Exploring plant investment strategies

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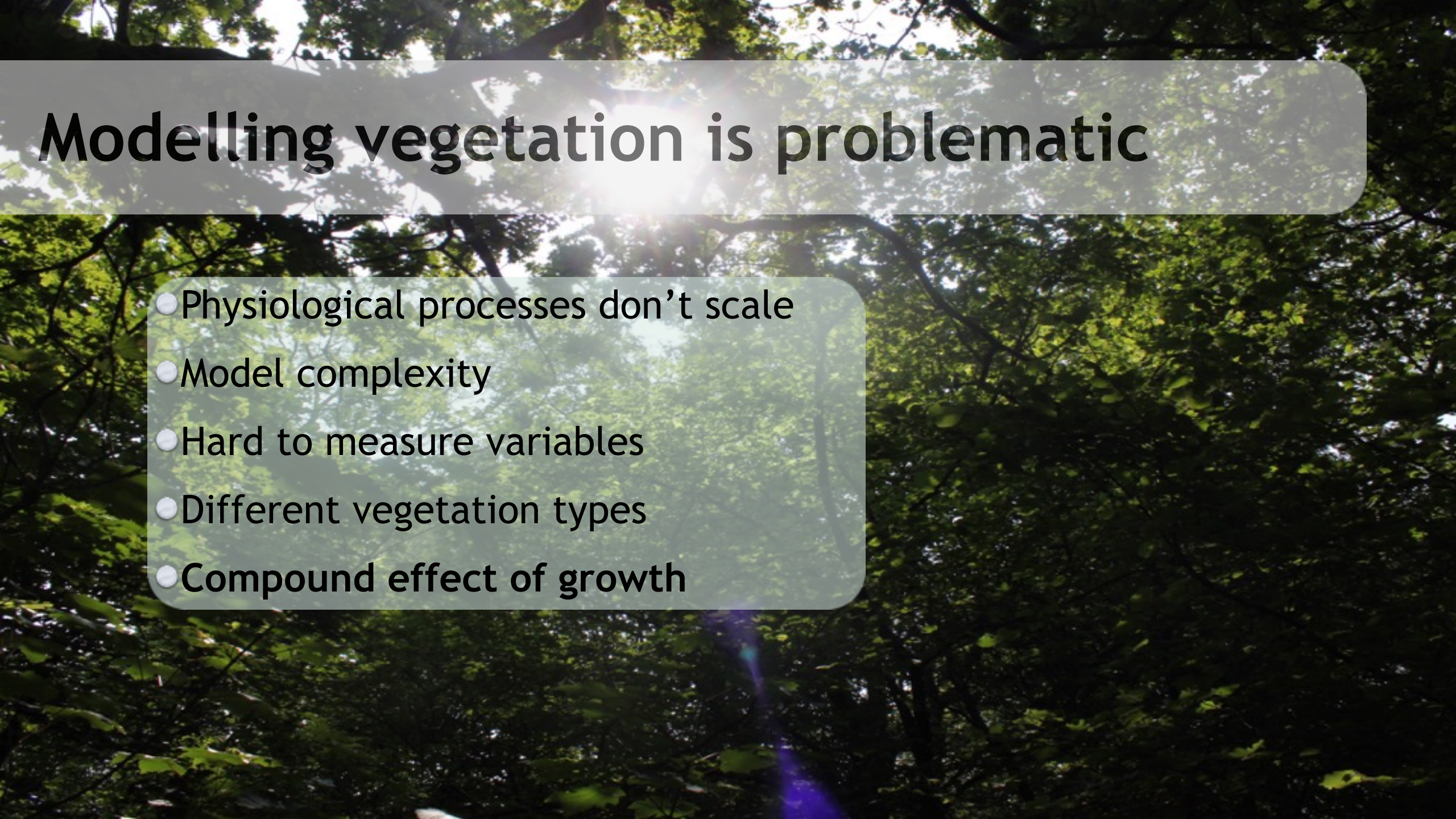
Modelling vegetation is problematic

- Physiological processes don’t scale
- Model complexity
- Hard to measure variables
- Different vegetation types



Modelling vegetation is problematic

- Physiological processes don’t scale
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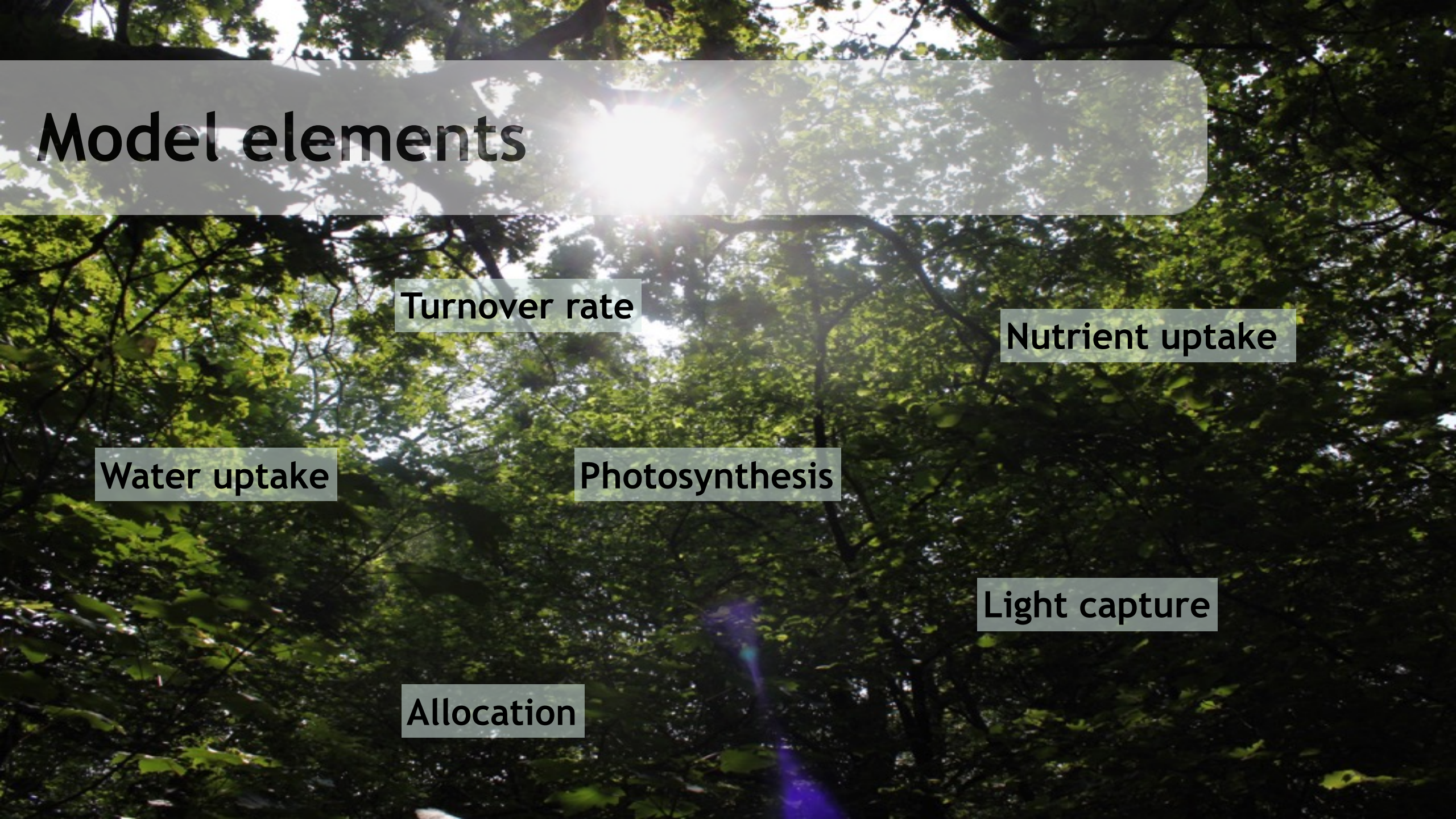
- Hard to measure variables
- Different vegetation types
- **Compound effect of growth**


Model elements
Turnover rate
Nutrient uptake
Water uptake
Photosynthesis
Light capture
Allocation

Tree growth

Photosynthetic Capital

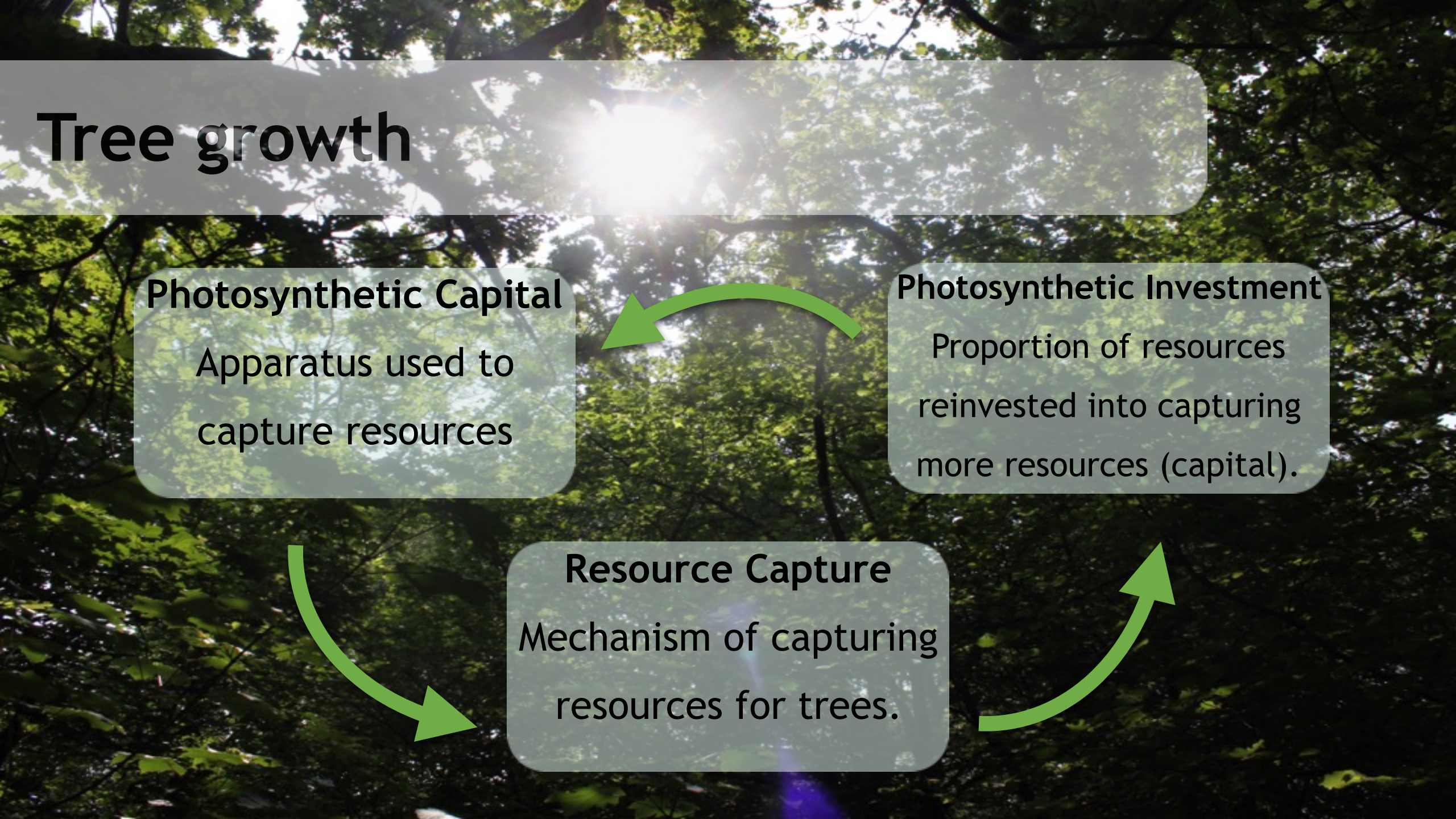
Apparatus used to capture resources

Photosynthetic Investment

Proportion of resources reinvested into capturing more resources (capital).

Resource Capture

Mechanism of capturing resources for trees.



Data & Methods

- **Data:** 13 FLUXNET sites (7 deciduous forests and 6 evergreen forests) in temperate North American and European climates.
- **Method:** combination of regression analysis and optimisation to find model parameters.

Photosynthetic Capital

- All apparatus used to perform photosynthesis (P).
- Capital (K) is assumed to include:
  - Leaves, stems, roots, etc.,
  - Other apparatus directly or indirectly affecting growth.

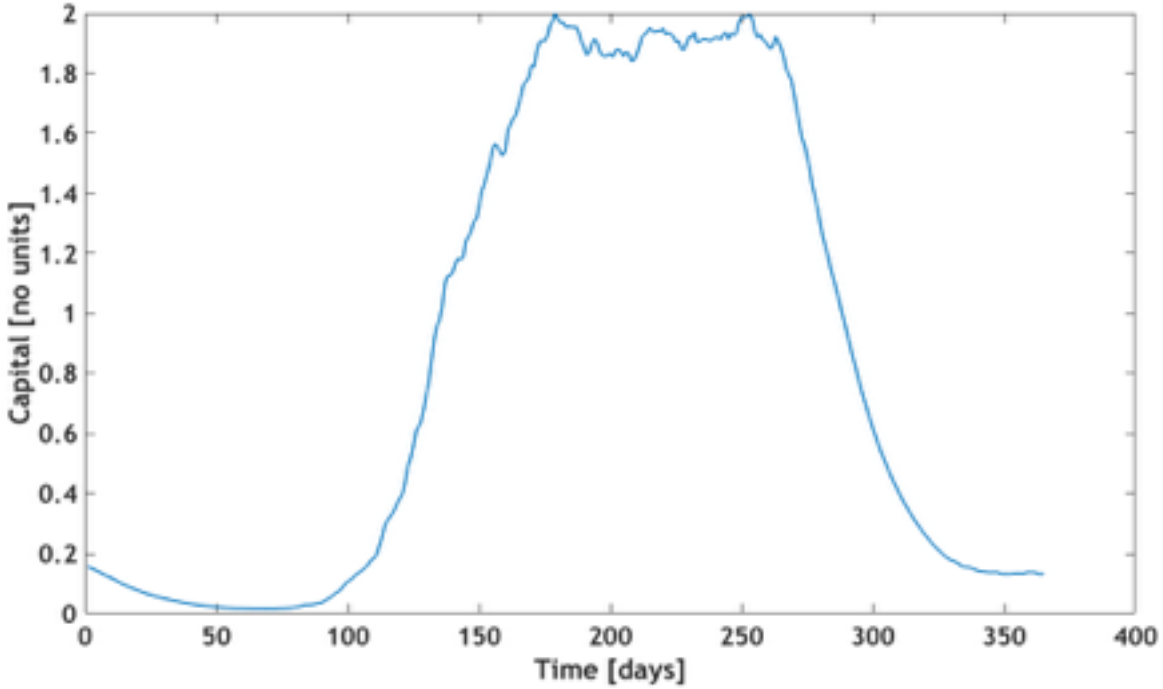


Fig 1. Capital change throughout an average year. Harvard Deciduous Forest.

Representing capital and resource capture

- **Capital accumulation:**
  - $K_{t+1} = K_t - dK_t + i_t P_t$
    - *d* - decay
    - *i* - investment
- **Resource Capture:**
  - $P_t = f\{K_t, R_t\}$
    - R_t - resource in the environment at time *t*

...and Photosynthetic Investment -

- Defines how the capital changes throughout the year and how energy is reinvested into capital on each uptake.
- Investment can help understand how the external environment influences changes in photosynthetic uptake.

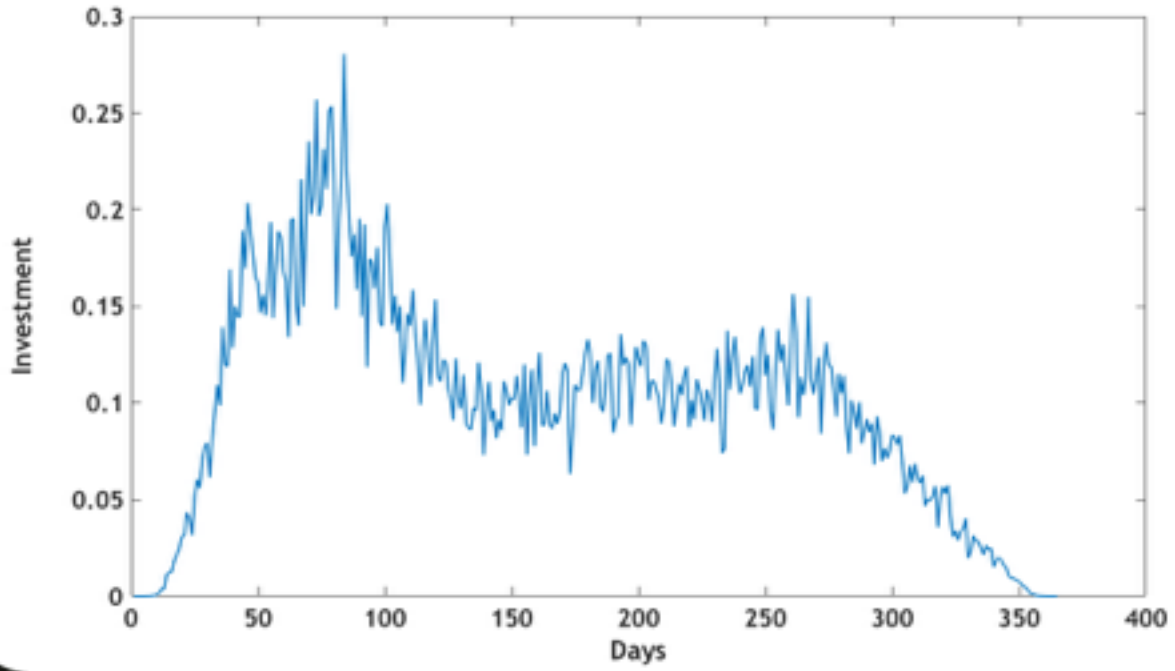


Fig 2. Changes in investment in an average year. Howland Evergreen Forest.

Investment and Marginal Return

- Marginal return: internal decision making process based on which investment will increase or decrease.

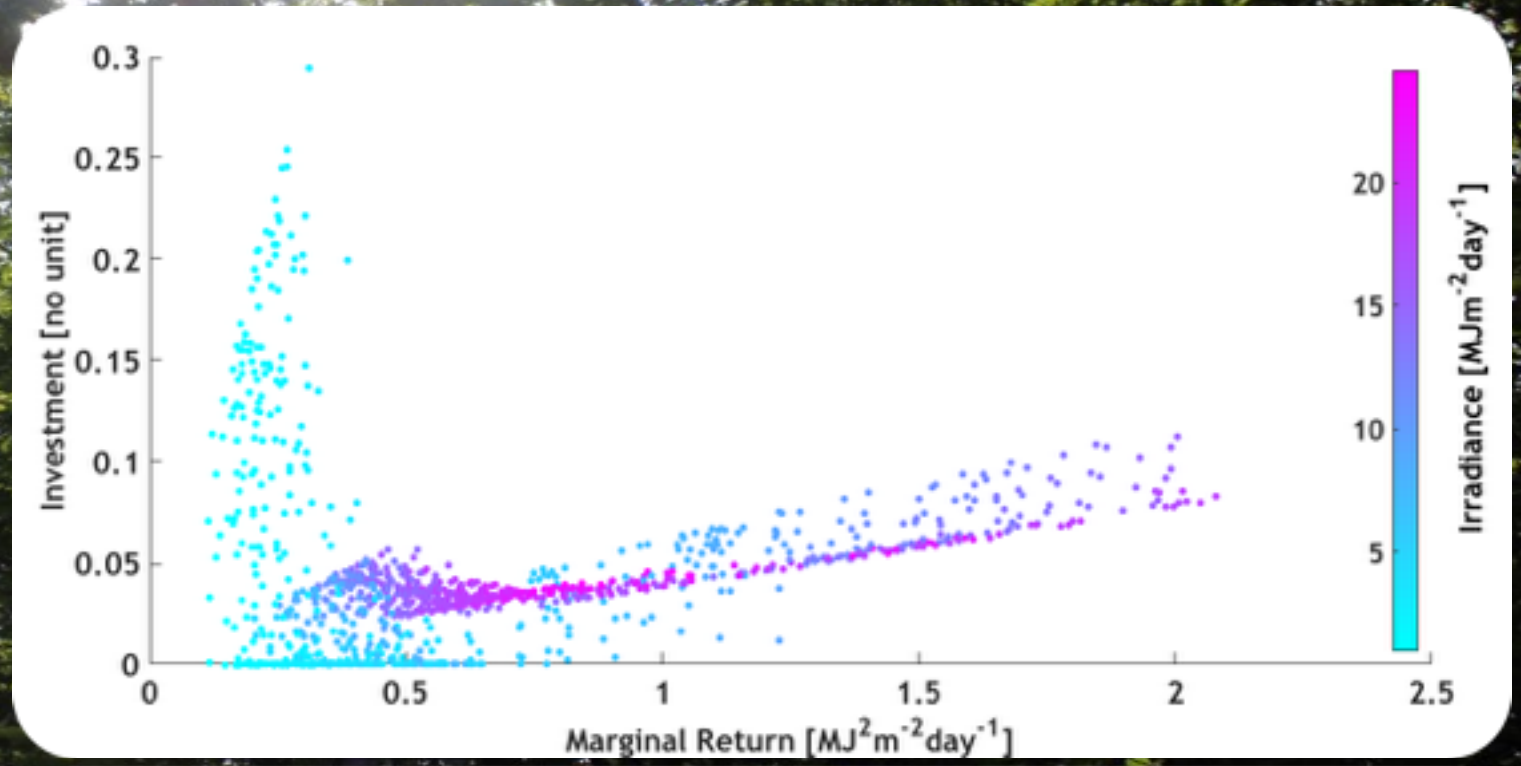


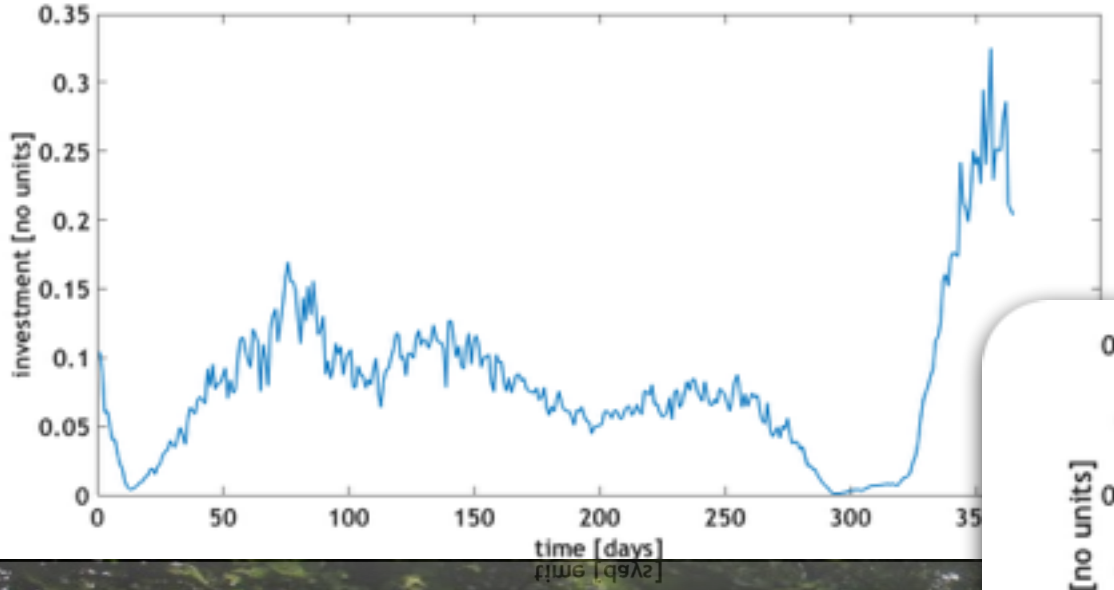
Fig 3. Investment and marginal return in a three year average-year period. Hainich Deciduous Forest.

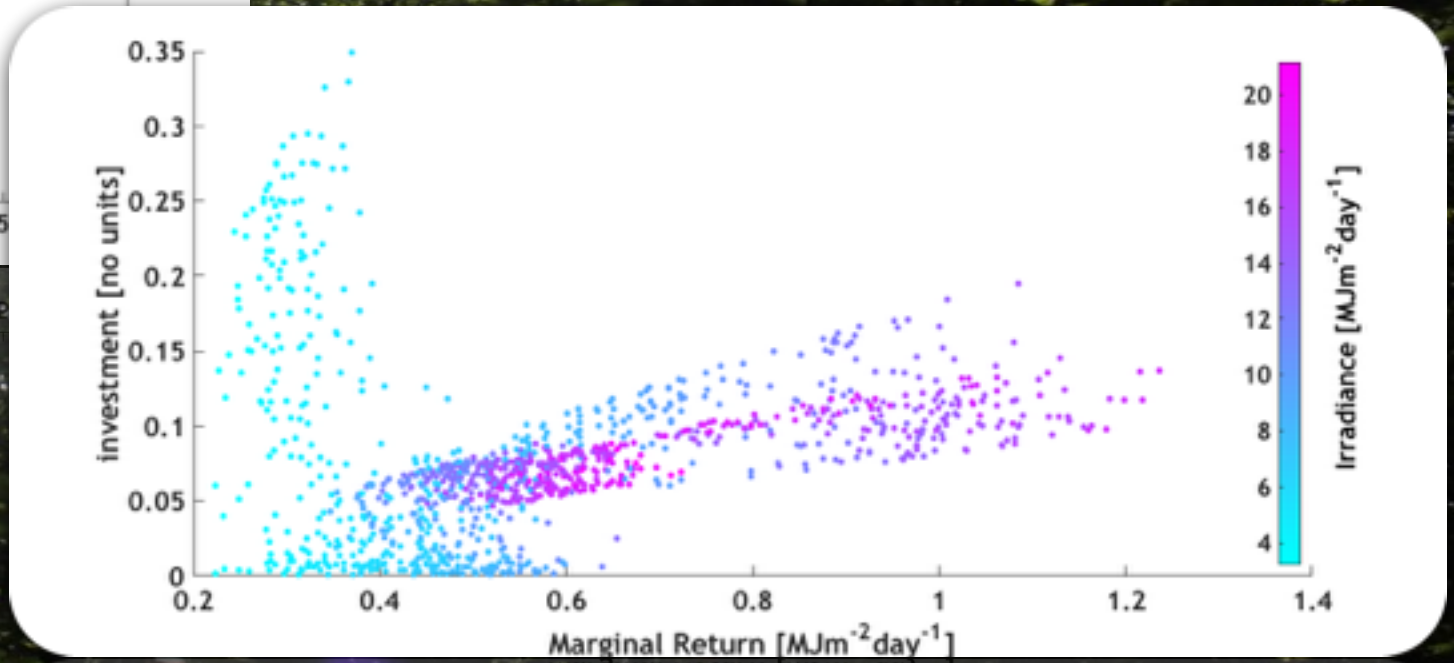

Thank you

Forming the model

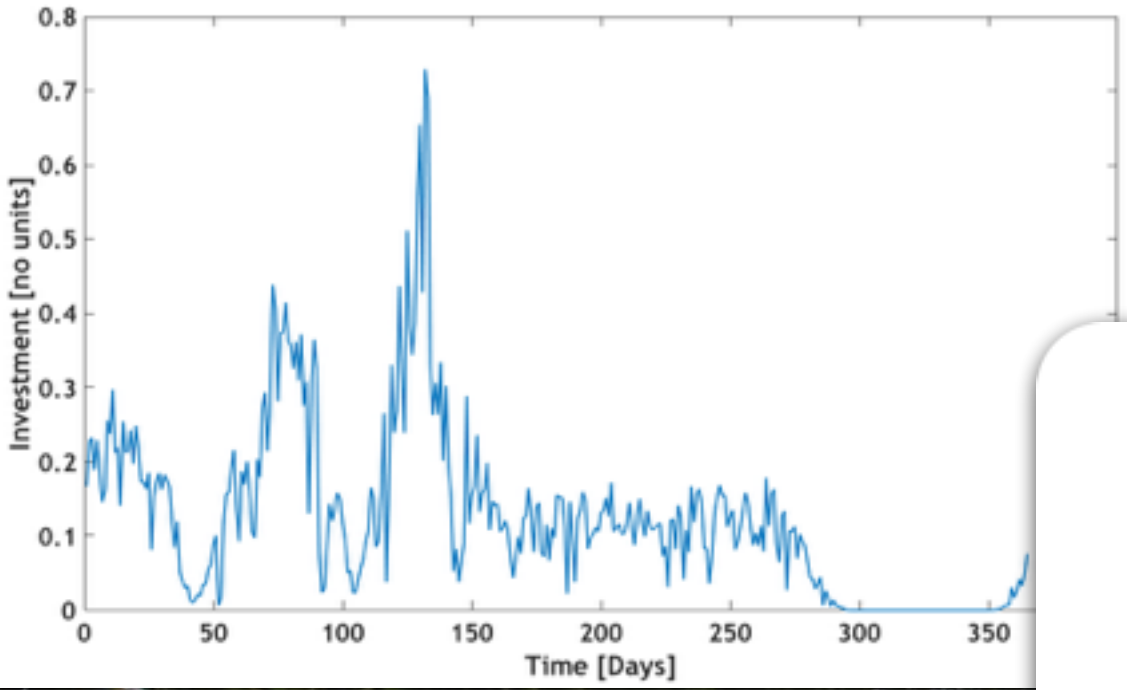
- 1) Capital: $K_{t+1} = K_t - \epsilon_1 K_t + i_t P_t$
- 2) Photosynthesis: $P_t = E_t(1 - e^{(-\epsilon_2 * K_t)})R_t$
- 3) Efficiency: $E_t = \epsilon_3 e^{\epsilon_4 (T_t - \bar{T})}$
- 4) Investment: $i_t = \epsilon_{5t} \frac{\delta P}{\delta K_t}$

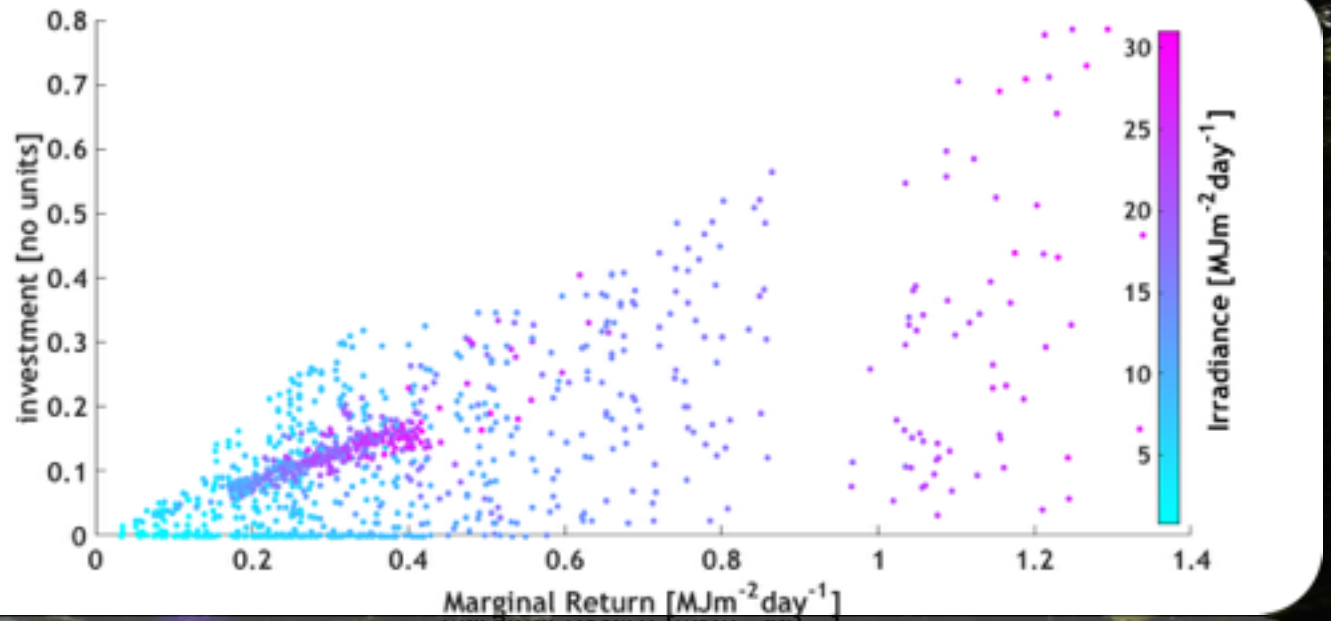
Harvard Forest : Deciduous



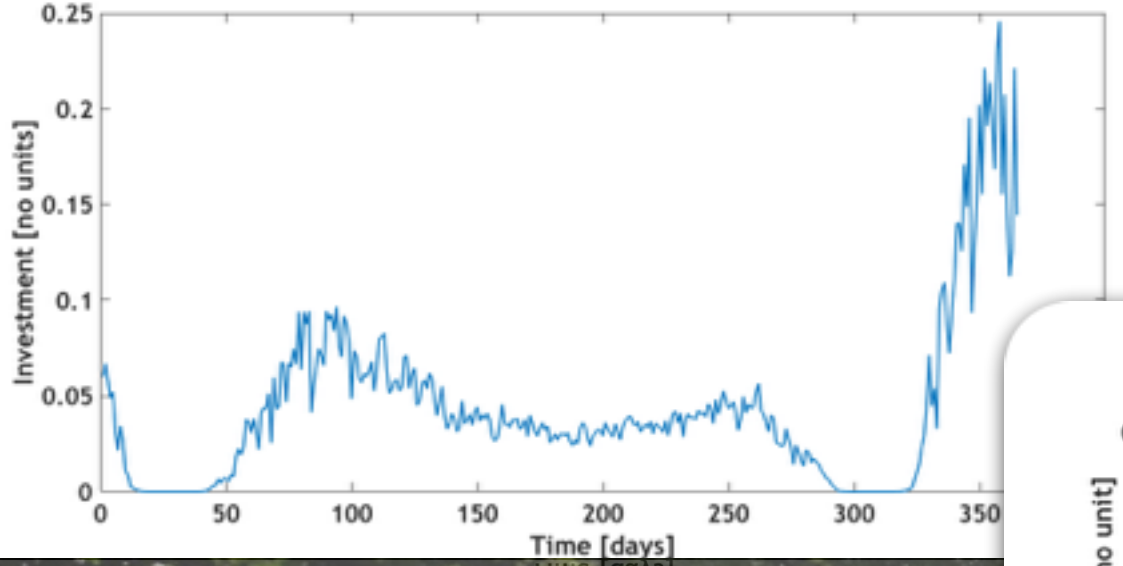


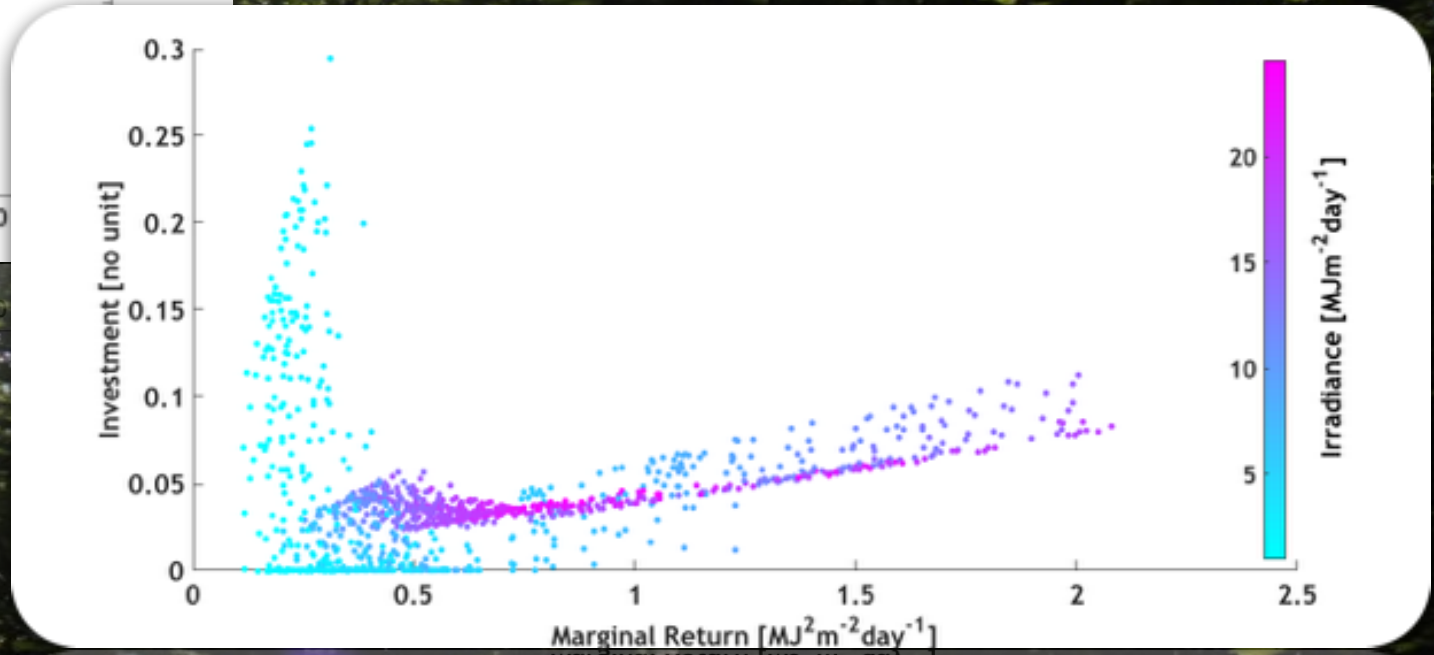
Bartlett Forest : Deciduous



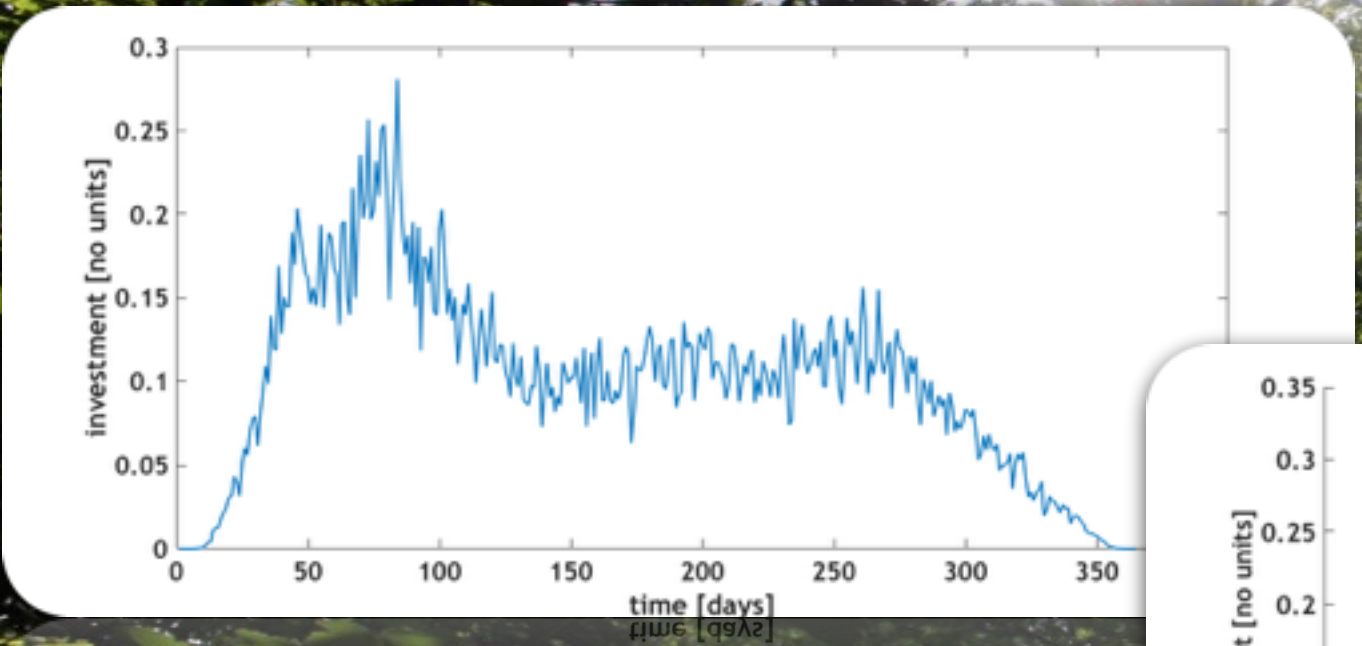


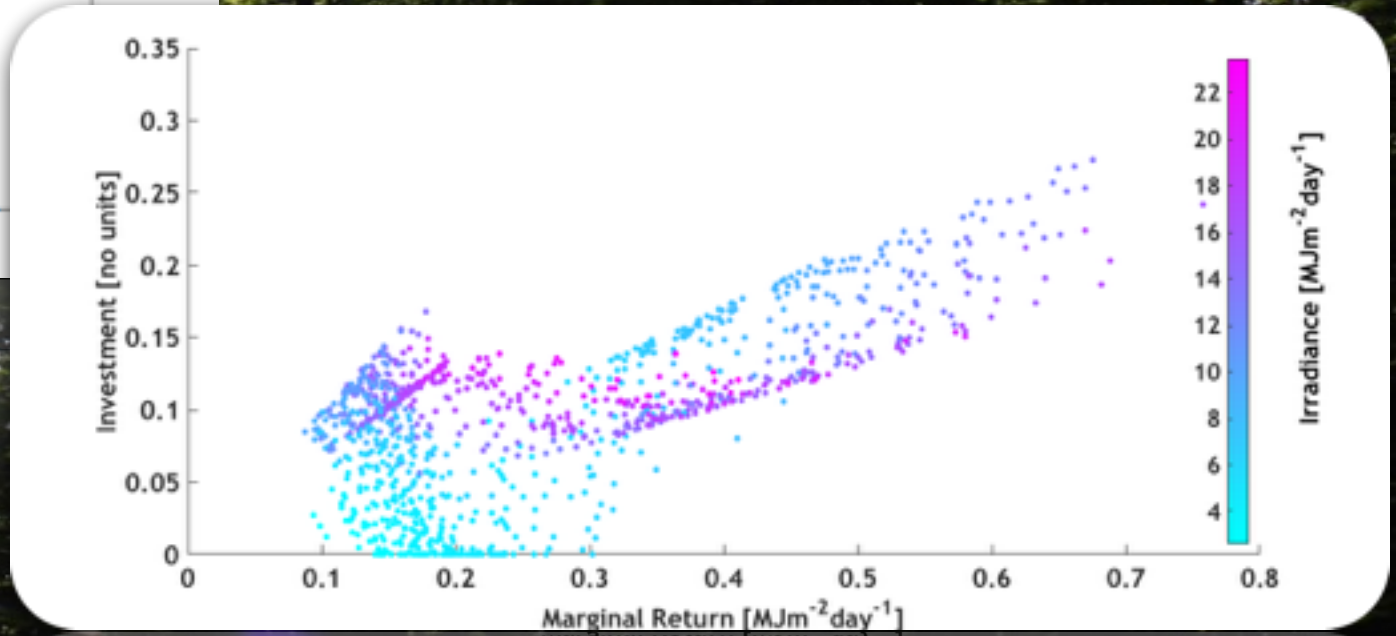
Hainich Forest : Deciduous



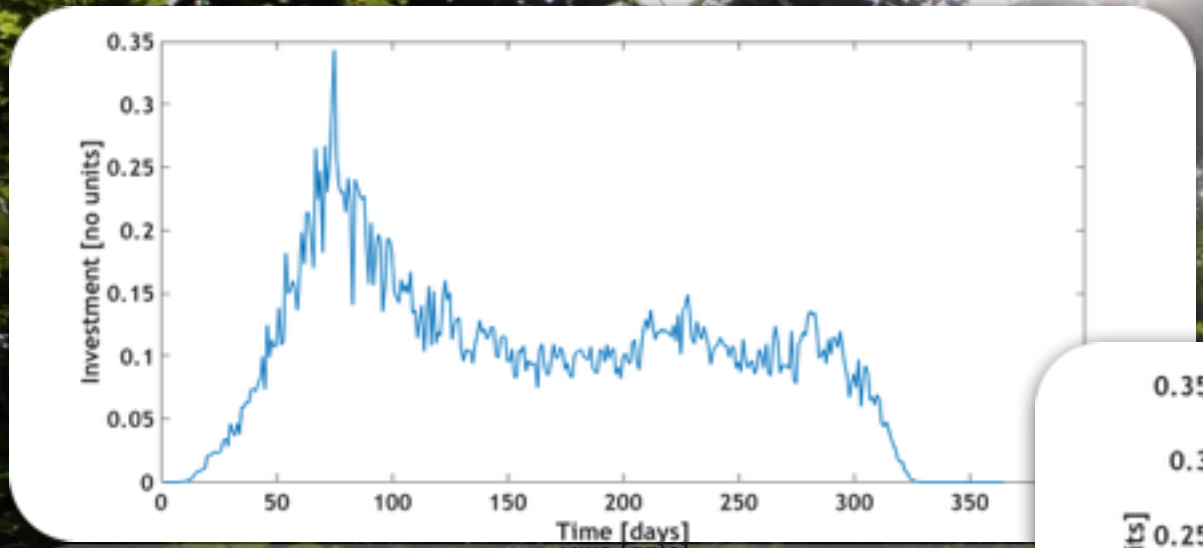


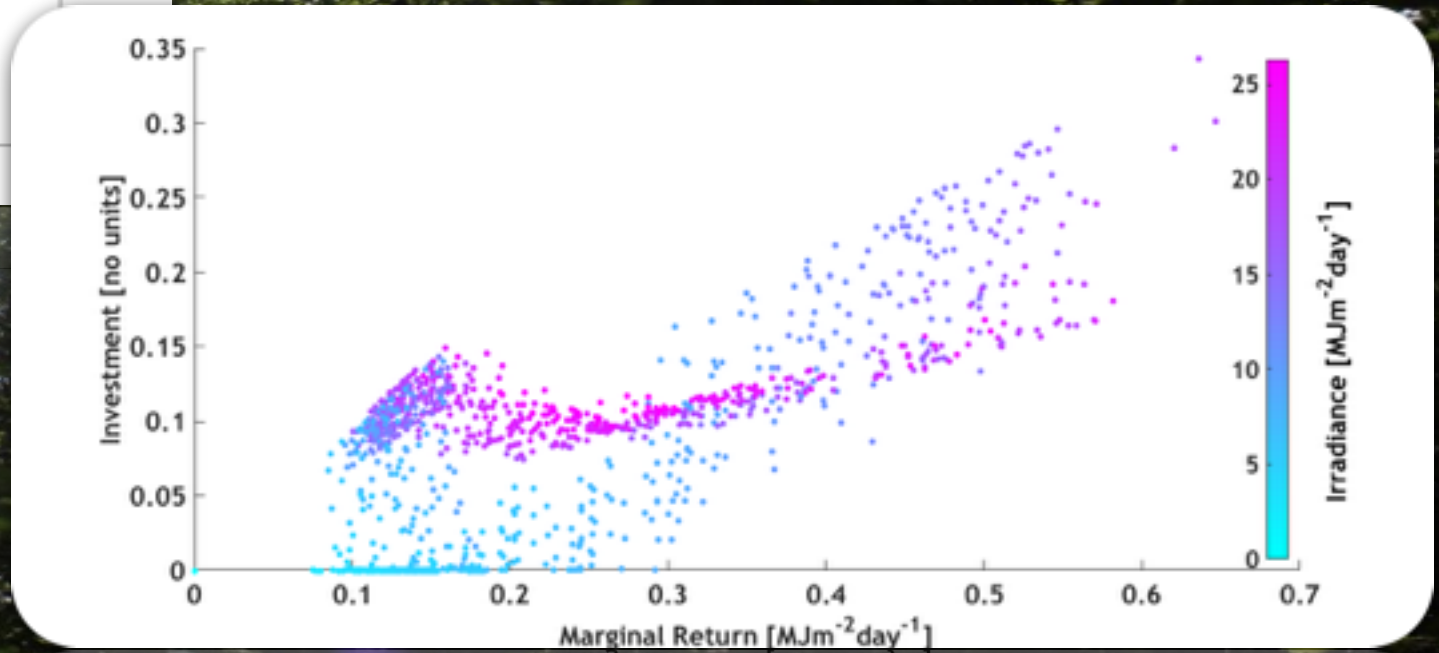
Howland Forest : Evergreen





Ontario Turkey Point Forest : Evergreen





Ontario Turkey Point Forest : Evergreen