



How climatic drivers and intrinsic biological processes shape beech masting dynamics



Talking about masting in Zürich – V. Van der Meersch



Current state of the field



Current state of the field

⚖️ clear explicit theories on the **evolutionary drivers**



Current state of the field

- ⚖️ clear explicit theories on the **evolutionary drivers**
 - maximize pollination



Current state of the field

⚖️ clear explicit theories on the **evolutionary drivers**

- maximize pollination
- avoid predation



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- (- improve dispersion)



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Fitness benefit that would favor phenotypes that are synchronized



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- 🦠 some ideas of the **environmental drivers**



Current state of the field

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- effect of previous summer temperatures



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⚖️ clear explicit theories on the **evolutionary drivers** ————— **ultimate causes**

❄️ some ideas of the **environmental drivers**

- effect of previous summer temperatures
- spring weather and pollination

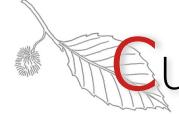


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- spring weather and pollination
- “vetos”: frost, drought



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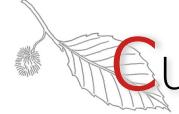
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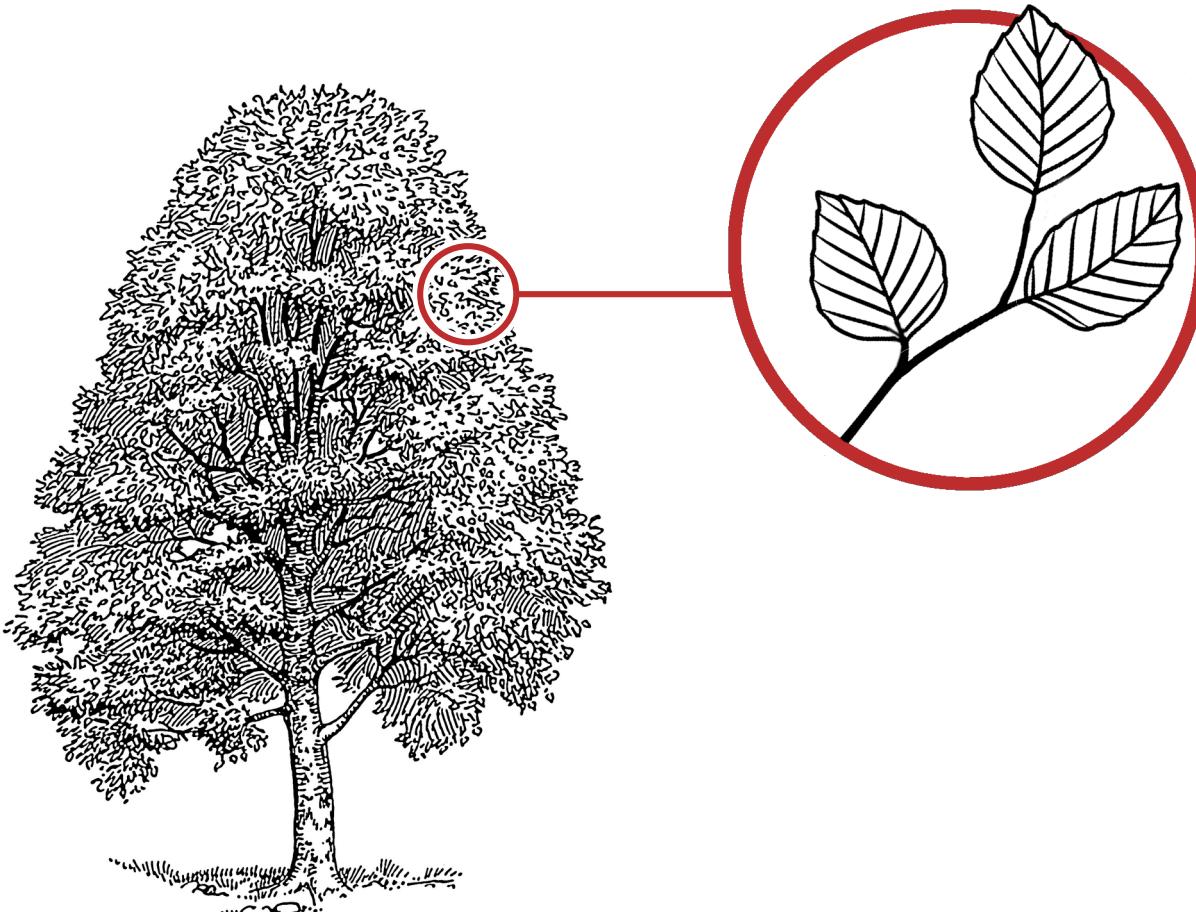


Current state of the field

- ⚖️ clear explicit theories on the **evolutionary drivers** ————— **ultimate** causes
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- 🌿 overlooked **biological mechanisms**

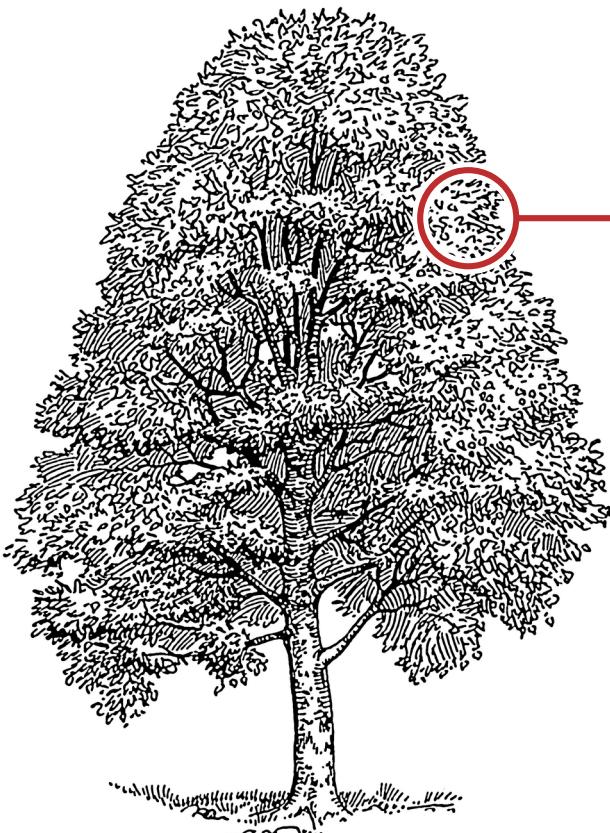


The biology behind tree reproduction





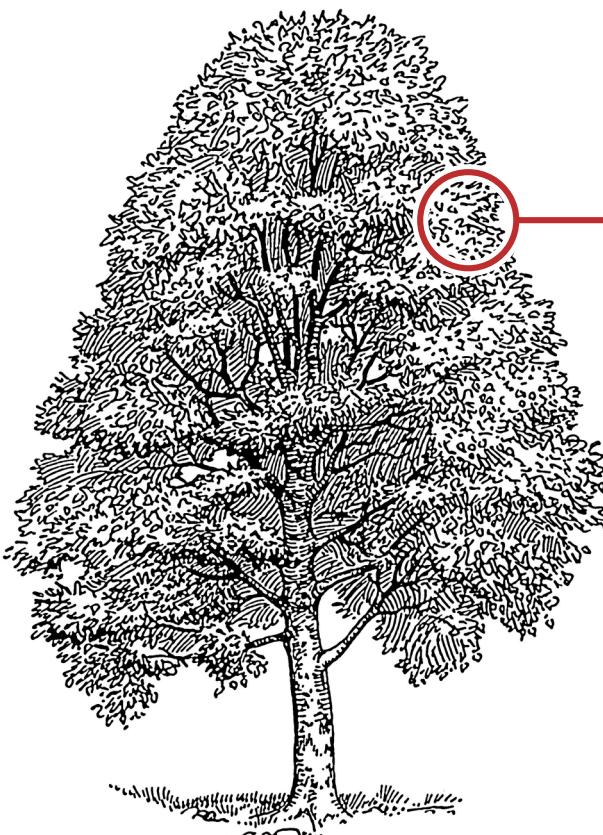
The biology behind tree reproduction



Induction of
flowers in **buds**
the previous
summer



The biology behind tree reproduction

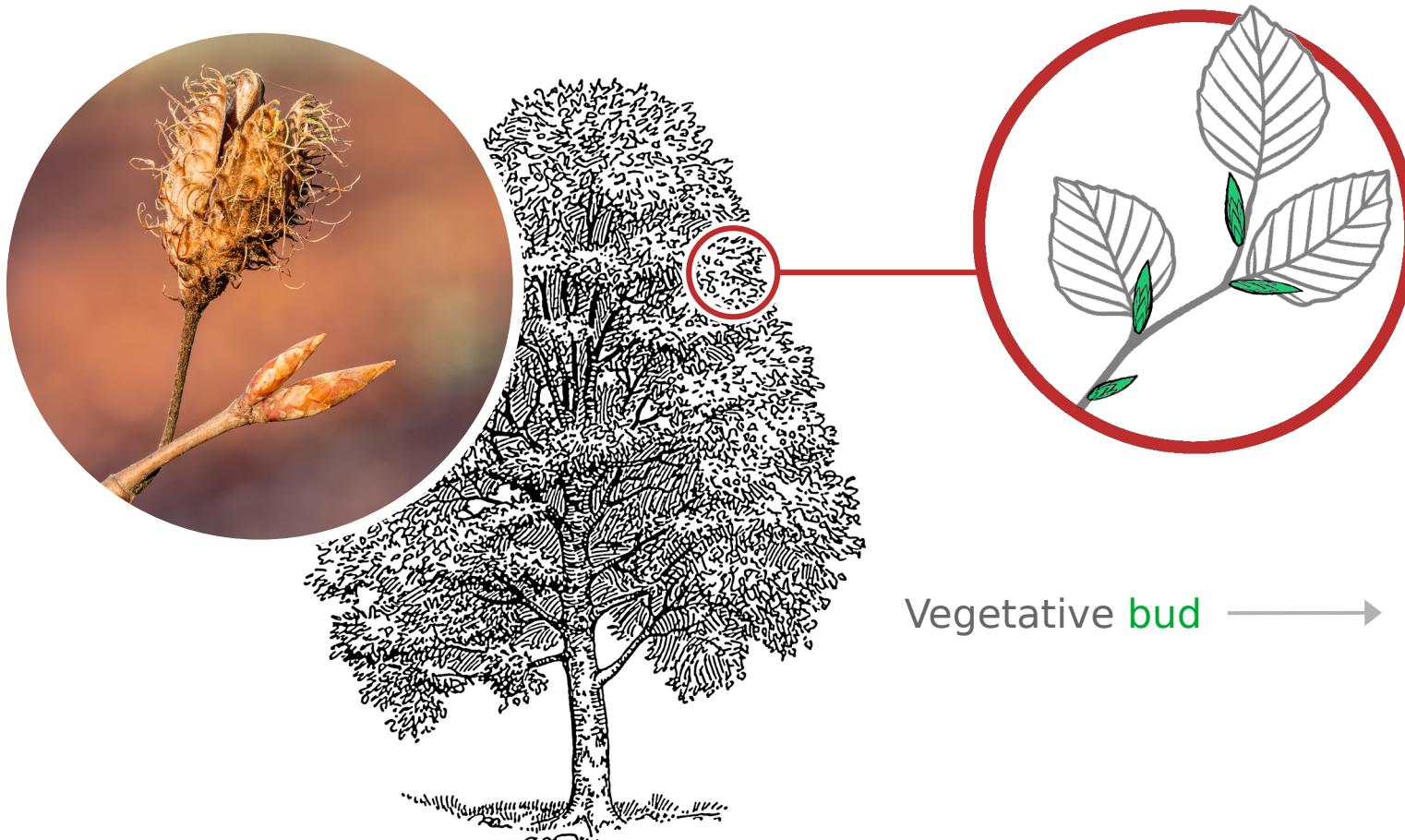


Vegetative bud → Mixed bud

Induction of
flowers in **buds**
the previous
summer



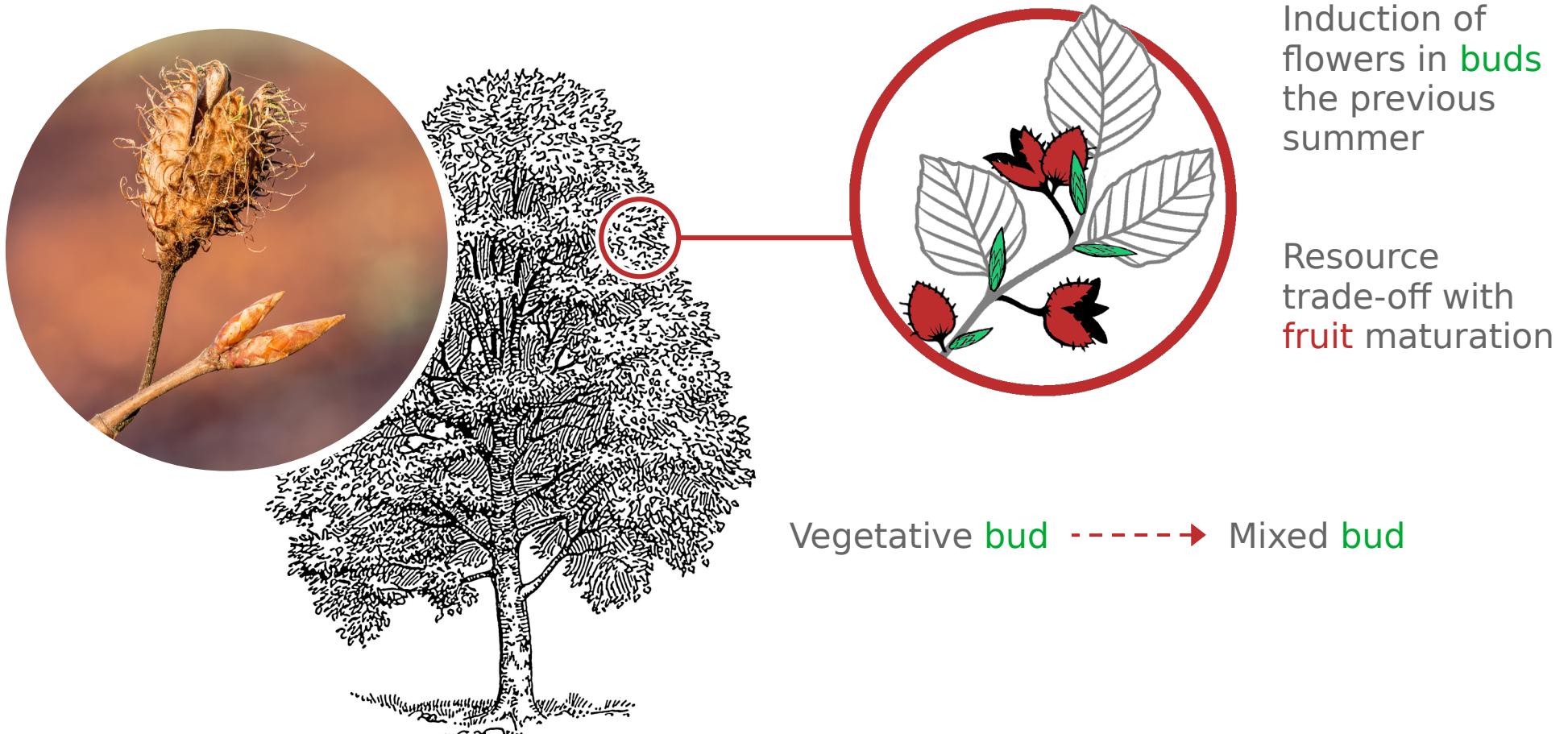
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The biology behind tree reproduction





Current state of the field

-  clear explicit theories on the **evolutionary drivers** ————— **ultimate** causes
-  some ideas of the **environmental drivers** ————— **proximal** causes
-  overlooked **biological mechanisms**
 - flower induction in previous year
 - trade-off between fruit maturation and flower induction



Current state of the field

 clear explicit theories on the **evolutionary drivers** ————— **ultimate causes**

 some ideas of the **environmental drivers** ————— **proximal causes**

 overlooked **biological mechanisms** ————— **biol. constraints**

- flower induction in previous year

- trade-off between fruit maturation and flower budget



More regeneration failures in future climates?

Climate warming disrupts mast seeding and its fitness benefits in European beech

Widespread breakdown in masting in European beech due to rising summer temperatures

Climate warming



increase seed production
less years without reproduction
less synchrony



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Climate warming

— increase seed production
— less years without reproduction
— less synchrony



Disruption of long-term reproductive patterns?



Biological constraints (may) matter!



ultimate causes



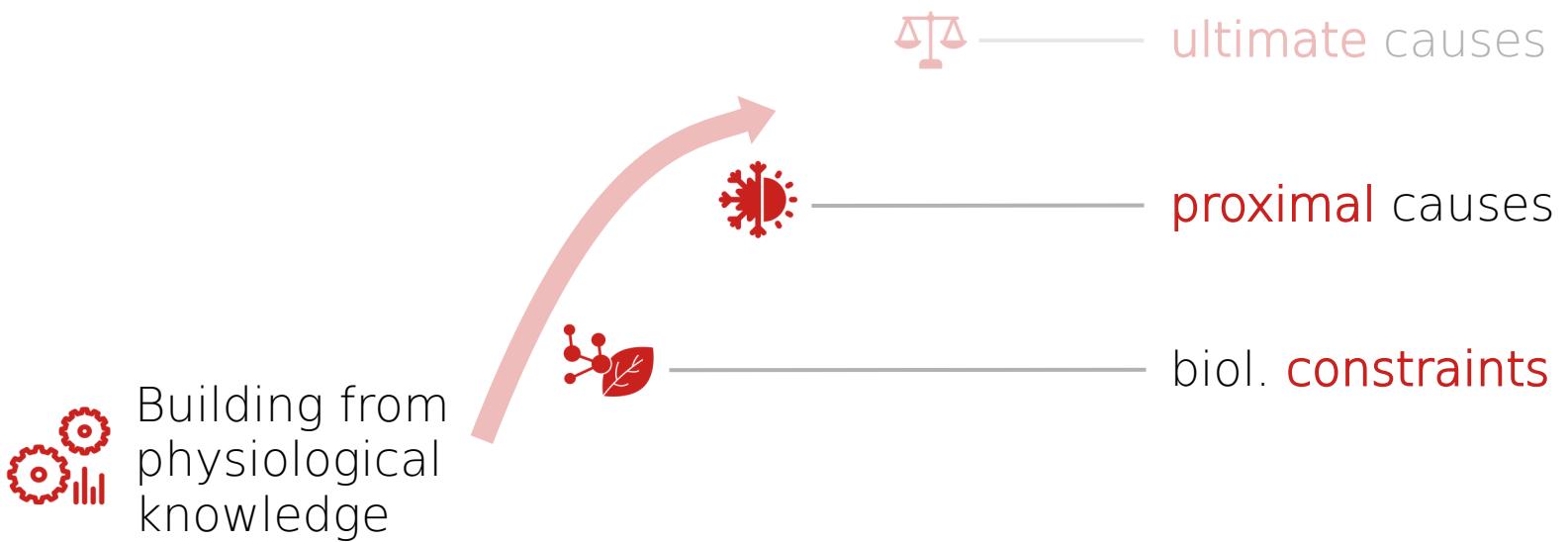
proximal causes



biol. constraints

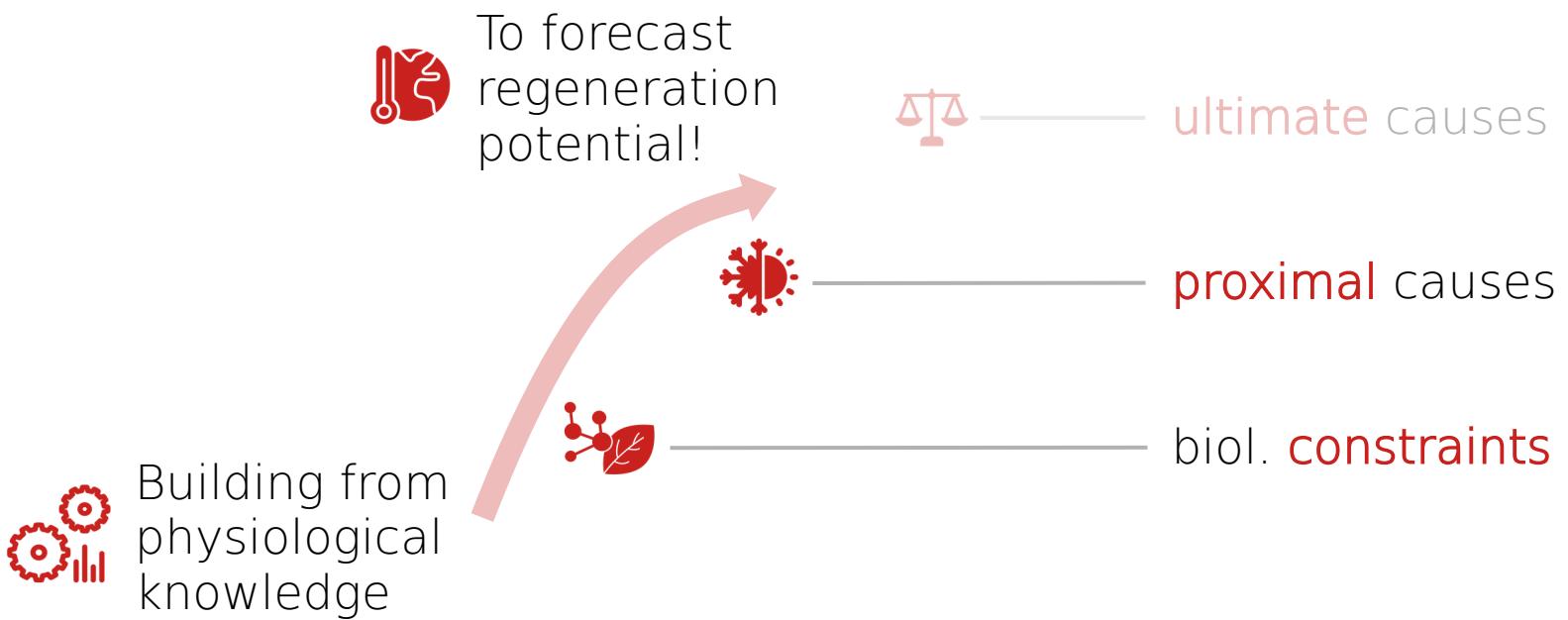


Biological constraints (may) matter!



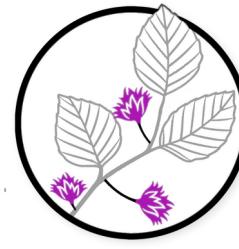
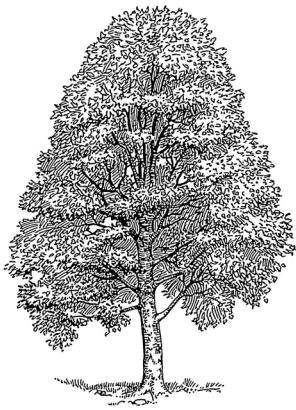


Biological constraints (may) matter!





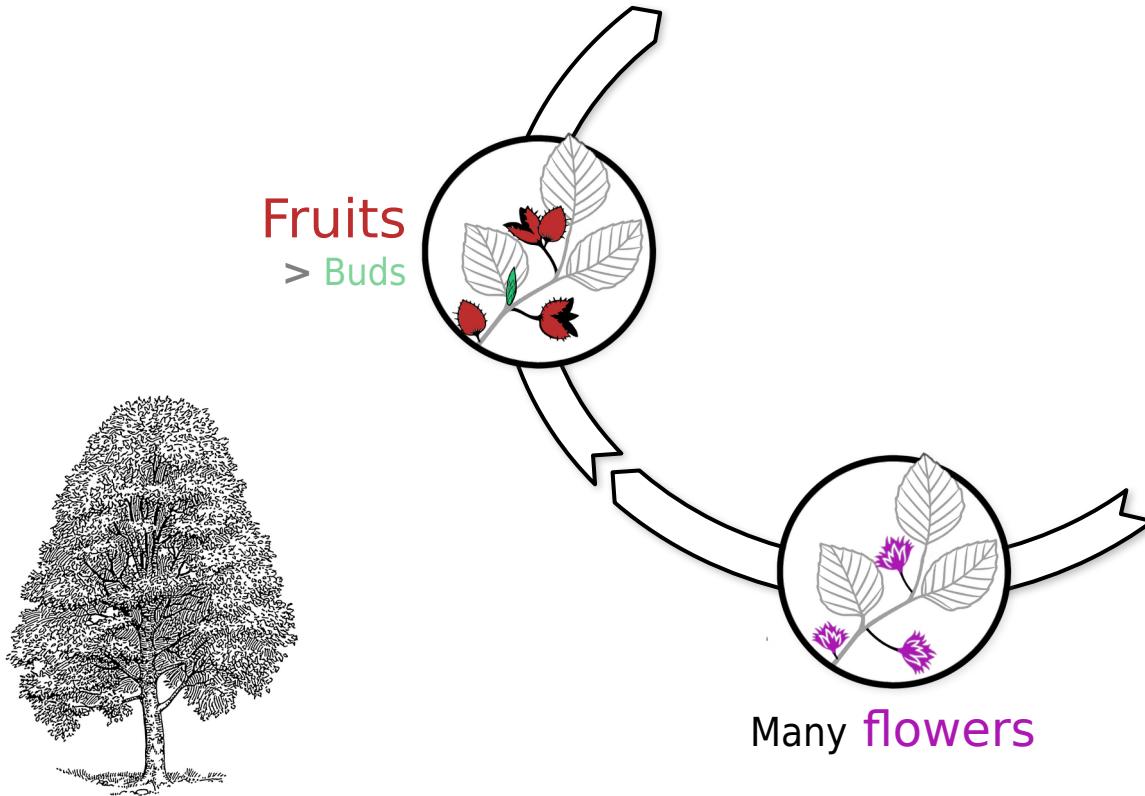
Modelling explicit states at the tree level



Many flowers

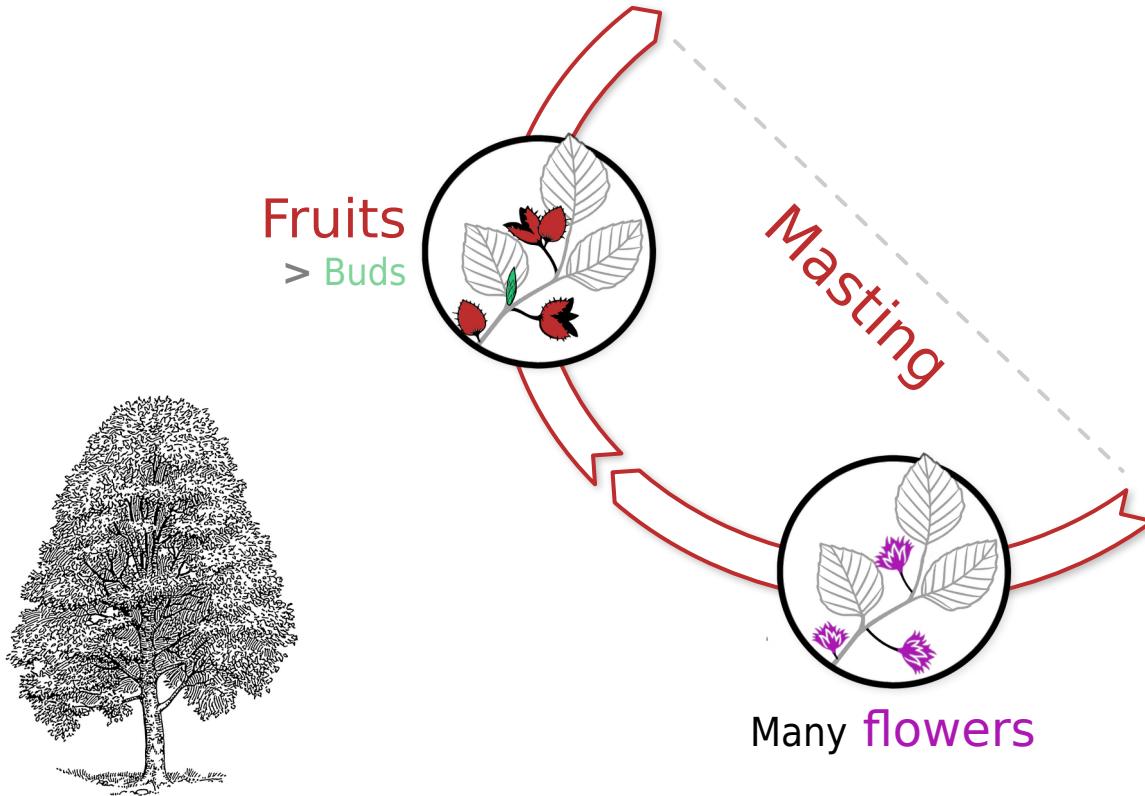


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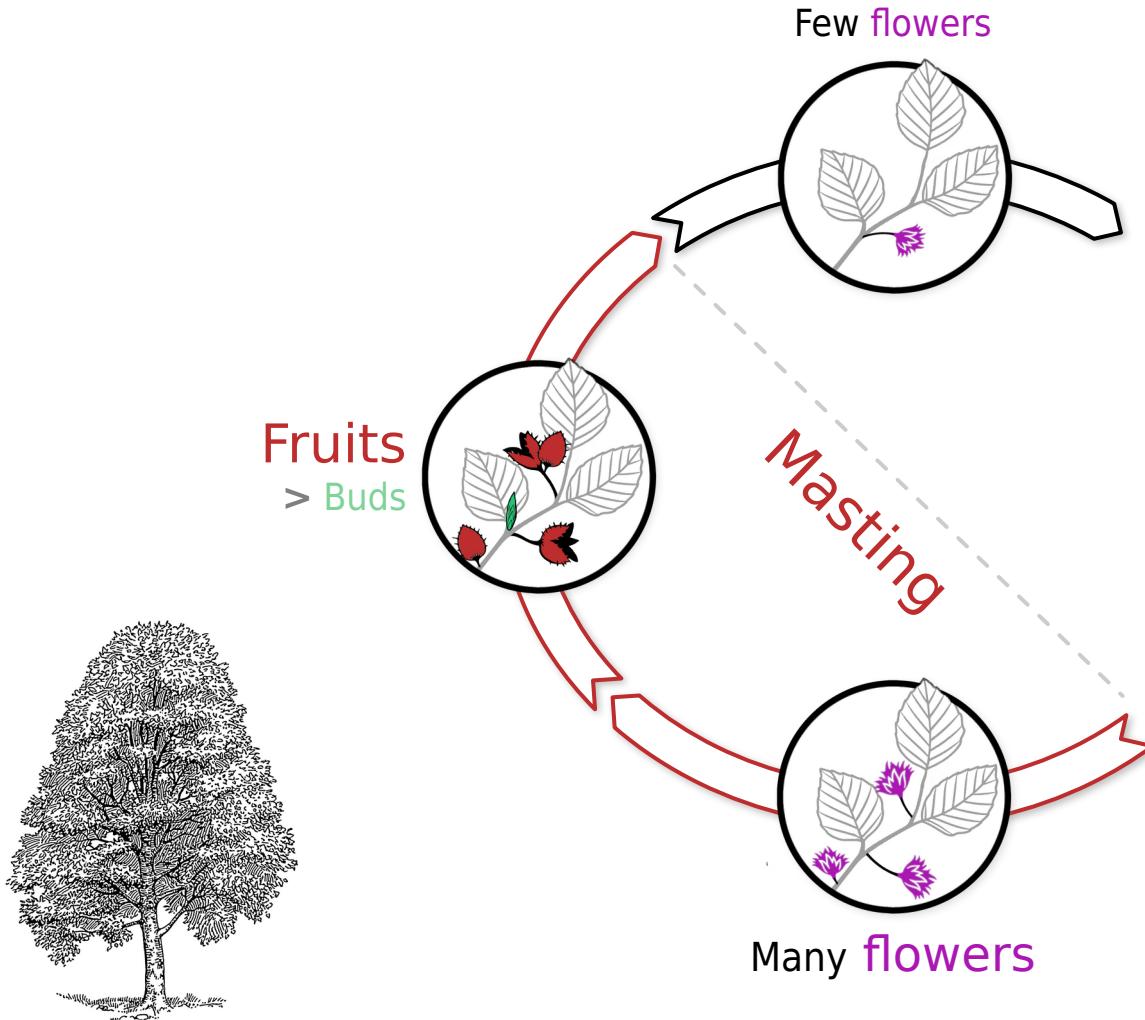


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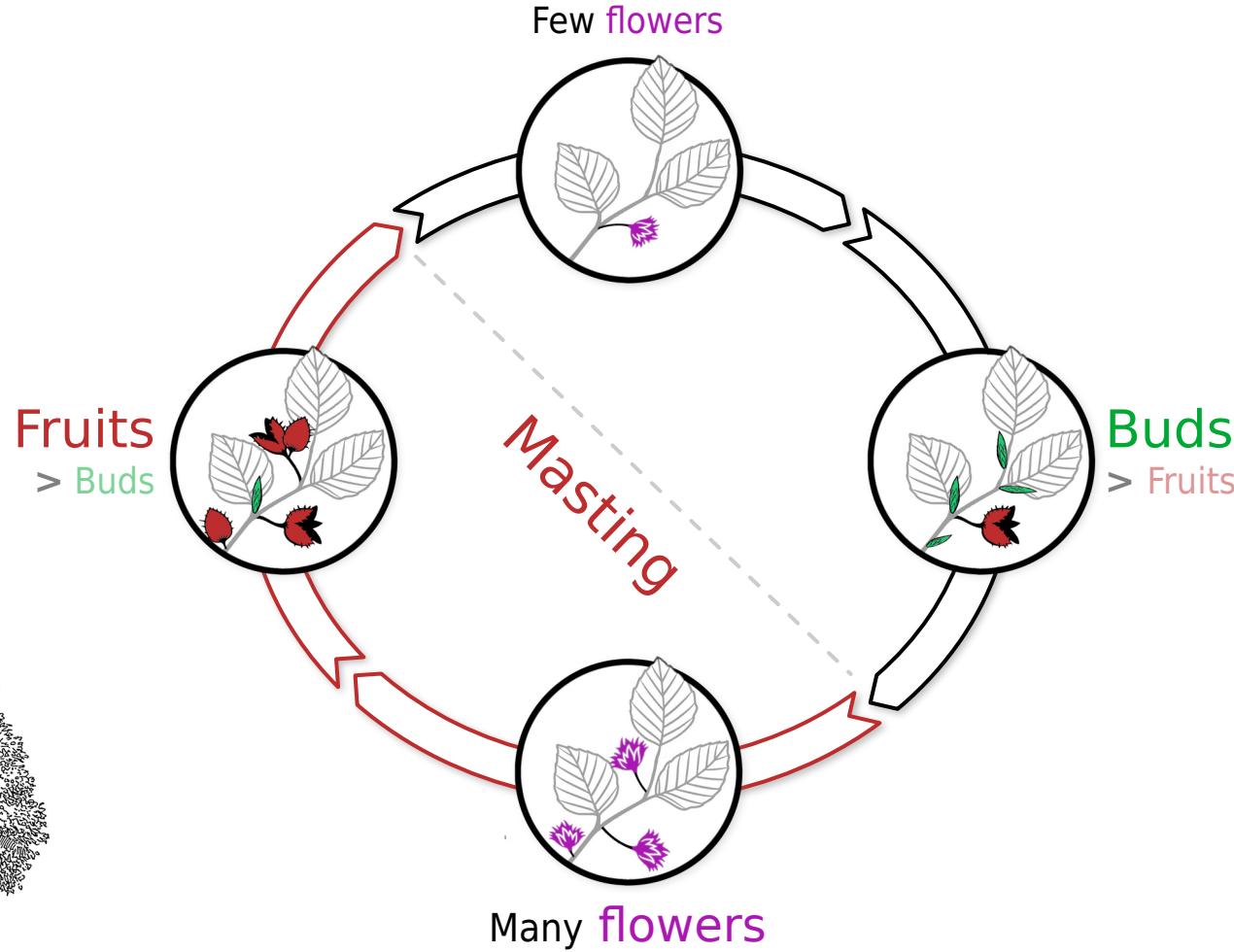
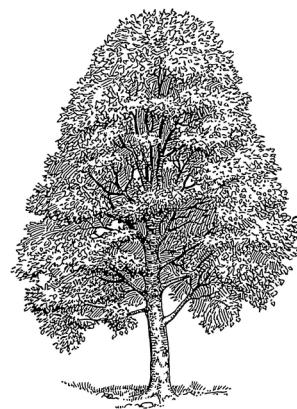


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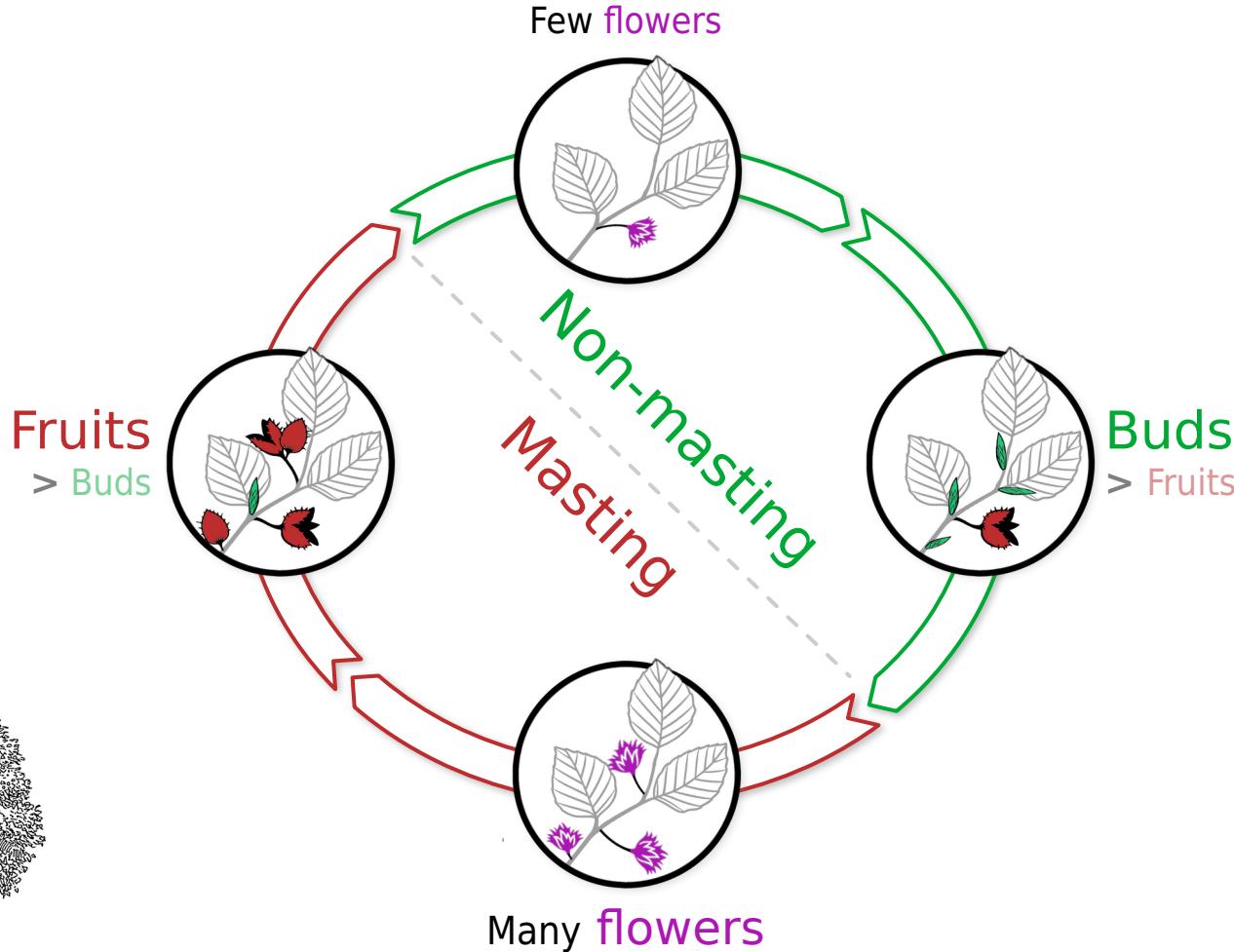
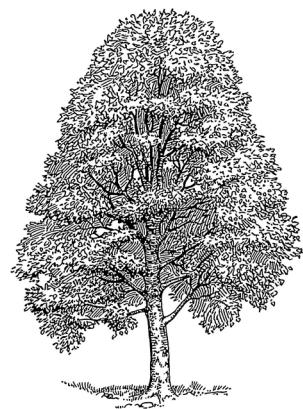


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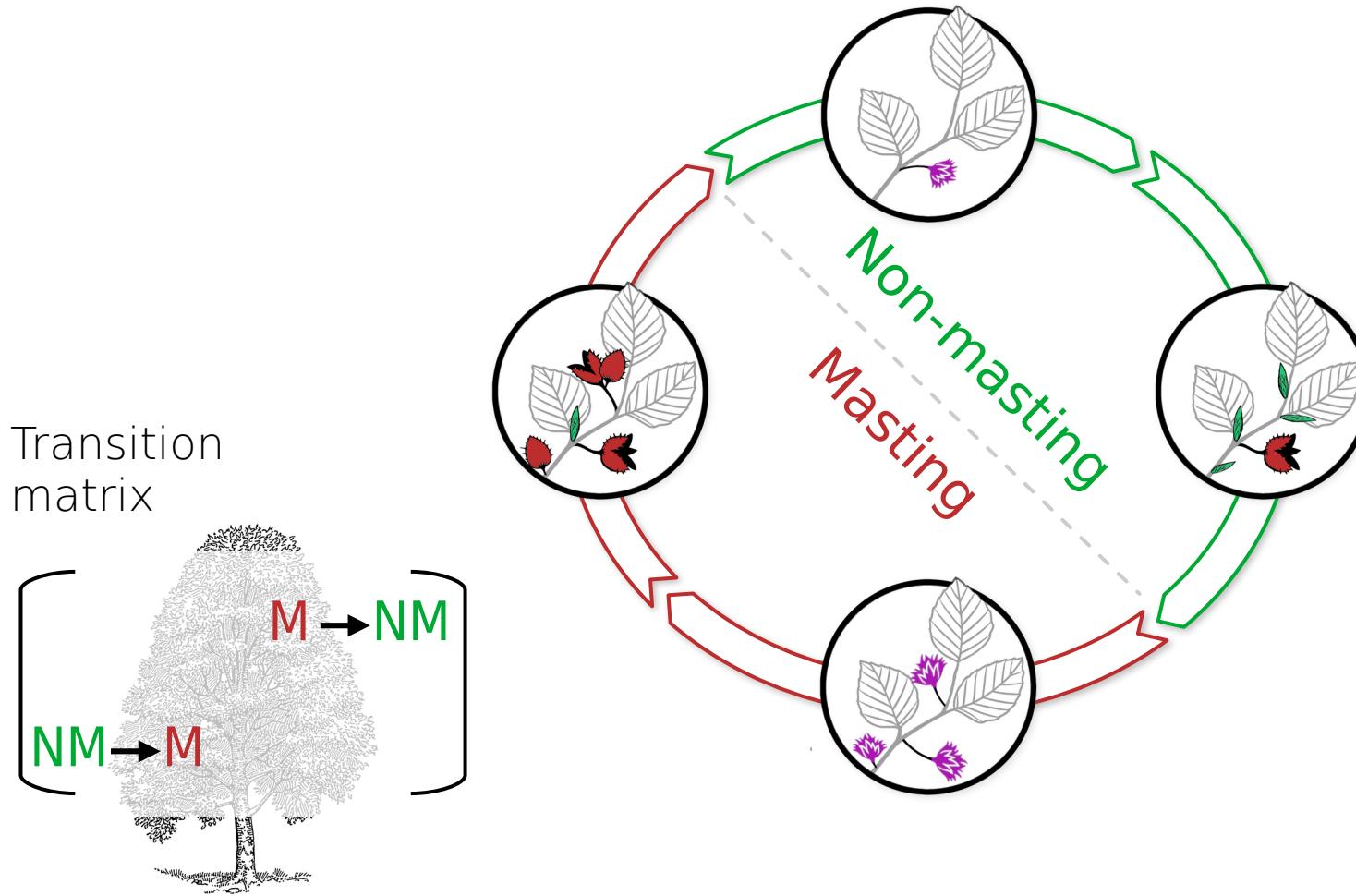


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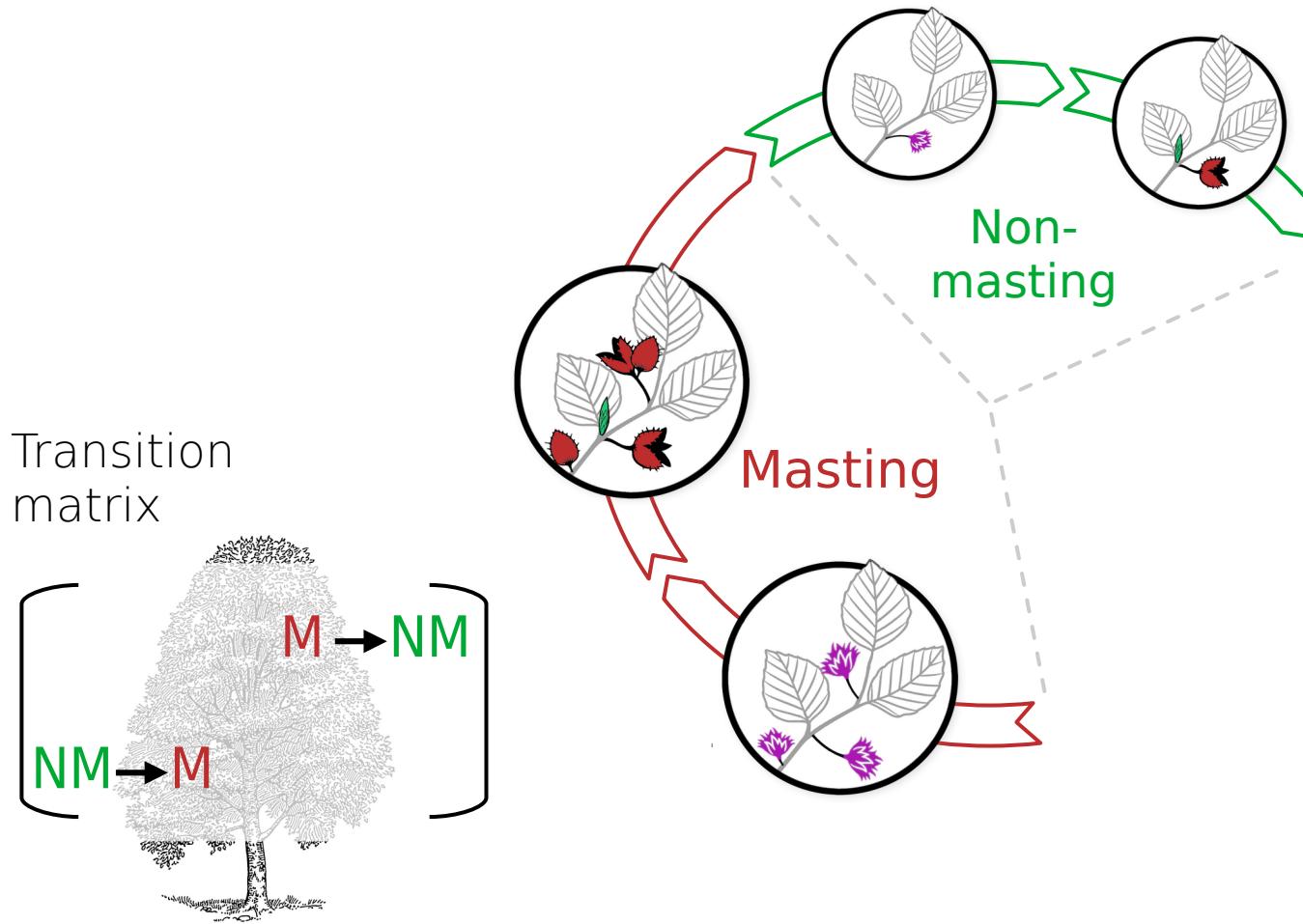


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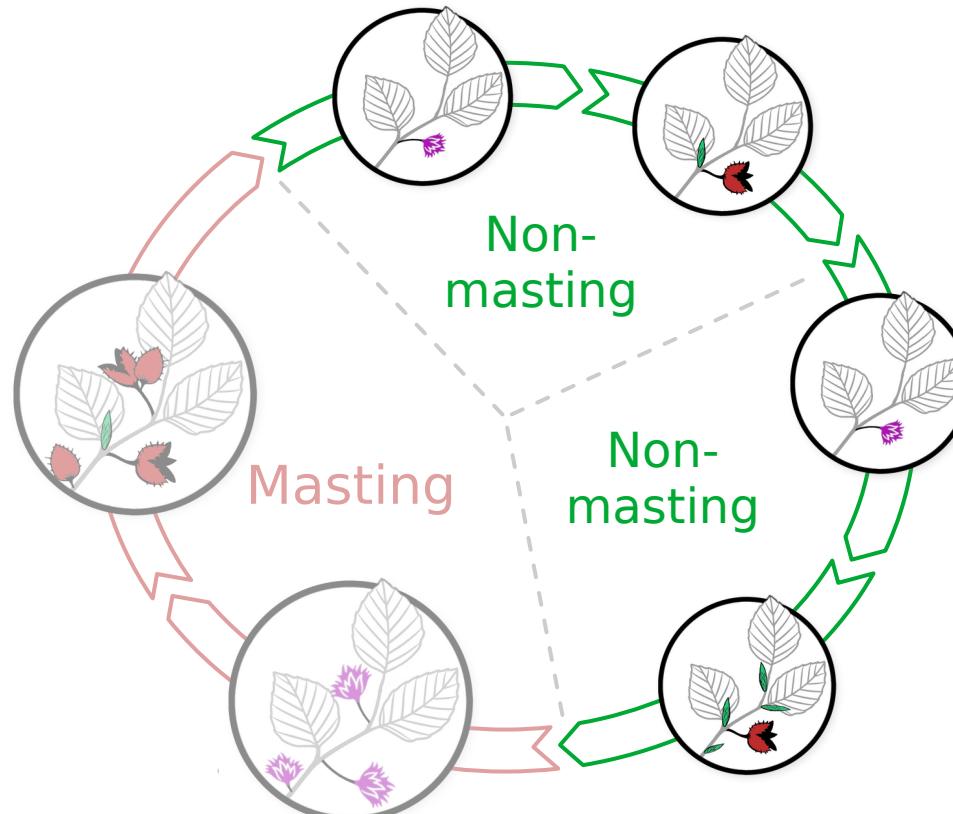
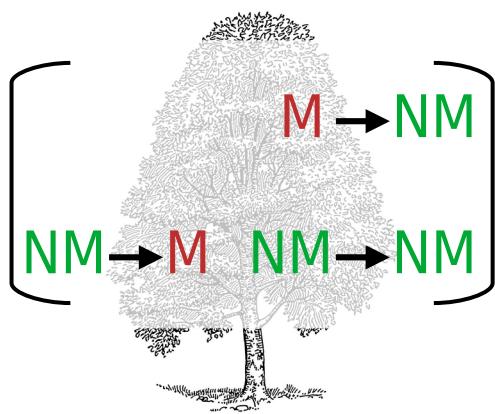
Modelling explicit states at the tree level





Modelling explicit states at the tree level

Transition
matrix

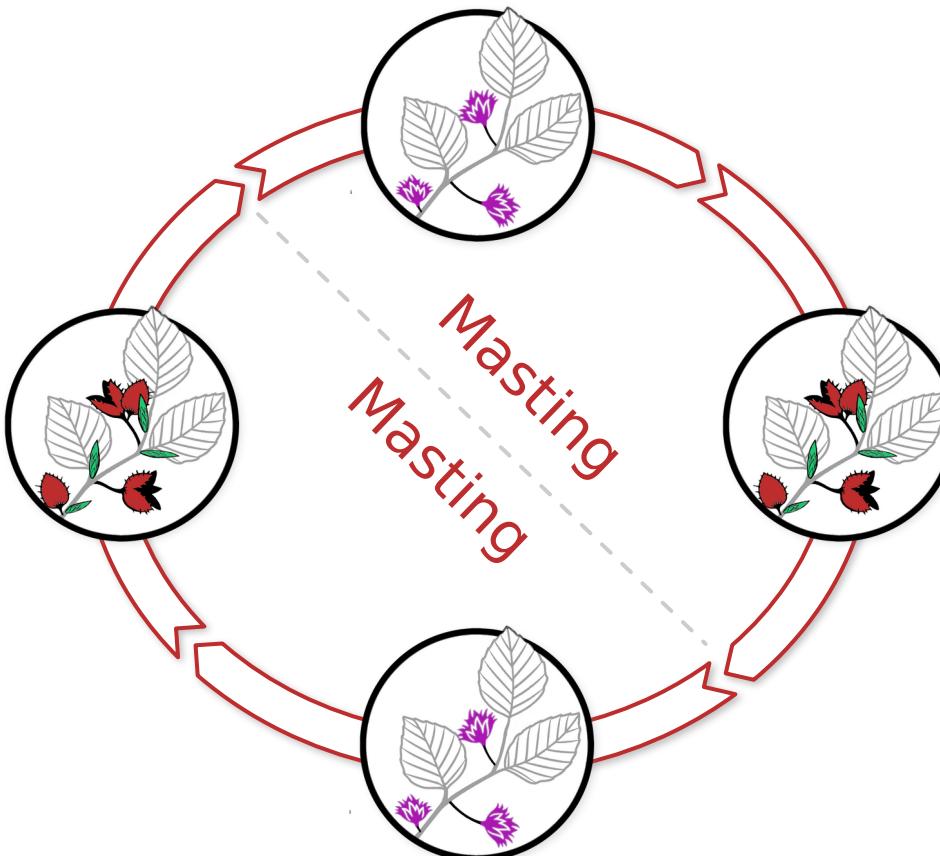
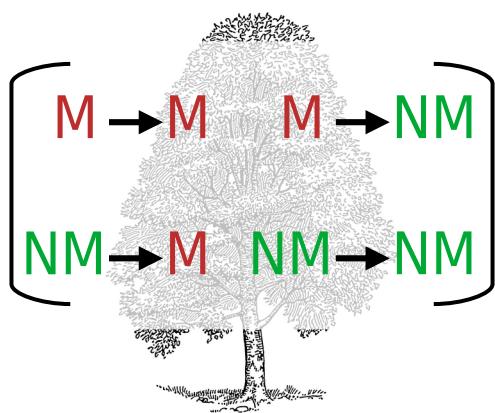


Cold summer
↓
Stay in a
non-masting
state



Modelling explicit states at the tree level

Transition
matrix

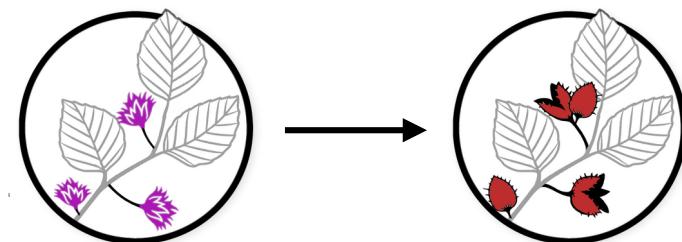
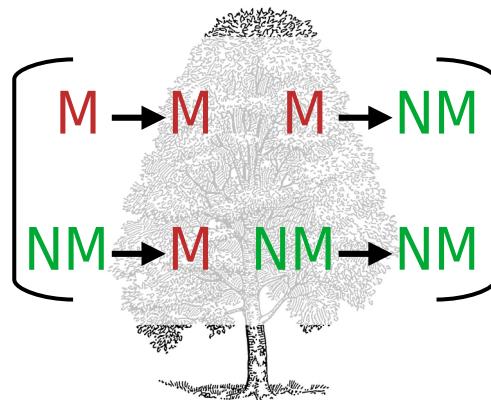


Summer warming
↓
Stay in a
masting
state



Incorporating the influence of climate

Transition matrix

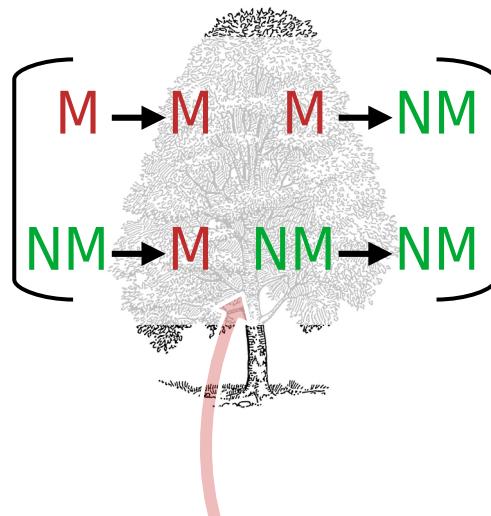


Seed production
(while in a masting state)



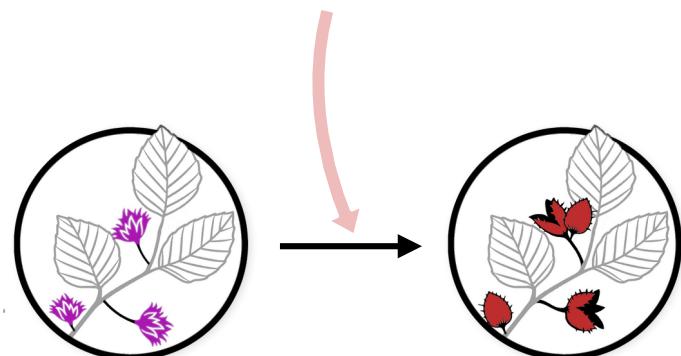
Incorporating the influence of climate

Transition matrix



☀ Summer temperatures
(previous year)

Late spring frosts ❄️
(current year)



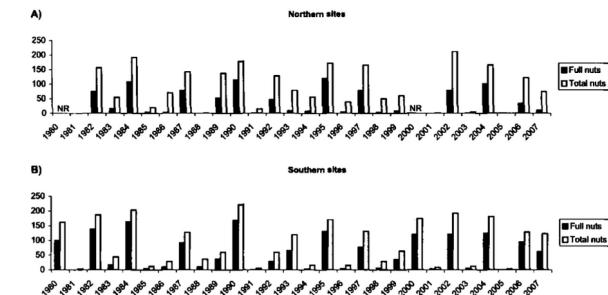
Seed production
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Beech trees in England



Beech.
Fagus Sylvatica.
— CUPULIFERÆ. —



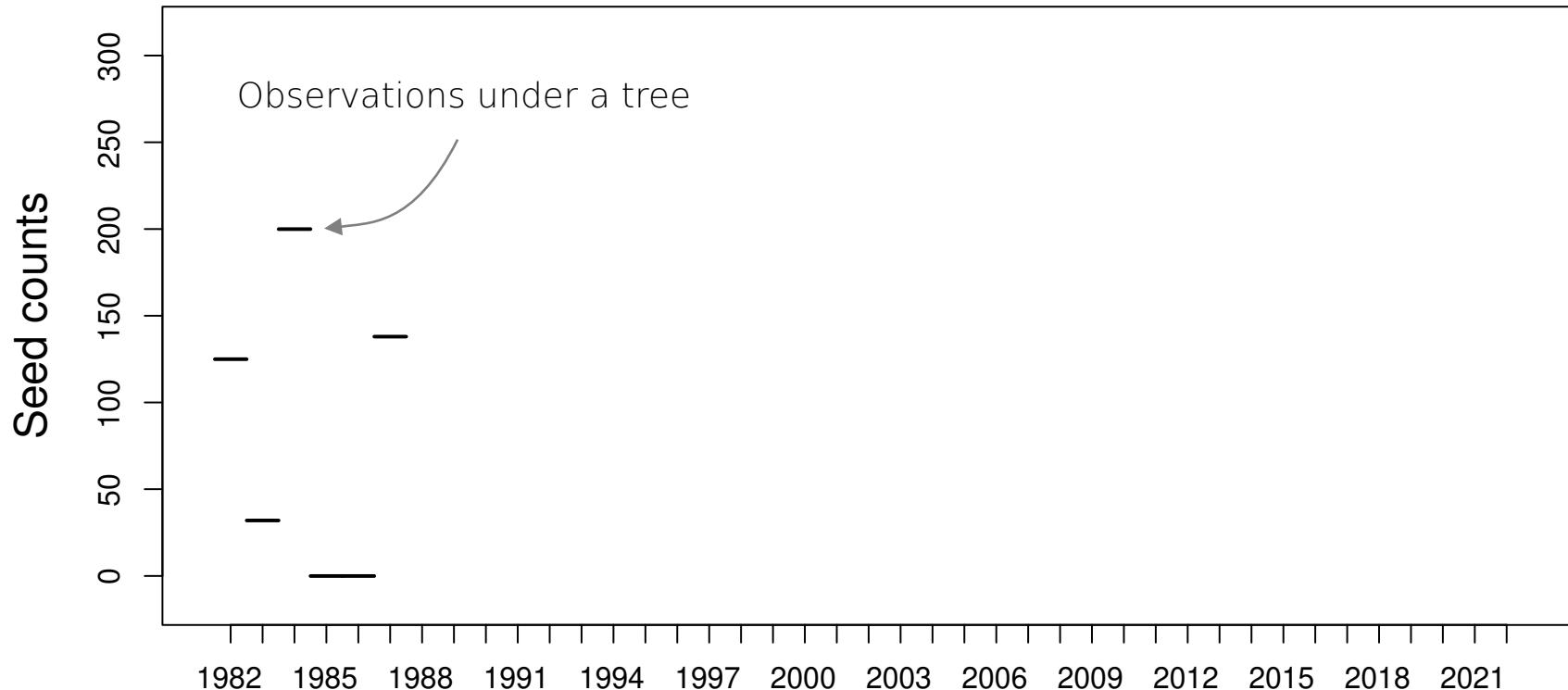


Investigations across multiple scales

- * Do trees have **multiple states**?
- * How **synchronous** are the populations?
- * How **climate** influences mast dynamics?



Boom-bust individual dynamics



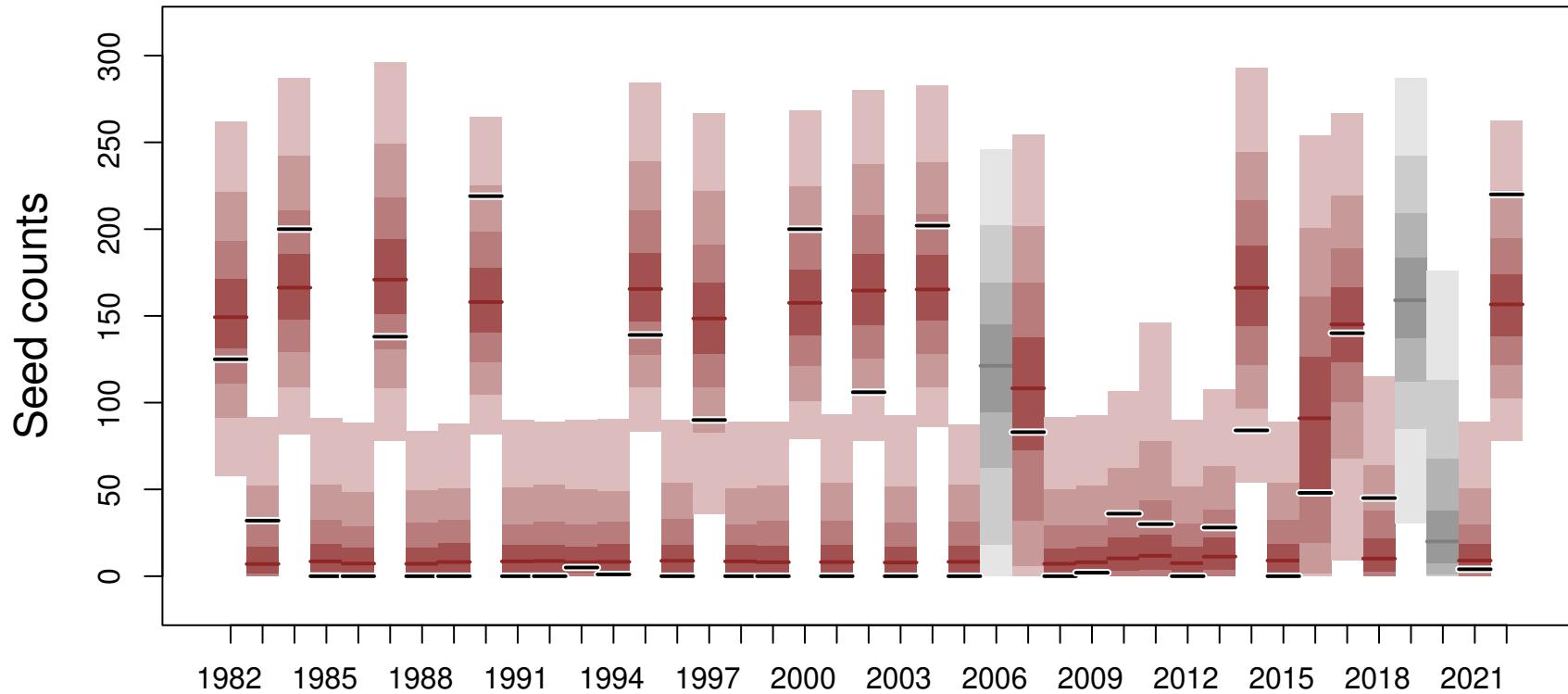


Boom-bust individual dynamics



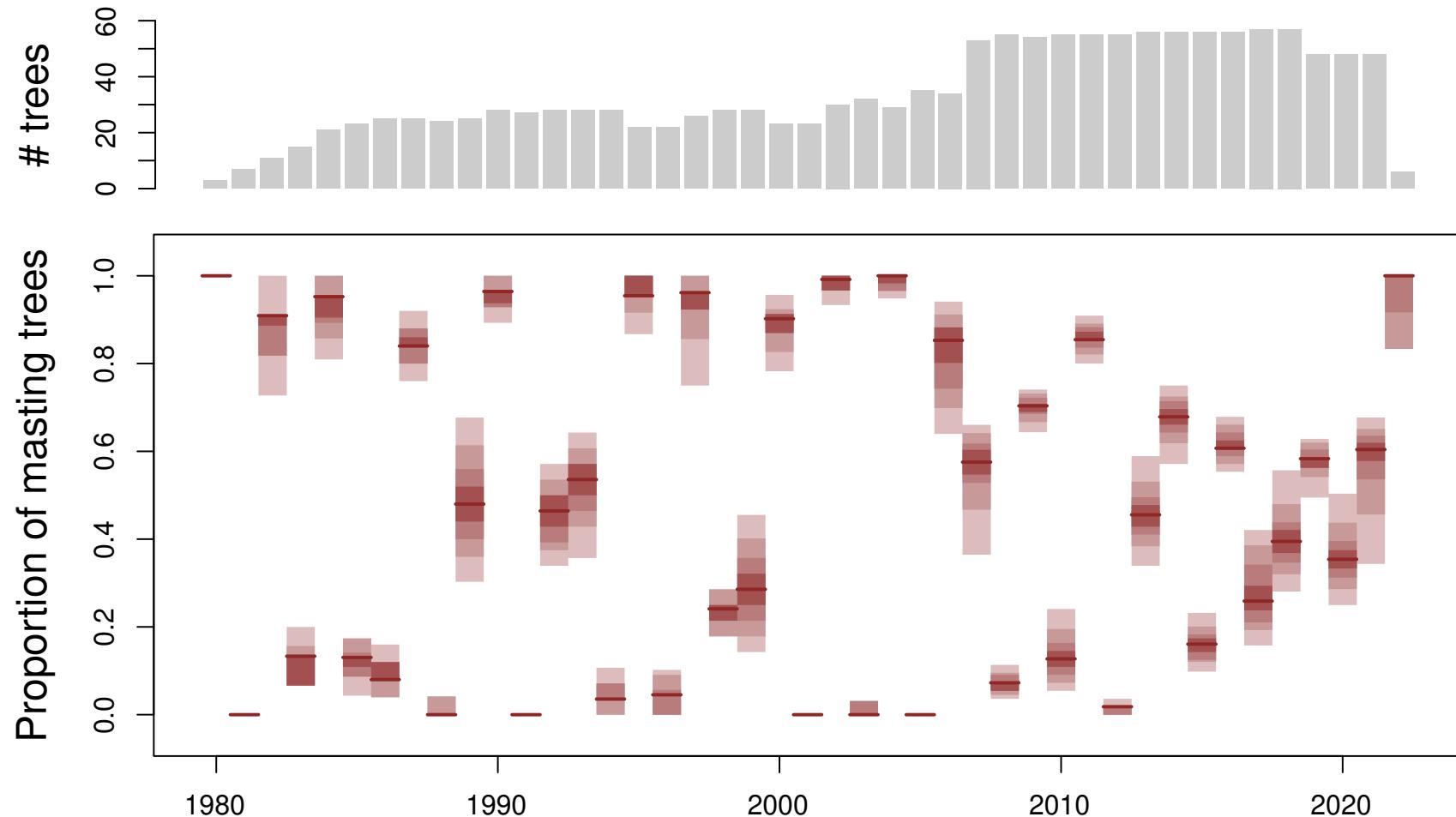


Boom-bust individual dynamics



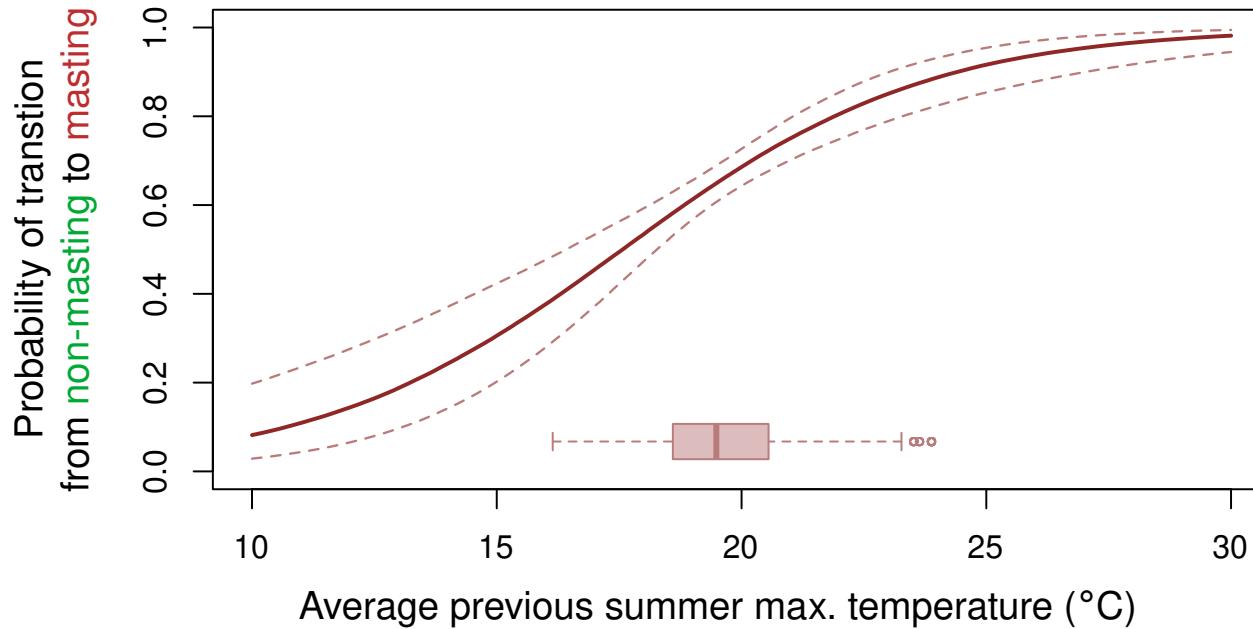


Synchrony across populations



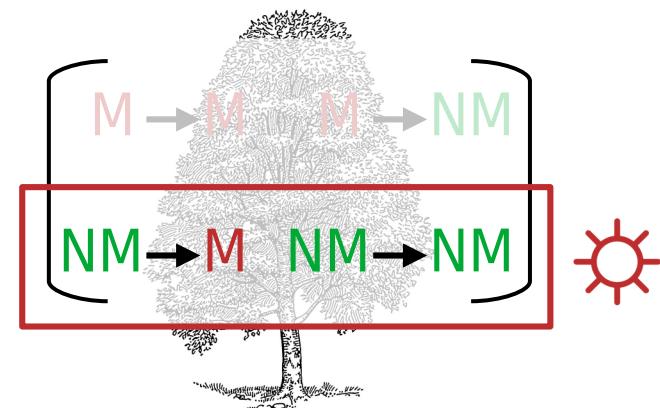
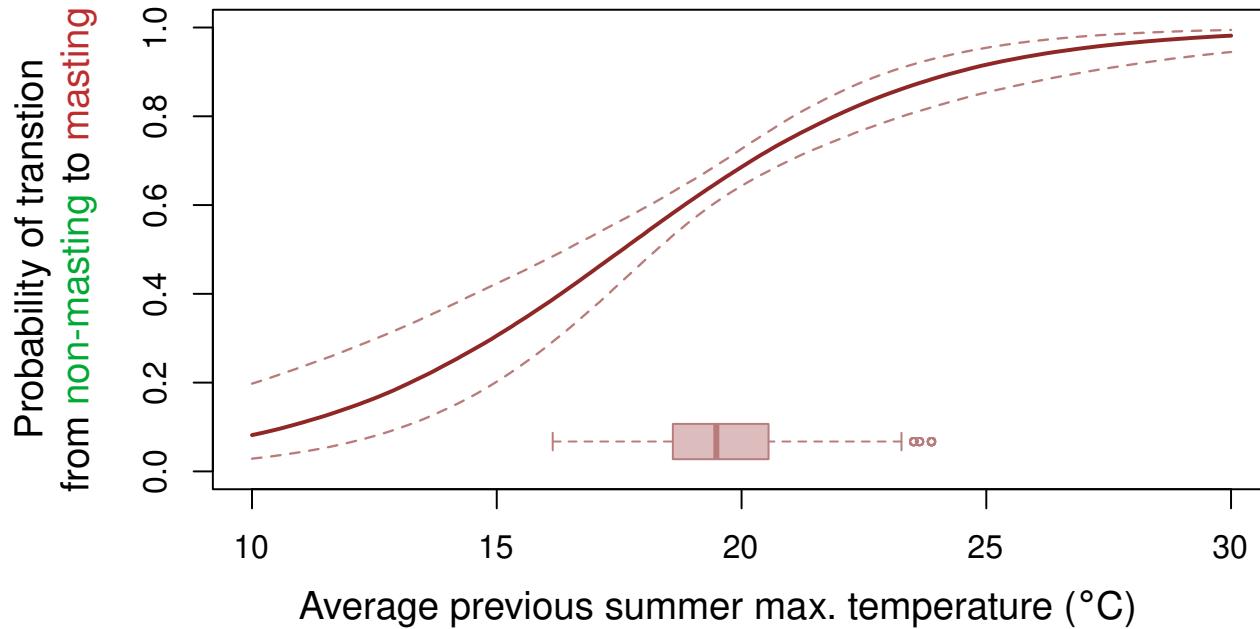


More chance to mast with warm summer



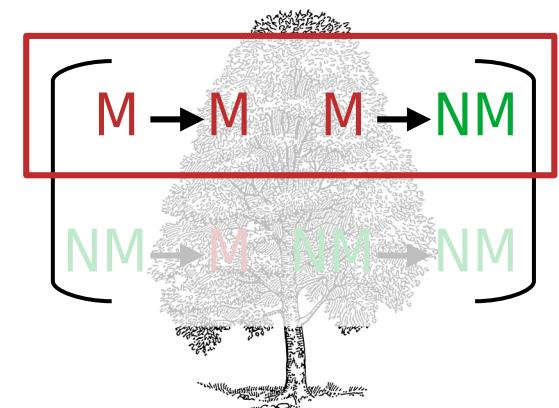
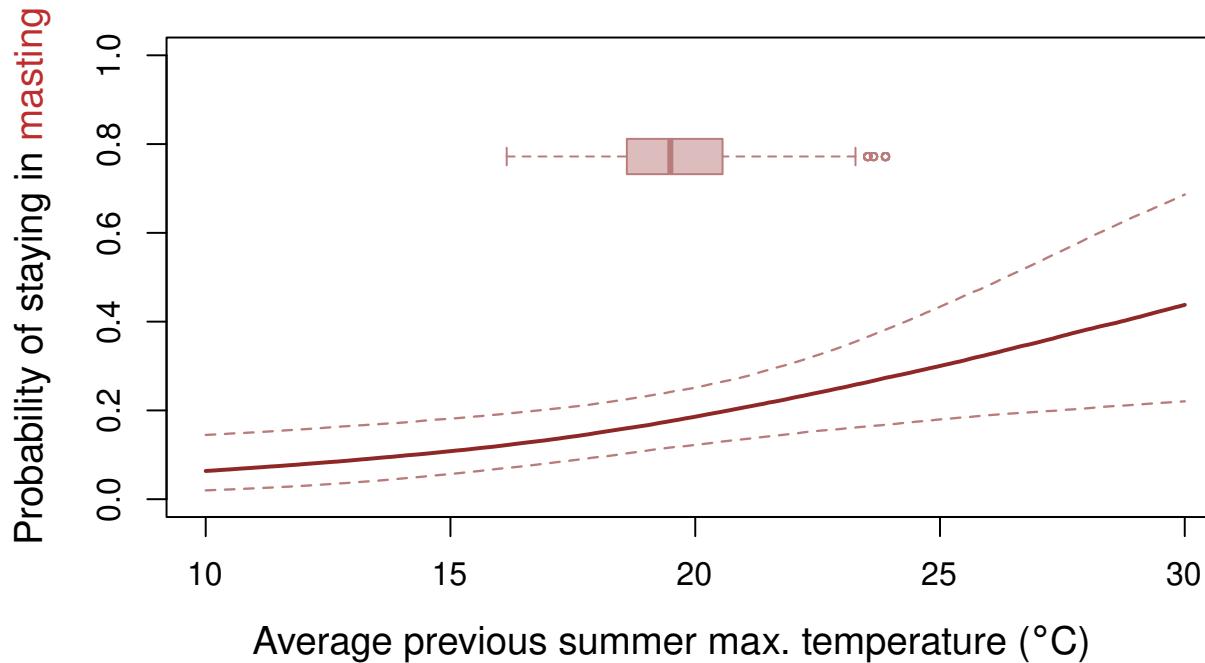


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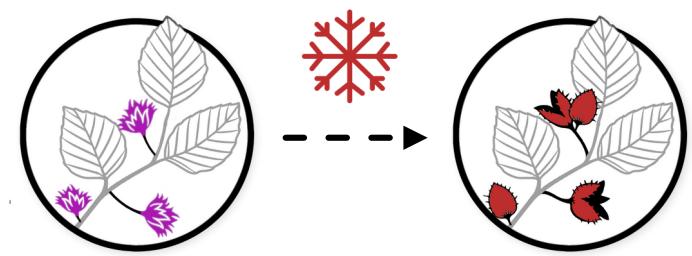
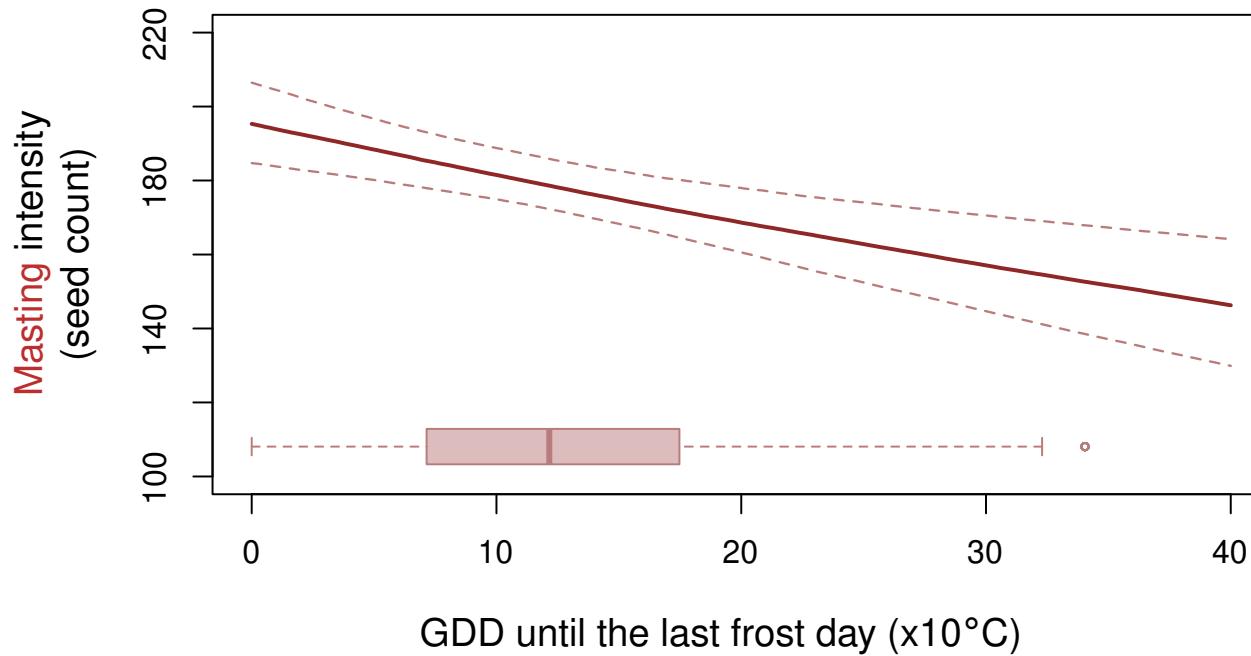


More chance to mast with warm summer... to some extent



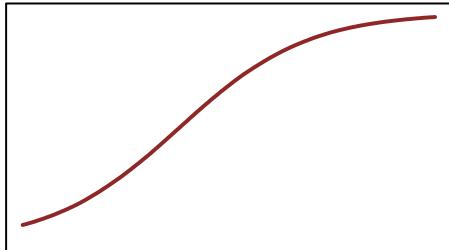


Late spring frosts decrease seed production in masting years





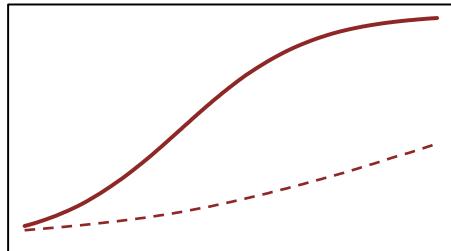
Implications in a warming world



Warm summers increase the probability of transition from
non-masting to **masting**



Implications in a warming world

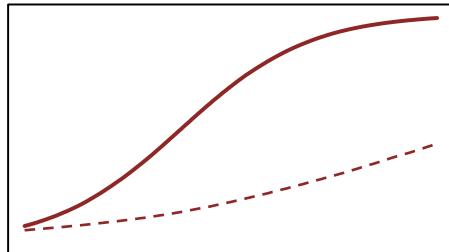


Warm summers increase the probability of transition from **non-masting** to **masting**

But limited impact on the probability of **staying in a masting state**

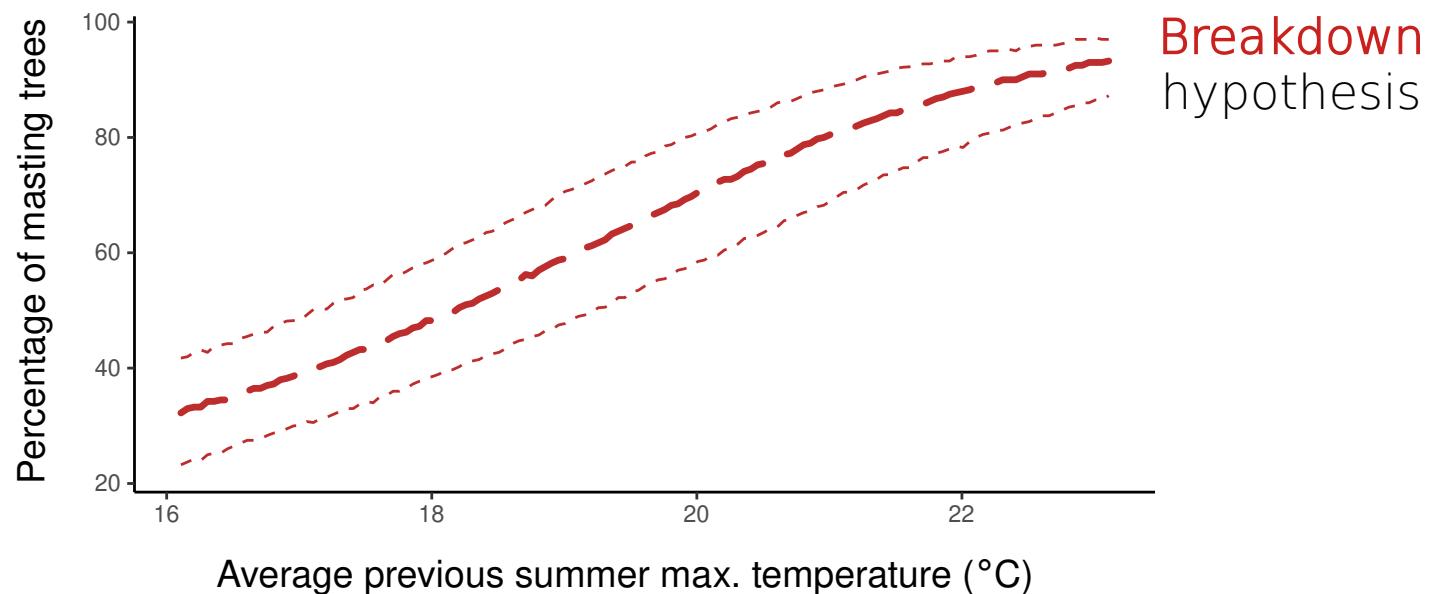


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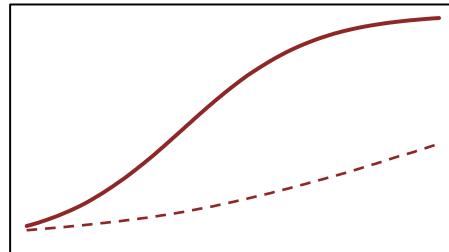
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Breakdown
hypothesis

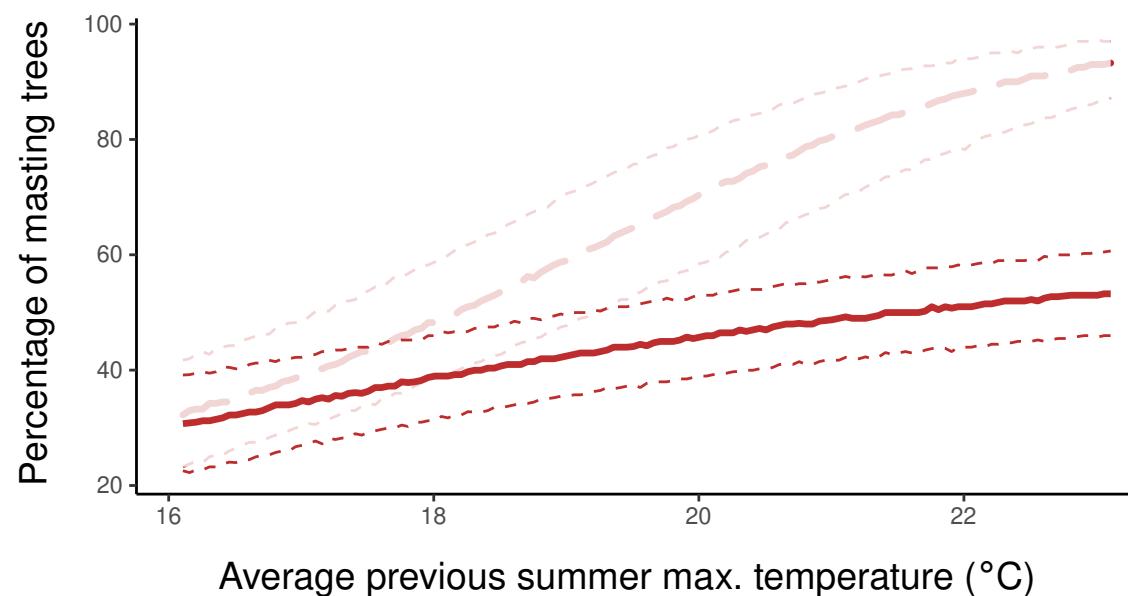


Implications in a warming world



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Breakdown
hypothesis

What this
model says



What's next?



Population **synchrony**:
primarily driven by 'bad' years?

Model **trade-off** with growth with
explicit reproductive states



Adaptive value: how taking into
account species biology could help
redefine evolutionary theories?

