



Project: Fire as a tool in restoring forest successional properties and biodiversity in managed and protected boreal forests (Finland)

Background

Boreal forests are typically affected by occasional disturbances that maintain successional cycles and mosaic patterns in the landscape. Fires of differing intensity used to be a key disturbance process in the Fennoscandian boreal forests until late 1800s. Since then efficient fire suppression has practically eliminated fires from these regions. Consequently, current forests contain only seldom those structural characteristics and properties that were created and maintained by natural fires. The natural disturbance factors (fire, windstorm) have been replaced by disturbances created by intensive timber harvesting that produce very different ecological consequences to the ecosystems.

The fire suppression has also affected the characteristics of the protected areas in Fennoscandia since no fires have traditionally been allowed in these areas either. As a result of this, many protected areas have experienced considerable changes in the tree species compositions and volumes.

The lack of fires is reflected also in the large number of threatened species that depend on fire or on those successional forest types that follow natural fires. Re-establishment of fires through prescribed burnings is potentially a very effective way to restore the lost ecosystems properties and to alleviate the negative consequences that recent forestry has had on biota.

Objectives

The natural-like early successional phases can be created in several ways in the managed and protected forests. Based on the previous studies the two most important factors to be considered are the amount of trees left in the regeneration areas and the use of fire to promote natural characteristics. The ecological effectiveness of these factors are, however, largely unknown.

The project aims at revealing how fire and forest structure affect ecosystem properties in eastern Fennoscandian boreal forests. The emphasis is on diversity of the forest-dwelling species and especially of the threatened species. The main objective of the experiment is to reveal what are the ecological consequences of fire on biota when tree biomass before fire varies. The results are applicable both in restoring natural forests in protected areas and in developing new forest management guidelines in production forests.

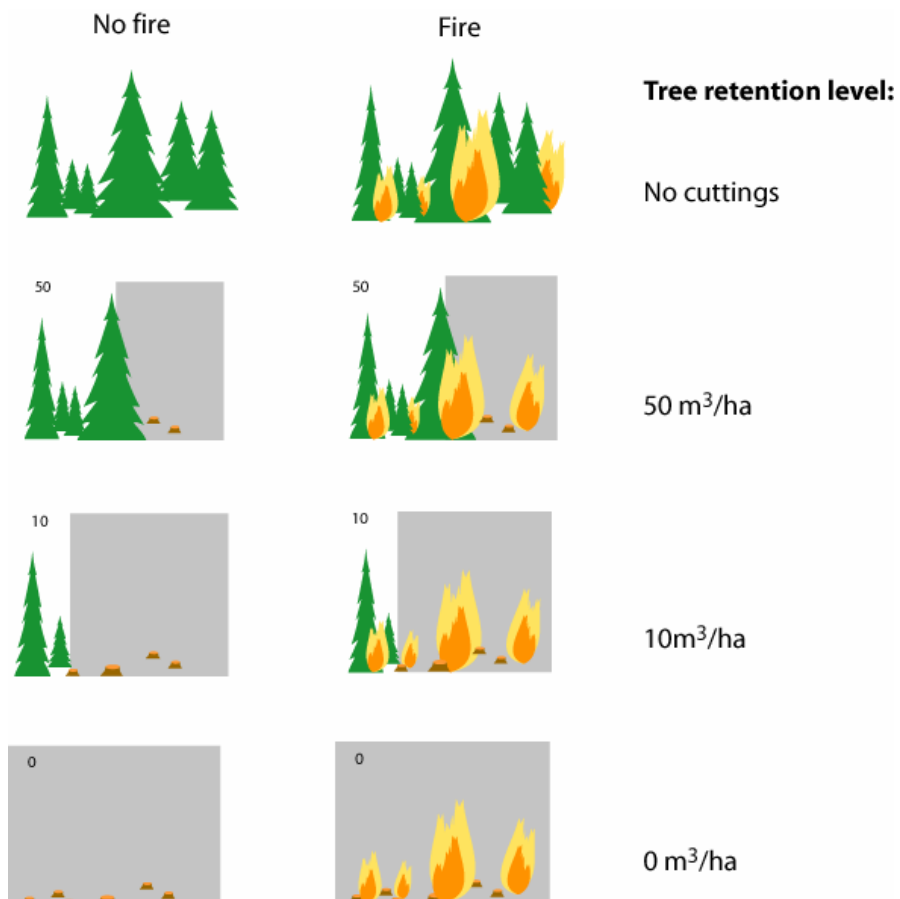
Location

The study is conducted in eastern Finland. 24 forest areas (each covering 3-5 hectares) are included. Six of the areas are located within Patvinsuo national park and 18 in the surrounding managed forests.



Experimental design

The project is designed with a large-scale factorial experiment where the manipulated factors are fire (yes, no) and four levels of tree volume retained in the experimental forest plots. The experimental design is as follows:



From each treatment combination (fire x tree retention) there are three replicates, and each of these cover 3-5 hectares. The forest type in the study is pine-dominated, sub-xeric type with upper canopy dominated by mature Scots pines, and lower canopy contains also some Norwegian spruces and admixture of deciduous species, mainly birch.

The design applies BACI (before-after-control-impact) extension where the experimental forests are thoroughly inventoried both before and after the treatment application.

Schedule

The project was initiated in 1999, with the following milestones:

- 1999 experimental design; selection and establishment of the experimental forests
- 2000 ecological inventories before treatment application
- 2000/01 winter, cuttings to create different tree retention levels
- 2001 (27-28 June) burning half of the areas (12), according to the design
- 2001 July onwards, ecological inventories after the treatments

Ecological response variables: measuring the impacts

The effects of the treatments are measured with several ecological response variables. The variables measured in each experimental site before (2000) and after (2001 onwards) the treatments include, for example:

1. living trees (species composition, volumes)
2. dead trees (species composition, volumes, decay characteristics)
3. beetles (species composition)
4. coverage of vascular plants, mosses and ground lichens
5. polypore fungi (species composition)
6. other fungi
7. soil seed bank (only before the treatments)
8. chemical and structural characteristics of the soil
9. soil enchytraeids
10. assessment of past fire history with dendrochronology
11. fire intensity (burnt humus)

Funding and cooperating organisations

The project is led and coordinated by the **University of Joensuu** (Faculty of Forest Sciences, Centre of Excellence for Forest Ecology and Management).

Funding for the experiment is provided by :

- Academy of Finland (Centre of Excellence Programme)
- University of Joensuu
- Finnish Forest Research Institute (Joensuu Research Centre))
- Finnish Forest and Park Service (Metsähallitus)

- Finnish Forest Industries Federation
- Finnish Game and Fisheries Research Institute
- Ministry of Environment
- Ministry of Agriculture and Forestry
- Maj and Tor Nessling Foundation

The following organisations are involved in the the execution of the treatments or in the research activities:

- University of Joensuu (Faculty of Forest Sciences)
- University of Joensuu (Mekrijärvi Research Station)
- University of Joensuu (Department of Biology)
- Finnish Forest Research Institute (Joensuu Research Centre)
- Kuopio Natural History Museum
- Finnish Forest and Park Service
- Finnish Game and Fisheries Research Institute (Joensuu)

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Publications

On the background of the project

Kouki, J., Löfman, S., Martikainen, P., Rouvinen, S. & Uotila, A. 2001. Forest fragmentation in Fennoscandia: linking habitat requirements of wood-associated threatened species to landscape and habitat changes. *Scandinavian Journal of Forest Research Suppl. 3*: 27-37.

Löfman, S. & Kouki, J. 2001. 50 years of landscape transformation in managed forests in southern Finland. *Scandinavian Journal of Forest Research* 16: 44-53.

Martikainen, P. 2001. Conservation of threatened saproxylic beetles: significance of retained aspen *Populus tremula* on clearcut areas. *Ecological Bulletins* 49:205-218.

Martikainen, P. & J. Kouki 2003: Sampling the rarest: threatened beetles in boreal forest biodiversity inventories. – *Biodiversity and Conservation*, in press.

Rouvinen, S. & Kouki, J. 2002. Spatiotemporal availability of dead wood in protected old-growth forests: a case study from boreal forests in eastern Finland. *Scandinavian Journal of Forest Research* 17: 317–329.

Similä, M., Kouki, J. & Martikainen, P. 2002. Saproxylic beetles in managed and seminatural forests: quality of dead wood matters. *Forest Ecology and Management* 174:365–381.

Similä, M., Kouki J., Martikainen, P. & Uotila, A. 2002. Conservation of beetles in boreal pine forests: the effects of forest age and naturalness on species assemblages. *Biological Conservation* 106:19-27.

Uotila, A., J. Kouki, H. Kontkanen & P. Pulkkinen 2002: Assessing the naturalness of boreal forests in eastern Fennoscandia. – *Forest Ecology and Management* 161:257-277.

Completed MSc theses from the project (written in Finnish)

- Jukka Behm 2000: Soil seed banks in boreal pine-dominated forests
- Mervi Hakulinen 2001: Immediate effects of fire on vascular plants
- Terhi Kaipainen 2001: Fire history in the North Karelia
- Jarkko Laamanen 2001: Soil properties and the intensity of fire
- Rauli Perkiö 2003: The effect of past fires on current occurrence of aspens in old-growth protected areas
- Katja Sidoroff 2001: The effects of fire on immediate tree mortality
- Jaana Turunen 2002: Pine regeneration in burned forests
- Veera Tähtö 2001: The effects of fire on tree growth
- Arto Vilén 2002: The effects of large mammalian herbivores on deciduous tree regeneration in old-growth areas in eastern Finland
- Tiia Yrjölä 2002: The effects of fire on soil enchytraeids

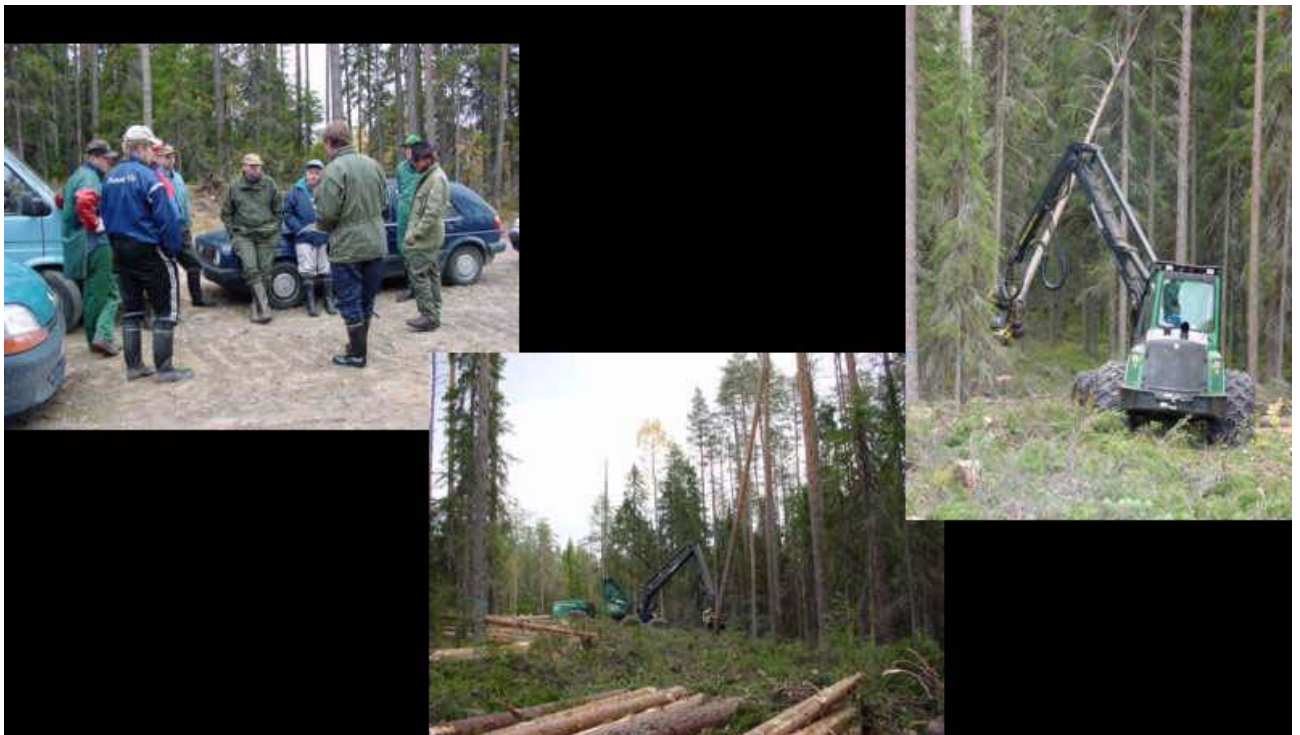
Visual impressions



Boreal landscape in eastern Finland

**All the burnings (12 areas) were completed in two days 27-28 June, 2001.
The burnings were done by the Finnish Forest and Park Service.**





Timber cuttings on 18 areas were performed during the winter 2000/01. Pictures above are taken at the end of October just before snow season. The area is typically covered by 1 metre of snow during the winter season.



A window trap used for beetle inventories (summer 2001, about one month after fire). Each experimental forest contains 20 window traps that are emptied once a month between May-September.



Field inventories in progress, summer 2002.