Status and drivers of oak population decline in Western European forests

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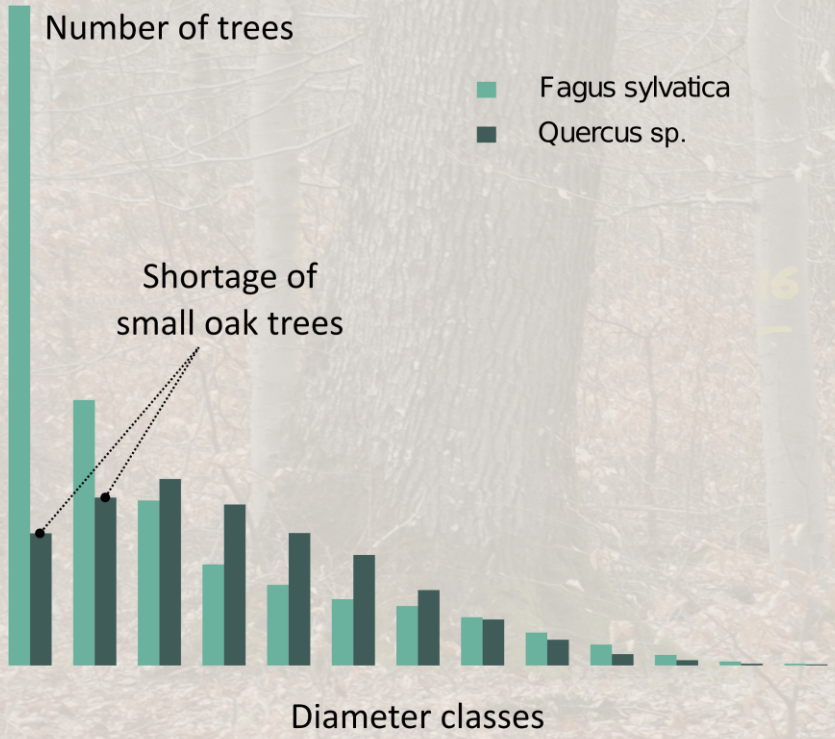
Sessile oak
Quercus petraea (Matt) Liebl.

Less shade-tolerant
Scarce in natural regeneration

European beech
Fagus sylvatica L.

Shade-tolerant
Invade the understory

Density of oak and beech by size class in southern Belgium (550 000 ha)



7.5 – 9.0 °C

800-1300 mm/year

Forests on **mesic acidophilous** sites dominated by broadleaved species and managed with **continuous cover forestry**.

Main species with different shade tolerance :

Fagus sylvatica (beech)
Picea abies (spruce)
Carpinus betulus (hornbeam)
Acer plseudoplatanus (mapple)
Quercus petraea (oak)
Fraxinus excelsior (ash)
Quercus robur (oak)
Betula pendula, *Betula pubescens* (birch)







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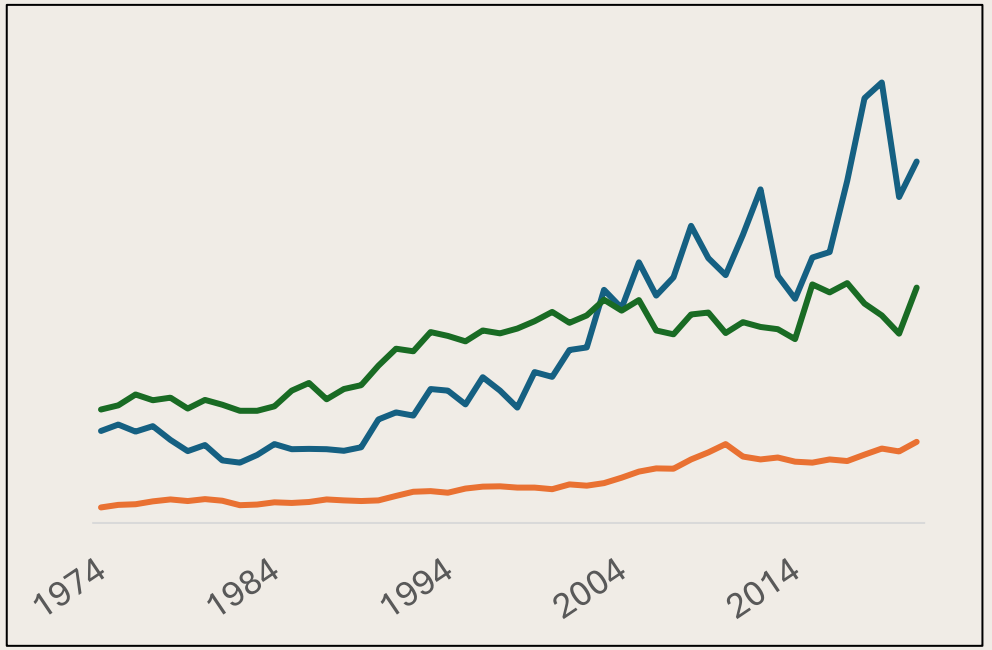
Isle of Man
Ireland
U.K. of Great Britain and Northern Ireland
Netherlands
Poland
Germany
Ukraine
Belgium
Luxembourg
Guernsey
Jersey
France

Ungulate population have increased since the 80s threatening the development of natural regeneration.



Can we promote oak natural regeneration in mixed broadleaved forest managed with continuous cover forestry ?

Studied factors : understory light and ungulate density

Questions

1. What are the optimum understory light levels to promote natural oak regeneration ? Can oak juveniles outcompete admixed species in certain light conditions ?
2. How can forest managers provide optimum light conditions ?
3. How much ungulate reduce forest diversity and growth of oak juveniles ?

27 fenced sites

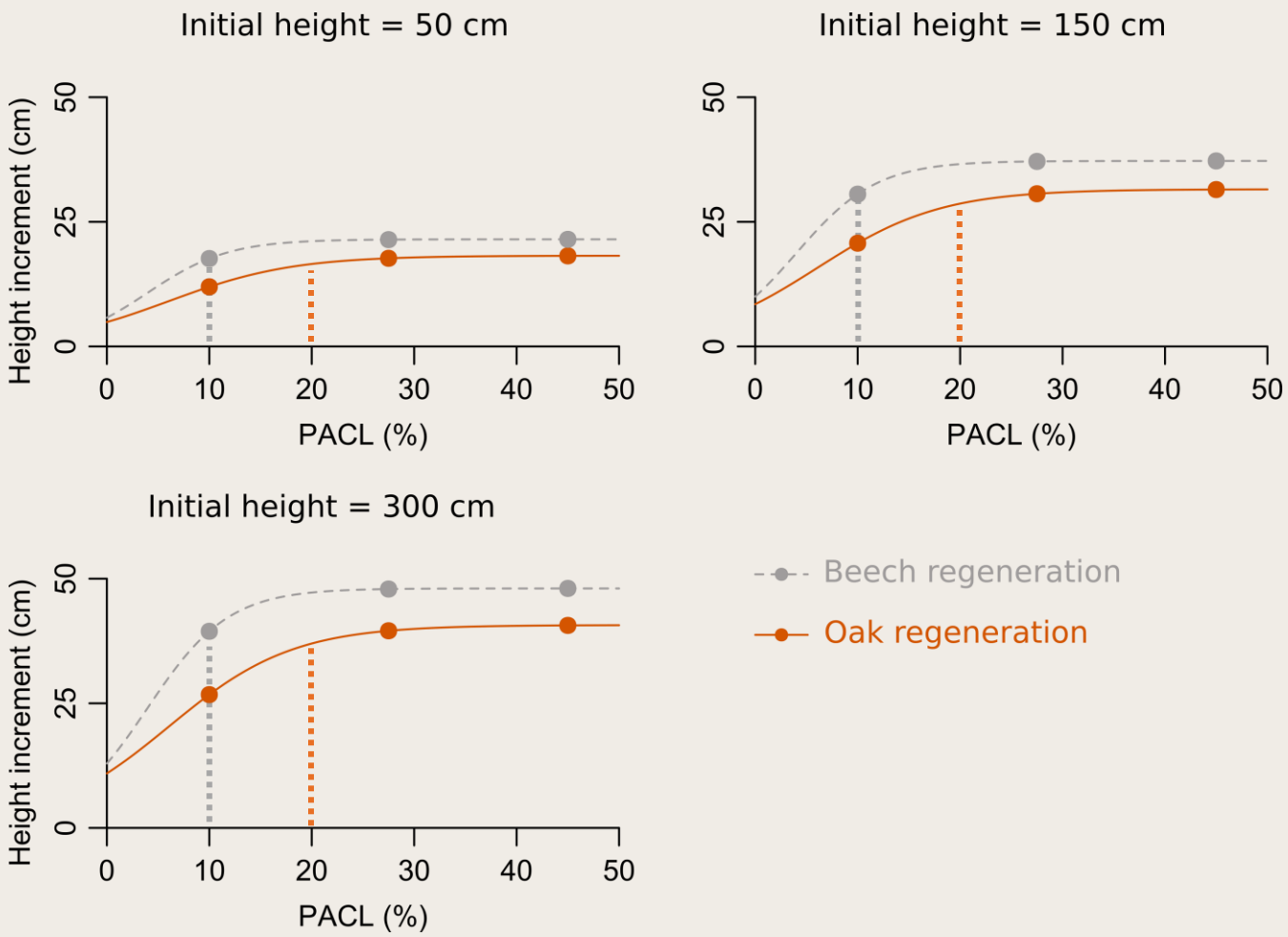
From early successional oak forests to late successional beech forests

Height of the 3 tallest saplings. Repeated measurements during 3 years.

Hemispherical photographs to estimate the percentage of above canopy light (PACL) transmitted to the understory.

Non-linear mixed model of the height growth rate as a function of light conditions and initial height.

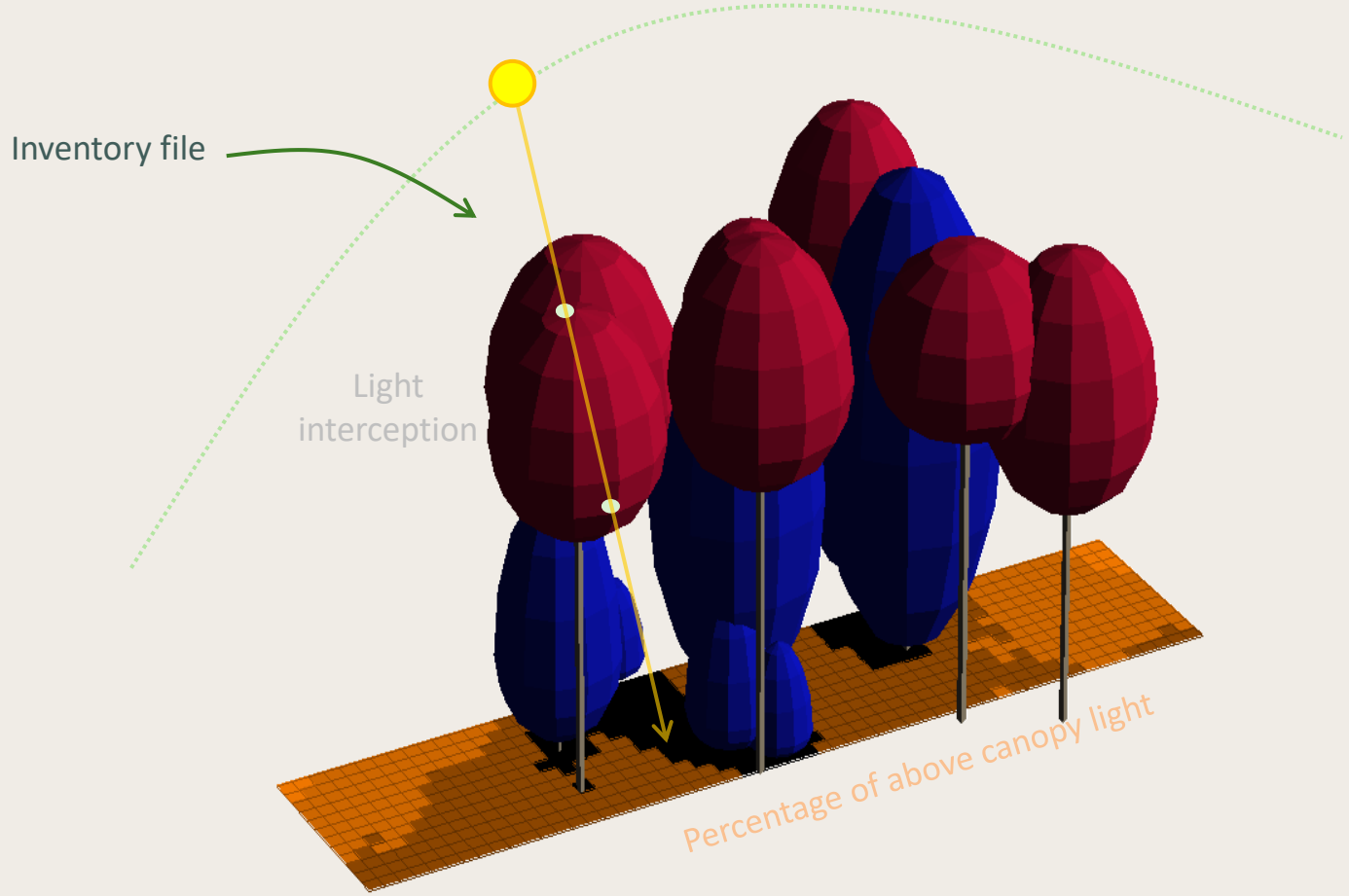
Beech regenerations grow faster than oak regenerations whatever the light conditions



- No tradeoff between survival in shade and growth in high-light condition
- Oak needs twice more light than beech to reach its optimum growth
- Optimum light : 20 – 40% of above canopy light

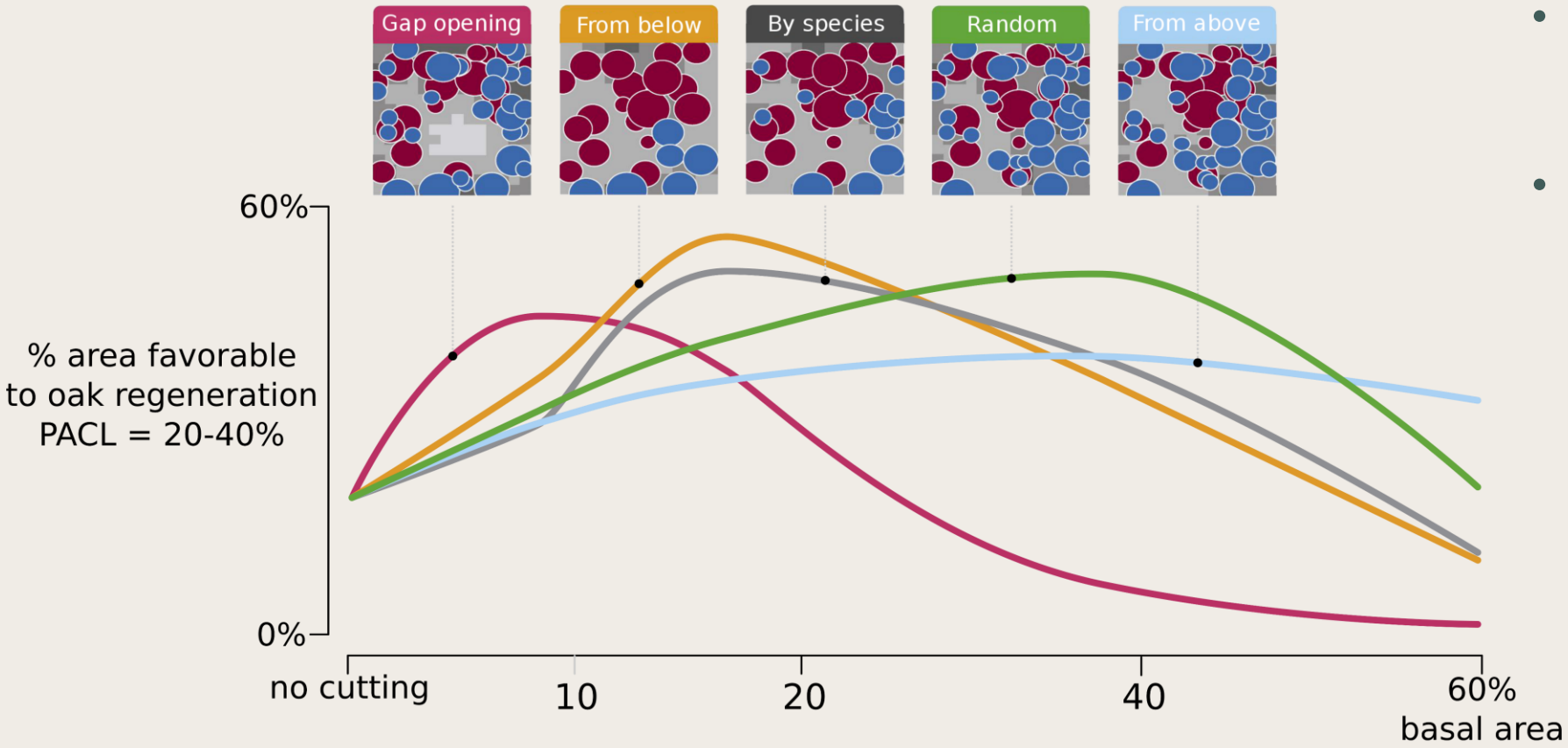
LIGOT et al. 2013, For. Ecol. Manage. 304

Modeling light interception



LIGOT et al. 2014, Can. J. For. Res. 44

Simulating different silvicultural options to promote oak regeneration



- Opening small gaps (<500 m²)
- Cutting preferentially small trees and trees of shade tolerant species maximized the area favorable to oak

LIGOT et al. 2014, For. Ecol. Manage. 327

Monitoring natural regeneration in pairs of fenced-unfenced plots

726 plot pairs (Systematic sampling) established where regeneration is not advanced but expected to be in good conditions (e.g. understory light) to thrive.

Annual monitoring (2016-2021) : Species identity and height of the 5 tallest seedlings ; Cover of woody/non-woody species.

Unfenced 1

1 m

Fenced

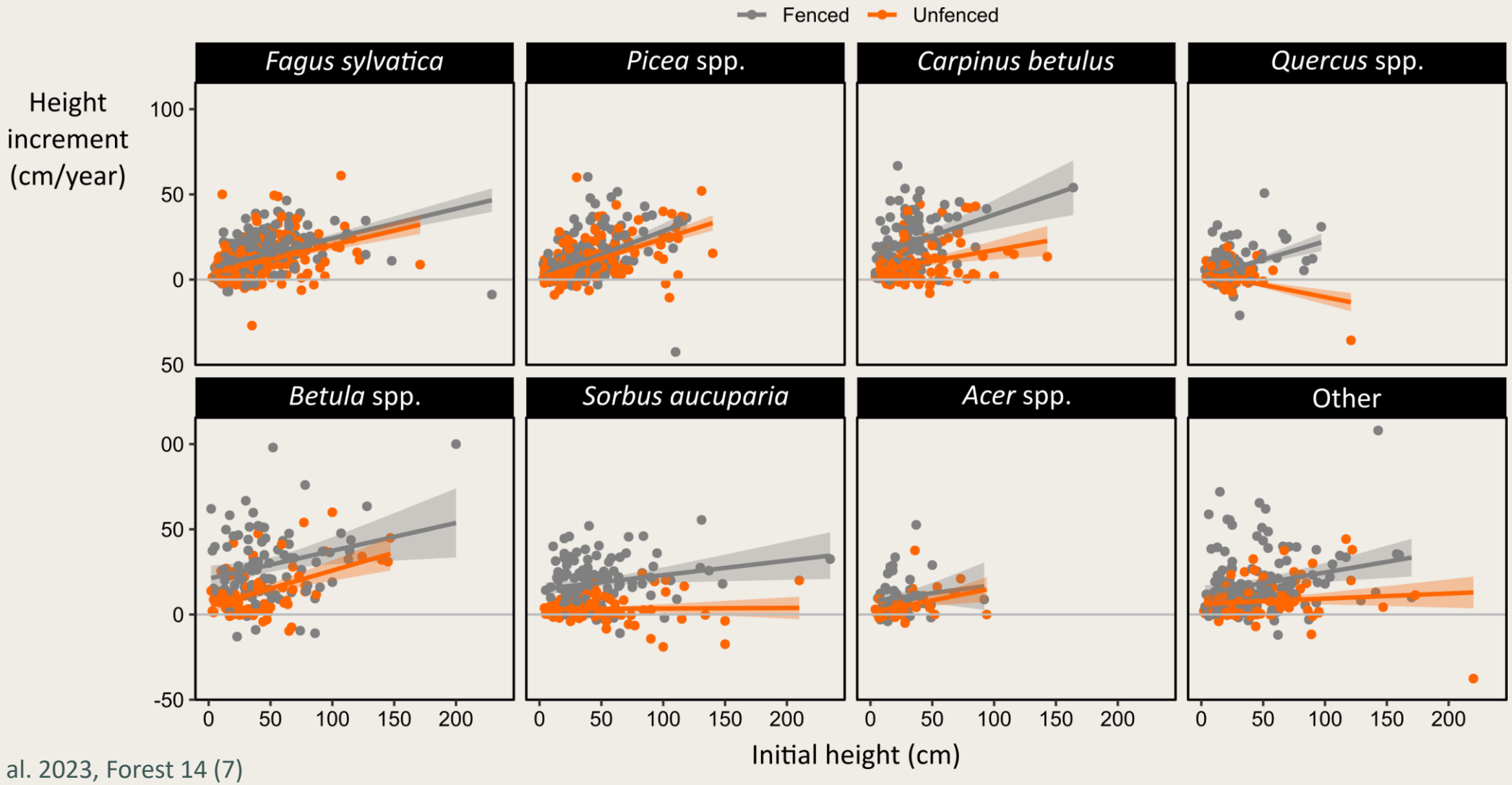
1 control plots with wooden lattice

1 m

Unfenced 2

(In case the 1st plot get damaged)

Considering only the tallest saplings, the height increment of all species but beech and spruce was significantly reduced by browsing.



CANDAELE et al. 2023, Forest 14 (7)

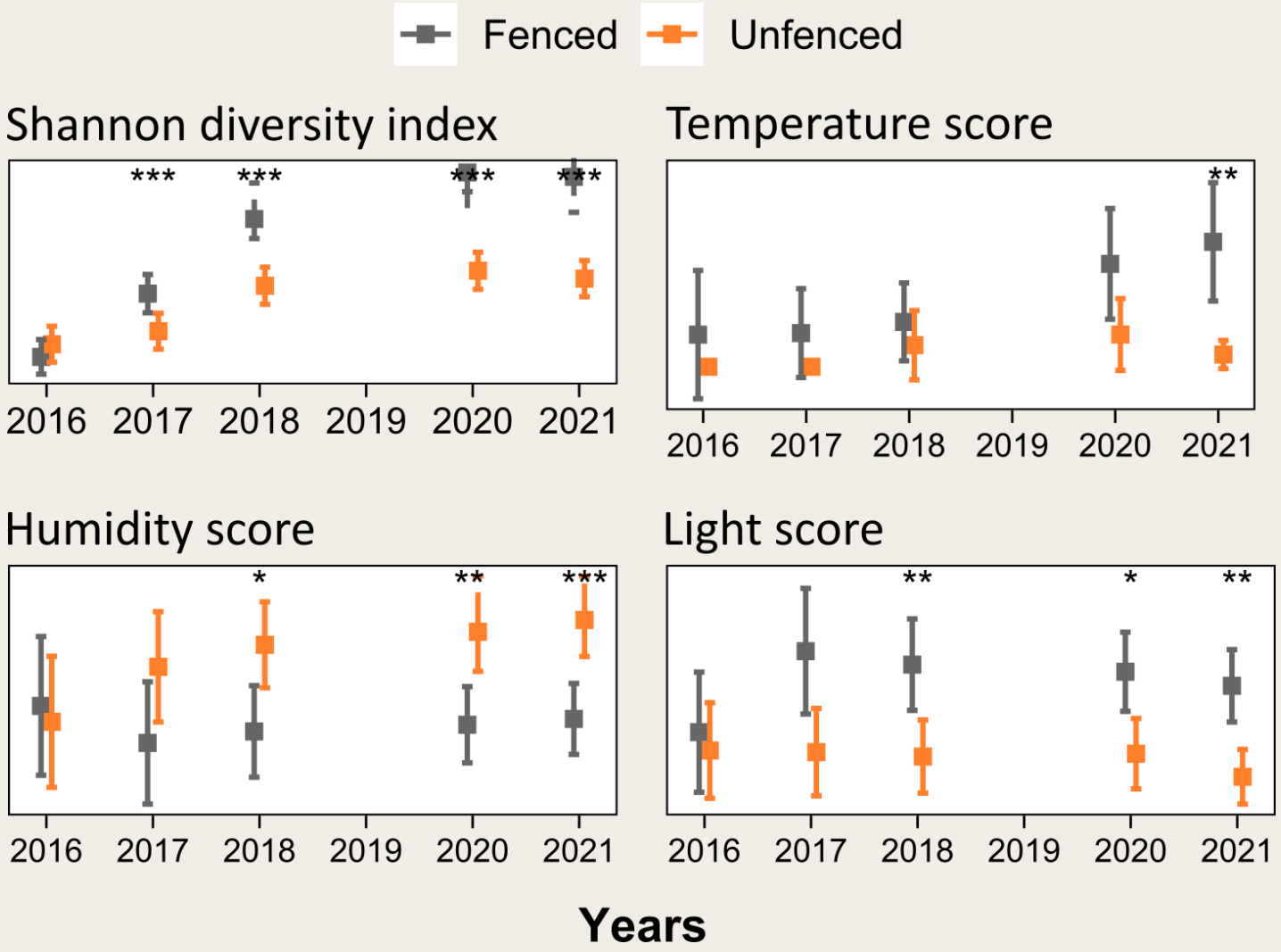
Species ranking in height increment was altered by browsing but oak was the slowest growing species in fenced and unfenced plots.

In fenced plots	
Species	**iH (cm/yr)**
Birch (Betula sp.)	25
Rowan (Sorbus aucuparia)	18
Hornbeam (Carpinus betulus)	17
Beech (Fagus sylvatica)	13
Maple (Acer pseudoplatanus)	11
Norway spruce (Picea abies)	10
Oak (Quercus sp.)	7

Unfenced plots			
Species	**iH (cm/yr)**	**Δ (cm/yr)**	**Δ (%)**
Birch	10	15	60
Spruce	10	n.s.	n.s.
Beech	9	4	30
Hornbeam	6	11	65
Maple	5	6	54
Rowan	3	15	83
Oak	3	4	57

strongly suppressed species

CANDAELE et al. 2023, Forest 14 (7)



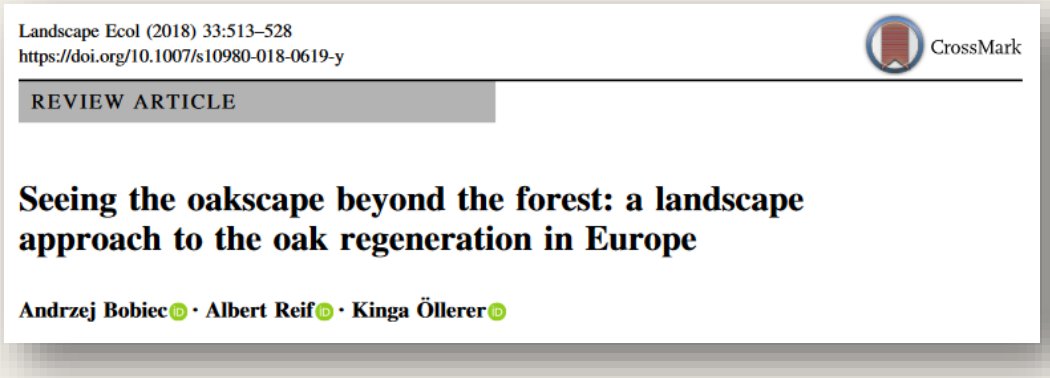
Browsing reduced regeneration diversity, increased the share of shade tolerant species and species less-tolerant to warmer and drier conditions

CANDAELE et al. 2023, Forest 14 (7)

Call to action

In most temperate forest managed with CCF, oak poorly regenerate without expensive interventions (e.g. plantations, competition release, fences).

- Compare **different silvicultural strategies** to promote oak regeneration (with simulation tools).
- Investigate new solutions **at the landscape scale** as oak is known to regenerate profusely in transitional habitats (e.g. abandoned farmland) which requires allowing land use change.


Landscape Ecol (2018) 33:513–528
https://doi.org/10.1007/s10980-018-0619-y

CrossMark

REVIEW ARTICLE

Seeing the oakscape beyond the forest: a landscape approach to the oak regeneration in Europe

Andrzej Bobiec · Albert Reif · Kinga Öllerer

Thank you !

LIGOT et al. 2013, For. Ecol. Manage. 304
LIGOT et al. 2014, Can. J. For. Res. 44
LIGOT et al. 2014, For. Ecol. Manage. 327
LIGOT 2014, PHD THESIS.
CANDAELE et al. 2023, Forest 14