International Forest Fire News (IFFN) No. 30 (January – June 2004, 22-28)

Forest Fire Research in Finland

Effective wildfire suppression and diminished use of prescribed burning in forestry has clearly eliminated the role of fire in Finnish forest ecosystems as compared to pristine stands. The reintroduction of fire back to nature has therefore been suggested in various instructions, forest certification and forest conservation programmes. At the same time it is recognized that possible climate change might cause increased fire risk also in Finland in the future. Various interests to fire have led to remarkably increased fire research activities in recent years. Several national research organisations, Universities, Polytechnic schools and Ministry of Interior are working together with landowners, forest companies and other end-users despite of sometimes contradictory aims. At the same time, possibilities to fire prevention and minimizing fire risks and reintroduction of fire because of biodiversity aspects are being studied. The overall aim is to help in creating national fire use strategy and aim to controlled use of fire. This is a task that should be recognized also at European level. This overlook describes briefly part of the ongoing fire research in Finland that is connected to European level fire research.

Introduction

Considering the role of fire in Finnish ecosystems, different era's in the past can be distinguished, and over the last hundred years there has been a drastic decline of area burned in Finnish forests. In pristine forests number of fires was probably lower than today, but their size was on an average higher. Humans have affected the forests in southern Finland for at least 4000 years, and today practically all forests in Finland have been affected by human utilization. Increased population and forest utilization increased also fire frequency. Human impact and especially several centuries lasting slash-and-burn cultivation further increased fire frequency as compared to pristine forests. Between 1865-1870, up to 55,000 to 70,000 hectares (ha) burned annually with the average forest fire size being 131 ha (Saari 1923). By the beginning of the 20th century slash-and-burn cultivation was finally denied. The annually burned area remained, however, up to 40,000 ha/yr until the end of the 1960s, when clear change especially in state owned forests can be seen (Figure 1).

This change was caused e.g. by the use of prescribed burning which started to be used in the beginning of 20th century to enhance forest regeneration. Prescribed burning now replaced the era of slash-and-burn cultivation in keeping the fire in nature. The golden era of prescribed burning, when annually 30,000 ha could be burned, lasted until 1960s, when mechanical site preparation replaced it (Figure 2).

After the Second World War, the structure of Finnish forests was shaped by intensive forest management, aiming to efficient timber production. Forest management, using compartments of 1-100 ha as basic operational units, aimed at fully utilizing the sites' wood production potential by converting naturally heterogeneous stands to homogeneous even-aged single-species stands using clear-cut harvesting and silvicultural treatments such as thinning and planting. At landscape level the management goal was a fully regulated even-aged forest, where each stand age class covers an equal area. This led to a mosaic of even-aged forest stands with extensive road network for forest utilization. E.g. in southern Finland's managed forests there is currently only on average 2 m^3/ha of coarse woody debris (CWD), while in natural forests there is 60-90 m^3/ha. This means that the average volume of CWD has decreased by 90-98%. A steep decline in annual area burned happened in 1960s and 1970s when both wildfire and prescribed burning areas dropped significantly. Even-aged stands with low levels of fuel, fragmented forests together and more developed fire suppression tools, changes in legislation and people's attitudes etc. led to a situation where the role of fire and other natural disturbance processes were nearly totally eliminated from Finnish forests. Currently around 500 hectares is burned annually in wildfires and 2 000 hectares in prescribed fires with the average size of one fire being less than one hectare (Finnish Forest Research Institute 2004).

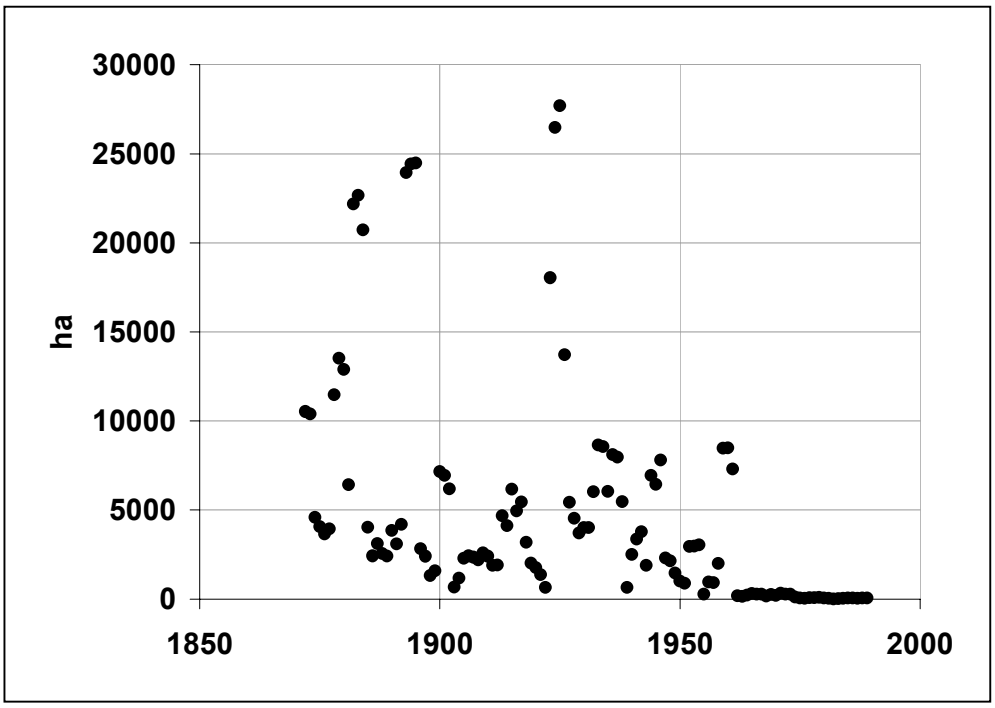

Figure 1. Annually burned area in state owned forests. Source: Forest and Park Service, Suvanto
2004

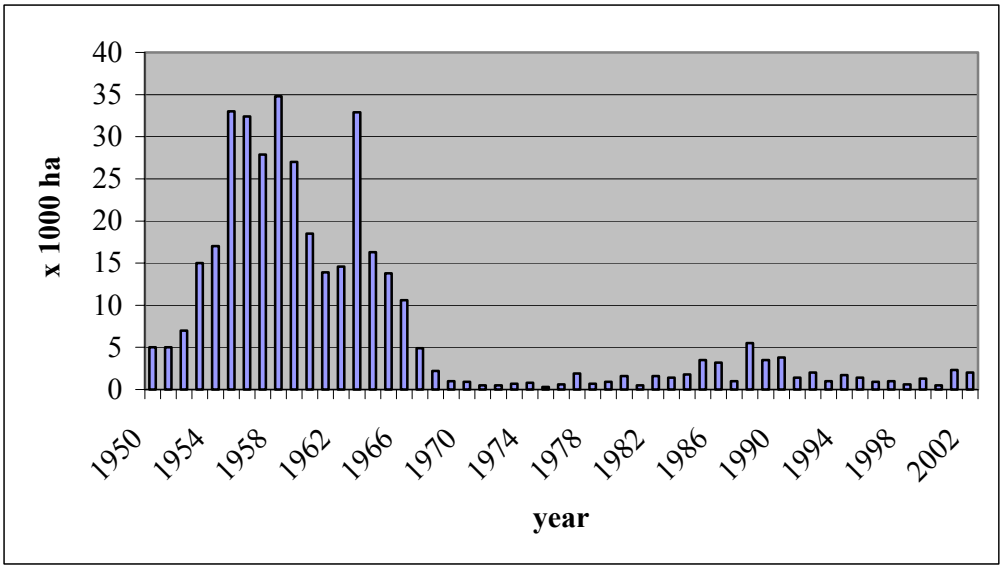

Figure 2. The annual area of prescribed burnings in Finland between 1950-2002 (Finnish Forest Research Institute. 2004, Lindberg and Vanha-Majamaa 2004).

Various ways to reintroduce fire back to nature?

The use of fire in restoration aims to imitate a forest fire disturbance with a natural regeneration and succession after that. Restoration burnings are usually understood as burnings most often in conservation areas. In the last five years restoration burnings have begun to establish a status of “normal” method, and although there are no national statistics available, the areas have increased recently to about 100 hectares annually, while the total area of all restoration burnings performed is estimated to be still only a couple of

hundreds of hectares. In the future there is a national goal to burn about 1 300 hectares in next ten years (Working group...2003), the amount still being rather low.

Occasionally a question has also been raised if in certain conditions existing forest fires could be let to burn under control. This could be done especially in conservation areas so natural disturbances could shape the landscape and forest structure as in natural fire regimes. Practical safety issues and interpretation of legislation have prevented the possible use of this kind policy and the attitudes of rescue authorities are still very suspicious so it is very unlikely that a *let burn policy* will be introduced in Finland in the near future.

It has also been suggested that especially larger forest fire areas should be purchased to conservation areas so that larger-scale post disturbance areas with natural succession could be created. In state-owned forests this has been possible to do in a few occasions, but otherwise this kind of acts have been rare. Also new more voluntary-based methods of maintaining biodiversity are introduced, such as land owner being able voluntarily suggest fire areas to be purchased for conservation either permanently or for a fixed time, but these acts have also been very rare. Finally, increase in prescribed burning area has been suggested and even promoted in many programmes, but no increase can yet be seen (Finnish Forest Research Institute 2004).

Consequently, entire ecosystems have been modified and the changes have not always been favourable to all forest species. Some species are directly threatened by the elimination of fire, but even species that are relatively common have been affected by altered site conditions and stand structures. In the future, however, possible climate changes may cause increased fire risk. There has been a clear need to develop fire research in order to be able to answer several different aspects concerning fire and aim to controlled fire use.

Current research activities

During the last two years 65 forest stands and sample plots have been burned for research purposes in Southern and Northern Finland. Half of the burning experiments are connected to a restoration experiment, in which effects of logging and prescribed burning as tools to maintain and restore biodiversity are being studied. Another part of the experiment is connected to a study where fire behavior in different vegetation types and forest structures is being studied. In this part the goal is finally to develop fuel type and fire risk classification of Finnish forests. The national team includes Finnish Forest Research Institute (FFRI), Ministry of Interior, Helsinki and Jyväskylä University, Finnish Meteorological Institute, VTT, Geological Survey of Finland, Environmental Agency, Häme and Seinäjoki Polytechnic schools, and as land-owners besides FFRI, Forest and Park Service, UPM-Kymmene and City of Hämeenlinna.

When studying fire behavior in different vegetation types, we have burned 30x30 meter plots in different vegetation types and forest structure from clear-felled areas to mature forest with three replicates each (Figure 3). Studied forests include stands dominated by Scots pine (*Pinus sylvestris*), Norway spruce (*Picea abies*) and birch (*Betula pubescens, B. pendula*).

Figure 3. Ignition of the experimental fire in a *Pinus sylvestris* stand.

During the fire event, fire spread, flame length and weather conditions have been measured (Figure 4). After fire, various fire effects, such as tree mortality, changes in the soil and vegetation etc. have been studied. With these experimental burnings research tasks are generally various and research aims finally to create fuel type classification of Finnish forests, description of fire behavior in different vegetation types, develop Finnish fire risk index & forest fire risk assessment. In connection to this, e.g. FMC measurements and flammability tests with different materials have been carried out. The collected information will be finally also used in developing prescribed burning and restoration methods and techniques.

Figure 4. Recording of fire behaviour parameters during the fire experiment

In order to study the usability of fire as a restoration tool, we located a logging and prescribed burning experiment in Norway spruce-dominated mature managed forest stands, described as mesic-site type in stand characteristics (Figures 5 and 6). However, each stand included a paludified patch. These depressions are common in mesic forests though they are not normally distinguished in stand characteristics. In small-sized wet depressions (paludified patches) e.g. species composition, the basal area of aspen (*Populus tremula*, rich in epixylic species and therefore important species for biodiversity) and the amount of CWD are often highest. Since these wet depressions are likely not to burn as easily as dry areas, we hypothesized that small-scale site type variation in combination with fire play an important role in restoring structures, dynamics and species in these mesic sites.

Stands (1-3 ha) have been treated with shelterwood cuttings (50 m^3 ha^{-1} of standing retention trees) and three levels of down retention trees (5, 30, and 50 m^3 ha^{-1}) to create woody debris, as well as with prescribed burning or no burning. In addition, control stands, where all trees were left standing were included. Each of the combination of treatments was replicated 3 times, for a total of 24 stands. Within each stand, sample quadrates (20×40 m) were randomly selected, avoiding edge effects, on wet and dry biotopes, for a total of 48 sample quadrates.

With the restoration experiment the main task is to study ecological impacts of fire and compare the results to effects of logging. We are concentrating on studies on stand structure and tree mortality, regeneration of the tree stand and the effects of different microhabitats on regeneration, succession of ground and field layer vegetation, changes in humus and soil, effects of logging and fire on epixylic lichens and bryophytes growing on coarse woody debris, colonization of epixylic species after disturbance, effects of fire on invertebrates, CWD dynamics and polypores, functional groups of microbes and effects of fire on them etc.

Some of the study areas, such as those for restoration studies, are guaranteed for research for the next 20-30 years with the land-owners. Follow-up studies will therefore be able to be done for a long period.

Figure 5. Logging and prescribed burning experiment in Norway a spruce-dominated mature managed forest stand

Figure 6. Restoration burn in a spruce-dominated mature managed forest stand

Table 1. Treatments in the restoration experiment (DR = Down retention, SR = Standing retention)

	Burn	Replicates	Unburn	Replicates
Treatment 1. & 2.	$5m^3$/ha DR $60m^3$/haSR	3	$5m^3$/ha DR $60m^3$/haSR	3
Treatment 3. & 4.	$30m^3$/ha DR $60m^3$/haSR	3	$30m^3$/ha DR $60m^3$/haSR	3
Treatment 5. & 6.	$60m^3$/ha DR $60m^3$/haSR	3	$60m^3$/ha DR $60m^3$/haSR	3
Control	No cuttings	3	No cuttings	3
				Total 24 forest stands

National fire research is currently also part of larger European fire research, as we are participating to two European funded fire projects. SPREAD (Forest Fire Spread Prevention and Mitigation) is concentrating on studying various aspects of fire. EUFIRELAB (Euro-Mediterranean Wildland Fire Laboratory), is a wall-less Laboratory for Wildland Fire Sciences and Technologies in the Euro-Mediterranean Region and serving as a coordinating project among European fire researchers and end-users.

General goal is to find tools, especially in the Mediterranean, for minimizing fire risk, but especially in the Boreal, to study reintroducing fire back to forest ecosystems, final aim being controlled fire use strategy.

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