A matter of size and shape

The “Pilis Gap Experiment”, a new multi-taxa study focusing on the effects of continuous cover forestry and its first results

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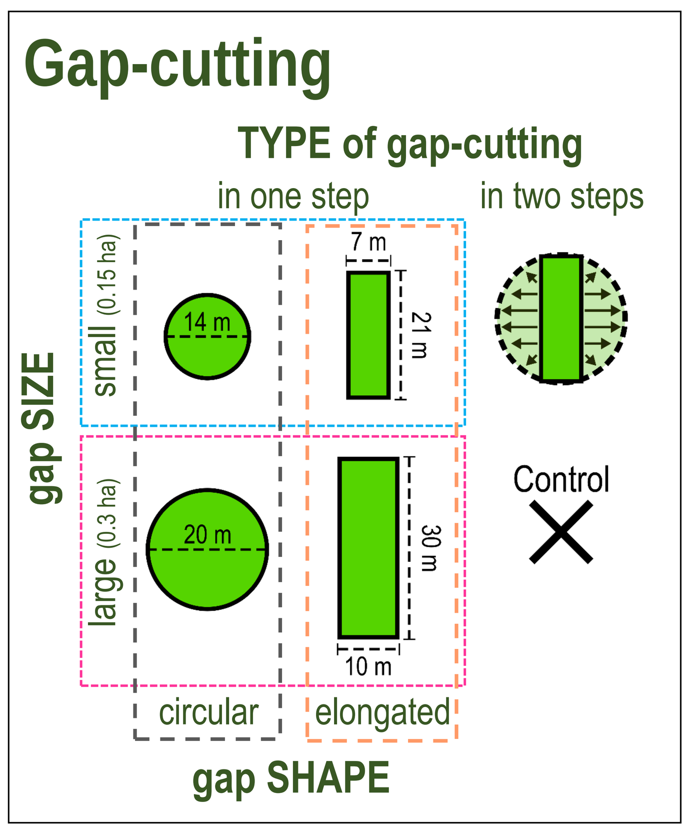
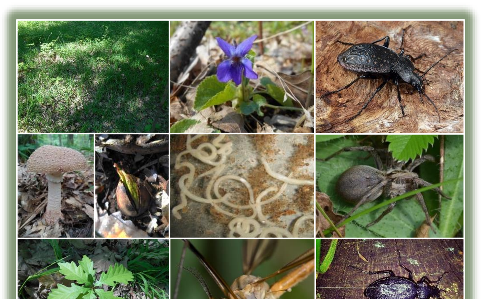
FRAMEWORK OF THE EXPERIMENT

Gap-cutting



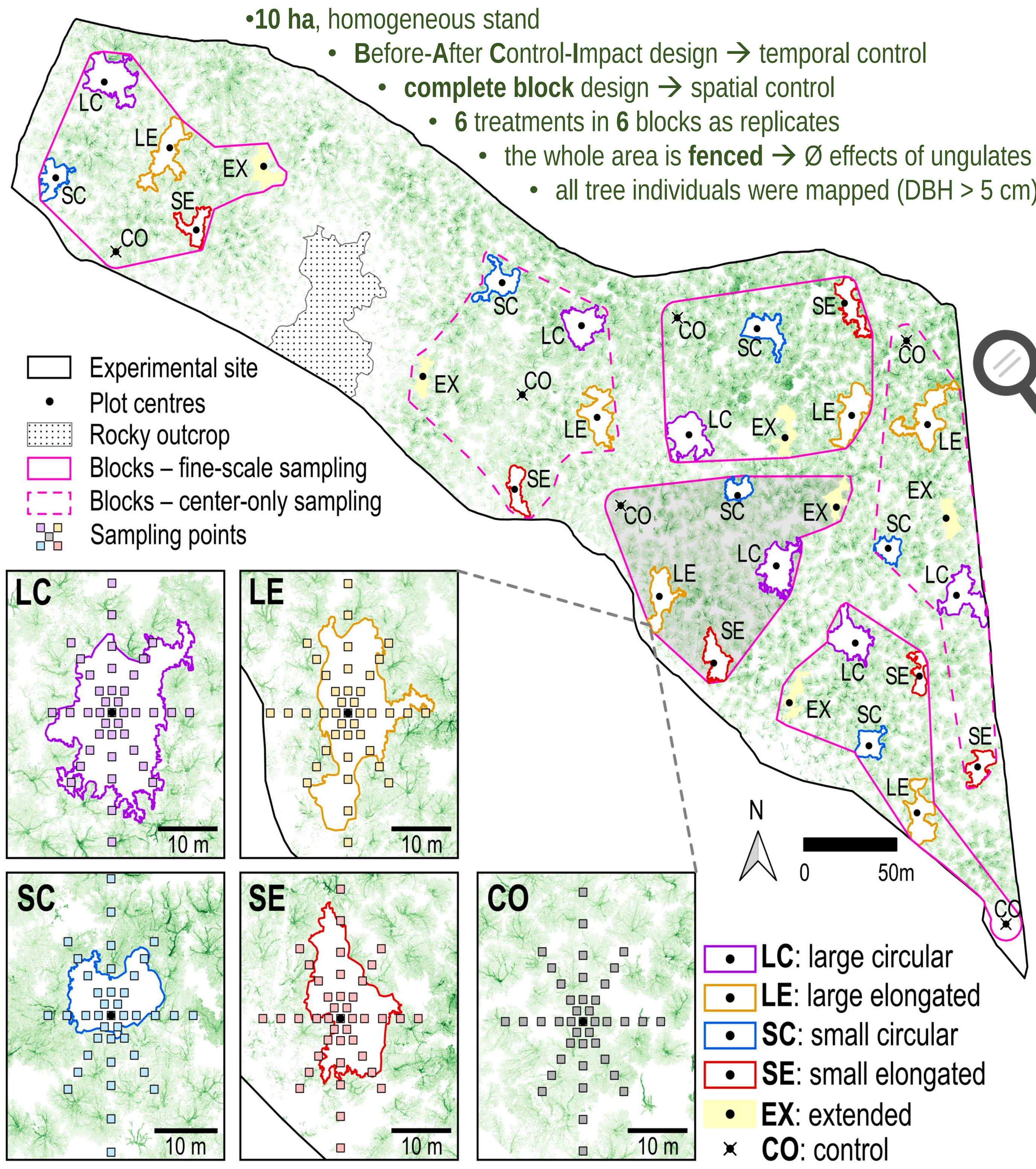


Forest site
- air temperature
- air humidity
- direct and diffuse light
- soil temperature
- soil moisture
- soil nutrient content
- soil physical properties

Regeneration and biodiversity
- ground beetles
- spiders
- dipterans
- soil fauna
- fungal communities
- vascular plants

STUDY DESIGN

- 10 ha, homogeneous stand
- Before-After Control-Impact design → temporal control
- complete block design → spatial control
- 6 treatments in 6 blocks as replicates
- the whole area is fenced → Ø effects of ungulates
- all tree individuals were mapped (DBH > 5 cm)



surveys and measurements at three spatial levels:

1. **stand level**
   sampled every 3rd-4th year

stand structure
regeneration patches

2. **gap level**
   near to the gap-center
   sampled every year

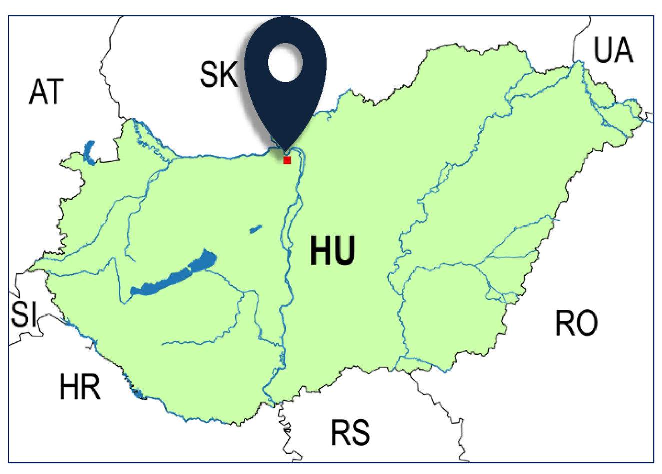
all variable groups

3. **subplot level**
   41 quadrats/gap
   systematic sampling design
   sampled every 2nd year

direct and diffuse light
soil moisture
herbs and saplings

STUDY SITE

- **location**: Pilis Mts., Northern Hungary (47°40' 13" N, 18°54' 55" E)
- **topography:** 390-460 m a.s.l., moderate (<10°), North-facing slopes
- **bedrock:** sandstone and limestone with loess
- **soil type:** Luvisols and Rendzic Leptosol, soil depth 0.5–1.5 m
- **regional climate:** humid continental (9.0–9.5°C, 650 mm/yr)
- **vegetation type**: sessile oak – hornbeam forest (91G0)
- **stand type**: mature (~90 yrs old), managed stand
- upper canopy layer: h≈22 m, DBH≈37 cm
- secondary canopy layer: h≈14 m, DBH≈18 cm
- dense herb layer (>100%): *Carex pilosa* and *Melica uniflora*



CREDITS

Notes: This experiment belongs to Péter Ódor’s Lab (Forest Ecological Research Group) at Centre for Ecological Research, Institute of Ecology and Botany (H-2163 Vácrátót, Alkotmány út 2-4., Hungary).

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We are open to any collaborations!

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Forest Ecological Research Group

MOTIVATIONS

- multifunctionality of managed forests: profitability and economical sustainability, ecosystem functionality, social needs → simultaneous requirements
- paradigm shift in silviculture towards continuous cover forestry (CCF)

need for the harmonization between the functions

- in Central European broadleaved forests, the most widely applied tool is the creation of artificial gaps
- gap shapes, sizes and the methods of gap-cutting vary from region to region, and from managers to managers → numerous uncertainties remain: where, how and when to create gaps

need for finding best available practices to help practicioners

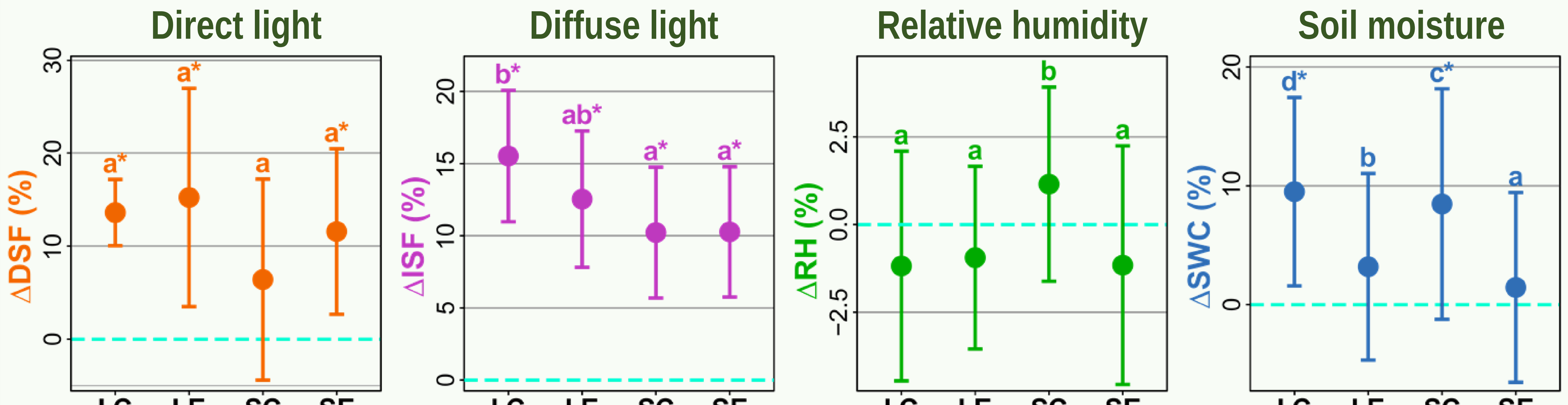
- the effects of the gap-cutting schemes and other aspects of the harvests on forest site conditions, natural regeneration and multi-taxa diversity are still poorly understood in the European oak-dominated forest

need for well-designed, multi-taxa field experiments

FIRST RESULTS

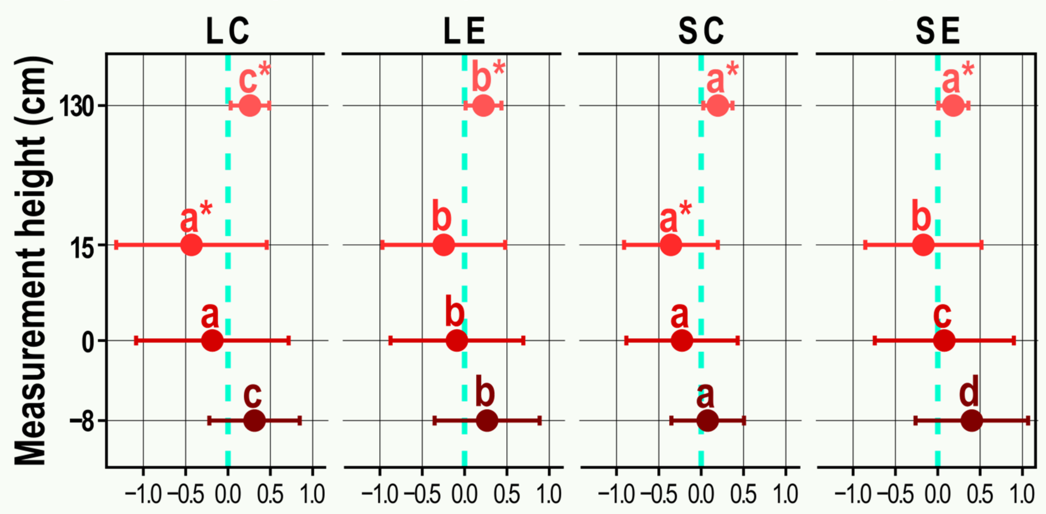
Short-term microclimate response: gaps up to one tree height per diameter ratio can maintain forest conditions in managed stands!

*Data analysis: LME – fixed effect: treatment random: block Δ: difference from control (0) → * P < 0.05 abc Tukey-type post-hoc (α = 0.05)*



Direct light	Diffuse light	Relative humidity	Soil moisture
more light but gaps are similar	*larger gaps = more diffuse light*	*remained similar to the closed forest*	*increased in circular gaps*

Temperature responses vary from measurement heigths → the interplay of light and soil moisture



gap size ~ incoming light

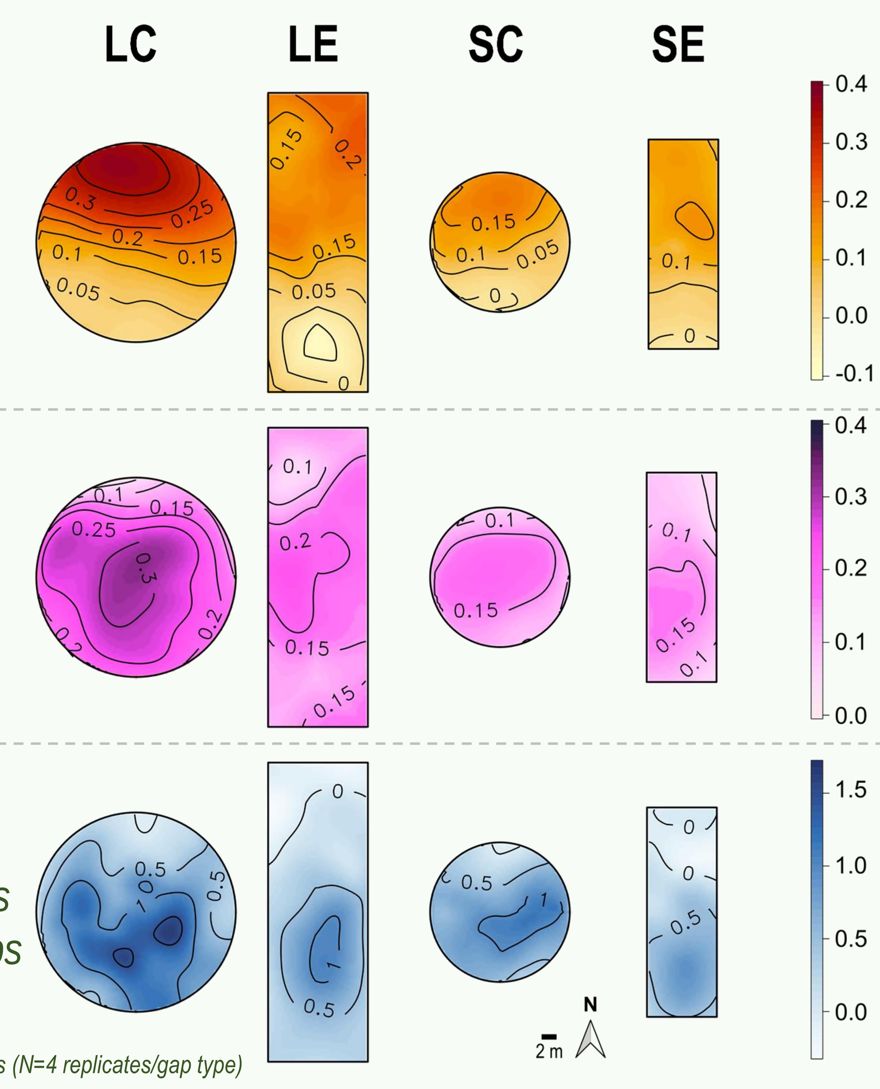
gap shape ~ light × soil moisture
negative effect sizes!

gap size + soil moisture

Direct light
- *strong south-north gradient*
- *most pronounced in LC gaps*
- *maximum irradiance in the northwestern parts*

Diffuse light
- *concentric pattern*
- *local maxima near the centers*

Soil moisture
- *multiple local maxima*
- *in the central and southern parts*
- *largest increment in circular gaps*



Data analysis: universal kriging and averaged effec sizes (N=4 replicates/gap type)

TECHNICAL DETAILS

Stand structure

measuring the pre- and post-treatment state → focusing on the the gap-filling and regeneration patches

detailed maps and stand models: Field-Map System (IFER Ltd.) and ground-based LiDAR (Trimble TX6)

Gap level variables *– sampled in the gap centers*

Forest site conditions

total, diffuse and direct components of light (WinSCANOPY) – yearly, in July

air temperature and relative humidity at 130 cm (Voltcraft DL-210TH) – continuously with 15-min logging interval

air, surface and soil temperature at 15, 0, -8 cm and soil moisture to -14 cm (TMS-4) – continuously, 15-min logging interval

litter and soil samples – twice a year (May, September)

Understory vegetation

cover of all species in a permanent 2 m × 2 m plot at the center of the gaps – two samplings per year (April, July)

Regeneration of sessile oak (*Quercus petraea* agg.)

growth, health status and survival of permanent seedlings in a 3 m × 3 m plot – one sampling per year (August)

Enchytraeid worms

abundance of all species → three soil cores per gap and wet funnel method – two samplings per year (May, September)

Dipterans

abundance of all species → one Malaise trap per gap – twice a year, two weeks sampling interval (May, September)

Groundbeetles and spiders

abundance (activity density) of all species → three pitfall traps per gap – twice a year, one month sampling interval (May, September)

Fungal communities

eDNA sampling (from soil and litter) – once a year (September-October)

Subplot-level variables – *sampled in systematically arranged subplots within gaps*

total, diffuse and direct components of light (WinSCANOPY) – once in every second year (July)

soil moisture (Fildscout TDR350) – four times (between June and September) in every second year

cover of all vascular plant species, and the number and height of seedlings/saplings in 41 quadrats (0.5 m × 0.5 m) – once in every second year (July)