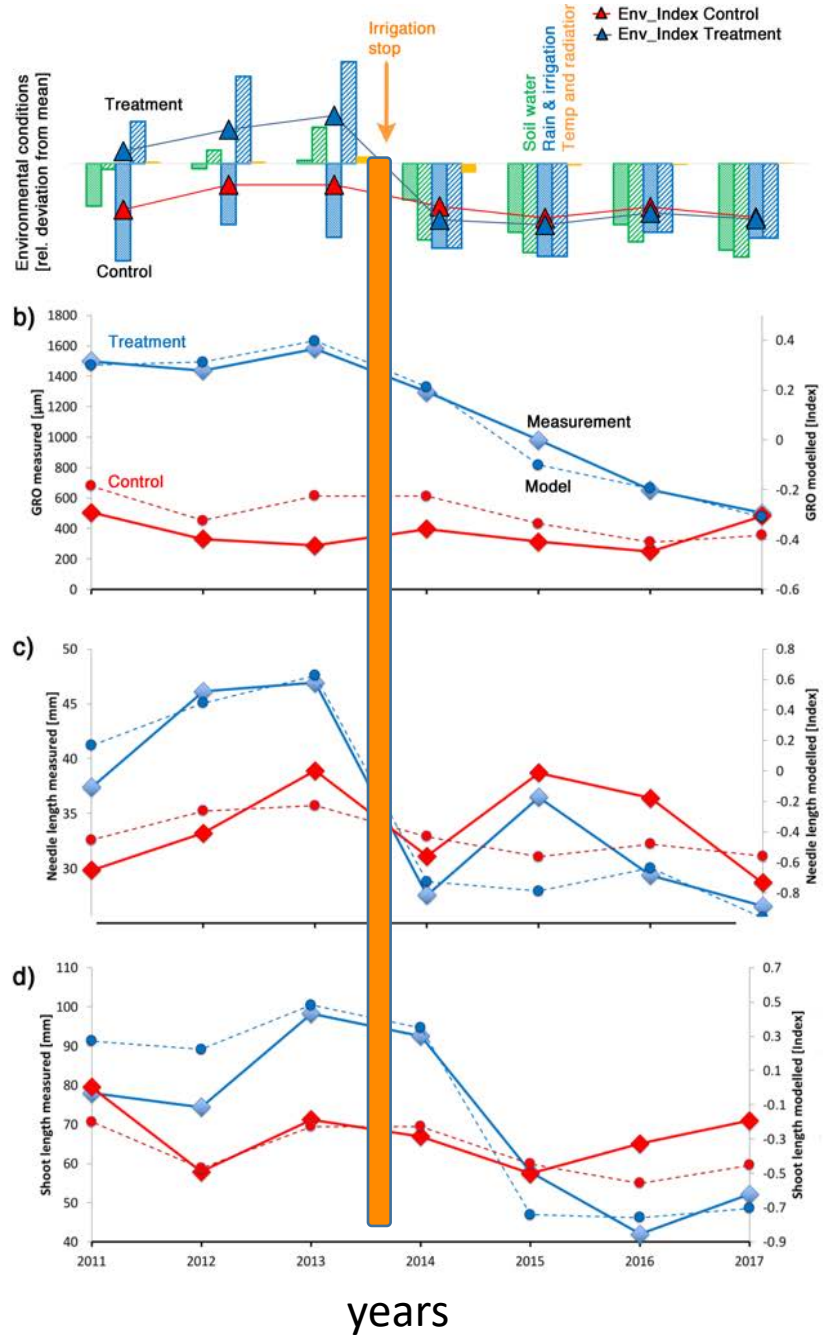


Model findings

- The longer the lifetimes of organs and reserves are, the stronger is the legacy effect of past conditions on the physiological response
- The stronger the legacy effect is, the lower is the explanatory power of current conditions on growth

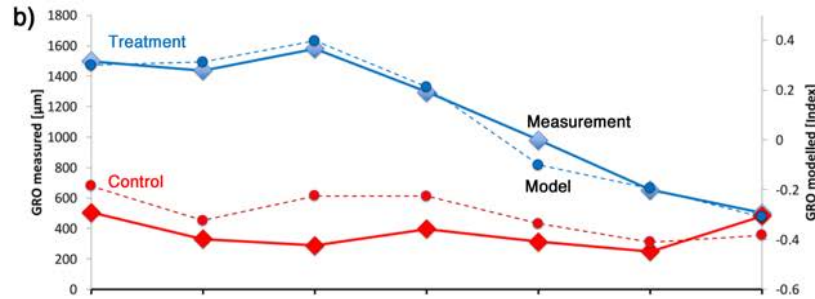
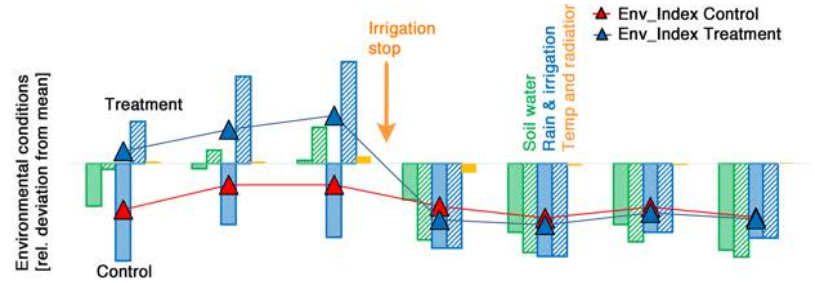
Model parameters: needle lifetime (5 yr), sapwood (50), carbon (10)

Annual stem growth

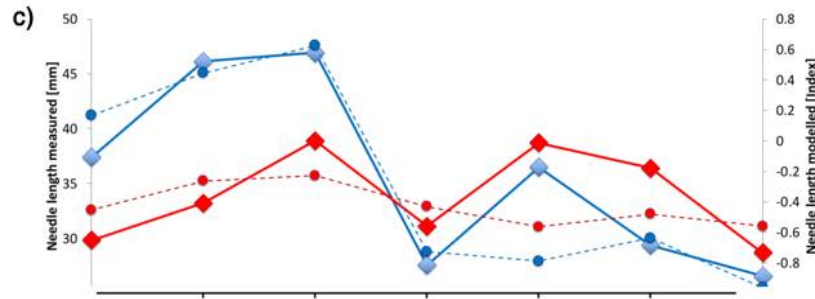


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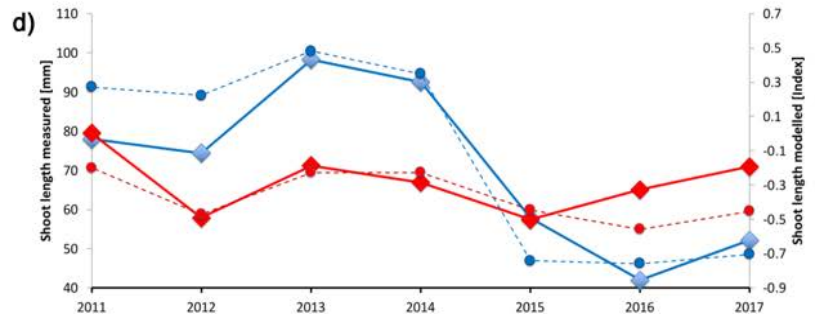
Annual stem growth



Needle size

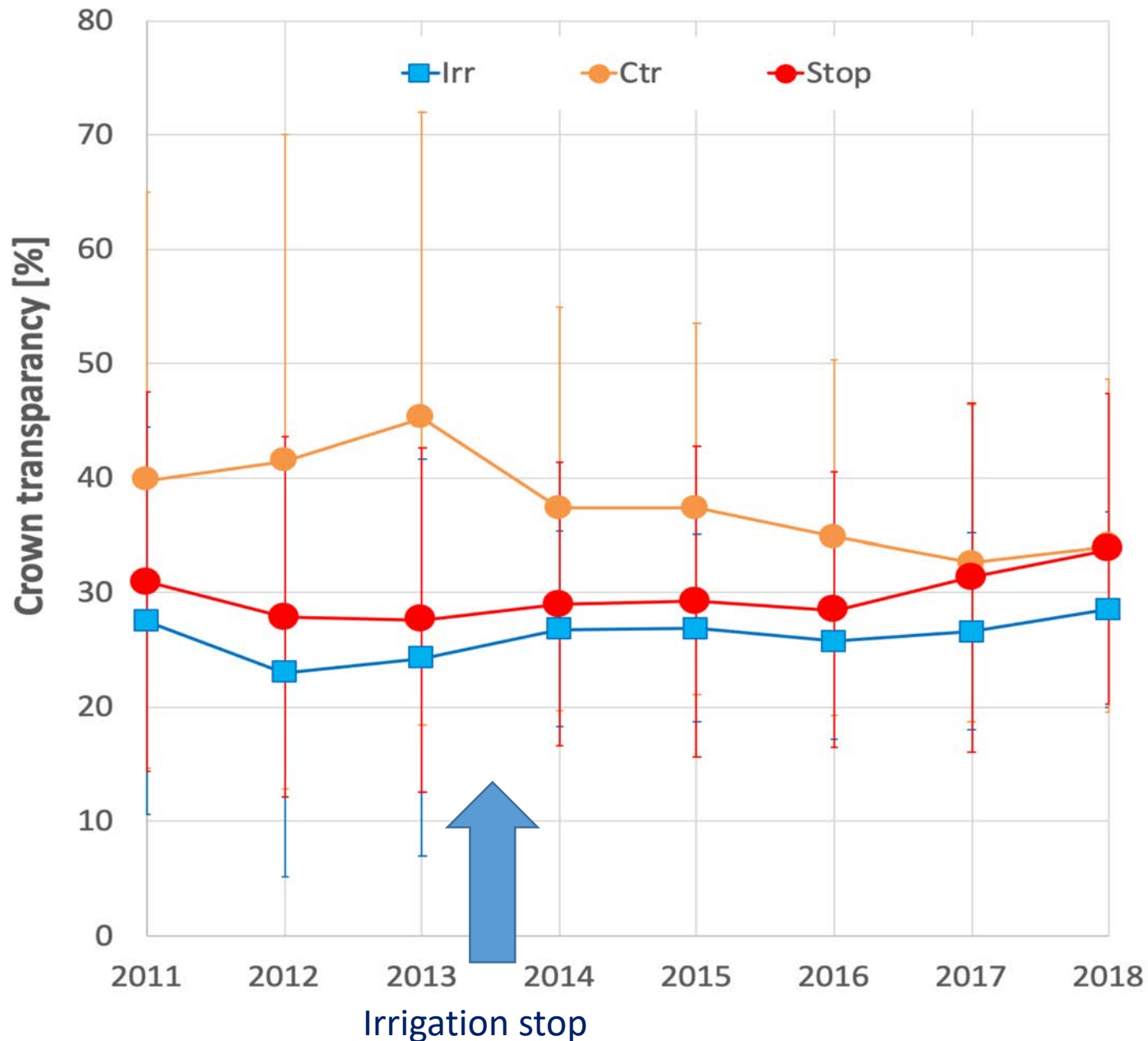


Shoot length



years

- Model is able to catch the characteristic interannual measured courses of:
 - > stem growth
 - > needle length
 - > shoot length
- Model suggests that a slow change of the crown size is the main reason for the legacy effect on stem growth
 - > transpiration potential of crown determines the demand for additional sapwood
 - > the stored resources may support during the transition time (acclimation to dry conditions)



- Measured crown transparency indicates:
 - > slow reduction of crown size
 - > strong legacy effect lasting 3-4 years
 - > backup of model results

- > Large crown size needs sapwood
- > stem growth despite highly drought stress conditions

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Take home message

The lifetimes of organs and reserves is KEY to explain legacy effects

It's still a hypothesis! Go and test it!!