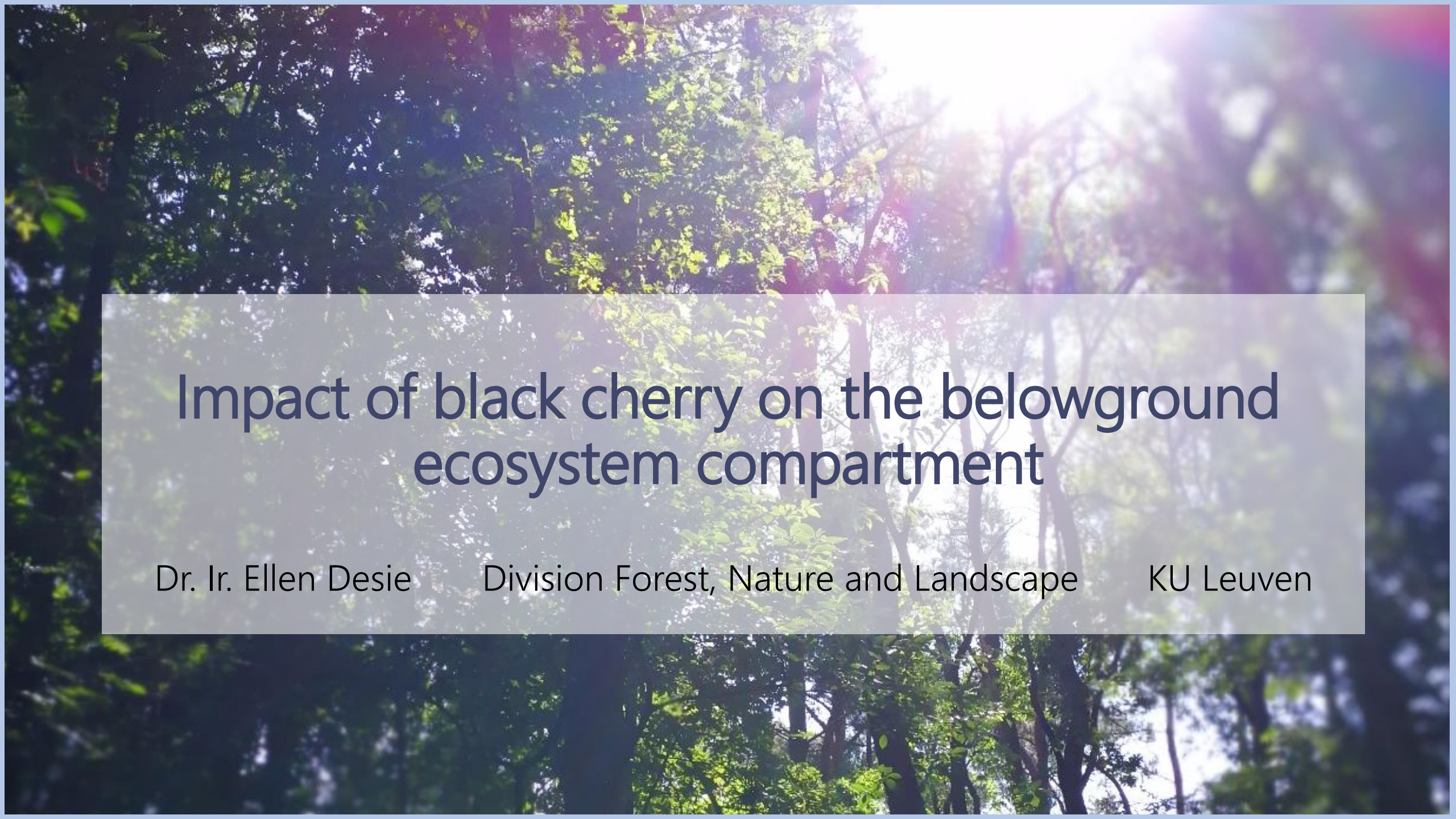

Impact of black cherry on the belowground ecosystem compartment

Dr. Ir. Ellen Desie Division Forest, Nature and Landscape KU Leuven


Why?

With the technical support of

UNECE

With the technical support of

Food and Agriculture Organization of the United Nations

State of Europe's Forests 2020

With the technical support of

UNECE

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Food and Agriculture Organization of the United Nations

Forest Ecosystem Health and Vitality

Deposition of air pollution has been continuously decreasing since 1997

Despite an overall decrease in deposition of air pollution, forests in Europe are still exposed to excessive levels of nitrogen deposition and tropospheric ozone.

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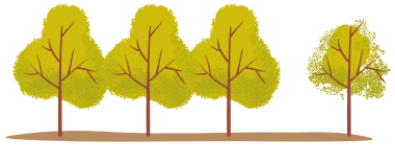
Defoliation is increasing

Although defoliation of trees at 72% of monitoring plots remained stable, foliage loss increased at 19% of plots in the period 2010-2018. Overall, the condition of European forests is apparently deteriorating, with increasing mean defoliation of the main tree species.



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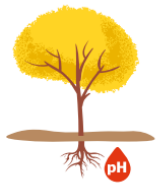

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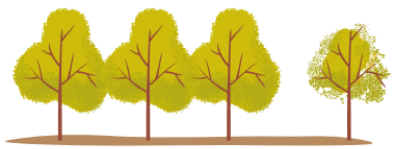


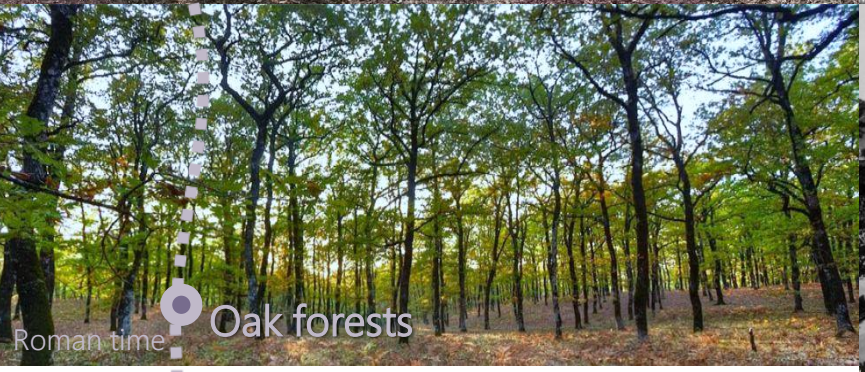
About 3% of European forests are damaged, mainly by wind, insects, ungulate browsing, and forest fires

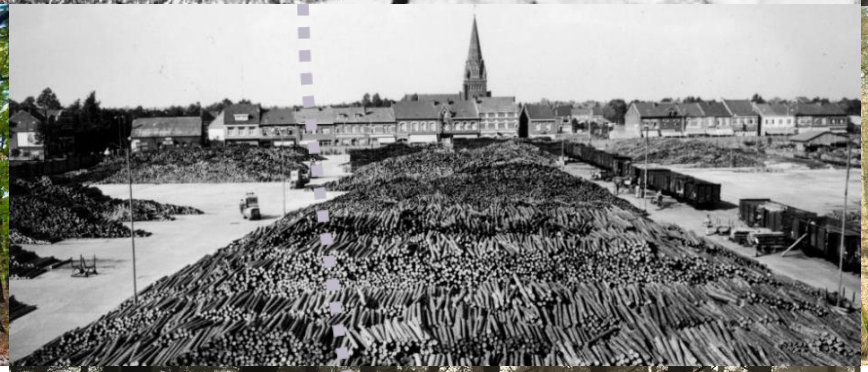
There is a clear regional pattern in specific disturbances: fires occur mostly in the Mediterranean region, and windstorms and heavy snowfalls in central and north-western regions. Ungulate browsing is a European-wide disturbance. Damage by insects fluctuates, while damage by wind and snow has increased. However, an apparent shift in disturbances has been observed recently, suggesting extreme droughts and heat waves, more extensive bark beetle outbreaks, and a wider occurrence of forest fires.

Related policy responses focus mainly on prevention of forest fires, ungulate browsing, and insect outbreaks

Reported measures address the prevention and control of hazards, crisis management, as well as a reduction of soil degradation. The major challenges and obstacles are the increasing threat of damage caused to forests by harmful organisms and extreme weather events, mass dying of forest tree species, and the unclear adaptive potential of tree species.

Anthropogenic influence over time…





Degraded soil


How to
restore?


Rich litter

high ← **productivity** → low

fast ← **nutrient cycle** → slow

mesotrophic ← **herb layer** → oligotrophic

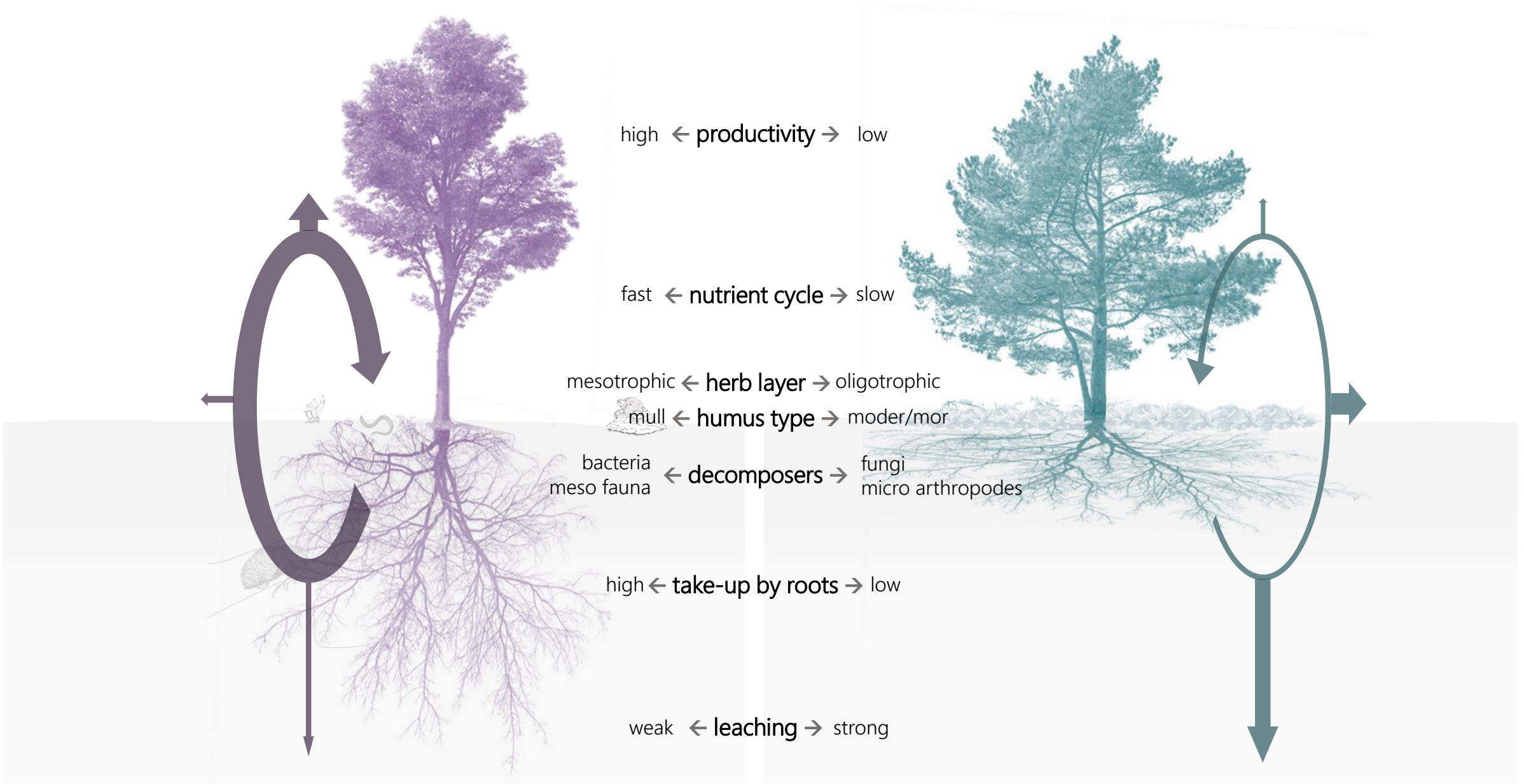
mull ← **humus type** → moder/mor

bacteria
meso fauna ← **decomposers** → fungi
micro arthropodes

high ← **take-up by roots** → low

weak ← **leaching** → strong

Muys and Granval, 1991



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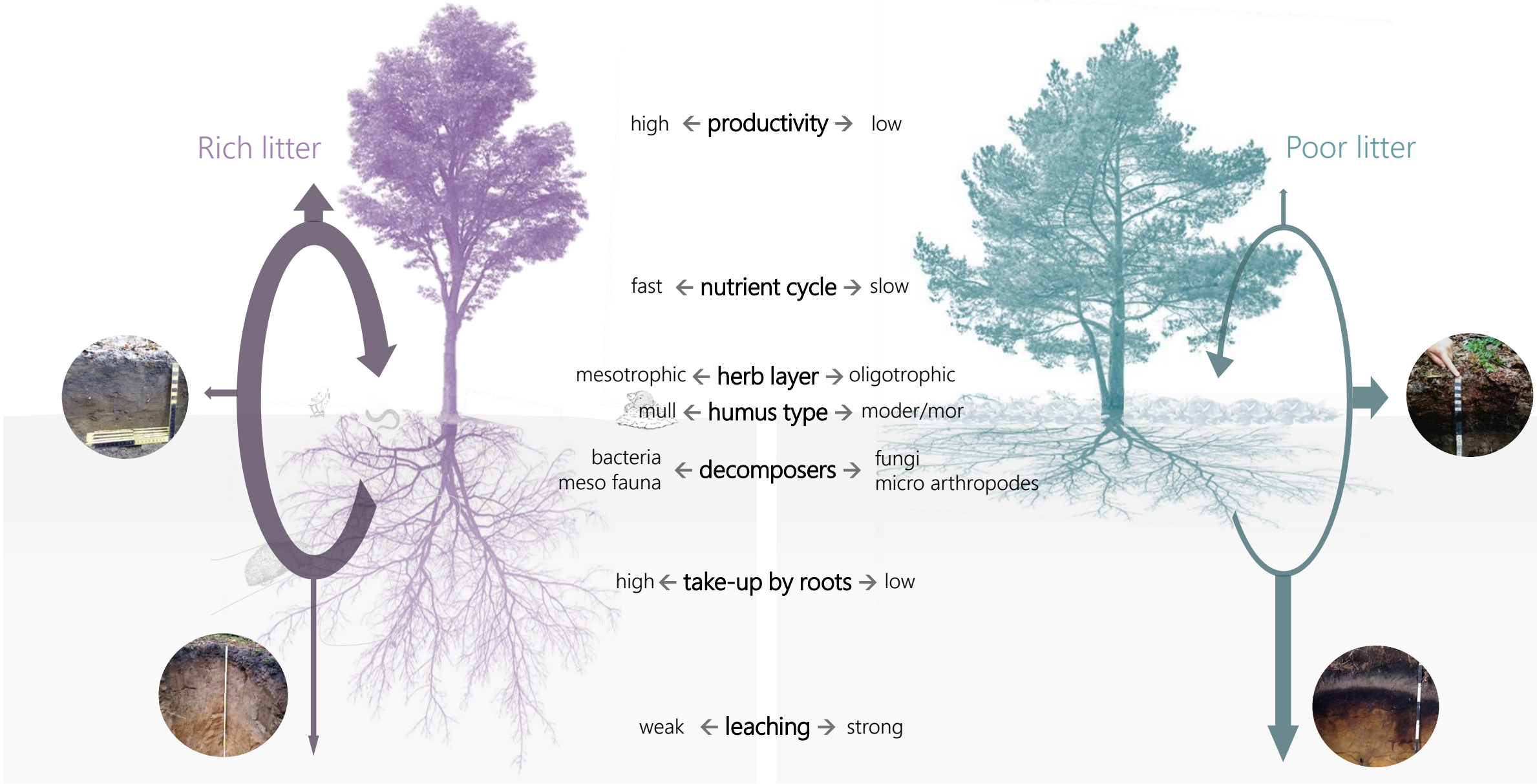


Muys and Granval, 1991

Research hypotheses

1. Rich litter admixture improves soil nutrient status

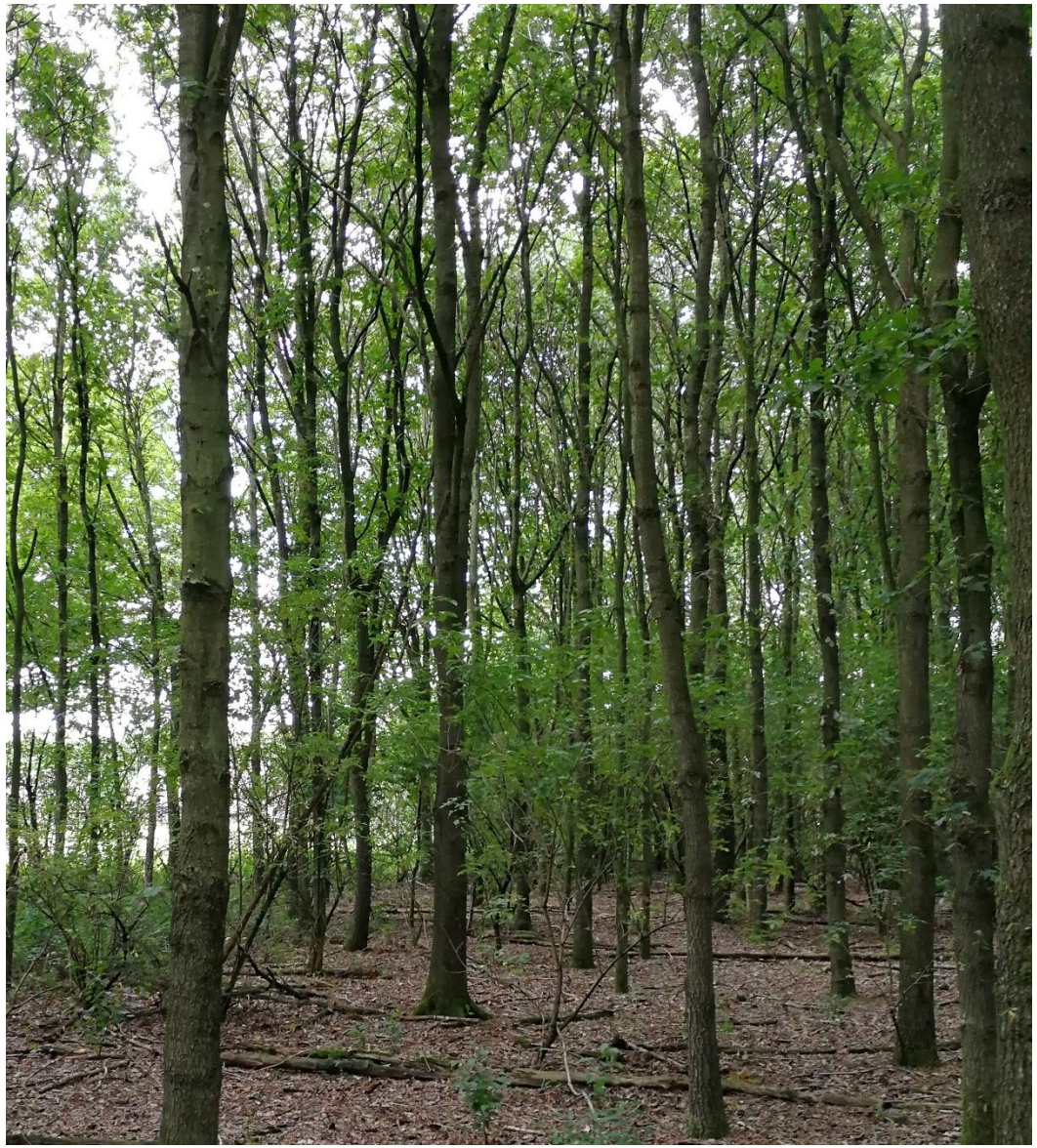
   -> Black cherry is ideal “study” species

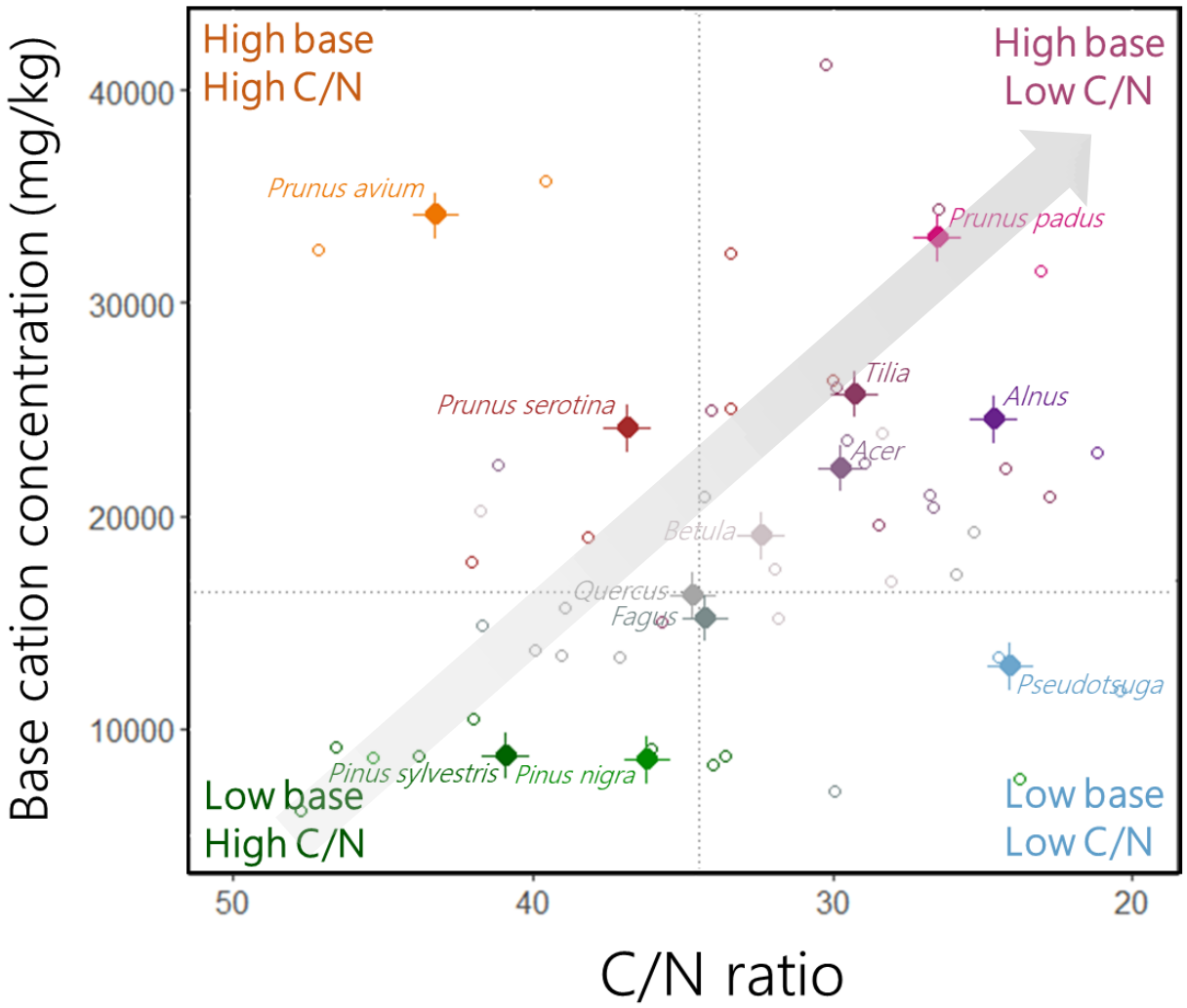
2. Forest vitality will improve as a consequence

   -> Pedunculate oak is interesting “study species”

Monocultures

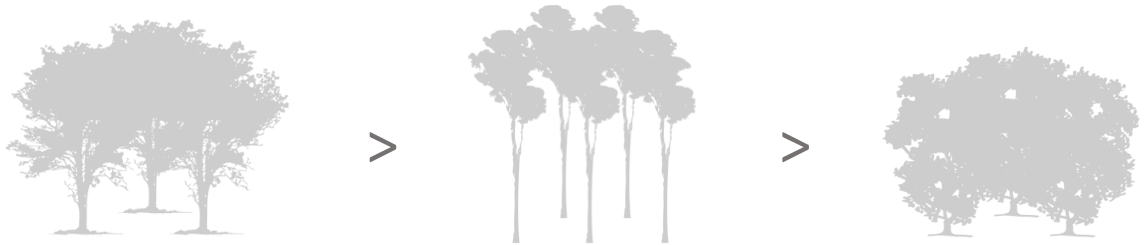
Monocultures





Desie et al., 2020. STOTEN

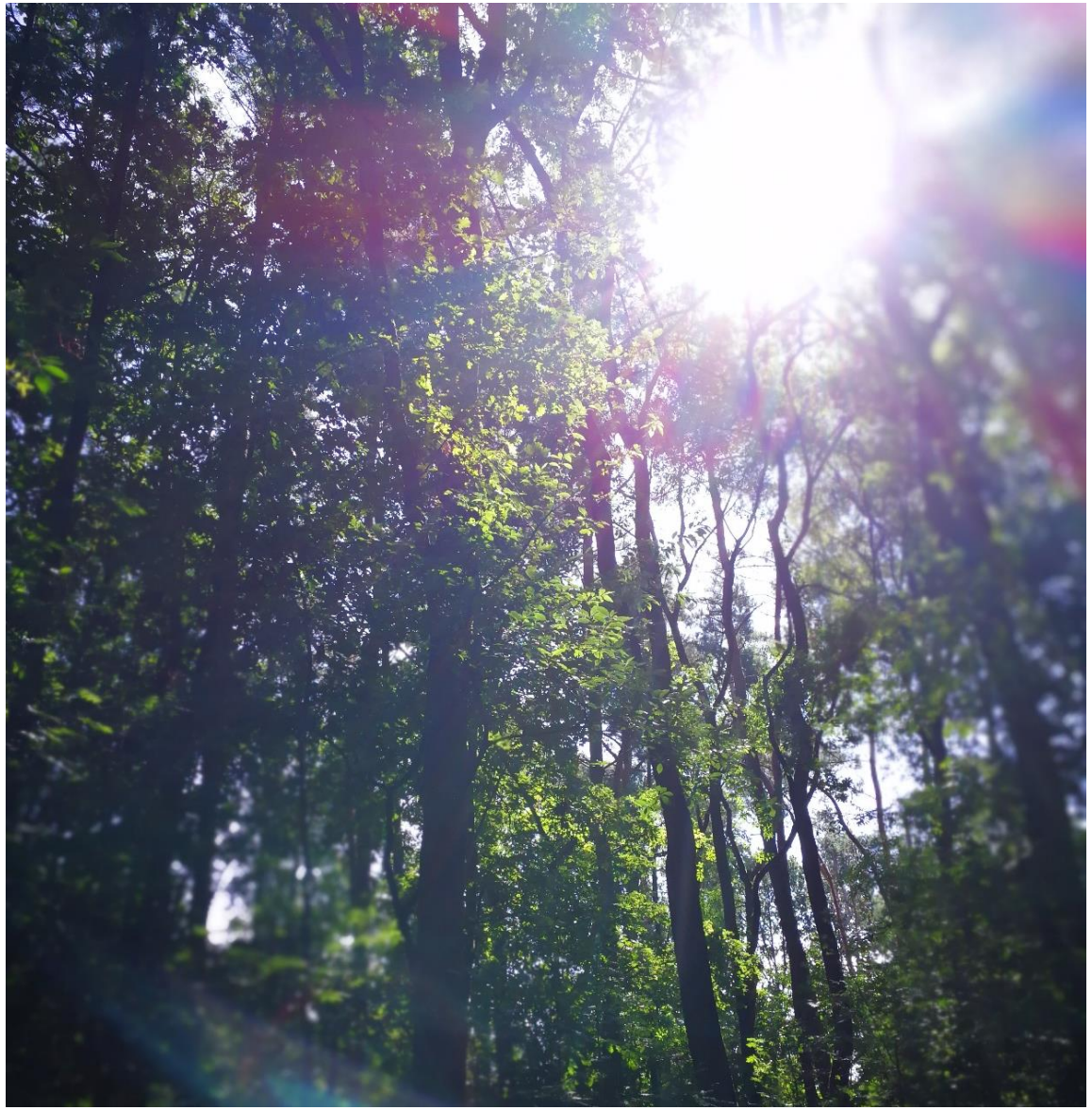
Monocultures



Desie et al., 2020. STOTEN

Monocultures

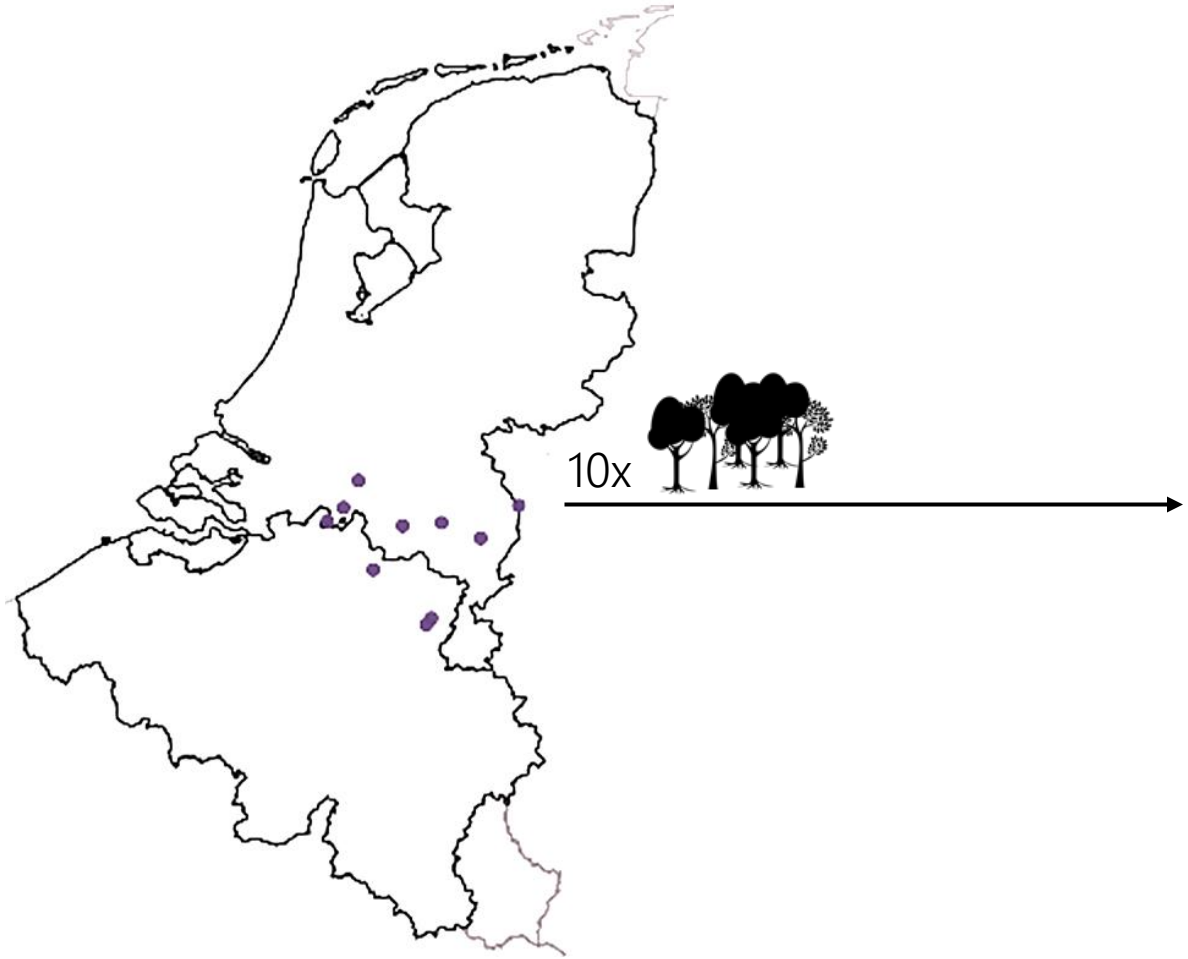
Black cherry & Pedunculate oak

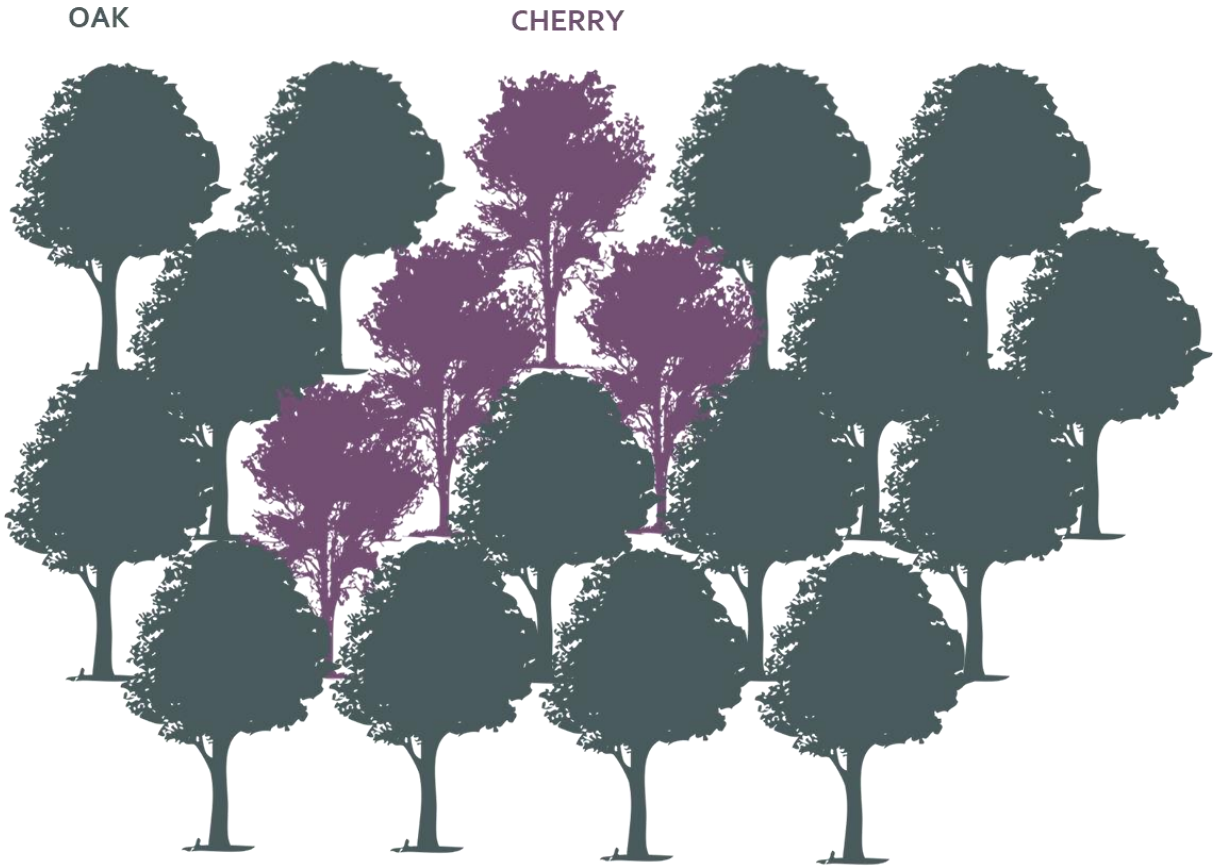


Research questions

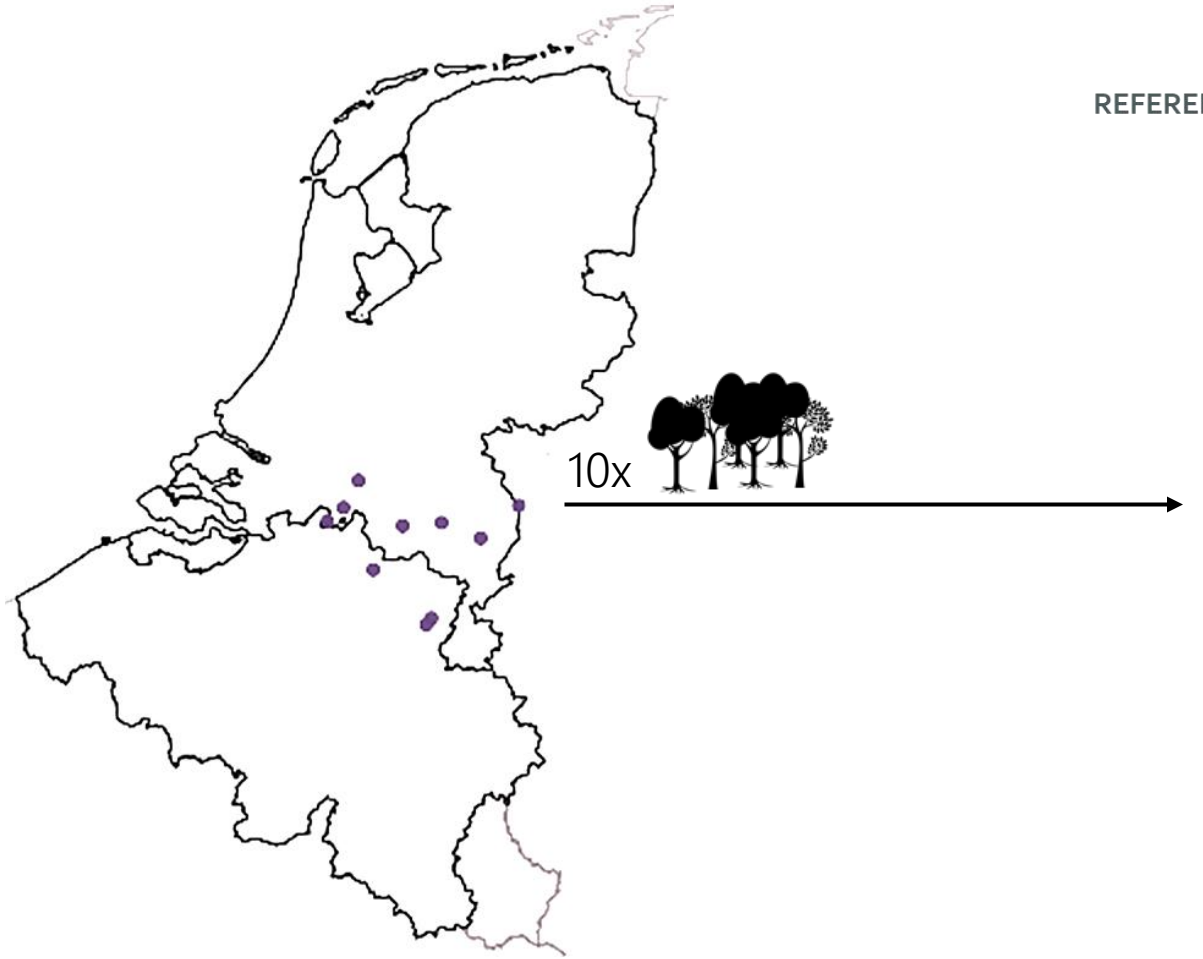
- Does black cherry improve soil quality in a mixed forest stand?
- How much admixture of black cherry is needed to improve soil quality?
- Does the impact depend on soil type?

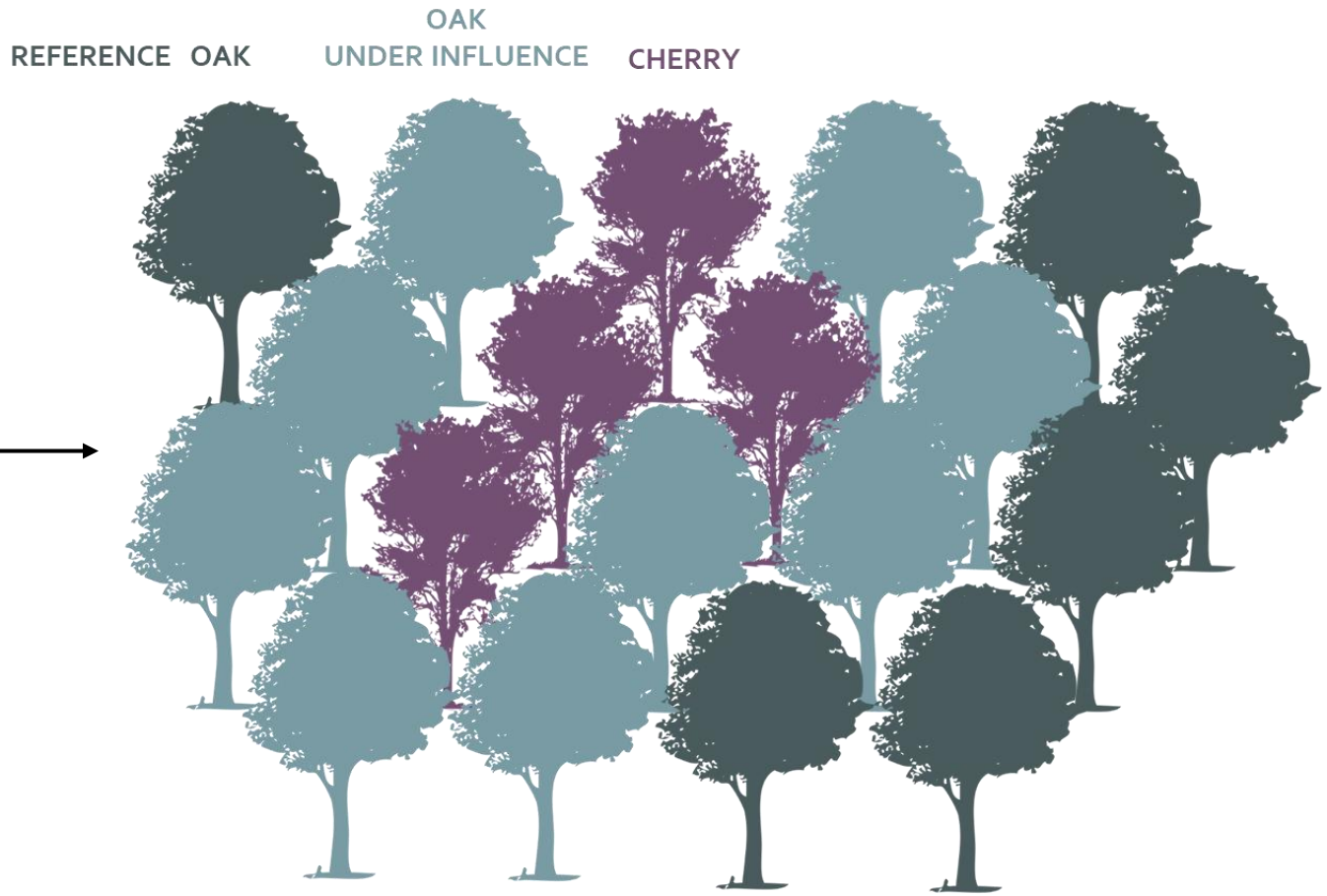
Methodology





Methodology





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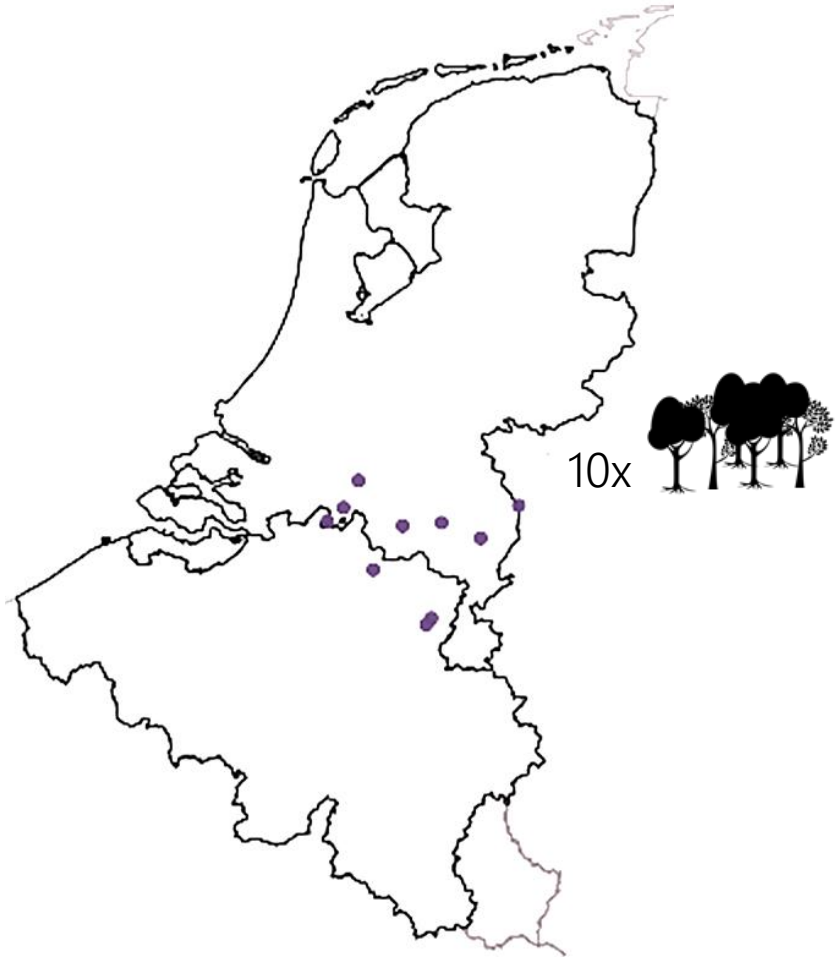

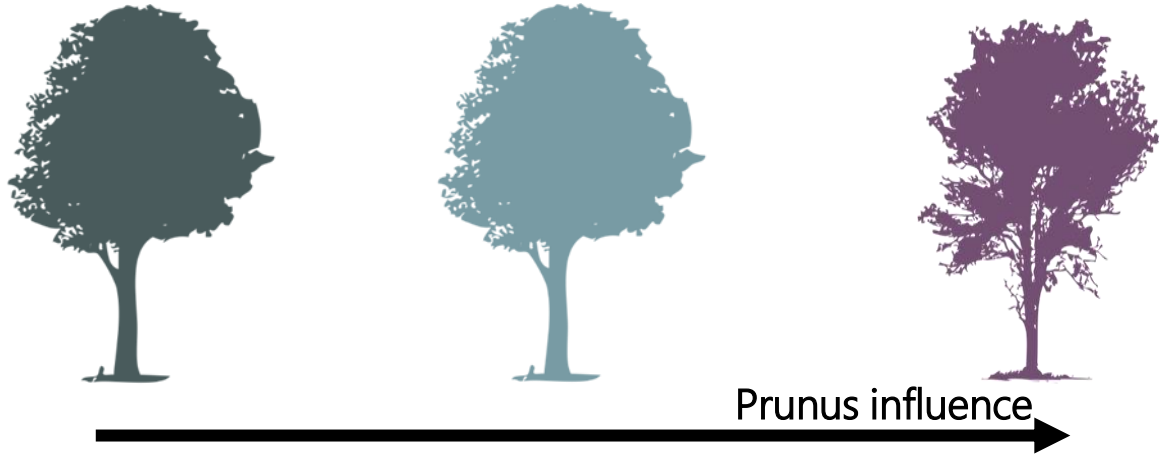

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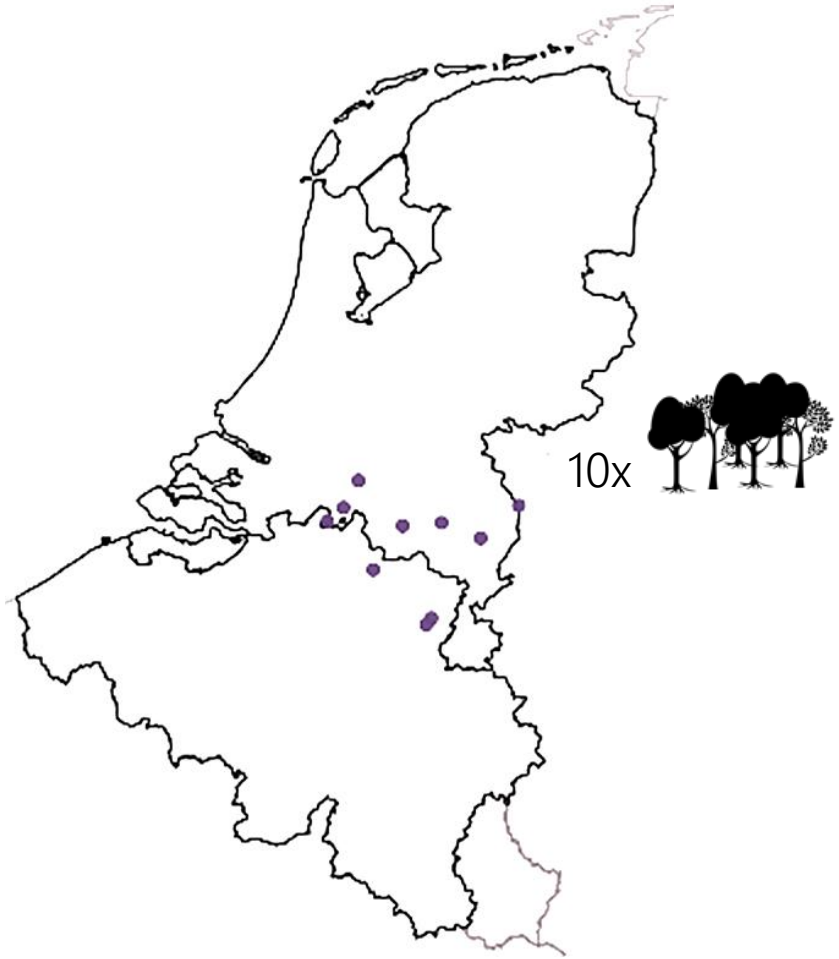
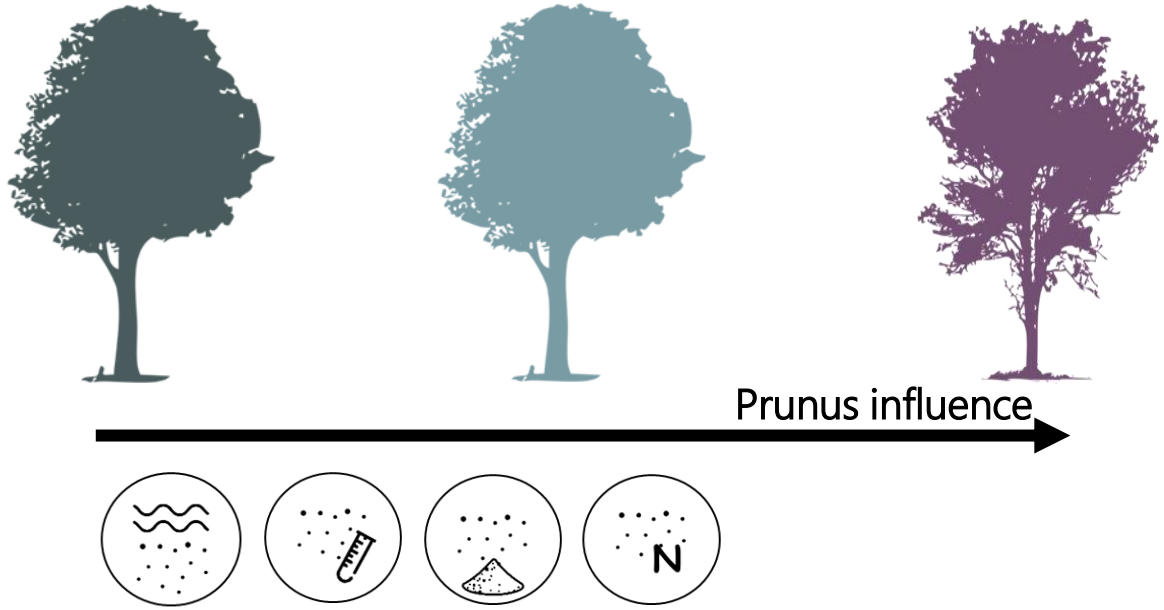
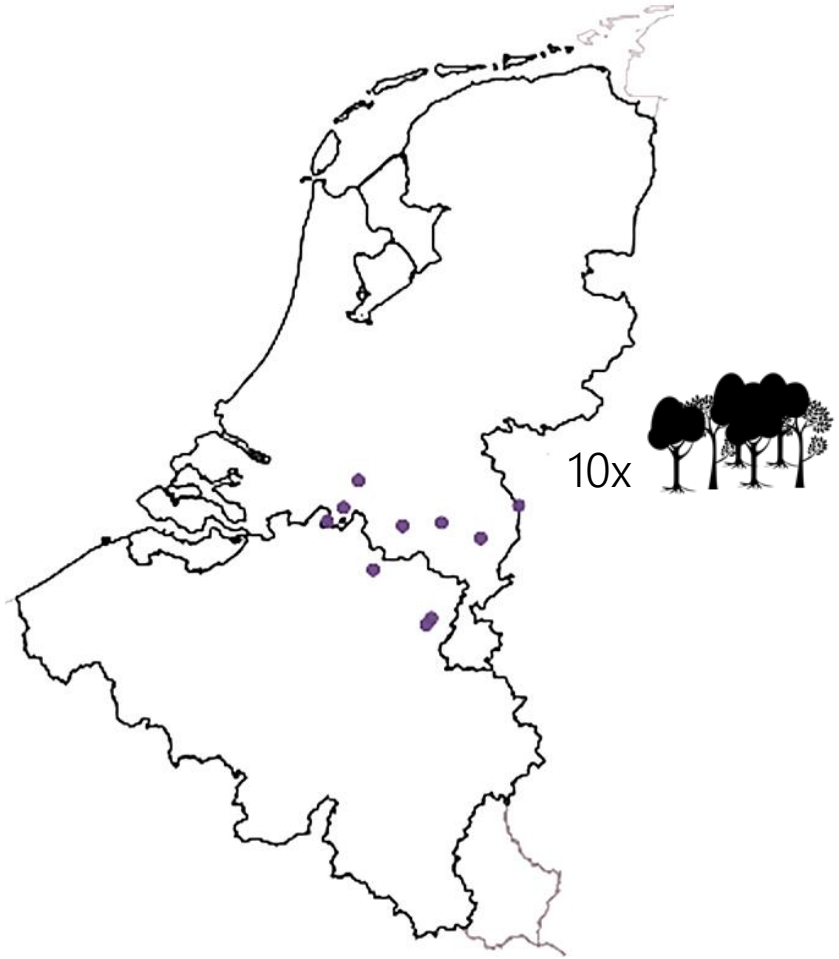
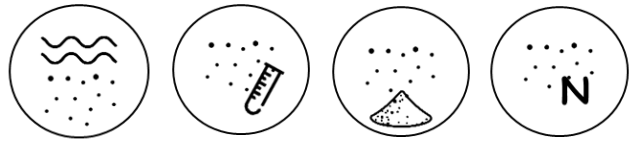




July 2017: forest floor + soil parameters

Methodology





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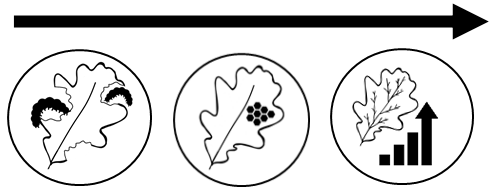


April 2018: oak leaf defoliation and chlorophyl content

July 2019: oak leaf nutrient content

Methodology











KU LEUVEN

Bosgroep Zuid Nederland

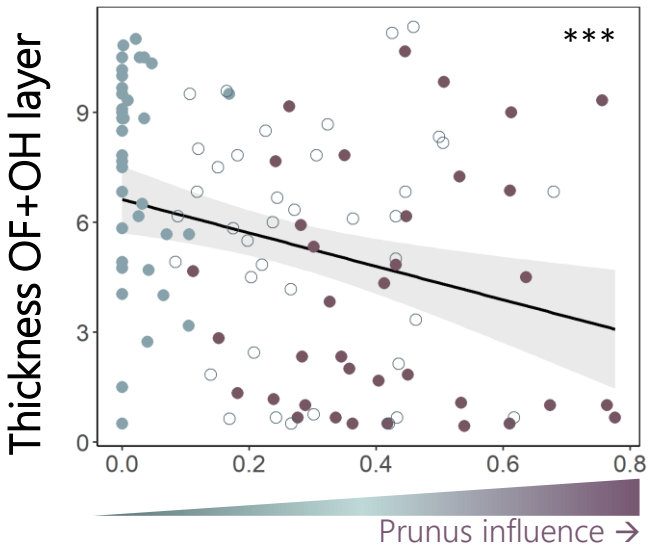
Results belowground

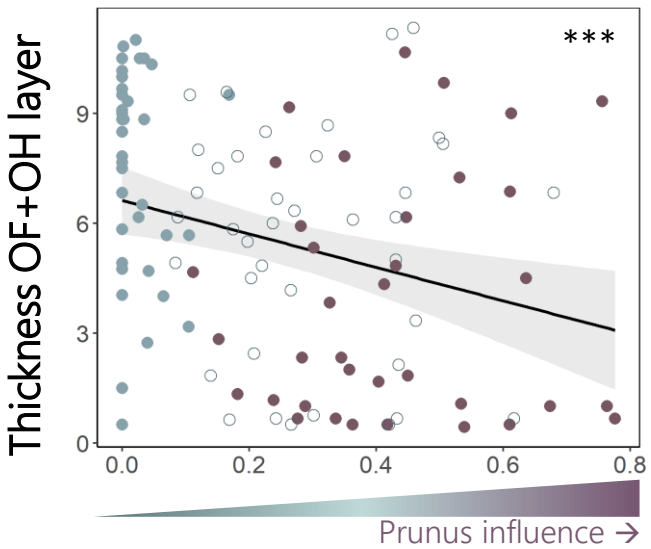
Hypothesis 1: Rich litter admixture improves soil nutrient status

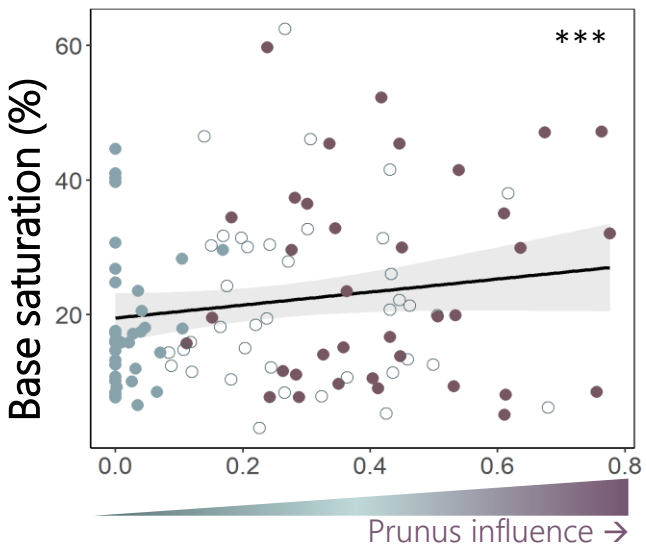
Prunus influence →

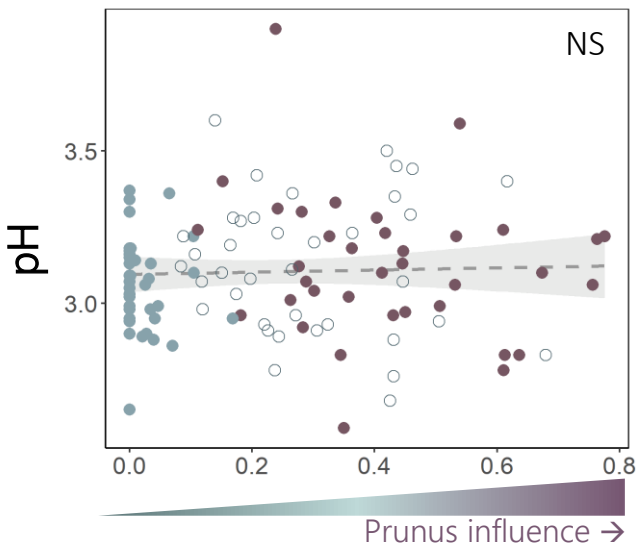


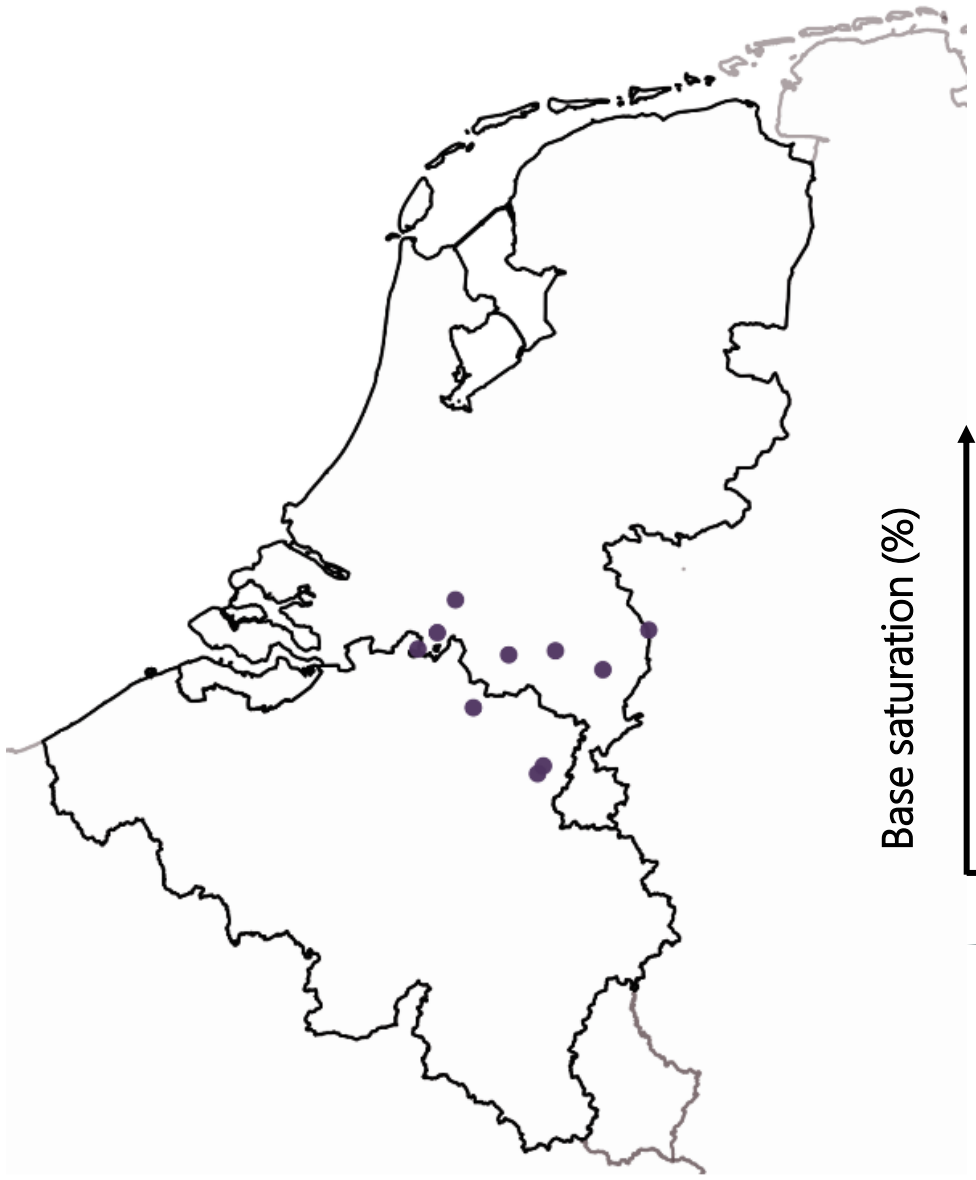


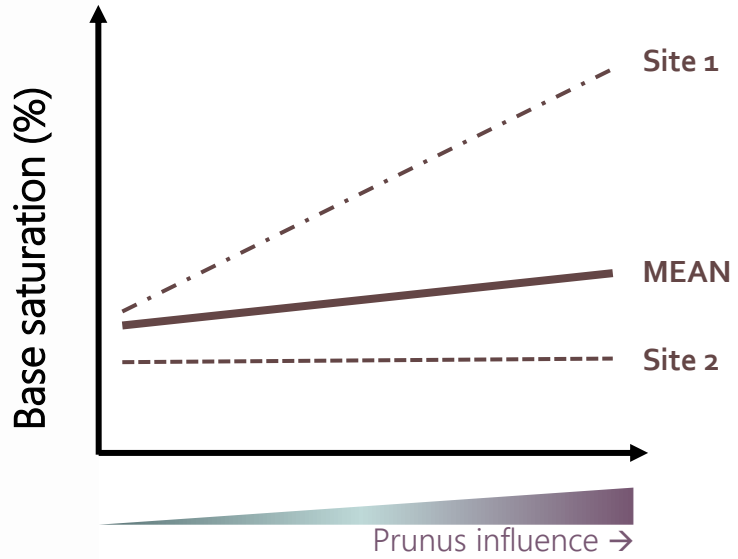


Thickness OF+OH layer
***
9
6
3
0
0.0
0.2
0.4
0.6
0.8
Prunus influence →

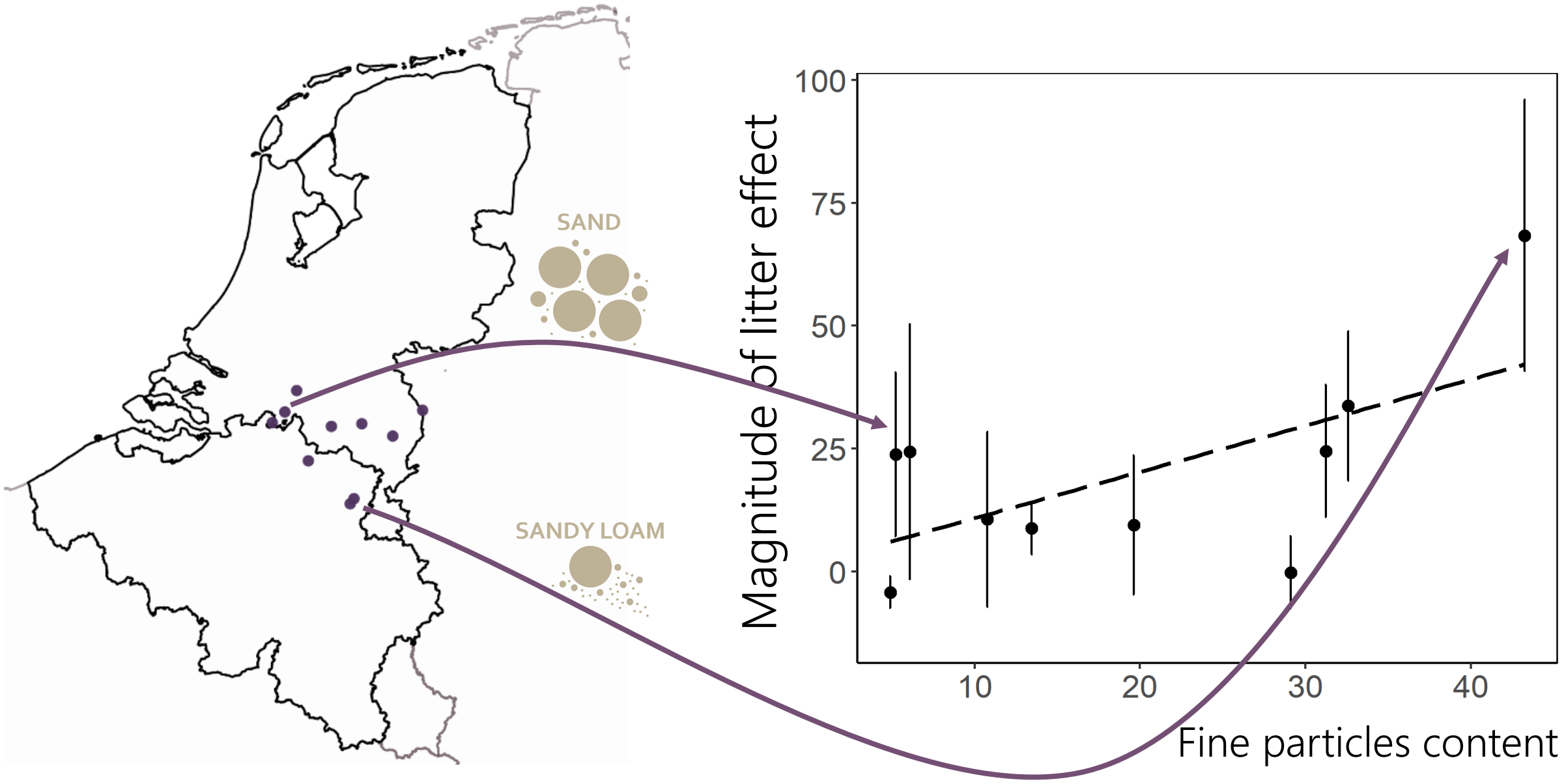

Thickness OF+OH layer
***
0
3
6
9
0.0
0.2
0.4
0.6
0.8
Prunus influence →


Base saturation (%)
***
20
40
60
0.0
0.2
0.4
0.6
0.8
Prunus influence →


pH
NS
3.0
3.5
0.0
0.2
0.4
0.6
0.8
Prunus influence →

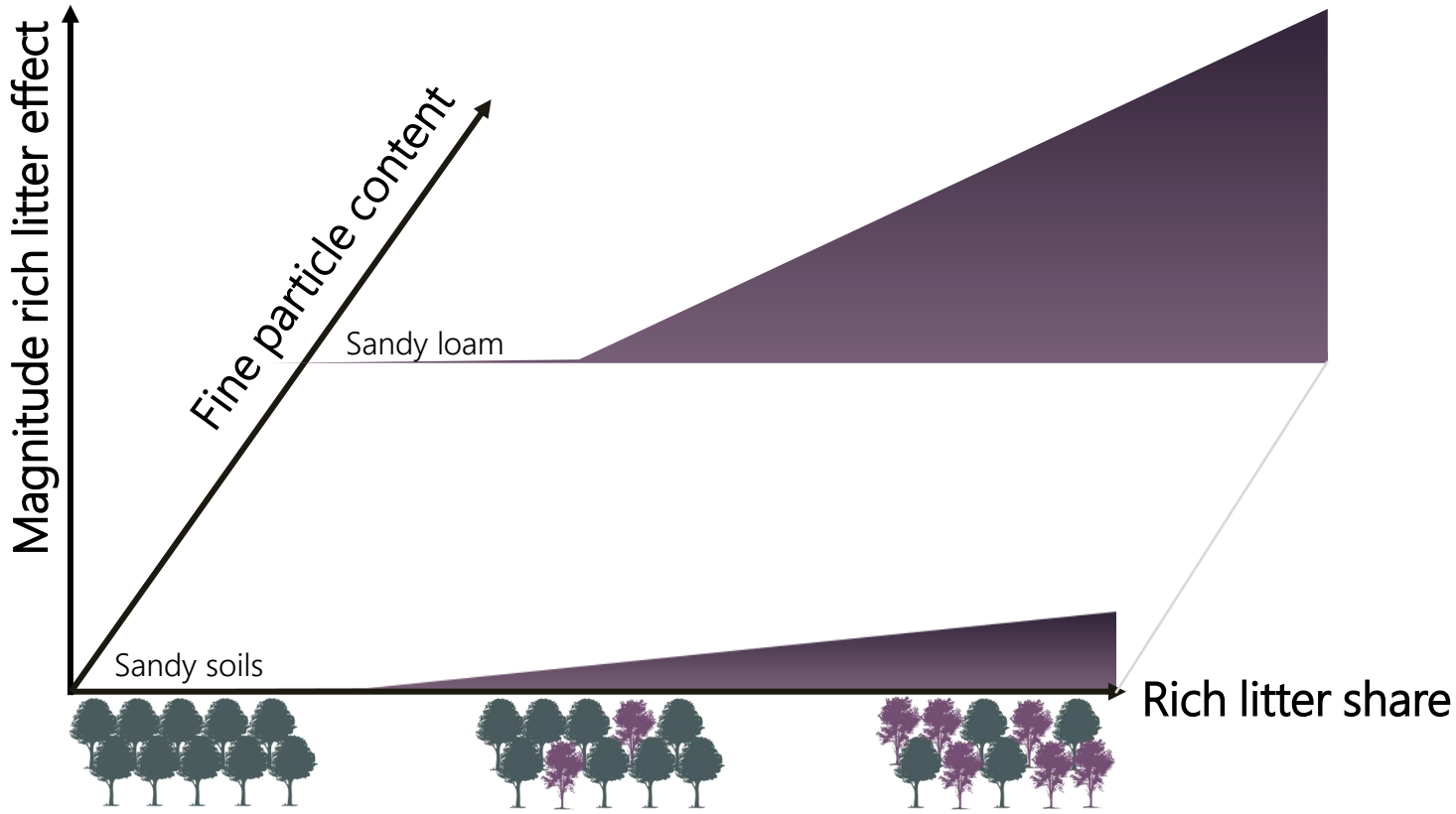



Base saturation (%)
Site 1
MEAN
Site 2
Prunus influence →


SAND
SANDY LOAM
Magnitude of litter effect
100
75
50
25
0
10
20
30
40
Fine particles content

Conclusions: belowground

- Black cherry still has a significant soil improving effect in mixtures
- Large shares of admixture needed
- The magnitude of the effect depends on soil texture



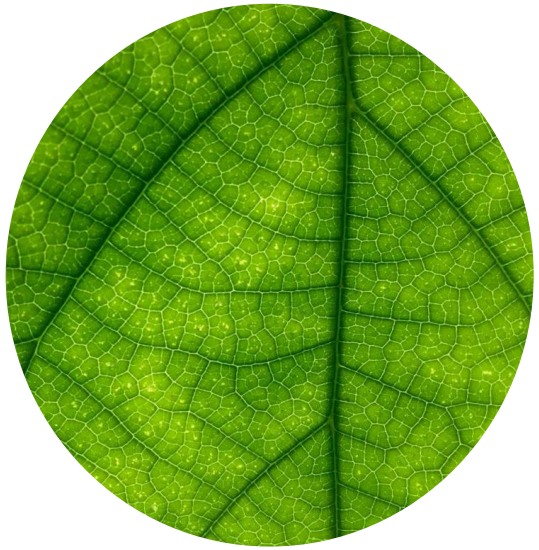
Aboveground ecosystem

Hypothesis 2: Forest vitality will improve as a consequence

Vitality oak

Nutrient content

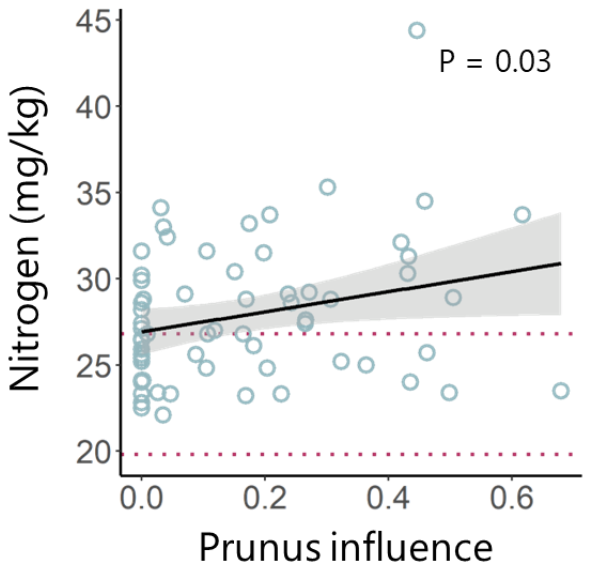
Chlorophyl

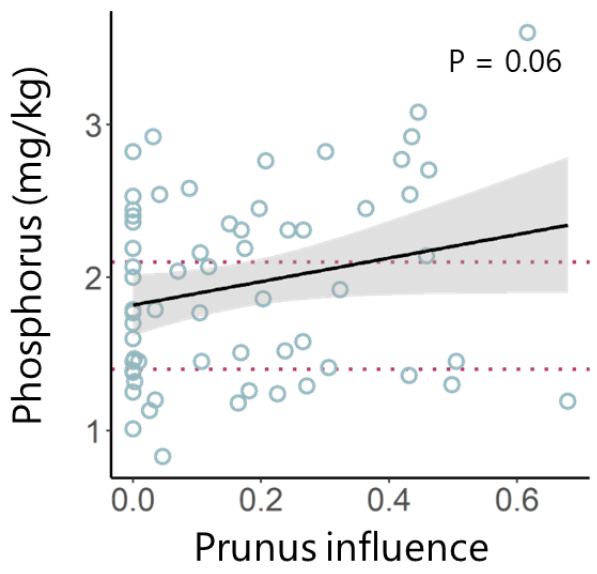


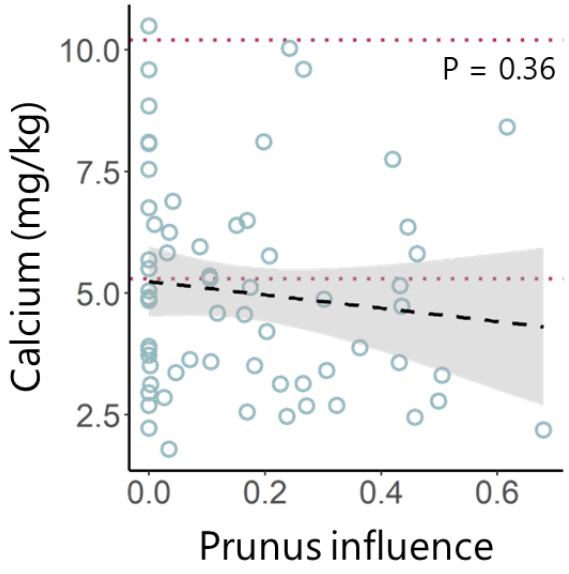
Defoliation

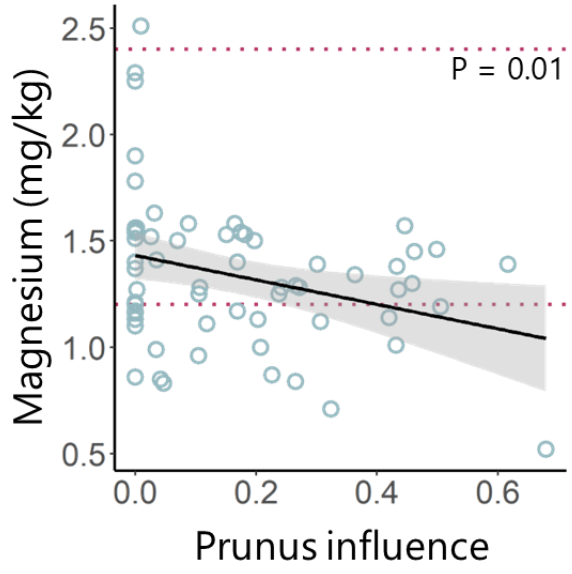
Nutrient content

Vitality oak





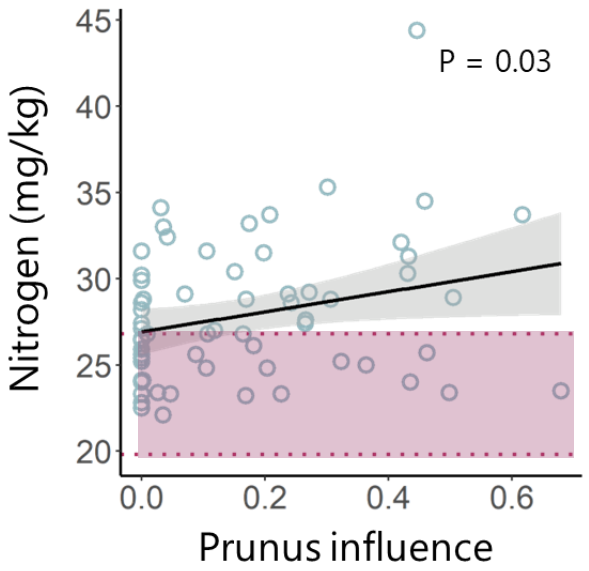


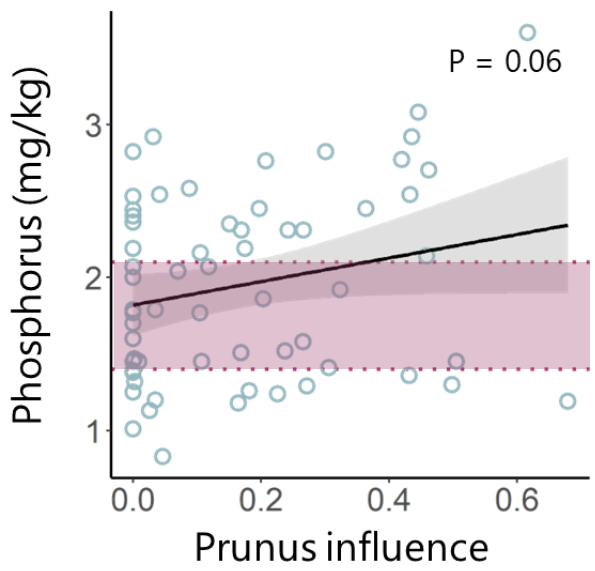


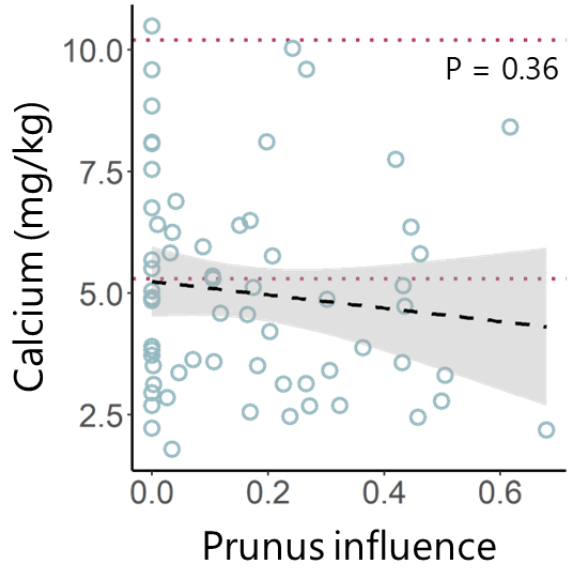
Nutrient content

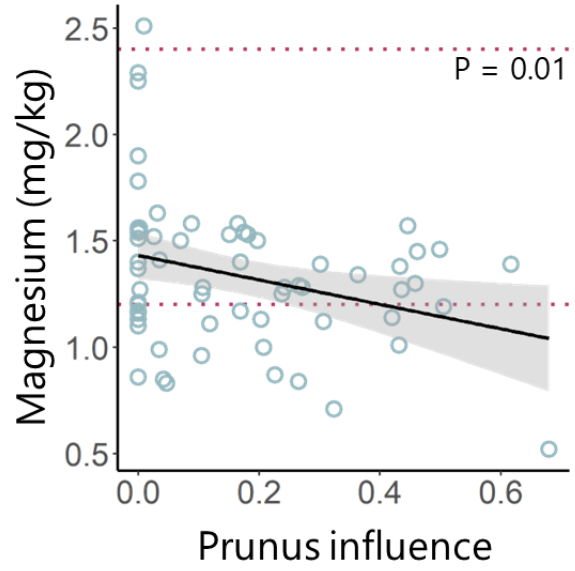
Vitality oak

Critical ranges according to Mellert and Göttlein (2011)









Nutrient content

Vitality oak

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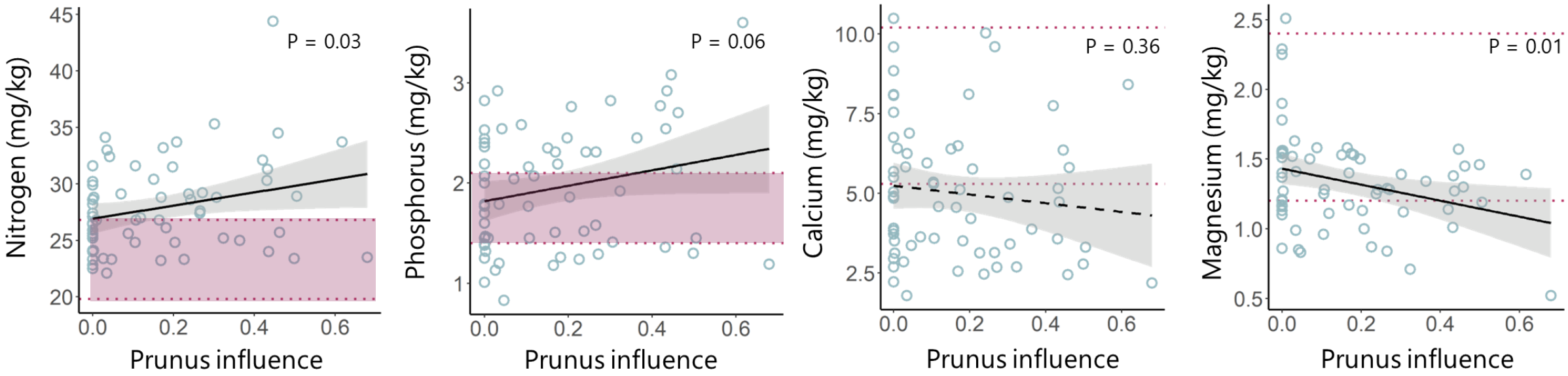
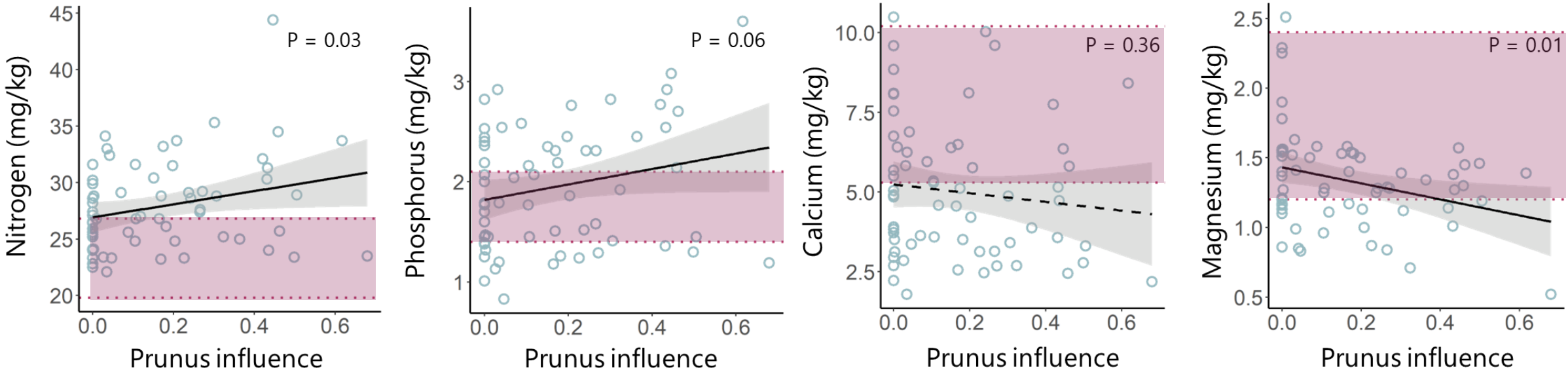


Black cherry improves oak N&P content oak

Nutrient content

Vitality oak

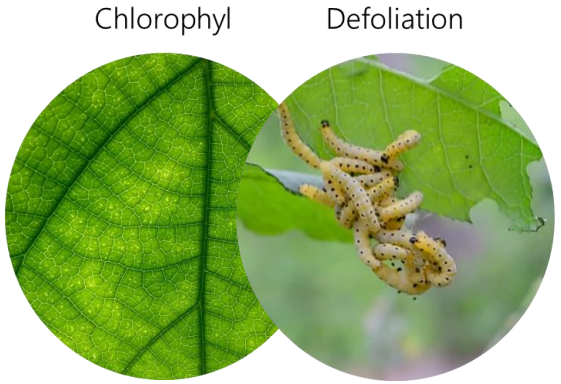
Critical ranges according to Mellert and Göttlein (2011)

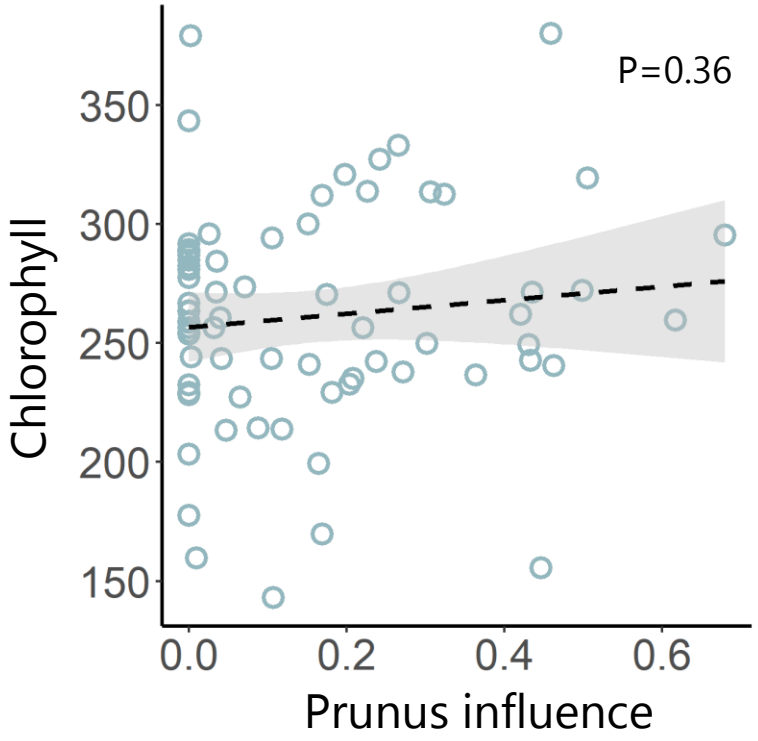


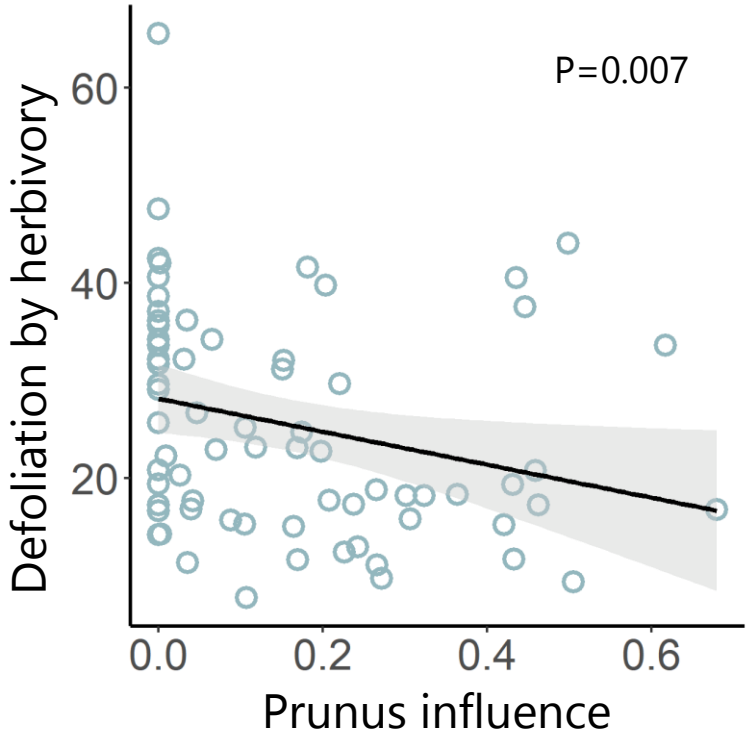
Black cherry improves oak N&P content oak

Black cherry is competitor for Mg

Vitality oak



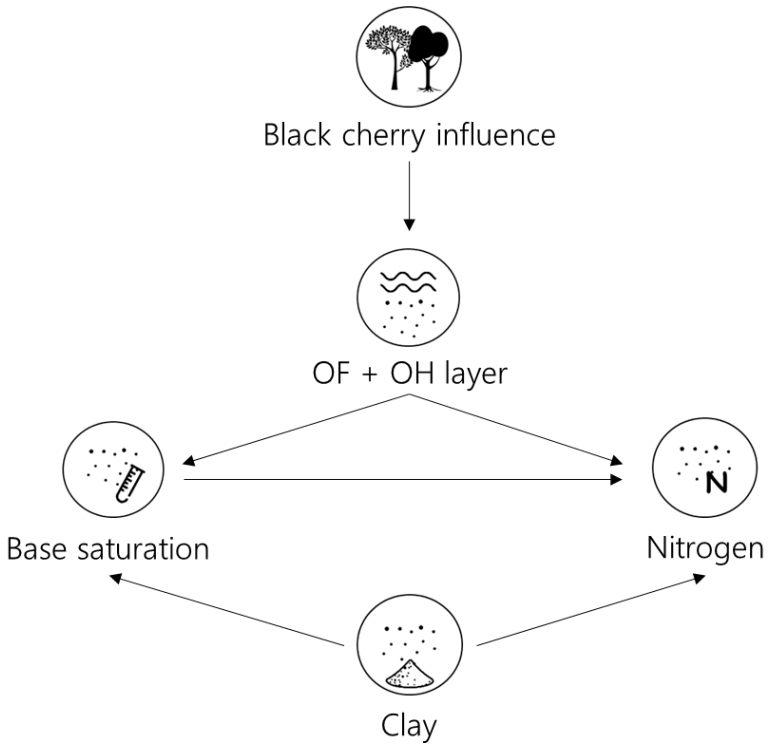




+

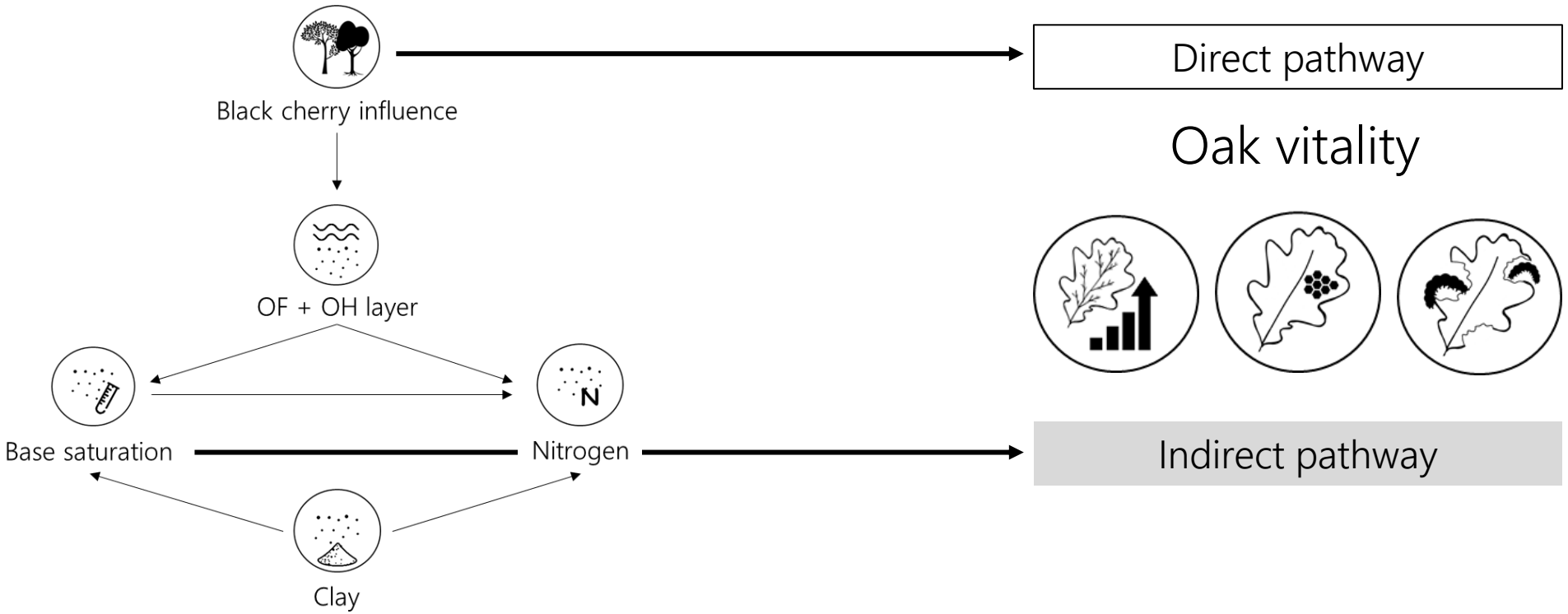
Link belowground – aboveground ecosystem

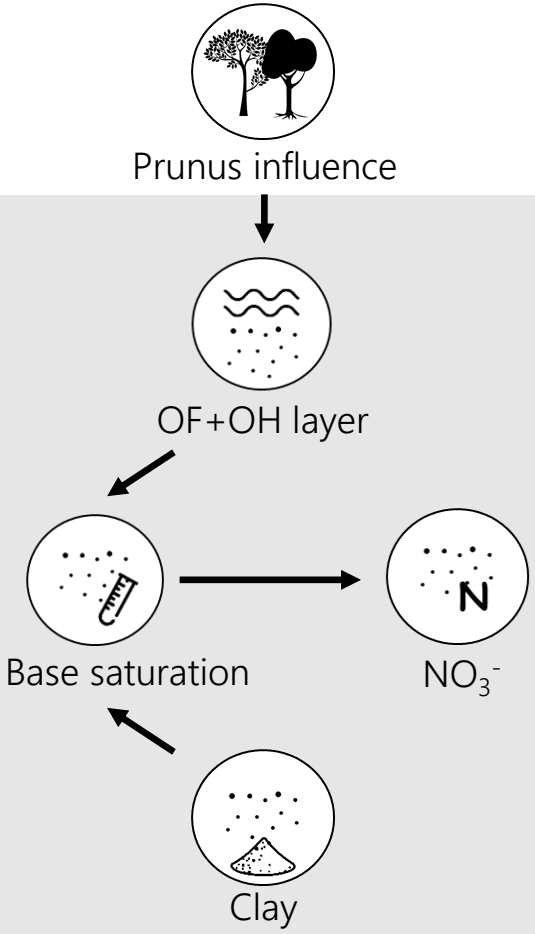
Structural equation model



Oak vitality

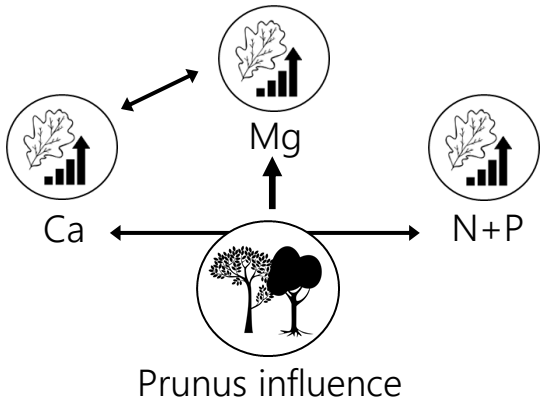
Structural equation model

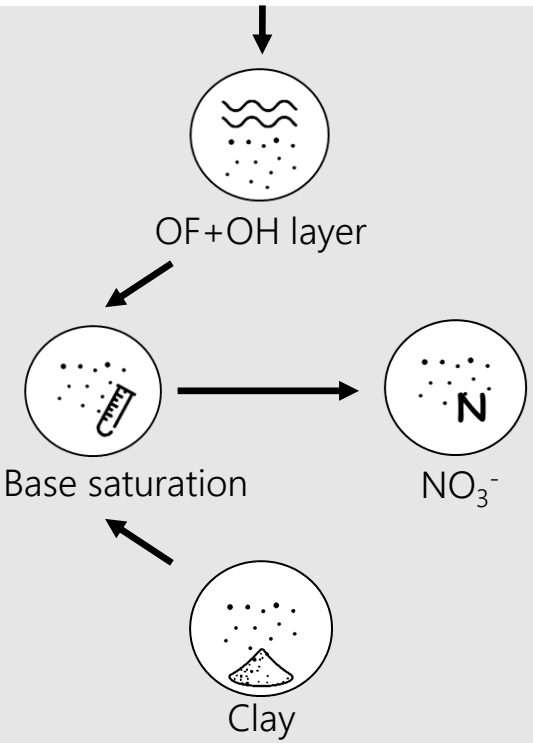



Prunus influence
OF+OH layer
Base saturation
N
NO_3^-
Clay

Direct pathway

a. Nutrient content

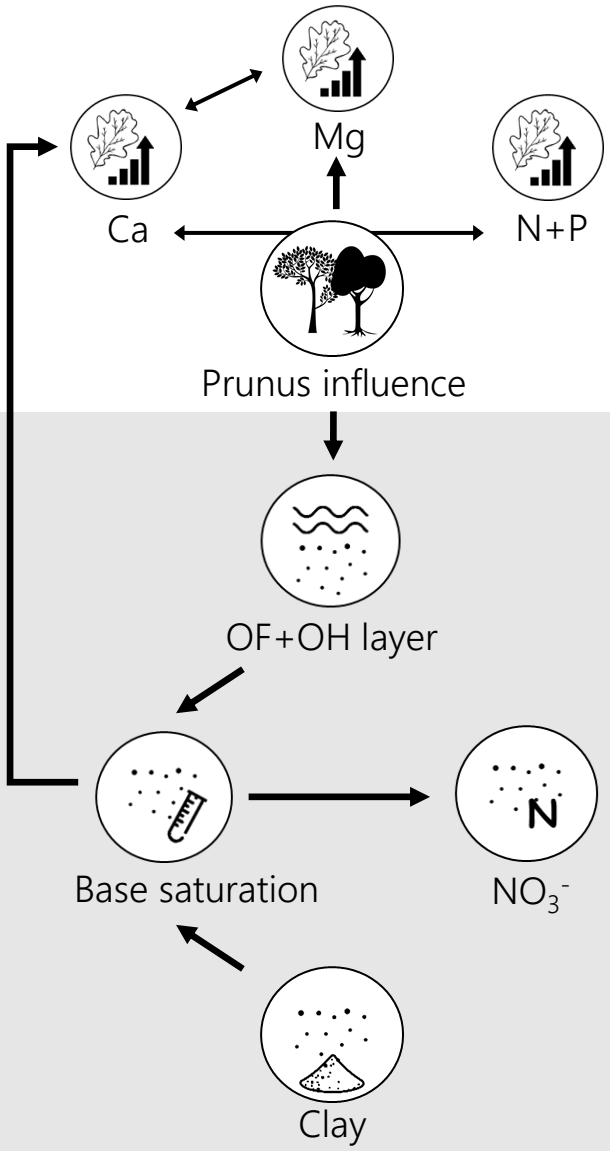




a. Nutrient content

Direct pathway

Indirect pathway



a. Nutrient content

b. Chlorophyll

Direct pathway

Indirect pathway

Mg

Ca

N+P

Prunus influence

OF+OH layer

Base saturation

N

NO_3^-

Clay

Total chlorophyll

Prunus influence

OF+OH layer

Base saturation

N

NO_3^-

Clay

a. Nutrient content

b. Chlorophyll

c. Defoliation

Direct pathway

Indirect pathway

Mg

Ca

N+P

Prunus influence

OF+OH layer

Base saturation

N

NO_3^-

Clay

Total chlorophyll

Prunus influence

OF+OH layer

Base saturation

N

NO_3^-

Clay

Leaf damage by herbivory

Prunus influence

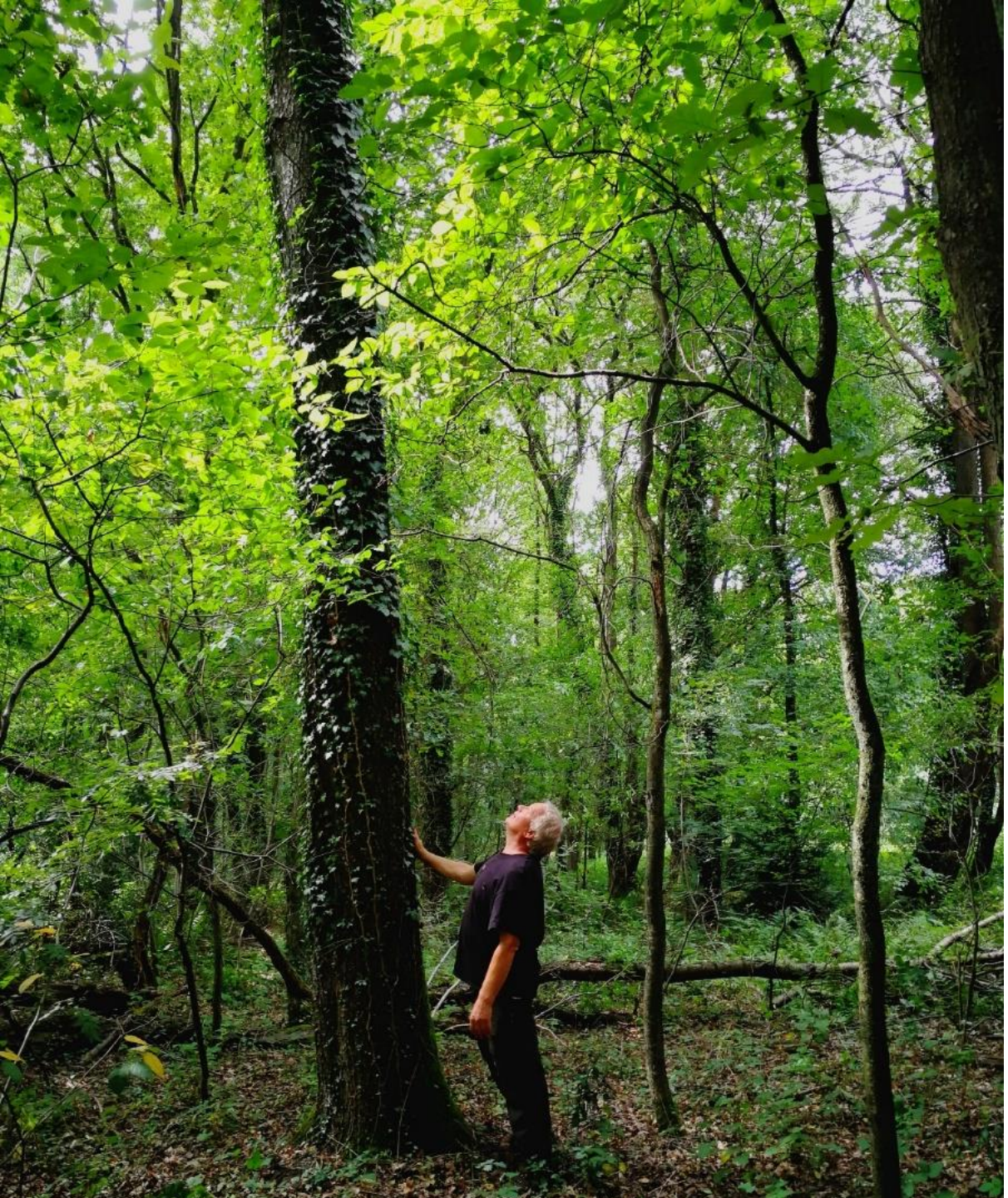
OF+OH layer

Base saturation

N

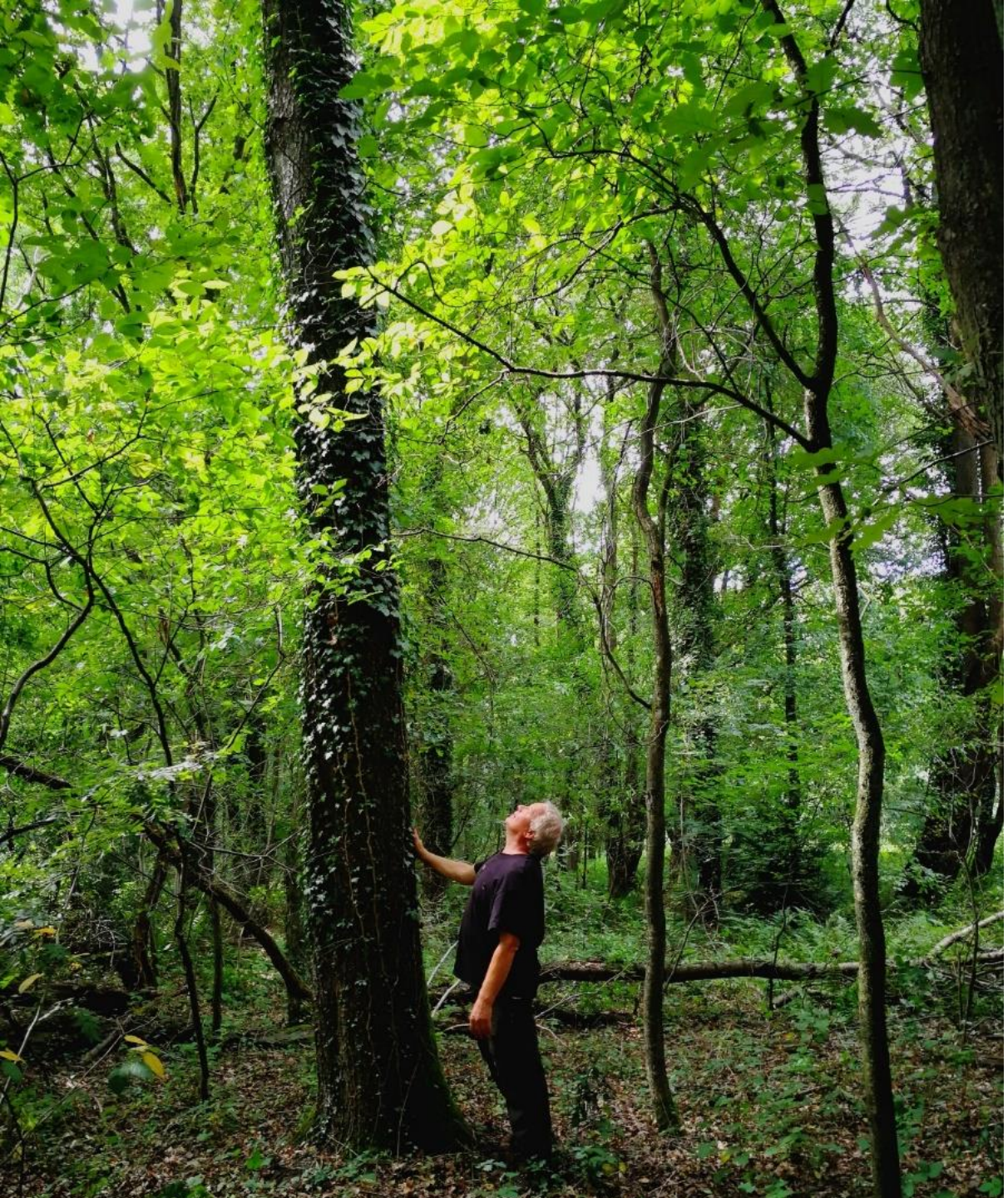
NO_3^-

Clay



Conclusion

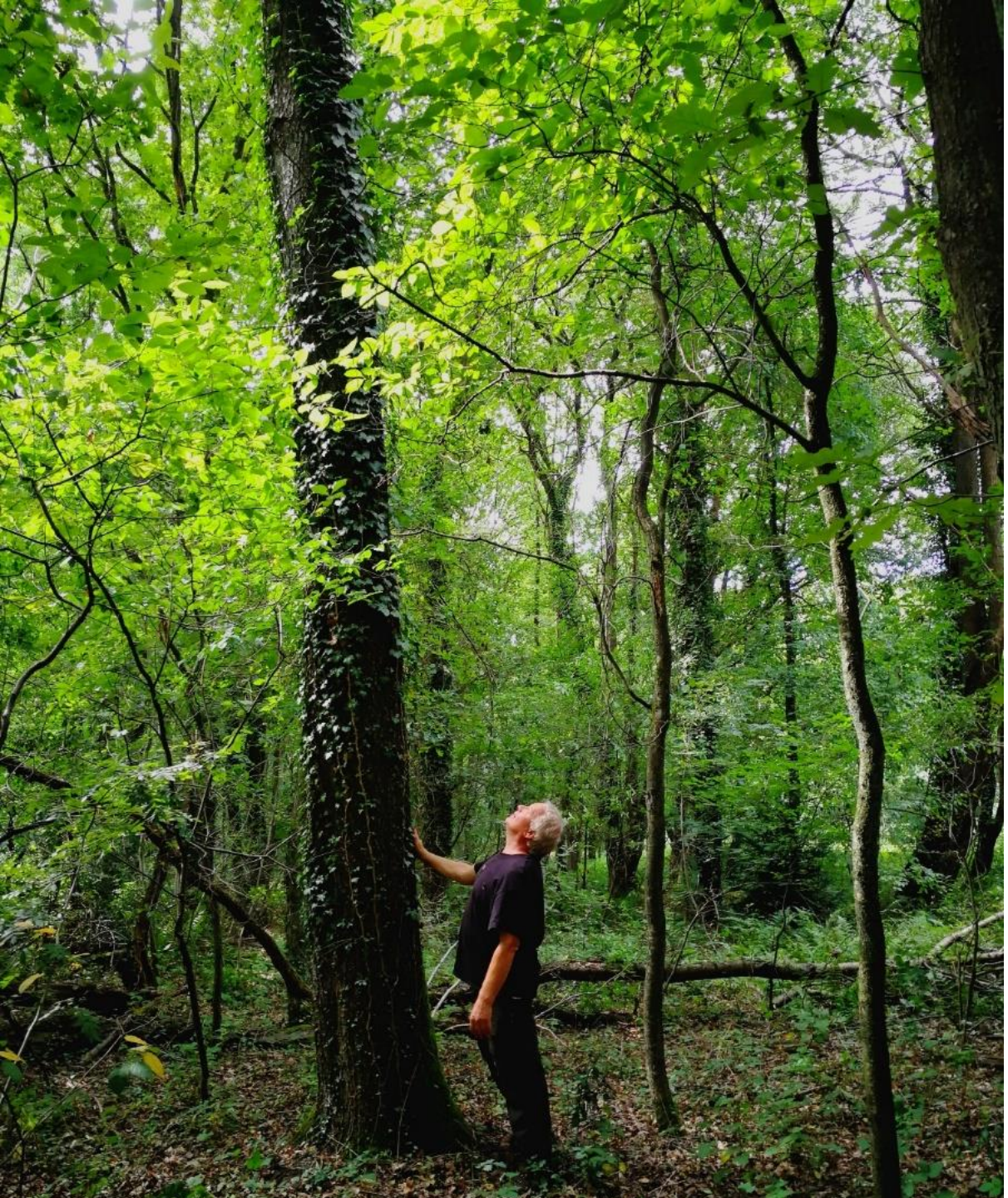
Admixture of black cherry in oak forest



Conclusion

Admixture of black cherry in oak forest

- ✢ Rich litter effect
  - on topsoil chemistry
  - large share of black cherry needed
  - effect depends on soil texture



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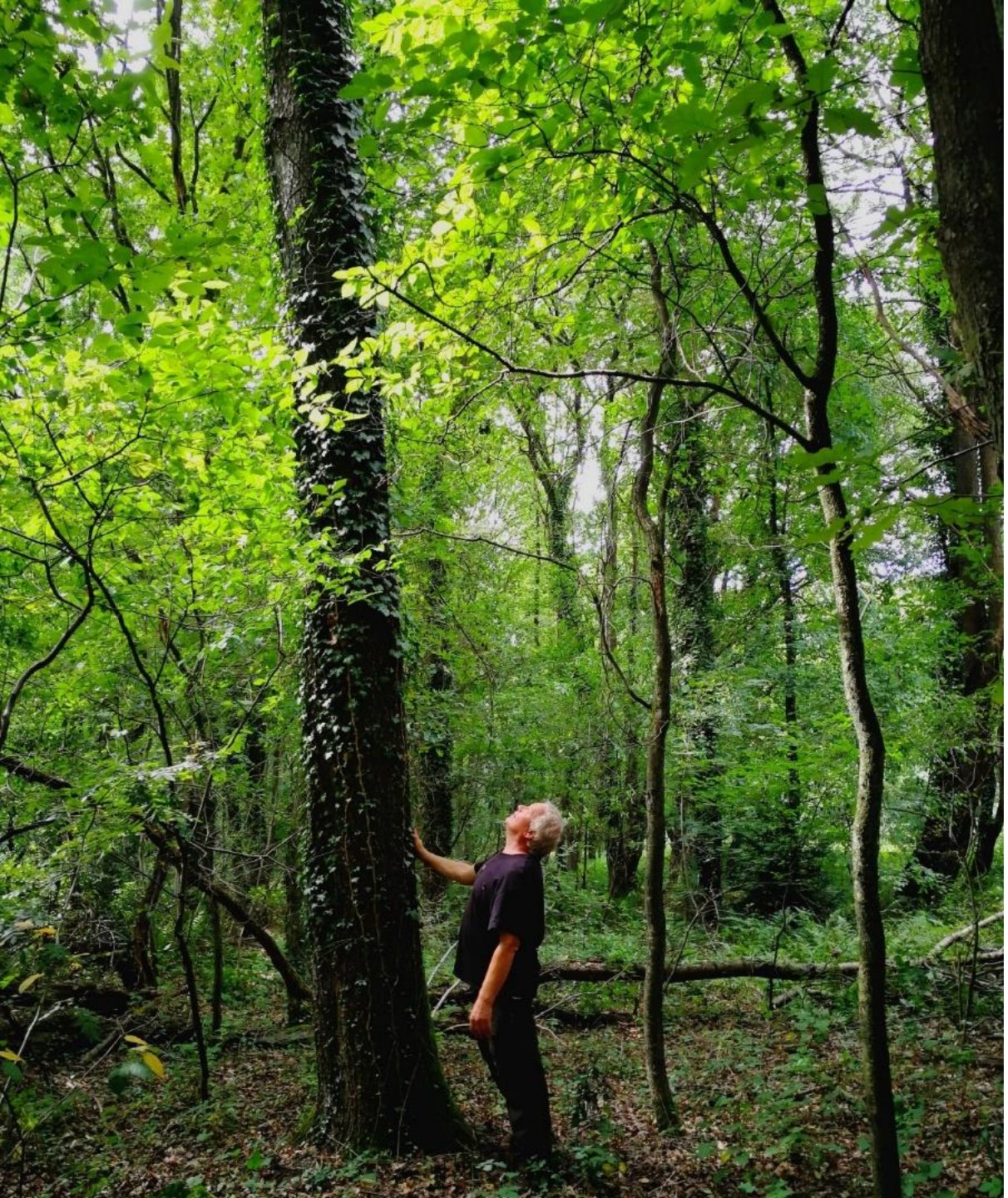
- Positive effect on N, P and defoliation of oak



Conclusion

Admixture of black cherry in oak forest

+ Rich litter effect
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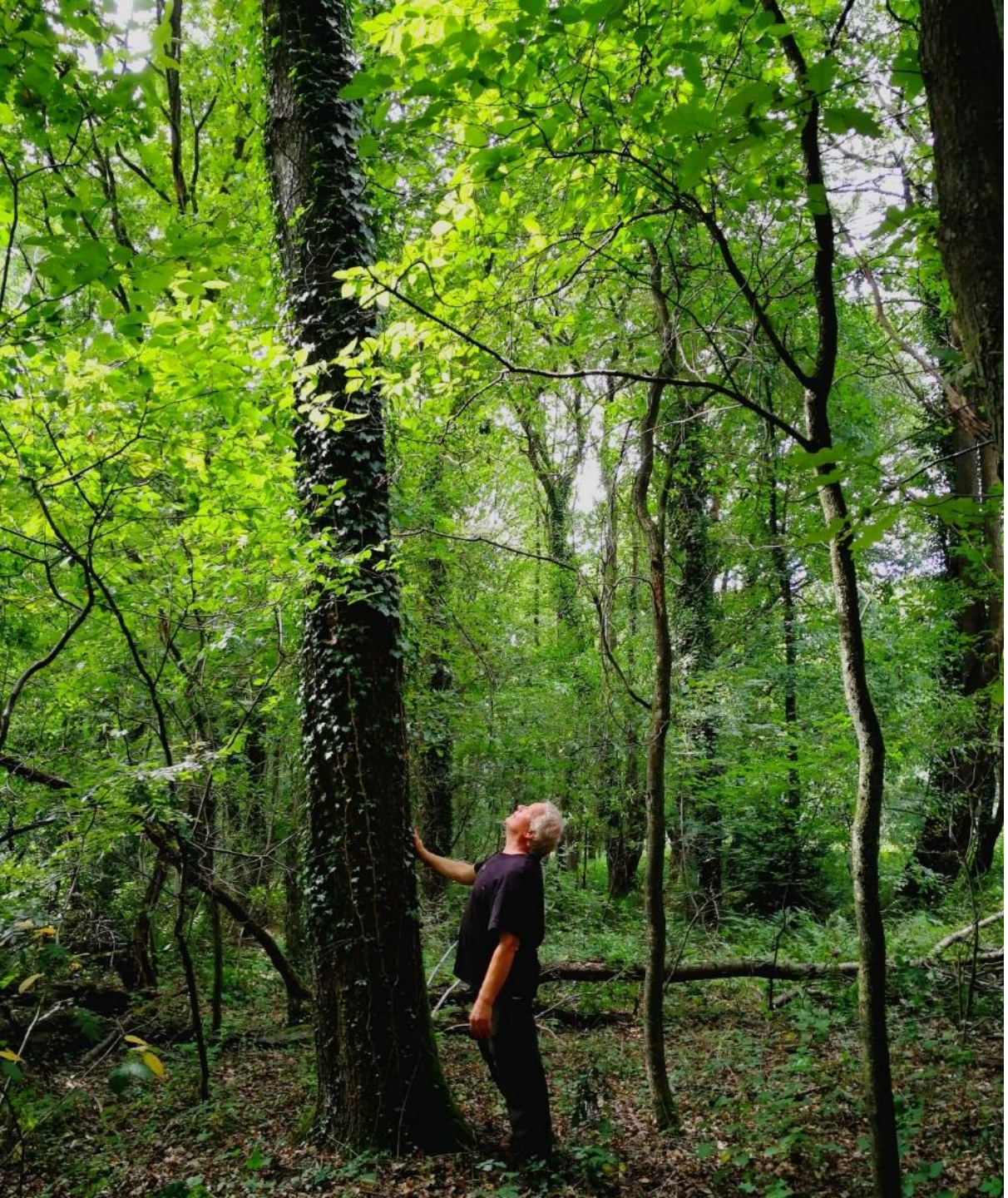
+ Positive effect on N, P and defoliation of oak

− Competition for Mg



Conclusion

Admixture of black cherry in oak forest

- ✚ Rich litter effect
  - on topsoil chemistry
  - large share of black cherry needed
  - effect depends on soil texture
- ✚ Positive effect on N, P and defoliation of oak
- ➖ Competition for Mg
- ± Indirect effects are subtle

Thank you for your attention!
Questions?

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