COST ACTION BOTTOMS-UP, WORKING GROUP 3

DELIVERABLE 1. DESCRIPTION OF THE EXISTING FOREST MANIPULATION EXPERIMENTS

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ANNEX 3
DETAILED DESCRIPTIONS OF THE EXPERIMENTS

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EX01_CZ_LC

1. General information

Name of the experiment: **Partial cutting promotes biodiversity in deciduous lowland forests**

Contact(s) in the COST Action: Lukáš Čížek (lukascizek@gmail.cz), Pavel Šebek (pav.sebek@gmail.com), Petr Kozel (petrkozel.kozel@seznam.cz)
Organization of the Contact(s): Institute of Entomology, Biology Centre, Czech Academy of Sciences, Branišovská 1160/31, České Budějovice, CZ-37005, Czech Republic
Website of the experiment: -

The question of the experiment: How does canopy opening affect biodiversity? Is there difference between openings (gaps) connected to open habitats and openings isolated in dense forest?

Locality: Podyji National Park, South Moravia, Czech Republic
Number of Sites: 6
Number of Blocks: 6
Treatments and number of Levels:
Treatment 1: without manipulation (4 levels – control habitats)
Treatment 2: partial cutting (2 levels – intervention habitats)
Number of Plots: 36 (6 sites, each with 6 plots)

Dates:
Beginning of the experiment: 2011
Date of Before-treatment data collection: no
Date of intervention: spring 2011 (4 sites), spring 2012 (2 sites)
Dates of after-treatment data collection: 5 years (2011–2015)

2. Site descriptions

2.1. Site 1.

Location: Nový Gáliš, near Lukov, Czech Republic (code GLN)
GPS coordinates: 48.8427719N, 15.8873400E
Altitude: 270–370 m
Aspect: south-west
Slope: 14.6°
Mean annual temperature: 9.5 °C
Annual precipitation: 559 mm
Bedrock: loess and loess loam
Soil type: modal fluvisol
Site area: 0.16 ha
Forest type: Oak–hornbeam forest of the *Carpinion betuli* (EEA 2006: 5.2; Annex I. Habitat Directive: 9160)

Age of the stand at the beginning of the experiment: ca. 65 years
Stand structure before the interventions: non-intervention oak-dominated forest
canopy: oak, hornbeam layer
shrub layer: hornbeam, oak, maple,
understory layer: mesic and termophilous species
Canopy openness: 3.5–23.3%
Management type before the experiment: no management applied at the site
Available data for the stand structure of the stand: tree species, DBH, basal area, volume of dead wood, deadwood microhabitat data, canopy openness

2.2. Site 2.
Location: Široké pole, Čížov, Czech Republic (code HRN)
GPS coordinates: 48.8605692N, 15.8512189E
Altitude: 305–400 m
Aspect: south
Slope: 16.7°
Mean annual temperature: 9.5 °C
Annual precipitation: 559 mm
Bedrock: stoney and clayey-stoney sediment
Soil type: modal fluvisol
Site area: 0.16 ha
Forest type: Oak–hornbeam forest of the *Carpinion betuli* (EEA 2006: 5.2; Annex I. Habitat Directive: 9160)
Age of the stand at the beginning of the experiment: 75 years
Stand structure before the interventions: non-intervention oak-dominated forest
canopy: oak, hornbeam, European cornel
shrub layer: hornbeam, oak,
understory layer: mesic and termophilous species
Canopy openness: 7.1–29.8%
Management type before the experiment: no management applied at the site
Available data for the stand structure of the stand: tree species, DBH, basal area, volume of dead wood, deadwood microhabitat data, canopy openness

2.3. Site 3.
Location: Starý Gáliš, Lukov, Czech Republic (GLS)
GPS coordinates: 48.8451408N, 15.8905750E
Altitude: 270–370 m
Aspect: south-west
Slope: 20.8°
Mean annual temperature: 9.5 °C
Annual precipitation: 559 mm
Bedrock: loess and loess loam
Soil type: modal fluvisol
Site area: 0.16 ha
Forest type: Oak–hornbeam forest of the *Carpinion betuli* (EEA 2006: 5.2; Annex I. Habitat Directive: 9160)
Age of the stand at the beginning of the experiment: 70 years

Stand structure before the interventions: non-intervention oak-dominated forest
canopy: oak, hornbeam layer
shrub layer: hornbeam, oak, maple,
understory layer: mesic and termophilous species
Canopy openness: 4.4.–25.9%
Management type before the experiment: no management applied at the site
Available data for the stand structure of the stand: tree species, DBH, basal area, volume of dead wood, deadwood microhabitat data, canopy openness

2.4. Site 4.
Location: Hardegg, Čížov, Czech Republic (code HRD)
GPS coordinates: 48.8539831N, 15.8686747E
Altitude: 290 –330 m
Aspect: south
Slope: 23.7°
Mean annual temperature: 9.5 °C
Annual precipitation: 559 mm
Bedrock: alluvial sediments, partly limestone
Soil type: modal fluvisol
Site area: 0.16 ha
Forest type: Oak–hornbeam forest of the *Carpinion betuli* (EEA 2006: 5.2; Annex I. Habitat Directive: 9160)
Age of the stand at the beginning of the experiment: 85 years
Stand structure before the interventions: non-intervention oak-dominated forest
canopy: oak, hornbeam, lime
shrub layer: hornbeam, oak, lime
understory layer: mesic and termophilous species
Canopy openness: 5.3–30.7%
Management type before the experiment: no management applied at the site
Available data for the stand structure of the stand: tree species, DBH, basal area, volume of dead wood, deadwood microhabitat data, canopy openness

2.5. Site 5.
Location: Hlubocké louky, Podmolí, Czech Republic (code HLB)
GPS coordinates: 48.8229872N, 15.9399192E
Altitude: 275 –375 m
Aspect: east
Slope: 15.6°
Mean annual temperature: 9.5 °C
Annual precipitation: 559 mm
Bedrock: alluvial sediment, biotitic granite
Soil type: modal fluvisol
Site area: 0.16 ha
Forest type: Oak–hornbeam forest of the *Carpinion betuli* (EEA 2006: 5.2; Annex I. Habitat Directive: 9160)
Age of the stand at the beginning of the experiment: 90 years
Stand structure before the interventions: non-intervention oak-dominated forest

canopy: oak, hornbeam, lime
shrub layer: hornbeam, oak, lime
understory layer: mesic and termophilous species
Canopy openness: 5.2–23.2%
Management type before the experiment: no management applied at the site
Available data for the stand structure of the stand: tree species, DBH, basal area, volume of dead wood, deadwood microhabitat data, canopy openness

2.6. Site 6.
Location: Lipina, Podmolí, Czech Republic (code LIP)
GPS coordinates: 48.8180850N, 15.9643658E
Altitude: 255 –305 m
Aspect: south
Slope: 21.8°
Mean annual temperature: 9.5 °C
Annual precipitation: 559 mm
Bedrock: alluvial sediment, biotitic granite
Soil type: modal fluvisol
Site area: 0.16 ha
Forest type: Oak–hornbeam forest of the *Carpinion betuli* (EEA 2006: 5.2; Annex I. Habitat Directive: 9160)
Age of the stand at the beginning of the experiment: 90 years
Stand structure before the interventions: non-intervention oak-dominated forest
canopy: oak, hornbeam, ash, lime
shrub layer: hornbeam, oak, maple,
understory layer: mesic and termophilous species
Canopy openness: 8.5–28.1%
Management type before the experiment: no management applied at the site
Available data for the stand structure of the stand: tree species, DBH, basal area, volume of dead wood, deadwood microhabitat data, canopy openness

3. Applied treatments

3.1. Treatment 1. Partial cutting
Without manipulation:
1. closed forest: dense forest control plots with no forestry manipulation (core zone of NP)
2. open forest: semi-open forest control plots with no forestry manipulation
3. edge: boundary between closed forest and alluvial meadow – control plots with no forestry manipulation
4. alluvial meadow: control plots, no forestry management

Partial cutting:
5. connected clearing: experimental clearing connected to forest edge and alluvial meadow, a few trees were retained during felling
6. isolated clearing: experimental clearing isolated in dense forest, at least 20 m from any open habitats, a few trees were retained during felling

3.2. Description of the study design

Twelve experimental clearings were created at six sites within Podyji NP, always in pairs, one connected and one isolated clearing per site. Moreover, at each site, 4 control plots were established in the vicinity of the clearings, control plots were: dense forest, open forest, forest edge, alluvial meadow. Therefore altogether, there were 36 study plots (6 sites x 6 plots (2 treated – clearings, 4 control plots).

3.3. Graphical representation of the experiment

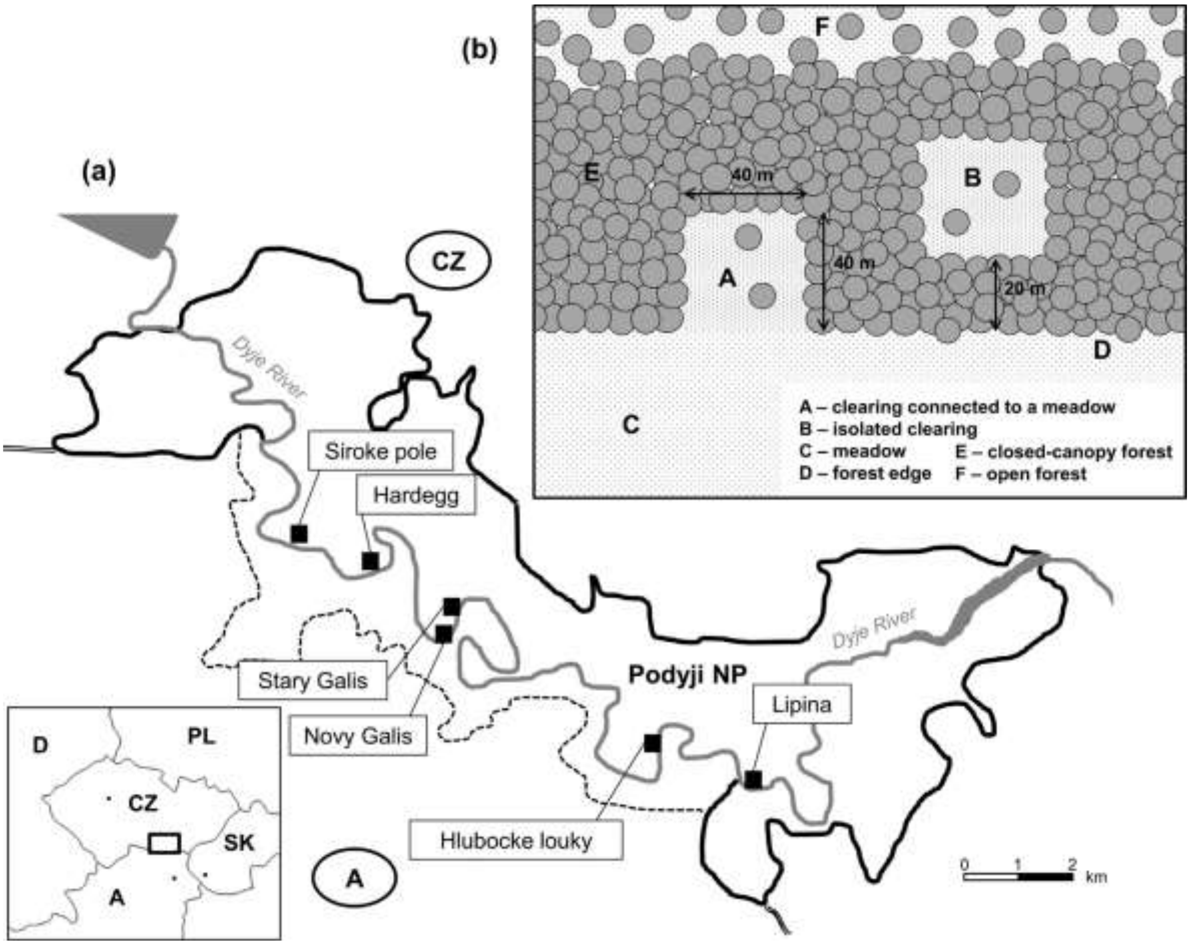


Figure 1. a) Location of 6 sites within Podyji NP, Czech Republic. b) Schematic set-up of experimental design, two types of clearings were created in dense forests, A – clearing connected to forest edge and alluvial meadow, B – clearing isolated from open habitats in dense forests. C-F – control habitats.

4. Investigated organism groups

4.1. Saproxylic beetles
Sampled by 2 flight interception traps per plot except for meadows, active from April to August. Clearings were sampled every year (2011–2015). Control plots only in the first of the experiment (in 2011 for four and in 2012 for two sites) and in then again in 2015.
4.2. Epigeic beetles
Sampled by 5 pitfall traps per plot, active from April to August. Sampling was performed in the first year of the experiment (2011 and 2012).

4.3. Floricolous beetles
Sampled by 3 yellow pan traps per plot, 5 times in the season. In the first year of experiment.

4.4. Butterflies
Sampled at each plot by 7 min. transect walks (zigzagging), 5 times in season (every months from May to September (2011–2015).

4.5. Moths
Sampled by UV-light traps, 1 per plot once per month from May to September (2011–2015).

4.6. Reptiles
Sampled using artificial shelters from toughened plastic sheets. 5 sheets per plot were used. Sampled from April to August.

4.7. Spiders
Sampled by pitfall traps (see 4.2. epigeic beetles).

4.8. Birds
Recorded directly at the plot by visual and acoustical observations during 3 visits in the first and third year of the study.

4.6. *Vascular plants*
Census of vascular plants was performed twice per season, from 2011–2016.

4.7. *Hymenoptera (Bees and wasps)*
Sampled by coloured traps, two of yellow, white, blue, and red per plot. Traps were installed 4 times per season. Only in 2015.

Timetable of the sampling is summarized in the table below. E = sampling performed in experimental clearings, C = sampling performed in control plots.

	2011		2012		2013		2014		2015	
	GLS, HRD, LIP, HLB	GLN, HRN	GLS, HRD, LIP, HLB	GLN, HRN	GLS, HRD, LIP, HLB	GLN, HRN	GLS, HRD, LIP, HLB	GLN, HRN	GLS, HRD, LIP, HLB	GLN, HRN
saproxylic beetles	E, C		E	E, C	E	E		E	E, C	E, C
epigeic beetles	E, C			E, C						
floricolous beetles	E, C			E, C						
butterflies	E, C		E	E, C	E	E		E	E, C	E, C
hymenopterans									E, C	E, C
moths	E, C		E	E, C	E	E		E	E, C	E, C
reptiles			E, C	E, C	E, C	E, C	E, C	E, C	E, C	E, C
spiders	E, C			E, C						
birds	E, C			E, C						
vascular plants	E, C		E	E, C	E	E	E	E	E	E

5. Investigated environmental variables

5.1. Sunlight conditions

Openness was measured by digital hemispherical photographs at 1.3 m above the ground analysed in WinSCANOPY image processing software

6. Other investigated functions/processes

6.1. Resprouting of stumps and high stumps after felling

7. References

Sebek, P., Bace, R., Bartos, M., Benes, J., Chlumska, Z., Dolezal, J., Dvorsky, M., Kovar, J., Machac, O., Mikatova, B., Perlik, M., Platek, M., Polakova, S., Skorpik, M., Stejskal, R., Svoboda, M., Trnka, F., Vlasin, M., Zapletal, M. & Cizek, L. (2015). Does a minimal intervention approach threaten the biodiversity of protected areas? A multi-taxa short-term response to intervention in temperate oak-dominated forests. *Forest Ecology and Management*, 358, 80–89.

Lanta, V., Mudrák, O., Liancourt, P., Bartoš, M., Chlumská, Z., Dvorský, M., Pusztaiová, Z., Münzbergová Z., Sebek, P., Čížek, L., & Doležal, J. (2019). Active management promotes plant diversity in lowland forests: A landscape-scale experiment with two types of clearings. *Forest Ecology and Management*, *448*, 94–103.

Lanta, V., et al. (*in prep.*) Active management in lowland forests promotes endangered plant species: interaction between habitat and dispersal limitations.

8. Participating experts in the project

Cizek, Lukas – Institute of Entomology, Biology Centre CAS (insect ecology and conservation)
Sebek, Pavel – Institute of Entomology, Biology Centre CAS (insect ecology and conservation)
Platek, Michal – Institute of Entomology, Biology Centre CAS (insect ecology and conservation)
Kozel, Petr – Institute of Entomology, Biology Centre CAS (insect ecology, saproxylic beetles)
Polakova, Simona – University of South Bohemia (bird ecology)
Perlik, Michal – Institute of Entomology, Biology Centre CAS (insect ecology, Hymenoptera)
Benes, Jiri – Institute of Entomology, Biology Centre CAS (insect ecology, Lepidoptera)
Zapletal, Michal – Institute of Entomology, Biology Centre CAS (insect ecology, Lepidoptera)
Mikatova, Blanka – Nature Conservation Agency of the Czech Republic (reptiles)
Baloun, Jaroslav, Faculty of Science, University of South Bohemia (reptiles)
Bace, Radek, Faculty of Forestry and Wood Sciences, Czech University of Life Sciences (forest ecology)
Dolezal, Jiri, Institute of Botany CAS (botany, forest ecology)
Lanta, Vojtech, Institute of Botany CAS (botany)
Svoboda, Miroslav, Faculty of Forestry and Wood Sciences (forest ecology)

EX02_CZ_RH

1. General information

Name of the experiment: **Děvín coppicing restoration**

Contact in the COST Action: Radim Hédl (radim.hedl@ibot.cas.cz)
Organization of the Contact: Institute of Botany, Czech Academy of Sciences, Lidická 25/27, 60200 Brno, Czech Republic
Website of the experiment: no

The question of the experiment:
How will the canopy thinning of various intensity affect the biodiversity of several taxonomic groups?
Will it successfully restore the vanishing biodiversity of abandoned coppices-with-standards?

Locality: Děvín, Pálava
Number of Sites: 1
Number of Blocks: 0 (forest stands of different canopy thinning intensity, each with several plots)
Treatments and number of Levels: Treatment 1: Canopy thinning of three levels – thinning intensities (zero or weak in 2009/2010; intermediate in 2012/2013; intense in 2015)
Number of Plots: 15 (5 per treatment level)

Dates:
Beginning of the experiment: 2009
Date of Before-treatment data collection: yes, 2008 (only 7 of 15 plots)
Date of intervention: 2009, 2013, 2015 (so far)
Dates of after-treatment data collection: 2015, 2016, 2017, 2018, 2019 (and on; see 4.)

2. Site descriptions

2.1. Site 1.

Location: Děvín Nature Reserve, Pálava Protected landscape area, Czech Republic
GPS coordinates:
48.8786414N
16.6595844E
Altitude: 288–395 m
Aspect: north-north-east
Slope: 5–20°
Mean annual temperature: 9.6 °C (1947–1975, station Mikulov)
Annual precipitation: 571 mm (1947–1975, station Mikulov)
Bedrock: Jurassic limestones, loess, slope deposits
Soil type: Luvisol, Rendzic leptosol
Site area: 28.5 ha (restored), 380 ha (whole site)

Forest type: Mesophytic deciduous forest
Age of the stand at the beginning of the experiment: 50, 70, 80 or 90 (depends on stand, mostly 80 years)
Stand structure before the interventions:
canopy: lime, hornbeam, maple and ash coppices, oak, ash and other standards
shrub layer: mostly absent or scattered resprouts of lime and other species
understory layer: relatively species-rich, coverage around 10–20, varying
Canopy openness: 4–12% (hemispheric photos, 60°)
Management type before the experiment: coppicing until the 1930s, from 1946 strict nature reserve, with conversions to high forest and occasional small-scale canopy thinning
Available data for the stand structure of the stand: number of stems, dbh, tree height, species, canopy cover (visually estimated), canopy openness (hemispheric photographs)

3. Applied treatments

3.1. Treatment 1. Canopy thinning
1. Zero or weak: no intervention or negligible thinning – single trees
2. Intermediate: individual trees cut out from the stands, gaps of tens of sq. m
3. Intense: groups of trees cut out, only standards left

3.2. Description of the study design

The experiment uses a set of plots established in 2008 and canopy thinning of three increasing intensities in the following years. In 2015, after the last and most intense thinning, the plots were extended in number and complexity, and set with microclimatic sensors. To seven existing, eight new plots were added in 2015.

Fifteen plots with nine subplots are equally distributed over the canopy thinning intensity: 5 in zero or weak thinning from 2009, 5 in moderate thinning from 2013, and five in intense thinning from 2015.

Since 2015, yearly data sampling of vegetation and canopy openness are undertaken. Other taxonomic groups were sampled in plots at least once, see below.

Because the pre-treatment data on vegetation and environmental conditions are available for part of the plots (7, see above), BACI design can be considered for this experiment.

3.3. Graphical representation of the experiment

4. Investigated organism groups

4.1. Understory vegetation
Lists of vascular plant species with estimates of relative cover, both herbs and woody regeneration up to 1 m of height.
Two variants per plot: a) whole plot, size 15 × 15 m; b) nine subplots, size 3.14 m^2 (circles).
Complete sampling in 2015, 2016, 2017, 2018; planned in 2020, 2024 and possibly onwards.
In full vegetation season – usually June.

4.2. Spiders
Individuals were sampled by pitfall traps (3 per plot), once a month between May and September. A total of 450 samples (3 traps per plot * 15 plots * 5 months * 2 years) were collected in 2016–2017. Unprocessed material from 2018–2019 (2020 to be collected) is not available yet.

4.3. Carabid beetles
Individuals were sampled by pitfall traps (3 per plot) once a month between May and September. A total of 450 samples (3 traps per transect * 15 plots * 5 months * 2 years) were collected in 2016–2017. Unprocessed material from 2018–2019 (2020 to be collected) is not available yet.

4.4. Ants
Individuals were collected by pitfall traps with bait (3 per plot) twice a month between April and September. Each trap was baited with 0.4 ml honey and 0.4 mg of tuna fish. The traps were

left overnight and individuals were collected on the next day. A total of 864 samples (3 traps per plot * 12 plots * 6 months* 2 years) were taken in 2017–2018.

4.5. Herbivorous insects

Sweeping of herb vegetation was carried out during May and August 2018–2019. A total of 120 samples were taken. Insect were not identified to species yet.

5. Investigated environmental variables

5.1. Light

Hemispherical photographs taken during summer at 9 (or 5, in seven plots before the treatment) subplots within the plot. Analyzed in WinScanopy for canopy openness and related parameters. Records from 2010, 2013 (poor quality), 2015, 2016, 2017, 2018.

5.2. Topsoil

Samples from the upper 5 cm of the organomineral horizon were collected in summer 2015 from 9 subplots per plot (not mixed). Analyzed parameters: pH (water), dry matter, N (total), C (total), P (exchangeable), Ca, Mg, K.

5.3. Tree stand

DBH and height measurement of all trees and shrubs at least 5 cm thick growing within the 15 m × 15 m plots. Measured only after cutting in spring-winter 2018/2019. There are some older records from 7 plots, but these were taken mostly after management interventions

5.4. Microclimate

Recorded automatically every 15 minutes, continuously since April 2016 (in part of the plots since May 2014), using TMS data loggers (https://tomst.com/web/en/systems/tms/tms-4/). Measured parameters: a) temperature 10 cm aboveground, b) temperature at the ground level, c) temperature 10 cm belowground, d) soil moisture.

6. Other investigated functions/processes

6.1. Seedling recruitment of understory herbs

(Not exactly at each plot.) Recruitment of herbaceous seedlings is monitored from spring 2019 within four 20 cm × 20 cm plots placed in the center of selected plots. *In situ* monitoring is complemented by cultivation of soil seed bank samples collected in spring and autumn 2019 in the vicinity of the seedling plots.

6.2. Transplant experiment of two sedge species

Two local sedge species were experimentally planted in a block design in thinned vs. untouched stands, in ten replicates. Soil was manipulated as a second treatment (local vs. homogenized). *Carex digitata* was planted in 2017, *Carex michelii* in 2018. Observed parameters, yearly: number of spikes, number of flower stems, number of young tillers, dead or alive. Density of the surrounding understory vegetation estimated visually. Microclimatic sensors set to each replicate.

7. References

Publications directly from the experiment

Hédl, R., Riedl, V., Chudomelová, M. 2019. Restoration of coppice biodiversity in southern Moravia. In Jongepierová, I., Pešout, P., Prach, K. (Eds), Ecological restoration in the Czech Republic II, Nature conservation agency of the Czech Republic, Prague, pp. 32–36. ISBN 978-80-7620-040-1

Šipoš, J., Hédl, R., Hula, V., Chudomelová, M., Košulič, O., Niedobová, J., Riedl, V. 2017. Patterns of functional diversity of two trophic groups after canopy thinning in an abandoned coppice. Folia Geobotanica 52: 45–58. https://doi.org/10.1007/s12224-017-9282-3

Publications closely related to the topic, from the site

Altman, J., Hédl, R., Szabó, P., Mazůrek, P., Riedl, V., Müllerová, J., Kopecký, M., Doležal, J. 2013. Tree-rings mirror management legacy: dramatic response of standard oaks to past coppicing in Central Europe. PLOS ONE 8(2): e55770. https://doi.org/10.1371/journal.pone.0055770

Hédl, R. 2005. Comparison of the forest Děvín NNR after 50 years of natural succession. PhD thesis, Mendel University, Brno.

Hédl, R., Kopecký, M., Komárek, J. 2010. Half a century of succession in a temperate oakwood: from species-rich community to mesic forest. Diversity and Distributions 16: 267–276. https://doi.org/10.1111/j.1472-4642.2010.00637.x

Kopecký, M., Hédl, R., Szabó, P. 2013. Non-random extinctions dominate plant community changes in abandoned coppices. Journal of Applied Ecology 50(1): 79–87. https://doi.org/10.1111/1365-2664.12010

Müllerová, J., Hédl, R., Szabó, P. 2015. Coppice abandonment and its implications for species diversity in forest vegetation. Forest Ecology and Management 343: 88–100. https://doi.org/10.1016/j.foreco.2015.02.003

Müllerová, J., Szabó, P., Hédl, R. 2014. The rise and fall of traditional forest management in southern Moravia: A history of the past 700 years. Forest Ecology and Management 331: 104–115.

Szabó, P. 2010. Driving forces of stability and change in woodland structure: a case-study from the Czech lowlands. Forest Ecology and Management 259: 650–656.

8. Participating experts in the project

Markéta Chudomelová, Institute of Botany, Czech Academy of Sciences (vascular plants, microclimate, canopy openness)

Ondřej Dorňák, University of Ostrava (ants)

Radim Hédl, Institute of Botany, Czech Academy of Sciences (vascular plants, microclimate, soil conditions)

Ondřej Košulič, Mendel University in Brno (spiders)

Vladan Riedl, Nature Conservation Agency of the Czech Republic (forestry interventions, nature conservation)

Jan Šipoš, Mendel University in Brno (carabid beetles)

Pavla Vymazalová, Mendel University in Brno (spiders)

EX03_CZ_VO

1. General information

Name of the experiment: **Podyjí litter raking experiment**

Contact(s) in the COST Action: Ondřej Vild (ondrej.vild@ibot.cas.cz)
Organization of the Contact(s): Institute of Botany, Czech Academy of Sciences, Lidická 25/27, 60200 Brno, Czech Republic
Website of the experiment: NA

The question of the experiment: How will litter raking thinning in autumn and spring affect the biodiversity of several taxonomic groups? Will the target species colonize the experimental plots?

Locality: Hnanice, Podyjí National Park
Number of Sites: 1
Number of Blocks: 15
Treatments and number of Levels: Three treatments: litter raking in spring, litter raking in autumn, control
Number of Plots: 45 (3x15)

Dates:
Beginning of the experiment: 2010
Date of Before-treatment data collection: 2010
Date of intervention: 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019
Dates of after-treatment data collection: 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019

2. Site descriptions

2.1. Site 1.

Location: Hnanice, Podyjí National Park, Czech Republic
GPS coordinates: 48°48' N, 15°57' E = 48.00 N, 15.95 E
Altitude: 365–375 m a.s.l.
Aspect: southern
Slope: 5°
Mean annual temperature: 8.5 °C
Annual precipitation: 550 mm
Bedrock: granite
Soil type: oligotrophic cambisol
Site area: 3 ha
Forest type: Thermophilous oakwoods, thermophilous oak–hornbeam forests
Age of the stand at the beginning of the experiment: 65
Stand structure before the interventions:

Tree layer: the stand is dominated by 10–12 m high *Quercus petraea* agg. with occasional *Pinus sylvestris* and *Carpinus betulus*. Neither the tree or shrub layer was manipulated.
Shrub layer: rejuvenating *Quercus petraea*, *Carpinus betulus*, *Tilia cordata and T. platyphyllos*
Understory layer: 14 species per 5 × 5 m plot in average, cover 35% in average

Canopy openness: 12.17%
Management type before the experiment: wood pasture until about end of the 19th century, part of the national park since 1991, no tree layer intervention since.
Available data for the stand structure of the stand: canopy cover measurements (hemispheric photographs) and estimations, tree height estimation, woody species

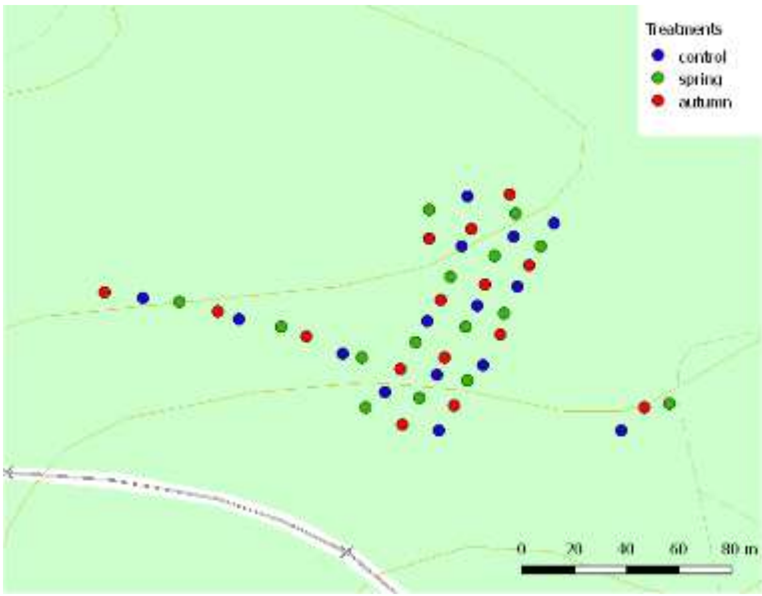
3. Applied treatments

3.1. Treatment 1. Litter raking

3.2. Description of the study design

A total of 45 plots of 5 × 5 m were selected in a randomized complete block design. Each block (N = 15) consisted of one plot for each of the three treatments. To ensure that an experimental treatment affected the respective plot only, a minimum distance between plots was set at 6.0 m. Experimental treatment was applied as follows: (1) autumn litter raking annually in November, (2) spring litter raking annually in March, and (3) no litter raking as control. Our observations indicated that the area was not subjected to strong winds, suggesting that fencing or other means to prevent post-treatment litter accumulation was unnecessary. Litter raking consisted of collecting and weighing all leaf litter from a plot using a standard leaf rake, including the removal of litter from the adjacent 1.0 m buffer zone.

3.3. Graphical representation of the experiment



4. Investigated organism groups

4.1. Understory vegetation

Lists of vascular plant species with estimates of relative cover (nine-level Braun-Blanquet scale), both herbs and woody regeneration up to 1,3 m of height.

Sampled in July/August in 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019; planned in 2020 and every year onwards.

4.2. Bryophytes

Bryophytes were sampled prior the treatment (2010) and in the final year of the experiment (2019). All bryophytes on the soil surface in each of the plots were recorded and their cover-abundance estimated using the nine-level Braun-Blanquet scale.

4.3. Myriapoda

Soil invertebrates (centipedes and millipedes) were sampled using soil corer (diameter 27.2 cm, depth 10 cm) at autumn of the seventh year (2016), before raking. Spiders, pseudoscorpiones and isopods were also found, counted and identified but the number of species and individuals were very low.

5. Investigated environmental variables

5.1. Light

Hemispherical photographs taken during summer at 9 (or 5, in seven plots before the treatment) subplots within the plot. Analyzed in WinScanopy for canopy openness and related parameters. Records from 2010, 2013 (poor quality), 2015, 2016, 2017, 2018.

5.2. Topsoil

In 2010, 2011 and 2012, samples from the upper 5 cm of the organomineral horizon (A) and from the 5–10 cm horizon (B) were collected in summer 2015 from 4 subplots per plot, mixed and analyzed for following parameters: pH (water), dry matter, N (total), C (total), P (exchangeable), Ca, Mg, K. Additionally, pH was measured in 2013 and 2014.

5.4. Microclimate

During 2016 and 2017, TMS data loggers (https://tomst.com/web/en/systems/tms/tms-4/) were used to measure following parameters: a) temperature 10 cm aboveground, b) temperature at the ground level, c) temperature 10 cm belowground, d) soil moisture. The data were recorded automatically every 15 minutes on several plots.

6. Other investigated functions/processes

-

7. References

Vild O., Kalwij, J.M., & Hédl, R. 2015. Effects of simulated historical tree litter raking on the understorey vegetation in a central European forest. Applied Vegetation Science 18: 569–578.

Vild, O., Hédl, R., & Kalwij, J.M. 2019. Litter raking as restoration management in an oak forest in Podyjí National Park. In *Ecological Restoration in the Czech Republic*, pp. 17–19. Nature Conservation Agency of the Czech Republic, Prague, Czech Republic.

8. Participating experts in the project

Ondřej Vild, Institute of Botany, Czech Academy of Sciences (project leadership, plants)
Radim Hédl, Institute of Botany, Czech Academy of Sciences (various)
Eva Mikulášková, Department of Forest Ecology, Silva Tarouca Research Institute (bryophytes)
Svatava Kubešová, Department of Botany, Moravian Museum (bryophytes)
Jana Procházková, Department of Botany and Zoology, Masaryk University (bryophytes)
Ivan H. Tuf, Department of Ecology and Environmental Sciences, Faculty of Science, Palacky University, Olomouc (myriapoda)
Ondřej Machač, Department of Ecology and Environmental Sciences, Faculty of Science, Palacky University, Olomouc (myriapoda)

EX04_DE_ID

1. General information

Name of the experiment: **Steigerwald experiment** (There is no real existing name except the "finance number" L55)

Contact(s) in the COST Action: Inken Dörfler (inkendoerfler@gmail.com or inken.doerfler@uol.de)
Organization of the Contact(s): Carl von Ossietzky Universität Oldenburg, Institut für Biologie und Umweltwissenschaften, Vegetation Science and Nature Conservation, Ammerländer Heerstraße 114-118, 26129 Oldenburg, Germany
Website of the experiment: Not existing

The question of the experiment: How does deadwood enrichment, applied by a forestry, affect biodiversity?

Locality: Country: Germany, State: Bavaria, District: Oberfranken, Region: Steigerwald (Google: 49°50'52.0"N 10°29'32.8"E)
Number of Sites: 1
Number of Blocks: None
Treatments and number of Levels: various
Number of Plots: 69

Dates:
Beginning of the experiment: 2004
Date of Before-treatment data collection: yes (2004)
Date of intervention: since 2005/2006 and from then on continuous (deadwood enrichment)
Dates of after-treatment data collection: 2014–2017

2. Site descriptions

2.1. Site 1.

Location: Country: Germany, State: Bavaria, District: Oberfranken, Region: Steigerwald
GPS coordinates: Lat: 49.847778N, Lon: 10.492444E
Altitude: 300 to 450 m
Aspect: varying
Slope: varying
Mean annual temperature: 8.6 °C
Annual precipitation: 650–850 mm
Bedrock: hard sand- and soft claystone
Soil type: brown soil developed from loess clay (Colluvisole, Cambisol)
Site area: ~1800 ha
Forest type: 'Luzulo-Fagetum'' and 'Galio odorati-Fagetum' (Central European submountainous beech forest – 6.4)

Age of the stand at the beginning of the experiment: 1–200 years
Stand structure before the interventions:
canopy: Beech (5 to >100% (with a second canopy layer))
shrub layer: Beech
understory layer: typical beech forest flora with 1–30 species
Canopy openness: 0–10%
Management type before the experiment: Selection cut
Available data for the stand structure of the stand: For 2/3 of the plot forest inventory data (tree wise measures = DBH, height, species…), for all plots airborne laser scans; age of trees, CO (visual estimation)

3. Applied treatments

3.1. Treatment 1. Deadwood enrichment

3.2. Description of the study design
"In 2006, a 'deadwood enrichment strategy' was introduced in Ebrach. In addition to the creation of small protected areas, a key element of this strategy is to enrich the structural diversity of the managed forest, by (i) increasing deadwood amounts, and (ii) retention of 'habitat trees' that provide special structures (Kraus et al., 2016) which serve as microhabitats for various forest taxa. Deadwood target values are set to 20 m3/ha in deciduous stands older than 100 years, and 40 m3/ha in deciduous stands older than 140 years. Stands older 180 years are only carefully managed to preserve deadwood amounts. The intended deadwood profile consists of the 50% logs (diameter threshold 20 cm) and branches, 38% snags and 12% stumps. In practice, deadwood enrichment is realised during harvest operations, by leaving deadwood crowns and parts of low quality stems in the forest and preserving existing deadwood objects. For the retention of 'habitat trees', a target of 10 trees per hectare was set. These trees are marked during forest inspections and spared during thinning and harvest operations."
Doerfler, I., Müller, J., Gossner, M.M., Hofner, B. & Weisser, W.W. (2017) Success of a deadwood enrichment strategy in production forests depends on stand type and management intensity. Forest Ecology and Management, 400, 607–620.

3.3. Graphical representation of the experiment

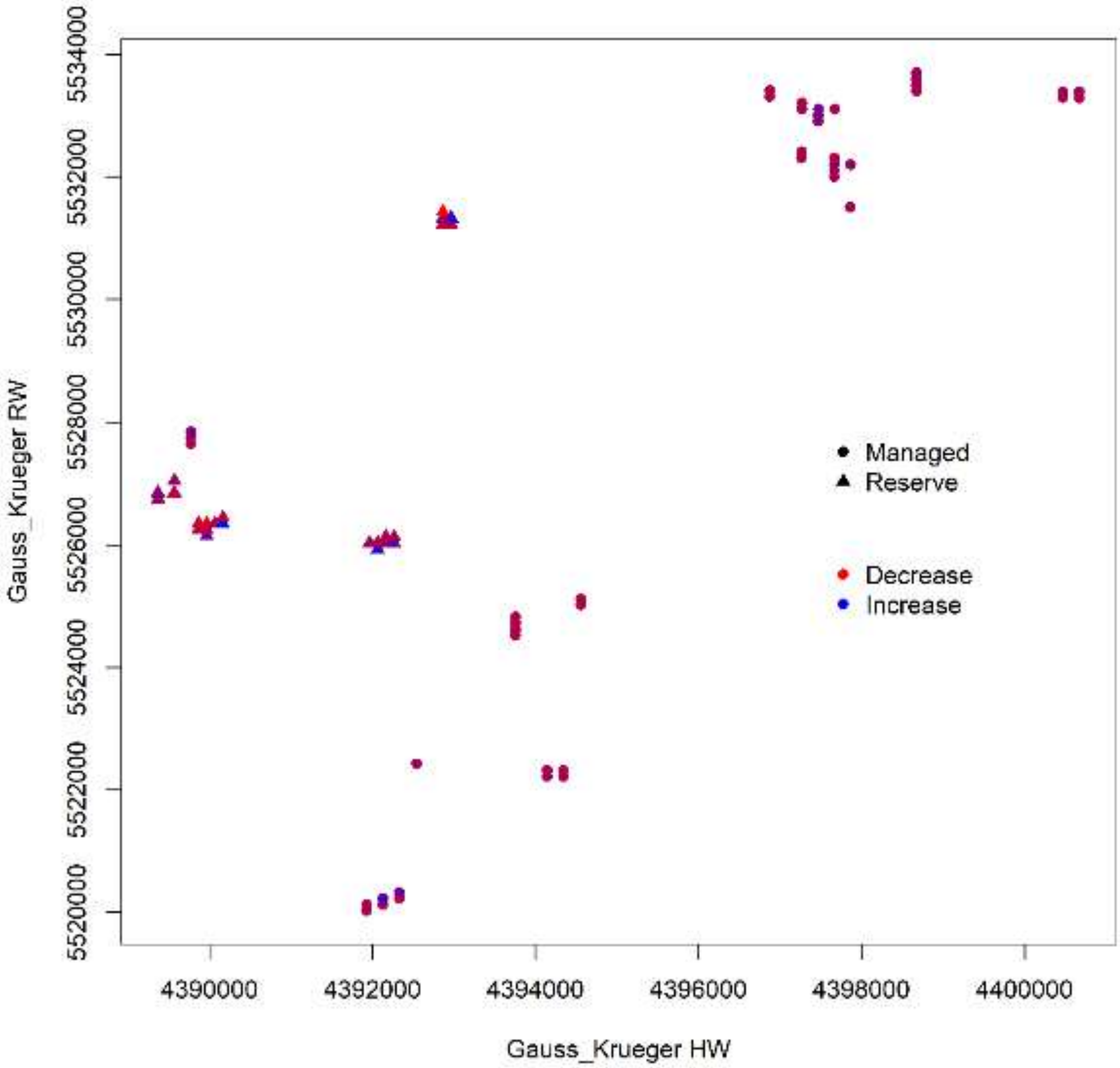


Figure 1. Development of deadwood amounts after the implementation of the treatment.

4. Investigated organism groups

4.1. Coleoptera

Beetles were sampled before (2004) and after (2014) the treatment with two methods: expert sampling on deadwood (12 m circle, 45 min, three times: spring, summer, autumn), flight interception traps (from May to October). Number of trapped individuals was used as abundance scale.

Ground dwelling beetles were sampled only after the treatment with pitfall traps in 2016 (May–October). Number of trapped individuals was used as abundance scale.

4.2. Heteroptera
True Bugs were sampled before (2004) and after (2014), using flight interception traps. Number of trapped individuals was used as abundance scale.

4.3. Aves
Birds were recorded before (2004) and after (2014) the treatment using point-stop grid sampling (1 ha, 7 min, five times: spring to summer). Number of recorded species was used as abundance scale.

4.4 Chiroptera
Bats were recorded only after the treatment (2016) using bat recorders (7 times, spring-summer)

4.5. Tracheophyta
Plants were recorded before (2004) and after (2014) the treatment on soil, deadwood and stones (14 m x 14 m square, two times: May, June). Abundance was recorded using the Braun-Blanquet scale.

4.6. Bryophytes
Bryophytes were recorded only after (2014) the treatment on the lower 1 m of living tree trunks, soil, deadwood and stones (14 m x 14 m square, two times: May, June). Abundance was recorded using the Braun-Blanquet scale.

4.7. Fungi
Fungi were sampled before (2004) and after (2014) the treatment with expert sampling on deadwood and soil (12 m circle, 45 min, three times: spring, summer, autumn). Number of occurrences on different patches or deadwood elements was used as abundance scale.

4.8. Lichen
Lichen were sampled only after (2017) the treatment with expert sampling on living tree trunks.

5. Investigated environmental variables

5.1. Deadwood
All deadwood elements > 12 cm diameter (no minimum of length or height) were recorded (snags, stumps, lying deadwood, root plates). Smaller deadwood elements were recorded as cover per plot.

5.2. Living stand variables
For most (~2/3) of the plots forest inventory data are existing before (1997) and after (2010, 2016) the treatment. These include tree-wise measures of DBH, height, age, species.
Living stand data derived from airborne laser scans are available after (2016) the treatment.

6. Other investigated functions/processes

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7. References

Doerfler, I. (2017) Evaluation of an integrative strategy in forests: does deadwood enrichment work and increase biodiversity? Doctoral, Technischen Universität München.

Doerfler, I., Gossner, M.M., Müller, J., Seibold, S. & Weisser, W.W. (2018) Deadwood enrichment combining integrative and segregative conservation elements enhances biodiversity of multiple taxa in managed forests. Biological Conservation, 228, 70–78.

Doerfler, I., Müller, J., Gossner, M.M., Hofner, B. & Weisser, W.W. (2017) Success of a deadwood enrichment strategy in production forests depends on stand type and management intensity. Forest Ecology and Management, 400, 607–620.

Müller, J. (2005) Waldstrukturen als Steuergröße für Artengemeinschaften in kollinen bis submontanen Buchenwäldern. Technical University of Munich.

Müller, J. & Hothorn, T. (2004) Maximally selected two-sample statistics as a new tool for the identification and assessment of habitat factors with an application to breeding-bird communities in oak forests. European Journal of Forest Research, 123, 219–228.

Roth, N., Doerfler, I., Bässler, C., Blaschke, M., Bussler, H., Gossner, M.M., Heideroth, A., Thorn, S., Weisser, W.W. & Müller, J. (2019) Decadal effects of landscape-wide enrichment of dead wood on saproxylic organisms in beech forests of different historic management intensity. Diversity and Distributions, 25, 430–441.

8. Participating experts in the project

Species groups:
Beetles: Heinz Bußler (expert sampling), Ludger Schmidt, Johannes Bail
Fungi: Heinz Engel (expert sampling 2004), Markus Blaschke (expert sampling 2014), Claus Bässler
Plants and Bryophytes: 2004: Holger Hastreiter, Michael Seuß, 2014: Inken Doerfler
Lichen: Stefan Kaufmann
Birds: Rico Michaelis, Niclas Böhm, Jörg Müller, Volker Zahner, Christine Franz
Bats: Jan Leidinger
True Bugs: Martin Gossner
Forest inventory data and repeated measures: Jörg Müller

EX05_DE_PS

1. General information

Name of the experiment: **Biodiversity Exploratories FOrest gap eXperiment – FOX**

Contact(s) in the COST Action: Peter Schall (peter.schall@forst.uni-goettingen.de)
Organization of the Contact(s): Silviculture and Forest Ecology of the Temperate Zones, University of Göttingen, Büsgenweg 1, D-37077 Göttingen, Germany
Website of the experiment: www.biodiversity-exploratories.de

The question of the experiment: In the first ten years of research in the forests of Biodiversity Exploratories, it was found that differences tree species composition rather than cutting intensities, which varied within a limited range, drove biodiversity. We hypothesize that heavier interventions, increasing temperature and light availability on the forest floor substantially, would lead to more pronounced changes in species communities. We combined canopy gaps with deadwood enrichment full factorial in seven different forest types in three regions in Germany.

Locality: Germany, Biodiversity-Exploratories 'Schwäbische Alb', 'Hainich-Dün' and 'Schorfheide-Chorin'
Number of Sites: 3 Regions
Number of Blocks: 29
Treatments and number of levels:
Treatment 1: Canopy gap (2 levels: -Gap, +Gap)
Treatment 2: Deadwood enrichment (2 levels: -DW, +DW)
Number of Plots: 116 (29 blocks x 4 treatments)

Dates:
Beginning of the experiment: 2019
Before-treatment data collection:
Stand structure: 2019
Soil properties: 2019
Taxa of control treatment (-Gap/-DW): since 2008
Interventions: Jan to April 2020
After-treatment data collection: 6 years (2020–2025)

2. Site descriptions

2.1. Site 1
Location: Schwäbische Alb, comprising 8 blocks
GPS coordinates:
Lat: 48.4°N
Lon: 9.4° E
Altitude: 680–820 m

Aspect: -
Slope: -
Mean annual temperature: 6–7 °C
Annual precipitation: 700–1000 mm
Bedrock: Jurassic limestone with karst phenomena
Soil type: Eutric Cambisols (partly Leptosols)
Site area: -
Forest type: 3 different forest types: European beech forest, European beech mixed deciduous forest, Norway spruce forest. Natural vegetation ranges from Galio-Fagetum to Hordelymo-Fagetum (Natura 2000: 9130 and 9150).
Dominant tree species: Fagus sylvatica, Fraxinus excelsior, Picea abies.
Age of the stand at the beginning of the experiment: 80–140 years
Stand structure:
canopy: mature timber stage
shrub layer: scarce
understory layer: depending on forest type (higher cover in spruce)
Canopy openness: around 5%
Management type before the experiment: shelterwood system with thinning from above and target diameter harvesting
Available data for the stand structure of the stand: Tree level: species, geographic location, DBH, height, volume. Stand level: composition, basal area, height, volume, dead wood volume, canopy openness.

2.2. Site 2.
Location: Hainich-Dün, comprising 9 blocks
GPS coordinates:
Lat: 51.2°
Lon: 10.3°
Altitude: 290–500 m
Aspect: -
Slope: -
Mean annual temperature: 6.5–8 °C
Annual precipitation: 500–800 mm
Bedrock: Triassic limestone with loess cover
Soil type: Eutric Cambisols and Luvisols
Site area: -
Forest type: 2 different forest types: European beech age-class forests, European uneven-aged forests. Natural vegetation ranges from Galio-Fagetum to Hordelymo-Fagetum (Natura 2000: 9130 and 9150).
Dominant tree species: Fagus sylvatica
Age of the stand at the beginning of the experiment: 100–160 years
Stand structure:
canopy: single layered or multi-layered
shrub layer: scarce
understory layer: Geophytes
Canopy openness: around 5% in even-aged forests. Rugged canopy in uneven-aged forests.

Management type before the experiment: shelterwood system with thinning from below/above or single-tree selection system.
Available data for the stand structure of the stand: Tree level: species, geographic location, DBH, height, volume. Stand level: composition, basal area, height, volume, dead wood volume, canopy openness.

2.3. Site 3.
Location: Schorfheide-Chorin, comprising 12 blocks
GPS coordinates:
Lat: 52.9°N
Lon: 13.8°E
Altitude: 45–100 m
Aspect: none
Slope: none
Mean annual temperature: 8–8.5 °C
Annual precipitation: 500–600 mm
Bedrock: Young glacio-fluvial and aeolian substrates (sand, silt)
Soil type: Dystric Cambisols
Site area: -
Forest type: 4 different forest types: Scots pine forests, European beech forests, Scots pine-European beech forests, Oak (*Q. petraea* and *Q. robur*) forests. Natural vegetation ranges from Luzulo-Fagetum to Galio-Fagetum (Natura 2000: 9110 and 9130).
Dominant tree species: Relative to forest type, i.e. *Pinus sylvestris* or *Fagus sylvatica* or *Pinus sylvestris* and *Fagus sylvatica* (1st and 2nd tree layer, respectively) or *Quercus robur/petrea*.
Age of the stand at the beginning of the experiment: 100–160 years
Stand structure:
canopy: single layered or double-layered
shrub layer: dwarf shrub in pine forests, otherwise scarce
understory layer: Relative to forest type, i.e: higher cover in pine and oak forests than in forests with beech.
Canopy openness: driven by forest type. Light transmission higher in pine and oak forests than in forests with beech.
Management type before the experiment: Relative to forest type, and closely following German-style silvicultural textbook knowledge.
Available data for the stand structure of the stand: Tree level: species, geographic location, DBH, height, volume. Stand level: composition, basal area, height, volume, dead wood volume, canopy openness.

3. Applied treatments

3.1. Treatment 1. Forestry treatments
1. -Gap/-DW: Forest management as usual without creating gaps or enriching deadwood.
2. +Gap/-DW: Gap-cutting in a previously closed stand (diameter approximates stand height)
3. +Gap/+DW: Gap-cutting in a previously closed stand (diameter approximates stand height) and enriching deadwood DWV (m^3 / ha) relative to previous stand volume V (m^3 / ha) (DWV ~ 50 + 0.25 x V).

4. -Gap/+DW: Enriching deadwood relative to previous stand volume.

3.2. Treatment 2. Forest types
1. European beech across regions
2. Forest types within regions

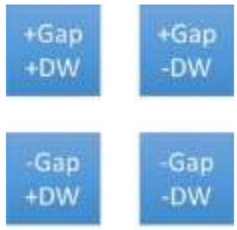
3.3. Description of the study design

Full factorial design

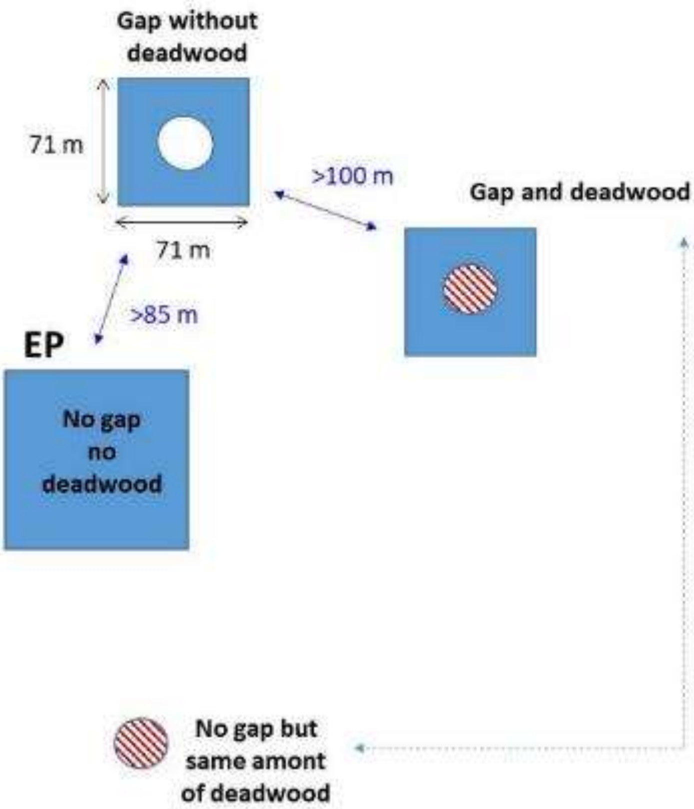
- Canopy gap: Yes/no
- Deadwood enriched: Yes/no

Blocks

- Treatments blocked in vicinity of plots of the Biodivesity-Exploratories
- Minimum distance between treatments
- Comparable site conditions
- Comparable forest structure and composition
- Only mature forests
- Plots of the Biodivesity-Exploratories as control (-Gap/-DW)



3.4. Graphical representation of the experiment



4. Investigated organism groups

4.1. Understory vegetation
Visual estimation of cover and frequency of plant species (incl. byrophytes).
a. 5 m × 5 m understory quadrats, surveyed in every year, in spring and summer.
b. N/S and E/W transects, each 50 m in length

4.2. Regeneration of woody species
a. Recording the number of saplings in 6 regeneration subplots (4 m x 3 m) arranged N/S per species per size categories (0–20 cm, 20–50 cm, 50–130 cm, >130 cm height) and if browsed. Surveyed in every autumn.
b. Quantifying root biomass and composition (grasses, herbs, trees) taking soil cores in the regeneration subplots. Every two years.

4.3. Root associated fungi
Quantifying biomass and composition of root associated fungi using soil cores. Annual sampling.

4.4. Deadwood microbiome
Identity and composition of the deadwood microbiome based on drilling material. Annual sampling.

4.5. Arthropods (Lepidoptera, Hymeoptera, Heteroptera)
a. Continuous sampling of individuals using flight interception traps (2 per plot) during spring and summer.
b. Sampling of individuals using light traps (1 per plot).

4.6. Earthworms
Earthworm sampling using soil cores (4 per plot arranged N/S).

4.7. Wood-inhabiting fungi

4. 8. Coleoptera (carabids, carnivore, herbivore, omnivore, decomposer, saproxylic)
Pitfall trap, ...

5. Investigated environmental variables

5.1. Climate
Climate within the gap will be monitored continuously recording light (PAR), air temperature and humidity (height gradient) and soil temperature.

5.2. Soil physical and chemical parameters
Soil sampling on 4 subplots from 0–10 cm depth. Standard physical and chemical properties (Soil texture, pH, organic matter, nutrient content, etc.).

5.3. Physical forest structure
TLS and ALS scanning of forest physical properties.

6. Other investigated functions/processes

-

7. References

Fischer, M., Bossdorf, O., Gockel, S., Hansel, F., Hemp, A., Hessenmoller, D., … Weisser, W.W. (2010) Implementing large-scale and long-term functional biodiversity research: The Biodiversity Exploratories. Basic and Applied Ecology, 11 (6), 473–485.

Schall, P., Schulze, E.-D., Fischer, M., Ayasse, M. & Ammer, C. (2018) Relations between forest management, stand structure and productivity across different types of Central European forests. Basic and Applied Ecology, 39–52.

8. Participating experts in the project

Christian Ammer, Silviculture and Forest Ecology of the Temperate Zones, University of Göttingen
Markus Fischer, Institute of Plant Sciences, University of Bern
Wolfgang Weisser, Terrestrial Ecology Research Group, Technische Universität München
Manfred Ayasse, Institute of Evolutionary Ecology and Conservation Genomics, University of Ulm
François Buscot, German Centre for Integrative Biodiversity Research (iDiv) Halle – Jena – Leipzig
Marion Schrumpf, Max-Planck-Institute for Biogeochemistry, Department for Biogeochemical Processes, Jena
Thomas Nauss, Philipps-Universität Marburg
Christoph Kleinn, Forest Inventory and Remote Sensing, University of Göttingen
Jörg Müller, Animal Ecology of the temperate zone, University Würzburg
Claus Bässler, Goethe University Frankfurt
Andrea Polle, Forest Botany and Tree Physiology, University of Göttingen
Peter Schall, Silviculture and Forest Ecology of the Temperate Zones, University of Göttingen

See www.biodiversity-exploratories.de/en/projects/current-projects for all people involved in current projects.

EX06_DK_JHC

1. General information

Name of the experiment: No official name but commonly known as **"The beech forest experiment"**

Contact(s) in the COST Action: Jacob Heilmann-Clausen (jheilmann-clausen@snm.ku.dk)
Organization of the Contact(s): University of Copenhagen, CMEC
Website of the experiment:
https://macroecology.ku.dk/pdf-files/Skovprojekt_forkortet_offentlig_version.pdf

The question of the experiment: Can we improve biodiversity in managed beech forests by active veteranization, dead wood creation and artificial gaps?

Locality: Gribskov, Denmark
Number of (Sub)-sites: 5
Number of Blocks: 1 per site
Treatments and number of Levels: 3 overall types (unmanaged control, managed control and experimental stand). Experimental stands include three macroscale treatments (no gap, gap 40 m diam. with timber extraction, gap 40 m diam. with felled trees left on site) and four treelevel treatments (ringbarking, basal burn, artificial cavity, tree felled in ca 1.5 m) + control trees
Number of Plots: five per site (unmanaged control, managed control, experimental no gap, experimental, gap with timber extraction, gap with felled trees left on site), c. 15 trees x treatment per site (i.e. 60 trees + controls per site)

<u>Dates:</u>
Beginning of the experiment:
Date of Before-treatment data collection: 2014
Date of intervention: winter 2014/2015
Dates of after-treatment data collection: 2017–2018 with planned continuation in 2020

2. Site descriptions

2.1. Sites 1–5. (for details on each site see master META-DATA file for WP1)

Location: Northern Zealand, Denmark
GPS coordinates: easting 12.3°, northing 56.0°
Altitude: 20–70 m
Aspect: mainly flat
Slope: mainly flat to undulating
Mean annual temperature: 8.6–8.8 °C
Annual precipitation: 700–800 mm
Bedrock: Glacial tills
Soil type: Cambisols, partly Luvisols
Site area: 10 ha (each site)

Forest type: beech forest on mull (9130) and mor (9110) – EEA: Lowland beech forest of southern Scandinavia and north central Europe (6.1)
Age of the stand at the beginning of the experiment: 101–136 years
Stand structure before the interventions:

canopy: pure beech (with very few admixed conifers)
shrub layer: sparse/absent
understory layer: absent to well-developed, mainly beech

Canopy openness: closed
Management type before the experiment: shelterwood
Available data for the stand structure of the stand: tree species, DBH, basal area, height, volume, standing and lying dead wood volume, canopy openness

3. Applied treatments

1. Unmanaged control
2. Managed control
3. Experimental stands

In experimental stands:
3.1. Treatment 1. Macroscale treatments: gap-cutting
- no gap
- gap 40 m diam. with timber extraction
- gap 40 m diam. with felled trees left on site

3.2. Treatment 2. Tree-level treatments:
- ringbarking
- basal bur
- artificial cavity
- tree felled in ca 1.5 m

+ control trees

3.3. Description of the study design
Same for each site – described above.

3.4. Graphical representation of the experiment

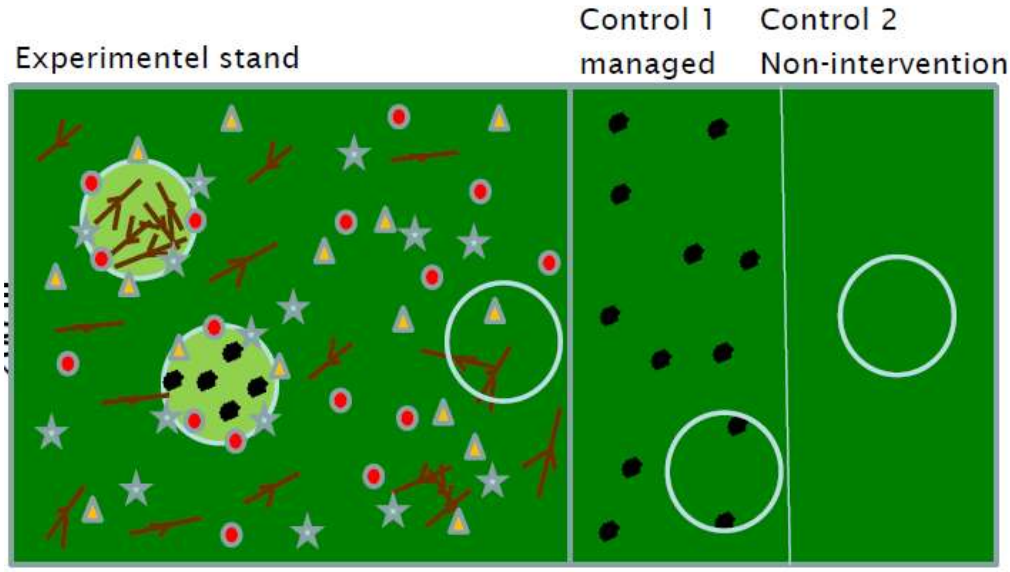


Figure 1. Principal design (experimental stand c. 5 ha, controls c. 2.5 ha each) with grey circles indicating sample plots

Figure 2. Treatments

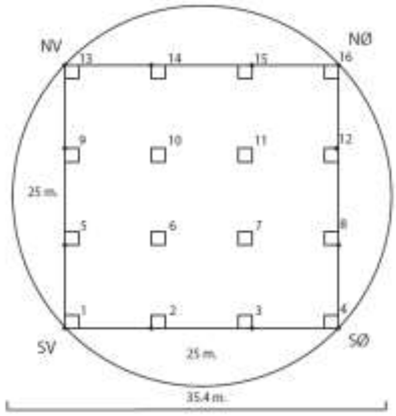


Figure 3. Design of each sample plot with subplots

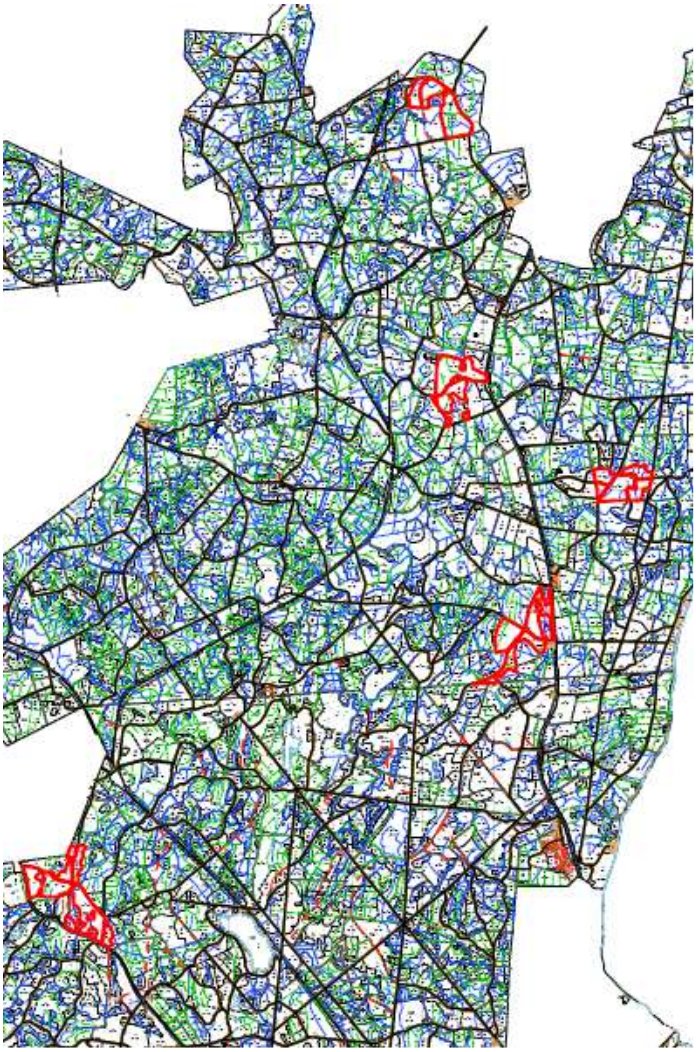


Figure 4. Distribution of sites/blocks in Gribskov (Max distance between sites = 7.1 km)

4. Investigated organism groups

4.1. Understorey vegetation including bryophytes

4.2. Regeneration of woody species
based on detailed measurements in 16 x 1 m3 subplots per plot

4.3. Wood-inhabiting fungi

4.4. Epiphyte mosses

4.5. Epiphyte lichens

4.6. Breeding birds

4.7. Beetles
pitfall + window traps

For details see master META-DATA file for WP1

5. Investigated environmental variables

5.1. Microclimate (temperature + humidity)
with automatic loggers

5.2. Humus and litter layer thickness
four subplots per plot

5.3. Soil pH

5.4. Dead wood

6. Other investigated functions/processes

6.1. Volume and timber value of trees before treatments

7. References
-

8. Participating experts in the project

Jacob Heilmann-Clausen
Hans Henrik Bruun

EX07_EE_LR

1. General information

Name of the experiment: **Drained-forest Restoration Experiment (DREX)**

Contact(s) in the COST Action: Asko Lõhmus (asko.lohmus@ut.ee), Liina Remm (liina.remm@ut.ee)
Organization of the Contact(s): Institute of Ecology and Earth Sciences University of Tartu, Vanemuise 46, Tartu, Estonia, 51014
Website of the experiment: none

The question of the experiment: How do habitat restoration (thinning treatments and water level rising) in drained pine woodlands on peat soil influence capercaillie (*Tetrao urogallus*), other species groups, ecosystem functioning and stand structure?

Locality: Soomaa, Estonia
Number of Sites: 2
Number of Blocks: 8
Treatments and number of Levels:
Treatment 1: thinning treatments (4 levels, incl. control)
Treatment 2: hydrological restoration via ditch blocking (2 levels: yes/no)
Number of Plots: 64

Dates:
Beginning of the experiment: 2013
Date of Before-treatment data collection: 2013–2014
Date of intervention: VIII 2014–II 2016
Dates of after-treatment data collection: 2015–2019, but not annually for all parameters

2. Site descriptions

2.1. Site 1.
Location: Soomaa, Vanaveski
GPS coordinates: Longitude 883 073.59, Latitude 804 891.81 (WGS84 X: 25.20510, Y: 58.38360)
Altitude: ca 35 m
Aspect: flat
Slope: flat
Mean annual temperature: +5.8 °C
Annual precipitation: 764 mm
Bedrock: Devonian sandstone
Soil type: Histosol, Gleysol
Site area: 8 km^2

Forest type: *Pinus sylvestris* – *Betula* sp. – *Picea abies* forests on drained peat (EEA 2006: 6.11.1)
Age of the stand at the beginning of the experiment: 42–118 years (several stands)
Stand structure before the interventions:

canopy: pine (and some birch and spruce) in the first layer, spruce in the second layer, varies between the plots

shrub layer: varies between the plots, typically *Frangula alnus* and spruce

understory layer: dwarf shrubs and some grasses; well-developed moss cover, incl. remnant Sphagnum moss patches of former wetland stage

Canopy openness: 40%
Management type before the experiment: some older stands have old stumps from light thinnings; everywhere the canopy has been grown denser after the drainage in 1975 (part of the area was open before that). Currently no timber production.
Available data for the stand structure of the stand: tree species, DBH, basal area, height, volume, standing and lying dead wood volume, canopy openness, variation in openness.

2.2. Site 2.
Location: Soomaa, Räksi
GPS coordinates: Longitude 872 177.25, Latitude 795 971.04
Altitude: ca 35 m
Aspect: -
Slope: -
Mean annual temperature: +5.8 °C
Annual precipitation: 764 mm
Bedrock: Devonian sandstone
Soil type: Histosol, Gleysol
Site area: 15 km^2
Forest type: Pinus sylvestris – *Betula* sp. – *Picea abies* forests on drained peat (EEA 2006: 6.11.1)
Age of the stand at the beginning of the experiment: 45–112 years
Stand structure before the interventions:

canopy: pine (and some birch and spruce) in the first layer, spruce in the second layer, varies between the plots

shrub layer: varies between the plots

understory layer: dwarf shrubs and some grasses, well-developed moss cover, ingl. Sphagnum mosses

Canopy openness: 35%
Management type before the experiment: no cuttings, but the canopy has been grown more dense, because of the drainage in late 1960s.
Available data for the stand structure of the stand: tree species, DBH, basal area, height, volume, standing and lying dead wood volume, canopy openness, variation in openness.

3. Applied treatments

The treatments are introduced under the figure, which originates from Lõhmus et al. 2017.

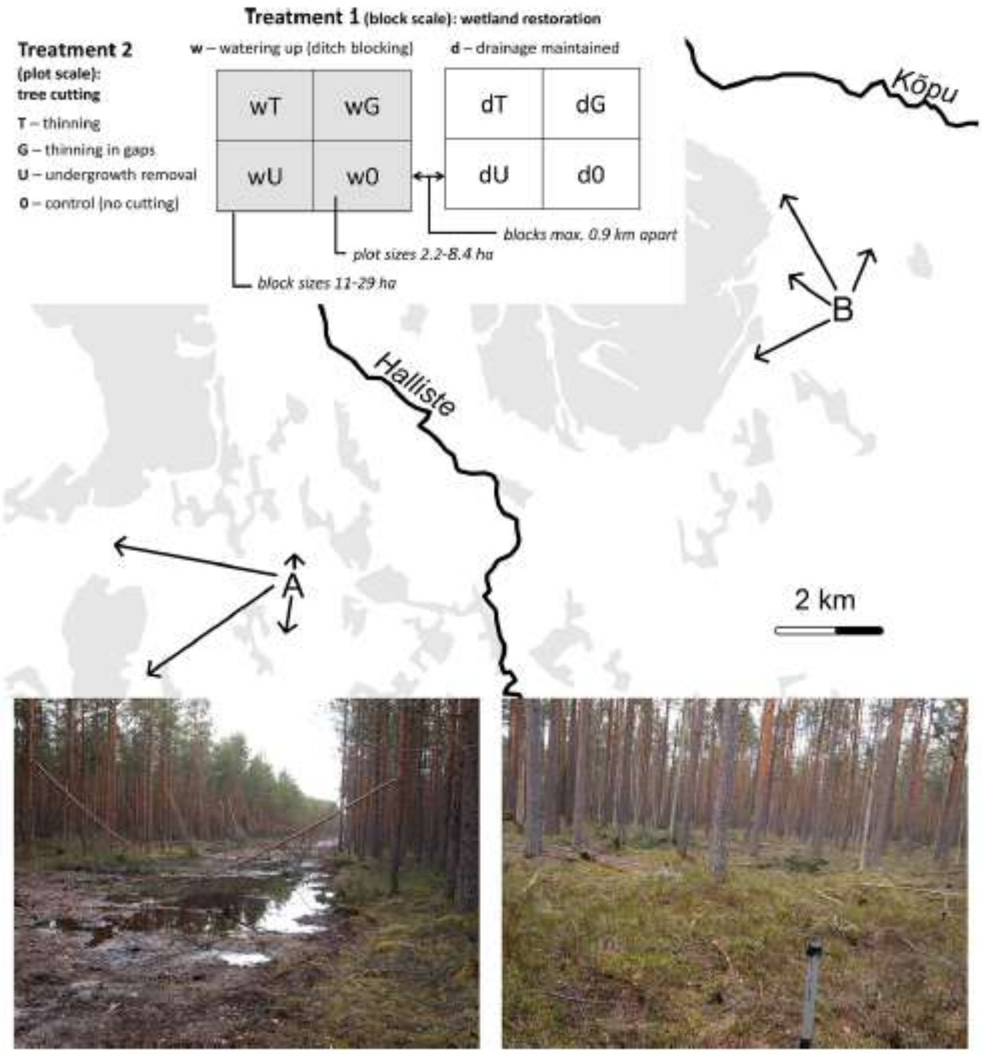


Figure 1. Design of the Capercaillie habitat management experiment in Soomaa, southwestern Estonia. Background map: there are 4 × 4 experimental sites (pointed by arrows) 0.4–3.5 km away from two leks (A, B) in heavily drained forest landscapes near large mires (grey areas). Treatment scheme each experimental site comprises a pair of blocks, one of which undergoes wetland restoration by ditch filling. Each block is divided into four plots, which receive randomly assigned cutting treatments. Undergrowth is removed (retaining 20–30 dense spruces ha-1) in all treatments except control; it is supplemented with thinning in treatments T (up to 30% of volume harvested throughout the stand) and G (thinning in 40–100 m diameter gaps covering half of the forest area). Photos treatment ‘‘wT’’ in a test site in Latvia (filled ditch and adjacent thinned stand on 30 April 2013). Photo credits: A. Lõhmus

4. Investigated organism groups

4.1. Understory vegetation (incl. woody regeneration)
Abundance data from 2 ha plots (see Lõhmus et al. 2018 for the method), the abundance of dwarf shrubs was also estimated on 24 1 m^2 squares in each 2 ha plots. The surveys were made once before and once after the experiments

4.2. Lichens
Abundance data from 2 ha plots (see Lõhmus et al. 2018 for the method). The inventory has been made only before the experiment (not repeated yet).

4.3. Birds
Bird counting was made on larger areas than the 2 ha plots (9.8–30.1 ha) Inventories were made on four springs: before in 2013 (site 1) and 2014 (site 2); after manipulation in 2015, 2016 and 2019 (see Lõhmus and Rosenvald 2005 for the method).

4.4. Fungi
Polypore inventories were made in 2013 and in 2017 on 2 ha plots (see Lõhmus et al. 2018 for the method). All fungi were sequenced from soil samples from four extreme treatments: block ditching (yes/no) × uniform thinning (yes/no) (not yet published).

5. Investigated environmental variables

5.1. Groundwater level
27 Geotech AB push-in type piezometers in four extreme treatments: block ditching (yes/no) × uniform thinning (yes/no) since 2013.

5.2. Microclimate
TinyTag sensors on trees at breast height, measuring air temperature and relative humidity.

6. Other investigated functions/processes

6.1. Decomposition rate
in topsoil, based on Keuskamp et al. 2013 Methods Ecol. Evol. (measured in 2014–2018) in four extreme treatments: block ditching (yes/no) × uniform thinning (yes/no).

7. References

Lõhmus, A., Leivits, M., Pēterhofs, E., Zizas, R., Hofmanis, H., Ojaste, I., & Kurlavičius, P. (2017). The Capercaillie (*Tetrao urogallus*): an iconic focal species for knowledge-based integrative management and conservation of Baltic forests. Biodiversity and Conservation, 26(1), 1–21.

Lõhmus, A., Lõhmus, P., & Runnel, K. (2018). A simple survey protocol for assessing terrestrial biodiversity in a broad range of ecosystems. PloS one, 13(12), e0208535.

Lõhmus, A.; Rosenvald, R. (2005). Järvselja looduskaitsekvartali haudelinnustik: pikaajalised muutused ja inventeerimismetoodika analüüs [Breeding bird fauna of the Järvselja Primeval Forest Reserve: long-term changes and an analysis of inventory methods]. Hirundo : Eesti Ornitoloogiaühingu ajakiri, 18 (1), 18−30.

8. Participating experts in the project

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...

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EX08_ES_MP

1. General information

Name of the experiment: **Life Pinassa "Sustainable Management for Conservation of *Pinus nigra* forests in Catalonia (NE Spain)"**

Contact(s) in the COST Action: Míriam Piqué (miriam.pique@ctfc.cat), Jordi Camprodon (jordi.camprodon@ctfc.cat)
Organization of the Contact(s): Forest Science and Technology Centre of Catalonia (CTFC)
Website of the experiment: http://lifepinassa.eu/?lang=en

The question of the experiment:
- Which forest types and forest structures (mature, regular/even aged and irregular/uneven aged) are more rich in biodiversity?
- How do different forest treatments (thinning, clearing, selection cutting, prescribed burning) influence in forest stand structure, forest biodiversity, forest growth and fire prevention?

Locality: It is a regional experiment, Catalonia (NE Spain)
Number of Sites:
Different sites within the two main *Pinus nigra* distribution areas in Catalonia (Central/ Pyrenees area and Meridional area)
Number of Blocks:
Treatments and number of Levels:
Number of Plots:
Forest types C1 (mature stands), C2 (young even aged stands), C3 (adults even aged stands), C4 (uneven aged stands), C5 (restoration stands), C6 (fire prevention stands) and C7 (fire adapted stands) of the project (see Fig. 1) have been reclassified into three forest types:
- Mature (not managed in last 20–30 years): include forest types C1 and C7. <u>37 plots in total.</u>
- Regular/even aged (managed forests): include forests types C3 and part of forest types C6 (the ones with regular forest structure). <u>37 plots in total.</u>
- Irregular/uneven aged (managed forests): include all the forests types C4 and part of forest types C6 (the ones with irregular forest structure). <u>22 plots in total.</u>
<u>In total, 96 plots (</u>distributed in 53 forest stands, 2 plots/forests stand approximately).
Moreover, we have <u>80 control plots</u> (21 mature plots, 37 regular plots, 22 irregular plots).

<u>*Dates:*</u>
Beginning of the experiment: 2014
Date of Before-treatment data collection: 2015
Date of intervention: 2015–2016
Dates of after-treatment data collection: 2016, 2018

2. Site descriptions

2.1. Site 1. Pre-pyrenean and central distribution area

Location: Pre-pyrenees range and pre-coastal central range, Catalonia
GPS coordinates: (in EPSG25831)
Easting 297876 – 491404
Northing 4582344 – 4698320
Altitude: median 670 m (110 – 1.760 m)
Aspect: wide variety, mainly south faces
Slope: wide variety, median 18º
Mean annual temperature: median 11.9 ºC (6.3 – 14.7 ºC)
Annual precipitation: median 700 mm (350–1160 mm)
Bedrock: Not assessed
Soil type: Not assessed
Site area: Estimated area for *Pinus nigra* forests in Pre-pyrenees and central distribution area: 131.000 ha

2.2. Site 2. Meridional distribution area

Location: south-eastern Iberian range, Catalonia
GPS coordinates: (in EPSG25831)
Easting 261415–351701
Northing 4503689–4590147

Altitude: median 870 m (235–1380 m)
Aspect: wide variety, mainly north faces
Slope: wide variety, median 26º
Mean annual temperature: median 12.1 ºC (10.0–15.4 ºC)
Annual precipitation: median 850 mm (550–1.070 mm)
Bedrock: Not assessed
Soil type: Not assessed
Site area: Estimated area for *Pinus nigra* forests in meridional distribution area: 12.000 ha. Total area where experiments were implanted is 283 ha, distributed in 53 forest stands within Pyrenees/Central and Meridional *Pinus nigra* distribution areas in Catalonia.

Forest type: Pinus nigra – Black pine (Priority conservation habitat of European Union: 9530* Mediterranean Pines (south-), Endemic. Annex I: Habitat Directive, (143,000 ha, in Catalonia)

Age of the stand at the beginning of the experiment: Different ages, depending on the forest structure:
Mature forests, more than 100–120 years
Regular/even aged forests, 50–100 years
Irregular/uneven aged forest: all ages

Stand structure before the interventions:
Different forest structures (regular and irregular). Main canopy species *Pinus nigra*. In general, abundant understory layers, with *Buxus sempervirens*, *Quercus* sp., etc.
Meridional distribution: more affected by fires and less abundant understory layer.

Canopy openness: In general < 30%
Management type before the experiment: Different types of management: no management in 20–30 years, even aged management, uneven aged management.

Available data for the stand structure of the stand:
- Canopy cover
- Density of living trees (Dn> 7,5 cm)
- Mean square diameter
- Basal area of living trees (Dn> 7,5 cm)
- Percentage of basal area corresponding to *Pinus nigra* trees
- Percentage of basal area corresponding to coniferous trees (exept *Pinus nigra*)
- Percentage of basal area corresponding to broadleaved trees
- Dominant diameter. Average of the 100 trees with the highest Dn per hectare
- Mean height
- Dominant height. It is calculated as the average of the 100 trees with the highest Hm per hectare
- Volume with bark calculated from AB (allometric relationship)
- Crown base height
- Mean crown diameter
- Density of small *Pinus nigra* (Dn <7,5 cm and H >1.3 m)
- Density of small coniferous trees (except *Pinus nigra*) (Dn <7,5 cm i H >1.3 m)
- Density of small broadleaved trees (Dn <7,5 cm i H >1.3 m)
- Percentage of vital trees (only C4 stand)
- *Pinus nigra* saplings density (H <1.3 m)
- Coniferous saplings (except *Pinus nigra*) density (H <1.3 m)
- Broadleaved trees saplings density (H <1.3 m)

3. Applied treatments

3.1. Description of the study design:
3 factors:
- Forest treatment (thinning, clearing, selection cutting, prescribed burning)
- Forest structure (regular/even aged managed forests, irregular/uneven aged managed forests, mature no managed forests)
- Biogeographical area (Central/Pyrenees, Meridional)

3.2. Graphical representation of the experiment

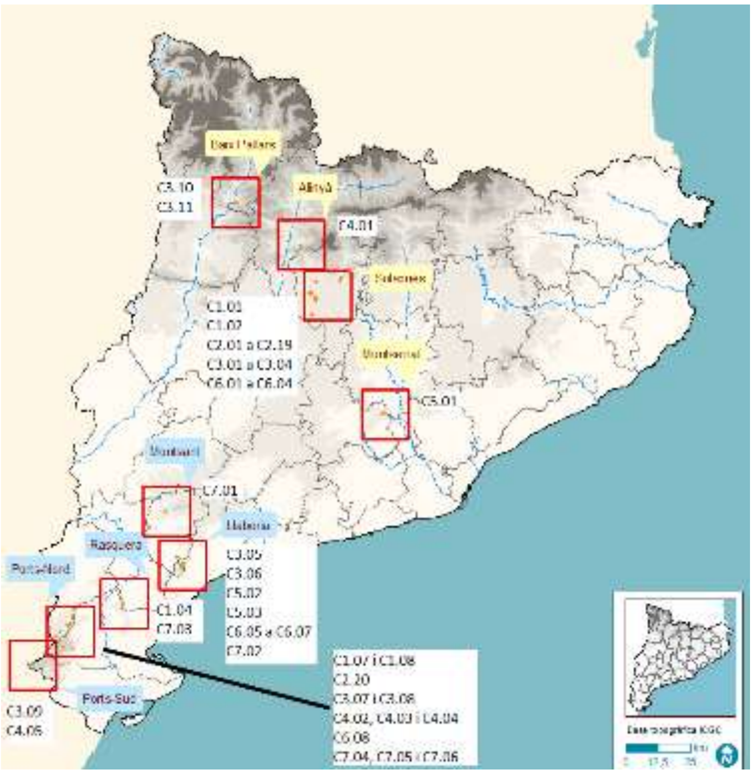

Figure 1: Forest stands were plots have been installed.

4. Investigated organism groups

4.1. Understory

- Herbaceous cover
- Shrub cover
- Proportional average of shrub height
- Number of plant species of interest detected
- Abundance of plant species of interest per km of transect

4.2. Bryophytes

- Moss cover

4.3. Birds

- Number of creeping bird species registered per census point within r=50 m
- Number of bird species (woodpeckers, tree-creepers and relatives) registered per census point within r=50 m
- Number of bird species registered per census point within r=50 m
- Number of bird individuals registered per census point within r=50 m
- Number of creeper bird (woodpeckers, tree-creepers and relatives) individuals registered per census point within r=50 m
- Number of forest bird individuals registered per census point within r=50 m

5. Investigated environmental variables

5.1. Site variables
- Altitude
- Aspect
- Climatic data (Prec, Temp, etc.)
- Site quality evaluated with ecological parameters, three categories: (A) high, (B) medium and (C) low
- Slash cover (diameter > 5 cm)
- Rocks cover

5.2. Deadwood
- Estimated density of dead wood (stands) items. Extrapolated from 50 m width band in predefined transects.
- Estimated density of dead wood (logs) items. Extrapolated from 4 m width band in predefined transects.
- Estimated dead wood volume from dead stands
- Estimated dead wood volume from logs

6. Other investigated functions/processes

6.1. Fire behavior indicators (only C6 plots)
- Crown foliage biomass
- Crown twigs (<0.6 cm diameter) biomass
- Available biomass (foliage + 1/2 twigs <0.6 cm)
- Foliage crown fuel load
- Twigs <0.6 cm diametre crown fuel load
- Available Crown Fuel Load (foliage + 1/2 twigs <0.6 cm)
- Crown height [Hm-CBH]
- Available Crown Fuel Load (foliage + 1/2 twigs <0.6 cm)

7. References

http://lifepinassa.eu/docs/manual_rodals_singulars_eng.pdf
http://lifepinassa.eu/docs/Manual_gestio_ENG.pdf
http://lifepinassa.eu/docs/Manual_foc_ENG.pdf

8. Participating experts in the project

Baiges, Teresa. Centre de la Propietat Forestal, CPF, (forest management)
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Camprodon, Jordi. Forest Science and Technology Centre, CTFC, (biodiversity)
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Guixé, David. Forest Science and Technology Centre, CTFC (biodiversity)
Larrañaga, Asier. Fire Fighting Department, Catalan Government (forest fires)
Palero, Noemí. Centre de la Propietat Forestal, CPF, (forest management)
Piqué, Míriam. Forest Science and Technology Centre, CTFC, (forest dynamics)

EX10_ES_FR_JRC

1. General information

Name of the experiment: **Innovative Forest Management Strategies to Enhance Biodiversity in Mediterranean Forest. Incentives & Management Tools. Life17 NAT/ES/000568**

Contact(s) in the COST Action: Joan Rovira Ciuró (joan.rovira@forestal.cat), Roser Mundet (roser.mundet@forestal.cat)
Organization of the Contact(s): **Consorci Forestal de Catalunya**

Street name and nº	Jacint Verdaguer, 3
Post Code	17430
Town/City	Santa Coloma de Farners
State	Spain
Telephone nº	+34 972 842 708

Website of the experiment: http://lifebiorgest.eu/en/home-2/

The questions of the experiment:
How can we implement measures to improve biodiversity in the guidelines for forest management in Mediterranean forests?
How to evaluate the potential biodiversity of the Mediterranean forests of Catalonia and that it can be implemented for other regions with similar characteristics?
How can we integrate measures to improve biodiversity into regional policies and regulations?

Locality: Spain: Catalonia (Girona-Barcelona)/ France: Occitania (Pyrenées Orientales)
Number of Sites: 6
Number of Blocks: plots are not arranged into blocks
Treatments and number of Levels: 4
Treatment 1: Catalan reference models
Treatment 2: Naturalistic forestry.
Treatment 3: Preparation for a natural dynamic.
Treatment 4: No treatment; Natural evolution.

Number of Plots: 24 (3 Tree species x 2 Forest mass x 4 Treatments)
Beginning of the experiment: October 2018

Dates:
Date of before-treatment data collection: November 2019
Date of intervention: December 2019–March 2020
Dates of after-treatment data collection: April 2020, April 2022

2. Site descriptions

2.1. Site 1.

Location:	**Serra de Collserola (ES)**
GPS coordinates:	Extreme west (41.430064/2.023564) Extreme north (41.433397/2.029033) Extreme east (41.429893/2.123861) Extreme south (41.418717/2.064303)
Altitude:	(75–405) m
Aspect:	NE, NW, S
Slope:	(25–37.5)%
Mean annual temperature:	14.4 ºC
Annual precipitation:	619 mm
Bedrock:	Clays, conglomerates
Soil type:	Eutric leptosol and eutric skeletic leptic regosol
Forest type:	Aleppo pine, *Pinus halepensis* HIC (9540): Coniferous forest of the Mediterranean (10.1) Holm oak, *Quercus ilex* HIC (9340): Broadleaved evergreen forest (9.1) Mediterranean oaks, *Quercus humilis*: Sessile oak–hombean forest (5.2)
Dominant tree species:	*Pinus halepensis* (FCC=28%, DBH=35.8 cm, Heigth=17.5 m), *Quercus ilex* (FCC=26%, DBH=10.6 cm, Heigth=9.4 m), *Quercus humilis* (FCC=15%, DBH=13.4 cm, Heigth=11.8 m)
Site area:	- 3 forests stand to natural evolution with 9 ha each one - 4 forests stand to preparation for a natural dynamic with 9 ha each one - 1 Close to nature forestry with 9 ha - 1 Catalan reference models with 9 ha
Age of the stand at the beginning of the experiment:	Undetermined, but more than 60 years
canopy:	63% *Pinus halepensis, Quercus ilex,* and *Quercus humilis.*
shrub layer:	FCC: 73%, Height: 3,2 m, *Viburnum tinus, Pistacia lentiscus, Erica multiflora, Arbutus unedo*
understory layer:	
Canopy openness:	10–30%
Management type before the experiment:	Forest abandonment, sustainable forest management, management for the carbon production. (coppice system and selection forestry system)
Available data for the stand structure of the stand:	Tree species, DBH, basal area, height, volume, standing and lying dead wood volume, canopy openness, bird, bryophytes and flora inventory

2.2. Site 2.

Location:	**Zona Volcànica de la Garrotxa i L'Alta Garrotxa (ES)**
GPS coordinates:	Extreme west (42.141838/2.576586) Extreme north (42.270927/2.626129) Extreme east (42.270927/2.626129) Extreme south (42.1410815/2.5790078)
Altitude:	474–635 m
Aspect:	S, SE
Slope:	25–37.5%
Mean annual temperature:	13.46 ºC
Annual precipitation:	840 mm
Bedrock:	Conglomerates, clays, stonewares, marlstones
Soil type:	Calcaric leptosol and skeletic leptic rendzic phaeozem
Forest type:	Holm oak, *Quercus ilex* HIC (9340), Mediterranean oaks, *Quercus humilis*
Dominant tree species:	*Quercus ilex* (FCC=80–60%, DBH=10–15 cm, Heigth=8–14 m), *Quercus petraea* (FCC=0–40%, DBH=25–30 cm, Heigth=14–18 m) *Pinus sylvestris* (FCC=0–30%, DBH=25 cm, Heigth=16–18 m)
Site area:	- 1 forest stand with close to nature forestry with 8 ha - 1 forest stand with Catalans reference models with 8 ha
Age of the stand at the beginning of the experiment:	Undetermined, but more than 60 years
canopy:	10–40%
shrub layer:	FCC=10–70% Height=1.5–2 m, *Pistacia lenctiscus*, *Viburnum lantana*, *Corylus avellana*
understory layer:	FCC=15%, *Smilax aspera*, *Hedera elix*
Canopy openness:	
Management type before the experiment:	Forest abandonment, sustainable forest management, management for the carbon production. (coppice system and selection forestry system)
Available data for the stand structure of the stand:	Tree species, DBH, basal area, height, volume, standing and lying dead wood volume, canopy openness, bird, bryophytes and flora inventory

2.3. Site 3.

Location:	**Serres del Litoral Septentrional (ES)**
GPS coordinates:	Extreme west (41.62290/2.46059) Extreme north (41.71093/2.56682) Extreme east (41.65995/2.58019) Extreme south (41.62148/2.46242)
Altitude:	425–720 m
Aspect:	N, NW, NE, SE, W
Slope:	19–35%
Mean annual temperature:	15.02 ºC
Annual precipitation:	750–800 mm
Bedrock:	Phyllites and cornubianites, leukogranites, granodiorites, alkaline granites
Soil type:	Eutric Leptosol and Eutric skeletic leptic regosol, Dystric Leptosol amd skeletic leptic umbrisol
Forest type:	Holm oak, *Quercus ilex* HIC (9340), Mediterranean oaks, *Quercus humilis*
Dominant tree species:	*Quercus humilis* (FCC=25–65%, DBH=25 cm, Heigth=16 m) *Quercus ilex* (FCC=12–45%, DBH=20 cm, Heigth=10–14,5 m), *Quercus suber* (FCC=0–10%, DBH=40 cm, Heigth=10 m), *Prunus avium* (FCC=5%, DBH=15 cm, Heigth=12 m)
Site area:	- 1 Forest stand to natural evolution with 9 ha - 1 Forest stand to preparation for a natural dynamic with 9 ha - 1 Close to nature forestry with 8 ha - 2 Forests stand with Catalans reference models with 8 ha each one
Age of the stand at the beginning of the experiment:	Undetermined, but more than 60 years
canopy:	*Pinus pinaster, Pinus pinea*
shrub layer:	FCC=60% Height=1.5–2 m, *Arbutus unedo, Viburnum tinus Castanea sativa, Ilex aquifolium*
understory layer:	*FCC=0–20%, Smilax aspera, Ruscus aculeatus, Hedera elix, Rubia peregrina, Ulex parvifolius*
Canopy openness:	10–40%
Management type before the experiment:	Forest abandonment, sustainable forest management, management for the carbon production. (coppice system and selection forestry system)
Available data for the stand structure of the stand:	Tree species, DBH, basal area, height, volume, standing and lying dead wood volume, canopy openness, bird, bryophytes and flora inventory

2.4. Site 4.

Location:	**Massís del Montseny (ES)**
GPS coordinates:	Extreme west (41.78467/2.53649) Extreme north (41.78688/2.53739) Extreme east (41.749219/2.681542) Extreme south (41.75072/2.67896/)
Altitude:	50–600 m
Aspect:	N, NW, NE, SE, W
Slope:	19–55%
Mean annual temperature:	14.2 ºC
Annual precipitation:	800–830 mm
Bedrock:	Shales, gneiss and marbles/granodiorites and alkaline granites
Soil type:	Eutric Leptosol and eutric skeletic leptic regosol/ skeletik leptic phaeozem
Forest type:	Holm oak, *Quercus ilex* HIC (9340), Mediterranean oaks, *Quercus humilis*
Dominant tree species:	*Quercus ilex* (FCC=90%, DBH=16,5 cm, Heigth=13 m)
Site area:	- 2 Forest stand close to nature forestry with 8 ha each one - 1 Forest stand with Catalans reference models with 8 ha
Age of the stand at the beginning of the experiment:	Undetermined, but more than 60 years
canopy:	
shrub layer:	FCC=40%, Height=1.5–2 m, *Erica multiflora*, *Arbutus unedo*, *Rhamnus alaternus*, *Viburnum tinus*
understory layer:	*Smilax aspera*, *Hedera elix*
Canopy openness:	20–40%
Management type before the experiment:	Forest abandonment, sustainable forest management, management for the carbon production. (coppice system and selection forestry system)
Available data for the stand structure of the stand:	Tree species, DBH, basal area, height, volume, standing and lying dead wood volume, canopy openness, bird, bryophytes and flora inventory

2.5. Site 5.

Location:	**Massís del Montgrí (ES)**
GPS coordinates:	Extreme west (42.061356/3.164103) Extreme north (42.09844/3.16714) Extreme east (42.09101/3.17654) Extreme south (42.05645/3.17199)
Altitude:	50–120 m
Aspect:	NW, SW
Slope:	10–30%
Mean annual temperature:	15.6 ºC
Annual precipitation:	584 mm
Bedrock:	Detritic and bioblastic limestones, clays with conglomerates and stoneware
Soil type:	Calcaric leptosol and Chromic Leptic Luvisol
Forest type:	Aleppo pine, *Pinus halepensis* HIC (9540)
Site area:	- 1 Forest stand to natural evolution with 10 ha - 1 Forest stand to preparation for a natural dynamic with 9 ha - 1 Forests stand Close to nature forestry with 8 ha - 1 Forests stand with Catalans reference models with 8 ha
Dominant tree species:	*Pinus halepensis* (FCC=45%, DBH=30 cm, Heigth=15.5 m), *Pinus pinea* (FCC=5%, DBH=40 cm, Heigth=12 m)
Age of the stand at the beginning of the experiment:	Undetermined, but more than 60 years
canopy:	
shrub layer:	FCC=40%, Height=1–1.5 m, *Cistus sp.*, *Quercus coccifera*, *Olea europaea*
understory layer:	*Smilax aspera, Rosmarinus officinalis*
Canopy openness:	10–30%
Management type before the experiment:	Forest abandonment, sustainable forest management, management for the carbon production. (coppice system and selection forestry system)
Available data for the stand structure of the stand:	Tree species, DBH, basal area, height, volume, standing and lying dead wood volume, canopy openness, bird, bryophytes and flora inventory

2.6. Site 6.

Location:	**Languedoc-Roussillon (Bases Corbières, Massif des Albères) (FR)**
GPS coordinates:	Extreme west (42.79776/2.40784) Extreme north (42.807508/2.814223) Extreme east (42.48963/3.05248) Extreme south (42.367309/2.564119)
Altitude:	150–400–661–1150 m
Aspect:	SE, E, S, N
Slope:	20–50%
Mean annual temperature:	(13.2–14.8) ºC
Annual precipitation:	(580–730) mm
Bedrock:	Sedimentary rock
Soil type:	NA
Forest type:	Aleppo pine (*Pinus halepensis)* HIC (9540), Holm oak, (*Quercus ilex)* HIC (9340), Mediterranean oaks, (*Quercus humilis)*, Cork oak *(Quercus suber)* HIC (9330)
Dominant tree species:	*Quercus suber* (FCC=0–40%, DBH=42.5 cm, Heigth=9 m), *Quercus ilex* (FCC=0–90%, DBH=12–33 cm, Heigth=6–8 m) *Pinus halepensis* (FCC=0–70%, DBH=20 cm, Heigth=11 m)
Site area:	- 20 ha - 3 Forests stand with pure mass - 3 Forests stand mixed mass Treatment: similar to Catalan reference model, but a French type (traditional management)
Age of the stand at the beginning of the experiment:	Undetermined, but more than 60 years
canopy:	
shrub layer:	FCC=0–10%, Height=1,5–2 m, *Erica multiflora*, *Jiniperus communis*, *Quercus coccifera*
understory layer:	FCC= 0–5%, *Rosmarinus officinalis*
Canopy openness:	20–50%
Management type before the experiment:	Forest abandonment, sustainable forest management, management for the carbon production. (coppice system and selection forestry system)
Available data for the stand structure of the stand:	Tree species, DBH, basal area, height, volume, standing and lying dead wood volume, canopy openness, bird, bryophytes and flora inventory

3. Applied treatments

3.1. Treatment 1. Catalan reference models of the forest management with biodiversity criteria.
In Catalonia, we have been working since 2004 on a programme that grew out of the need to provide guidance and support instruments for forest management adapted to the current context, which emphasizes both the importance of forests due to their multifunctionality and their vulnerability to climate change.
Management orientations based on the different forest typologies were developed, taking into account existing forest formations and seasonal quality, integrating forest management criteria with fire prevention and wood production objectives.
From this previous phase, 157 management models were developed for 32 different tree species that integrate the different objectives and ecosystem services. The manuals of the different models for Catalonia can be accessed free of charge from the following link:
http://cpf.gencat.cat/ca/cpf_03_linies_actuacio/cpf_transferencia_coneixement/cpf_orientacions_gestio_forestal_sostenible_catalunya/

This Life BIORGEST project will add criteria that support biodiversity and will seek to incorporate them into forestry itineraries. Some of the measures planned for the improvement of biodiversity are:
- Favour the vertical and horizontal heterogeneity of the masses.
- Ensure the presence of dead wood
- Maintain specimens of extraordinary diameters
- Microhabitats reservation
- Removal of exotic species
- Maintain the least represented species
- Favouring fleshy fruit producing species

3.2. Treatment 2. Naturlistic forestry
Naturlistic forestry proposes a reflection and a global management of the whole forest ecosystem, including economic and non-economic objectives, and forests have to satisfy four main functions:
- Natural or bio-ecological function
- Protection function
- Production function
- Culture function

The natural function, is the indispensable function for the (production, protection and cultural) of the forest. It is based on the following elements of the functional capacity of the ecosystem to correctly fulfill its function:
- Diversity of fauna and flora typical of its habitat.
- Genetic diversity
- Variability of forest structures
- Correct working of the ecological processes
- Internal ecological relations
- Influence of the forest on the landscape and the surrounding climate conditions.
- Conservation of soil productivity, thanks to a continuous cover.
- Maintenance and propagation of mixed species in forests with economic objectives, favouring less represented or at risk species.

The protection function tries to improve different processes of the forest such as the fertility of the soil and its structure, to avoid erosion, infiltration and water quality, helping to fix CO_2 for the improvement of air quality.

The production function works in synergy with the other functions of the forest, in a way that will be viable when it does not reduce the potential of the other three, proposing the following actions:

- Maintenance of the continuity of the forest cover to protect the productivity of the soil.
- Production of quality wood by selection and silvicultural treatments at all stages of the forest's development.
- The individualisation of trees and their functions during silvicultural work, looking to achieve greater stability in the mass.
- Renunciation of hard-harvesting.
- Abandoning the concept of the harvesting time.
- More importance to silvicultural care than to regeneration.
- Prudence in the introduction of external elements to the ecosystem, machines, phytosanitary products, fertilizers, etc.).

The cultural function of the forest affects the physical and psychological well-being of people, among them it considers the human-nature relationship as an emotional relationship generated by history and culture in which it has been transmitted between generations, through legends and myths. Serving as an inspiration for art (painting, music).

3.3. Treatment 3. Preparation for a natural dynamic

The preparation towards a natural dynamic promotes the restoration of one's ecological processes of mature forests and, consequently, to restore the characteristic structure of these forests through active management. This very low intensity management means that no extract of product.

3.4. Treatment 4. Natural evolution

In these stands, they already have characteristics of naturalness in which no actions have been carried out over forty years, they will be without intervention to study the evolution of biodiversity throughout the project.

3.5. Description of the project

The main objective of the project is to improve the biodiversity of Mediterranean forests by integrating specific measures and innovative practices into forest planning and management instruments and through new financing and compensation mechanisms. It is therefore intended to reconcile the improvement of biodiversity with the economic sustainability of forest management, ensuring forest persistence and their adaptation to climate change.

The specific objectives are:

1) To improve the biodiversity of the most representative Mediterranean forests (pine and *Quercus* forests), reconciling their environmental and socio-economic values and promoting their adaptation to climate change.

2) To demonstrate the applicability of innovative forest management measures through field-scale actions, the effect of which is thoroughly characterized during the project.

3) To develop new measures for forest biodiversity promotion: (i) guidelines and forest management models including concepts close-to-nature forestry and criteria to prepare and establish areas left for natural development; (ii) development of a Potential Biodiversity Index adapted to Mediterranean forests, which allows evaluating its conservation status and to propose improvement measures.

4) To develop innovative compensation mechanisms (including quantification methods and suitable custody options) that allow rewarding forest ownership due to the loss of income caused by the integration of biodiversity promotion practices.

5) To integrate the measures developed into the regional policies and regulations governing Mediterranean forest management: (i) territorial and sectoral planning; (ii) forest management instruments; (iii) sustainable forest management guidelines.

6) To transfer the techniques, indicators and measures developed to the main stakeholders involved in forest management (property, managers, forest administration and companies).

7) To disseminate the results to specific stakeholders and raise awareness of the importance of improving biodiversity through sustainable and multifunctional forest management that avoids rural abandonment and promotes healthy forests capable of generating ecosystem services (renewable products, recreation, landscape, soil and water protection, carbon storage) and hosting a resilient and diverse ecosystem.

3.6. Graphical representation of the experiment

Serra de Collserola

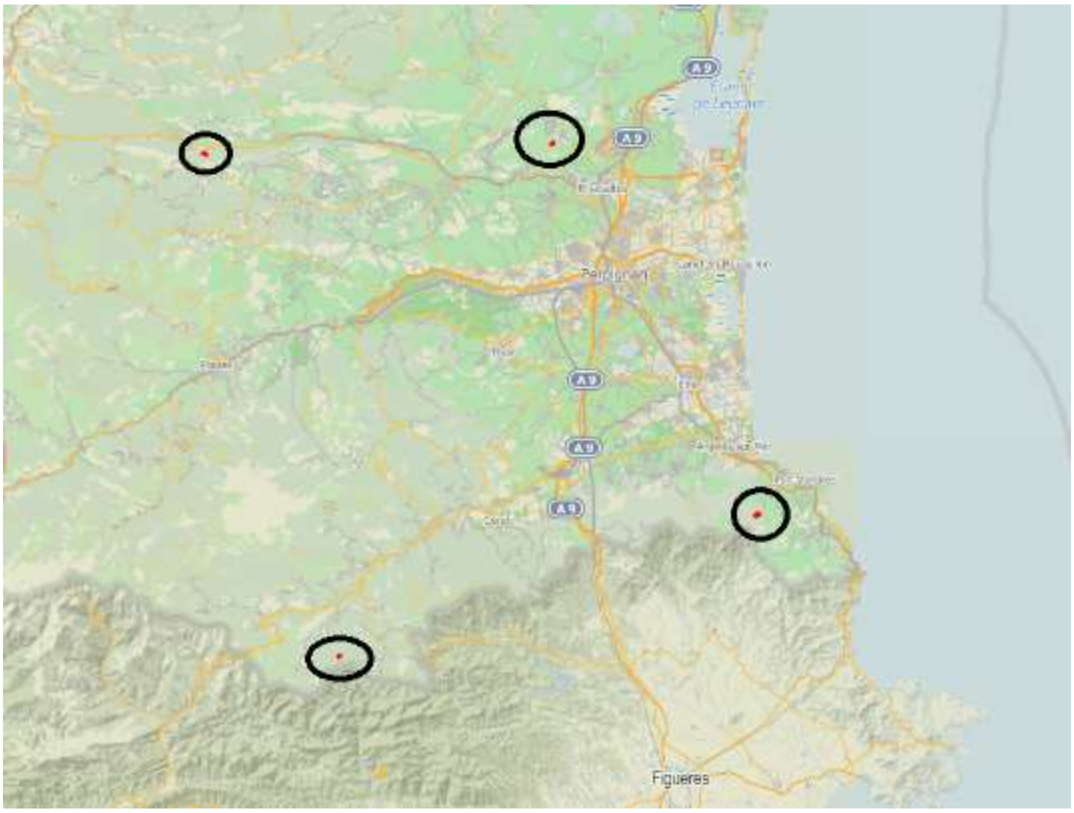
Zona Volcànica de la Garrotxa i L'Alta Garrotxa

Serres del Litoral Septentrional

Massís del Montseny

Massís del Montgrí

Languedoc-Roussillon (Bases Corbières, Massif des Albères)



4. Investigated organism groups

4.1. Birds
20 minute listening stations with 25 m 50 m and 100 m bands. The aim is to measure the richness and abundance of species in relation to the forest structure. Two samples will be taken: Before the performances and the last year.

4.2. Chiropters
Echolocation stations with automatic SM3-SM4 Bat Recorder station. 1 detector per stand for 7 consecutive nights. Measurement of the activity of acoustic groups and species in relation to the forest structure.

4.3. Saproxylic Coleoptera:
A representative habitat: holm oak.
Trapping (flight interception trap) in 8 plots of mixed or pure holm oak woods (2 plots x 1 formation (alzinar) x 3 types of intervention + 2 plots in holm oak woodland stands referring to natural dynamics.
Before actions, after actions and the last year of the project.

4.4. Flora
Determination of the species of flora (incl. woody regeneration) on the sampling plots within the project stands, before and after the actions, as well as the last year of the project.

4.5. Bryophytes
Determination of bryophyte species on the sampling plots within the project stands, before and after the actions, as well as the last year of the project.

5. Investigated environmental variables

Establishment an IBP for Catalonia:
This IBP will be developed by both the CNPF and the CPF and is a simple tool that will serve to determine the species diversity (taxonomy) that can be accommodated by the forest ecosystem being evaluated.
It is based on an indirect assessment, based on the composition and structure of a stand and the relationship between these and the fauna. It aims to help the manager make decisions by considering biodiversity as a criterion for management.

5.1. Deadwood and availability of cavities
5.1.a. Large trees
5.1.b. Richness of woody species
5.1.c Vertical and horizontal heterogeneity

5.2. Bio-indicator organisms
5.3. Endangered species of fauna

5.4. Taking a Dasometric Inventory
5.4.a. Basimetric area
5.4.b. Average height
5.4.c. Mass Stratification (Fire Vulnerability)
5.4.d. Regeneration

5.5. Anthropogenic use of the forest
5.5.a. Presence of past human activity
5.5.b. Presence of forest in the orthophotos of 1945–1956

***6.* Other investigated functions/processes**

6.1. Incorporation of the models created into the ORGEST:
ORGEST are models that are being implemented continuously and are designed to give greater weight to different management criteria such as production or forest fire prevention. At the end of the project, the aim is to incorporate new forestry itineraries that favour biodiversity in a progressive manner with respect to the level of intervention.

6.2. Socio-economic evaluation of the project to study the replicability of the models
The impact on the economic and social level that each type of management could have will be studied in order to find mechanisms that can help and encourage their application.

7. References

Baiges, T., Cervera, T., Larríeu. L., Palero.N., Gonin, P. 2019. Posada a punt de l'Index de Biodiversitat Potencial (IBP): Un termòmetre per a mesurar la capacitat d'allotjar biodiversitat dels boscos (gestionats) de Catalunya. Silvicultura 80:26–36. http://cpf.gencat.cat/web/.content/or_organismes/or04_centre_propietat_forestal/06-Publicacions/revista_silvicultura/numeros_publicats/documents/Silvicultura_80.pdf

BIORGEST Team. 2019. El Life BIORGEST com instrument de consens per a la millora de la biodiversitat als boscos. Catalunya Forestal 141:21–22. http://lifebiorgest.eu/wp-content/uploads/2019/11/El-Life-BIORGEST-en-la-revista-Catalunya-Forestal.pdf

8. Participating experts in the project

Name	Center	Country
Marc Deconchat	INRA	France
Thierry Gauquelin	IMBE	France
Laurent Larrieu	CNPF CNPF	France
Bouteloup, Romain	CNPF CEN	France
Florence Lespine	CNPF Federació de Reserves Naturals del Depart. Francia	France
Patrizia Tartarino	Université de Bari	Italia
Marcello Miozzo	Dream Italia, responsable projet life GOPROFOR	Italia
Wadi Badri	Université de Casablanca	Marruecos
Jean Stephan	Lebanese University	Libano
Marcos Valderrábano	UICN MED	Spain
Josep M. Forcadell Roig	DG Polítiques Ambientals i Medi Natural (DTS) Parc Natural dels Ports Catalunya	Spain
Paco Cano Ibáñez	DG Ecosistemes Forestals i Gestió del Medi (DARP) Catalunya	Spain
Josep M. Collellmir Morales	Vicepresident del CFC Catalunya	Spain
Josep M. Valls Tort	Comissió Permanent CFC	Spain
Anna Sanitjas	Diputació de Girona Catalunya	Spain
Francisco Lloret	CREAF-UAB Catalunya	Spain
José Antonio Atauri	Oficina Técnica EUROPARC-España Fundación Fernando González Bernáldez (FunGoBe) Madrid	Spain
Álvaro Hernández Jiménez	Gobierno de Aragón Aragón	Spain
Xavier Carbonell Casadesus	CREAF CREAF Catalunya	Spain
Paul Daniel Kraus	Researcher at Freiburgh University Bavaria/Germany	Spain
Joana Barber		Spain
	Cap de l'oficina tècnica de Parcs Naturals. Diputació de Barcelona Catalunya	
Jaume Hidalgo	Associació Selvans Catalunya	Spain
Ignasi Puig	Fundació ENT Catalunya	Spain
Martí Rosell	Associació de Propietaris Montnegre-Corredor Catalunya	Spain
Elena Gorriz	CTFC EFIMED Catalunya	Spain
David Camps	Fundació DKV Integralia Catalunya	Spain

EX11_FI_AO

1. General information

Name of the experiment: **PuroMonta Buffer Strip Experiment**

Contact(s) in the COST Action: Anna Oldén (anna.m.olden@jyu.fi) and Panu Halme (panu.halme@jyu.fi)
Organization of the Contact(s): University of Jyväskylä, Department of Biological and Environmental Sciences, P.O. Box 35, FI-40014 University of Jyväskylä, Finland
Website of the experiment: -

The question of the experiment: How do the different kinds of streamside buffer strips affect the community composition of vascular plants, mosses and polypores? Do the buffer strips differ in their microclimatic conditions or the number of windthrown trees?

Locality: Central and Eastern Finland
Number of Sites: 43 (but not all variables were measured in all of the sites)
Number of Blocks: -
Treatments and number of Levels: Buffer strips treatments (5 different)
Number of Plots: One in each site

<u>*Dates:*</u>
Beginning of the experiment: 2004
Date of Before-treatment data collection: 2004 (vascular plants, mosses and polypores)
Date of intervention: Early 2006 (winter)
Dates of after-treatment data collection: 2007 for vascular plants and mosses, 2017 for polypores, microclimate and windthrows

2. Site descriptions

The study sites are located in Central and Eastern Finland, on southern and middle boreal vegetation zones. The mean annual air temperature in the area is 2–4 °C and precipitation 600–700 mm year−1. Each site was located on a separate stream. Before the logging treatments, all study sites were dominated by even-aged spruce (*Picea abies* (L.) H. Karst.), and the dominant trees were at least 80 years old. The sites were completely forested, i.e. spruce trees grew close to the stream and there were no extensive treeless riparian zones. The water channels were small streams or rivulets with regular, year-round flow. The width of the water channels varied from 0.2 to 4.3 meters. All sites had been managed with periodic cover silviculture and were regeneration-ready. The nearest clear-cut was located at least 80 meters from the studied site.

Information on the 43 study sites are presented in the table below: Municipality and name of the location, North and East coordinates in decimal degrees, width of the stream, and the logging treatment: buffer width or control (C) and selective logging.

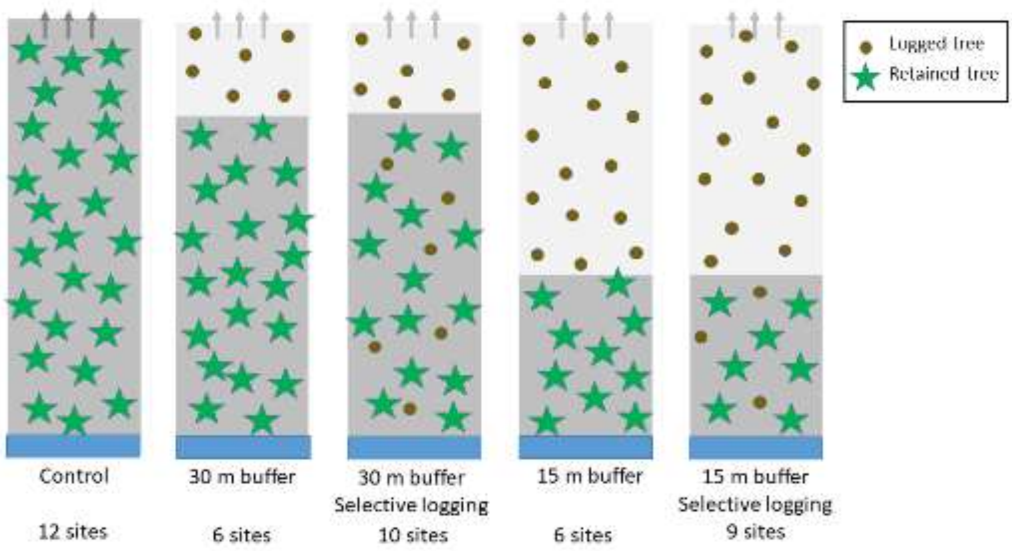
Site ID	Municipality	Name	N	E	Stream width (m)	Buffer width	Selective logging
1	Vieremä	Kellopuro	63.83188	26.94863	0.3	15	No
2	Pieksämäki	Koukunjoki	62.39258	26.93276	1.5	15	No
3	Vieremä	Puolinpuro1	63.98682	26.90886	0.5	15	Yes
4	Vieremä	Puolinpuro2	63.98945	26.89380	0.25	30	No
6	Vieremä	Kurkipuro	63.94052	26.66638	0.95	C	No
7	Suonenjoki	Haukipuro	62.60683	27.30495	4.25	30	Yes
8	Pielavesi	Leppipuro	63.39579	26.39757	0.2	15	Yes
15	Kaavi	Kalalamminpuro	63.11614	28.73192	0.55	30	Yes
16	Lieksa	Pieni Ruosmanjärvi 1 SE	63.46902	29.89890	0.45	30	No
17	Lieksa	Pieni Ruosmanjärvi 2 SE	63.46600	29.89691	1.55	15	Yes
18	Lieksa	Tetrikangas NW	63.46808	29.94605	0.3	30	Yes
19	Lieksa	Huosiopuro	63.49229	29.93862	0.65	C	No
20	Lieksa	Hanhilamminpuro	63.28729	30.34200	1.1	15	Yes
21	Lieksa	Palkinoja	63.23884	30.75467	1.6	C	No
22	Lieksa	Lavapuro	63.21131	30.22918	0.35	15	Yes
23	Äänekoski	Kivipuro	62.56329	25.51531	1.2	30	Yes
24	Pihtipudas	Valkeispuro	63.41049	26.05685	0.75	15	Yes
25	Kivijärvi	Kangaspuro	63.20412	24.90234	1.9	30	No
26	Korpilahti	Karhuoja	62.04014	25.42641	1.1	30	Yes
27	Leivonmäki	Väärämäki S	61.90145	25.92199	1.5	C	No
28	Leivonmäki	Hakosjärvi W	62.02793	26.18217	0.55	C	No
29	Korpilahti	Tuppela NE	62.21604	25.39608	0.8	15	No
31	Kuhmoinen	Nokiniemi SW	61.71589	24.93035	0.4	C	No
32	Orivesi	Jokisalo S	61.61620	24.20887	0.6	15	No
33	Karstula	Kurjuksenkulkku NE	62.97202	24.97654	1.65	30	Yes
34	Uurainen	Kivipuro	62.54641	25.48799	2.5	30	No
35	Sotkamo	Ruunapuro	63.93125	28.22158	3.2	C	No
37	Rautavaara	Risupuro	63.40130	28.30241	1.2	15	No
38	Rautavaara	Nurmespuro	63.40632	28.20288	0.65	15	No
39	Rautavaara	Riitapuro	63.67432	28.56051	0.4	30	Yes
40	Rautavaara	Pieni Sammakkomäki S	63.66626	28.57471	0.2	30	No
41	Rautavaara	Mäntykangas N	63.69888	28.54942	1.05	C	No
42	Nurmes	Niinimäki E	63.56566	29.33364	0.55	30	Yes
43	Nurmes	Rajapuro	63.57713	29.50002	0.3	30	Yes
44	Nurmes	Venepuro	63.55592	29.45544	0.4	C	No
45	Rautavaara	Rinnepuro	63.59531	28.48888	2.05	C	No
47	Rautavaara	Pankapuro	63.63822	28.44861	0.75	C	No
48	Rautavaara	Ukonpuro	63.59369	28.45654	0.7	15	Yes
49	Nurmes	Kuomavaara N	63.78579	29.35355	0.7	15	Yes
50	Varpaisjärvi	Muuraispuro	63.52853	28.01496	0.4	30	No
51	Varpaisjärvi	Juudinsalo S	63.48378	28.04813	0.55	30	Yes
53	Karttula	Suojärvenpuro	62.74879	27.15719	0.95	C	No
56	Pieksämäki	Hietisenpuro	62.26919	26.99563	2.15	15	Yes

3. Applied treatments

3.1. Treatment 1. Buffer strip treatments
1. Control (no harvesting)
2. 30 m buffer strip (between the clear-cut and the stream a buffer strip of 30 m width was left and it was not selectively logged)
3. 30 m buffer strip with selective logging (a buffer strip of 30 m width was left and it was selectively logged so that 30% of tree basal area was removed)
4. 15 m buffer strip (a buffer strip of 15 m width was left and it was not selectively logged)
5. 15 m buffer strip with selective logging (a buffer strip of 15 m width was left and it was selectively logged so that 30% of tree basal area was removed)

3.2. Description of the study design: The experiment involved 43 sites where each site received one of the five treatments. The treatments were assigned randomly to the sites.

3.3. Graphical representation of the experiment



4. Investigated organism groups

4.1. Vascular plants
24 vegetation sub-plots were placed in each site/plot so that 20 of them were 0–5 m from the stream, two at 10 m and two at 15 m distance from the stream. The same plots were studied in 2004 and 2007 and the cover of each species was estimated. All 43 study sites were included.

4.2. Mosses
Sampling as above. Species growing on all substrates were included.

4.3. Polypores
Polypores were surveyed on 0.1 ha plots that were located 0–15 m from the stream. The same plots were surveyed in 2004 and 2017. 35 sites were included.

5. Investigated environmental variables

5.1. Dead wood
Dead wood was surveyed on 0.045 ha study plots in 2004 and 2017. Data is available for 30 sites.

5.2. Microclimate
Air temperature and relative air humidity was measured with two data loggers in each site for a month in the summer of 2017. Data loggers were placed at about 7.5 m from the stream. 35 sites were included.

5.3. Canopy openness
Canopy openness was measured from fisheye-photographs in 35 sites in 2017. Eight photographs were taken at the stream shoreline and eight at a distance of 10 meters.

5.4. Pre-treatment data on trees and seedlings
Researchers of Luke (Natural Resources Institute Finland) measured pre-treatment tree and seedling data in 2004. Post-treatment data may be measured in the coming years. Questions about these data should be directed to Juha Siitonen (juha.siitonen@luke.fi).

6. Other investigated functions/processes

6.1. Windthrow
Windthrown trees were surveyed in autumn 2017 on 0.2 ha plots next to the stream. 36 sites were included.

7. References

Mäenpää, H., Oldén, A., Halme, P., Siitonen, J., Mönkkönen, M. & Peura, M.: Windthrow in streamside key habitats: effects of buffer strip width and selective logging. *Manuscript*.

Oldén, A., Peura, M., Saine, S., Kotiaho, J.S. & Halme, P. 2019: The effect of buffer strip width and selective logging on riparian forest microclimate. *Forest Ecology and Management* 453: 117623. https://doi.org/10.1016/j.foreco.2019.117623

Oldén, A., Selonen, V.A.O., Lehkonen, E. & Kotiaho, J.S. 2019: The effect of buffer strip width and selective logging on streamside plant communities. *BMC Ecology* 19 (9), 1–9. https://doi.org/10.1186/s12898-019-0225-0.

Peura, M., Oldén, A., Elo, M., Halme, P., Kotiaho, J.S. & Mönkkönen, M.: The effect of buffer strip width and selective logging on streamside polypore communities. *In review*.

8. Participating experts in the project

Main researchers all in University of Jyväskylä:
Halme, Panu (project leader 2017–)
Kotiaho, Janne S. (project leader 2004–2007)

Oldén, Anna (vascular plants, mosses, microclimate)
Peura, Maiju (polypores, dead wood)
Mäenpää, Hennariikka (windthrow)

EX12_FI_JK

1. General information

Name of the experiment: **Fire and retention trees in facilitating biodiversity in boreal forests (FIRE)**

Contact(s): Jari Kouki (jari.kouki@uef.fi)
Organization of the Contact(s): University of Eastern Finland
Website of the experiment: http://forest.uef.fi/jarikouki/project_fire.htm

The question of the experiment: What are the impacts of tree retention (or harvest intensity) and fire on species occurrence patterns and ecosystem properties in boreal forests?

Locality: Eastern Finland, North Karelia
Number of Sites: 1
Number of Blocks: n/a (factorial fully randomized design)
Treatments and number of Levels:
Treatment 1: Harvest intensity (4 levels)
Treatment 2: Fire (prescribed burning, two levels: yes-no)
Number of Plots: 24

Dates:
Beginning of the experiment: 2000
Date of Before-treatment data collection: 2000
Date of intervention: 2000–2001 (harvests in winter 2000/01 and fire the following summer 2001
Dates of aftertreatment data collection: 2001–2019, 19 years but different response variables measured with different intervals

2. Site descriptions

2.1. Site 1.

Location: Eastern Finland, North Karelia (plots located on an area of ca. 15x20 km^2)
GPS coordinates:
WGS 84 (sorry, could not find these in the requested format)
N: 63° 15' 11"
E: 30° 44' 25"

Altitude: 160–200 m
Aspect: mainly flat
Slope: mainly flat
Mean annual temperature: +2.1 °C
Annual precipitation: 600 mm
Bedrock: Granite

Soil type: Podzol
Site area: 24 x 4–5 ha, located in an area of ca. 20 x 30 km^2
Forest type: Western Taiga 9010 (boreal conifer-dominated forests), Dominant tree species: Scots pines (*Pinus sylvestris*), Norwegian Spruce (*Picea abies*). EEA: Boreal forest (1).
Age of the stand at the beginning of the experiment: 150 years
Stand structure before the interventions:
canopy: upper pine, secondary spruce
shrub layer: scarce
understory layer: mainly dwarf shrubs (*Vaccinium myrtillus, V. vitis-idaea, Empetrum nigrum*)
Canopy openness: around 10–20%
Management type before the experiment: no management during 100 years, before that low-intensity selective cuttings in 1800s and before
Available data for the stand structure of the stand: tree species, DBH, volume, standing and lying dead wood

3. Applied treatments

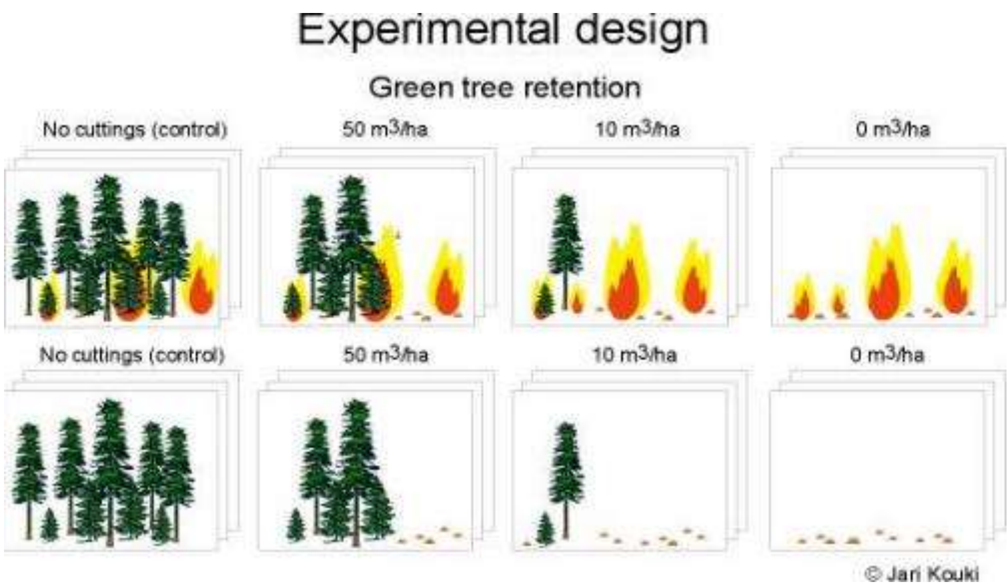
The design is fully factorial BACI with 2 factors (harvest, fire). In the following, these are under different treatments although they are applied simultaneously, according to the principles of factorial design.

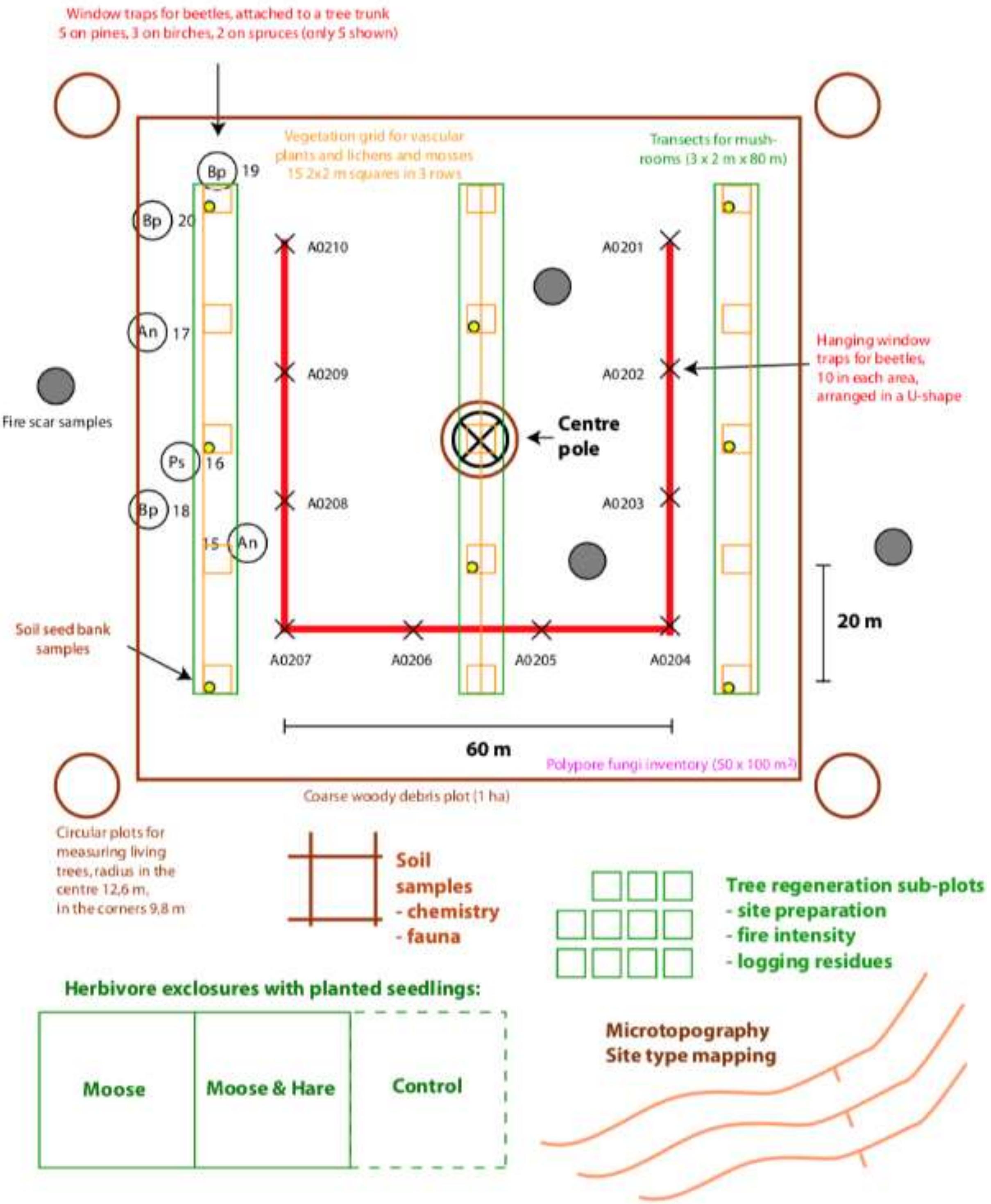
3.1. Treatment 1. Harvest intensity
Four levels of harvests, retention trees left mostly aggregated, with some individual solitary trees:
Retention 0 m3/ha
Retention 10 m3/ha
Retention 50 m3/ha
No harvests (full retention)

3.2. Treatment 2. Fire
Two levels:
Fire Yes (prescribed burning)
Fire No

3.3. Treatment 3. Fencing
In all but 10 m3/ha retention sites, a fence was built to follow the effects of moose and hare browsing on tree seedlings. Fences are 15x30 m, divided into two compartments with two different mesh sizes.

3.4. Graphical representation of the experiment




Window traps for beetles, attached to a tree trunk
5 on pines, 3 on birches, 2 on spruces (only 5 shown)
Vegetation grid for vascular
plants and lichens and mosses
15 2x2 m squares in 3 rows
Transects for mush-
rooms (3 x 2 m x 80 m)
Bp 19
Bp 20
An 17
Ps 16
Bp 18
15 An
A0210
A0209
A0208
A0207
A0206
A0205
A0204
A0203
A0202
A0201
Centre
pole
Hanging window
traps for beetles,
10 in each area,
arranged in a U-shape
Fire scar samples
Soil seed bank
samples
20 m
60 m
Polypore fungi inventory (50 x 100 m²)
Coarse woody debris plot (1 ha)
Circular plots for
measuring living
trees, radius in the
centre 12,6 m,
in the corners 9,8 m
Soil
samples
- chemistry
- fauna
Tree regeneration sub-plots
- site preparation
- fire intensity
- logging residues
Herbivore exclosures with planted seedlings:
Moose
Moose & Hare
Control
Microtopography
Site type mapping

4. Investigated organism groups

Monitoring of these groups, irregular intervals:
4.1. Beetles (including saproxylic species, herbivores, carabids)
Collected by window traps, and carabids by pitfall traps (only one short-term study).

4.2. Aradus bugs

4.3. Epiphytic lichens

4.4. Ground lichens

4.5. Ground bryophytes

4.6. Vascular plants

4.7. Tree seedlings and recruitment

4.8. Polypore fungi (wood-associated decomposer fungi)

4.9. Other macrofungi (mushrooms, other saprotrophic fungi)

5. Investigated environmental variables

5.1. Forest type mapping

5.2. Living and dead trees
volume

5.3. Humus layer (depht)

5.4. Soil properties
On some sites only: SOM, pH

6. Other investigated functions/processes

6.1. Browsing

6.2. Decomposition of wood

6.3. Decomposition of soil organic matter
On some sites

7. References

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Aino Hämäläinen (PhD completed in 2016): Retention forestry and intensified biomass harvest: epiphytic lichen assemblages under opposing ecological effects in pine-dominated boreal forests

Osmo Heikkala (PhD completed in 2016): Emulation of natural disturbances and the maintenance of biodiversity in managed boreal forests: the effects of prescribed fire and retention forestry on insect assemblages.

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Mai Suominen (PhD completed in 2018): Harvested and burned forests as habitats for polypore fungi

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Tommi Kinnunen (MSc thesis,2004): The effects of fire on fungal infections of pine saplings

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Sabrina Van de Velde (MSc thesis 2015: The role of prescribed fire and harvest intensity on Cerambycidae beetle diversity in managed Scots pine forests

Laura Pekkola (MSc thesis 2016): Long-term effects of small-scale spatial variations in fire severity on bilberry (*Vaccinium myrtillus* L.) growth in the boreal forests of eastern Finland

8. Participating experts in the project

NA

EX13_DE_SS

1. General information

Name of the experiment: **Bavarian Forest Deadwood Experiment**

Contact(s) in the COST Action: Sebastian Seibold (Sebastian.seibold@tum.de), Jörg Müller (joerg.mueller@npv-bw.bayern.de)
Organization of the Contact(s): Bavarian Forest National Park, Freyunger Str. 2, 94481 Grafenau, Germany
Website of the experiment: none

The question of the experiment: How is canopy openness, deadwood amount and deadwood diversity affecting biodiversity?

Locality: Germany, Bavarian Forest National Park
Number of Sites: 1
Number of Blocks: 5
Treatments and number of Levels: canopy openness (fully open vs. closed), deadwood amount (0, 10, 100 m³/ha), deadwood diversity (0, 1, 2, 4 deadwood types)
Number of Plots: 190

Dates:
Beginning of the experiment: 2012
Date of Before-treatment data collection: -
Date of intervention: 11/2011
Dates of after-treatment data collection: since 2012 (not all organism groups, see below)

2. Site descriptions

2.1. Site 1.

Location: Germany, Bavarian Forest National Park
GPS coordinates: 48.944141, 13.383167
Altitude: 750–1200
Aspect: various
Slope: various
Mean annual temperature: 3.8 to 5.8 °C
Annual precipitation: 1200 to 1800 mm
Bedrock: granite, gneiss
Soil type: Cambisol, Podzol
Site area: 24000 ha (size of national park)
Forest type: Mountainous beech forest
Age of the stand at the beginning of the experiment: 80 to 140
Stand structure before the interventions:

canopy: NA
shrub layer: NA

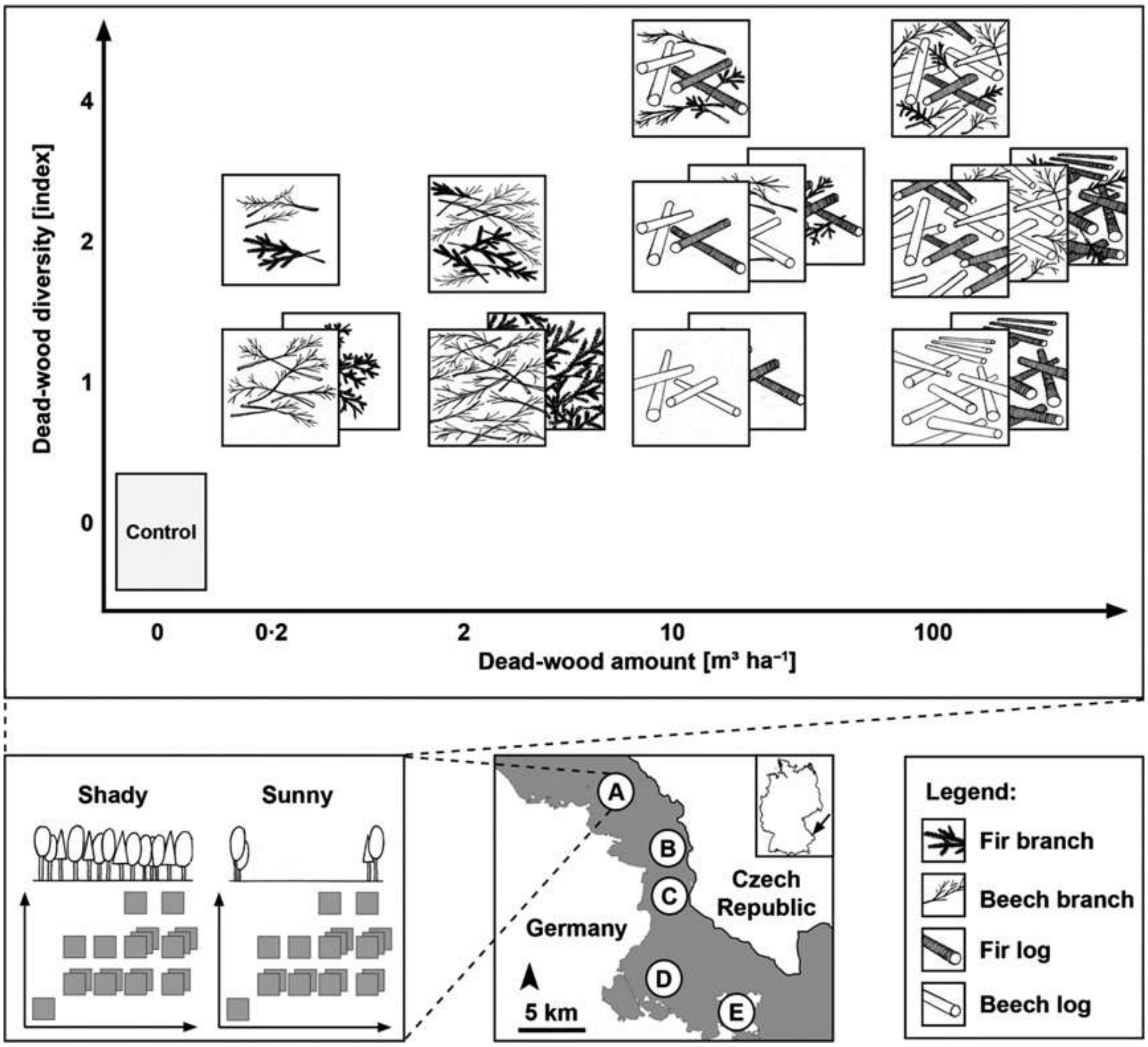
understory layer: NA
Canopy openness: either 90–100% or 0–30% (see treatment 1)
Management type before the experiment: none
Available data for the stand structure of the stand: LiDAR data

3. Applied treatments

3.1. Treatment 1. Canopy opening
selection of plots in canopy gaps and under closed canopy

3.2. Treatment 2. Deadwood addition
Each plot was randomly assigned to one of 19 treatments designed to create gradients in amount and diversity of deadwood. The wood was cut less than 8 weeks before deposition and included logs (diameter: 25–50 cm, length: 5 m) of European beech and/or silver fir Abies alba (Mill.) and/or branches (diameter: 3–5 cm, length: 2–3 m) of one or both tree species. Besides a control plot in which no wood was added, each plot contained either a low or high amount of branches (8 branches, about 0.2 m^3/ha or 80 branches, about 2 m^3/ha) or logs (4 logs, about 10 m^3/ha or 40 logs, about 100 m^3/ha) or a combination of logs and branches of low or high amounts (see figure). To form a gradient of deadwood diversity, we realized combinations of the different substrate types comprising three different levels of diversity. The lowest level of deadwood diversity comprised only one of each of the four substrate types (beech logs, beech branches, fir logs, fir branches) and the intermediate level comprised either both diameter classes of the same tree species (beech logs and branches, fir logs and branches) or only one diameter class of both tree species (beech and fir logs, beech and fir branches). The highest level of diversity comprised logs and branches of both tree species. Half of the logs were placed on top of others such that some had full soil contact, whereas others were partly elevated and therefore comparatively dry.

3.3. Graphical representation of the experiment



4. Investigated organism groups

4.1. Beetles

Saproxylic and non-saproxylic beetles were collected using 2 flight-interception traps and2 pitfalls traps per plot in 2012–2014 and in 2017–2018. In addition, 80 stem emergence traps were mounted on stems and operated since 2012.

4.2. Heteroptera

Saproxylic and non-saproxylic heteroptera were collected using 2 flight-interception traps and 2 pitfalls traps per plot in 2012–2014.

4.3. Spiders

Spiders were collected using 2 pitfalls traps per plot in 2012–2014. In addition, 80 stem emergence traps were mounted on stems and operated since 2012.

4.4. Fungi

Wood-inhabiting fungi were recorded on four logs per plot by fruit-body surveys and DNA-sequencing from wood samples over several years.

4.5. Bacteria

Wood-inhabiting bacteria were recorded on four logs per plot by DNA-sequencing from wood samples over several years.

4.6. Gastropods

Gastropods were recorded in 2014.

4.7. Vascular plants and bryophytes

Composition and cover of vascular plants and bryophytes were recorded in 2012.

5. Investigated environmental variables

5.1. Canopy openness

Measured using LiDAR

5.2. Soil characteristics: pH, C–N ratio

6. Other investigated functions/processes

6.1. Wood decomposition

Density, pH, C/N, enzyme activity were recorded in several years

7. References

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8. Participating experts in the project

Claus Bässler
Petr Baldrian
Jonas Hagge

EX14_FR_MN

1. General information

Name of the experiment: **RENECOFOR**

Contact(s) in the COST Action: Lucie Vincenot (lucie.vincenot@univ-rouen.fr); Manuel Nicolas (manuel.nicolas@onf.fr)
Organization of the Contact(s): Laboratoire ECODIV, Université de Rouen, France; Office national des forêts, Département RDI, France
Website of the experiment: http://www1.onf.fr/renecofor/@@index.html

The question of the experiment: Long-term changes in forest ecosystems in response to environmental drivers (e.g. atmospheric pollution, climate, attacks by biotic agents), also considering the impact of herbivory on the ground vegetation (Boulanger *et al*., 2018)

Locality: all over France (without French overseas territories)
Number of Sites: 89 sites, including a subset of 48 sites with assessments of Macrofungi
Number of Blocks: 89
Treatments and number of Levels: Fencing (2 levels)
Number of Plots: 178 (89 sites x 2 Fencing treatments)

Dates:
Beginning of the experiment: 1992
Date of Before-treatment data collection: no
Date of intervention: 1992 (Fencing)
Dates of after-treatment data collection: 1995–2015

2. Site descriptions

RENECOFOR is the French part of ICP Forests intensive monitoring network (Level II). All sites were installed in 1992 in adult stands with homogeneous ecological conditions and following the same design over an area of 2 ha each. They have all been maintained under usual management by local foresters (the fence is temporarily removed during cuttings). Most of them are in even-aged high forest stands under shelterwood silviculture systems, but a few ones are in uneven-aged stands. Stand structure has been documented by periodical inventory of all the trees thicker than 5 cm diameter at breast height (DBH) within the 0,5 ha central part of the site, with following variables per tree: tree species, DBH, status (part of the overstorey, suppressed, or dead). The RENECOFOR network is made of 102 sites in total, but 13 of them were severely disturbed by storm damages or bark beetle attacks and are not included here. The table below describes the following parameters for each of the retained 89 sites: site code, monitoring set, location (municipality), coordinates, altitude (alt.) in m, aspect, slope in %, mean annual temperature (MAT) in °C, mean annual precipitation (MAP) in mm, soil parent material, soil type, age of the stand in 1995 (in years), occurrence of assessments of Macrofungi.

The monitoring set corresponds to the set of surveys made in a site. All sites (set 1 or higher) have been monitored for individual tree parameters (species, status, growth, health, phenology), stand parameters (foliar nutrition, and litterfall at least until 2007), ground vegetation composition (Tracheophytes, bryophytes), and solid soil and litter properties. In addition, the set 2 comprises atmospheric deposition chemistry, and meteorology (until 2007). In addition to set 2, the set 3 comprises meteorology continued up to now, soil solution chemistry, ozone concentrations in the air and ozone-induced symptoms on the vegetation, and litterfall continued up to now.

Site code	Set	Municipality	Latitude	Longitude	Alt. (m)	Aspect	Slope (%)	MAT	MAP	Parent material	Soil type	Age in 1995	Fungi
CHP 10	1	Rouilly-Sacey	48°20'51'' N	4°18'17'' E	115	flat	0	10.5	757	Marl	Cambisol	134	no
CHP 18	1	Verneuil	46°49'33'' N	2°34'27'' E	175	north-west	2	11.3	748	Loess	Planosol	58	no
CHP 40	2	Gamarde-les-Bains	43°44'19'' N	0°50'32'' W	20	north-east	5	13.4	1121	Sandy Till	Gleysol	46	no
CHP 49	1	Jumelles	47°27'22'' N	0°01'52'' W	57	south-west	0	11.9	651	Non-Calcareous Sandy Deposits	Cambisol	70	yes
CHP 55	1	Lachaussée	49°01'21'' N	5°46'01'' E	220	flat	0	9.9	791	Calcareous Clayey Deposits	Regosol	100	no
CHP 59	3	Locquignol	50°10'16'' N	3°45'16'' E	149	flat	3	9.7	841	Loess	Luvisol	70	yes
CHP 65	1	Azereix	43°12'13'' N	0°02'17'' W	370	south-east	12	12.3	1163	Stony Loam	Cambisol	54	yes
CHP 70	1	Anjeux	47°52'14'' N	6°12'41'' E	240	flat	0	9.8	1034	Loess	Luvisol	35	no
CHP 71	1	Pourlans	46°58'13'' N	5°14'36'' E	190	flat	0	10.8	873	Old Loam	Luvisol	67	no
CHS 01	1	Péronnas	46°10'17'' N	5°14'22'' E	260	flat	3	11.2	1102	Old Loam	Cambisol	88	no
CHS 03	1	Isle et Bardais	46°40'05'' N	2°43'37'' E	260	flat	0	10.8	831	Clayey Sandstone	Cambisol	115	no
CHS 10	1	Amance	48°17'54'' N	4°27'36'' E	160	flat	0	10.3	816	Loess	Luvisol	83	yes
CHS 18	1	Saint Laurent	47°15'17'' N	2°07'29'' E	176	flat	1	11	801	Sandy Loess	Luvisol	78	no
CHS 21	1	Argilly	47°04'58'' N	5°04'30'' E	220	flat	0	10.6	788	Loess	Albeluvisol	87	yes
CHS 27	1	Puchay	49°21'58'' N	1°30'15'' E	175	flat	0	10.3	839	Stony Loam	Luvisol	55	yes
CHS 35	2	Liffré	48°10'41'' N	1°32'01'' W	80	flat	0	11.6	784	Greenschist	Luvisol	101	yes
CHS 41	3	Chambon sur Cisse	47°34'09'' N	1°15'36'' E	127	flat	0	11.2	696	Sandy Loess	Luvisol	92	no
CHS 51	1	Chatrices	49°02'00'' N	4°57'38'' E	180	south	2	10.2	851	Sandstones	Podzol	139	yes
CHS 57a	1	Fonteny	48°52'18'' N	6°29'02'' E	315	north-east	4	9.2	832	Clayey Sandstone	Cambisol	85	no
CHS 57b	1	Mouterhouse	49°00'59'' N	7°27'45'' E	320	north-west	15	9.2	956	Quartzy Sandstone	Podzol	128	no
CHS 58	1	Biches	46°58'13'' N	3°39'39'' E	270	south-west	7	10.4	963	Stony Loam	Cambisol	61	no
CHS 60	1	La Neuville en Hez	49°23'51'' N	2°18'00'' E	55	flat	1	10.4	663	Non-Calcareous Sandy Deposits	Podzol	60	yes
CHS 61	1	Saint-Victor de Reno	48°31'23'' N	0°40'48'' E	220	south-east	5	10.2	750	Stony Loam	Cambisol	88	no
CHS 68	1	Schlierbach	47°41'33'' N	7°28'06'' E	256	flat	0	10.2	812	Stony Loam	Cambisol	137	yes
CHS 72	1	Jupilles	47°47'46'' N	0°22'49'' E	170	flat	0	10.9	791	Old Loam	Cambisol	64	yes
CHS 81	1	Castelnau de Montmirail	44°02'44'' N	1°44'56'' E	300	south-east	18	11.7	915	Clayey Sandstone	Cambisol	98	no
CHS 86	1	Liniers	46°37'38'' N	0°29'44'' E	116	north-west	4	11.4	703	Stony Loam	Cambisol	82	yes

Site code	Set	Municipality	Latitude	Longitude	Alt. (m)	Aspect	Slope (%)	MAT	MAP	Parent material	Soil type	Age in 1995	Fungi
CHS 88	1	Claudon	48°01'36'' N	6°02'24'' E	330	flat	0	9.5	1022	Loess	Cambisol	129	yes
CPS 67	1	Langensoultzbach	48°59'25'' N	7°43'46'' E	350	south	10	9.8	920	Quartzy Sandstone	Cambisol	76	yes
CPS 77	3	Fontainebleau	48°27'14'' N	2°43'02'' E	80	flat	0	10.8	698	Cover Sands	Luvisol	113	no
DOU 23	1	Saint Léger le Guérétois	46°09'47'' N	1°49'33'' E	610	west	7	10	1065	Granite	Podzol	24	no
DOU 34	1	Verreries de Moussans	43°26'54'' N	2°42'56'' E	700	south	15	11.9	1242	SCHIST	Cambisol	48	no
DOU 61	1	La Lande de Goult	48°34'29'' N	0°04'05'' W	375	east	4	9.5	906	Quartzy Sandstone	Podzol	30	yes
DOU 65	1	Lourdes	43°06'00'' N	0°06'25'' W	420	north-east	32	12.2	1522	Stony Loam	Cambisol	24	yes
DOU 71	2	Anost	47°05'35'' N	4°05'10'' E	650	south-west	10	9.1	1407	Granite	Podzol	20	yes
EPC 08	3	Thilay	49°56'51'' N	4°48'35'' E	480	flat	1	8.2	1324	Siltstone	Podzol	35	yes
EPC 39a	1	La Chaux du Dombief	46°34'47'' N	5°52'37'' E	970	south-east	10	7.4	1873	Pure Limestone	Cambisol	58	yes
EPC 39b	1	Les Rousses	46°31'00'' N	6°03'44'' E	1210	west	8	5.6	1987	Pure Limestone	Umbrisol	111	yes
EPC 63	3	Saint Genès Champanelle	45°45'20'' N	2°57'58'' E	950	flat	0	6.6	1043	Cinder	Cambisol	28	no
EPC 73	1	Bourg-Saint-Maurice	45°35'12'' N	6°47'23'' E	1700	north-west	40	7.6	1118	Stony Loam	Cambisol	182	yes
EPC 74	2	Saint-Cergues	46°13'42'' N	6°20'58'' E	1200	west	20	8	1487	Flysch	Luvisol	73	yes
EPC 81	1	Mazamet	43°26'31'' N	2°26'05'' E	820	north	24	10.1	1439	Gneiss	Podzol	43	no
EPC 87	3	Peyrat le Chateau	45°48'00'' N	1°48'55'' E	650	west	25	9.3	1312	Granite	Podzol	23	no
HET 02	1	Oigny en Valois	49°12'21'' N	3°07'36'' E	145	flat	0	10.5	753	Loess	Luvisol	53	yes
HET 03	1	Coutansouze	46°11'37'' N	2°59'54'' E	590	north	15	9.6	894	Micaschist	Cambisol	87	no
HET 04	1	Noyers sur Jabron	44°07'52'' N	5°48'00'' E	1300	north	50	7.7	1259	Calcareous Alluvial Clays	Cambisol	88	no
HET 09	1	Soulan	42°55'53'' N	1°16'56'' E	1250	south-west	32	9.4	1339	Schist	Podzol	152	yes
HET 14	1	Montfiquet	49°10'57'' N	0°51'23'' W	90	flat	4	10.4	888	Siltstone	Cambisol	83	yes
HET 25	1	Verrière du Grosbois	47°11'31'' N	6°16'41'' E	570	west	2	8.9	1368	Pure Limestone	Cambisol	41	yes
HET 26	1	Bouvante	44°55'04'' N	5°17'46'' E	1320	west	12	7.1	1545	Pure Limestone	Leptosol	158	yes
HET 29	1	Quimperlé	47°50'16'' N	3°32'34'' W	50	flat	0	11.7	1026	Gneiss	Cambisol	64	yes
HET 30	3	Valleraugue	44°06'55'' N	3°32'36'' E	1400	south-west	25	4.9	1894	Micaschist	Podzol	143	yes
HET 55	1	Lachalade	49°10'15'' N	5°00'17'' E	250	flat	0	9.9	977	Sandstones	Podzol	89	no
HET 60	1	Orrouy	49°19'27'' N	2°52'34'' E	138	flat	0	10.5	736	Non-Calcareous Sandy Deposits	Cambisol	62	yes
HET 64	3	Ance	43°09'01'' N	0°39'29'' W	400	north-west	44	13.3	1410	Flysch	Cambisol	67	yes
HET 65	1	Bize	43°01'36'' N	0°26'12'' E	850	north-west	25	10.1	1141	Flysch	Cambisol	160	yes

Site code	Set	Municipality	Latitude	Longitude	Alt. (m)	Aspect	Slope (%)	MAT	MAP	Parent material	Soil type	Age in 1995	Fungi
HET 76	1	Les Ventes St Rémy	49°42'39'' N	1°19'34'' E	210	flat	0	9.5	972	Stony Loam	Cambisol	87	no
HET 81	1	Arfons	43°24'38'' N	2°10'40'' E	700	flat	0	9.8	1409	Granodiorite	Podzol	108	no
HET 88	1	Charmois-l'Orgueilleux	48°06'21'' N	6°14'50'' E	400	west	3	9.3	1110	Sandstones	Cambisol	68	yes
MEL 05	1	Champcella	44°42'18'' N	6°33'42'' E	1850	north-east	20	6.7	922	Undifferentiated glaciofluvial deposits	Leptosol	132	no
PL 20	2	Evisa	42°15'56'' N	8°50'49'' E	1100	north-west	40	9.6	1566	Granodiorite	Cambisol	173	no
PL 41	1	Vouzon	47°39'36'' N	2°05'58'' E	140	flat	0	10.9	743	Non-Calcareous Sandy Deposits	Podzol	45	no
PM 17	2	St Georges d'Oléron	45°58'59'' N	1°16'25'' W	15	flat	0	13.6	775	Shelly Coastal Sands	Arenosol	23	yes
PM 20	1	Zonza	41°45'08'' N	9°12'23'' E	850	north-west	10	12.3	1328	Granodiorite	Cambisol	42	yes
PM 40a	1	Vielle Saint Girons	43°56'37'' N	1°20'54'' W	27	south-west	7	13.2	1114	Non-Calcareous Coastal Sands	Arenosol	29	no
PM 40b	1	Arx	44°06'23'' N	0°06'34'' E	110	flat	5	12.7	872	Non-Calcareous Sandy Deposits	Podzol	17	no
PM 40c	2	Losse	44°02'46'' N	0°00'02'' W	150	flat	0	12.7	906	Non-Calcareous Sandy Deposits	Podzol	15	no
PM 72	2	Lavernat	47°44'53'' N	0°20'04'' E	153	flat	0	11	779	Stony Loam	Podzol	26	yes
PM 85	2	Notre Dame de Monts	46°52'37'' N	2°08'18'' W	5	flat	0	12.5	781	Shelly Coastal Sands	Arenosol	62	yes
PS 04	1	Le Fugeret	44°01'30'' N	6°40'16'' E	1670	south	20	8.2	1121	Sandstones	Cambisol	69	yes
PS 35	1	Liffre	48°12'04'' N	1°33'17'' W	80	flat	0	11.5	793	Greenschist	Luvisol	41	yes
PS 41	1	Vouzon	47°39'14'' N	2°05'41'' E	140	flat	0	10.9	746	Non-Calcareous Sandy Deposits	Podzol	39	no
PS 44	2	Le Gavre	47°32'24'' N	1°48'05'' W	38	flat	0	11.8	810	Stony Loam	Luvisol	56	yes
PS 45	1	Les Bordes	47°49'12'' N	2°26'04'' E	145	flat	0	10.7	711	Non-Calcareous Sandy Deposits	Planosol	54	yes
PS 63	1	Arlanc	45°24'21'' N	3°41'44'' E	750	north-west	25	8.9	907	Micaschist	Cambisol	94	no
PS 67a	3	Haguenau	48°51'01'' N	7°42'39'' E	175	flat	0	10.2	758	Gravelly Sands	Podzol	65	yes
PS 67b	1	Wimmenau	48°55'53'' N	7°26'40'' E	290	flat	5	9.3	919	Quartzy Sandstone	Podzol	64	no
PS 78	1	Poigny la Forêt	48°41'37'' N	1°43'58'' E	170	flat	3	10.4	699	Cover Sands	Podzol	43	yes
PS 89	1	Vergigny	47°56'57'' N	3°43'05'' E	120	flat	0	10.8	738	Non-Calcareous Sandy Deposits	Podzol	58	no
SP 05	3	Crots	44°29'25'' N	6°27'33'' E	1360	north-east	30	7	925	Marl	Cambisol	99	no
SP 07	1	Lavillatte	44°42'36'' N	3°57'57'' E	1300	west	20	6.1	1452	Gneiss	Podzol	80	no
SP 11	3	Belvis	42°52'02'' N	2°06'04'' E	950	north	40	10	1193	Marl	Cambisol	80	yes
SP 25	2	Montbenoît	46°58'34'' N	6°27'42'' E	1000	north-west	10	7.1	1537	Clay-with-flints	Leptosol	81	yes
SP 26	1	Bouvante	44°56'53'' N	5°19'50'' E	1150	west	7	7.4	1563	Clay-with-flints	Cambisol	120	yes

Site code	Set	Municipality	Latitude	Longitude	Alt. (m)	Aspect	Slope (%)	MAT	MAP	Parent material	Soil type	Age in 1995	Fungi
SP 38	3	La Chapelle du Bard	45°25'17'' N	6°07'53'' E	1100	east	35	8.3	1264	Stony Loam	Cambisol	94	no
SP 39	1	Arbois	46°50'33'' N	5°47'18'' E	560	south-east	7	9	1564	Clay-with-flints	Cambisol	41	yes
SP 57	3	Abreschviller	48°36'36'' N	7°08'02'' E	400	north-west	20	9.2	1280	Quartzy Sandstone	Cambisol	54	no
SP 63	1	Saint-Germain-l'Herm	45°26'51'' N	3°31'39'' E	1040	south-west	25	7.1	1222	Gneiss	Cambisol	108	no
SP 68	3	Lautenbachzell	47°56'01'' N	7°07'31'' E	680	north-west	45	8.5	1383	Graywacke	Cambisol	104	yes

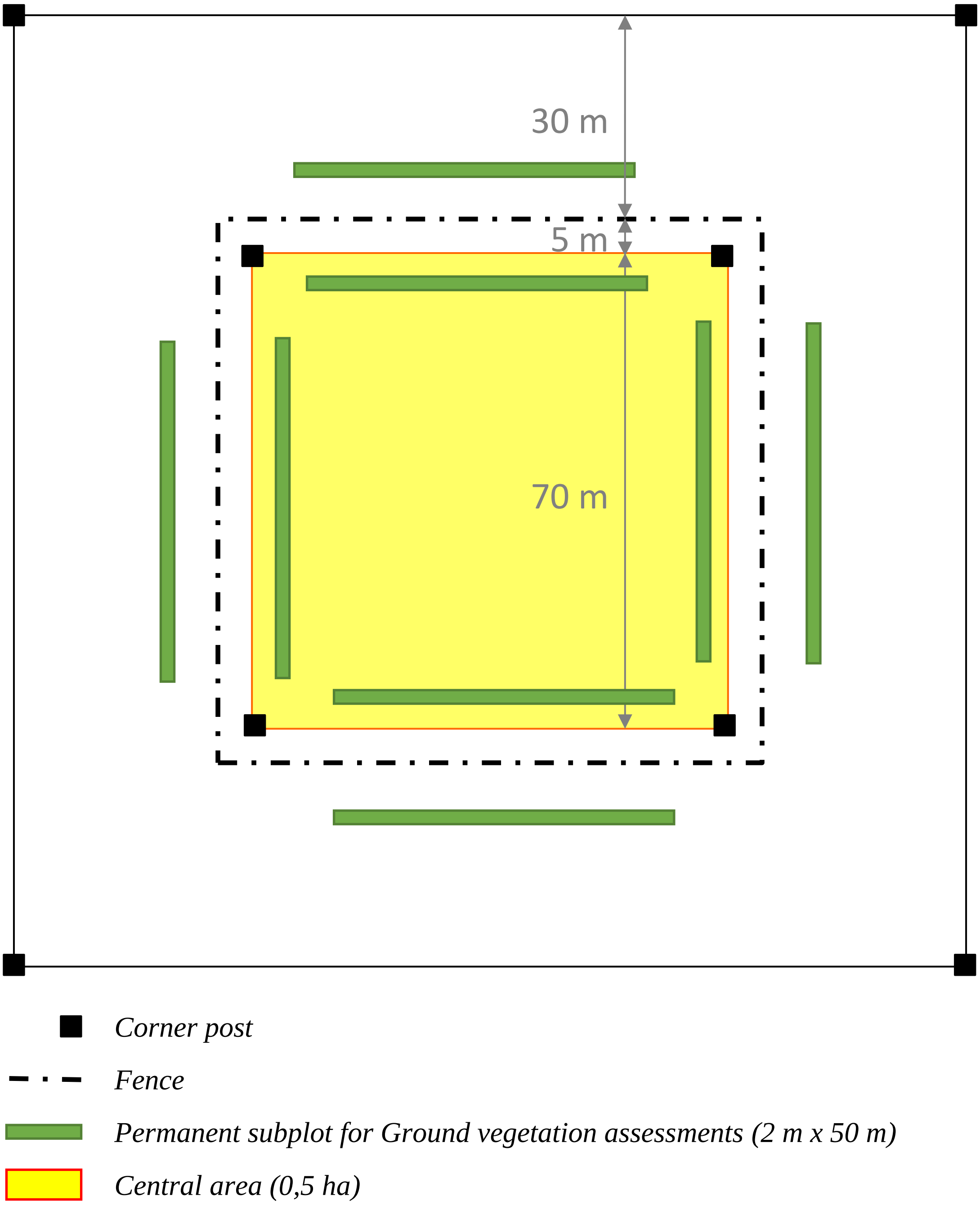
The main tree species (in French) is indicated in the site code: CHP for *Quercus robur*, CHS for *Quercus petraea*, CPS for mixed *Quercus robur & petraea*, DOU for *Pseudotsuga menziesii*, EPC for *Picea abies*, HET for *Fagus sylvatica*, MEL for *Larix decidua*, PL for *Pinus nigra ssp laricio*, PM for *Pinus pinaster*, PS for *Pinus sylvestris*, SP for *Abies alba*.

3. Applied treatments

3.1. Treatment: Fencing
1. Fenced area
2. Unfenced area

3.2. Description of the study design
Each site is a square or rectangle area of 2 ha, made of a fenced central 0,5 ha area and of a unfenced 1,5 ha area all around.

3.3 Graphical representation of the experiment



4. Investigated organism groups

4.1. Understorey vegetation

Recorded parameters: Census of plant species, and species-specific relative abundance per vegetation layer + visual assessment of the coverage of each layer. The layers are:

- Herb layer (all non-ligneous, and ligneous only if ≤ 0.5 m height),
- Small shrub layer (ligneous species between 0,5 m and 2 m height)
- High shrub layer (ligneous species between 2 m and 7 m height)

Sampling area: 4 permanent subplots of 100 m² (2 m x 50 m) each in the fenced central part + 4 permanent subplots of 100 m² (2x50 m) each in the unfenced surrounding area. The subplots are delimitated with permanent boundary markers.

Sampling frequency: 2 seasonal censuses (Spring + Summer), every 5 years (1995, 2000, 2005, 2010, 2015)

Quality assurance & control: Methodology has been described in detail in French since 1994, and updated in 2001 and 2006, following the ICP Forests Manual (Canullo *et al.*, 2016). Intercalibration courses have been organized with all field crews every 5 years. During field campaigns, control assessments have been performed by a second team in 10% of the sites.

4.2. Woody species

Recorded parameters, sampling area and sampling frequency:

- For shrubs and small trees (DBH<5 cm) inside and outside the fenced area: species composition and species-specific relative abundance per vegetation layer (cf. Understorey vegetation)
- For every trees with DBH≥5 cm inside the fenced central area, every 4–5 years (1991, 1995, 2000, 2004, 2009, 2014, 2019): species, status (part of the overstorey, suppressed, dead), diameter at breast height, total height (for a subsample of individuals)
- For a permanent subsample of individual dominant trees of the main tree species inside the fenced central area, every year: diameter at breast height (permanent girth band, since 2016), phenology (budburst, leaf senescence), health (defoliation + symptoms of pathologies)
- Stand related parameters, inside fenced area only: litterfall (sorted into leaves, fruits and branches, at least 4 times per year), phenology (budburst and leaf senescence, every year)
- Stand related parameters, outside fenced area only: foliar chemistry (major nutrient concentrations from composite sampling of 8 trees, every 2 years)

Quality assurance & control: Methodology has been described in detail and updated in French, following the ICP Forests Manual (Beuker *et al.*, 2016; Dobbertin *et al.*, 2016; Eichhorn *et al.*, 2016; Raution *et al.*, 2016; Ukonmaanaho *et al.*, 2016). Intercalibration courses have been organized regularly for tree health assessment and stand inventory. Foliar analyses have been performed by an accredited laboratory using standard methods, with internal quality controls (analysis of reference samples systematically repeated) and successful participation to yearly ICP Forests ringtests.

4.3. Bryophytes

Recorded parameters: Census of moss species, and species-specific relative abundance + visual assessment of the coverage of the moss layer.

Sampling area: 4 permanent subplots of 100 m² (2 m x 50 m) each in the fenced central part + 4 permanent subplots of 100 m² (2x50 m) each in the unfenced surrounding area. The subplots are delimitated with permanent boundary markers.
Sampling frequency: 2 seasonal censuses (Spring + Summer), every 5 years
Quality assurance & control: Methodology has been described in detail in French since 1994, and updated in 2001 and 2006, following the ICP Forests Manual (Canullo *et al.*, 2016). Intercalibration courses have been organized with all field crews every 5 years. During field campaigns, control assessments have been performed by a second team in 10% of the sites.

4.4. Macrofungi
Recorded parameters: Census of species based on sporophores.
Sampling area: The whole fenced area (0,5 m²).
Sampling frequency: at least 4 seasonal censuses, for 1 to 3 years.
Quality assurance & control: Two intercalibration courses were organized with field observers (taxonomists from the French society for mycology).

5. Investigated environmental variables

5.1. Soil physical and chemical parameters
Soil properties (pH, exchangeable nutrients and acidity, carbonates, organic C, total N, extractable P, and bulk density) have been surveyed every 15 years by systematic layers (0–10 cm, 10–20 cm, 20–40 cm), on the basis of 25 sampling points grouped into 5 spatial composites per site. The deeper layers (40–80 cm, 80–100 cm) were characterized once for the same parameters on samples taken from 2 large pits dug for soil description. Particle size distribution was determined for all of these systematic layers also. Methodology has been described in detail and updated in French, following the ICP Forests Manual (Cools & De Vos, 2016). The analyses have been performed by an accredited laboratory using standard methods, with internal quality controls and successful participation to periodical ICP Forests ringtests (König *et al.*, 2016).

5.2. Litter physical and chemical parameters
Litter properties (mass per hectare, organic C, total nutrients) have been surveyed every 15 years by horizons (OL, OF, OH), on the basis of 25 sampling points grouped into 5 spatial composites per site. Methodology has been described in detail and updated in French, following the ICP Forests Manual (Cools & De Vos, 2016). The analyses have been performed by an accredited laboratory using standard methods, with internal quality controls and successful participation to periodical ICP Forests ringtests (König *et al.*, 2016).

5.3. Atmospheric deposition chemistry
In a subset of sites (set 2 and 3), precipitations have been measured and sampled every week under the canopy (throughfall) and in a nearby open-field area with bulk samplers. Analyses have been made on 4-week composites for deposition acidity, N and S pollutants, major nutrients, and dissolved organic C. Methodology has been described in detail and updated in French, following the ICP Forests Manual (Clarke *et al.*, 2016). The analyses have been performed by an accredited laboratory using standard methods, with internal quality controls and successful participation to periodical ICP Forests ringtests (König *et al.*, 2016).

5.4. Soil solution chemistry

In a subset of sites (set 3), Soil solution has been and sampled every week with tension lysimeters at 20 cm and 70 cm depth. Analyses have been made on 4-week composites for acidity, N and S pollutants, major nutrients, and dissolved organic C. Methodology has been described in detail and updated in French, following the ICP Forests Manual (Nieminen *et al*., 2016). The analyses have been performed by an accredited laboratory using standard methods, with internal quality controls and successful participation to periodical ICP Forests ringtests (König *et al*., 2016).

5.5. Meteorology

Automatic meteorological stations were installed in an open field area in the vicinity of a subset of sites (set 2 and 3). Measurements comprise temperature, precipitation, and relative air humidity. Wind (speed, direction) and global radiation have been measured only where relevant as regard to the size of the open field area. Methodology is following the ICP Forests Manual (Raspe *et al*., 2016). Sensors have been regularly calibrated to ensure the comparability of the measurements over long term.

5.6. Ozone concentrations and symptoms induced on the vegetation

In a subset of sites (set 3), ozone concentrations in the air have been monitored with passive samplers every week from April 1st until September 30th in the same open field are used for deposition and meteorological surveys. stations were installed in a nearby open field area in the st until September 30th vicinity of a subset of sites (set 2 and 3). Visible symptoms induced by ozone were assessed in summer on the vegetation (on tree foliage, and on light exposed ground vegetation. Methodology is following the ICP Forests Manual (Schaub *et al*., 2016). Quality control of the passive samplers was ensured by regularly installing some of them in the vicinity of active stations as reference ozone measurements. The French field observers participated to periodic ICP Forests intercalibration courses for the assessment of ozone-induced symptoms on the vegetation.

6. Other investigated functions/processes

6.1. Forest management history

All sites were installed in 1992 in adult stands and maintained under usual management by local foresters (the fence is temporarily removed during cuttings). Tree removals have been documented by stand inventories made in the central part of each site every 5 years and also before and after each thinning operation since site installation. Forest management history before site installation was investigated through local management documents (Ponce et al., 1998). Stand age has been determined by a dendrochronological survey in 1995 (Lebourgeois, 1997).

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8. Participating experts in the project

RENECOFOR coordinating team (Office national des forêts): Manuel Nicolas, Sébastien Cecchini, Luc Croisé, Sébastien Macé

Current expert members of RENECOFOR Scientific Board: Michaël Aubert (Université de Rouen), Delphine Derrien (INRAE), Eric Dufrêne (CNRS), Jean-Luc Dupouey (INRAE), Hans-Peter Ehrhart (FAWF), Isabelle Feix (ADEME), Hervé Jactel (INRAE), Mathieu Jonard (Université catholique de Louvain la neuve), Nathalie Korboulewsky (INRAE), Guy Landmann (GIP ECOFOR, Président du Comité), Myriam Legay (AgroParisTech), François Morneau (IGN), Quentin Ponette (Université catholique de Louvain la neuve), Anne Probst (CNRS)

RENECOFOR has involved hundreds of contributors in France since 1992: foresters, researchers, laboratories, botanists, mycologists... They cannot be individually listed here, but their contribution is warmly acknowledged anyway.

As part of ICP Forests monitoring programme, RENECOFOR has also benefited from the international expertise of all scientists involved in the development of ICP Forests Manual and in the coordination of its activities.

EX15_FR_NK

1. General information

Name of the experiment: **OPTMix (Oak Pine Tree Mixture)**

Contact(s) in the COST Action: Nathalie Korboulewsky (nathalie.korboulewsky@inrae.fr), Anders Mårell (anders.marell@inrae.fr)
Organization of the Contact(s): INRAE, UR EFNO, Domaine des Barres, F-45290 Nogent-sur-Vernisson, France
Website of the experiment: https://optmix.inrae.fr/

The question of the experiment:

OPTMix aims to improve knowledge on the functioning of mixed forests in temperate regions with direct applications to forest management, especially in the context of climate change.
What are the mixture effects on productivity, resistance, and resilience of the stands?
What are the pros and cons of scenarios relative to water and nutrient resources? Effects of mixture on water budget and nutrient and C stocks and cycles.
What role do games (roe deer, red deer, wild boar) play in the regeneration of mixed forest stands and in understory vegetation dynamics?
What are the effects of silvicultural practices (tree density and composition) on biodiversity?

Locality: France, Orleans state forest
Number of Sites: 12
Number of Blocks: 0
Treatments and number of Levels:
The factors of the experimental treatments:

- Tree composition: pure and mixture of two tree species
- Tree density
- Herbivory pressure (exclosure)

Number of Plots: Total of 33

The combinations of the factors tree density and herbivory corresponds to three unique management strategies: low density without herbivory, low and medium density with herbivory. The experiment is set up with three replicates for each unique combination of factors with a total of 27 plots (3 compositions x 3 management strategies x 3 repetitions). Plus the 6 additional plots in the mixture treatments. Total of 33 individual plots.

Dates:
Beginning of the experiment:
Oct 2015. The three repetition and sensors were completed in 2015, but some plots were running from 2012.
Date of Before-treatment data collection:

From 2011. Dates and frequency depends on data collected. Even "before treatment" means that we had tree composition treatment which can be studied, not the other factors (tree density and herbivory pressure).

Tree growth: 2011, 2013, 2015 (for the 3d repetition)
Floral and bryophyte diversity: 2015
Ground beetles (Carabidae): 2012, 2013, 2014
Regeneration: 20XX
Litter and fruit fall: 2016–2017, partial in 2018–2019

Date of intervention:

Tree thinning: spread over 2012–2015, then again in 2017
Fencing: spread over 2014 and 2015

Dates of after-treatment data collection:

Biodiversity (vascular plants, bryophytes, lichens), regeneration, microclimate (rain, T°, light, H%), soil humidity, inter and intra-annual tree growth and phenology, litterfall measurements

Tree growth: 2015, 2017
Biodiversity: 2019
Soil diversity: 2019–2020
Regeneration: 2016 and 2019
Litter and fruit fall: 2016–2017, partial in: 2018–2019
Microclimate: from 4/hours to every 2 weeks

2. Site descriptions

2.1. Site 1–12.

Site name	Location	Altitude (m)	Area (ha)	Age	Canopy openness (%)
O108	Ouzouer-sur-Loire	150	1.1	74	5–25
O12	Dampierre-en-Burly	155	3.4	74	11–31
O178	Ouzouer-sur-Loire	147	1.0	88	5–25
O200	Les Bordes	146	3.3	65	33–57
O214	Les Bordes	148	3.6	66	14–32
O216	Les Bordes	147	4.4	64	13–47
O255	Les Bordes	145	1.0	74	5–25
O333	Bray-Saint-Aignan	135	3.4	57	20–31
O57	Montereau	149	4.7	75	17–45
O593	Vitry-aux-Loges	129	3.4	66	16–40
O598	Châteauneuf-sur-Loire	126	4.7	74	9–30
O83	Montereau	151	3.5	58	22–47

Location: France, Orleans state forest
GPS coordinates: Latitude: 47.8166 (northing
Longitude : 2.4833 (easting) in the WGS 84 decimal degree system
Altitude: 125–158 m
Aspect: flat
Slope: flat
Mean annual temperature: 10.6 °C

Annual precipitation: 716 mm
Bedrock: burgalien superior, sand and clay from Sologne

Soil type: planosol
Site area: 40 ha (12 sites together)
Forest type: Atlantic and subatlantic lowland beech forest (EEA: 6.2)
Age of the stand at the beginning of the experiment: -

Density	Composition	Species	Dg (cm)	Basal area (m²/ha)	Number of stem (/ha)	RDI
Low	Pure oak	Oak	23.5 (2.5)	14.8 (0.4)	347 (60)	0.41 (0.01)
	Mixture	Oak	23.5 (2.1)	8.9 (0.9)	209 (38)	0.24 (0.03)
		Pine	35.9 (3.6)	10.7 (1.5)	106 (19)	0.24 (0.03)
	Pure Pine	Pine	33.8 (1.2)	21.7 (3.2)	242 (45)	0.48 (0.07)
Medium	Pure oak	Oak	22.5 (2.4)	20.8 (1.6)	530 (75)	0.57 (0.05)
	Mixture	Oak	23.6 (1.9)	10.4 (1.1)	245 (60)	0.29 (0.03)
		Pine	36.0 (3.3)	15.7 (2.8)	154 (19)	0.35 (0.06)
	Pure Pine	Pine	33.6 (1.7)	30.7 (1.7)	348 (23)	0.68 (0.04)

Stand structure before the interventions:
canopy: oak and pine
shrub layer: very few and only at some places *Carpinus*
understory layer: *Molinia caerulea, Calluna vulgaris, Pteridium aquilinum* from 10 to 100%
Canopy openness: -
Management type before the experiment: even-aged stand
Available data for the stand structure of the stand: tree species, DBH, basal area, height, light transmittance, LAI

3. Applied treatments

Three factors are tested and controlled: stand composition, stand density and pressure of herbivory by ungulates. 3 replicates were installed for each studied combination of factors.

3.1. Treatment 1. stand composition

- 3 compositions: pure oak (*Quercus petraea*), pure pine (*Pinus sylvestris*) and oak-pine mixture;

3.2. Treatment 2. tree density

To control the density over the all life of the stands, the relative density index (RDI) is used (see figure). Two level of density are tested: RDI around 0.4 corresponding to the dynamic scenario and RDI around 0.7 corresponding to the conservative scenario;

- 2 densities for all three stand composition

  - a dynamic scenario and
  - a conservative scenario.

- An extra density for the mixture
  - Unthinned stand corresponding to a RDI of 1

3.3. Treatment 3. Herbivore pressure

- 2 types of herbivory pressure:
  - open access and
  - total exclusion with fences.

- An extra level for the mixture
- Selective fences allowing the entry of wild boars but not the other ungulates (3 additional plots).

Stand composition and tree density have a completely crossed factorial design, while herbivory is completely crossed with stand composition only for the low tree density.

The combinations of the factors tree density and herbivory corresponds to three unique management strategies: low density without herbivory, low and medium density with herbivory. The experiment is set up with three replicates for each unique combination of factors with a total of 27 plots (3 compositions x 3 management strategies x 3 repetitions).

In the case of mixed stands, additional treatments are tested:

Control plot with no management actions (3 additional plots);
Selective fences allowing the entry of wild boars but not the other ungulates (3 additional plots).
Finally, the experiment includes 33 experimental plots spread over 12 management plots.

Each experimental plot covers a surface area of 0.5 ha where all the trees are mapped. The experimental plots are surrounded by a buffer zone of 20 meters wide subject to the same silvicultural treatments. All the specific experiments of the project are accurately located and pathways are defined for recurrent measurements (downloads of dataloggers, dendrometer measurements, flora and regeneration monitoring, collection of beetle traps …).

3.4. Graphical representation of the experiment

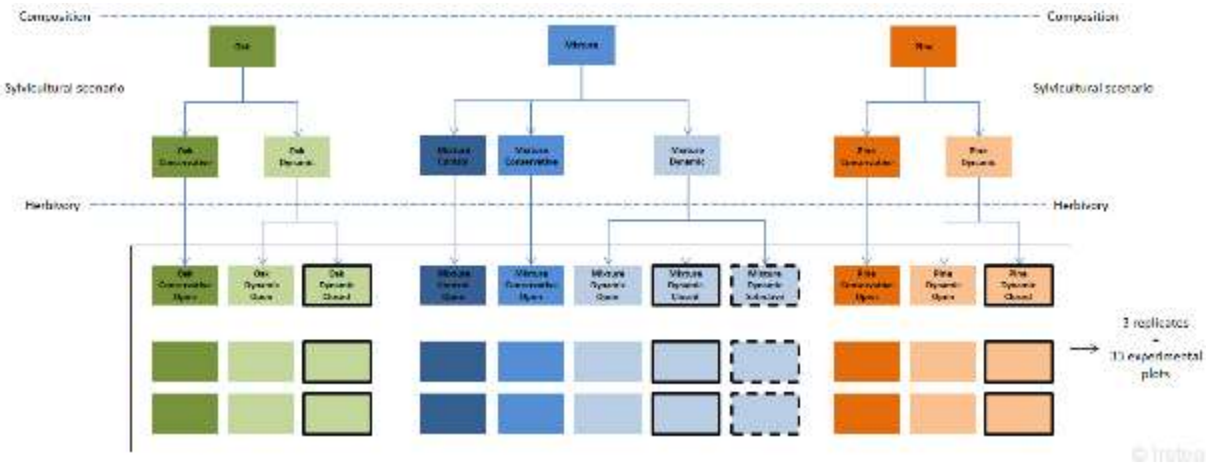


Figure 1. Diagram of the OPTMix experimental design. 11 treatments were applied corresponding to the combination of the three factors: composition, sylvicultural scenario and herbivory. For each treatment 3 replicates were installed leading to 33 experimental plots.

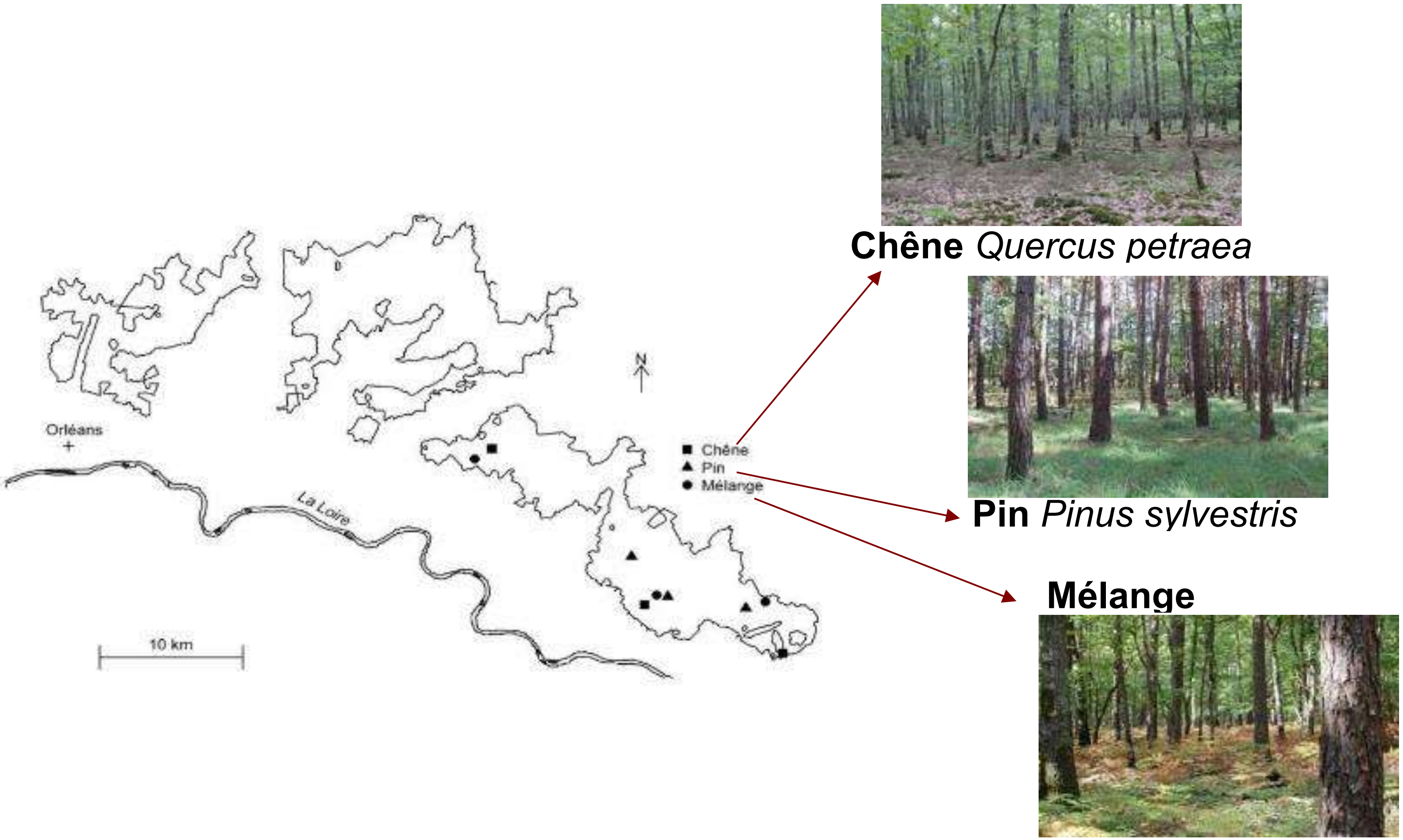
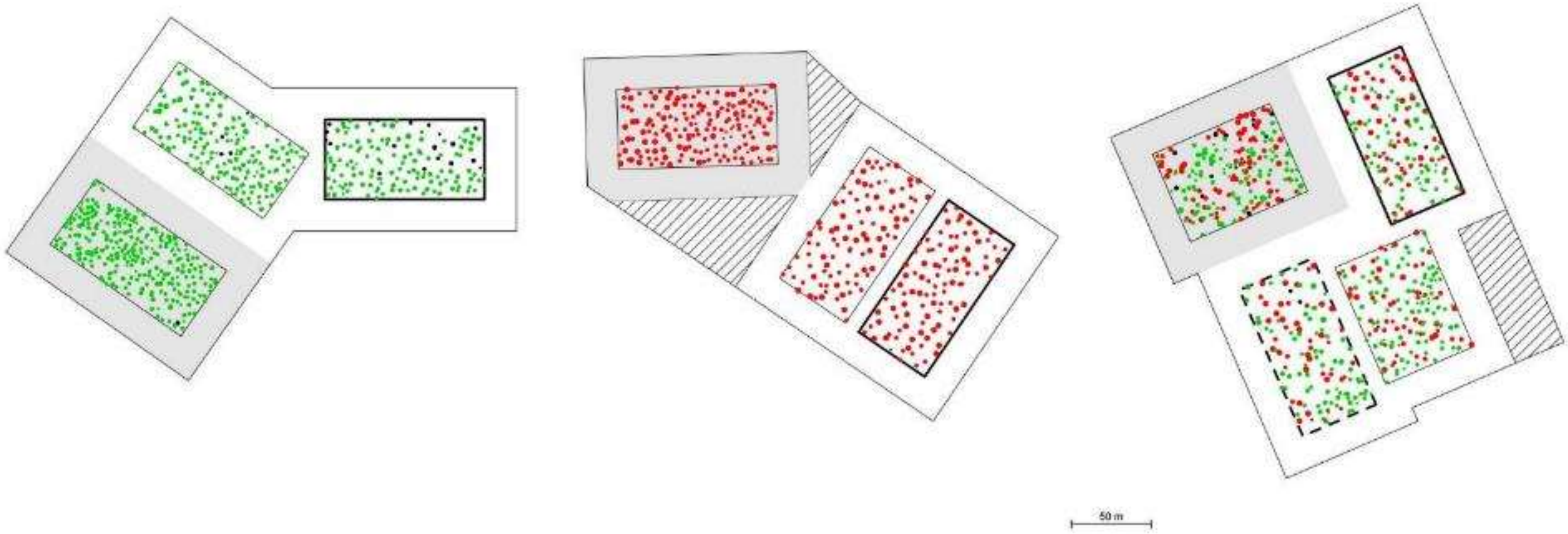


Figure 2. Location of the stands.



Pure oak stand (0214) | Pure pine stand (0200) | Oak–pine Mixture (O216)

Figure 3. Example of experimental plots in a mixed stand. Four treatments are studied: conservative scenario without exclusion of herbivores (open), dynamic scenario without exclusion of herbivores (open), dynamic scenario with exclusion of all herbivores with a fence (closed) and dynamic scenario allowing the entry of wild boars but not other ungulates (selective).

4. Investigated organism groups

Summarized in the table below

5. Investigated environmental variables

Summarized in the table below

6. Other investigated functions/processes

Summarized in the table below

Mesurements/ observations	Equipements	Nombre total sur le dispositif
REFEERENCE CLIMATIC DATA (outside the tree cover)		
Complete reference weather station	• Collecting data CR1000 - Campbell Scientific Lt • Protection ENC 12/14 – Campbell Scientific Lt • Temperature and relativ huumidity CS215 – Campbell Scientific Lt avec abris ventilés MET20 – Campbell Scientific Lt • Pyranometer SP1110 – Skye instruments Ltd et Embase et plateau de fixation pour capteur de lumière SKE211 & CM225E MET20 – Campbell Scientific Lt • PAR SKP215 – Skye instruments Ltd et • Global radiation sensor for diffuse radiation BF3 – Delta-t Devices	1
SOIL		
Soil moisture and water table level	• CS616 – Campbell Scientific Lt • CS450 – Campbell Scientific Lt • Soil T° • thermocouple • Soil pH	234 26 automatique et 52 manual 78
Soil physico-chemical characteristaiton		3 soil pits described on 26 plots 10 points/plots + caracterisations of 80 pits
Soil pedological description	soil profile desciption	80 on ecah pits
Humus characterisation and description		Allplots, 33
Litter decomposition	Litter amount, components (C, N, P, K, Ca, Mg) 120 litter-bag/plot	12 plots, 3 years of following (2013–2016) Chemical analysis on composite samples at the year level, one or two years of data only
ENVIRONNEMENTAL PARAMETERS –CONTINUOUS COLLECTION IN THE PLOTS		
Air relative humidity	• T° and air humidity, CS215 – Campbell Scientific Lt avec Abris ventilés MET20 – Campbell Scientific Lt	52
Rainfall	• AGR100 – Campbell Scientific Lt	52
Light	• Pyranometer SP1110 – Skye instruments Ltd Campbell Scientific Lt	78
TREES		
Growth • DBH • Cicumference Increment • Height • Crown base heigh and diameter	Height is measured only on a subsample of trees in order to calibrate allometric equations that are then used to predict the height of all trees from DBH; Crown base heigh and diameter: exists on a subsample of trees, on a few selected plots	33 plots (all trees) 21 plots (15 trees/species, so 450 trees)

Inbtra-annual growth	• Dendrometer (manual) • Dendrometer (automatic, DR26 – EMS BRNO)	21 plots, 235 trees 180
Phenology (bud burst)		21 plots, 235 trees
Regeneration Évaluation quantitative et qualitative sur placeaux de rayon 2 m (comptages et mesures de hauteur) – Comparaison entre 9 placettes ouvertes, 9 placettes fermées et 3 placettes sélectives		420 subplots (20 subplots/treatment plots on unfenced plots)
Tree health subsample; in all plots		Around 20 tress/plot
Age of trees		
Microhabitats		a small subsample on only three plots
Deadwood planned for winter of 2020–2021		
Laser scanning		done on oak on a selected small number of plots (we do not have the raw data)
Litter and seeds fall	Collectorrs de 0,5 m²	10/plots (all unfenced plots), so 210 collectors in total
PEST MAMMALS		
Attendance and activities by large wild ungulates 3 periods (Feb. / March, May / June, Nov. / Dec.), hybrid mode (automatic 4 hrs morning / 4 hrs evening + detection at night), 6 days per period in each corner of the plots, followed by continuous in detection mode between the 3 periods for selective plots	• Photographic traps, Moultrie Game Spy M-80XT	11 plots, 792 days/ yr (including 24 days/plots/period)
Cervid browsing rate Estimated cervid browsing rate on forest regeneration		9 plots unfenced and 3 selective plots, so 240 subplots
Percentage of soil returned by wild boar Estimated percentage of soil returned by wild boar		9 plots unfenced and 3 selective plots, so 240 subplots
Abundance of micromammal populations (rodents) Non-destructive capture of micromammals traps with dormitory, 1 campaign per year (fall), 48 h of capture, 204 traps / ha		9 plots, 102 trap per plots
BIODIVERSITY		
Vascular plants Floristic survey on 5 subplots of 40 m² per plot every 4 years		33 plots, 165 subplots
Bryophytes, lichens Floristic survey on 5 subplots of 40 m² plots per plot every 4 years Survey at the foot and on the trunk of 3 trees of each species by plots on 30 plots		33 plots, 165 subplots + 90 trees
Insects (carabes, soil fauna) Ground beetles (Carabidae) collected by pitfall traps, 3 traps per plot, campaign in 2012, 2013, 2014 Harvesting of soil fauna (mesofauna – Oribatida, Gamasida, Collembola): collected by soil cores and litter bags, campaign in 2013, 2020		30 plots
Birds 10-min point counts		

7. References

About OPTMix

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8. Participating experts in the project

NA

EX16_HU_FT

1. General information

Name of the experiment: **Pilis Gap Experiment**

Contact(s) in the COST Action: Flóra Tinya (tinya.flora@ecolres.hu), Péter Ódor (odor.peter@ecolres.hu)
Organization of the Contact(s): Centre for Ecological Research, Institute of Ecology and Botany, Alkotmány u. 2–4. Vácrátót, H-2163, Hungary
Website of the experiment: https://piliskiserlet.ecolres.hu/

The question of the experiment:
How do the various kind of gap cuttings affect the forest site, the forest biodiversity, and the regeneration of the stands?

Locality: Pilis Mountains, Hungary
Number of Sites: 1
Number of Blocks: 6
Treatments and number of levels:
Treatment 1: Gap-cutting treatments (6 levels)
Number of Plots: 36 (6 Blocks x 6 Gap-cutting treatments)

Dates:
Beginning of the experiment: 2018
Before-treatment data collection: yes (2018)
Interventions: 2018/2019 winter (gap-cutting)
After-treatment data collection: 2019, 2020, will be continued yearly

2. Site descriptions

2.1. Site 1.
Location: Hosszú-hill, Pilisszántó village, Pilis Mountains, Hungary
GPS coordinates:
18˚ 54'54.62" E
47 ˚ 40'13.20" N
Altitude: 390–460 m
Aspect: north-east
Slope: <10°
Mean annual temperature: 9.3 °C
Annual precipitation: 650 mm
Bedrock: limestone and sandstone with loess
Soil type: Luvisol, Rendzic Leptosol
Site area: 10 ha
Forest type: Sessile oak–hornbeam forest (EEA 2006: 5.2; Annex I. Habitat Directive: 91G0)

Dominant tree species: Quercus petraea (DBH = 37 cm, Height = 22 m), *Carpinus betulus* (DBH = 18 cm, Height = 14 m)
Age of the stand at the beginning of the experiment: 90 years
Stand structure:

canopy: upper oak and a scarce secondary hornbeam layer, slight partial preparation cutting (10%) 10 years ago

shrub layer: scarce, mainly the regeneration of trees (*C. betulus, Q. petraea, Fraxinus ornus*)

understory layer: general and mesic species, cover 100% (dominant species: *Carex pilosa, Melica uniflora*)

the whole stand fenced against ungulate browsing in 2019

Canopy openness: around 11%
Management type before the experiment: shelterwood forestry system
Available data for the stand structure of the stand: detailed map and stand model (Field-Map System and ground-based LiDAR); tree species, DBH, height, basal area, volume, standing and lying dead wood volume, canopy openness

3. Applied treatments

3.1. Treatment 1: Gap-cutting treatments

1. Large circular gap: diameter: 20 m, area: 0.03 ha, surrounded by closed stand;
2. Small circular gap: diameter: 14 m, area: 0.015 ha, surrounded by closed stand;
3. Large elongated gap: 10×30 m, area: 0.03 ha, surrounded by closed stand;
4. Small elongated gap: 7×21 m, area: 0.015 ha, surrounded by closed stand;
5. Extended gap: small elongated gap, some years later (after the establishment of oak regeneration) will be extended to large circular gap;
6. Control: closed-canopy stand, without harvesting, plot for stand structure, diameter: 30 m, area: 0.07 ha

3.2. Description of the study design

There are 6 forestry treatments occurring in 6 blocks as replicates, following a complete block design, and resulting 36 plots.

The experiment follows a BACI (Before-After-Control-Impact) design. Virtually all of the studied variables were recorded in 2018 in each plot, before the intervention of the forestry treatments.

3.3. Graphical representation of the experiment

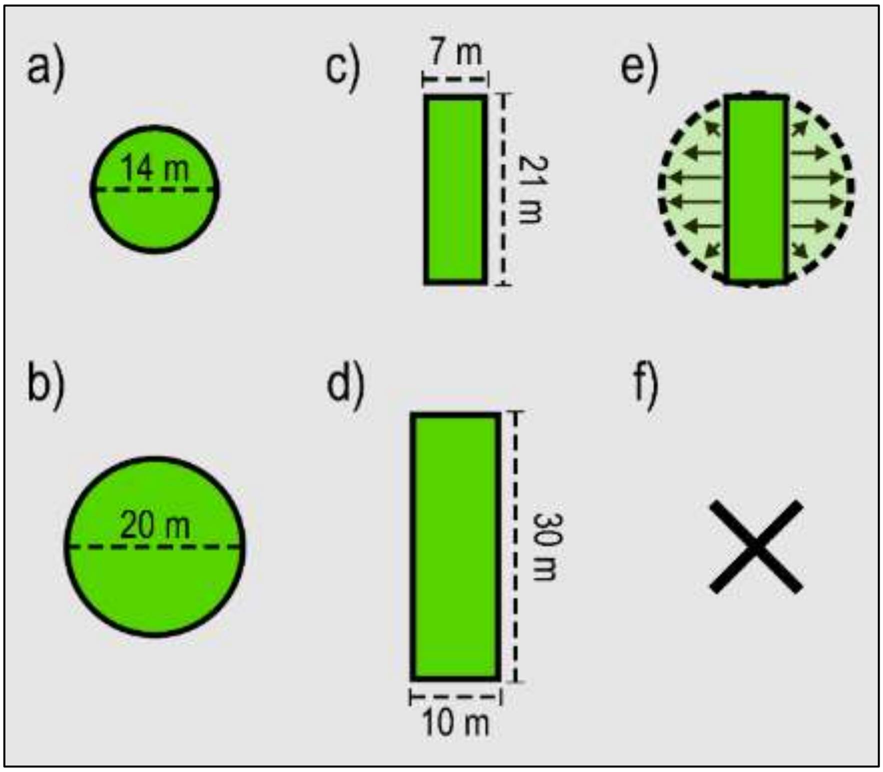


Figure 1. The investigated gap types in the Pilis Gap experiment. a) Small circular, b) large circular, c) small elongated, d) large elongated gap, e) gap created in two steps (small elongated gap enlarged some years later to large circular), f) uncut control.

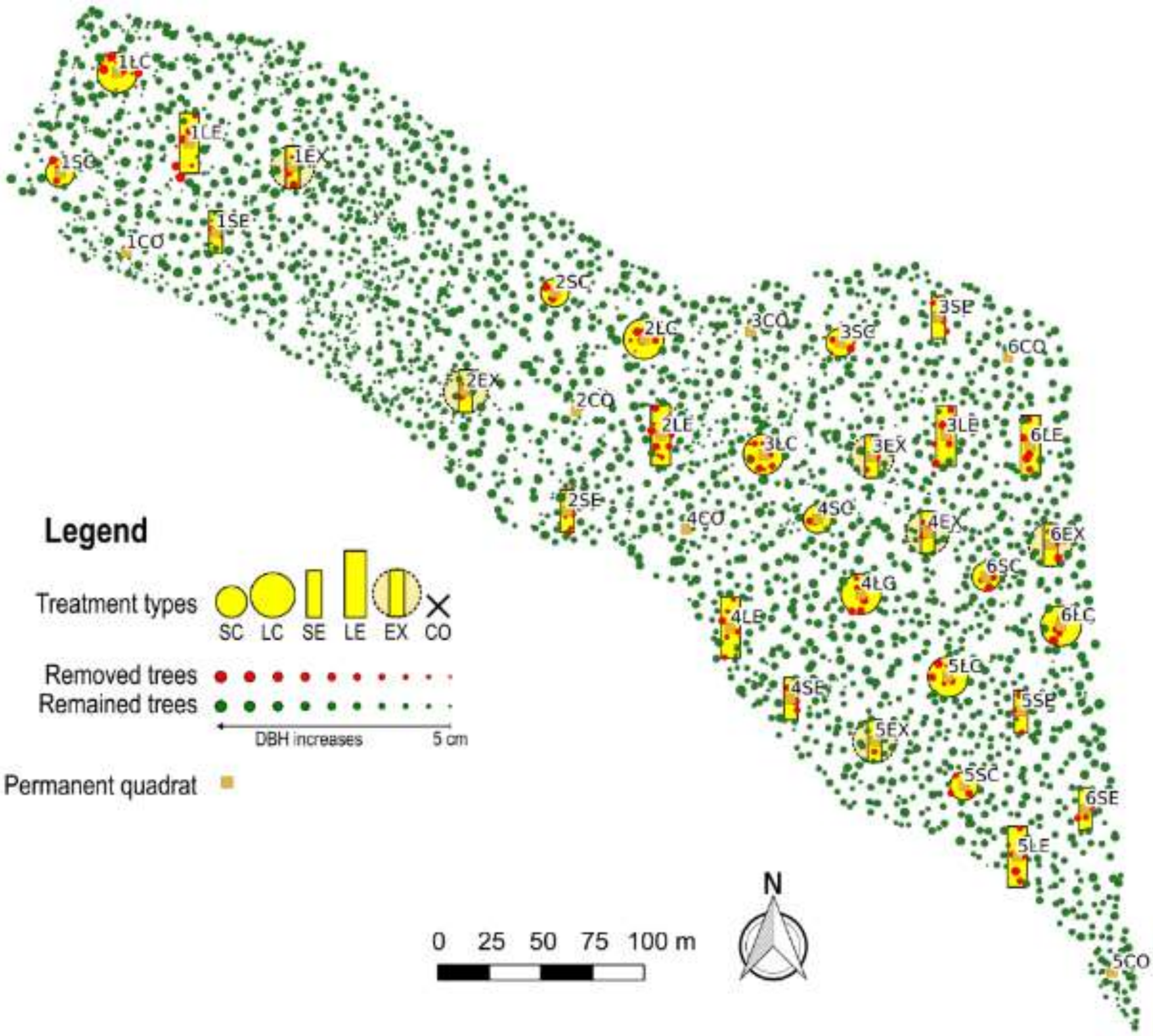


Figure 2. Map of the forest stand around the Pilis Gap Experiment, with the created artificial gaps. SC = small circular, LC = large circular, SE = small elongated, LE = large elongated, EX = extended gap, CO = control site.

4. Investigated organism groups

4.1. Understory vegetation

Visual estimation of the cover of the species including all herbs plus woody species under 50 cm height.

a. One 2 m × 2 m understory quadrat per plot, surveyed in every year, from 2018, in spring and summer.

b. Spatially finer sampling: 41 0.5 m × 0.5 m quadrats along eight radial transects in each plot, surveyed in only in 4 blocks, in every second year (from 2019), in summer.

4.2. Regeneration of woody species

a. Recording the number of saplings in the understory quadrats per species per size categories (0–20 cm, 20–50 cm, 50–130 cm, >130 cm height). Surveyed in every summer, from 2018.

b. Counting the *Quercus petraea* seedlings from the cohort established in the 2018 masting year, in four 0.5 m × 0.5 m quadrats, in order to estimate mortality. Surveyed in every autumn from 2019.

b. Recording the individual growth of marked *Quercus petraea* seedlings. Surveyed in every autumn, from 2020.

4.3. Ground beetles (Carabidae)

Individuals were collected by pitfall traps (3 per plot) from 2018, in every year twice (spring and autumn) with one month sampling length.

4.4. Ground-welling spiders

Individuals were collected by pitfall traps (3 per plot) from 2018, in every year twice (spring and autumn) with one month sampling length.

4.5. Enchytraeid worms

They were collected in 2018 in May and September, and in 2020 in May. Soil samples (3 per plot) were taken from 12 cm depth, samples of a plot were mixed and after 78 cm^3 soil was taken for worm extraction by wet funnel method. The extracted individuals were determined and counted.

4.7. Dipterans

In each plot, a Malaise traps were used in 2018 and 2019 in spring and autumn, and from 2020 in spring with one month sampling length.

5. Investigated environmental variables

5.1. Light

a. Relative diffuse light: Li-COR LAI-2000 Plant Canopy Analyzer was used in 2018, with one recording in each plot, in summer.

b. Percentage of above-canopy light (direct, diffuse, total): It has been recorded by hemispherical photos using WinSCANOPY system from 2019. The survey was made in summer.

c. Canopy openness: Spherical densiometer has been used from 2018 yearly, in summer. From 2019, it can be calculated also from the hemispherical photos.

5.2. Air temperature and air humidity

It is permanently recorded in the middle of the plots, from 2018 March, recording interval is 15 min. Air temperature and air humidity is measured by Voltcraft DI-2 sensor at 130 cm height, while air temperature is also measured by TOMST TMS-4 sensor at 15 cm height above ground.

5.3. Soil temperature
It is permanently recorded in the middle of the plots, from 2018 March, recording interval is 15 min. It is recorded at two vertical layer: 0 cm (soil surface) and -15 cm (below ground) by TOMST TMS-4 sensor.

5.4. Soil water content
It is permanently recorded in the middle of the plots, from 2018 March, recording interval is 15 min. It is measured at -15 cm (below ground) by TOMST TMS-4 sensor.

5.5. Soil physical and chemical parameters
4 soil samples are collected in each plot, from 0–20 cm depth, from 2018, in every year in spring and autumn. Measured soil variables are pH, hygroscopicity, organic matter content, nutrient content (C, N, S, P, K).

5.6. Litter physical and chemical parameters
4 litter samples are collected in each plot, from a 30 × 30 cm^2 area, from 2018, in every year in spring and autumn. Measured variables are litter mass, pH, moisture content, C, N, S content.

6. Other investigated functions/processes

6. 1. Acorn fall
In 2018 (masting year): counting the number of fallen *Quercus* acorns in one 0.25 m^2 quadrat/plot.
In 2020 (masting year): counting the number of fallen *Quercus* acorns in 41 0.5 m × 0.5 m quadrats along eight radial transects in each plot. Surveyed only in 4 blocks.

7. References

Kovács, B., Tinya, F., Bidló, A., Boros, G., Csépányi, P., Elek, Z., Horváth, Cs. V., Illés, G., Locatelli, J., Németh, Cs., Soltész, Z., Samu, F., Sass, V., Ódor, P. (2020). Introducing the "Pilis Gap Experiment": a new multi-taxa study focusing on the effects of continuous cover forestry. In: Abruscato, S., Joa, B., Winkel, G. (eds.): Governing and managing forests for multiple ecosystem services across the globe. February 26–28, 2020. Book of Abstracts. pp. 105–106. P3.6. Poster.

8. Participating experts in the project

Bidló, András, University of Sopron (soil, litter)
Boros, Gergely, Szent István University (enchytraeid worms)
Csépányi, Péter, Pilis Park Forestry Company (forest management)
Elek, Zoltán, MTA–ELTE–MTM Ecology Research Group (carabid beetles)
Farkas, Viktor, Pilis Park Forestry Company (forest management)

Horváth, Csenge Veronika, Eötvös Loránd University, Centre for Ecological Research (understory vegetation)
Illés, Gábor, National Agricultural Research and Innovation Centre, Forest Research Institute, (stand structure – LiDAR)
Kovács, Bence, Centre for Ecological Research (microclimate)
Locatelli, Julia, Eötvös Loránd University, Centre for Ecological Research (understory)
Németh, Csaba, Centre for Ecological Research (microclimate)
Ódor, Péter, Centre for Ecological Research (leader)
Samu, Ferenc, Centre for Agricultural Research (spiders)
Sass, Vivien, University of Sopron (soil, litter)
Soltész, Zoltán, Centre for Ecological Research (dipterans)
Szenthe, Gábor, Pilis Park Forestry Company (forest management)
Tinya, Flóra, Centre for Ecological Research (light, understory, regeneration)

EX17_HU_PO

1. General information

Name of the experiment: **Pilis Forestry Systems Experiment**

Contact(s) in the COST Action: Péter Ódor (odor.peter@ecolres.hu), Flóra Tinya (tinya.flora@ecolres.hu)
Organization of the Contact(s): Centre for Ecological Research, Institute of Ecology and Botany, Alkotmány u. 2–4. Vácrátót, H-2163, Hungary
Website of the experiment: https://piliskiserlet.ecolres.hu/

The question of the experiment:
How do the various forestry treatments affect the forest site, the forest biodiversity, forest functions, and the regeneration of the stands?
How does the game browsing influence the effect of the treatments on the regeneration?

Locality: Hungary, Pilis Mountains
Number of Sites: 1
Number of Blocks: 6
Treatments and number of levels:
Treatment 1: Forestry treatment (5 levels)
Treatment 2: Fencing (2 levels)
Number of Plots: 30 (6 Blocks x 5 Forestry treatments; fenced and unfences areas are within the plot)

Dates:
Beginning of the experiment: 2014
Before-treatment data collection: yes (2014)
Interventions: 2014/15 winter (Forestry treatment + Fencing)
After-treatment data collection: 5 years (2015, 2016, 2017, 2018, 2019)

2. Site descriptions

2.1. Site 1

Location: Hosszú-hill, Pilisszántó village, Pilis Mountains, Hungary
GPS coordinates:
Easting: 4988501
Northing: 2769117
Altitude: 370–470 m
Aspect: north-east
Slope: 9°
Mean annual temperature: 9.3 °C
Annual precipitation: 650 mm
Bedrock: limestone and sandstone with loess

Soil type: Luvisol, Rendzic Leptosol
Site area: 40 ha
Forest type: Sessile oak–hornbeam forest (EEA 2006: 5.2; Annex I. Habitat Directive: 91G0)
Dominant tree species: Quercus petraea (DBH = 28 cm, Height = 21 m), *Carpinus betulus* (DBH = 12 cm, Height = 11 m)
Age of the stand at the beginning of the experiment: 80 years
Stand structure:
canopy: upper oak and a secondary hornbeam layer
shrub layer: scarce
understory layer: general and mesic species, cover 40%
Canopy openness: around 5%
Management type before the experiment: shelterwood forestry system
Available data for the stand structure of the stand: tree species, DBH, basal area, height, volume, standing and lying dead wood volume, canopy openness

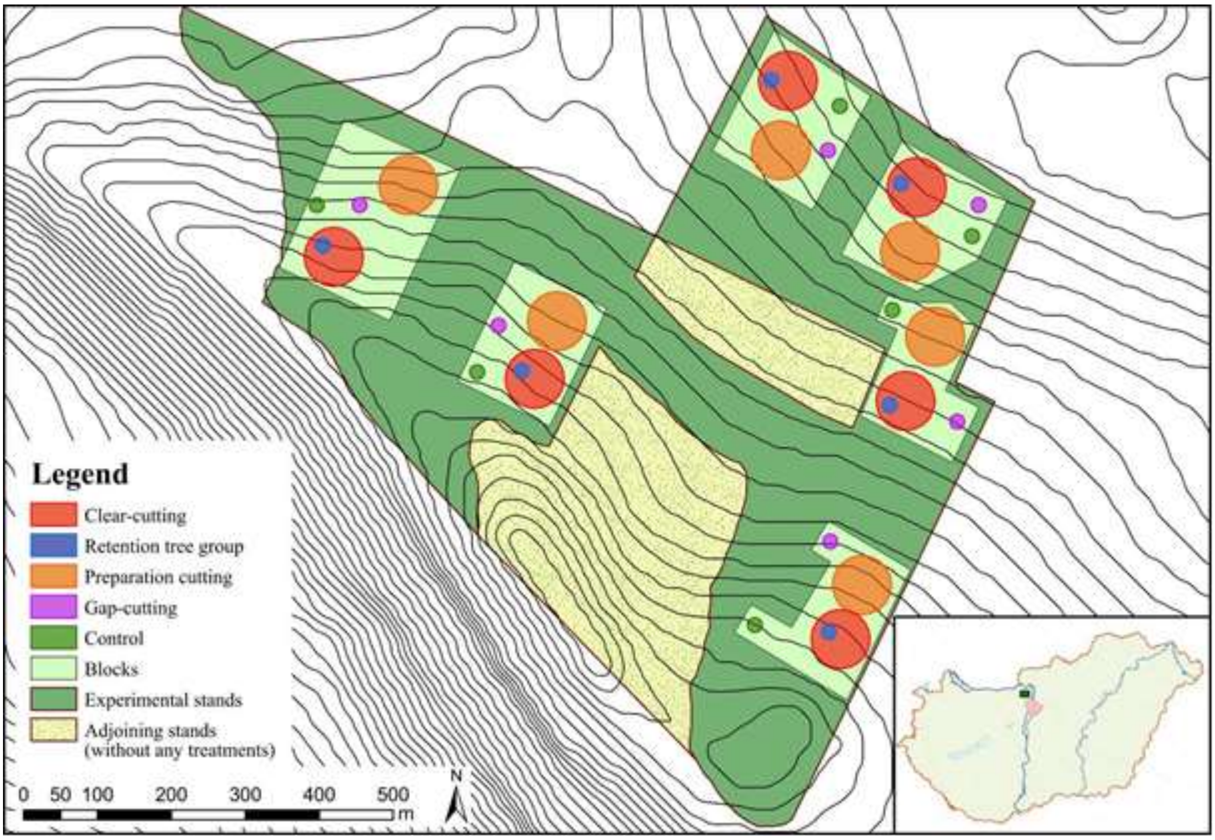
3. Applied treatments

3.1. Treatment 1: Forestry treatments
1. Clear-cutting: a circular clear-cut (diameter: 80 m), surrounded by closed stand;
2. Gap-cutting: an artificial circular gap in the closed stand (diameter: 20 m, approximately one tree height/gap diameter ratio);
3. Preparation cutting: 30% of the dominant trees (based on the basal area) was removed in a spatially even arrangement, and the whole secondary canopy and shrub layers were felled (diameter: 80 m),
4. Retention tree group: within the clear-cuts, a circular group of trees was retained
5. Control: closed-canopy stand, without harvesting (diameter 20 m, 8–12 individuals)

3.2. Treatment 2: Fencing
1. Fenced area: In each forestry treatment level, we have a 6 m × 6 m fenced area. This treatment is applied only for the vegetation and natural regeneration inventory.
2. Unfenced area

3.3. Description of the study design
There are 5 forestry treatments occurring in 6 blocks as replicates, following a complete block design, and resulting 30 plots. In each plot there is a fenced area (as a secondary treatment), but fencing as an effect is applied only for understory vegetation and natural regeneration inventories.
The experiment follows a BACI (Before-After-Control-Impact) design. Virtually all of the studied variables were recorded in 2014 in each plot, before the intervention of the forestry treatments.

3.4. Graphical representation of the experiment



4. Investigated organism groups

4.1. Understory vegetation
Visual estimation of the cover of the species including all herbs plus woody species under 50 cm height.
a. 2 m × 2 m understory quadrats (one fenced and one unfenced per plot), surveyed in every year, from 2014, in spring and summer.
b. Spatially finer sampling: 81 0.5 m × 0.5 m quadrats in a 2 m × 2 m grid in each plot, surveyed in only in 4 blocks, in every second year (2016, 2018, 2020), in summer.

4.2. Regeneration of woody species
a. Recording the number of saplings in the understory quadrats per species per size categories (0–20 cm, 20–50 cm, 50–130 cm, >130 cm height). Surveyed from 2014, in every summer in fenced and unfenced quadrats.
b. Recording the individual growth of planted saplings (*Quercus petraea, Q. cerris, Carpinus betulus, Fagus sylvatica, Fraxinus excelsior)*. Surveyed the height and stem diameter of 5 individuals per species per plot in the fenced area. Surveyed in every summer from 2014.

4.4. Ground beetles (Carabidae)
Individuals were collected by pitfall traps (4 per plot) between 2014–2018 yearly, planned again to 2021. Sampling is in every year twice (spring and autumn) with one month sampling length.

4.5. Ground dwelling spiders

Individuals were collected by pitfall traps (4 per plot) between 2014–2018 yearly, planned again to 2021. Sampling is in every year twice (spring and autumn) with one month sampling length.

4.6. Enchytraeid worms

Between 2014–2017, soil samples were taken twice a year (May and September). The next sampling is planned for 2021. 3 soil samples were taken per plot, from 12 cm depth. Samples of a plot were mixed and after 78 cm^3 soil was taken for worm extraction by wet funnel method. The extracted individuals were determined and counted.

4.7. Dipterans

In each plot, a Malaise traps were used between 2017–2019 in spring and autumn, and from 2020 in spring, with one month sampling length.

4. 8. Litter-dwelling beetles

Litter sampling and filtering. Only since 2020.

4. 9. Springtails (Collembola)

Soil samples were taken from two depth: 0–10 and 10–20 cm (diameter: 10 cm). Springtails were extracted from the samples by dry funel method. Only since 2020.

5. Investigated environmental variables

5.1. Light

a. PAR (photosynthetically active radiation): Onset ‘S-LIA-M003’ quantum sensors were used in every year, with 2-3 sampling day per month in the vegetation period.

b. Relative diffuse light: Li-COR LAI-2000 Plant Canopy Analyzer was used between 2015–2018, with one recording in each plot, in summer.

c. Percentage of above-canopy light (direct, diffuse, total): It has been recorded by hemispherical photos using WinSCANOPY system from 2019. The survey was made in summer.

d. Canopy openness: Spherical densiometer were used in each year in summer; from 2019, it can be calculated also from the hemispherical photos.

5.2. Air temperature and air humidity

It was recorded by Onset ‘S-THB-M002’ sensors from 2014, in every year with 2-3 sampling day per month in the vegetation period.

5.3. Soil temperature

It was recorded 2 cm below ground by Onset ‘S-TMB-M002’ sensors from 2014, in every year with 2-3 sampling day per month in the vegetation period.

5.4. Soil water content

It was recorded 10–20 cm below ground by Onset ‘S-SMD-M005’ sensors from 2014, in every year with 2-3 sampling day per month in the vegetation period.

5.5. Soil physical and chemical parameters
4 soil samples were collected in each plot from 0–20 cm depth in every year from 2014, in spring and autumn. Measured soil variables were pH, hygroscopicity, organic matter content, nutrient content (C, N, S, P, K).

5.6. Litter physical and chemical parameters
4 litter samples were collected in each plot from a 30 × 30 cm^2 area in every year from 2014 (until 2019 in spring and autumn, from 2020 only in spring). Measured variables were litter mass, pH, moisture content, C, N, S content.

6. Other investigated functions/processes

6.1. Game browsing
6 m × 6 m fenced area (one per plot)
Before the treatments, pairs of seedling individuals were selected from inside and outside the fenced area. The two members of a pair are the same species and have similar initial size and browsing conditions. Altogether 178 pairs were selected in the whole experiment. The individuals were measured in every year in autumn, from 2014. Measured variables were height, shoot length, stem diameter (at root collar), leaf area, shoot number, browsing condition.

6.2. Decomposition processes
a. Decomposition of leaf litter. 10 freshly collected and air-dried leaves of *Quercus petraea* were put into plastic bags (mesh size: 1 mm). 5 litter bags per plot were installed onto bare soil surface (150 samples in total), it was incubation for 6 months in 2017. The initial and remained mass of the bags were measured.
b. Decomposition of deadwood. Living branches (diameter 4-5 cm, length 50 cm) of three tree species (*Quercus petraea*, *Carpinus betulus*, *Fraxinus excelsior*) were cut. Two branch sets per plot were installed in 2015 and collected after two different incubation periods (1.5 and 3 years, respectively). Measured variables: initial and remained mass, fruiting bodies of fungi, subsamples for fungi eDNA analyses.

6. 3. Acorn fall
Recording the number of fallen acorns in 1 m^2 quadrats in fenced area. Recorded in every year, in autumn (except 2019).

6.4. Bryophyte transplantation
5 patches of two species (*Lophocolea heterophylla*, *Hypnum cupressiforme*) were planted in each plot in the fenced area, onto woody trunks. The survival of patches estimation was estimated (the proportion of green part related to the original patch size). Recording was made in every month between May 2015 – August 2018 (*Lophocolea*) and April 2016 – August 2018.

7. References

Elek, Z., Kovács, B., Aszalós, R., Boros, G., Samu, F., Tinya, F., Ódor, P. 2018. Taxon-specific responses to different forestry treatments in a temperate forest. Scientific Reports 8:16990. https://doi.org/10.1038/s41598-018-35159-z.

Boros, G., Kovács, B., Ódor, P. 2019. Green tree retention enhances negative short-term effects of clear-cutting on enchytraeid assemblages in a temperate forest. Applied Soil Ecology 136:106–115. https://doi.org/10.1016/j.apsoil.2018.12.018.

Kovács, B., Tinya, F., Guba, E., Németh Cs., Sass, V., Bidló, A., Ódor, P. 2018. The short-term effects of experimental forestry treatments on site conditions in an oak–hornbeam forest. Forests. 9(7): 406. https://doi.org/10.3390/f9070406.

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Tinya, F., Kovács, B., Aszalós, R., Tóth, B., Csépányi, P., Németh, Cs., Ódor, P. Initial regeneration success of tree species after different forestry treatments in a sessile oak–hornbeam forest. Forest Ecology and Management, 459: 117810. https://doi.org/10.1016/j.foreco.2019.117810.

8. Participating experts in the project

Aszalós, Réka, Centre for Ecological Research (understory vegetation)
Bidló, András, University of Sopron (soil, litter)
Boros, Gergely, Szent István University (enchytraeid worms, decomposition)
Csépányi, Péter, Pilis Park Forestry Company (forest management)
Elek, Zoltán, MTA–ELTE–MTM Ecology Research Group (carabid beetles)
Farkas, Viktor, Pilis Park Forestry Company (forest management)
Flórán, Norbert, Centre for Agricultural Research (springtails)
Horváth, Csenge Veronika, Eötvös Loránd University, Centre for Ecological Research (understory vegetation)
Kovács, Bence, Centre for Ecological Research (microclimate, game browsing, decomposition)
Németh, Csaba, Centre for Ecological Research (microclimate)
Németh, Tamás, Hungarian Natural History Museum (litter dwelling beetles)
Ódor, Péter, Centre for Ecological Research (leader)
Samu, Ferenc, Centre for Agricultural Research (spiders)
Sass, Vivien, University of Sopron (soil, litter)
Soltész, Zoltán, Centre for Ecological Research (dipterans)
Szabó, Lilla, Eötvös Loránd University, Centre for Ecological Research (game browsing)
Szenthe, Gábor, Pilis Park Forestry Company (forest management)
Tinya, Flóra, Centre for Ecological Research (light, regeneration)
Tóth, Bence, Eötvös Loránd University, Centre for Ecological Research (game browsing)
Vadas, Ákos, Eötvös Loránd University, Centre for Ecological Research (bryophytes)
Wirth, Kristóf, Eötvös Loránd University (springtails)

EX18_HU_RA

1. General information

Name of the experiment: 1 ha monitoring in the framework of **LIFE4OakForests** EU funded project **(Conservation management tools for increasing structural and compositional biodiversity in Natura2000 oak forests)**

Contact(s) in the COST Action: Réka Aszalós (aszalos.reka@ecolres.hu)
Organization of the Contact(s): Centre for Ecological Research, Institute of Ecology and Botany, Alkotmány u. 2–4. Vácrátót, H-2163, Hungary
Website of the experiment: no specific website, the website of the LIFE4OakForests is: http://www.life4oakforests.eu/general-information/

The question of the experiment: What is the effect of nature-conservation management (deadwood enrichment and gap opening) on different organism groups and forest structural elements – herb layer, shrub layer, saproxylophagous beetles, woodpecker feeding activity, microhabitats?

Locality: Hungary
Number of Sites: 8
Number of Blocks: 8
Treatments and number of Levels: We have one block in each site. Six sites have 3 plots (treatment1, treatment2, control), and two sites have 2 plots (treatment and control). Treatment 1 and treatment 2 are identical; three smaller and one large gaps are created within the 1 ha area. All generated deadwood are left on the site (deadwood enrichment).
Number of Plots: 22

Dates:
Beginning of the experiment: 01.01.2019
Date of Before-treatment data collection: yes, 2019, 2020
Date of intervention: 2019/2020 winter and 2020/2021 winter
Dates of after-treatment data collection: 2021, 2023, 2025

2. Site descriptions

2.1. Site 1. Pécsely

Location: Pécsely village, Balaton highland, Hungary
GPS coordinates: (EPSG3035)
Easting: 4910255.3632
Northing: 2680947.3838
Altitude: 340–360 m
Aspect: south
Slope: 2.5–5°
Mean annual temperature: 9–10 °C

Annual precipitation: 600–650 mm
Bedrock: marl, limestone
Soil type: brown forest soil (Cambisol)
Site area: 2 ha
Forest type:
6.8.2 Turkey oak, Hungarian oak and Sessile oak forest, 6.5.2 Sessile oak–hornbeam forest
91M0 — Pannonian-Balkanic turkey oak–sessile oak forest
91G0 — *Pannonic woods with *Quercus petraea* and *Carpinus betulus*

Age of the stand at the beginning of the experiment: 100 years
Stand structure before the interventions:
canopy: upper *Quercus cerris, Q. pubescens, Q. petrarea* (DBH = 30 cm, Height = 20 m), *Carpinus betulus, Fraxinus ornus, Acer campestre second layer*
shrub layer: scarce
understory layer: *Quercus cerris, Fraxinus ornus, Sorbus torminalis*
Canopy openness: opened
Management type before the experiment: clear-cutting
Available data for the stand structure of the stand: tree species and position, DBH, height, crown class, health status, standing and lying dead wood volume

2.2. Site 2. Koloska
Location: Koloska valley, Balatonfüred town, Balaton highland, Hungary
GPS coordinates: (EPSG3035)
Easting: 4920767.72577
Northing: 2684424.86553
Altitude: 220 m
Aspect: south-east
Slope: 2.5–5°
Mean annual temperature: 9–10 °C
Annual precipitation: 600–650 mm
Bedrock: marl, limestone
Soil type: brown forest soil (Cambisol)
Site area: 2 ha
Forest type: 6.8.2 Turkey oak, Hungarian oak and Sessile oak forest
91M0 — Pannonian-Balkanic turkey oak – sessile oak forest
Age of the stand at the beginning of the experiment: 96 years
Stand structure before the interventions:
canopy: upper *Quercus cerris* and *Q. petrarea* (DBH = 28 cm, Height = 19 m), scarce *Fraxinus ornus* second layer
shrub layer: scarce
understory layer: *Fraxinus ornus, Acer campestre*
Canopy openness: closed
Management type before the experiment: clear-cutting
Available data for the stand structure of the stand: tree species and position, DBH, height, crown class, health status, standing and lying dead wood volume

2.3. Site 3. Esztergom
Location: Strázsa-hill, Esztergom town, Pilis Mountains, Hungary
GPS coordinates:
easting: 4573789
northing: 3092241
Altitude: 240 m
Aspect: south-south-west
Slope: 5–10°
Mean annual temperature: 9–10 °C
Annual precipitation: 550–600 mm
Bedrock: limestone
Soil type: brown forest soil (Cambisol)
Site area: 3 ha
Forest type: 6.5.2 Sessile oak–hornbeam forest, 6.8.2 Turkey oak, Hungarian oak and Sessile oak forest
91G0 — *Pannonic woods with *Quercus petraea* and *Carpinus betulus*,
91M0 — Pannonian-Balkanic turkey oak–sessile oak forest
Age of the stand at the beginning of the experiment: 83 years
Stand structure before the interventions:
canopy: upper *Quercus cerris* (DBH = 28 cm, Height = 16 m), *Carpinus betulus* (DBH = 21 cm, Height = 15 m), *Q. petrarea* (DBH = 31 cm, Height = 17 m), other deciduous
shrub layer: scarse
understory layer: *Carpinus betulus, Acer campestre*
Canopy openness: closed
Management type before the experiment: forests with no commercial purposes
Available data for the stand structure of the stand: tree species and position, DBH, height, crown class, health status, standing and lying dead wood volume

2.4. Site 4. Nagyoroszi
Location: Nagyoroszi village, Börzsöny mountains, Hungary
GPS coordinates: (EPSG3035)
easting: 4994143.97667
northing: 2774785.22244
Altitude: 335–365 m
Aspect: east-south
Slope: 10–15°
Mean annual temperature: 8–9 °C
Annual precipitation: 600–650 mm
Bedrock: sandstone, gravel
Soil type: brown forest soil (Cambisol)
Site area: 3 ha
Forest type: 6.8.2 Turkey oak, Hungarian oak and Sessile oak forest
91M0 — Pannonian-Balkanic turkey oak–sessile oak forest
Age of the stand at the beginning of the experiment: 99–103 years
Stand structure before the interventions:
canopy: *Quercus petrarea* (DBH = 42 cm, Height = 22 m), Q. *cerris* (DBH = 40 cm, Height = 22 m)

shrub layer: scarce
understory layer: *Quercus petrarea, Q. cerris, Carpinus betulus*
Canopy openness: closed
Management type before the experiment: clear-cutting
Available data for the stand structure of the stand: tree species and position, DBH, height, crown class, health status, standing and lying dead wood volume

2.5. Site 5. Buják
Location: Bokri-hegy, Buják village, Cserhát hills, Hungary
GPS coordinates: (EPSG3035)
easting: 5033833.19822
northing: 2801270.15608
Altitude: 300 m
Aspect: south-east
Slope: 10°
Mean annual temperature: 9–10 °C
Annual precipitation: 550–600 mm
Bedrock: andesite
Soil type: brown forest soil (Cambisol)
Site area: 3 ha
Forest type: 6.8.2 Turkey oak, Hungarian oak and Sessile oak forest
91M0 — Pannonian-Balkanic turkey oak–sessile oak forest
Age of the stand at the beginning of the experiment: 97 years
Stand structure before the interventions:
canopy: *Quercus cerris* (DBH = 35 cm, Height = 20 m), *Q. robur* (DBH = 30 cm, Height = 21 m)
shrub layer: very dense (>70%)
understory layer: no data
Canopy openness: closed
Management type before the experiment: transition system
Available data for the stand structure of the stand: tree species and position, DBH, height, crown class, health status, standing and lying dead wood volume

2.6. Site 6. Garáb
Location: Cserhát hills Varjú-bérc, Garáb village, Hungary
GPS coordinates: (EPSG3035)
easting: 5039615.98822
northing: 2810558.19277
Altitude: 450–550 m
Aspect: south, south-east
Slope: 5–10°
Mean annual temperature: 9–10 °C
Annual precipitation: 550–600 mm
Bedrock: andesite
Soil type: brown forest soil (Cambisol)
Site area: 3 ha
Forest type: 6.8.2 Turkey oak, Hungarian oak and Sessile oak forest

91M0 — Pannonian-Balkanic turkey oak–sessile oak forest
Age of the stand at the beginning of the experiment: 70 years
Stand structure before the interventions:
canopy: *Quercus petraea* (DBH = 30 cm, Height = 20 m),
shrub layer: scarce
understory layer: *Acer campestre*
Canopy openness: closed
Management type before the experiment: transition system
Available data for the stand structure of the stand: tree species and position, DBH, height, crown class, health status, standing and lying dead wood volume

2.7. Site 7. Bükkzsérc
Location: Ortás, Bükkzsérc village, Bükk mountains, Hungary
GPS coordinates: (EPSG3035)
easting: 5100308.61823
northing: 2816172.50019
Altitude: 350–450 m
Aspect: east
Slope: 10–15°
Mean annual temperature: 8–9 °C
Annual precipitation: 600–650 mm
Bedrock: shale, limestone
Soil type: brown forest soil (Cambisol)
Site area: 3 ha
Forest type: 6.8.2 Turkey oak, Hungarian oak and Sessile oak forest / 91M0 — Pannonian-Balkanic turkey oak – sessile oak forest
Age of the stand at the beginning of the experiment: 100 years
Stand structure before the interventions:
canopy: *Quercus cerris* (DBH = 31 cm, Height = 22 m), *Q. petraea* (DBH = 25 cm, Height = 19 m)
shrub layer: scarce
understory layer: no data
Canopy openness: closed
Management type before the experiment: selection cutting
Available data for the stand structure of the stand: tree species and position, DBH, height, crown class, health status, standing and lying dead wood volume

2.8. Site 8. Cserépfalu
Location: Bükk mountains, Cserépfalu village, Hungary
GPS coordinates: (EPSG3035)
easting: 5106042.44757
northing: 2817541.833
Altitude: 250–350 m
Aspect: south
Slope: 5–10°
Mean annual temperature: 8–9 °C
Annual precipitation: 600–650 mm

Bedrock: riolyte
Soil type: brown forest soil (Cambisol)
Site area: 3 ha
Forest type: 6.8.2 Turkey oak, Hungarian oak and Sessile oak forest 91M0 — Pannonian-Balkanic turkey oak–sessile oak forest
Age of the stand at the beginning of the experiment: 90 years
Stand structure before the interventions:

canopy: *Quercus cerris* (DBH = 30 cm, Height = 22 m), *Q. petraea* (DBH = 29 cm, Height = 19 m) with *Acer campestre* and *Carpinus betulus* second layer
shrub layer: dense (*Cornus mas*)
understory layer: no data

Canopy openness: closed
Management type before the experiment: selection cutting
Available data for the stand structure of the stand: tree species and position, DBH, height, crown class, health status, standing and lying dead wood volume

3. Applied treatments

3.1. Treatment 1. Opening gaps

3.2. Treatment 2. Deadwood enrichment

3.3. Description of the study design
1. Arrangement of the 1 ha areas
The treatments are implemented according to a pre-defined design, which allows that the impact of the two most important treatment types of the project – opening of canopy gaps and creation of dead wood – can be observed. A block contains two (Koloska and Pécsely) or three 1 hectare areas (Esztergom, Nagyoroszi, Garáb, Buják, Bükkzsérc, Cserépfalu), close to each other. In this block, one area remains untouched (Control), canopy gaps are going to be opened at the second (and third) sites, where all dead wood remains within the 1 hectare area (Gap+dead wood1, Gap+dead wood2).

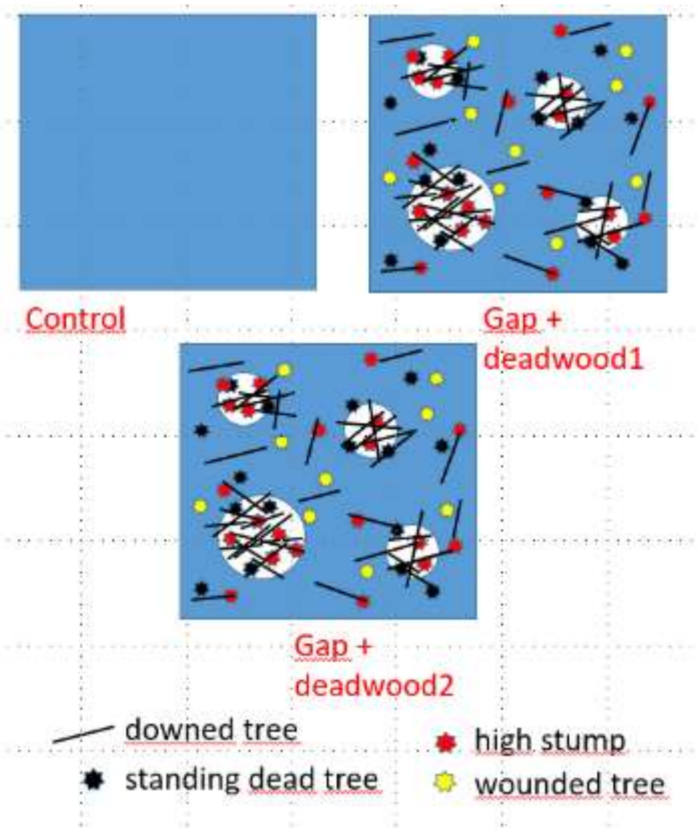


Figure 1. Arrangement of the 1 hectare monitoring areas.

2. Intensity

The intensity of the management should reach 20% of the living tree volume of the stand. Approximately 15% should come from the gaps, and the 5% should originate from the rest of the 1 hectare area (scattered SDW and DDW). In case of the model stand, it would mean 70 m^3/ha, out of that 50 m^3 from the gaps, and the remaining 20 m^3 from the non-gap part of the area. Note that incompact gap in quarter B should be counted as gap! The exact number and m^3 of trees to be felled are determined by the original number of tree individuals, and by the diameter distribution of the given site, but in case of the model forest it can be assessed and described.

A stand similar to Garáb project site the majority of the tree volume and approx. the half of the tree individuals are given by trees having larger DBH that 20 cm. In case of 20% management intensity approximately 70 piece of larger tree individuals (DBH > 20 cm) should be cut down, approx. 50 piece from the gaps and approx. 20 from the rest of the 1 hectare area, 5–5 from each quarter. In means 2–3 standing and 2–3 downed scattered dead tree per quarter (see next point).

3. Creation of standing dead wood, downed dead trees, and wounded trees

Ratio of standing and downed dead trees in natural old-growth forest is 1/3 – 2/3 , hence in case of 70 treated trees it means 47 downed and 23 standing dead trees. As several felled trees should be created with high stumps, the following numbers could be guideline for the treatments in the 1 ha areas: 34 downed trees, 16 standing dead wood, 21 high stumps. High stumps are counted as downed trees and standing dead trees as well, so the 21 high stumps equal 14 downed and 7 standing dead trees.

Standing dead trees should be created in scattered way, and also close to the gap edges, as it takes 2–3 years for the girled trees to lose their canopy, this way slowing down the effect of the treatments. High stumps should be arranged in scattered way and in the gaps, 4–7 in each quarter, more in case of the large gap, then in the other quarters.

Wounded trees with peeled bark are crucial microhabitats, hence 9 piece of this tree type should be created in each “Gap+dedwood1” and “Gap+dedwood2” area, two in each quarter and one in the middle of the site. The method of creating wounded trees: bark on the south face of the tree, close to the ground should be peeled up to 1.3 m height, width: half of the tree.

4. Opening canopy gaps

Altogether 4 gaps should be opened, they cover approximately the 15% of the area (1500 m^2) should have a circle form. One of them is the large gap in quarter C, which represents the half of all gap area, 750 m^2, which is a circle with 15.5 meter radius. Area of the two small gaps in A and D quarters is 250 m^2, with 9 meter radius. The last gap in quarter B is a more incompact gap, removing only every second trees. The creation of the gaps in the four quarters is the followings (Fig. 2):

<u>Quarter A</u>: small gap, center of the gap is 20–20 meter from the edge of the area.

<u>Quarter B:</u> incompact small gap, center of the gap is 35–35 meter from the edge of the area. The gap should be designed in a scattered way – not one single, 9 m gap is suggested, but a single tree selection design, with removing every second tree individuals.

<u>Quarter C</u>: large gap, a center of the gap is 25–25 meter from the edge of the area.

<u>Quarter D</u>: small gap, center of the gap is 20–20 meter from the edge of the area.

Centers of the gaps can be moved slightly in case the terrain conditions require.

3.4. Graphical representation of the experiment

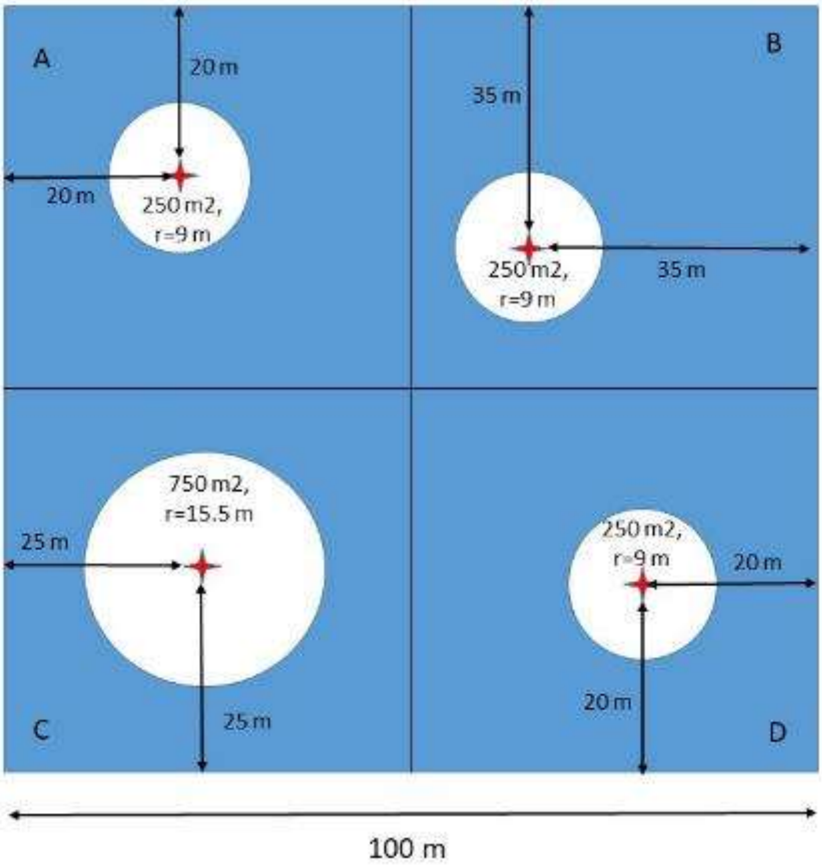


Figure 2. Creation of the gaps in the four quarters of the treated 1 hectare areas. Note that in quarter B a more incompact gap should be created.

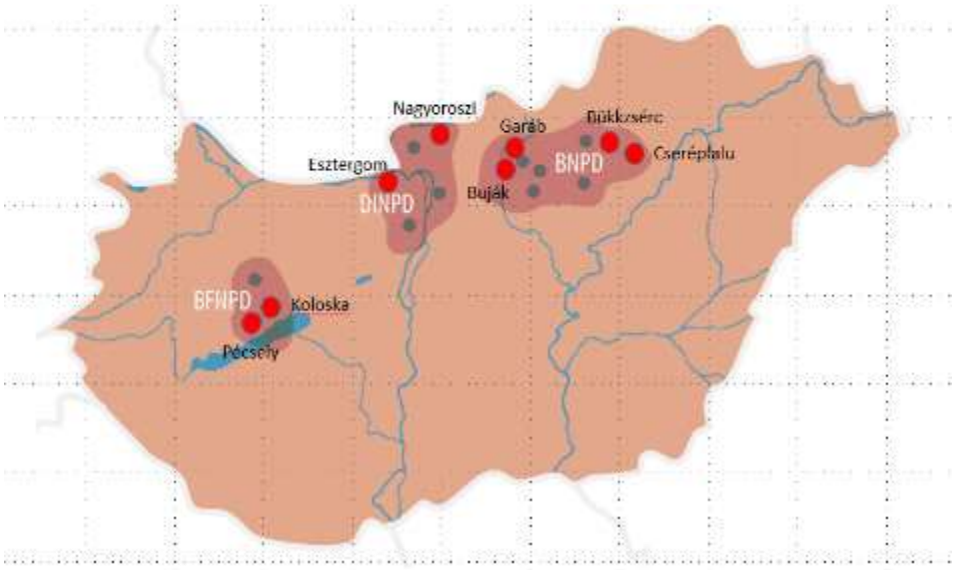


Figure 3. Location of the sites.

4. Investigated organism groups

4.1. Saproxylophagous beetles

From and of April until early August

4.1.1. Individuals were collected by window traps (16 per site) in every ten days during summer, on site 2, site 3 and site 4 (from end of April until early August)

4.1.2. Survey and qualification of habitat types of the forest stand were made according to categories, on site 3 and site 4.

4.1.3. Protected, but not saproxylofagous species were also recorded to evaluate ecosystem services in the future.

The survey is implemented on Koloska, Esztergom, Nagyoroszi, Bükkzsérc, Cserépfalu sites, on the Gap+deadwood1 Control plots in 2019 (before the treatment), and will be repeated in 2023 and/or 2025.

4.2. Ground dwelling invertebrates

Individuals are collected by pitfall traps (12 per plot) in every year (spring) with one month sampling length only in Esztergom and Nagyoroszi sites, Control and Gap+deadwood1 plots. Carabidae are identified, but spiders are also collected.

4.3. Woodpecker foraging signs on treated trees

In winter, the percentage cover of woodpecker foraging signs are monitored on both tree trunks and limbs, as signs on the bark, underneath the bark, scaling of the bark, signs that reached the sapwood, signs that reached the heartwood. The survey is implemented on each site, on the Gap+deadwood1 and Gap+deadwood2 plots both on trees marked for treatment and on control trees in 2019 (before the treatment), and will be repeated in 2023 and/or 2025.

4.4. Understory vegetation

The herb- and shrub layers of the 1 ha areas are planned to be surveyed in a sampling grid in 2019/2020 (before the treatment), and 2025, the survey in 2022 is optional. The sampling points of the survey are the gridpoints of a 10 x 10 meter virtual network (Fig. 4). The outermost row of the network is not sampled, the survey of the herb and regeneration layer happens at the rest 81 points. All vascular plants of the herb layer and woody species under 50 cm should be recorded (presence-absence) in a 0.5 m^2 sampling circle at each gridpoint. Total cover of the herb layer should be also recorded in each circle. A hula hoop with 0.4 m radius can be used to represent the 0.5 m^2 sampling circle.

The low shrub layer ("seedlings", H 0.5–1.3 m) is surveyed in the sampling circles than the herb layer. Stem number of all woody species should be recoded. Centers of the sampling circles of the high shrub layer ("saplings" H > 1.3 m, DBH < 5 cm) are coincide with the centers of the herb layer circles, but stem number of all woody species of this category should be sampled in a circle of 1 meter radius. Technically it can be implemented with "nail-string" method. Suggested time of the survey for the herb- and shrub-layers is June.

Light measurements, as the reciprocal of crown closure are implemented in 13 point of the herb layer survey grid in the summer of 2019/2020 and 2025, optionally in 2022 (Fig. 4). It is measured to the four cardinal directions, resulting 4 measurements per point.

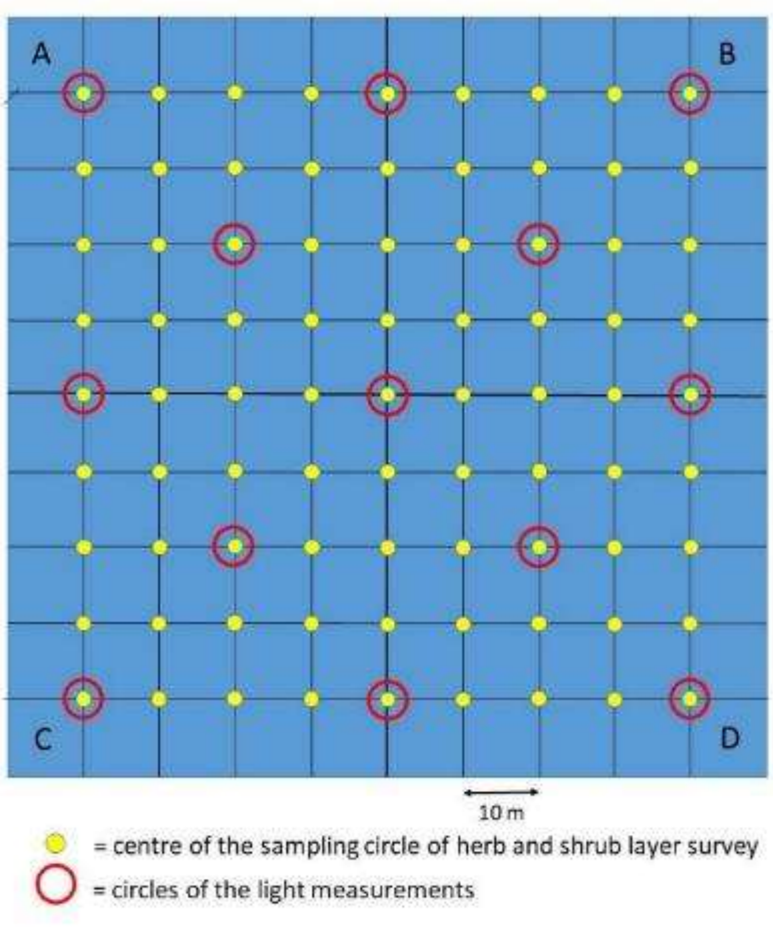


Figure 4. Sampling design of the herb-layer and shrub-layer survey, and of the light measurements.

5. Investigated environmental variables

5.1. Light measurements (see above)

6. Other investigated functions/processes

6.1. Several microhabitat categories, and the effect of the management on their type/number
Number of each microhabitat type are be recorded separately for each surveyed living and standing dead tree individual (DBH > 10 cm) of the 1 hectare site. The following 11 categories are going to be surveyed:

1. CV1: Woodpecker cavities,
2. CV2: Trunk and mould cavities,
3. CV3: Branch holes,
4. CV4: Dendrothelmes and water-filled holes,
5. IN1: Bark loss / exposed sapwood,
6. IN2: Exposed heartwood / trunk and crown breakage,
7. BA1: Bark pockets,
8. DE1: Dead branches and limbs /crown deadwood,
9. GR3: Cankers and burrs,
10. EP1 Fruiting bodies of fungi,
11. NE1: Nests.

7. References

-

8. Participating experts in the project

Aszalós, Réka, Centre for Ecological Research (understory vegetation)
Bölöni, János, Centre for Ecological Research (understory vegetation)
Frank, Tamás, Centre for Ecological Research (stand survey, microhabitats)
Németh, Csaba, Centre for Ecological Research (stand survey)
Kovács, Bence, Centre for Ecological Research (stand survey)
Veres, Katalin, Centre for Ecological Research (stand survey)
Ónodi, Gábor, Centre for Ecological Research (woodpeckers, microhabitats)
Komlós, Mariann, Sopron University, Faculty of Forestry (woodpeckers, microhabitats)
Németh, Tamás, Hungarian Natural History Museum (saproxylophagous beetles)
Elek, Zoltán, MTA–ELTE–MTM Ecology Research Group (carabid beetles)

EX19_IT_EDA

1. General information

Name of the experiment: **ManFor C.BD. (Managing Forests for multiple purposes: Carbon, BioDiversity and socio-economic well-being)**

Contact(s) in the COST Action: Ettore D'Andrea, ettore.dandrea@isafom.cnr.it
Giorgio Matteucci, giorgio.matteucci@isafom.cnr.it
Organization of the Contact(s): CNR -ISAFOM
Website of the experiment: https://www.manfor.eu/new/

The question of the experiment: ManFor C.BD. is a European LIFE project aiming at testing and verifying in the field the effectiveness of forest management options in meeting multiple objectives (timber production, environment protection and biodiversity conservation, etc.), providing data, guidance and indications of best-practice.

Locality: Italy
Number of Sites: 6
Number of Blocks: 17
Treatments and number of Levels: depend on sites
Number of Plots: usually 9, three per treatment (site differences can be possible)

Dates:
Beginning of the experiment: 2010
Date of Before-treatment data collection: it was strictly dependent from the type of data collection
Date of intervention: variable between and inside the sites (specific dates are available for each plot)
Dates of after-treatment data collection: it was/is strictly dependent from the type of data collection

2. Site descriptions

2.1. Site 1.
Location: Bosco del Cansiglio
GPS coordinates: 4504865.42, 2550700.25
Altitude: 1300 m a.s.l.
Aspect: variable (on average S-SE)
Slope: 0.8–23.8%
Mean annual temperature: 5 °C
Annual precipitation: 1900 mm
Bedrock: Limestone, Marlstone (Cretaceous Med.-Sup.)
Soil type: Endoleptic Cutanic Luvisols, Endoleptic Cambisols, Haplic Luvisols
Site area: The total area of the forest is 667 ha, and the dominant species is the beech. The experimental area is approximately 35 ha

Forest type: Illyrian mountainous beech forest – 9130 Asperulo-Fagetum beech forests
Age of the stand at the beginning of the experiment: about 120 years
Stand structure before the interventions:
canopy: beech (100%)
shrub layer:
understory layer:
Canopy openness: 10% (before the treatment)
Management type before the experiment: The main management type is high forest treated with shelterwood cuttings. Generally, 700–1000 m^3 of wood is extracted per intervention, over 10 to 15 ha.
Available data for the stand structure of the stand: diameter at 1.30 m, tree position, tree heights

3. Applied treatments

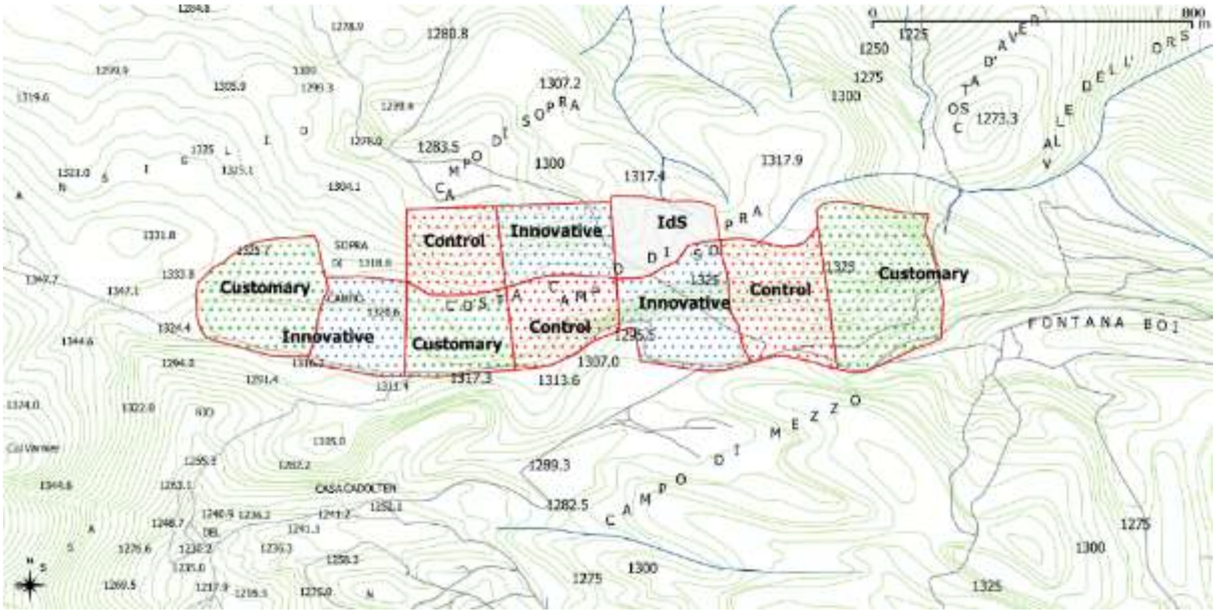
3.1. Treatment 1.
The demonstrative/innovative management criterium (innovative) consisted of the identification of a non-fixed number of scattered, well-shaped trees (usually in the predominant-dominant social classes), around which crown thinning of neighbouring competitors was done (thinning from above) to promote better growth ability of selected trees at crown, stem and root level in the future (light penetration, competition). The designed option included the increased release of deadwood in different forms.

3.2. Treatment 2.
The traditional treatment (customary) consists in a moderate thinning from below or mixed, repeated every 20 years, while stand regeneration is by group shelterwood system.

3.3. Treatment 3.
Delayed-intervention measure (control), which in the context of beech high forests, with the prolongation of standing crop permanence time (rotation length), has sound reasons to be tested because of its wide application in similar conditions.

3.4. Description of the study design
There are 3 forestry treatments occurring in 3 blocks as replicates following a complete block design, and resulting in 9 plots (3 per treatment). The experiment allows a BACI (Before-After-Control-Impact) design. Approximate surface of each plot is 3.3 ha. In each plot, the most of the measurements are performed in three permanent sampling areas (radius: 17 m).

3.5. Graphical representation of the experiment



4. Investigated organism groups

4.1. Understory vegetation

The approaches applied to the forest sites were chosen to describe the stand physiognomy (sensu Braun-Blanquet, 1932) at large scale and to describe the main floristic traits. Particularly, floristic data were collected in order to define the relationship between understory flora and canopy cover before and after intervention. A phytosociological approach (Braun-Blanquet, 1932) was used in plots of 20 m side square, positioned on the same units where structural measurements were realized. The phytosociological approach is a useful and expeditious method useful to detect correlations between the vegetation communities and the environmental factors. Species of vascular flora and plants were defined following Pignatti (1982) and the nomenclature according to Conti et al. (2005). Moreover, in each sampling area, one plot was randomly chosen and divided in 4 subplots, in order to perform a detailed measure of the cover percentage of each vascular species for tree, shrubs and herbaceous forest layer.

4.2. Ground beetles (Carabidae)

Individuals were collected every two weeks by pitfall traps during the 2014. A total of 100 traps were installed in Cansiglio forest, and 12 inside the experimental area. Traps were located at more than 50 m from each other and from the forest edge in order to ensure data independence and to avoid edge effect.

4.3. Coleoptera and Dipterans

Before and after treatment, the sampling design included 3 Malaise trap and 9 window traps per plot, activated for all the adults' flight season, using 70° ethanol as preservative. Samples were collected every second week and target groups were successively determined.

4.4. Amphibian

Presence/absence of the amphibian species, that require highly humidity level and are not thermophilous species (i.e. forest guild), was assessed before and after the silvicultural treatments. Different methods were used as: VES (Visual Encountery Survey) of any life stage (eggs, larvae and adults) including scanning with binoculars, visual searches, blind dip nettings; ACS (Active cover searches); CS (Calling Survey, for anurans); aural/visual point counts to assess the presence/abundance of each species.

4.5. Chiroptera

Check list of bat species applying both acoustic surveys with bat detector and mist netting capture sessions; evaluation of threatened bat species (according to the risk rank reported in the IUCN Red List, the inclusion in the annexes II and IV of Habitat directive, and the risk rank reported in National Mammals Red List); evaluation of tree-dwelling (or strictly forest associated) threatened bat species.

4.6. Birds

Aural/visual point counts to assess the presence/abundance of each species (Blondel et al. 1981). For the present study, a point count was carried out in each experimental plot. An additional buffer, with an area comparable to the forest management unit (FMU), was included, and the same amount of point counts included in the FMU was performed in this area. Point counts were repeated in different seasons and before/after forest interventions.

5. Investigated environmental variables

5.1. Soil physical and chemical parameters

9 soil samples were collected in each plot from 0–40 cm depth before and after the treatment. Measured soil variables were nutrient and carbon content (C, N).

5.2. Humus forms

In each plot, before and after the silvicultural treatment, humus assessment was performed. The experimental design was planned in three phases:
1. macroscopic description of humus form profile in the field;
2. samples collection for each horizon and storage at 4 °C;
3. laboratory analysis: estimation of organic carbon ISO 10694, total nitrogen ISO 13878 and pH of A horizon ISO 10390;
4. determination of humus form.

5.3. Deadwood

In each plot, snags, standing and dead downed trees with DBH ≥ 5 cm and height ≥ 1.30 m were included. Coarse woody debris was sampled if its minimum diameter was ≥ 5 cm and length ≥100 cm. Stumps threshold were: top diameter ≥ 5 cm and height ≤ 130 cm. Measurements have been repeated before and after the silvicultural operations to determine their impact on the parameter (however, the increased release of deadwood was included in the “innovative” management options designed by the project)

5.4. Microhabitat
In each plot surveyed, the microhabitat census consists in a visual inspection and a careful examination of the trunks (living trees) from the ground to the crown or the whole length of horizontal elements (deadwood).Usually, the sampling method is based on the identification of a set of 23 types of microhabitats.

5.5. QBS-ar
For the microarthropods extraction and QBS-ar index application, three soil cores 100 cm^2 and 10 cm deep were sampled in each soil typology. Microarthropods were extracted using a Berlese-Tüllgren funnel; the specimens were collected in a preserving solution and identified to different taxonomic levels (class for Myriapoda and order for Insecta, Chelicerata and Crustacea) using a stereo microscope. Soil quality was estimated with the QBS-ar index.

2.2. Site 2.

Location: Chiarano-Sparvera
GPS coordinates: 4650797.18, 2092380.80
Altitude: 1600–1800 m a.s.l.
Aspect: N-NE
Slope: 25.5–50.8%
Mean annual temperature: 8.5 °C*
Annual precipitation: 1000 mm*

* data from the meteorological station of Roccaraso (AQ) – 3 km bird distance, 1250 m a.s.l. (500 m under the demonstration area. Data can be corrected by the following factor: 0.6 °C each 100 m altitude variation). Data from Passo Godi meterological station were requested.

Bedrock: Cretaceous limestone
Soil type: Eutric Cambisol Humic Acrisols
Site area: Total area of Forest Management Unit is ~ 30 ha, the area consist of 2 parts separated by a stripe of meadow and rocks.
Forest type: Apennine Corsican mountainous beech forest – 9210 — Appenine beech forests with Taxus
Age of the stand at the beginning of the experiment: about 70 years
Stand structure before the interventions:

canopy: beech (100%)
shrub layer:
understory layer:

Canopy openness: 5% (before the treatment)
Management type before the experiment: The experimental area is included into a wide compartment under conversion. The practice of coppice conversion into high forest consists of low to mixed thinnings of the transitory crop, repeated every 20–30 years, usually performed for the first time few years after the end of former rotation and up to the age of regeneration establishment from seed.
Available data for the stand structure of the stand: diameter at 1.30 m, tree position, tree heights

3. Applied treatments

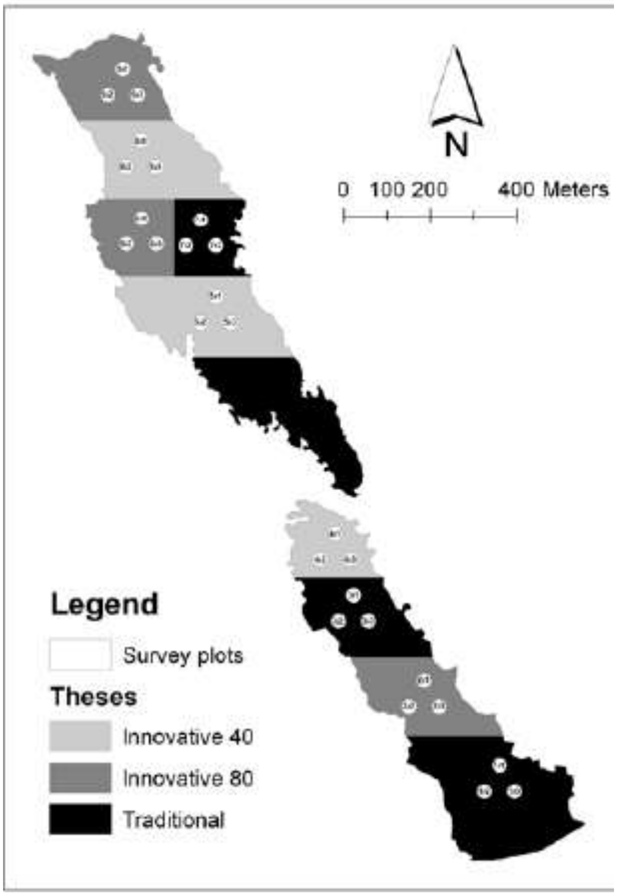
3.1. Treatment 1.
The first demonstrative/innovative criteria consisted of the preliminary choice of a number of 40 (I40) well-shaped phenotypes per hectare (stem form and crown development are the relevant attributes) and of cutting all surrounding competitors (thinning from above around those trees). Intercropping trees were fully released or removed only along hauling courses, using the “traditional” approach. The increased release of deadwood in different forms was included in this options.

3.2. Treatment 2.
The second demonstrative/innovative criteria consisted of the preliminary choice of a number of 80 (I80) well-shaped phenotypes per hectare (stem form and crown development are the relevant attributes) and of cutting all surrounding competitors (thinning from above around those trees). Intercropping trees were fully released or removed only along hauling courses, using the “traditional” approach. The increased release of deadwood in different forms was included in this options

3.3. Treatment 3.
Traditional measure, low to mixed thinnings of the transitory stand from below.

3.4. Description of the study design
There are 3 forestry treatments occurring in 3 blocks as replicates following a complete block design, and resulting in 9 plots. The experiment allows a BACI (Before-After-Control-Impact) design. Approximate surface of each plot is 3 ha. In each plot, the most of the measurements are performed in three permanent sampling areas (radius: 13 m).
Even if the status and structure of the stand was not suitable to include a “control” of “no intervention”, a part of the stand was left untouched and could be used as a comparison of “no practice” (1 plot, approximately 3 ha).

3.5. Graphical representation of the experiment



4. Investigated organism groups

4.1. Understory vegetation

The approaches applied to the forest sites were chosen to describe the stand physiognomy (sensu Braun-Blanquet, 1932) at large scale and to describe the main floristic traits. Particularly, floristic data were collected in order to define the relationship between understory flora and canopy cover before and after intervention. A phytosociological approach (Braun-Blanquet, 1932) was used in plots of 20 m side square, positioned on the same units where structural measurements were realized. The hytosociological approach is a useful and expeditious method useful to detect correlations between the vegetation communities and the environmental factors. Species of vascular flora and plants were defined following Pignatti (1982) and the nomenclature according to Conti et al. (2005). Moreover, in each sampling area, one plot was randomly chosen and divided in 4 subplots, in order to perform a detailed measure of the cover percentage of each vascular species for tree, shrubs and herbaceous forest layer.

4.2. Coleoptera and Dipterans

Before and after treatment, the sampling design included 3 Malaise trap and 9 window traps per plot, activated for all the adults' flight season, using 70° ethanol as preservative. Samples were collected every second week and target groups were successively determined.

4.3. Amphibian

Presence/absence of the amphibian species that require highly humidity level and are not thermophilous species (i.e. forest guild), was assessed before and after the silvicultural treatments. Different methods were used as: VES (Visual Encountery Survey) of any life stage (eggs, larvae and adults) including scanning with binoculars, visual searches, blind dip nettings; ACS (Active cover searches); CS (Calling Survey, for anurans); aural/visual point counts to assess the presence/abundance of each species.

4.4. Chiroptera

Check list of bat species applying both acoustic surveys with bat detector and mist netting capture sessions; evaluation of threatened bat species (according to the risk rank reported in the IUCN Red List, the inclusion in the annexes II and IV of Habitat directive, and the risk rank reported in National Mammals Red List); evaluation of tree-dwelling (or strictly forest associated) threatened bat species.

4.5. Birds

Aural/visual point counts to assess the presence/ abundance of each species (Blondel et al. 1981). For the present study, a point count was carried out in each experimental plot. An additional buffer, with an area comparable to the forest management unit (FMU), was included, and the same amount of point counts included in the FMU was performed in this area. Point counts were repeated in different seasons and before/after forest interventions.

5. Investigated environmental variables

5.1. Soil physical and chemical parameters

9 soil samples were collected in each plot from 0–40 cm depth before and after the treatment. Measured soil variables were nutrient and carbon content (C, N).

5.2. Humus forms

In each plot, before and after the silvicultural treatment, humus assessment was performed. The experimental design was planned in three phases:

1. macroscopic description of humus form profile in the field;
2. samples collection for each horizon and storage at 4 °C;
3. laboratory analysis: estimation of organic carbon ISO 10694, total nitrogen ISO 13878 and pH of A horizon ISO 10390;
4. determination of humus form.

5.3. Deadwood

In each plot, snags, standing and dead downed trees with DBH ≥ 5 cm and height ≥ 1.30 m were included. Coarse woody debris was sampled if its minimum diameter was ≥ 5 cm and length ≥100 cm. Stumps threshold were: top diameter ≥ 5 cm and height ≤ 130 cm. Measurements have been repeated before and after the silvicultural operations to determine their impact on the parameter (however, the increased release of deadwood was included in the "innovative" management options designed by the project).

5.4. Microhabitat
In each plot surveyed, the microhabitat census consists in a visual inspection and a careful examination of the trunks (living trees) from the ground to the crown or the whole length of horizontal elements (deadwood).Usually, the sampling method is based on the identification of a set of 23 types of microhabitats.

5.5. QBS-ar
For the microarthropods extraction and QBS-ar index application, three soil cores 100 cm^2 and 10 cm deep were sampled in each soil typology. Microarthropods were extracted using a Berlese-Tüllgren funnel; the specimens were collected in a preserving solution and identified to different taxonomic levels (class for Myriapoda and order for Insecta, Chelicerata and Crustacea) using a stereo microscope. Soil quality was estimated with the QBS-ar index.

5.6. Soil CO_2 effluxes
From May 2014 to May 2015.

2.3. Site 3.
Location: Lorenzago di Cadore
GPS coordinates: 4510764.39, 2598733.70
Altitude: 1000–1100 m a.s.l.
Aspect: N-NW
Slope: 38–39%
Mean annual temperature: 6.7 °C*
Annual precipitation: 1200 mm*
*data from the meteorological station of Santo Stefano di Cadore (BL) – 900 m a.s.l.
Bedrock: Marlstone, sandstone, schist and dolomite rock
Soil type: Cutanic Luvisols, Haplic Cambisols
Site area: Total area of Forest Management Unit is ~ 25 ha, included in a total forest area of 1100 ha
Forest type: Subalpine and mountainous spruce and mountainous mixed spruce silver fir forest; subalpine larch arolla pine and dwarf pine forest – 9410 – Acidophilous *Picea* forests of the montane to alpine levels (Vaccinio-Piceetea).

Age of the stand at the beginning of the experiment: about 90 years (from management plan)
Stand structure before the interventions:
canopy: uneven-aged coniferous forest (silver fir 51%, Norway spruce 46%, European larch 2%, beech 1%)
shrub layer:
understory layer:
Canopy openness: closed
Management type before the experiment: The main management type applied is selection cuttings (from single-tree to small groups). Every ‘n’ years the practice includes the contemporary: i) harvesting of mature trees; ii) thinning in the intermediate storey; iii) progressive side cuttings around the already-established regeneration patches to promote their successful growth; iv) felling of defective stems and withering trees throughout.

Available data for the stand structure of the stand: diameter at 1.30 m, tree position, tree heights. LIDAR

3. Applied treatments

3.1. Treatment 1.

Traditional: management according to the selection system i.e., every n years the practice includes the contemporary: (i) harvesting of mature trees; (ii) thinning in the intermediate storey; (iii) progressive side cuttings around the already-established regeneration patches to promote their successful growth; (iv) felling of defective stems and withering trees throughout.

3.2. Treatment 2.

In the first innovative thesis, the contemporary harvesting of a few mature trees and thinning of intermediate-sized trees is arranged into small groups, and allows minimal interventions with mechanized harvesting. Such demonstrative/innovative practice has been implemented by the opening of strip clear cuttings 60 m long (1½ top height) and 20 m wide (½ top height). These 'light thinnings' were used to promote larch regeneration

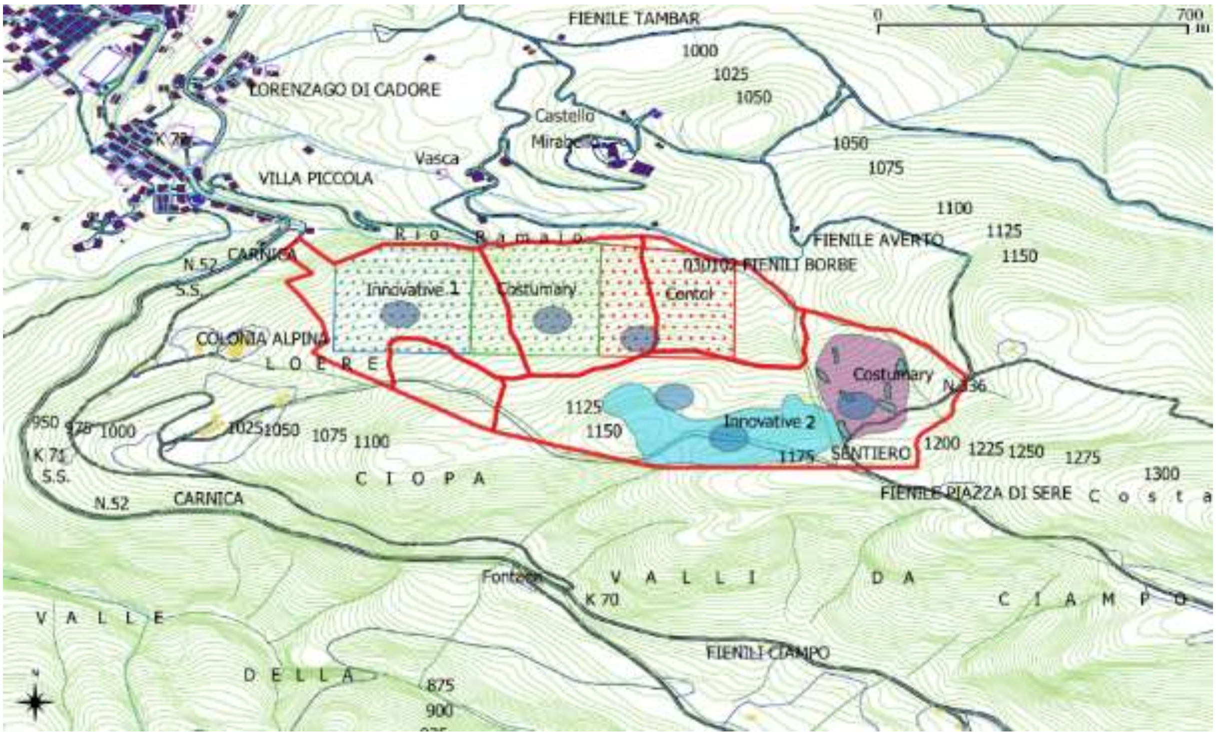
3.3. Treatment 3.

In the second innovative thesis, "light thinnings", similar to the first thesis, were applied. Such practice contributes to a more balanced structure, triggering establishment of regeneration (canopy opening) and allowing to concentrate log harvesting along each strip. Striped are NW-SE oriented along the direction of maximum slope. Broadleaved trees and young regeneration along the strips are being released. Cutting, as usual, connects strips. Beech regeneration (eradicated in the past because of low value compared to fir or spruce timber) is always favored to enhance tree species diversity.

3.4. Description of the study design

In this site, unfortunately it was not possible to replicate the same silvicultural treatments inside blocks. However, each innovative thesis was compared with a traditional treatment.

3.5. Graphical representation of the experiment



4. Investigated organism groups

4.1. Understory vegetation

The approaches applied to the forest sites were chosen to describe the stand physiognomy (sensu Braun-Blanquet, 1932) at large scale and to describe the main floristic traits. Particularly, floristic data were collected in order to define the relationship between understory flora and canopy cover before and after intervention. A phytosociological approach (Braun-Blanquet, 1932) was used in plots of 20 m side square, positioned on the same units where structural measurements were realized. The hytosociological approach is an useful and expeditious method useful to detect correlations between the vegetation communities and the environmental factors. Species of vascular flora and plants were defined following Pignatti (1982) and the nomenclature according to Conti et al. (2005). Moreover, in each sampling area, one plot was randomly chosen and divided in 4 subplots, in order to perform a detailed measure of the cover percentage of each vascular species for tree, shrubs and herbaceous forest layer.

4.2. Coleoptera and Dipterans

Before and after treatment, the sampling design included 3 Malaise trap and 9 window traps per plot, activated for all the adults' flight season, using 70° ethanol as preservative. Samples were collected every second week and target groups were successively determined.

4.3. Ground beetles (Carabidae)
92 pitfall traps were installed randomly and positioned across eleven sample forest stands, at elevation between 800 and 1500 m asl. One of these stands corresponded to the ManFor Lorenzago site.
The total number of pitfall traps, corresponding to eight traps per sample unit, represented the minimal unit to assure sufficient representativeness of the Carabidae local communities. Traps were located more than 50 m apart and from the forest edge.

4.4. Amphibian
Presence/absence of the amphibian species that require highly humidity level and are not thermophilous species (i.e. forest guild), was assessed before and after the silvicultural treatments. Different methods were used as: VES (Visual Encountery Survey) of any life stage (eggs, larvae and adults) including scanning with binoculars, visual searches, blind dip nettings; ACS (Active cover searches); CS (Calling Survey, for anurans); aural/visual point counts to assess the presence/abundance of each species.

4.5. Chiroptera
Check list of bat species applying both acoustic surveys with bat detector and mist netting capture sessions; evaluation of threatened bat species (according to the risk rank reported in the IUCN Red List, the inclusion in the annexes II and IV of Habitat directive, and the risk rank reported in National Mammals Red List); evaluation of tree-dwelling (or strictly forest associated) threatened bat species.

4.6. Birds
Aural/visual point counts to assess the presence/ abundance of each species (Blondel et al. 1981). For the present study, a point count was carried out in each experimental plot. An additional buffer, with an area comparable to the forest management unit (FMU), was included, and the same amount of point counts included in the FMU was performed in this area. Point counts were repeated in different seasons and before/after forest interventions.

5. Investigated environmental variables

5.1. Soil physical and chemical parameters
9 soil samples were collected in each plot from 0–40 cm depth before and after the treatment. Measured soil variables were nutrient and carbon content (C, N).

5.2. Deadwood
In each plot, snags, standing and dead downed trees with DBH ≥ 5 cm and height ≥ 1.30 m were included. Coarse woody debris was sampled if its minimum diameter was ≥ 5 cm and length ≥100 cm. Stumps threshold were: top diameter ≥ 5 cm and height ≤ 130 cm. Measurements have been repeated before and after the silvicultural operations to determine their impact on the parameter. Deadwood sampling were performed only before treatments (however, the increased release of deadwood was included in the “innovative” management options designed by the project).

5.3. Microhabitat
In each plot surveyed, the microhabitat census consists in a visual inspection and a careful examination of the trunks (living trees) from the ground to the crown or the whole length of horizontal elements (deadwood).Usually, the sampling method is based on the identification of a set of 23 types of microhabitats. Observations were performed only before treatments.

2.4. Site 4.
Location: Mongiana
GPS coordinates: 4868568.25, 1735178.54
Altitude: 1000–1100 m
Aspect: variable (on average S-SE)
Slope: 0.8–20.3%
Mean annual temperature: 10 °C
Annual precipitation: 1880 mm
Bedrock: Granite
Soil type: Umbrisols, Haplic Podzols
Site area: Total area of Foret Management Unit is ~30 ha. Altitude within FMU ranges from 1000 m to 1100 m asl. The experimental area is included in a forest area of 1200 ha.
Forest type: Subatlantic sub-mountainous beech forest, 9110, Acidophilous (Luzulo-Fagetum) beech forests
Age of the stand at the beginning of the experiment: about 70 years (The site lies in a beech high forest, originated from regeneration following the final cutting by the shelterwood system or clear-cut or clear-cut with reserves, performed at mid 19th century close to the end of the World War II – in the ‘50s).
Stand structure before the interventions:
canopy: beech (100%)
shrub layer:
understory layer:
Canopy openness: 5%
Management type before the experiment: The traditional system, made up of periodical low thinnings, is rather conservative and only occasionally opens the canopy.
Available data for the stand structure of the stand: diameter at 1.30 m, tree position, tree heights

3. Applied treatments

3.1. Treatment 1.
Traditional: the traditional system made up of periodical low thinnings, rather conservative with only occasional opening of the canopy.

3.2. Treatment 2.
The demonstrative/innovative criterion consisted of the identification of 45–50 trees per hectare i.e. “the candidate trees” and removal of direct competitors (thinning from above around those tress). Sometimes couples of neighbouring trees have been selected as “candidate”. No thinning has been applied in the space between candidates or where groups of older trees have naturally spaced the structure. Silver fir patches have been set free all around from beech crown cover.

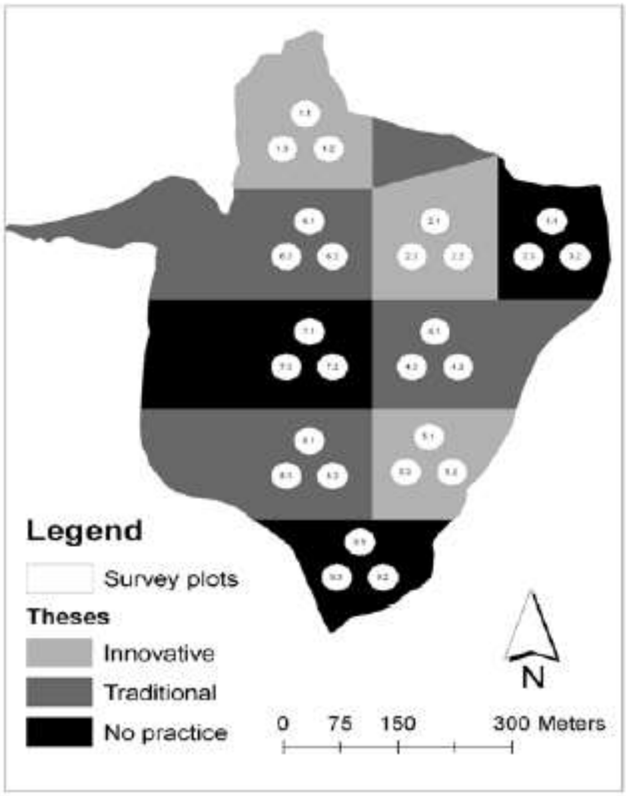
3.3. Treatment 3.

Delayed-intervention measure (control), which in the context of beech high forests, with the prolongation of standing crop permanence time (rotation length), has sound reasons to be tested because of its wide application in similar conditions.

3.4. Description of the study design

There are 3 forestry treatments occurring in 3 blocks as replicates following a complete block design, and resulting 9 plots. The experiment allows a BACI (Before-After-Control-Impact) design. Approximate surface of each plot is 3 ha. In each plot, the most of the measurements are performed in three permanent sampling areas (radius: 17 m).

3.5. Graphical representation of the experiment



4. Investigated organism groups

4.1. Understory vegetation

The approaches applied to the forest sites were chosen to describe the stand physiognomy (sensu Braun-Blanquet, 1932) at large scale and to describe the main floristic traits. Particularly, floristic data were collected in order to define the relationship between understory flora and canopy cover before and after intervention. A phytosociological approach (Braun-Blanquet, 1932) was used in plots of 20 m side square, positioned on the same units where structural measurements were realized. The hytosociological approach is a useful and expeditious method useful to detect correlations between the vegetation communities and the environmental factors.

Species of vascular flora and plants were defined following Pignatti (1982) and the nomenclature according to Conti et al. (2005). Moreover, in each sampling area, one plot was randomly chosen and divided in 4 subplots, in order to perform a detailed measure of the cover percentage of each vascular species for tree, shrubs and herbaceous forest layer.

4.2. Coleoptera and Dipterans

Before and after treatment, the sampling design included 3 Malaise trap and 9 window traps per plot, activated for all the adults' flight season, using 70° ethanol as preservative. Samples were collected every second week and target groups were successively determined.

4.3. Amphibian

Presence/absence of the amphibian species, that require highly humidity level and are not thermophilous species (i.e. forest guild), was assessed before and after the silvicultural treatments. Different methods were used as: VES (Visual Encountery Survey) of any life stage (eggs, larvae and adults) including scanning with binoculars, visual searches, blind dip nettings; ACS (Active cover searches); CS (Calling Survey, for anurans); aural/visual point counts to assess the presence/abundance of each species.

4.4. Chiroptera

Check list of bat species applying both acoustic surveys with bat detector and mist netting capture sessions; evaluation of threatened bat species (according to the risk rank reported in the IUCN Red List, the inclusion in the annexes II and IV of Habitat directive, and the risk rank reported in National Mammals Red List); evaluation of tree-dwelling (or strictly forest associated) threatened bat species.

4.5. Birds

Aural/visual point counts to assess the presence/ abundance of each species (Blondel et al. 1981). For the present study, a point count was carried out in each experimental plot. An additional buffer, with an area comparable to the forest management unit (FMU), was included, and the same amount of point counts included in the FMU was performed in this area. Point counts were repeated in different seasons and before/after forest interventions.

5. Investigated environmental variables

5.1. Soil physical and chemical parameters

9 soil samples were collected in each plot from 0-40 cm depth before and after the treatment. Measured soil variables were nutrient and carbon content (C, N).

5.2. Humus forms

In each plot, before and after the silvicultural treatment, humus assessment was performed. The experimental design was planned in three phases:

1. macroscopic description of humus form profile in the field;
2. samples collection for each horizon and storage at 4 °C;
3. laboratory analysis: estimation of organic carbon ISO 10694, total nitrogen ISO 13878 and pH of A horizon ISO 10390;
4. determination of humus form.

5.3. Deadwood

In each plot, snags, standing and dead downed trees with DBH ≥ 5 cm and height ≥ 1.30 m were included. Coarse woody debris was sampled if its minimum diameter was ≥ 5 cm and length ≥100 cm. Stumps threshold were: top diameter ≥ 5 cm and height ≤ 130 cm. Measurements have been repeated before and after the silvicultural operations to determine their impact on the parameter (however, the increased release of deadwood was included in the "innovative" management options designed by the project).

5.4. Microhabitat

In each plot surveyed, the microhabitat census consists in a visual inspection and a careful examination of the trunks (living trees) from the ground to the crown or the whole length of horizontal elements (deadwood).Usually, the sampling method is based on the identification of a set of 23 types of microhabitats.

5.5. QBS-ar

For the microarthropods extraction and QBS-ar index application, three soil cores 100 cm^2 and 10 cm deep were sampled in each soil typology. Microarthropods were extracted using a Berlese-Tüllgren funnel; the specimens were collected in a preserving solution and identified to different taxonomic levels (class for Myriapoda and order for Insecta, Chelicerata and Crustacea) using a stereo microscope. Soil quality was estimated with the QBS-ar index.

6. Other investigated functions/processes

6.1. Soil CO_2 effluxes

From May 2014 to May 2015

2.5. Site 5.

Location: Pennataro
GPS coordinates: 4650797.18, 2092380.80
Altitude: 1000 m a.s.l.
Aspect: N-NE
Slope: 5.8–26.8%
Mean annual temperature: 8.6 °C
Annual precipitation: 1100 mm
Bedrock: Limestone and marlstone (Miocene-Pliocene)
Soil type: Haplic Calcisols, Endoskeleti Calcaric Phaeozems
Site area: The total area is ~400 ha and its altitudinal range is 900–1300 m a.s.l., mainly constituted by pure or mixed stands of Turkey oak (*Quercus cerris*) (lower elevation) and beech forest, generally mono-layered (higher elevation). Total area of Forest Management Unit is ~30 ha. The experimental area has been settled in a Turkey oak forest. Other complementary broadleaves (maples, hornbeam, beech, other minor spp.) are scattered or grouped within the main oak layer.
Forest type: Downy oak forest; Subatlantic submountainous beech forest
Age of the stand at the beginning of the experiment: 60–70 years, but there are also several individuals of Turkey oak with an estimated age between 130–140 years

Stand structure before the interventions:

canopy: Turkey oak (complementary broadleaves as maples, hornbeam, beech, other minor spp., are scattered or grouped within the main oak layer)

shrub layer:

understory layer:

Canopy openness: 15–20%

Management type before the experiment: The traditional system performed extensive low thinnings over the last 40 years and a few seed cuttings in the aged forest patches, not followed by the removal of seed tree. Active forest management was suspended only recently. Such condition favoured other species than oaks to provide mixed forest. The main management type is high forest and aged coppice, partly in conversion to high forest.

Available data for the stand structure of the stand: diameter at 1.30 m, tree position, tree heights

3. Applied treatments

3.1. Treatment 1.

Thesis “pro mixed stand”: It consists in identifying trees of different species, with good characteristics, that can be considered as potential candidates for improving species diversity of the population. Around the candidate a selective thinning has been performed in order to improve the canopy expansion and their growth.

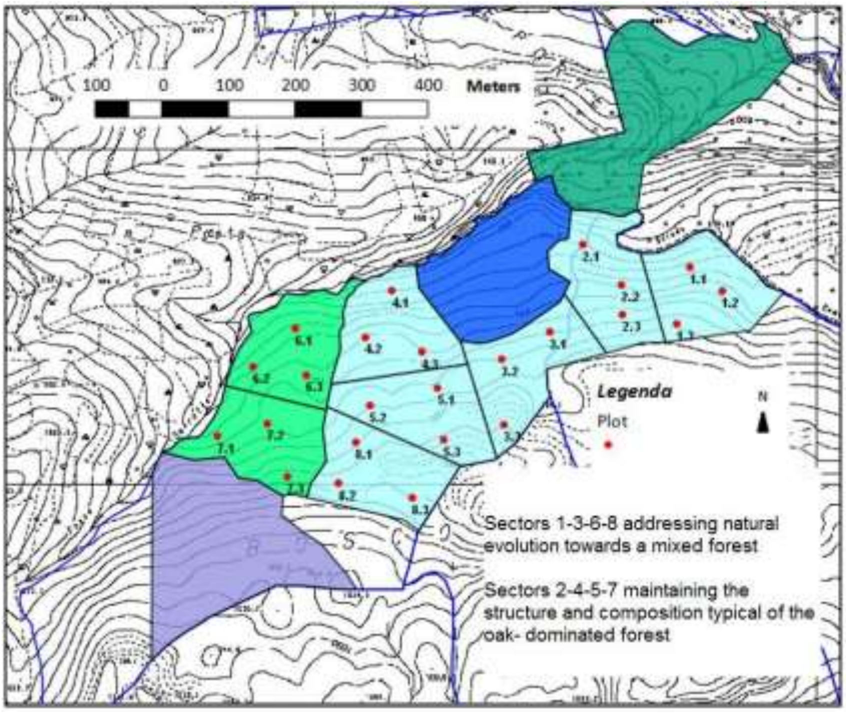
3.2. Treatment 2

Thesis “pro turkey oak”: It consists in identifying approximately 60 trees per hectare of Turkey oak among the best individuals (distance between the candidates of about 13–14 m). Around the candidate a selective thinning has been performed in order to improve the canopy expansion and their growth. Individuals of Turkey oak that do not compete with the candidate trees were not affected by the intervention.

3.3. Description of the study design

There are 2 forestry treatments occurring in 4 blocks as replicates following a complete block design, and resulting 8 plots. The experiment allows a BACI (Before-After-Control-Impact) design. Approximate surface of each plot is 2.5 ha. In each plot, the most of the measurements are performed in three permanent sampling areas (radius: 13 m).

3.4. Graphical representation of the experiment



4. Investigated organism groups

4.1. Understory vegetation

The approaches applied to the forest sites were chosen to describe the stand physiognomy (sensu Braun-Blanquet, 1932) at large scale and to describe the main floristic traits. Particularly, floristic data were collected in order to define the relationship between understory flora and canopy cover before and after intervention. A phytosociological approach (Braun-Blanquet, 1932) was used in plots of 20 m side square, positioned on the same units where structural measurements were realized. The hytosociological approach is a useful and expeditious method useful to detect correlations between the vegetation communities and the environmental factors. Species of vascular flora and plants were defined following Pignatti (1982) and the nomenclature according to Conti et al. (2005). Moreover, in each sampling area, one plot was randomly chosen and divided in 4 subplots, in order to perform a detailed measure of the cover percentage of each vascular species for tree, shrubs and herbaceous forest layer. Sampling were performed only before treatments.

4.2. Coleoptera and Dipterans

Before and after treatment, the sampling design included 3 Malaise trap and 9 window traps per plot, activated for all the adults' flight season, using 70° ethanol as preservative.

4.3. Amphibian

Presence/absence of the amphibian species that require highly humidity level and are not thermophilous species (i.e. forest guild), was assessed before and after the silvicultural treatments. Different methods were used as: VES (Visual Encountery Survey) of any life stage (eggs, larvae and adults) including scanning with binoculars, visual searches, blind dip nettings;

ACS (Active cover searches); CS (Calling Survey, for anurans); aural/visual point counts to assess the presence/abundance of each species.

4.4. Chiroptera

Check list of bat species applying both acoustic surveys with bat detector and mist netting capture sessions; evaluation of threatened bat species (according to the risk rank reported in the IUCN Red List, the inclusion in the annexes II and IV of Habitat directive, and the risk rank reported in National Mammals Red List); evaluation of tree-dwelling (or strictly forest associated) threatened bat species. For this site only the samplings before treatment were performed.

4.5. Birds

Aural/visual point counts to assess the presence/ abundance of each species (Blondel et al. 1981). For the present study, a point count was carried out in each experimental plot. An additional buffer, with an area comparable to the forest management unit (FMU), was included, and the same amount of point counts included in the FMU was performed in this area. Point counts were repeated in different seasons and before/after forest interventions.

5. Investigated environmental variables

5.1. Soil physical and chemical parameters

9 soil samples were collected in each plot from 0–40 cm depth before and after the treatment. Measured soil variables were nutrient and carbon content (C, N). Only pre-treatment samplings were performed.

5.2. Deadwood

In each plot, snags, standing and dead downed trees with DBH ≥ 5 cm and height ≥ 1.30 m were included. Coarse woody debris was sampled if its minimum diameter was ≥ 5 cm and length ≥100 cm. Stumps threshold were: top diameter ≥ 5 cm and height ≤ 130 cm. Measurements have been repeated before and after the silvicultural operations to determine their impact on the parameter. Only pre-treatment samplings were performed (however, the increased release of deadwood was included in the “innovative” management options designed by the project).

5.3. Microhabitat

In each plot surveyed, the microhabitat census consists in a visual inspection and a careful examination of the trunks (living trees) from the ground to the crown or the whole length of horizontal elements (deadwood).Usually, the sampling method is based on the identification of a set of 23 types of microhabitats. Only pre-treatment samplings were performed.

2.6. Site 6.

Location: Tarvisio
GPS coordinates: 4597841.167004, 2603995.008536
Altitude: 840–930 m a.s.l.
Aspect: N

Slope: 12.7–37.6%
Mean annual temperature: 6.7 °C
Annual precipitation: 1815 mm
Bedrock: Limestone, marlstone and sandstone (Paleozoic to Triassic)
Soil type: Haplic Luvisols
Site area: The total area is 23.362 ha, 15.152 ha with two main forest types: mixed forests of spruce, beech, pine and subalpine spruce. Forest Management Unit (~30 ha) is a Norway spruce and silver fir pole stage forest originated from regeneration following harvesting of the previous crop. A few other species are scattered within the standing crop, mainly larch and beech. Stand structure is naturally dense with many standing and lying dead trees under the main storey; living crowns are in the upper part only; scattered broadleaves (mainly beech) reach the main crop layer as co-dominant and dominant trees.
Forest type: Subalpine and mountainous spruce and mountainous mixed spruce silver fir forest; 9410 – Acidophilous *Picea* forests of the montane to alpine levels (Vaccinio-Piceetea).
Age of the stand at the beginning of the experiment: about 30 years
Stand structure before the interventions:
canopy: 91% Norway spruce, 2% silver fir, 1% larch, 6% beech
shrub layer:
understory layer:
Canopy openness: closed
Management type before the experiment: Main management type is high forest with close-to-nature silviculture. Forests are treated with border-shelterwood or group-shelterwood (Femmelschlag) cuttings.
Available data for the stand structure of the stand: diameter at 1.30 m, tree position (for 9 sampling plots)

3. Applied treatments

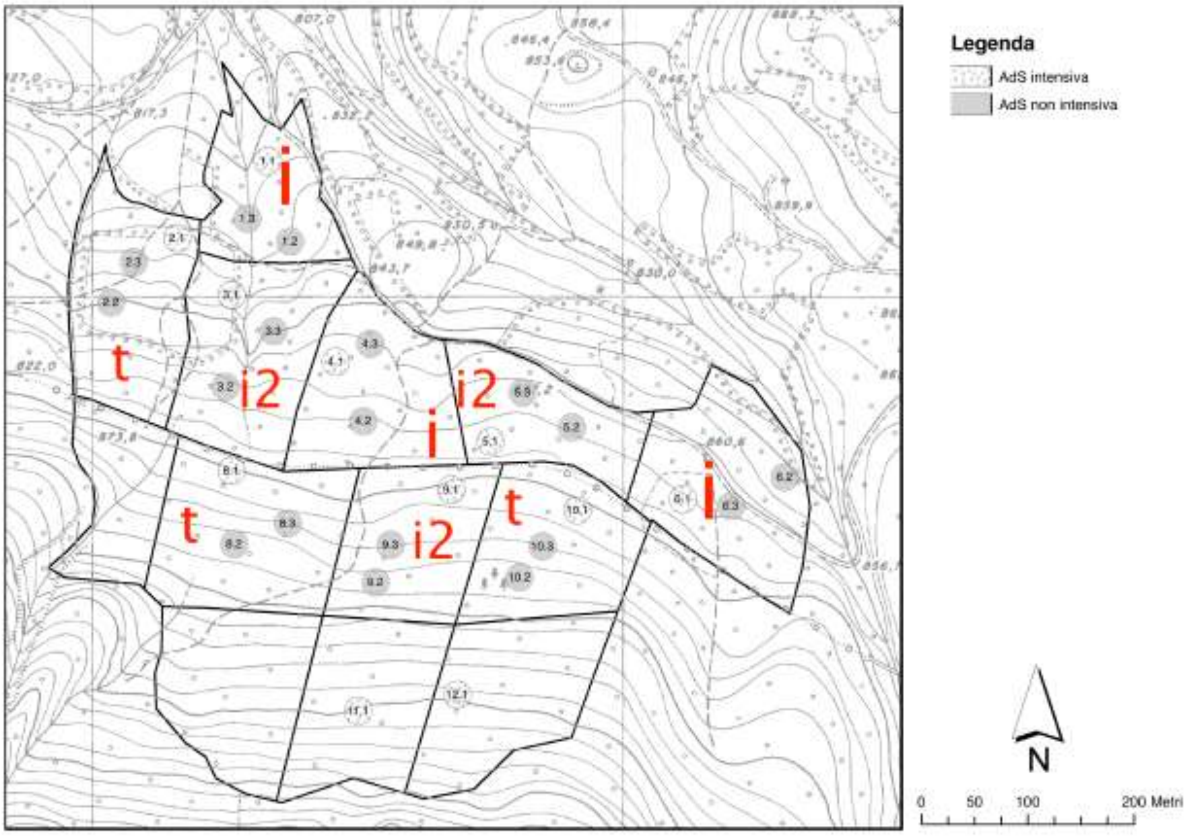
3.1. Treatment 1.
Mechanization (harvester) with a prevailing pre-commercial thinning criterion resulting in a lower density release and with an estimated time of repetition of 40 years.

3.2. Treatment 2.
Mechanization (harvester) with a more ecologically-based thinning criteria resulting in a higher density release and a shorter time of repetition

3.3. Treatment 3.
This stage of the life cycle was traditionally submitted to precommercial thinnings to reduce inter-tree competition and manage the release of main crop population.

3.4. Description of the study design
There are 3 forestry treatments occurring in 3 blocks as replicates following a complete block design, and resulting 9 plots. The experiment allows a BACI (Before-After-Control-Impact) design. Approximate surface of each plot is 2.5 ha. In each plot, the most of the measurements are performed in three permanent sampling areas (radius: 13 m)

3.5. Graphical representation of the experiment



4. Investigated organism groups

4.1. Understory vegetation

The approaches applied to the forest sites were chosen to describe the stand physiognomy (sensu Braun-Blanquet, 1932) at large scale and to describe the main floristic traits. Particularly, floristic data were collected in order to define the relationship between understory flora and canopy cover before and after intervention. A phytosociological approach (Braun-Blanquet, 1932) was used in plots of 20 m side square, positioned on the same units where structural measurements were realized. The hytosociological approach is a useful and expeditious method useful to detect correlations between the vegetation communities and the environmental factors. Species of vascular flora and plants were defined following Pignatti (1982) and the nomenclature according to Conti et al. (2005). Moreover, in each sampling area, one plot was randomly chosen and divided in 4 subplots, in order to perform a detailed measure of the cover percentage of each vascular species for tree, shrubs and herbaceous forest layer. Sampling were performed only before treatments.

4.2. Coleoptera and Dipterans

Before and after treatment, the sampling design included 3 Malaise trap and 9 window traps per plot, activated for all the adults' flight season, using 70° ethanol as preservative. Samples were collected every second week and target groups were successively determined.

4.3. Amphibian

Presence/absence of the amphibian species that require highly humidity level and are not thermophilous species (i.e. forest guild), was assessed before and after the silvicultural treatments. Different methods were used as: VES (Visual Encountery Survey) of any life stage (eggs, larvae and adults) including scanning with binoculars, visual searches, blind dip nettings; ACS (Active cover searches); CS (Calling Survey, for anurans); aural/visual point counts to assess the presence/abundance of each species.

4.4. Chiroptera

Check list of bat species applying both acoustic surveys with bat detector and mist netting capture sessions; evaluation of threatened bat species (according to the risk rank reported in the IUCN Red List, the inclusion in the annexes II and IV of Habitat directive, and the risk rank reported in National Mammals Red List); evaluation of tree-dwelling (or strictly forest associated) threatened bat species.

4.5. Birds

Aural/visual point counts to assess the presence/ abundance of each species (Blondel et al. 1981). For the present study, a point count was carried out in each experimental plot. An additional buffer, with an area comparable to the forest management unit (FMU), was included, and the same amount of point counts included in the FMU was performed in this area. Point counts were repeated in different seasons and before/after forest interventions.

5. Investigated environmental variables

5.1. Soil physical and chemical parameters

9 soil samples were collected in each plot from 0–40 cm depth before and after the treatment. Measured soil variables were nutrient and carbon content (C, N).

5.2. Deadwood

In each plot, snags, standing and dead downed trees with DBH ≥ 5 cm and height ≥ 1.30 m were included. Coarse woody debris was sampled if its minimum diameter was ≥ 5 cm and length ≥100 cm. Stumps threshold were: top diameter ≥ 5 cm and height ≤ 130 cm. Measurements have been repeated before and after the silvicultural operations to determine their impact on the parameter. Sampling were performed only before treatment

5.3. Microhabitat

In each plot surveyed, the microhabitat census consists in a visual inspection and a careful examination of the trunks (living trees) from the ground to the crown or the whole length of horizontal elements (deadwood).Usually, the sampling method is based on the identification of a set of 23 types of microhabitats. Sampling were performed only before treatment

5.4. QBS-ar

For the microarthropods extraction and QBS-ar index application, three soil cores 100 cm^2 and 10 cm deep were sampled in each soil typology. Microarthropods were extracted using a Berlese-Tüllgren funnel; the specimens were collected in a preserving solution and identified to different taxonomic levels (class for Myriapoda and order for Insecta, Chelicerata and Crustacea) using a stereo microscope. Soil quality was estimated with the QBS-ar index.

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8. Participating experts in the project

Carmen Giangola (vegetation)
Flavia Sicuriello (Humus, soil, vegetation)
Livia Zapponi (Carabids, hoverflies)
Pierluigi Bombi (Ground beetles, GIS)
Mario Posillico (Bats, Birds, Amphibians)
Luca Cistrone (Bats)
Rosario Balestrieri (Birds)
Antonio Romano (Amphibians)
Fabio Lombardi (Vegetation, Deadwood, Microhabitat)
Rodolfo Picchio (QBS-ar)
Ettore D'Andrea (forest structure)
Giorgio Matteucci (forest structure)

EX20_IT_SB

1. General information

Name of the experiment: **Forests of the Apennines: Good practices to conjugate Use and Sustainability (FAGUS)**

Contact(s) in the COST Action: Sabina Burrascano, Walter Mattioli
Organization of the Contact(s): Sapienza University of Rome
Website of the experiment: https://www.fagus-life-project.eu/en/

The question of the experiment:
How to enhance the structural heterogeneity of beech stands while increasing biological diversity for vascular plants, lichens, birds, saproxylic beetles and fungi within the habitats 9210* and 9220* of the Habitat Directive in National Parks through forestry treatments?
How promote the presence of target forest species (i.e., holly, yew, silver fir) within the habitats 9210* and 9220* in National Parks towards forestry treatments?
Is it possible to develop Sustainable Management Strategies for the habitat 9210* and 9220* while ensuring a sustainable forest use by the forest owners and the establishment of a benefit-sharing mechanism with local communities?

Locality: Italy, Gran Sasso National Park (SCI Gran Sasso – IT7110128), Cilento National Park (SCI Monti Alburni – IT8050033 and SCI Monte Motola – IT8050028)
Number of Sites: 6 (3 within Gran Sasso National Park, 3 within Cilento National Park)
Number of Blocks: The experiment follows a BACI (Before-After-Control-Impact) design without a fixed number of sample plots per level.
Treatments and number of Levels: 3 (Control – Intervention – Reference). No silvicultural treatments have been carried out on “Control” and “Reference” areas.
Number of Plots: 33 (19 within Gran Sasso National Park, 14 within Cilento National Park)

Dates:
Beginning of the experiment: 2013
Date of Before-treatment data collection: 2014
Date of intervention: 2015–2016
Dates of after-treatment data collection: 2017

2. Site descriptions

Site Group 1 – Gran Sasso and Monti della Laga National Park

2.1.1 Site 1.1 – Prati di Tivo
Location: Prati di Tivo, Province of Teramo, Abruzzo Region
GPS coordinates: from Google maps Y: 42.50492, X: 13.56577
Altitude: 1495 m
Aspect: 260°

Slope: 32%
Mean annual temperature: 10.6 °C
Annual precipitation: 1062 mm
Bedrock: Limestone
Soil type: Cambisols
Site area: 8.8 ha
Forest type: 7.3 Apennine-Corsican mountainous beech forest according to EEA Classification, Habitat 9210* for Annex II of Habitat Directive
Age of the stand at the beginning of the experiment: 40–50 (coppice), 100–120 (high forest)
Stand structure before the interventions:

- canopy: 90%
- shrub layer: 7%
- understory layer: 22%

Canopy openness: 4%
Management type before the experiment: old coppice stands with standards, even-aged high forest beech stand

2.1.2 Site 1.2 – Venaquaro

Location: Venaquaro, Province of Teramo, Abruzzo Region
GPS coordinates: from Google maps Y: 42.506, X: 13.51432
Altitude: 1210 m
Aspect: 270°
Slope: 55%
Mean annual temperature: 10 °C
Annual precipitation: 1097 mm
Bedrock: Marly limestone
Soil type: Cambisols
Site area: 17.2 ha
Forest type: 7.3 Apennine-Corsican mountainous beech forest according to EEA Classification, Habitat 9210* for Annex II of Habitat Directive
Age of the stand at the beginning of the experiment: 40–50 (transition), 100–120 (high forest)
Stand structure before the interventions:

- canopy: 96%
- shrub layer: 3%
- understory layer: 27%

Canopy openness: 5%
Management type before the experiment: even- and uneven-aged high forest beech stand; transition from old coppice stands with standards

2.1.3 Site 1.3 – Incodara

Location: Incodara, Province of Teramo, Abruzzo Region
GPS coordinates: from Google maps Y: 42.51101, X: 13.47213
Altitude: 1390 m
Aspect: 225°
Slope: 32%
Mean annual temperature: 10 °C
Annual precipitation: 1097 mm

Bedrock: Flysch
Soil type: Cambisols
Site area: 11 ha
Forest type: 7.3 Apennine-Corsican mountainous beech forest according to EEA Classification, Habitat 9220* for Annex II of Habitat Directive
Age of the stand at the beginning of the experiment: NA
Stand structure before the interventions:
canopy: 97%
shrub layer: 3%
understory layer: 3%
Canopy openness: 3%
Management type before the experiment: transition from old coppice stands with standards to high forest beech stand with silver fir and plantations of silver fir

Site Group 2 – Cilento, Vallo di Diano e Alburni National Park

2.2.1 Site 2.1 – Alburni – Ottati
Location: Ottati, Salento Province, Campania Region
GPS coordinates: from Google maps Y: 40.51074, X: 15.33647
Altitude: 1350 m
Aspect: 125°
Slope: 14%
Mean annual temperature: 13.6 °C
Annual precipitation: 718 mm
Bedrock: Limestone
Soil type: Cambisols
Site area: 12 ha
Forest type: 7.3 Apennine-Corsican mountainous beech forest according to EEA Classification, Habitat 9210* for Annex II of Habitat Directive.
Age of the stand at the beginning of the experiment: 40–50 years
Stand structure before the interventions:
canopy: NA
shrub layer: NA
understory layer: NA
Canopy openness: NA
Management type before the experiment: old beech coppice stands with standards

2.2.1 Site 2.2 – Alburni – Corleto Monforte
Location: Corleto Monforte, Salento Province, Campania Region
GPS coordinates: from Google maps Y: 40.46788, X: 15.43176
Altitude: 1280 m
Aspect: 60°
Slope: 18%
Mean annual temperature: 10 °C
Annual precipitation: 1250 mm
Bedrock: Limestone
Soil type: Cambisols

Site area: 20 ha
Forest type: 7.3 Apennine-Corsican mountainous beech forest according to EEA Classification, Habitat 9210* for Annex II of Habitat Directive
Age of the stand at the beginning of the experiment: 40–50 (transition), 100–120 (high forest)
Stand structure before the interventions:

canopy: NA
shrub layer: NA
understory layer: NA

Canopy openness: NA
Management type before the experiment: even-aged high forest beech stand; transition from old beech coppice stands with standards

2.2.3 Site 2.3 – Motola
Location: Motola, Salento Province, Campania Region
GPS coordinates: from Google maps Y: 40.37065, X: 15.4696
Altitude: 1200 m
Aspect: 105°
Slope: 42%
Mean annual temperature: 13.5 °C
Annual precipitation: 716 mm
Bedrock: Limestone
Soil type: Cambisols
Site area: 1.3 ha
Forest type: 7.3 Apennine-Corsican mountainous beech forest according to EEA Classification, Habitat 9220* for Annex II of Habitat Directive
Age of the stand at the beginning of the experiment: 40–50 (coppice), 100–120 (high forest). Age of the stand was not recorded because some sites have an uneven-aged structure, others were heterogenous with difference that could reach almost 50 years of difference (i.e. from 40 years old coppice stands with standards to even-aged high forest 100 years old beech stand in the same location).
Stand structure before the interventions:

canopy: NA
shrub layer: NA
understory layer: NA

Canopy openness: NA
Management type before the experiment: even- and uneven-aged high forest beech stand mixed with other mesophilous species; transition from old beech coppice stands with standards
Available data for the stand structure of the stand: tree species, DBH, basal area, top height, mean height, mean diameter, volume, snags, stumps, standing and lying dead wood volume

3. Applied treatments

3.1. Treatment "Intervention"
1. Removal of about 10–20% of the current growing stock by selective cutting of individual trees or groups of trees (2–4) with DBH > 60 cm and opening of canopy gaps with different shape and size (40–100 m^2);

2. Release of about 10% of the volume removed as deadwood;
3. Selective thinning around the target species (yew, silver fir, etc.);
3. Conversion of 3–4 stems ha^{-1} into deadwood (standing dead trees, snags, uprooted trees and leaning dead trees);
4. Creation of 3–4 habitat trees ha^{-1} (nest holes, basal slits, den trees) to foster the increase of lichens, coleoptera, saproxylic fungi and birds;
5. Fencing around some "intervention" area to avoid grazing and fauna damages.

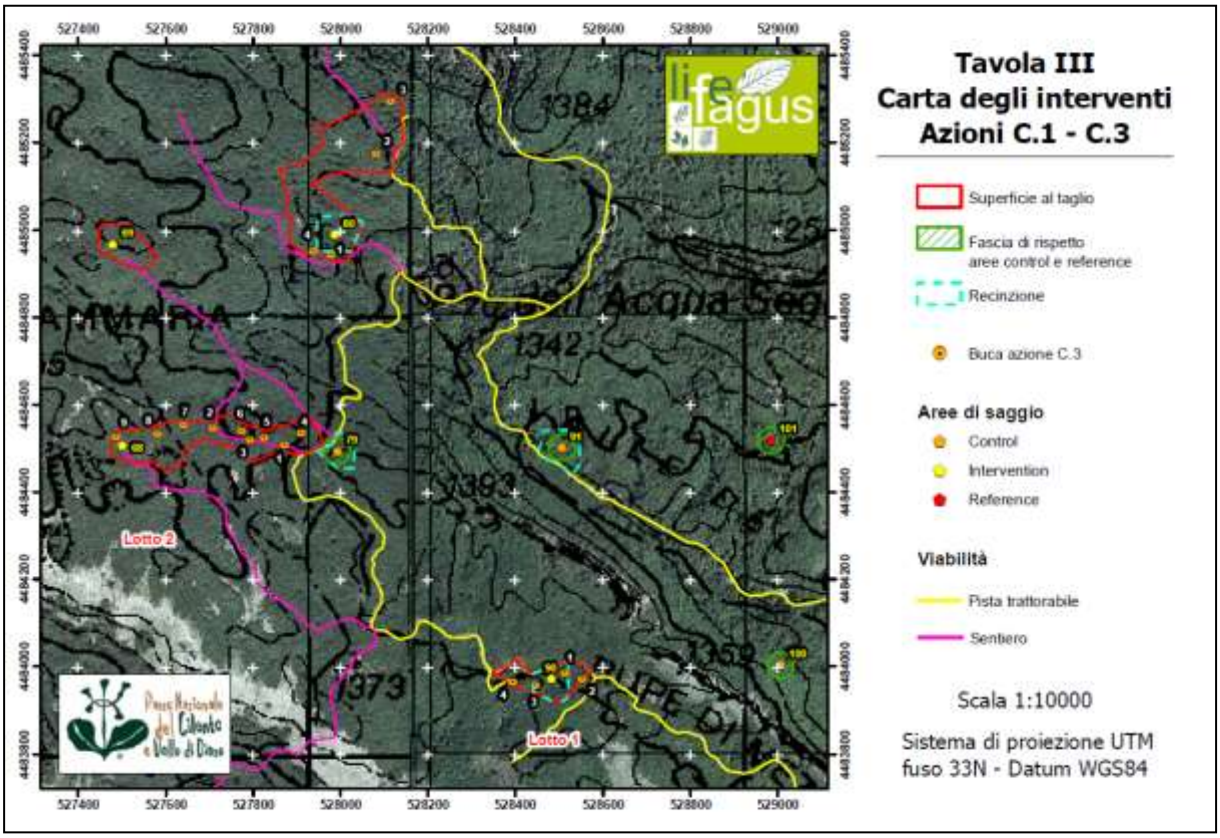
3.2. Treatment "Control" and "Reference"

No treatments have been carried out on "control" and "reference" area. Some "control" areas have been surrounded by fencing to avoid grazing and fauna damages.

3.3. Description of the study design

The achievement of the conservation targets is assessed comparing beech stands structure and composition and *multitaxa* biodiversity before and after the silvicultural interventions on 33 sample plots established in the two National Parks following a BACI (Before-After-Control-Impact) design. All the studied variables were recorded in 2014 in each plot, before the intervention of the forestry treatments. "Reference" areas are the ones where the recorded variables have shown the highest level of biological diversity and structural heterogeneity. Treatments have been carried out only on "intervention" areas while "control" and "reference" areas have been left on their original status.

3.4. Graphical representation of the experiment



4. Investigated organism groups

All the groups were sampled both in 2013 and 2016. Intervention were performed in 2013-2014.

4.1. Vascular plants

Vascular plants were sampled in 20 m circular plots divided into four quadrants along the cardinal directions. We visually assigned a cover value to each species in each quadrant, using an ordinal cover class scale with class limits 0.5%, 1%, 2%, 5%, 10%, 15%, 20%, and thereafter every 10% up to 100% (each class includes its upper limit). The cover values were then averaged across the four quadrants.

4.2. Epiphytic lichens

Epiphytic lichens were sampled on the three beech trees nearest to the center of each plot having a DBH equal or greater than16 cm. Lichens were sampled using a portable 10 × 50 cm frame composed of five 10 × 10 cm quadrats; the frame was placed on the tree trunk facing the four cardinal directions, with the bottom part being at a height of 100 cm from the ground. All lichen species inside the frames were considered; at the plot level, the richness ofthe lichen assemblage equalled the total number of species occurring across the three sampled trees. The frequency of each species in each given plot was computed as the proportion of the 60 quadrats (10 × 10 cm) in which the species occurred.

4.3. Fungi

Fungi (both saproxylic and epigeous) were sampled in autumn in the same 13 m circular plot (530 m2) used for deadwood sampling. All the standing and downed deadwood components characterized by a mid-diameter greater than 10 cm were examined for sporocarps larger than 1 mm, and data on deadwood decay class and fungal morphogroups were also recorded. Since fungi were surveyed only once, our measure should not be considered as an inventory of the overall fungi richness, but rather as a snapshot in time.

4.4. Beetles

Forest-dwelling beetles were sampled using one window flight trap for each plot. Traps were placed at 1.5–2 m height above the ground to intercept the flight of insects; they were then trapped inside a preserving vial containing a solution of water and salt. Since this method does not exert an attraction selective with respect to saproxylic beetles, it was integrated through the use of eclectors (emergence traps). Eclectors were used for collecting saproxylic insects active in deadwood fragments on the forest floor. Depending on the availability of coarse woody debris, up to three eclector traps were set up on deadwood fragments in the first three decay classes. Traps were placed as close as possible to the plot center. Nevertheless, deadwood fragments were not available in all the sampling plots. For this reason, in order to keep the sampling effort constant through the plots in quantitative analyses, these were run only considering the beetles collected through window flight traps (~96% of the captures). The data obtained through the use of eclectors were only used to provide an integrative description of the beetle assemblages. The monitoring of saproxylic insects took place from June to September 2013 and 2016. Each trap was sampled three times, once every 27–30 days.

4.5. Birds

Breeding birds were sampled through one 10-minute count points, during which we recorded every species detected.

5. Investigated environmental variables

No additional environmental variables were investigated.

6. Other investigated functions/processes

No other function/processes were investigated.

7. References

Sabatini F.M., Burrascano S., Azzella M.M., Barbati A., De Paulis S., Di Santo D., Facioni L., Giuliarelli D., Lombardi F., Maggi O., Mattioli W., Parisi F., Persiani A., Ravera S., Blasi C., 2016. One taxon does not fit all: Herb-layer diversity and stand structural complexity are weak predictors of biodiversity in *Fagus sylvatica* forests. Ecological Indicators 69: 126-137.

8. Participating experts in the project

Anna Barbati
Sonia Ravera
Francesco Parisi
Annamaria Persiani
Rosario Balestrieri

EX21_LT_GB

There are 5 sub-experiments (M01–M05), with separate descriptions.

Experiment description M01

1. General information

Name of the experiment: **EU protected habitat management experiment: Opening of inland dunes (M01X)**

Contact(s) in the COST Action: Gediminas Brazaitis gediminas.brazaitis@vdu.lt , Žydrūnas Preikša zydrunas.preiksa@vdu.lt
Organization of the Contact(s): Institute of Forest Biology and Silviculture Faculty of Forest Science and Ecology Agricultural Academy Vytautas Magnus University, Studentu str. 11, Akademija LT-53361, Kaunas dist. Lithuania
Website of the experiment: -

The question of the experiment: Improvement of EU protected habitats (Habitat and bird directives) conservation status. Opening of Inland dunes creating habitat with open *Corynephorus* and *Agrostis* grassland (2330)

Locality: Dzūkija National Park
Number of Sites: 3 (M011, M012, M013)
Number of Blocks: ND
Treatments and number of Levels: ND
Number of Plots: 18

Dates:
Beginning of the experiment: 2019
Date of Before-treatment data collection: 2019–2020
Date of intervention:2023
Dates of after-treatment data collection: planned on: 2024, 2026

2. Site descriptions

2.1. Site 1.
Location: Dzūkija National Park

GPS coordinates (WGS 84) and altitudes:

Site No.	East	North	Altitude (min–max)
LT_GB_M011	54.00382	24.41304	134–148
LT_GB_M012	54.110476	24.440761	124–133
LT_GB_M012	54.056079	24.498053	133–151

Type of managment	Location (Forest district, Compartment/Subcompartment)	No of site	No. of study plots	Area, ha	Total number of study plots
Opening of Inland dunes creating habitat with open *Corynephorus* and *Agrostis* grassland (2330)	Musteika FD 232/22, 29, 30 233 / 3, 4, 5, 6, 7, 8.	M011	84,85, 86, 87, 90,91	18.5	6
	Perloja FD 57 / 19, 20, 21 Marcinkonys FD 58 / 4, 5, 6	M012	1, 3, 4, 5, 6, 7	13.0	6
	Marcinkonys FD 112 / 12, 17, 18, 20, 27, 36–40 113 / 31, 32	M013	45–50	12.9	6
	Totally:			**44.4**	**18**

Aspect: ND
Slope: Undirectional mezorelief with small slopes and hills
Mean annual temperature: 6.4 °C
Annual precipitation: 645 mm
Bedrock: Fine sand
Soil type: Fine sand
Site area: 44.4 ha
Forest type: Pinewood with small mixture of birch; DBH=21.6 (15–25) cm; H=20.3 (13–24) m. Vol=265.7 (152–275) m^3/ha. Habitat: Inland dunes with open *Corynephorus* and *Agrostis* grassland (2330)
Age of the stand at the beginning of the experiment: 60 (42–67) yrs.
Stand structure before the interventions:
canopy: One layer; species: 9P1B;
shrub layer: Scarce rowan, junipers
understory layer: Scarce pine, birch
Canopy openness: Relative stocking density=0.84 (0.7–1.0)
Management type before the experiment: Low intensity sanitation cuttings
Available data for the stand structure of the stand: tree species, DBH, basal area, height, volume, stocking density, Class of Craft, Stand density, standing and lying dead wood volume, tree condition, tree microhabitat

3. Applied treatments

3.1. Treatment 1. Partial opening for inland dunes.

3.2. Description of the study design
Will be detailed up to 2020.12. Preliminary we are going to create opening following by natural lines. Expecting to create variety in size and shape, to analyse the effect of opening size on biodiversity and forest.
The data will be compared with control sites K01–K08, totalling 70 study plot.

3.3. Graphical representation of the experiment
Will be detailed up to 2022.

Figure 1. Experimental area position in Lithuania.

Figure 2. Distribution of plots in the landscape of Dzūkija National Park.

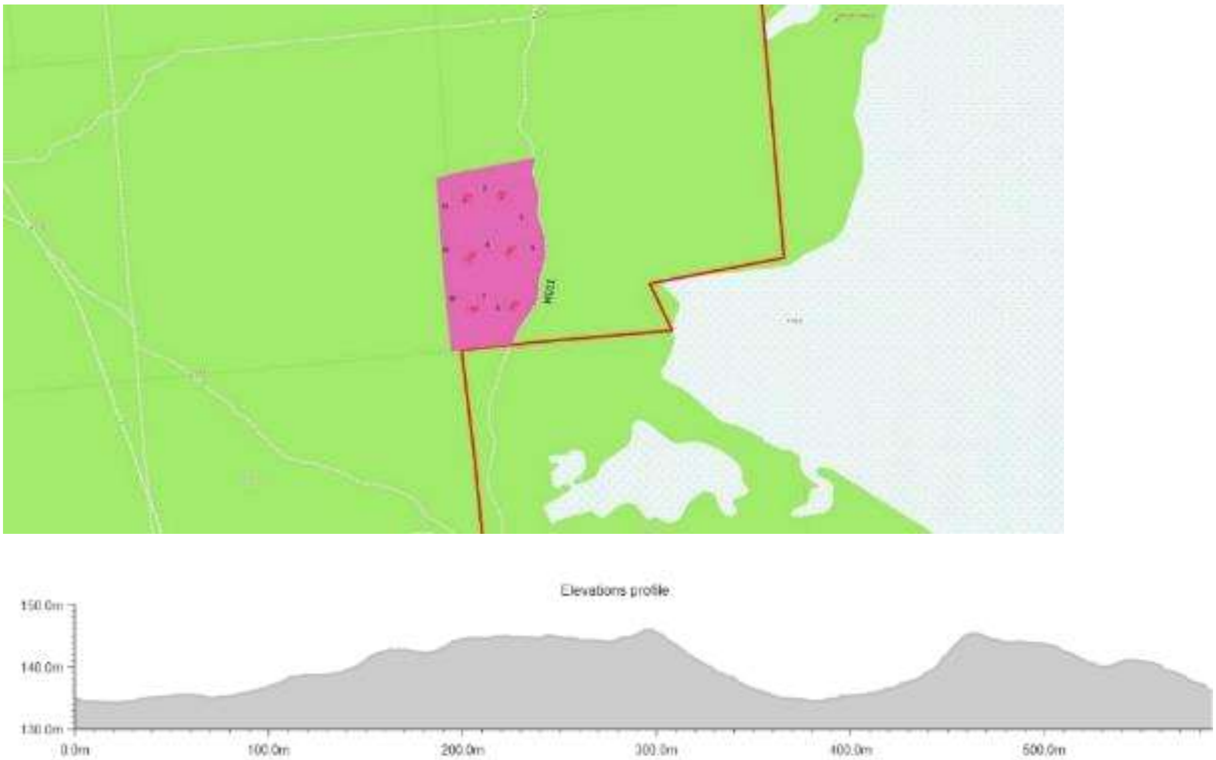


Figure 3. M011: Elevation profile N-S direction parallel to W border in the mid of plot.

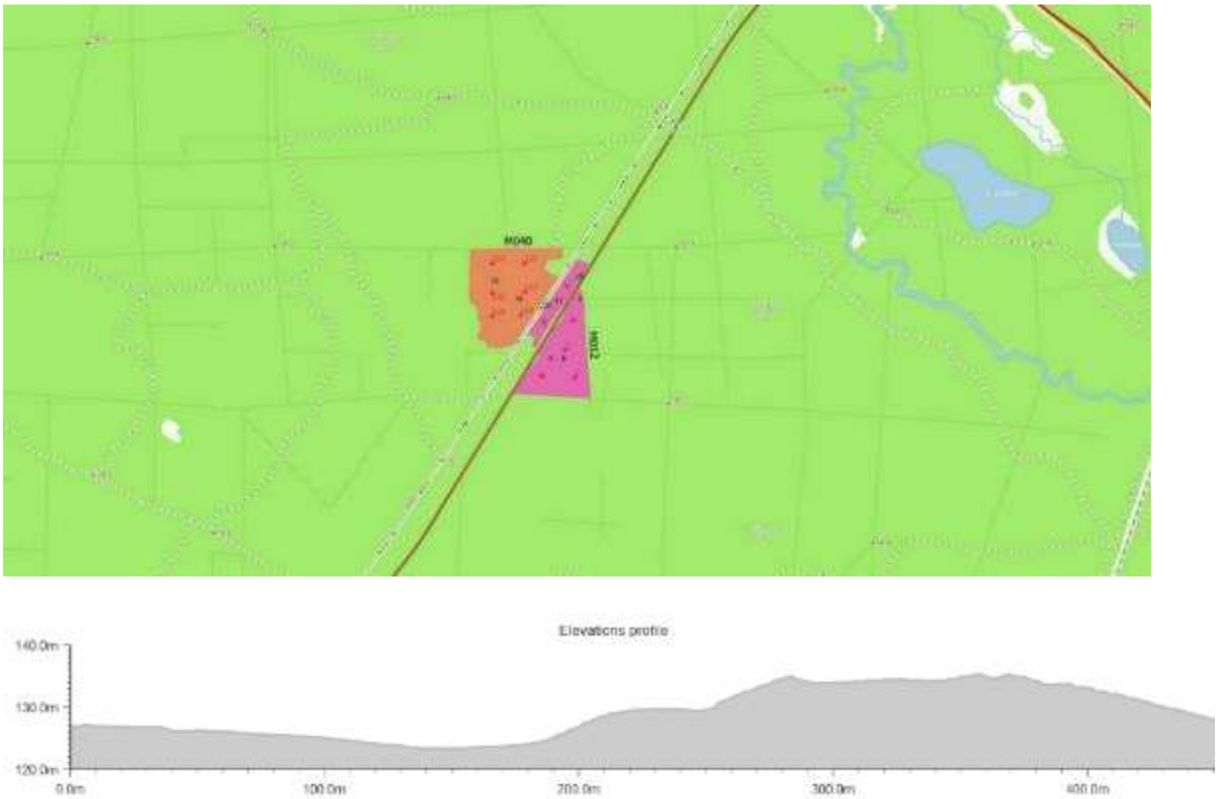


Figure 4. M012: Elevation profile N-S direction in the mid of plot.

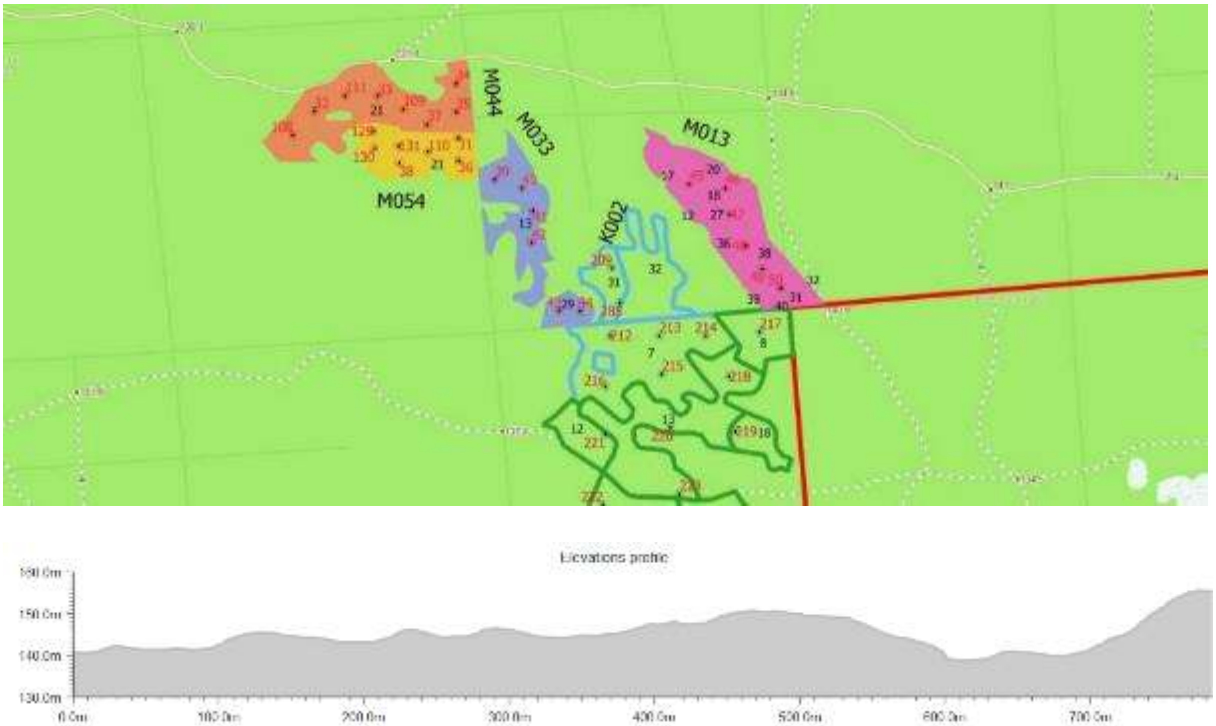


Figure 5. M013: Elevation profile NW-SE direction in the mid of plot.

4. Investigated organism groups

4.1. Bryophytes
4.2. Tracheophytes
4.3. Lichens
4.4. Birds
4.5. Beetles
4.6. Hymenoptera
as described in Metadata file

5. Investigated environmental variables

5.1. Soil variables

6. Other investigated functions/processes

-

7. References

-

8. Participating experts in the project

Gediminas Brazaitis (leader, birds, planning of management)
Vitas Marozas (stand, tracheophytes)
Žydrūnas Preikša (Bryophytes, Lichens, planning of management)
Kastytis Šimkevičius (Birds, stand)
Silvija Manton (Stand)
Vytautas Tamutis (Beetle)
Eduardas Budrys (Hymenoptera)
Loreta Bisikirskienė (Birds)

Experiment description M02

1. General information

Name of the experiment: **EU protected habitat management experiment: Improvement of Western taiga (9010) habitat structure by creating mosaic in the landscape (M02X)**

Contact(s) in the COST Action: Gediminas Brazaitis gediminas.brazaitis@vdu.lt, Žydrūnas Preikša zydrunas.preiksa@vdu.lt
Organization of the Contact(s): Institute of Forest Biology and Silviculture Faculty of Forest Science and Ecology Agricultural Academy Vytautas Magnus University, Studentu str. 11, Akademija LT-53361, Kaunas dist. Lithuania

Website of the experiment: -

The question of the experiment: Improvement of EU protected habitats (Habitat and bird directives) conservation status. Creating habitat mosaic in Western taiga (9010) habitat aiming to create more diversity in structure and species

Locality: Dzūkija National Park
Number of Sites: 3 (M021, M022, M023)
Number of Blocks: ND
Treatments and number of Levels: ND
Number of Plots: 23

<u>*Dates:*</u>
Beginning of the experiment: 2019
Date of Before-treatment data collection: 2019–2020
Date of intervention:2023
Dates of after-treatment data collection: planned on: 2024, 2026

2. Site descriptions
2.1. Site 1.
Location: Dzūkija National Park

GPS coordinates (WGS 84) and altitudes:

Site No.	East	North	Altitude (min–max)
LT_GB_M021	54.06857	24.47138	128–132
LT_GB_M022	54.02807	24.40811	132–142
LT_GB_M022	54.03661	24.47842	132–135

Type of managment	Location (Forest district, Compartment/Subcompartment)	**No of site**	**No. of study plots**	**Area, ha**	**Total number of study plots**
Improvement of Western taiga (9010) habitat structure by creating mosaic of landscape	Marcinkonys FD 77 / 15	M021	19, 21, 112, 113	1,2	4
	Marcinkonys FD 216 / 9 ,11 217 / 12, 20, 21	M022	74–83	26,2	10
	Marcinkonys FD 211 / 4, 37	M023	51–53, 55–60	29,0	9
	Totally:			**56,4**	**23**

Aspect: ND
Slope: Undirectional mezorelief with small slopes and hills
Mean annual temperature: 6.4 °C
Annual precipitation: 645 mm
Bedrock: Fine sand
Soil type: Fine sand
Site area: 56.4 ha
Forest type: Pinewood with small mixture of birch; DBH=28.7 (22–37) cm; H=25.5 (23–27) m. Vol=363.5 (328–447) m^3/ha. Habitat: Western taiga (9010).

Age of the stand at the beginning of the experiment: 89 (62–122) yrs.
Stand structure before the interventions:
canopy: One layer; species: 10P
shrub layer: Scarce rowan, junipers
understory layer: Scarce pine
Canopy openness: Relative stocking density=0.80 (0.7–1.0)
Management type before the experiment: Low intensity sanitation cuttings
Available data for the stand structure of the stand: tree species, DBH, basal area, height, volume, stocking density, Class of Craft, Stand density, standing and lying dead wood volume, tree condition, tree microhabitat

3. Applied treatments

3.1. Treatment 1. Partial opening for inland dunes

3.2. Description of the study design
Will be detailed up to 2020.12. Preliminary we are going to create mosaic by opening habitat. Expecting to create variety in size and shape, to analyse the effect of opening shape and size. The data will be compared with control sites K01–K08, totalling 70 study plot.

3.3. Graphical representation of the experiment
Will be detailed up to 2022.

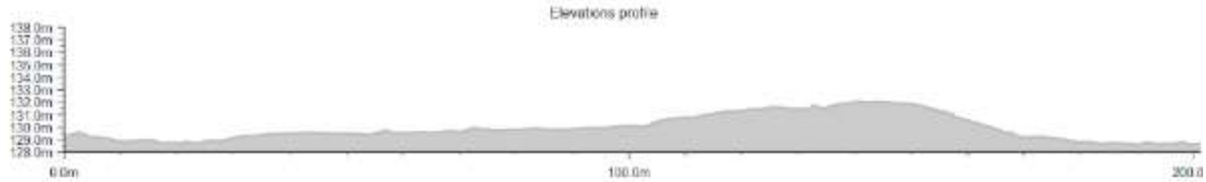


Figure 6. M021: Elevation profile W-E direction in the mid of plot.

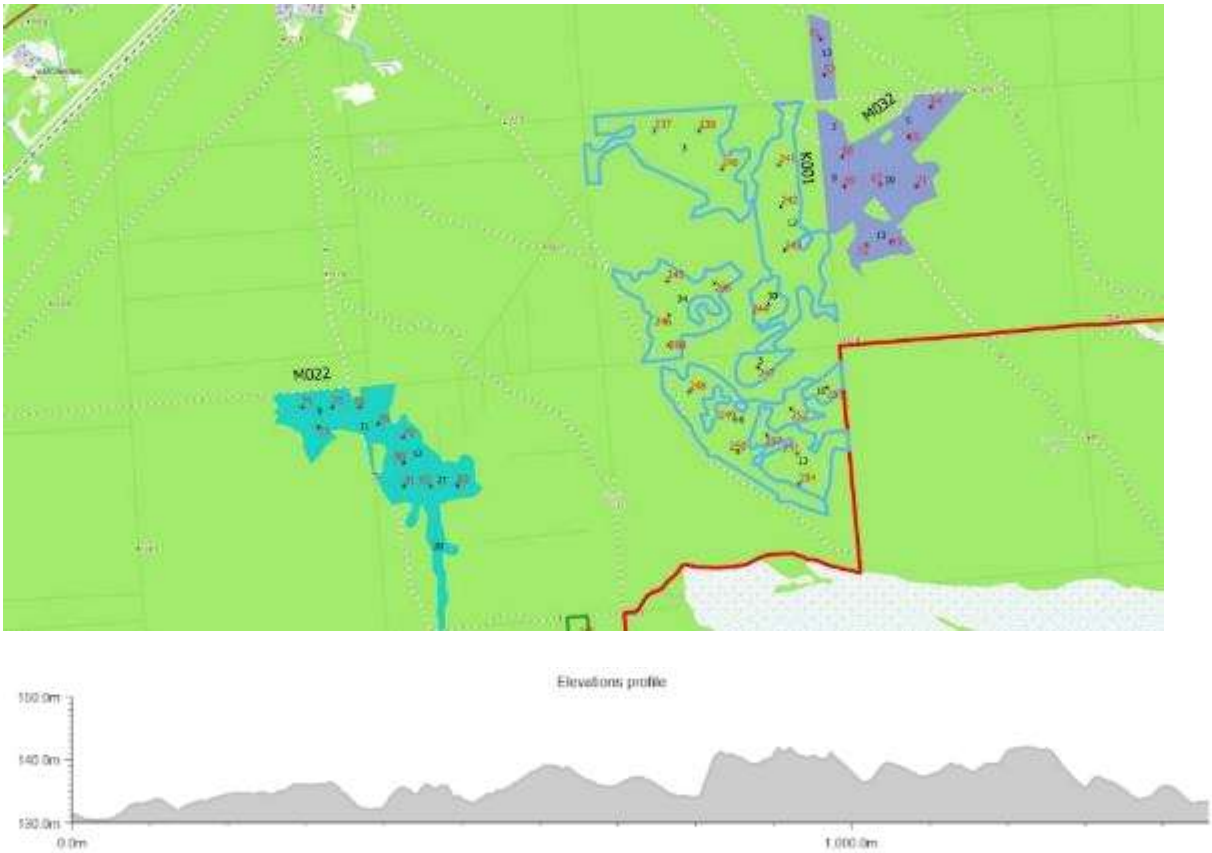


Figure 7. M022: Elevation profile NW-SE-S direction in the mid of plot. Line angle in 79 point.

Figure 8. M023: Elevation profile N-S direction in straight line from mid-northern to southern points.

4. Investigated organism groups

4.1. Bryophytes
4.2. Tracheophytes
4.3. Lichens
4.4. Birds
4.5. Beetles
4.6. Hymenoptera
as described in Metadata file

5. Investigated environmental variables

5.1. Soil variables

6. Other investigated functions/processes
-

7. References
-

8. Participating experts in the project

Gediminas Brazaitis (leader, birds, planning of management)
Vitas Marozas (stand, tracheophytes)
Žydrūnas Preikša (Bryophytes, Lichens, planning of management)
Kastytis Šimkevičius (Birds, stand)
Silvija Manton (Stand)
Vytautas Tamutis (Beetle)
Eduardas Budrys (Hymenoptera)
Loreta Bisikirskienė (Birds)

Experiment description M03

1. General information

Name of the experiment: **EU protected habitat management experiment: Improvement of Central European Lichen Scots Pine Forests (91T0) habitat structure by creating mosaic of landscape (M03X)**

Contact(s) in the COST Action: Gediminas Brazaitis gediminas.brazaitis@vdu.lt, Žydrūnas Preikša zydrunas.preiksa@vdu.lt
Organization of the Contact(s): Institute of Forest Biology and Silviculture Faculty of Forest Science and Ecology Agricultural Academy Vytautas Magnus University, Studentu str. 11, Akademija LT-53361, Kaunas dist. Lithuania
Website of the experiment: -

The question of the experiment: Improvement of EU protected habitats (Habitat and bird directives) conservation status. Creating habitat mosaic in Central European Lichen Scots Pine Forests (91T0) aiming to create more diversity in structure and species habitats.

Locality: Dzūkija National Park
Number of Sites: 3 (M031, M032, M033)
Number of Blocks: ND
Treatments and number of Levels: ND
Number of Plots: 21

Dates:
Beginning of the experiment: 2019
Date of Before-treatment data collection: 2019–2020. M33 will be inventoried on 2020.
Date of intervention:2023
Dates of after-treatment data collection: planned on: 2024, 2026

2. Site descriptions

2.1. Site 1.

Location: Dzūkija National Park

GPS coordinates (WGS 84) and altitudes:

Site No.	East	North	Altitude (min–max)
LT_GB_M031	54.05858	24.45467	129–134.5
LT_GB_M032	54.03789	24.44279	131–138
LT_GB_M033	54.05497	24.48813	134.5–142

Type of managment	Location (Forest district, Compartment/Subcompartment)	**No of site**	**No. of study plots**	**Area, ha**	**Total number of study plots**
Improvement of Central European Lichen Scots Pine Forests (91T0) habitat structure by creating mosaic of landscape	Marcinkonys FD 110 / 3, 9, 18	M031	23–27	10.2	5
	Marcinkonys FD 199 / 209 kv. – 3, 5, 9, 10, 13	M032	61, 63–65, 67–69, 71–73	29.9	10
	Marcinkonys FD 112 / 29, 13	M033	39–44	8.6	6
	Totally:			**48.7**	**21**

Aspect: ND
Slope: Undirectional mezorelief with small slopes and hills
Mean annual temperature: 6.4 °C
Annual precipitation: 645 mm
Bedrock: Fine sand
Soil type: Fine sand
Site area: 48.7 ha
Forest type: Pinewood with small mixture of birch; DBH=27.5 (22–37) cm; H=23.8 (20–27) m. Vol=363.5 m (241–389)^3/ha. Habitat: Central European Lichen Scots Pine Forests (91T0)

Age of the stand at the beginning of the experiment: 86 (62–122) yrs.
Stand structure before the interventions:
canopy: One layer; species: 10P
shrub layer: Scarce rowan, junipers
understory layer: Scarce pine
Canopy openness: Relative stocking density=0.67 (0.6–0.8)
Management type before the experiment: Low intensity sanitation cuttings
Available data for the stand structure of the stand: tree species, DBH, basal area, height, volume, stocking density, Class of Craft, Stand density, standing and lying dead wood volume, tree condition, tree microhabitat

3. Applied treatments

3.1. Treatment 1. Partial opening for inland dunes

3.2. Description of the study design
Will be detailed up to 2020.12. Preliminary we are going to create mosaic by opening habitat. Expecting to create variety in size and shape, to analyse the effect of opening shape and size on biodiversity.
The data will be compared with control sites K01–K08, totalling 70 study plot.

3.3. Graphical representation of the experiment
Will be detailed up to 2022.

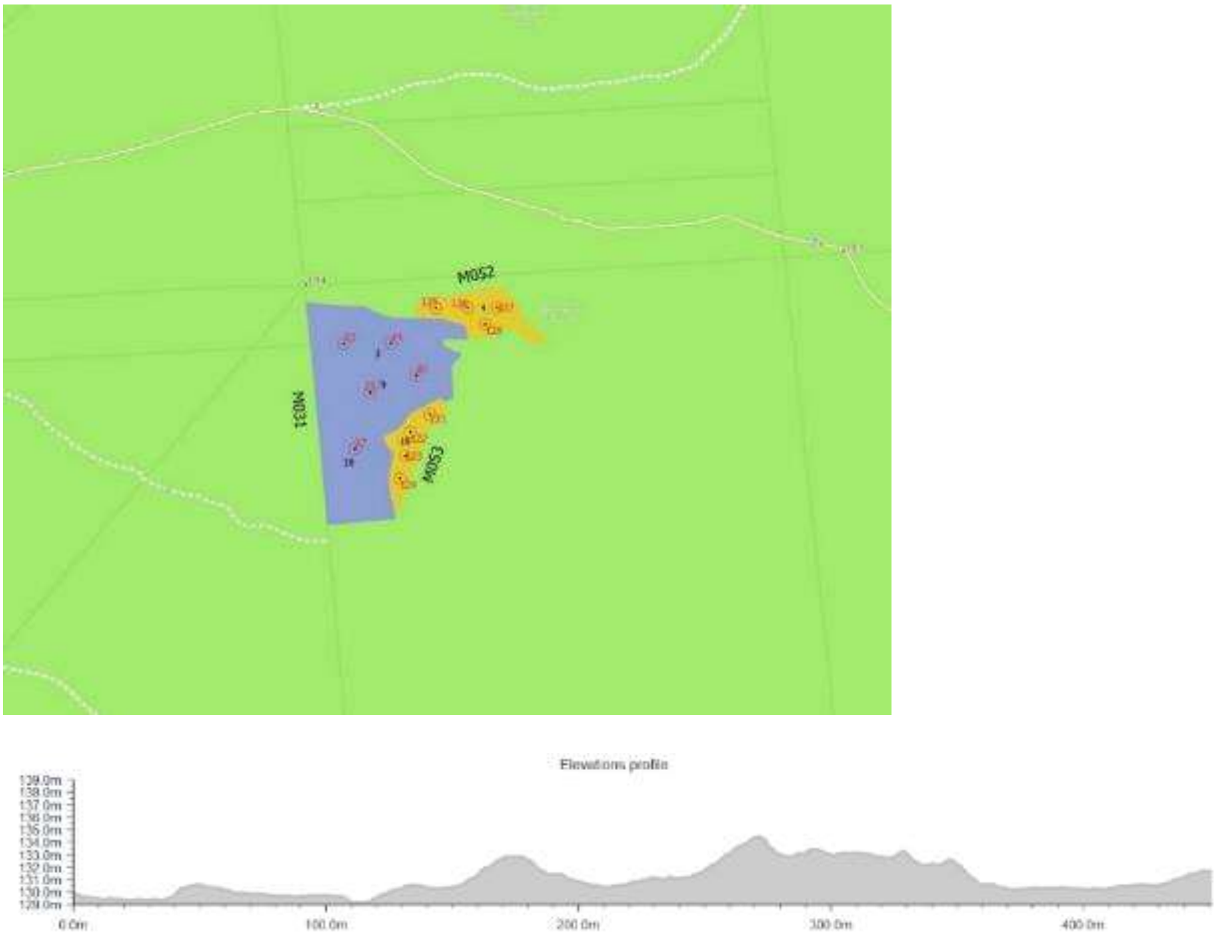


Figure 9. M031: Elevation profile N-S direction in the mid of plot.

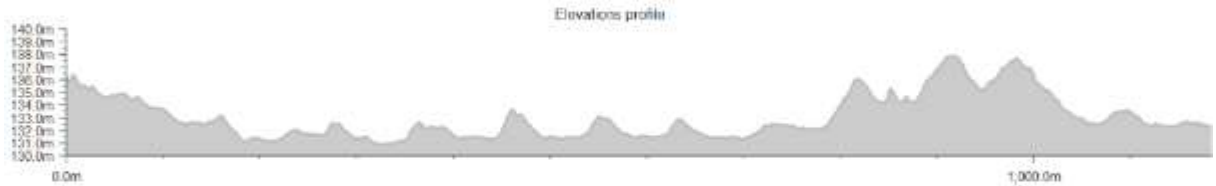


Figure 10. M032: Elevation profile N-S direction in the mid of plot.

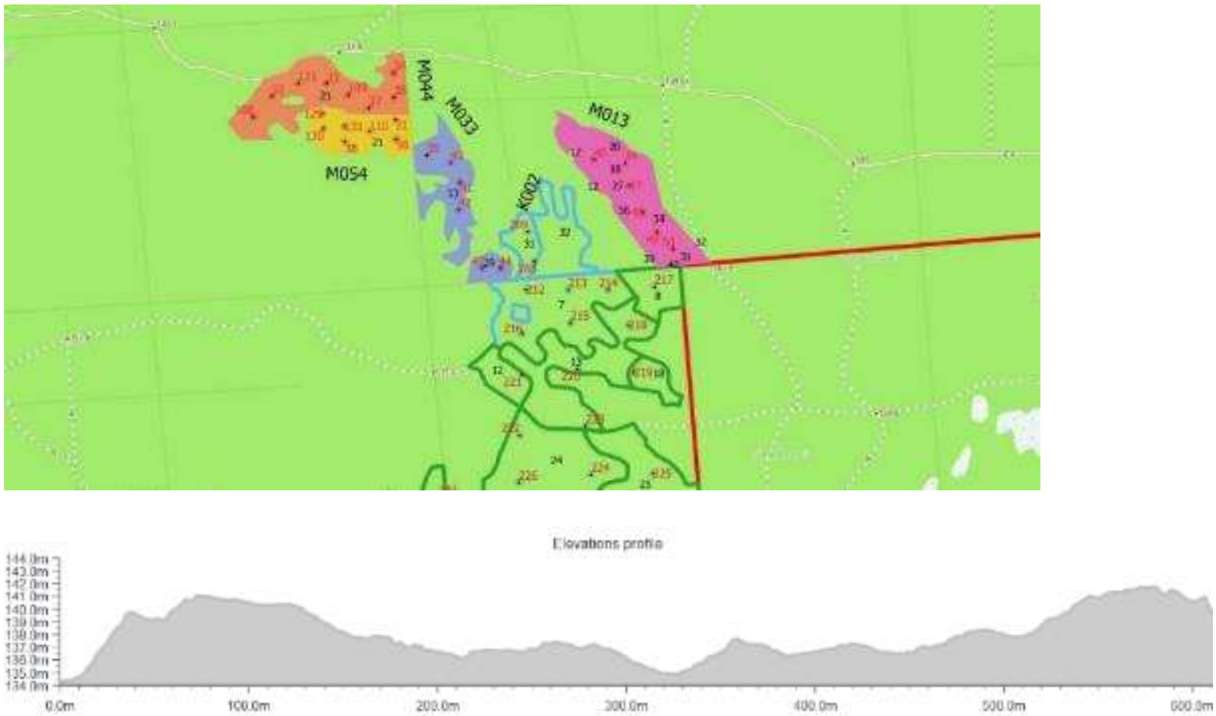


Figure 11. M033: Elevation profile N-S direction in straight line from mid-northern to southern points.

4. Investigated organism groups

4.1. Bryophytes
4.2. Tracheophytes
4.3. Lichens
4.4. Birds
4.5. Beetles
4.6. Hymenoptera
as described in Metadata file

5. Investigated environmental variables

5.1. Soil variables

6. Other investigated functions/processes:

-

7. References

-

8. Participating experts in the project

Gediminas Brazaitis (leader, birds, planning of management)
Vitas Marozas (stand, tracheophytes)
Žydrūnas Preikša (Bryophytes, Lichens, planning of management)
Kastytis Šimkevičius (Birds, stand)
Silvija Manton (Stand)
Vytautas Tamutis (Beetle)
Eduardas Budrys (Hymenoptera)
Loreta Bisikirskienė (Birds)

Experiment description M04

1. General information

Name of the experiment: **EU protected habitat management experiment: Improvement of Western Taiga (9010) and Central European Lichen Scots Pine Forests (91T0) habitat structure by prescribe burning (M04X)**

Contact(s) in the COST Action: Gediminas Brazaitis gediminas.brazaitis@vdu.lt, Žydrūnas Preikša zydrunas.preiksa@vdu.lt
Organization of the Contact(s): Institute of Forest Biology and Silviculture Faculty of Forest Science and Ecology Agricultural Academy Vytautas Magnus University, Studentu str. 11, Akademija LT-53361, Kaunas dist. Lithuania
Website of the experiment: -

The question of the experiment: Improvement of EU protected habitats (Habitat and bird directives) conservation status. To analyse how prescribe burning in Western Taiga (9010) and Central European Lichen Scots Pine Forests (91T0) affects biodiversity and forest structure.

Locality: Dzūkija National Park
Number of Sites: 5 (M040, M041, M042, M043, M044)
Number of Blocks: ND
Treatments and number of Levels: ND
Number of Plots: 30

Dates:
Beginning of the experiment: 2019
Date of Before-treatment data collection: 2019–2020. M40 and M44 will be inventoried on 2020.
Date of intervention:2023
Dates of after-treatment data collection: planned on: 2024, 2026

2. Site descriptions

2.1. Site 1.

Location: Dzūkija National Park

GPS coordinates (WGS 84) and altitudes:

Site No.	East	North	Altitude (min–max)
LT_GB_M040	54.113661	24.438165	121–127.5
LT_GB_M041	54.06896	24.49751	129.5–135
LT_GB_M042	54.09023	24.49675	125–126
LT_GB_M043	53.93994	24.40679	129–131
LT_GB_M044¤	54.058694	24.481111	131.5–140.5

Type of managment	Location (Forest district, Compartment/Subcompartment)	**No of site**	**No. of study plots**	**Area, ha**	**Total number of study plots**
Improvement of Western Taiga (9010) and Central European Lichen Scots Pine Forests (91T0) habitat structure by prescribe burning	Perloja FD 57 / 15, 16	M040	114–119	15,1	6
	Marcinkonys FD 78 / 29, 30, 40	M041	16–18, 120	2,4	4
	Marcinkonys FD 23 / 3, 4	M042	08–11	1,0	4
	Musteika FD 305 / 23 324 / 9, 10, 11	M043	92–99	10,4	8
	Marcinkonys FD 111 / 21	M044	32–35,37,108,109,111	12,1	8
	Totally:			**41.0**	**30**

Aspect: ND
Slope: Undirectional mezorelief with small slopes and hills
Mean annual temperature: 6.4°C
Annual precipitation: 645 mm
Bedrock: Fine sand
Soil type: Fine sand
Site area: 41 ha

Forest type: Pinewood with small mixture of birch; DBH=30.9 (28–36) cm; H=26.5 (26–30) m. Vol=323.9 (240–451) m^3/ha. Habitat: Western taiga (9010) and Central European Lichen Scots Pine Forests (91T0)
Age of the stand at the beginning of the experiment: 93 (72–147) yrs.
Stand structure before the interventions:
canopy: One layer; species: 8P2P
shrub layer: Scarce rowan, junipers
understory layer: Scarce pine
Canopy openness: Relative stocking density=0.75 (0.7–0.9)
Management type before the experiment: Low intensity sanitation cuttings
Available data for the stand structure of the stand: tree species, DBH, basal area, height, volume, stocking density, Class of Craft, Stand density, standing and lying dead wood volume, tree condition, tree microhabitat

3. Applied treatments

3.1. Treatment 1. Partial opening for inland dunes

3.2. Description of the study design
Will be detailed up to 2020.12. Preliminary we are going to make prescribe burning in various sizes and study its effect.
The data will be compared with control sites K01–K08, totalling 70 study plot.

3.3. Graphical representation of the experiment
Will be detailed up to 2022.

Figure 12. M040: Elevation profile N-S direction in the mid of plot.

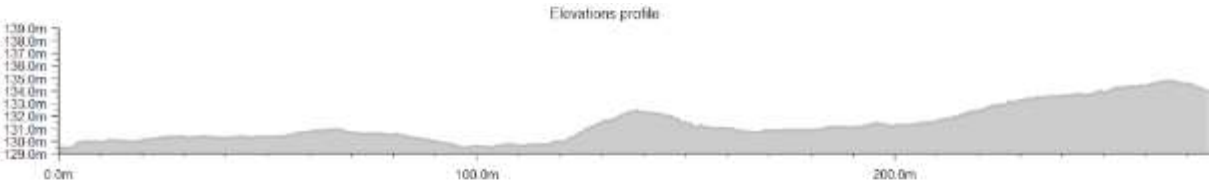


Figure 13. M041: Elevation profile NW-SE direction in the mid of plot.

Figure 14. M042: Elevation profile N-S direction in straight on the mid of plot.

Figure 15. M043: Elevation profile NNW-SSE direction in straight on the mid of plot.

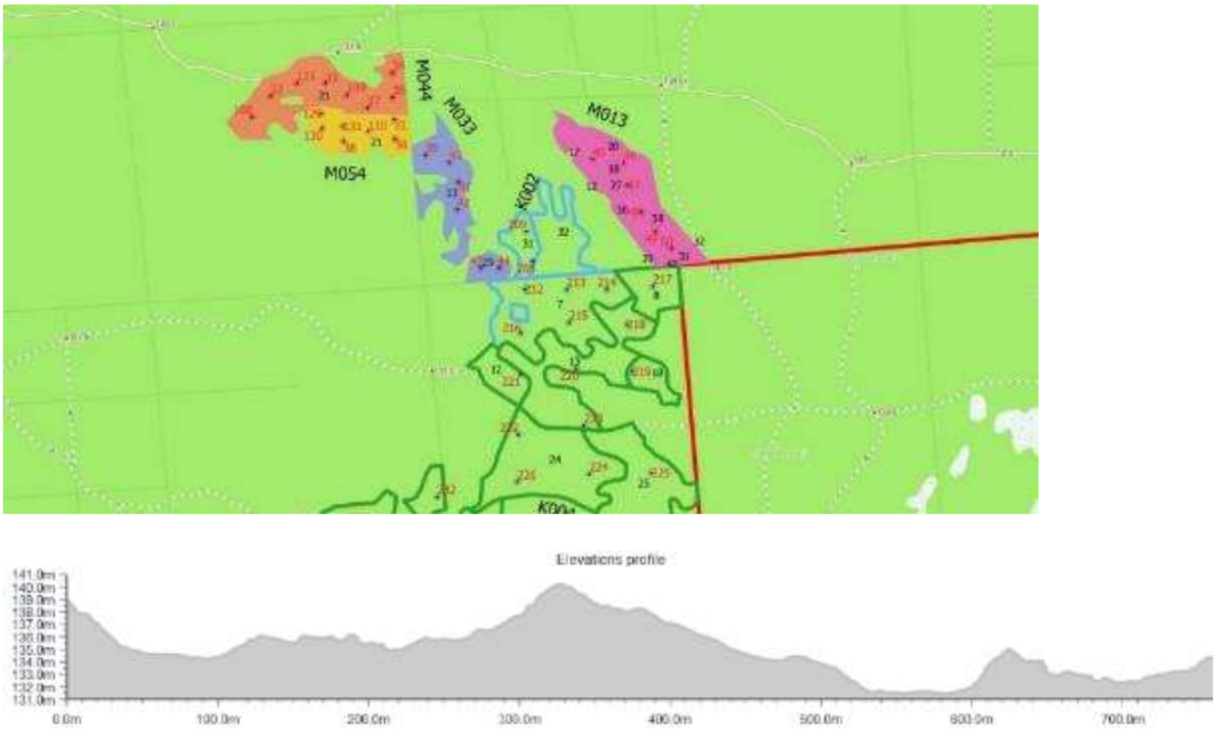


Figure 16. M044: Elevation profile E-W direction in straight on the mid of plot.

4. Investigated organism groups

4.1. Bryophytes
4.2. Tracheophytes
4.3. Lichens
4.4. Birds
4.5. Beetles
4.6. Hymenoptera
as described in Metadata file

5. Investigated environmental variables

5.1. Soil variables

6. Other investigated functions/processes
-

7. References
-

8. Participating experts in the project

Gediminas Brazaitis (leader, birds, planning of management)
Vitas Marozas (stand, tracheophytes)
Žydrūnas Preikša (Bryophytes, Lichens, planning of management)
Kastytis Šimkevičius (Birds, stand)
Silvija Manton (Stand)
Vytautas Tamutis (Beetle)
Eduardas Budrys (Hymenoptera)
Loreta Bisikirskienė (Birds)

Experiment description M05

1. General information

Name of the experiment: **EU protected habitat management experiment: Improvement of Central European Lichen Scots Pine Forests (91T0) habitat structure by eliminating floor layer (M05X)**

Contact(s) in the COST Action: Gediminas Brazaitis gediminas.brazaitis@vdu.lt , Žydrūnas Preikša zydrunas.preiksa@vdu.lt
Organization of the Contact(s): Institute of Forest Biology and Silviculture Faculty of Forest Science and Ecology Agricultural Academy Vytautas Magnus University, Studentu str. 11, Akademija LT-53361, Kaunas dist. Lithuania
Website of the experiment: -

The question of the experiment: Improvement of EU protected habitats (Habitat and bird directives) conservation status. How mechanical elimination of forest floor layer of Central European Lichen Scots Pine Forests (91T0) affects biodiversity and stand structure.

Locality: Dzūkija National Park

Number of Sites: 4 (M051, M052, M053, M054)
Number of Blocks: ND
Treatments and number of Levels: ND
Number of Plots: 27

Dates:
Beginning of the experiment: 2019
Date of Before-treatment data collection: 2019–2020. M52–M54 will be inventoried on 2020.
Date of intervention:2023
Dates of after-treatment data collection: planned on: 2024, 2026

2. Site descriptions

2.1. Site 1.

Location: Dzūkija National Park

GPS coordinates (WGS 84) and altitudes:

Site No.	East	North	Altitude (min–max)
LT_GB_M051	54.06738	24.53471	130–142
LT_GB_M052	54.060371	24.45967	131–135
LT_GB_M053	54.056338	24.457322	130–137
LT_GB_M054¤	54.05817	24.481429	134–141

Type of managment	Location (Forest district, Compartment/Subcompartment)	**No of site**	**No. of study plots**	**Area, ha**	**Total number of study plots**
Improvement of Central European Lichen Scots Pine Forests (91T0) habitat structure by eliminating forest floor layer	Marcinkonys FD 81 / 22	M051	12–15, 20, 22,102–107	6.3	12
	Marcinkonys FD 110 / 4	M052	125–128	1.7	4
	Marcinkonys FD 111 / 19	M053	121–124	1.2	4
	Marcinkonys FD 111 / 21, 25	M054	31,36,38,110,129–131	6.2	7
	Totally:			**15.4**	**27**

Aspect: ND
Slope: Undirectional mezorelief with small slopes and hills
Mean annual temperature: 6.4 °C
Annual precipitation: 645 mm
Bedrock: Fine sand
Soil type: Fine sand
Site area: 15.4 ha
Forest type: Pinewood with small mixture of birch; DBH=22cm; H=22.6 m. Vol=315 m^3/ha.
Habitat: Central European Lichen Scots Pine Forests (91T0)
Age of the stand at the beginning of the experiment: 62 yrs.
Stand structure before the interventions:
- canopy: One layer; species: 10P
- shrub layer: Scarce rowan, junipers
- understory layer: Scarce pine

Canopy openness: Relative stocking density=0.8
Management type before the experiment: Low intensity sanitation cuttings
Available data for the stand structure of the stand: tree species, DBH, basal area, height, volume, stocking density, Class of Craft, Stand density, standing and lying dead wood volume, tree condition, tree microhabitat

3. Applied treatments

3.1. Treatment 1. Partial opening for inland dunes

3.2. Description of the study design

Will be detailed up to 2020.12. Preliminary we are going to make prescribe burning in various sizes and study its effect.
The data will be compared with control sites K01–K08, totalling 70 study plot.

3.3. Graphical representation of the experiment

Will be detailed up to 2022.

Figure 17. M051: Elevation profile N-S direction in the mid of plot.

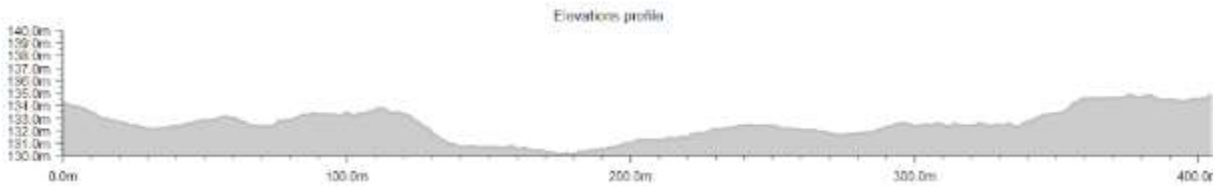


Figure 18. M052: Elevation profile W-E direction in the mid of plot.

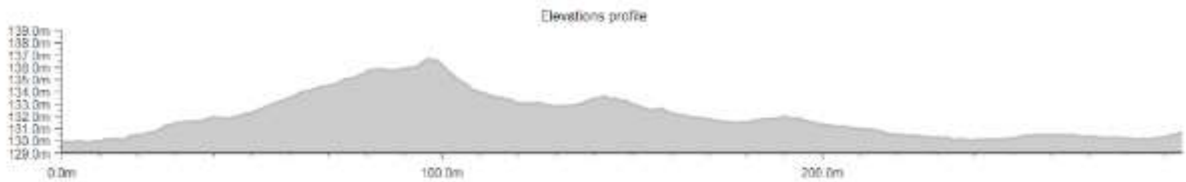


Figure 19. M053: Elevation profile NNW-SSE direction in the mid of plot.

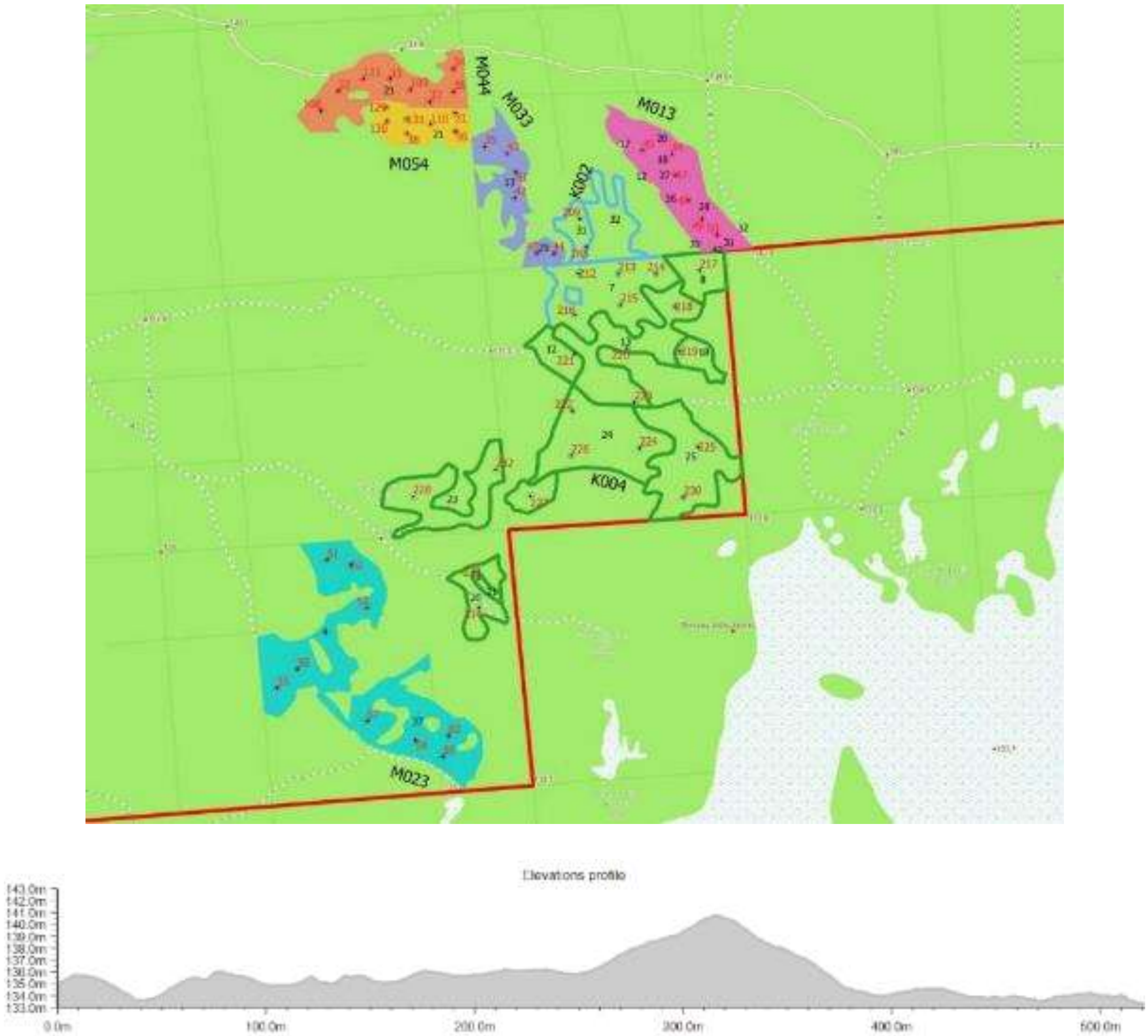


Figure 20. M054: Elevation profile W-E direction in straight on the mid of plot.

4. Investigated organism groups

4.1. Bryophytes
4.2. Tracheophytes
4.3. Lichens
4.4. Birds
4.5. Beetles
4.6. Hymenoptera
as described in Metadata file

5. Investigated environmental variables

5.1. Soil variables

6. Other investigated functions/processes

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7. References

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8. Participating experts in the project

Gediminas Brazaitis (leader, birds, planning of manmagment)
Vitas Marozas (stand, tracheophytes)
Žydrūnas Preikša (Bryophytes, Lichens, planning of managment)
Kastytis Šimkevičius (Birds, stand)
Silvija Manton (Stand)
Vytautas Tamutis (Beetle)
Eduardas Budrys (Hymenoptera)
Loreta Bisikirskienė (Birds)

Experiment description form: Control

1. General information

Name of the experiment: **EU protected habitat management experiment. Control section (K00X)**

Contact(s) in the COST Action: Gediminas Brazaitis gediminas.brazaitis@vdu.lt, Žydrūnas Preikša zydrunas.preiksa@vdu.lt
Organization of the Contact(s): Institute of Forest Biology and Silviculture Faculty of Forest Science and Ecology Agricultural Academy Vytautas Magnus University, Studentu str. 11, Akademija LT-53361, Kaunas dist. Lithuania
Website of the experiment: -

The question of the experiment: Improvement of EU protected habitats (Habitat and bird directives) conservation status.

Locality: Dzūkija National Park
Number of Sites: 8 (K001, K002, K003, K004, K005, K006, K007, K008)
Number of Blocks: ND
Treatments and number of Levels: ND
Number of Plots: 70

Beginning of the experiment: 2019
Date of Before-treatment data collection: 2019–2020.
Date of intervention:2023
Dates of after-treatment data collection: planned on: 2024, 2026

2. Site descriptions

2.1. Site 1.

Location: Dzūkija National Park

GPS coordinates (WGS 84) and altitudes:

Site No.	East	North	Altitude (min–max)
LT_GB_K001	54.03026	24.43370	131.5–151
LT_GB_K002	54.05216	24.49302	135.5–144.5
LT_GB_K003	54.07777	24.50539	121–127
LT_GB_K004	54.04563	24.4870	133–143
LT_GB_K005	54.01773	24.42246	133–137.5
LT_GB_K006	53.96955	24.43643	131–131.5
LT_GB_K007	53.96614	24.41502	129.5–130.5
LT_GB_K008	53.93836	24.43082	129–129.5

Type of managment	Location (Forest district, Compartment/Subcompartment)	**No of site**	**No. of study plots**	**Area, ha**	**Total number of study plots**
Control plots	Marcinkonys FD 208 / 3, 12, 24, 30 218 / 5, 8, 10, 13	K001	237, 238, 240–254, 286–288	80.8	20
	Marcinkonys FD 112 / 31 202 / 7	K002	209, 212, 213–216, 285	14.4	7
	Marcinkonys FD 48 / 35–37, 39	K003	201, 203–206	14.5	5
	Marcinkonys FD 201 /23 202 / 8, 12, 13, 18, 24, 25, 29 211 / 20, 21	K004	217–228; 230, 232–234	59.1	16
	Marcinkonys FD 227 / 12, 20, 22	K005	255, 256, 293–295	4.4	5
	Musteika FD 271 / 17, 21	K006	261–267	10.8	7
	Musteika FD 269 / 44	K007	268–270, 291, 292	3.2	5
	Musteika FD 325 / 20 326 / 6	K008	282–284, 289, 290	3.4	5
	Totally:			**190.6**	**70**

Aspect: ND
Slope: Undirectional mezorelief with small slopes and hills
Mean annual temperature: 6.4 °C
Annual precipitation: 645 mm
Bedrock: Fine sand
Soil type: Fine sand
Site area: 190.6 ha
Forest type: Pinewood with small mixture of birch; DBH=35.5 cm; H=27.6 m Vol=339.5 m^3/ha. Habitat: Western taiga (9010) and Central European Lichen Scots Pine Forests (91T0)
Age of the stand at the beginning of the experiment: 123 yrs.
Stand structure before the interventions:
canopy: one layer; species: 9P1P
shrub layer: scarce rowan, junipers, rowan
understory layer: scarce pine
Canopy openness: Relative stocking density=0.69
Management type before the experiment: Low intensity sanitation cuttings
Available data for the stand structure of the stand: tree species, DBH, basal area, height, volume, stocking density, Class of Craft, Stand density, standing and lying dead wood volume, tree condition, tree microhabitat

3. Applied treatments

3.1. Treatment 1. Partial opening for inland dunes

3.2. Description of the study design
Control plot for all experiments.

3.3. Graphical representation of the experiment
Will be detailed up to 2022.

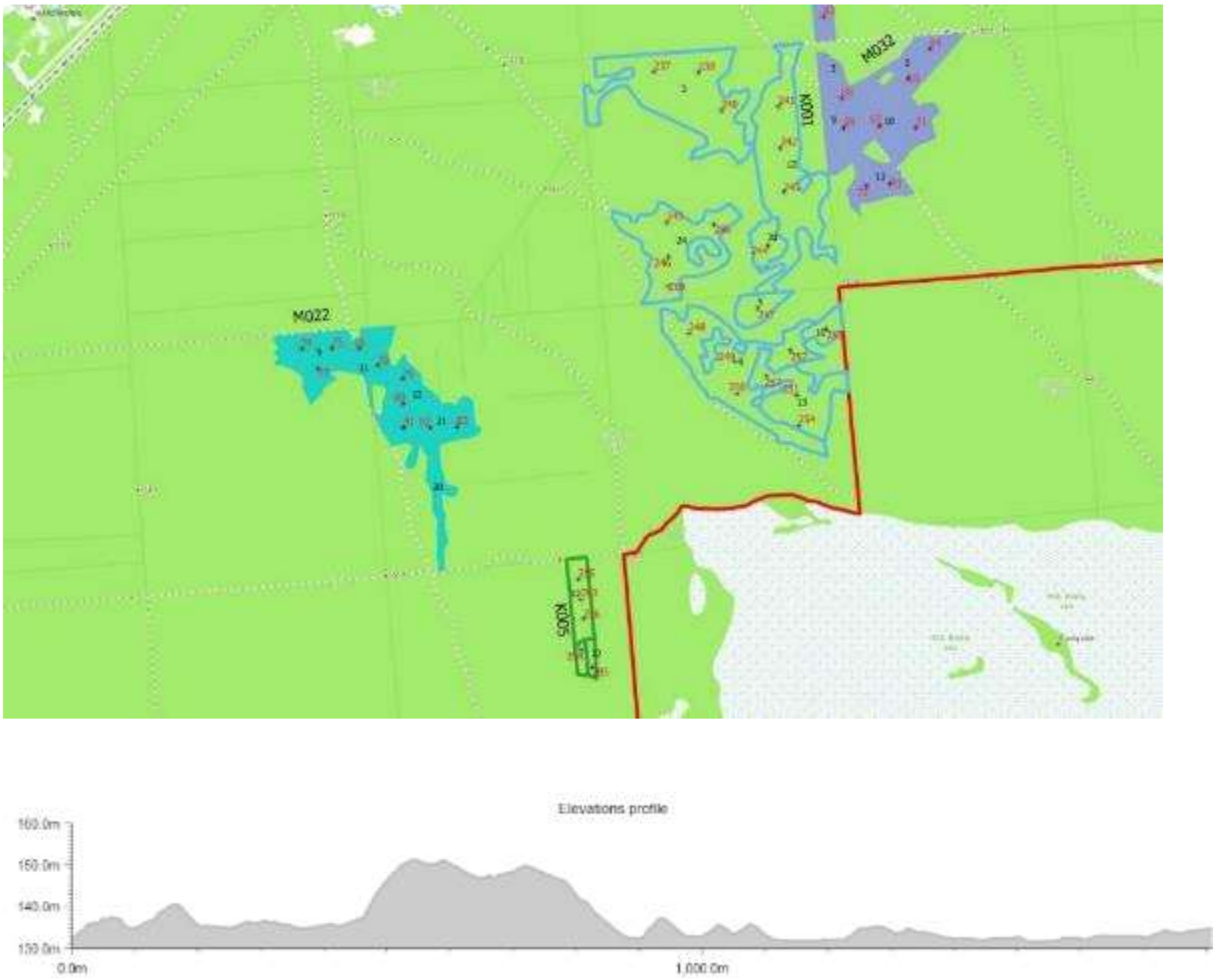
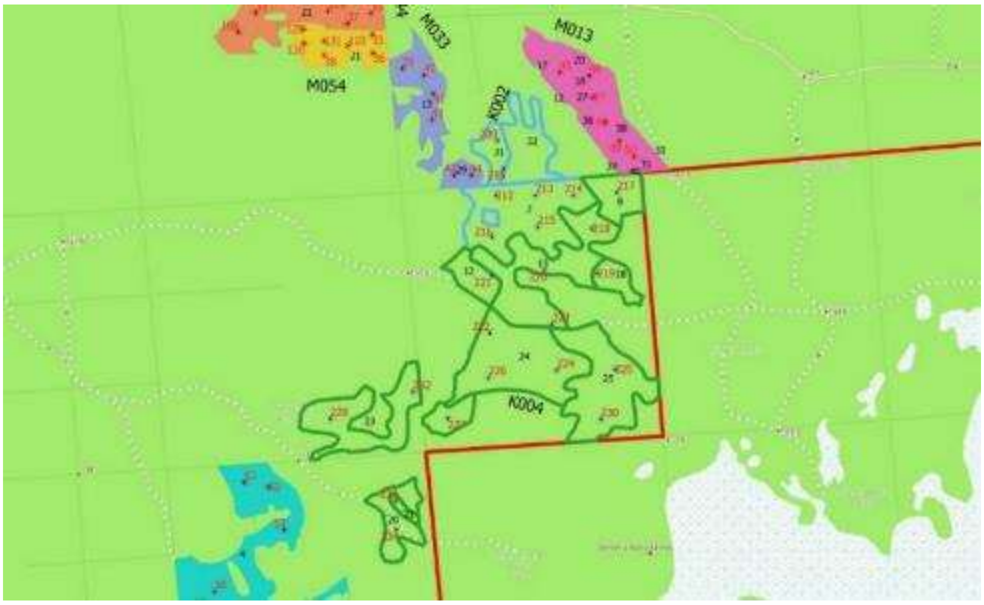


Figure 21. K001: Elevation profile N-S direction in straight on the mid of plot.



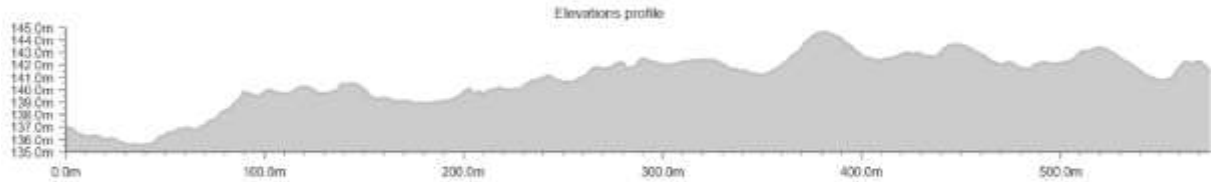


Figure 22. K002: Elevation profile N-S direction in straight on the mid of plot.

Figure 23. K003: Elevation profile N-S direction in straight on the mid of plot.

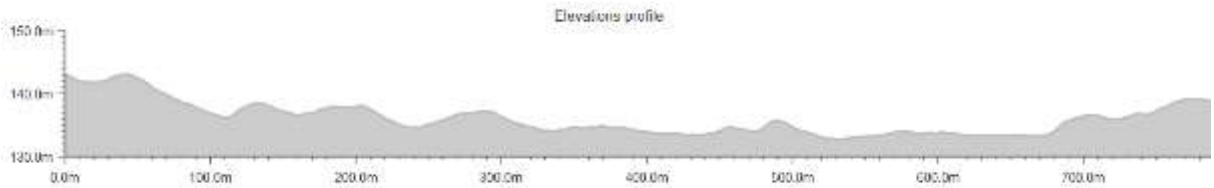


Figure 24. K004: Elevation profile N-S direction in straight on the mid of plot.

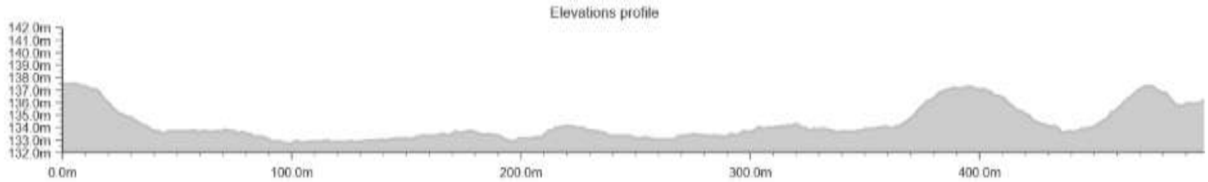


Figure 25. K005: Elevation profile N-S direction in straight on the mid of plot.

Figure 26. K006: Elevation profile W-E direction in straight on the mid of plot.

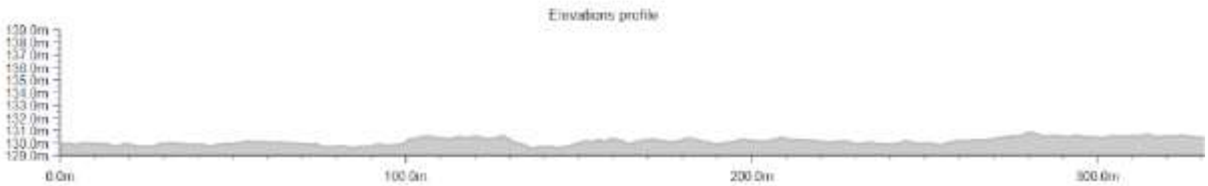


Figure 27. K007: Elevation profile W-E direction in straight on the mid of plot.

Figure 28. K008: Elevation profile W-E direction in straight on the mid of plot.

4. Investigated organism groups

4.1. Bryophytes
4.2. Tracheophytes
4.3. Lichens
4.4. Birds
4.5. Beetles
4.6. Hymenoptera
as described in Metadata file

5. Investigated environmental variables

5.1. Soil variables

6. Other investigated functions/processes

-

7. References

-

8. Participating experts in the project

Gediminas Brazaitis (leader, birds, planning of manmagment)
Vitas Marozas (stand, tracheophytes)
Žydrūnas Preikša (Bryophytes, Lichens, planning of managment)
Kastytis Šimkevičius (Birds, stand)
Silvija Manton (Stand)
Vytautas Tamutis (Beetle)
Eduardas Budrys (Hymenoptera)
Loreta Bisikirskienė (Birds)

EX22_SW_BN

1. General information

Name of the experiment: **The Swedish oak project**

Contact(s) in the COST Action: Björn Nordén (Bjorn.Norden@nina.no)
Organization of the Contact(s): Norwegian Institute for Nature Research
Website of the experiment: https://bioenv.gu.se/english/research/main-research-areas/evolutionary-ecology-conservation/oakproject

The question of the experiment: Does partial cutting (of mainly spruce) benefit biodiveristy in mixed forests with oak?

Locality: South Sweden
Number of Sites: 25
Number of Blocks: 25
Treatments and number of Levels: 2 treatments; conservation-oriented partial cutting and "handsoff" free development control plots. Each site has one partial cutting and one control plot.
Number of Plots: 50

Dates:
Beginning of the experiment: 2001
Date of Before-treatment data collection: 2001–2002
Date of intervention: main intervention (conservation oriented partial cutting) winter 2002/2003, cutting of re-growth (saplings, bushes) within a 10 m radius from 5 oaks per partial cutting plot (25) since 2013.
Dates of after-treatment data collection: 2004–2019

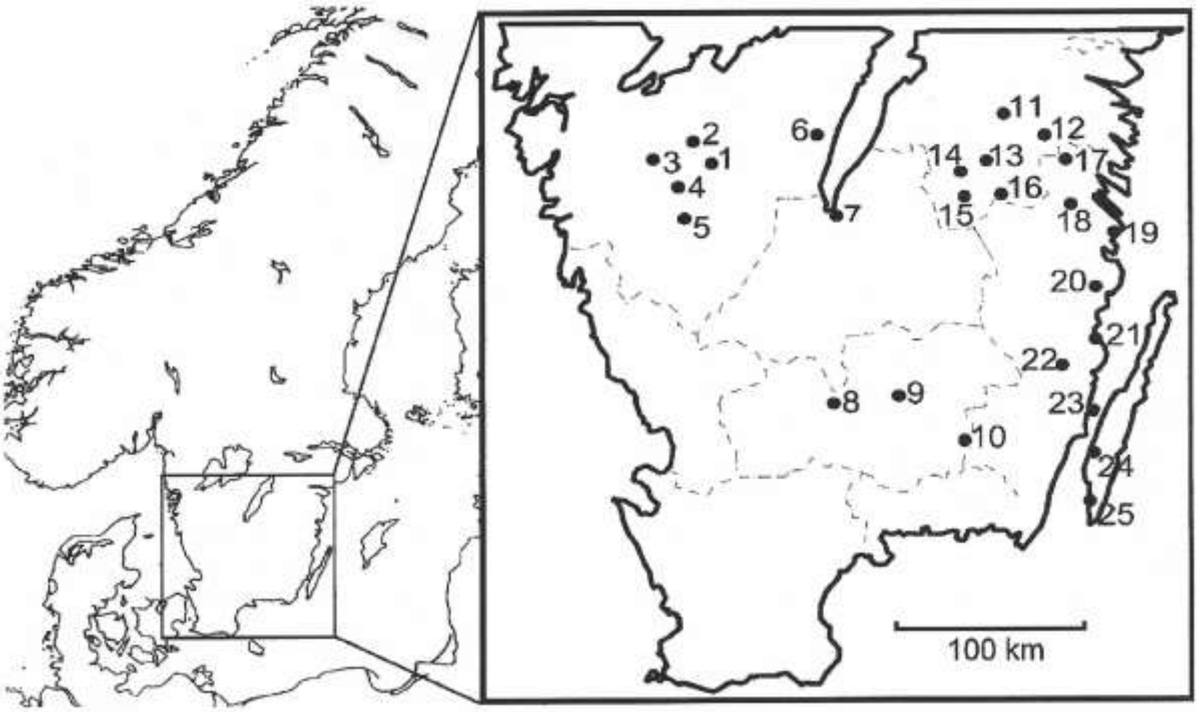
2. Site descriptions

2.1. Site 1–25.

Location and GPS coordinates (in Swedish grid):

1. Västra Götalands län, Skölvene Nyckelbiotop
6435900/1342710.
2. Västra Götalands län, Bitterna sn, Karla Nyckelbiotop
6448228/1333240.
3. Västra Götalands län, Lena sn, Östadkulle Nyckelbiotop,
6438527/1312401.
4. Västra Götalands län, Tämta sn, Sandviksås Nyckelbiotop,
6404716/1328335.
5. Västra Götalands län, Borås, Rya åsar Naturreservat,
6404716/1328335.

6. Västra Götalands län, Daretorp sn, Strakaskogen Nyckelbiotop
6451127/1397122.
7. Jönköpings län, Jönköping, Bondbergets Naturreservat,
6406533/1406729.
8. Kronobergs län, Ryssby sn, Långhults Nyckelbiotop,
6299701/1405344.
9. Kronobergs län, Växjö, Bokhultets Naturreservat,
6304778/1437963.
10. Kronobergs län, Ljuder sn, Kråksjö by Nyckelbiotop,
6279102/1472274.
11. Östergötlands län, Vist sn, Stafsäter Naturreservat,
6463954/1492277.
12. Östergötlands län, Åtvid sn, Åtvidaberg Nyckelbiotop,
6451645/1513420.
13. Östergötlands län, NNV Kisa, Fagerhult Nyckelbiotop (stand 218 1340760)
6437257/1483099.
14. Östergötlands län, Malexander sn, Aspenäs Nyckelbiotop
6430484/1470012.
15. Östergötlands län, Norra Vi Nyckelbiotop,
6416860/1471798.
16. Östergötlands län, Fröåsa, Kisa Nyckelbiotop,
6418101/1491305.
17. Kalmar län, Överum sn, Ulvsdal Nyckelbiotop,
6437347/1524191.
18. Kalmar län, Hallingeberg sn, Hallingeberg Nyckelbiotop,
6412083/1526971.
19. Kalmar län, Västrum sn, Ytterhult Nyckelbiotop,
6396388/1548643.
20. Kalmar län, Misterhult sn, Fårbo Nyckelbiotop (stand 218 33110090),
6365604/1538890.
21. Kalmar län, Påskallavik, Emsfors Nyckelbiotop
6336257/1539723.
22. Kalmar län, Hornsö, Getebro Naturreservat,
6321599/1521890.
23. Kalmar län, Rockneby, Lindö Naturreservat,
6296250/1539339.
24. Kalmar län, Vickleby sn, Lilla Vickleby Naturreservat,
6271764/1539205.
25. Kalmar län, S. Möckleby sn, Albrunna Naturreservat
6343586/1537705.



Altitude: The study sites lie 5–230 m above sea level.
Aspect: The sites have no significant aspect
Slope: The sites have no significant slope
Mean annual temperature: 5–8 ˚C
Annual precipitation: 400–1000 mm
The mean monthly precipitation (July) ranges from about 50 mm at the eastern coastal sites to about 90 mm at the western sites and the mean temperature in July varies from about 14 C in the west to about 17 C in the east.

Bedrock: site 1–3: gneiss, granite, at site 24–25 (Öland): calcareous bedrock
Soil type: The study sites are situated mainly (site 1–23) on mesic moraine soils (Podzol), at site 24–25 (Öland): Cambisol

Site area: In each stand, we delimited two plots (each 1 ha), usually 100 · 100 m or 83 · 120 m. The mean distance between the plots at a site was 50 m (range 10–250 m).

Forest type: The study sites are former oak wood pastures or meadows abandoned about 25–75 years ago, characterized by remnant large oaks and other broadleaved/coniferous trees of smaller dimensions, due to secondary succession. The proportion of pedunculate/sessile oak was 50% (range 13–86%) of the basal area at breast height. Corresponding figures for other noble broadleaved trees was 16% (0–62%), coniferous trees 12% (0–48%) and trivial broadleaved trees and shrubs 23% (4–56%). The forest communities are oligotrophic oak forests or mesotrophic mixed broadleaved forests (acc. Diekmann, 1994).

Age of the stand at the beginning of the experiment: Old oaks on average 80–150 years, with a few older oaks at some sites, as well as some old pines. The secondary succession usually 40 to 80 years.

Stand structure before the interventions:
canopy: Closed.
shrub layer: Usually quite dense
understory layer: Sparse to relatively rich.

Canopy openness: Almost closed canopy before partial cutting and remaining in control plots.

Close to the five biggest oaks in each plot: In 2009, significantly more light reached the trunks in the treatment plots compared to the reference plots (treatment plots mean and SD: 5500 ± 5600 lux per tree; reference plots 1200 ± 1200 lux per tree, average values for north and south sides of trunks was used; paired permutation test: $p < 0.001$, $n = 24$). The north-facing sides of the oaks received 3800 ± 4900 lux in the treatment plots and 900 ± 1000 lux in the reference plots. The south-facing sides received 7200 ± 9700 lux in the treatment plots and 1500 ± 1800 lux in the reference plots. Also the mean canopy cover of individual oak trees was higher in the reference plots (36% ± 11) than in the treatment plots (20% ± 7; $p < 0.001$, $n = 24$), as measured 2009.

Management type before the experiment: No management since many years, see above.

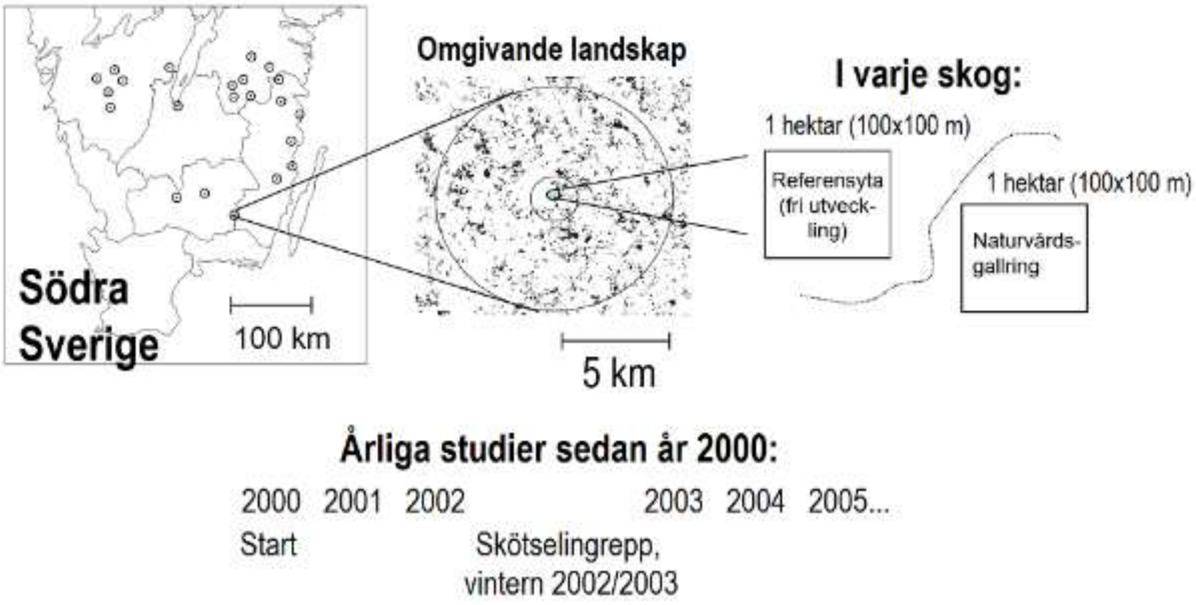
Available data for the stand structure of the stand: Living woody stems > 5 cm DBH measured. Dead wood including fine woody debris, attached dead wood, snags and stumps measured. Identified to species.
Oak recruitment, and resprouting after cutting of trees, bushed, measured.

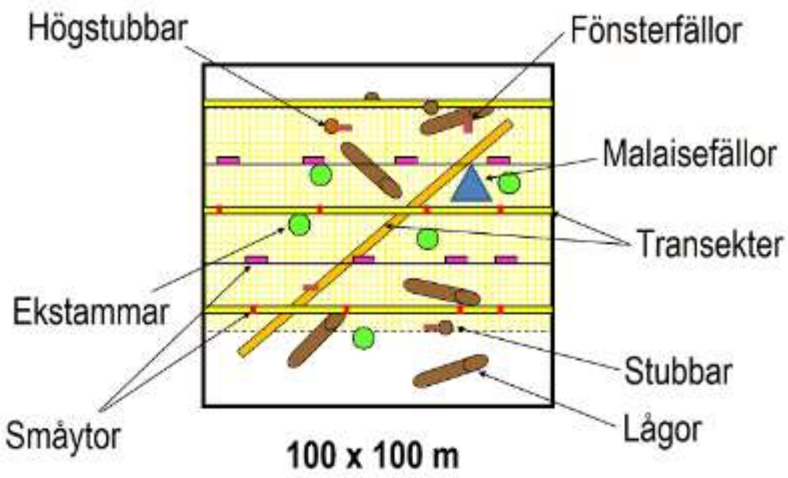
3. Applied treatments

3.1. Treatment 1.
About 25% of the basal area of living trees and bushes (>5 cm in diameter at breast height) was removed from the partial cutting plot in the winter 2002–2003, the control plot kept without cutting. Before cutting, the basal area in treatment plots was 28.3 ± 4.3 m2/ha (range 19.4–35.9 m2/ha; n = 24). On average 6.5 ± 2.9 m2/ha was removed (range 0.8–11.7 m2/ha). Further details are available in Götmark (2007).

3.2. Description of the study design
2 treatments; conservation-oriented partial cutting and “handsoff” free development control plots. Each site has one partial cutting and one control plot.

3.3. Graphical representation of the experiment





Högstubbar = snags, ekstammar = oak logs, småytor = squares used for frequency measures of vascular plants and bryophytes, fönsterfällor = flight interception traps, Malaisefällor = malaise tents, Transekter = transects used for surveys of vascular plants and fungi, Stubbar = stumps, Lågor = Coarse woody debris.

4. Investigated organism groups

4.1. Vascular plants (incl. woody regeneration)

4.2. Bryophytes

4.3. Lichenized fungi

4.4. Wood decaying fungi

4.5. Beetles
Flight interception window traps, placed on trunks of standing dead oaks. The traps consisted of 0.2×0.3 m clear plastic panes, attached vertically on oak trunks at a height of 1.5–3 m (facing south), and beneath these a white plastic tub containing a glycol and saltwater mixture (see Fig. 2 in Franc et al. 2007). On each plot (thinning and minimal intervention), we selected one recently (<~2 years) dead and one older (>~5 years) dead oak trunk, and put up one trap on each. The selected trunks lacked visible polypores and were not close to the edge of the plots.

4.6. Land molluscs

4.7. Fungus gnats
Collected by Malaise tents.

5. Investigated environmental variables

5.1. Light influx/Leaf area index
Canopy closure was measured in each plot from eight hemispherical photographs taken with a digital camera (28 mm lens) from ground level towards the sky, near transects. We converted colour pixels to binary black-and-white pixels using the program NIH Image, and calculated the mean proportion of sky visible for each plot

6. Other investigated functions/processes

6.1. Recruitment of oak

6.2. Resprouting of lignoses

6.3. Grazing by wild ungulates

6.4. Effects on species communities of landscape fragmentation, local and landscape habitat continuity

7. References

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8. Participating experts in the project

The involved experts can be gleaned from the literature list above.

EX23_SW-NO_BN

1. General information

Name of the experiment: **TransForest (Transformation of recent forest on abandoned agricultural land for the benefit of biodiversity, ecosystem services and green solutions)**

Contact(s) in the COST Action: Björn Nordén (Bjorn.Norden@nina.no)
Organization of the Contact(s): Norwegian Institute for Nature Research
Website of the experiment: https://ruralis.no/en/projects/transformation-of-recent-forest-on-abandoned-agricultural-land-for-the-benefit-of-biodiversity-ecosystem-services-and-green-solutions-transformasjon-av-skog-pa-gjengrodd-landbruksareal-for-biologis/

The question of the experiment: Does partial cutting (of mainly spruce) benefit biodiveristy in recent mixed forest on abandoned agricultural land?

Locality: South Norway and South Sweden
Number of Sites: 26
Number of Blocks: -
Treatments and number of Levels: 2 treatments; conservation oriented partial cutting and "handsoff" free development control plots. Each site has one partial cutting and one control plot.
Number of Plots: 52

<u>*Dates:*</u>
Beginning of the experiment: 2016
Date of Before-treatment data collection: 2016
Date of intervention: winter 2016/2017
Dates of after-treatment data collection: 2018-2019.

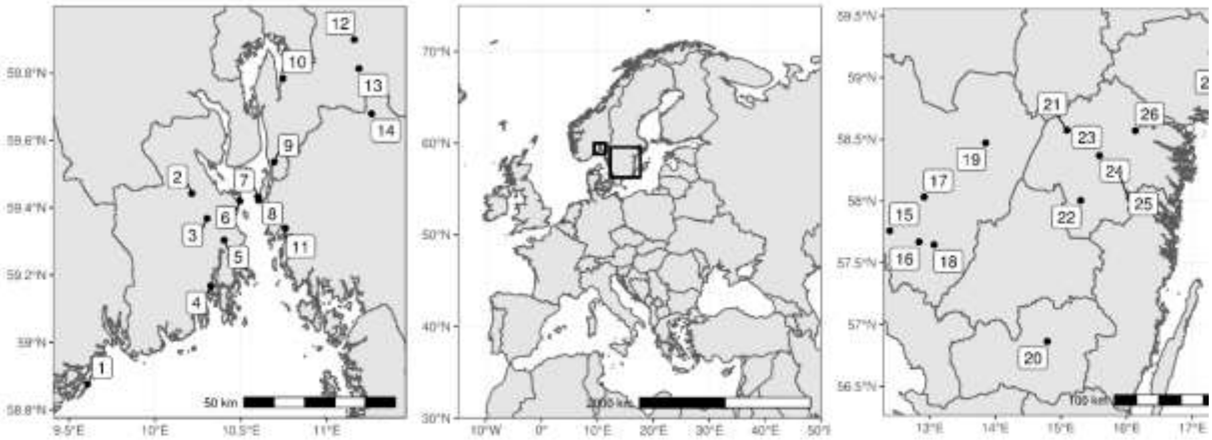
2. Site descriptions

2.1. Site 1-26.

Location and GPS coordinates (in UTM32):

	E	*N*
Norway		
Alby	*591171*	*6588177*
Berg	*579876*	*6573729*
Bjanes	*621043*	*6642122*
Grønliparken	*590906*	*6589076*
Håkås	*627277*	*6617791*
Jomfruland	*534984*	*6526137*
Karljohansvern	*584792*	*6588069*
Kolås	*595842*	*6600839*

Kåpe	*574079*	*6581932*
Omberg	*622644*	*6632475*
Sand	*575732*	*6559328*
Svartskog	*597953*	*6628505*
Tasken	*599838*	*6579360*
Sweden		
Aplared	*384891*	*6391009*
Aspenäs	*518042*	*6429075*
Bokhultet	*487302*	*6302274*
Bosnäs	*371114*	*6393896*
Hovetorp	*543382*	*6462228*
Klockaretorpet	*565833*	*6492832*
Kvarntorp	*552812*	*6451629*
Motala	*505240*	*6492579*
Remmene	*377089*	*6434225*
Slaka	*534107*	*6469878*
Stöpen	*433276*	*6481680*
Tullgarn	*647448*	*6538678*
Tvärsjönäs	*694056*	*6372466*



Altitude: The study sites are situated in the lowland (5-138 m a.s.l.).

Aspect: The sites have no significant aspect

Slope: The sites are relatively flat, but a few are situated in clay ravines and therefore have some steep topography.

Mean annual temperature: 5-8 ˚C

Annual precipitation: 400-1000 mm
The sites belong to the boreonemoral climatic region, which is a transition zone between the boreal region landscape and the temperate (nemoral) region. Differences in rain fall are not so

pronounced between Sweden and Norway since the Oslo region has a locally more continental climate than W Norway.

Bedrock: gneiss, granite
Soil type: The study sites are situated mainly on mesic moraine soils (Podzol)

Site area: In each stand, we delimited two plots (each 1 ha), usually 100 · 100 m. The two plots at a site were generally placed close to each other.

Forest type: The forest stands consisted mainly of mixed temperate deciduous trees such as ash (*Fraxinus excelsior*), elm (*Ulmus glabra*), and pedunculate oak (*Quercus robur*), boreal deciduous trees such as birches (*Betula pendula/pub*escens), and the coniferous trees Norway spruce (*Picea abies*) and Scots pine (*Pinus sylvestris*).

Age of the stand at the beginning of the experiment: The sites consisted of relatively young (40-80 years) trees, had closed canopies, and showed few signs of use for production of timber or fuel wood, or grazing, for several decades. Remnants of old fences, clearance cairns and other signs, as well as the position of the sites in the landscape close to farms, indicated that these areas had generally been used for grazing, hay-making, or to a lesser extent fields during earlier periods.

Stand structure before the interventions:
canopy: Closed.
shrub layer: Usually quite dense
understory layer: Sparse to relatively rich.

Canopy openness: Almost closed canopy before partial cutting and remaining in control plots.

Table 1. Land use categories in the stands and within the nearby landscape (200 m buffer) as judged from aerial photos.

		Land use type (%)		
Scale	Year	Tree cover	Open	Other
Stand	1960	72.1 ± 32.7	27.9 ± 28.5	0.0 ± 0.1
Stand	2017	99.2 ± 12.0	0.7 ± 1.9	0.1 ± 0.3
Landscape	1960	46.9 ± 26.2	44.4 ± 26.9	8.7 ± 9.7
Landscape	2017	63.2 ± 18.1	27.5 ± 19.5	9.3 ± 8.1

Management type before the experiment: Former pasture et c but no management since many years, see above.

Available data for the stand structure of the stand: The basal area in the investigated stands consisted of 258 on average 38±23% SD temperate deciduous trees, 26±28% SD coniferous trees (mainly Norway spruce), and 36±25% SD of other (boreal) deciduous trees (Nordén et al. 2019). The trees with the largest diameter were Scots pine (*Pinus sylvestris*), oaks (*Quercus robur/petraea),* and birches (*Betula pendula/pubescens*).

3. Applied treatment

3.1. Treatment 1. Thinning
On average 41.5 ± 27.5 m or ca 22% of the total volume solid of timber (mainly spruce and birch) was removed from the 1 ha thinned plots (Table 2). In addition, the average removal of wood for chips was 50.0 ± 72.6 m solid on the Swedish sites. Chips
were not produced at any of the Norwegian sites, and at some of the Swedish sites no or almost no timber was harvested. The chips were, however, mainly produced from harvest residues (branches and tops). In the majority of cases, the trees were felled manually with chain saw, but a harvester was used in seven cases (Table 2. Transportation from the forest to the landing was mainly carried out by forwarders in Sweden, while tractors were mainly used in Norway.

3.2. Description of the study design
2 treatments; conservation oriented partial cutting and “handsoff” free development control plots. Each site has one partial cutting and one control plot.

3.3. Graphical representation of the experiment
-

4. Investigated organism groups

4.1. Vascular plants (incl. woody regeneration)

4.2. Wood decaying fungi

4.3. Coleoptera

4.4. Lepidoptera

4.5. Syrphidae (Diptera)

4.6. (parts of) Homoptera
Collcted by Malaise tents.

5. Investigated environmental variables

5.1. Light influx/Leaf area index

Light availability was estimated using hemispherical photographs 2016. One photograph was taken at 120 cm above ground level in each treatment plot using a Nikon Coolpix 8800 VR digital camera, with a LC-ER2 fisheye lens. The camera was kept horizontal using a spirit level and oriented against the magnetic north using a compass. Images were thresholded using SideLook version 1.1.01 (Nobis and Hunziker, 2005) and then analysed with software Gap Light Analyzer to calculate the leaf area index (LAI) (Frazer et al., 1999).

6. Other investigated functions/processes

6.1. Recruitment of oak

6.2. Incidence of oak mildew and ash dieback

6.3. Effects on species communities of landscape fragmentation, local and landscape habitat continuity

7. References

Nordén B, Rørstad PK, Götmark F, Magnér J, Löf M. (2019): The economy of selective cutting in recent mixed stands during restoration of temperate deciduous forest. Scandinavian Journal of Forest Research 34: 709-717. https://doi.org/10.1080/02827581.2019.1679876. Published online: 24 Oct 2019.

8. Participating experts in the project

Anders Endrestøhl
Siri Lie Olsen
NINA Oslo

EX24_SI_MG

1. General information

Name of the experiment: **ManFor C.BD. (Managing Forests for multiple purposes: Carbon, BioDiversity and socio-economic well-being)**

Contact(s) in the COST Action: Maarten de Groot
Organization of the Contact(s): Slovenian Forestry Institute
Website of the experiment: -

The question of the experiment: What is the influence of different levels of cutting on the different biotic and abiotic variables?

Locality: Slovenia
Number of Sites: 3
Number of Blocks: 3
Treatments and number of Levels: control, 50% cutting, 100% cutting
Number of Plots: 27

Dates:
Beginning of the experiment: 2012
Date of Before-treatment data collection: for plants 2012
Date of intervention: 2012
Dates of after-treatment data collection: 2013 (insects, longhorn beetles and birds), 2014 and 2018 (plants), 2015 (mycorrhiza)

2. Site descriptions

2.1. Site 1.
Location: Kočevski rog
GPS coordinates: 45.668°N, 15.033°E
Altitude: 831–902 m a.s.l.
Aspect: 0–360°
Slope: 0–55%
Mean annual temperature: 8 °C
Annual precipitation: approximately 1700 mm
Bedrock: limestone and dolomite
Soil type: Rendzic Leptosol, Chromic Cambisol and Haplic Luvisol
Site area: approximately 70 ha
Forest type: uneven-aged Dinaric fir-beech forests, Illyrian *Fagus sylvatica* habitat type (91K0)
Age of the stand at the beginning of the experiment:
Stand structure before the interventions:
canopy: yes
shrub layer: yes

understory layer: yes
Canopy openness: 4%
Management type before the experiment: Close-to-nature silviculture; First forest management plan devised by Hufnagel (1892) introduced close-to-nature management and suspended clear-cutting; some virgin forest remnants were protected in this region (Kutnar et al 2015)
Available data for the stand structure of the stand:

2.2. Site 2.
Location: Snežnik
GPS coordinates: 45.672°N, 14.460°E
Altitude: 753–815 m a.s.l.
Aspect: 0–360°
Slope: 0–60%
Mean annual temperature: 8 °C
Annual precipitation: approximately 1700 mm
Bedrock: limestone and dolomite
Soil type: Rendzic Leptosol, Chromic Cambisol and Haplic Luvisol
Site area: approximately 70 ha
Forest type: uneven-aged Dinaric fir-beech forests, Illyrian *Fagus sylvatica* habitat type (91K0)
Age of the stand at the beginning of the experiment:
Stand structure before the interventions:
canopy: yes
shrub layer: yes
understory layer: yes
Canopy openness: 6%
Management type before the experiment: Close-to-nature silviculture. Systematic and organized forest management planning since the beginning of the 20th Century (Schollmayer 1906) (Kutnar et al 2015)
Available data for the stand structure of the stand:

2.3. Site 3.
Location: Trnovski gozd
GPS coordinates: 45.989°N, 13.759°E
Altitude: 801–869 m a.s.l.
Aspect: 0–360°
Slope: 0–50%
Mean annual temperature: 9 °C
Annual precipitation: approximately 2000 mm
Bedrock: limestone and dolomite
Soil type: Rendzic Leptosol, Chromic Cambisol and Haplic Luvisol
Site area: approximately 70 ha
Forest type: uneven–aged Dinaric fir-beech forests, Illyrian *Fagus sylvatica* habitat type (91K0)
Age of the stand at the beginning of the experiment:
Stand structure before the interventions:
canopy: yes
shrub layer: yes

understory layer: yes
Canopy openness: 4%
Management type before the experiment: Close-to-nature silviculture; First forestry plans in the 18th century (Flamek 1771); individual edicts for regulating forests as early as the 15th century (Kutnar et al 2015)
Available data for the stand structure of the stand:

3. Applied treatments

3.1. Treatment 1. Cutting
1. Control:
(Text from Kutnar et al. 2015.) An area of karst depressions (sinkholes) was preselected at each test site. Among all preselected sinkholes, three control sinkholes for 50% cutting were randomly chosen at each test site, and circular plots of 0.4 ha were established at the bottom of sinkholes (9 plots in total). At the beginning of the experiment, the stands in the sinkholes were relatively dense. No cutting.

2. 50% cutting
(Text from Kutnar et al. 2015.) An area of karst depressions (sinkholes) was preselected at each test site. Among all preselected sinkholes, three sinkholes were randomly chosen at each test site, and circular plots of 0.4 ha were established at the bottom of sinkholes (9 plots in total). At the beginning of the experiment, the stands in the sinkholes were relatively dense. 50% of all trees with a DBH larger than 10 cm were cut in the plot

3. 100% cutting
(Text from Kutnar et al. 2015.) An area of karst depressions (sinkholes) was preselected at each test site. Among all preselected sinkholes, three sinkholes for 100% cutting were randomly chosen at each test site, and circular plots of 0.4 ha were established at the bottom of sinkholes (9 plots in total). At the beginning of the experiment, the stands in the sinkholes were relatively dense. 100% of all trees with a DBH larger than 10 cm were cut in the plot

3.2. Description of the study design
-

3.3. Graphical representation of the experiment
-

4. Investigated organism groups

4.1. Ectomycorrhiza
Ectomycorrhiza was analyzed on all fine roots retrieved from soil core samples (4.2 cm dimeter, 20 cm long soil probe). Once, during the maximum vegetation period, five soil cores were taken per plot at different locations. One soil core was set in the center of the plot and the other four traps were in a radius of 5–10 m from the center in each cardinal direction. Fine roots from each soil core separately were separated into non-mycorrhizal and ectomycorrhizal, among which

each ectomycorrhizal root was used for morphological and/or a DNA markers-based identification of fungal partner in symbiosis. The statistical unit for community analysis and comparison was the total population of ectomycorrhizal roots in one soil core sample.

4.2. Plants

(Text from Kutnar et al. 2015.) The plant species diversity was assessed before and two years after the implementation of the silvicultural measures. Overall, 27 circular vegetation plots of 400 m² were established in the central/bottom part of the selected sinkhole. In each vegetation plot, cover estimation of different vertical vegetation layers and plant species diversity were assessed according to the modified ICP-Forests protocol (Canullo et al. 2011). All vascular plant species were recorded separately in three vertical layers (herb, shrub, and tree layer). A separate record was compiled for each species in the different vertical layers. The visual estimation of plant species cover was conducted using a modified Barkman's method (Barkman et al. 1964). Nomenclature of species names followed Mala Flora Slovenije (Martinčič et al. 2007) and Flora Europaea (Tutin et al. 1980, 1993).

4.3. Hoverflies

(Text from de Groot et al. 2016.) Hoverflies (Insect: Diptera: Syrphidae) were sampled in 2013 with two methods: a transect method and window traps. A circular transect with a 12 m radius was formed around the center of the plot. Upon completing the circle, the transect continued and ended in the center of the plot. Hoverflies were sampled in a buffer of 2.5 m along the transect. The counts were conducted three times during the flight season: the beginning of June, beginning of July and beginning of August. In order to avoid problems with diurnal differences in hoverfly flight activity, the counts were done during the main flight period between 10:00 and 15:00 h, and the order of the counts was changed every period and area. For the window trap method, we adjusted the method for catching hoverflies. We used transparent hard plastic cross-vein window traps with a size of 20 cm in width and 40 cm in height. A plastic strip with a double-sided transparent tape was attached on two sides of the window trap. The traps were set in the center of every plot and sampled three times during the flight season (beginning of June, beginning of July and the beginning of August) for one week. The two methods were used because they sample different subsets of hoverfly species and therefore give a better overview of the species composition.

4.4 Carabid beetles

(Text from de Groot et al. 2016.) Carabid beetles (Insecta: Coleoptera: Carabidae) were sampled in 2013 with the pitfall method. Five traps were set per plot at different locations. One trap was set in the center of the plot and the other four traps were placed in a radius of 12 m from the center in each cardinal direction. The traps were set for one week in three periods: the beginning of June, beginning of July and beginning of August.

4.5. Longhorn beetles

Longhorn beetles (Coleoptera: Cerambycidae) were sampled in 2013. The sampling period was throughout the whole vegetation season from the end of April till the beginning of October. The sampling was done with one black crosveign trap per plot using the attractant Galloprotect 2D. The traps were placed in all sites but only on six plots per site where there were presumably conifer trees. Problem with the use of pheromones is that the plots are relatively small and also beetles outside the plot could be attracted.

4.6. Birds

(text from de Groot et al 2016) The passerine bird community (Aves: Passerinae) was investigated with point counts in 2013. The point counts were done in every plot. Birds were counted within 36 m of the center. The counts were repeated twice: once in April and once at the end of May/beginning of June in the morning. Each count lasted 10 min, in which all species of passerine birds occurring in the plot (both singing and not singing) were recorded.

5. Investigated environmental variables

5.1. Light

The hemispherical photo analysis system includes compact or DSLR digital camera with calibrated "fish-eye" lens, self leveling mount to ensure leveling of the photos, a tripod and analysis software. It is preferable that the analyzing software supports evaluation of digital photos in batch mode and color classification. As the data evaluation gives number of possibilities, following would be obligatory for both winter and summer measurements: total openness (%), gap fraction (%), ISF (%), LAI $_{2000g}$…

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5.2. Soil

We performed soil sampling an all 27 plots. In each plot we determine 5 subplots (N, E, S, W and center of the plot). In each subplot, at three points (1 m far from each subplot centre, according to azimuths of 0°, 120° and 240°) soil sampling was performed. Mineral soil was sampled by fixed depths (0–10 cm, 10–20 cm, 20–40 cm, 40–60 cm, 60–80 cm), or less, depending the depth of soil (until reaching parent material).

Soil litter in the subplots was collected on square area 25 × 25 cm (area = 625 cm^2) and sampled material from all three points were put together (composite samples).

After 3 years the sampling was repeated. Again, in three points of each subplot, but with different azimuth: 60°, 180°and 300°.

We analysed the following soil parameters: soil depth, soil organic Matter (SOM), soil organic carbon (SOC), total nitrogen (TN) concentrations and SOC stocks, C/N ratio, S, pH, bulk density, and texture. For the litter, following parameters were analysed: Ol horizon thickness, total carbon and nitrogen, C/N ratio.

5.3. Soil respiration

Soil respiration, the second largest flux of carbon between terrestrial ecosystems and the atmosphere is substantially sensitive to climate change. Monitoring CO_2 efflux and its upscaling from field measurements to the ecosystem level is a complex task, due to the high spatial and temporal variability of the fluxes. Human intervention, e.g. through forest harvest, may change both CO_2 efflux and its spatial heterogeneity. The objective of our study was to quantify spatial heterogeneity of soil CO_2 efflux within and among plots distributed within silver fir–beech–spruce forest stand before and after harvesting.

Possible comparisons

- Soil characteristics
- Light environment
- Growth / increment in connection with type of measure
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5.4. Temperature and humidity

At the centre of each plot, measurements of microclimate were carried out with Voltcraft DL-120 TH (Conrad Electronic SE, Hirschau, Germany) data-logger with integrated sensor SHT11 (Sensirion Inc.) for air temperature (T, in °C) and relative humidity (RH, in %). Sensors (with typical accuracy of ± 0.4 °C and ± 3%, respectively) were installed 0.5 m above ground surface and were surrounded by radiation shields to protect the instruments against direct solar radiation. Data loggers were programmed to record T and RH every 30 minutes. Measurements were deployed over three subsequent growing seasons: immediately after cutting (2012) and two succeeding years (2013 and 2014).

5.5. Forest structure, dead wood and microhabitats

On plots with diameter of 35.7 m measured attributes were: site characteristics (relief, rockiness, development phase and structure of stand, canopy closure, regeneration, naturalness...), live and dead standing trees (with diameter over 10 cm at breast height; species, social class, height) and snags (diameter more than 10 cm on half of total height). On all measured trees also tree damages, stem quality and 20 types of microhabitats (size, type, and reason) were estimated.

On smaller subplots (diameter of 12 m) also other dead biomass as coarse woody debris, stumps and logging acumulations were measured, with estimation of decay (presence of bark and hardness of wood).

On 5 smallest plots (2 m radius) inside circular plots small trees (diameter less than 10 cm at breast height, but higher than 1.3 m, estimation of their origin and damage), logging acumulations and fine woody debris (diameter more than 2 cm and length more than 10 cm) were counted and measured.

6. Other investigated functions/processes

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Tom Levanič, Slovenian Forestry Institute, 1000 Ljubljana, Slovenia (tree growth)

EX25_SK_MU

1. General information

Name of the experiment: **Zvolen, Management experiment in oak–hornbeam forests**

Contact(s) in the COST Action: Mariana Ujházyová (ujhazyova@tuzvo.sk), Karol Ujházy (karol.ujházy@tuzvo.sk), František Máliš (frantisek.malis@tuzvo.sk)
Organization of the Contact(s): Technical University in Zvolen, Faculty of Forestry, T.G. Masaryka 24, 96001, Zvolen, Slovakia
Website of the experiment: -

The question of the experiment: How the various management interventions affect biodiversity of forest communities of temperate oak–hornbeam forests? Is it possible to restore former plant diversity of studied forest type by applying treatments which simulate historical forest management (reduction of canopy closure, litter raking) under high nitrogen deposition levels and ongoing climate change?

Locality: Slovakia, Javorie, Kremnické vrchy Mts.
Number of Sites: 5
Number of Blocks: 8
Treatments and number of Levels: 3
Treatment 1: thinning, reduction of canopy
Treatment 2: raking
Treatment 3: fertilization
Number of Plots: 5

Dates:
Beginning of the experiment: 2017
Date of Before-treatment data collection: yes (2017)
Date of intervention: 2017, 2018, 2019, 2020
Dates of after-treatment data collection: 4 years (2017, 2018, 2019, 2020)

2. Site descriptions

2.1. Site 1. Ekoma
Location: Javorie
GPS coordinates: 48°32'24,3"; 19°10'33,2"
Altitude: 534 m
Aspect: 232°
Slope: 18°
Mean annual temperature: 8 °C
Annual precipitation: 600 mm
Bedrock: andesite
Soil type: cambisol

Site area: 1600 m^2
Forest type: Sessile oak–hornbeam forest, dominant tree species – *Quercus petraea* agg., *Carpinus betulus*, admixed – *Sorbus torminalis, Acer platanoides, Acer campestre, Fagus sylvatica, Quercus cerris, Tilia* sp.
Age of the stand at the beginning of the experiment: 80 years
Stand structure before the interventions:
canopy: upper oak and a secondary hornbeam layer
shrub layer: *Crataegus sp., Corylus avellana*
understory layer: mesophilous and termophilous herb species, mosses on dead wood
Canopy openness: 30%
Management type before the experiment: conversion from coppice to high forests, selective thinning
Available data for the stand structure of the stand: tree species, DBH, basal area, height, age, dendrochronological analysis, canopy openness, age of trees (only 3 trees per plot), LAI

2.2. Site 2. Hrabiny
Location: Kremnické vrchy
GPS coordinates: 48°34'29,1"; 19°01'23,8"
Altitude: 534 m
Aspect: flat
Slope: 0°
Mean annual temperature: 8 °C
Annual precipitation: 600 mm
Bedrock: andesite
Soil type: cambisol
Site area: 1600 m^2
Forest type: Sessile oak–hornbeam forest, dominant tree species – *Quercus petraea* agg., *Carpinus betulus*, admixed – *Sorbus torminalis, Acer platanoides, Acer campestre, Fagus sylvatica, Quercus cerris*
Age of the stand at the beginning of the experiment: 80 years
Stand structure before the interventions:
canopy: upper oak and a secondary hornbeam layer
shrub layer: *Crataegus sp., Corylus avellana*
understory layer: mesophilous herb species
Canopy openness: 16%
Management type before the experiment: transformation from coppice to high forests
Available data for the stand structure of the stand: tree species, DBH, basal area, high, age, canopy openness, age of trees (only 3 trees per plot), LAI

2.3. Site 3. Kráľová
Location: Javorie
GPS coordinates: 48°32'13,86"; 19°09'14,36"
Altitude: 515 m
Aspect: 224°
Slope: 26°
Mean annual temperature: 8 °C
Annual precipitation: 600 mm

Bedrock: andesite
Soil type: cambisol
Site area: 1600 m^2
Forest type: Sessile oak–hornbeam forest, dominant tree species – *Quercus petraea* agg., *Carpinus betulus*, admixed – *Sorbus torminalis, Acer platanoides, Acer campestre, Fagus sylvatica, Quercus cerris, Pinus nigra*
Age of the stand at the beginning of the experiment: 80 years
Stand structure before the interventions:
canopy: upper oak and a secondary hornbeam layer
shrub layer: *Crataegus sp., Corylus avellana*
understory layer: mesophilous a termophilous species
Canopy openness: 36%
Management type before the experiment: transformation from coppice to high forests
Available data for the stand structure of the stand: tree species, DBH, basal area, high, age, canopy openness, age of trees (only 3 trees per plot), LAI

2.4. Site 4. Michalková
Location: Javorie
GPS coordinates: 48°32'17,31"; 19°07'50,6"
48°31'14,3"; 19°12'17,4"
Altitude: 510 m
Aspect: 230°
Slope: 17°
Mean annual temperature: 7 °C
Annual precipitation: 600 mm
Bedrock: andesite
Soil type: cambisol
Site area: 1600 m^2
Forest type: Sessile oak–hornbeam forest, dominant tree species – *Quercus petraea* agg., *Carpinus betulus*, admixed – *Sorbus torminalis, Acer platanoides, Acer campestre, Fagus sylvatica, Quercus cerris*
Age of the stand at the beginning of the experiment: 80 years
Stand structure before the interventions:
canopy: upper oak and a secondary hornbeam layer
shrub layer: *Crataegus* sp., *Ligustrum vulgare*
understory layer: mesophilous a termophilous species
Canopy openness: 24%
Management type before the experiment: transformation from coppice to high forests
Available data for the stand structure of the stand: tree species, DBH, basal area, high, age, canopy openness, age of trees (only 3 trees per plot) , LAI

2.5. Site 5. Sekier
Location: Javorie
GPS coordinates: 48°31'14,3"; 19°12'17,4"
Altitude: 619 m
Aspect: 240°
Slope: 17°

Mean annual temperature: 7 °C
Annual precipitation: 700 mm
Bedrock: andesite
Soil type: cambisol
Site area: 1600 m^2
Forest type: Sessile oak–hornbeam forest, dominant tree species – *Quercus petraea* agg., *Carpinus betulus*, admixed – *Sorbus torminalis, Acer platanoides, Fagus sylvatica*
Age of the stand at the beginning of the experiment: 80 years
Stand structure before the interventions:
canopy: upper oak and a secondary hornbeam layer
shrub layer: *Corylus avellana*
understory layer: mesophilous a termophilous species
Canopy openness: 29%
Management type before the experiment: transformation from coppice to high forests
Available data for the stand structure of the stand: tree species, DBH, basal area, high, age, canopy openness, age of trees (only 3 trees per plot), LAI

3. Applied treatments

3.1. Treatment 1. Low thinning, decrease of canopy closure

1. thinning was applied in half of plots (4 subplots; see Fig. 1) in the first year of the experiment (after the first sampling); approximately 30% of mature trees were removed especially from lower canopy layer, preferentially tree species of high shade-casting ability (hornbeam, beech, maple, hazel)
2. rest of plot remain unmanaged

3.2. Treatment 2. Llitter raking

1. half of plots (4 subplots) are raked in autumn (November) after oak leaves fell
2. half of plots remained unraked

3.3. Treatment 3. Fertilization

1. half of plots (4 subplots) are fertilized twice a year: in early spring (April) and autumn (November)
2. half of plots are not fertilized

3.4. Description of the study design

When excluding the extreme relief forms (slope over 30°, stony places, ridges and valleys), suitable localities were found on the andesite bedrock in Kremnické vrchy and Javorie Mts within the *Fageto-Quercetum* group of forest types (Hančinský 1972). Following Braun-Blanquet approach they can be classified as *Festuco heterophyllae-Quercetum* Neuhäusl et Neuhäuslová-Novotná 1964 association of *Carpinion betuli* Issler 1931 alliance. An indispensable condition was the presence of *Quercus petraea* individuals over 80 year-old, homogeneous site and vegetation in a continuous area of 50 x 100 m. Among multiple preselected localities, five were selected randomly: Ekoma, Hrabiny, Kráľová, Michalková and Sekier.

Summarizing, one rectangular plot of 40 x 80 m were set in each locality, and subdivided to eight subplots of 400 m^2 (Fig. 1). Within each subplot central square of 100 m^2 were established with 4 squares of 2.25 m^2 split to 9 squares of 0.25 m^2. Systematic sampling has been made for each locality each year (2017, 2018, 2019).
The management treatments started in October 2017 after the inventory of the overstorey layer, vegetation and soil sampling was finished.

3.5. Graphical representation of the experiment

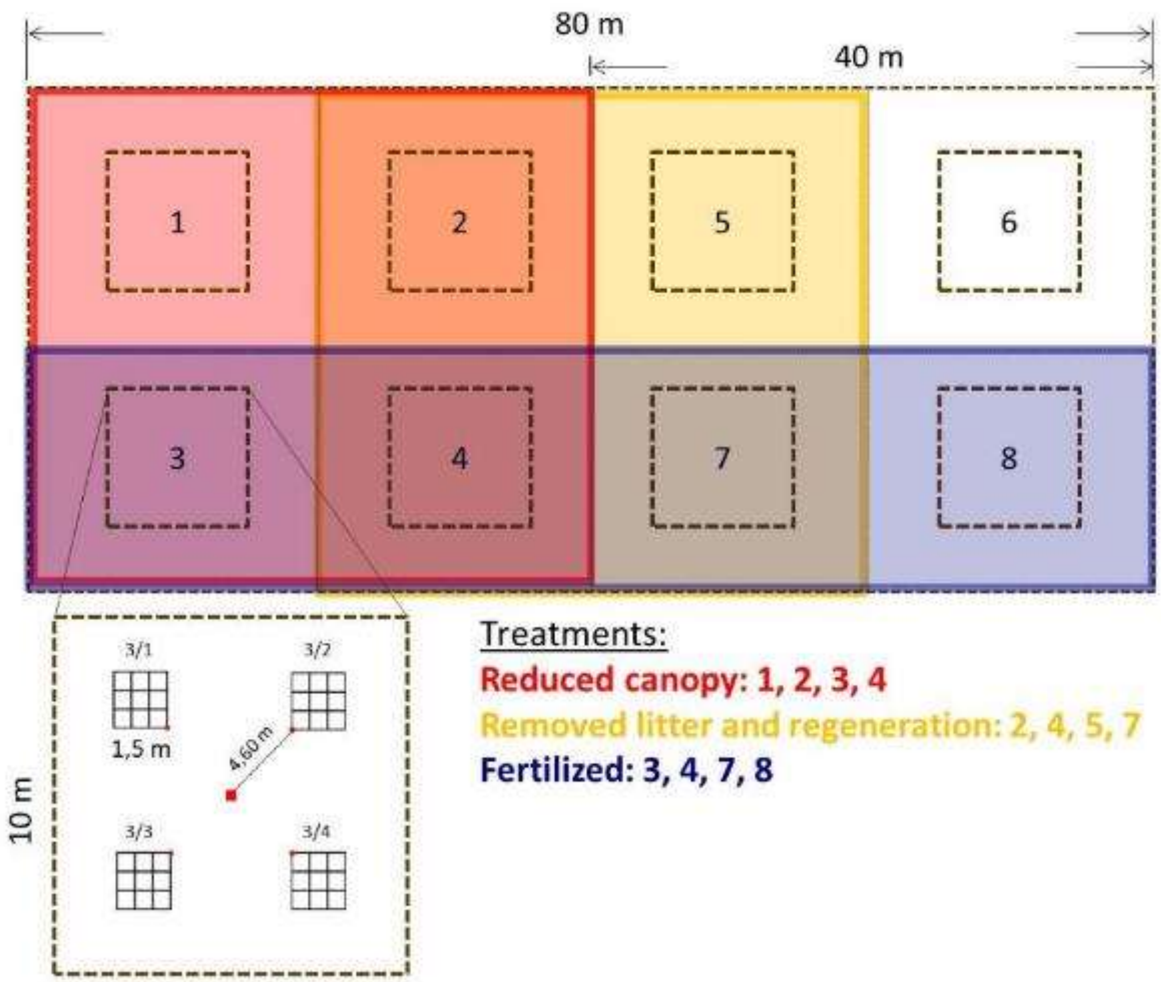

Figure 1. Sampling design of experimental locality.

4. Investigated organism groups

4.1. Understorey vegetation

3 levels

1. level

Visual estimation of cover of all herb and woody species on 20 m x 20 m subplot, surveyed in every year in early summer (in June)

2. level

Visual estimation of cover of all herb and woody species on 10 m x 10 m subplot, surveyed in every year in early summer (in June)
3. level
Finer sampling four squares 1.5 m × 1.5 m in each plot (10 m x 10 m), surveyed in early summer (in June), with recording of frequency and cover of vascular plants
4.2. Regeneration of woody species
1. level
Visual estimation using cover/abundance scale on 20 m x 20 m subplot, surveyed in every year in summer (in June)
2. level
Visual estimation using cover/abundance scale on 10 m x 10 m subplot, surveyed in every year in summer (in June)
3. level
Finer sampling of four squares 1.5 m × 1.5 m in each plot (10 m x 10 m), surveyed in summer (in June), with recording frequency a cover woody species

4.3. Microbial soil characteristics
Soil samples for determination microbial soil diversity and activity were taken from each small plot (1.5 m x 1.5 m), surveyed each year in autumn (September); 32 samples per locality.

4.4. Bryophytes
Only in 2020.

5. Investigated environmental variables

5.1. Light
Percentage of above-canopy light: recorded by hemispherical photos each year from 2017, and analysed using Gap Light Analyser 2.0 (FRAZER *et al*. 1999). The survey was made in summer.

5.2. Air temperature
Recorded by TMS4 sensors (https://tomst.com/web/cz/systemy/tms/tms-4/) during the year in 10 cm above ground, in the centre of each subplot (8 sensors in one locality).

5.3. Soil temperature
Recorded by TMS4 sensors (https://tomst.com/web/cz/systemy/tms/tms-4/) in the soil surface and 10 cm below ground.

5.4. Soil water content
Recorded by TMS4 sensors (https://tomst.com/web/cz/systemy/tms/tms-4/) 10 cm below ground.

5.5. Soil physical and chemical parameters
Four soil samples were collected in each 10 m x 10 m subplot from 0–20 cm depth in every year in autumn. Laboratory analysed variables: pH H_20, total carbon and nitrogen content, C/N ratio, litter dry mass, Mg, Ca, K, P, Cu, Fe, Mn and Zn content.

5.6. Litter physical and chemical parameters
Four litter samples were collected in each 10 m x 10 m plot from a 14 x 14 cm area in every year in autumn. Measured and laboratory analysed variables: litter dry mass, C/N, pH H_20, N, C, Mg, Ca, K, P, Cu, Fe, Mn and Zn content. Amount of dry matter of litter was measured also from 1 x 1 m area in every year in autumn from the raked plots to assess amount of removed litter.
5.7. Overstorey layer characteristics
DBH of all living trees with a minimum of 7 cm (inclusive) were recorded. Tree heights of all trees were measured using a Vertex Laser VL 400. Positions of all trees in the 400 m2 plots were measured using Field-Map technology (http:\fieldmap.cz). Three canopy oaks were selected for coring by Pressler borer. From three cored trees their age was calculated by counting the tree rings and dendrochronological profile was created on the Lintab instrument. Age of all cut trees and shrubs was determined by counting of the tree rings on the crosscuttings from the trunk.

6. Other investigated functions/processes

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Calvo A. F. 2020: Analysis of the relationships between the structure of the overstorey layer and the diversity of the understorey layer in the temperate oak–hornbeam forests in central slovakia. Master thesis. Universidad politécnica de madrid. Escuela técnica superior de ingeniería de montes, forestaly del medio natural, 67 pp.

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EX26_DE_WW

1. General information

Name of the experiment: **Biodiversity-Exploratories – BELongDead**

Contact(s) in the COST Action: Prof. Wolfgang Weisser, TU Munich, wolfgang.weisser@tum.de
Organization of the Contact(s): NA
Website of the experiment: https://www.biodiversity-exploratories.de/en/projects/current-projects/forest-deadwood/belongdead

The question of the experiment: How are biodiversity and ecosystem processes in dead wood affected by the tree species and the structure of the surrounding forest?

Locality: Germany
Number of Sites: 3
Number of Blocks: 30
Treatments and number of Levels: 13 tree species: Beech, oak, maple (sycamore maple, mountain maple and field maple in mixture), lime tree, cottonwood tree, hornbeam, ash, birch and cherry (one log per VIP=very intensively studies plot), as well as pine, larch, Douglas fir, and spruce.
Number of Plots: 90 (3 subplots of 13 tree species with one log each in each of 30 VIP plots)

Dates:
Beginning of the experiment: 2010
Date of Before-treatment data collection: YES
Date of intervention: 2010
Dates of after-treatment data collection: 2010–today

2. Site descriptions

2.1. Site 1: Schorfheide-Chorin
Location: Germany, North, Brandenburg
GPS coordinates: 13°23'27"–14°08'53" E, 52°47'25"–53°13'26" N
Altitude: 3–140 m a.s.l.
Aspect: NA
Slope: NA
Mean annual temperature: 8.0–8.5 °C
Annual precipitation: 500–600 mm
Bedrock: Young glacial landscape
Soil type: Dystric Cambisols with less frequent Albeluvisols, Podzols, and Regosols
Site area: ~1300 km^2
Forest type: beech/beech mixed/pine/oak
Age of the stand at the beginning of the experiment: various

Stand structure before the interventions:
canopy:
shrub layer:
understory layer:
Canopy openness: various
Management type before the experiment: various
Available data for the stand structure of the stand: various

2.2. Site 2: Hainich-Dün
Location: Germany, Thuringia
GPS coordinates: 10°12′28″–10°32′03″E, 51°02′45″–51°22′12″N
Altitude: 285–550 m a.s.l.
Aspect:
Slope:
Mean annual temperature: 6.5–8 °C
Annual precipitation: 500–800 mm
Bedrock: Calcareous bedrock, Loess over Triassic limestone
Soil type: Luvisols and Stagnosols
Site area: ~1300 km^2
Forest type: beech/beech mixed/spruce
Age of the stand at the beginning of the experiment: various
Stand structure before the interventions:
canopy:
shrub layer:
understory layer:
Canopy openness: various
Management type before the experiment: various
Available data for the stand structure of the stand: various

2.2. Site 3: Schwäbische Alb
Location: Germany, South-western Germany, Baden-Württemberg
GPS coordinates: 09°12’13’’–09°34’49’’E, 48°21’00’’–48°32’04’’N
Altitude: 460–860 m a.s.l.
Aspect:
Slope:
Mean annual temperature: 6–7 °C
Annual precipitation: 700–1000 mm
Bedrock: Calcareous bedrock with karst phenomena, i.e. Jurassic shell limestone resulting in soils extremely rich in clay
Soil type: Eutric Cambisols and Leptosols
Site area: ~422 km^2
Forest type: beech/beech mixed/spruce
Age of the stand at the beginning of the experiment: various
Stand structure before the interventions:
canopy:
shrub layer:
understory layer:

Canopy openness: various
Management type before the experiment: various
Available data for the stand structure of the stand: various

3. Applied treatments

3.1. Treatment 1. Deadwood enrichment

3.2. Description of the study design
In addition to tree species, we have the entire gradient of regions (3) and forest management (beech natural forest, beech age-class, conifer age-class). 13 logs in a subplot x 3 subplots per VIP plot x 3 VIP plot per management treatment x 3-4 management treatments x 3 regions (N=30 VIP plots).

3.3. Graphical representation of the experiment
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4. Investigated organism groups

Mainly:
4.1. Mainly saproxylic beetles
4.2. Saproxylic fungi

Further taxa:
4.3. Other insects
4.4. Mites
4.5. Bacteria
4.6. Other fungi

5. Investigated environmental variables

All abiotic variables measured in the forest plots (see Biodiversity Exploratories).

6. Other investigated functions/processes

6.1. Wood decay
6.2. DOC
6.3. Enzymes

7. References

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8. Participating experts in the project

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