

Symposium on Fire Management in Cultural and Natural Landscapes, Nature Conservation and Forestry in Temperate-Boreal Eurasia -- Freiburg, Germany, 25-27 January 2008



PRESCRIBED FIRE EXPERIMENTS IN KRASNOYARSK REGION, RUSSIA



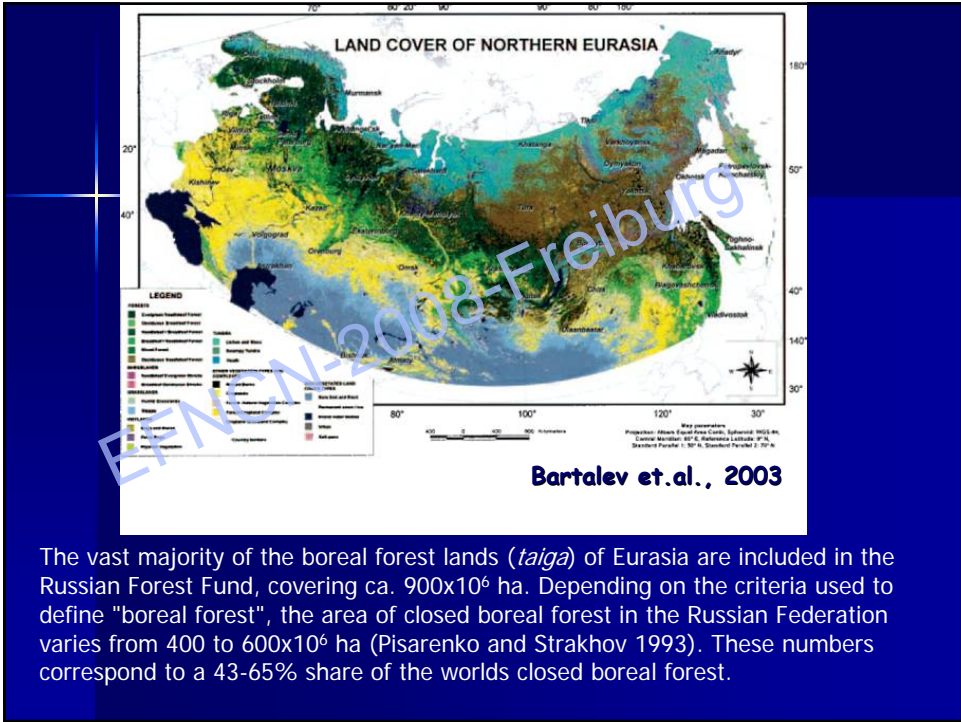
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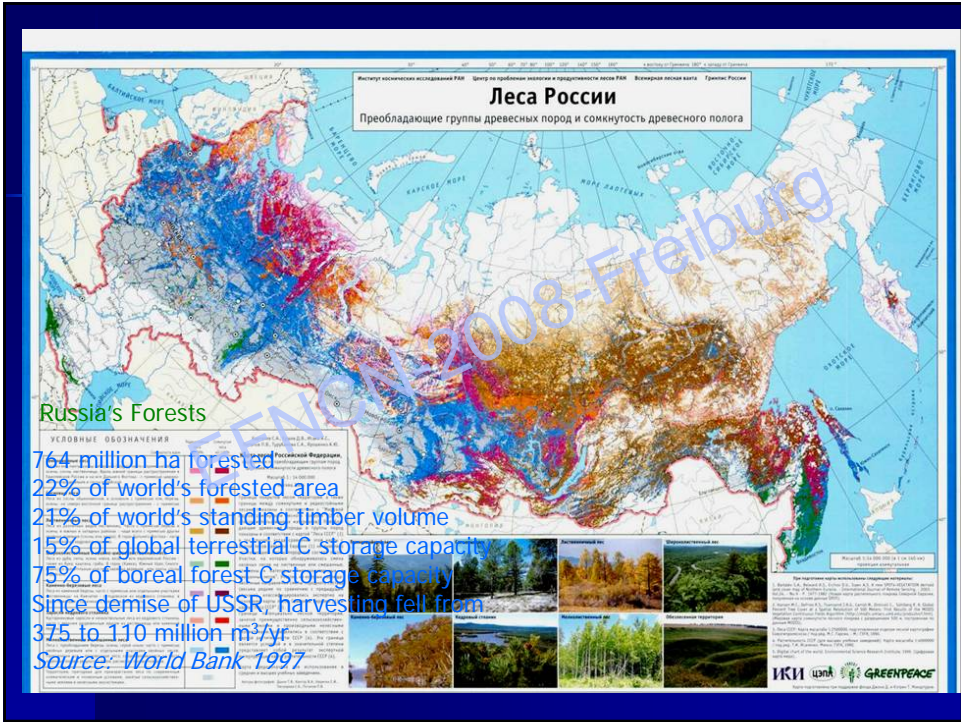
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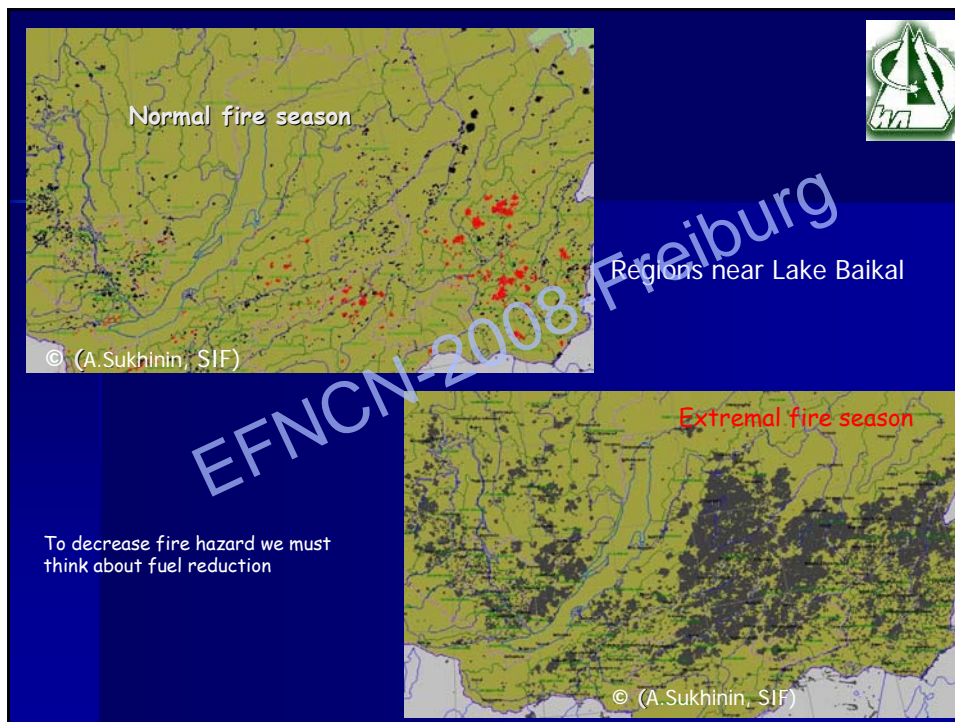



The worlds total boreal forests and other wooded land within the boreal zone cover 1.2×10^9 ha of which 920×10^6 ha are closed forest. The latter number corresponds to ca. 29% of the worlds total forest area and to 73% of its coniferous forest area (ECE/FAO 1985).




The vast majority of the boreal forest lands (*taiga*) of Eurasia are included in the Russian Forest Fund, covering ca. 900×10^6 ha. Depending on the criteria used to define "boreal forest", the area of closed boreal forest in the Russian Federation varies from 400 to 600×10^6 ha (Pisarenko and Strakhov 1993). These numbers correspond to a 43-65% share of the world's closed boreal forest.







In Russia it was the common practices of spring burning, firing for berries and honey production, burning to flush pasture and assist hunting (Pyne, 1997). The history of forestry shows a wide use of fire as understory "refreshing" measure for fuel reduction and stimulation of mushroom growth, as well as for fuel reduction burns on logged areas by broadcast burning (Tkachenko 1931). Until the middle of the 20th century the use of fire in Russian forest management was almost fully forbidden, with the exception of slash burning on piles during the winter period.



However, positive influence of surface fires on a forest had been noted in the beginning of last century and it was offered to use fire as helpful instrument for planting (Tkachenko 1911).

Some authors offered prescribed fires

- for broadcast burning of slash fuels after logging (Pobedinsky 1955)
- understory burning in mature pine stands 5-10 years before logging (Belov 1973)
- surface fire using as thinning instrument of pine saplings (Furyaev 1974)
- broadcast prescribed understory burning of pine and larch stands of 40-50 years for wildfire hazard reduction (Melekhov 1983)

But in a reality these studies were only as recommendations and the use of understory burning and prescribed burnings on logged sites were prohibited. Only after 1995 the use of early spring burns in grass fuels near roads had been permitted to mitigate fires starting near roads during fire season (Valendik 1996).



The new era of fire use in forestry of Russia encouraged foresters and scientists to look for more effective and cheap methods of cleaning logged areas and facilitating reforestation. Following the large basic scientific experiment and a regional fire analysis in the frame of the Fire Research Campaign Asia-North (FIRESCAN) in Krasnoyarsk Region in 1993 (FIRESCAN Science Team 1996; Goldammer and Furyaev 1996) the development of prescribed burning techniques was supported by international projects, such as Sustainable Forestry, FIREBEAR, ROLL USAID (Valendik et al. 2000).

Fire Research Campaign Asia-North (FIRESCAN)



Fire Research Campaign Asia-North (FIRESCAN)
Bor Forest Island Experiment © GFMC

The experimental site is in the central part of the Krasnoyarsk Region of Siberia, about 28 km west of the Yenisey River (60° 45'N, 89° 25'E) at an elevation of approximately 150 m above sea level. The study site is a nearly level, slightly elevated, sandy island, about 50 ha in size, which is surrounded by bogs dominated by mixed-grass, sphagnum and tall sedge. The site was referred to as Bor Forest Island, after the town of Bor, 90 km to the North, which served as the transportation base for research activities.



Fire Research Campaign Asia-North (FIRESCAN)
Bor Forest Island Experiment © GFMC



Fire Research Campaign Asia-North (FIRESCAN)
Bor Forest Island Experiment © GFMC



Fire Research Campaign Asia-North (FIRESCAN) Bor Forest Island Experiment

Preburn Fuel Sampling
Fire Weather
Fuel Moisture
Fire Behavior

Emissions from boreal Forest fires
Radiatively active trace gases (CO_2 , CO , H_2 , CH_4)
Aerosol
Halogenated compounds (CH_2Br , CH_2Cl)

FIRESCAN: 1993

Since the primary purpose of the Bor Forest Island Fire Experiment was the creation of a high-intensity, stand replacement fire, ignition along the windward side of the Island, with subsequent headfire development was considered essential. With light winds ($\sim 7 \text{ km h}^{-1}$) from the SE, ignition began along the east side of Bor Forest Island at 1420 h, using hand-held torches. By the time this ignition line was complete (1436 h), however, winds had shifted 90° to the SW. This sudden wind change turned the original ignition line into a backing fire, and it was necessary to begin a second ignition line along the west side of the Island in order to obtain a headfire effect. This line (approximately 500 m) was ignited between 1515 and 1520 h, and the two ignition lines began slowly moving together.

FIRESCAN: 1993 - Pre-fire © GPMC

FIRESCAN: 1993 - Postfire © GPMC

FIRESCAN: 1994 © GPMC

FIRESCAN: 1994 © GPMC




FIRESCAN: 1999 © GPMC

FIRESCAN: 2003 © GPMC

FIRESCAN - TEAM

Long-term research on Bor Forest Island
Project duration: 200 years (1993-2192)

Central Siberia Sustainable Forestry Project

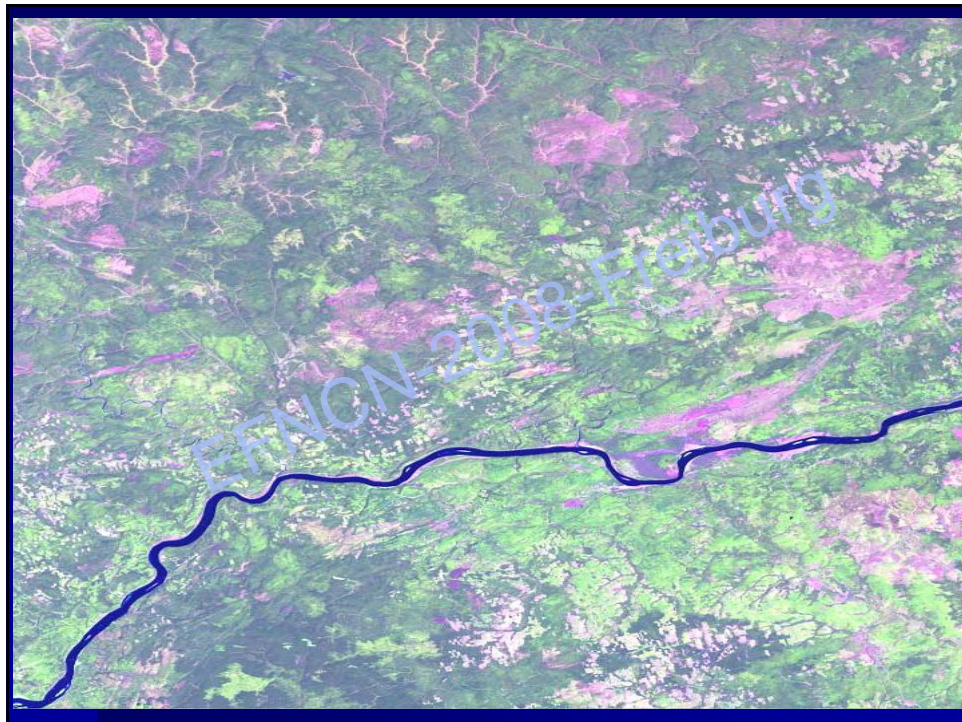
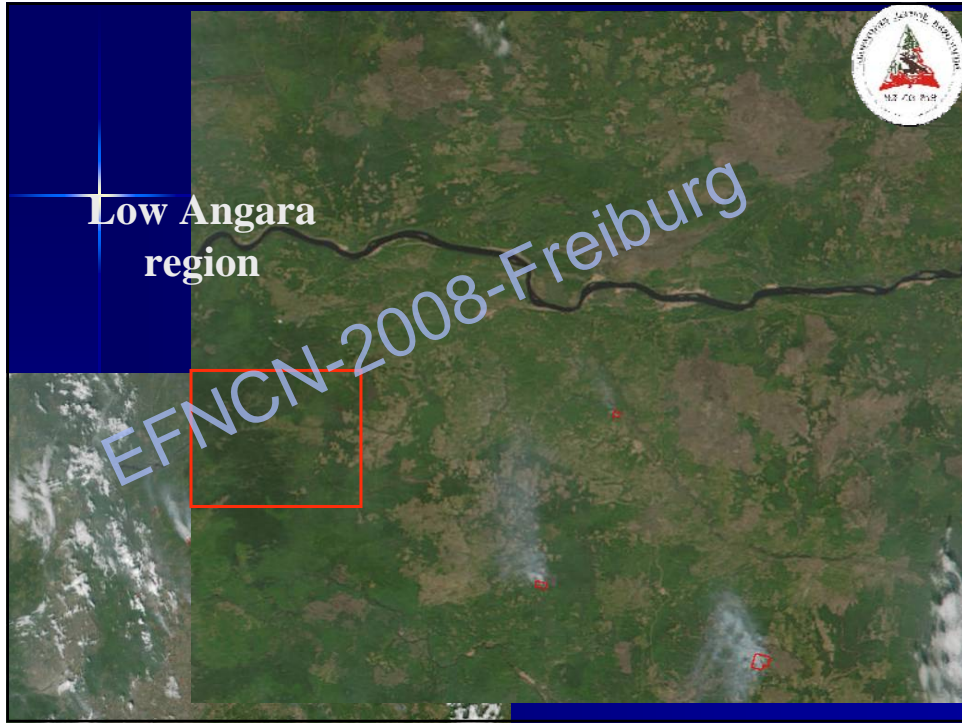


1993-2004

Wildfires reach huge area, going through clearcuts and spreading on surrounding forests




1999 wildfire moved through logged areas and forests in Mana region. Its burned area was more than 30 000 hectares




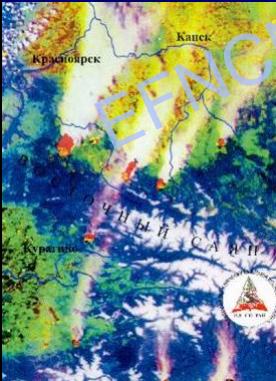


Central Siberian Sustainable Forestry Project




Problem of forest fires is very high in regions where forests actively are in use for logging. There is high probability to start high intensity wildfires during all fire season.

- Localization and suppressing of forest fires on logged sites impossible without use of expensive heavy mechanized equipment. Fires starting from logged sites move to surrounding forests and plantations.
- Mechanical removal of slash fuel used in Russian forestry is expensive and in usual practice logged areas are not cleaned. In this situation it is needed to find not expensive way for slash fuels removal after logging.
- Fire management on logged areas envisages the solving of two issues, first, their fire hazard decreasing and second, creating optimal conditions for first stage of forest succession.
- We studied the use of prescribed fires:
 - 1) on logged sites of dark coniferous forests on flat terrains.
 - 2)on mountainous terrains
 - 3) on logged sites of light coniferous forests
 - 4) In understory burning
 - 5) In forests damaged by Siberian moth








Category	Level
Fire season	100
Logged sites fire hazard	75
Dark coniferous forest fire hazard	25




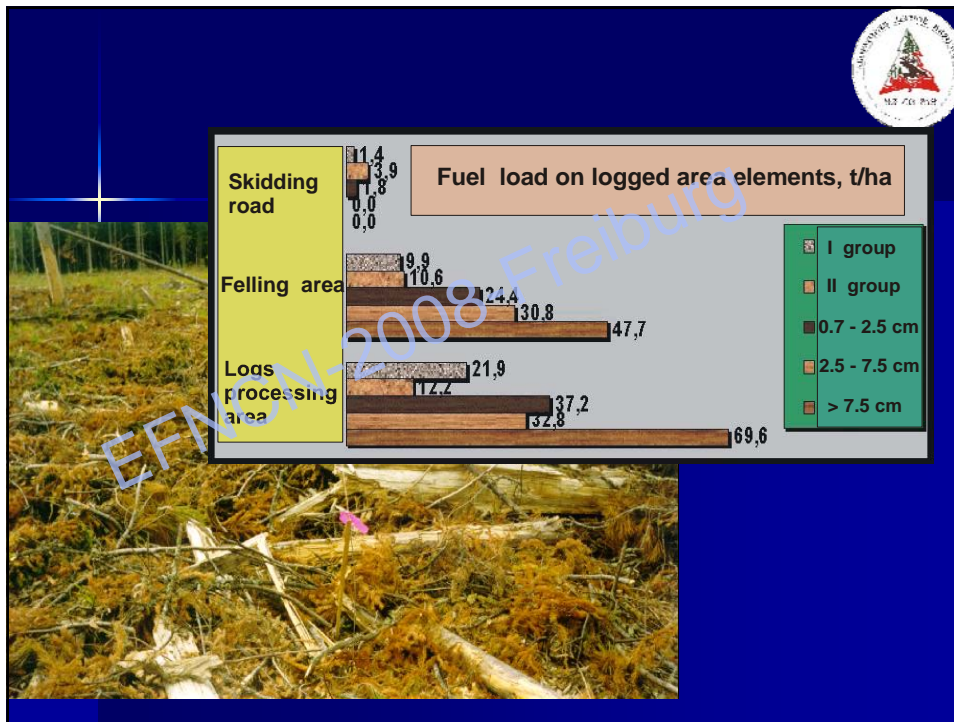
Fuel measurement procedure



- Studies have been conducted on fresh winter logged sites of dark and light coniferous forests of southern taiga in central parts of Krasnoyarsk Region. Logged sites had areas from 20 to 50 hectares.
- Logged sites before the prescribed burn have been prepared for fire safety. They were surrounded by 3-4 m firelines. In some cases they were divided into 2-3 ha small areas.
- On each logged site we determined slash fuel loading by diameter classes. Also litter, duff layer, live vegetation, downed wood material loading have been measured using special procedure.
- Slash fuels load were determined along triangle with 30 m sides using procedure offered by Van Wagner (1973).
- Litter, duff layer and live vegetation were measured along transect after 10 m apart 1 m from in both sides on subplot 0.2 x 0.25 - for litter and duff layer, 0.5 x 0.5 m - for live vegetation.













Fuel loadings

- On clearcuts fire carriers loading can reach 20 t/ha.
- Slash fuels and downed woody material - 100t/ha.
- Overall fuel load varies from 70 to 140 t/ha.
- Slash fuel loadings and their structure on 5-10 yrs clearcuts showed that fuel load doesn't decrease after green grass cover and fire hazard stays on high level.
- Our first prescribed burns were made on fresh logged sites without grasses like *Calamagrostis* spp. making sod layer.

Preliminary regeneration of coniferous species often die after harvesting


Prescribed burn methods

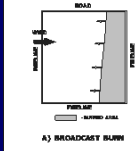




Three methods have been used for prescribed burning on logged sites:

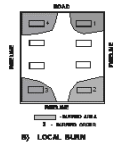
- 1) broadcast burning – on clearcuts with uniformly distributed slash fuels;
- 2) two stages burning – on clearcuts where large downed woody fuels have been piled
- 3) local burning – on logged sites with alive regeneration.

- ❖ Selection of prescribed burn methods depend on forest type before logging and weather.
- ❖ Prescribed burn characteristics also depend on forest fuels moisture content, loading, their structure and arrangement, relief etc.
- ❖ Flame height and other characteristics of burning define possibility to control burning and define needed man power and heavy equipment.
- ❖ So it is needed to forecast prescribed burn characteristics before the burn for that we used software BEHAVE which allowed to forecast fire behavior and make prescriptions for burning.

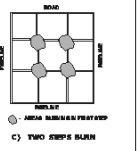





A) BROADCAST BURN





B) LOCAL BURN



C) TWO STAGES BURN




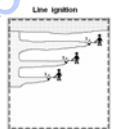
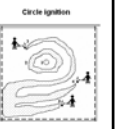
Ignition procedures

For ignition we used procedures:

- ✓ Point ignition
- ✓ Line ignition
- ✓ Circle ignition
- ✓ Combined ignition


- Fire spread rate, flame length and width have been measured after ignition and burning line formation
- In each experiment air humidity, mean wind velocity, etc. were measured before, in time and after prescribed burning.
- Using initial data and experimental results it has been defined prescriptions for prescribed burning for different periods of fire season.


Legend:

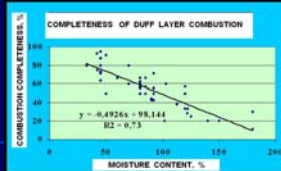

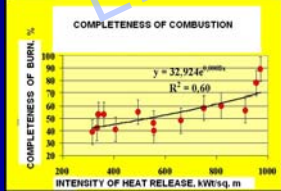
- Ignition point
- Ignition area
- Ignition line
- Ignition circle

Period of fire season	III tdp of May – I tdp of June	II tdp of June – I tdp of July	II-III tdp of July – I tdp of August	II-III tdp of August – I tdp of September
Fire danger class	II-III	III	III-IV	III-IV
Nesterov Index	600–1600	1700–2000	2100–3000	3100–4000
Wind velocity, m/s	< 2	< 3	< 4	< 5
Relative humidity, %	> 60	> 40	> 30	> 30
Dry bulb temperature, °C	15–18	19–22	20–24	18–20

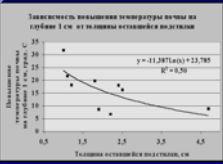



Results



- Slash fuels with diameters up to 7 cm were utilized by 70-90%, pieces larger than 7 cm - 40-50% in prescribed burning of fresh logged sites.
- Duff depth is decreased up to 1-2 cm.
- Ash content after prescribed burning was up to 2 t/ha which enriched soil.
- Upper soil temperatures in 1-5 cm layer were not higher than 45-50°C that don't destroy soils properties.
- On 2/3 of site it was suitable for seeds and seedlings growing.
- After prescribed burn live surface cover formed by fireweed create microclimate suitable for seeds and seedlings growth.
- Due to forest management enterprises (leskhoz) data soil treatment using prescribed burn 8-10 times cheaper than usual mechanical treatment for planting.

Summary








1998



2004

Experimental prescribed burns have been made on fresh clearcuts of 900 ha area in Krasnoyarsk Region.

- The use of the prescribed fire technologies on clearcuts allow to decrease slash fuels loading by 60% in particular forest fire carriers by 80% significantly decreasing fire hazard.
- The completeness of duff layer burn depend on its moisture content and combustion rate and is equal to 60%. And 2/3 of logged area is suitable for planting and seeding without preliminary mechanical soil treatment.
- Prescribed burns allow to eliminate *Calamagrostis spp.* and turn the process to fireweed formation promoting seeds and seedlings growth in first steps of succession.

Prescribed understory burning

Russian-U.S. team for prescribed fire experiments

1996-2005

1996 2004

Old logged sites burning

Prescribed burning of forests damaged by Siberian moth

Usolsky Leskhoz
(Forest Management Area)

Siberian moth outbreak in mid-1990s
Fully killed 51,100 ha dark
coniferous forests
Stand density reduced 1/3 - 1/2 on
55,200 ha

It is estimated that establishment of stands
similar in composition to the initial coniferous
forest may take 150-200 years.

In the Usolsky Leskhoz the number of fires 6-8 years after the most recent outbreak of Siberian moth doubled compared to before the outbreak but the total area burned increased many fold

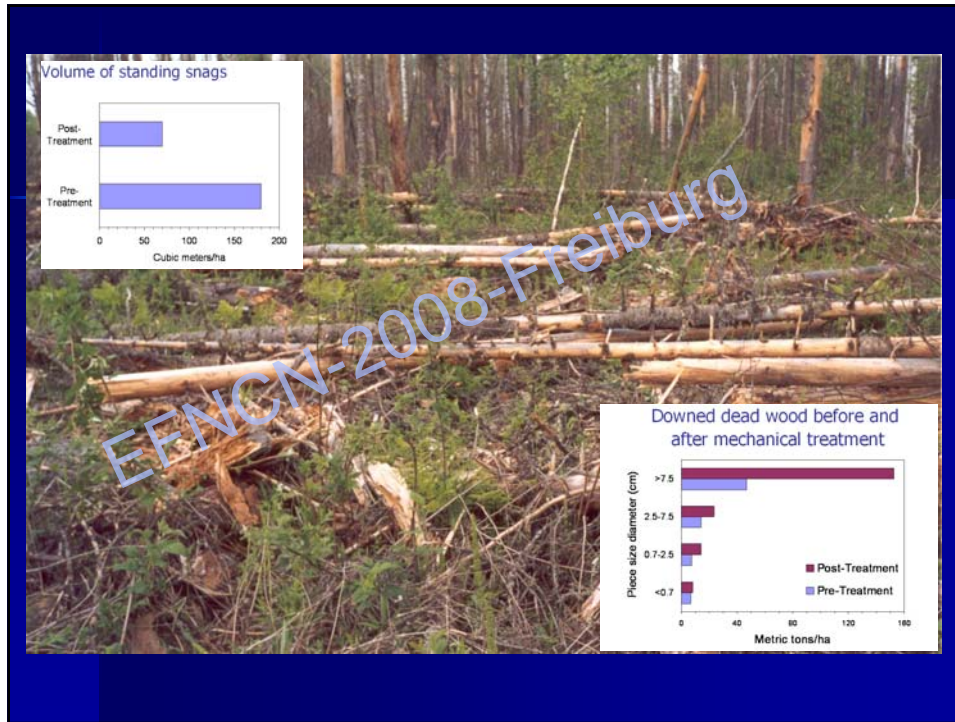
Annual area and amount of fires in Usolsky forest enterprise

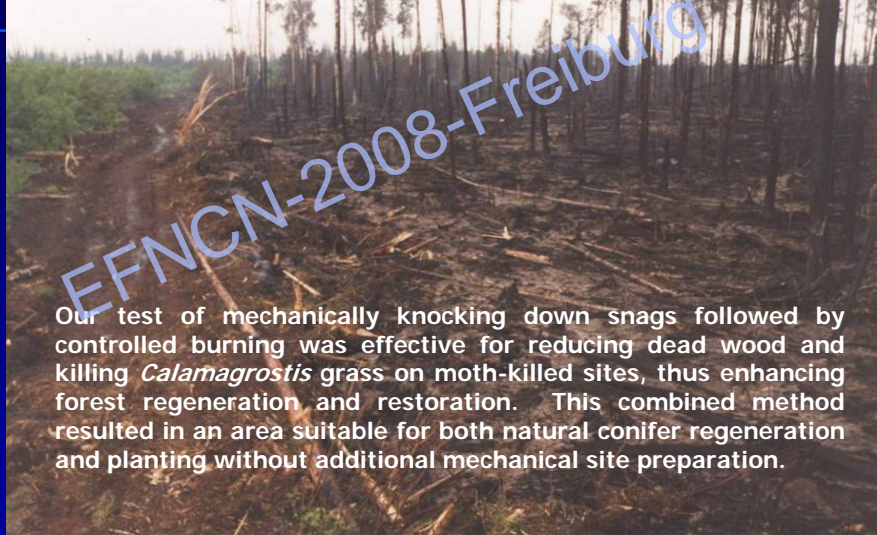
Period	Annual burned area (ha)	Annual amount of fires
before 1994 y	~200	~5
after 2000 y	~2000	~14

Defoliated forests represent two major problems for resource managers: they have high potential for forest fires and they may become unproductive wastelands

Special bulldozer was used to knock down snags and for firelines preparation

Reducing fire hazard in these forests requires removing dead woody material and accumulated ground fuels as a first step.






Our test of mechanically knocking down snags followed by controlled burning was effective for reducing dead wood and killing *Calamagrostis* grass on moth-killed sites, thus enhancing forest regeneration and restoration. This combined method resulted in an area suitable for both natural conifer regeneration and planting without additional mechanical site preparation.







Prescribed burns are also powerful sources of greenhouse gases but then carbon sequestration due to coming regeneration as carbon sink compensate first powerful carbon emissions



Conclusions

- Special rules and guidelines for prescribed burning have been developed and published in cooperation with regional forest enterprises. Crews of foresters and firefighters have been trained during these experiments.
- A range of demonstration plots of prescribed burning was established to serve for long-term monitoring of postfire succession.
- These plots will be integrated into the Eurasian Fire in Nature Conservation Network as well as in the Fire Paradox demonstration plot network.
- The cooperation with these networks will allow further studies of both prescribed burnings (fire danger, fire behaviour, fire effects) and long-term fire successions in Siberian forests.
- The results will be important to extend to other regions of the Russian Federation.

Acknowledgements:

- Many thanks to Bolshaya Murta, Mana, Usolie leskhoz employees who supported and took active part in experiments
- Special thanks to Steve Eubanks, John Brisette, Rich Lasko (USDA Forest Service)
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Thank you for your time!



Спасибо за внимание!

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