International Forest Fire News (IFFN) No. 32 (January – June 2005, 64-67)

Forest Fire Management Technologies

Erik N. Valendik, Yegor K. Kisilyakhov, Sergey V. Verkhovets
Sukachev Institute of Forest, Siberian Branch, Russian Academy of Sciences, Krasnoyarsk

Vladimir N. Vekshin
Ministry of Natural Resources, Forest Service, Krasnoyarsk

Richard Lasko
USDA Forest Service

Fire management in forests damaged by the Siberian Moth

Dark coniferous forests damaged by Siberian Moth (*Dendrolimus superans sibiricus* Tschetw. [Lepidoptera: Lasiocampidae]) occupy huge territories from Ural Mountains to Far East. Patches of fully or partially dead stands vary from ten to one hundred thousand hectares. Total damaged areas have been estimated to be equal to several million hectares.

Forest fire potential increases significantly for number of years after stand mortality. Surface fuels consist of both downed and dead roundwood material on the ground covered by low herbaceous and fir (*Abies sibirica*) vegetation that becomes highly flammable after curing and drying in spring (Shabalina et al., 2001). After 4-5 years enough dead and downed surface fuels accumulates through fir decomposition to offset dampening effect of understory vegetation and summer fires will spread through the fuel complex.

Crown breakage and wind throw, with resulting rearrangement of the fuel complex and corresponding high surface fuel loads lead to severe wildfires. Standing dead trees ("snags") after first high intensity fire don't burn completely. The lower part of tree trunk usually has a high moisture content (>100%) and is often only partially charred.

Destruction of the stand after their mortality under frequent wildfires continues many years. Full restoration of dark coniferous stand moves through deciduous trees stage and take more than 150-200 years (Kulikov, 1965). Tree trunks downed by wind quickly loose moisture content and they fully burn out in wildfires. Therefore for high fuel consumption standing dead trees must be fallen down.

The preparation of the restoration of forest completely killed by the Siberian Moth includes three stages. The first stage involves felling of dead trees using a special forest fire unit based on a converted military tank T-55. Shuttle passes have been made by the unit after 10-15 m. Thereby to fall down trees increase dry fuel load and increase wind to continue fall down dead trees. The weight of the forest fire unit is 40 tons. So falling down dead trees was made in the spring when soils were frozen and soil damage by unit was minimal. Also due to the frozen soil the unit was able to move through bogged part of the site. Strong winds blowing perpendicular to the strip passes also add falling down trees and fuel load before prescribed burning exceeds 200 tons per hectare. Second stage consist construction of firelines around the site to contain prescribed fire within area surrounded by firelines. After two passes by the unit mineralized fireline 3-4 m wide effectively prevents surface fire spread. Then additional work must be done for falling down dead trees standing near firelines to prevent their spotting. Third stage consist prescribed burning of the site. All surface fuels unless to green grasses and some brush contribute to fire spread. Burning after the ignition immediately turns into crowning. Fir and birch tops totally involve in burning. The intensity of burning in the prepared by unit site damaged by the Siberian Moth is comparable with the high intensity crown fire. Dead fir boles and tops having cured while standing for a number of years had moisture content values low enough to make virtually the whole tree readily available for combustion. Intensive burning of fallen trees helps to burn out also dead standing trees. Dead fir bark peels readily after mortality and this burning fuel was transported in large amounts along with burning fine twigs and branches in the convection column starting downwind spot fires with resulting control problems.

Approximately, 20-30% of downed dead charred trunks were left after burning. Temperature of the soil doesn't exceed critical temperatures for microflora. Some humus layer left on the soil will contribute to the planting of the site without additional mechanical preparation of the soil. This procedure gives us the possibility not wait for hundred years natural restoration of forest damaged by the Siberian Moth. Forest restoration will be started immediately after its drying and prescribed burning using this technology.

Fire management on logged sites

Dark coniferous forests of the West Sayan Mountains represents the Siberian ecosystem characterized the highest biodiversity. Besides their commercial value these forests effectively perform a water protection function because they regulate the flow of big Yenisey river tributaries in its middle segment.

However, the area of dark conifers, especially in easily accessible low-mountain regions, has been significantly reduced by wildfires and timber harvesting activities.

Wide-scale commercial forest use started here as far back as in the 1930s and continues nowadays. Two factors accounted for intensive development of wood industry in this region: (1) close location of wood processing enterprises to the exploitable forests, and (2) inexpensive delivery of extracted wood by floating it on Mana river to Krasnoyarsk.

Logged forest site restoration is extremely slow and usually occurs through stand replacement. Most wildfires occur during spring and summer in this region and they always start from logging sites. This is due to abundant cured *Calamagrostis* spp. covering some 90% of any cut site. Huge amounts of logging slash contribute much to high-intensity fire development (Ivanova and Perevoznikova, 1994).

The wildfires that occurred in May and June 1999 are clearly discernable in the NOAA satellite image received at the Institute of Forest, Krasnoyarsk

One of these fires that burned in Mana region was more than 30 hectares in size. Cut sites with high logging slash loading comprised about 60% of burned area. The fire killed hundreds hectares of plantations. It extended cut sites to adjacent forest stands and jumped to crowns on steep slopes. Trees became snags in a vast area, and since no seed source was intact, forest restoration will take many decades. Moreover, forest planting is also problematic on slopes that steep.

While wood harvesting has been reduced here by several orders of since 1990, logging slash fuels has significantly increased in cut sites to amount often to 150 tons per hectare. This high loading is primarily attributed to the fact that non-governmental forest use organizations usually manage to haul some 30-40% of the wood they have harvested.

That huge amounts of large downed woody elements left on logging site means also a high probability of fungi-induced diseases and heavy insect outbreaks often affecting surrounding healthy stands.

The first thing to be done after logging completed, is to construct a fireline at least 3 m wide along the cut site perimeter.

Second, remove logging slash from the site to reduce fire hazard and make it suitable for natural forest regeneration and planting.

Heavy machinery is useless on steep slopes, so the only effective tool left is controlled broadcast burning of logging slash. After briefing, fire safety operations begin to include removal of snags and large downed woody elements from the planned firing line.

Then it comes to ignition itself. For steep slopes, the fire should always move downslope from fireline made in the upper side of cut area.

People responsible for ignition ignite at the center of this upper fireline section and then walk at the same pace to the opposite sides looking for the ignited line to be more or less continuous.

In a case of a slowly spreading fire, the crew can use step firing to save the time required for firing and increase fire intensity through establishing one -more ignition line 15-20 m lower on the slope. If needed these additional ignition lines can be several.

When burning in summer, controlled fire intensity may be low because of abundant green grass and shrubs. In order to increase fire intensity to a desirable level, logging slash should be ignited at many places across the site simultaneously using multi-point firing technique.

Again, the fire perimeter should be patrolled permanently for potential spot fires beyond the control line.

Fire can get too intensive and jump beyond the cut site during daytime, when burning in spring remarkable for very high fire danger. Therefore, it makes sense to burn during night hours.

Controlled fire consumes all fuel elements up to 2.5 cm in diameter. Larger fuel elements are consumed by 25-30%. Controlled fire produces some 2-3 tons of ash per hectare. As the forest floor moisture content is high, the upper soil layer and, therefore, all microorganisms inhibiting it, remain intact in prescribed fire.

Successfully burned logging site are very good for either planting or seeding woody species without preliminary soil treatment. Seedlings perform very well on soil enriched with nutrients after fire.

Controlled burning promotes fireweed over *Calamagrostis* on logging sites. Fireweed is known not to compete with conifers and provides a good protecting canopy for developing self-seeded or planted trees. Fireweed loading is insufficient to carry a fire, therefore, fire danger remains low for several years on burned logging sites covered by fireweed.

Forest fire management in wildland-urban interface

Forest fires in wildland-urban interface have a great danger. People can be injured in fire and homes and properties could be destroyed not only in small populated areas but small cities. These kind of catastrophic forest fires occur not only in Eurasian boreal forests but in other forests of our planet. For example, 1994 catastrophic fires in Sidney (Australia) killed 3 men and burned out more than 100 homes. In another side of Globe Malibu (California) catastrophic fires burned three people and 380 homes were converted to ash. Two weeks fires more than 1000 homes were destroyed and 200 thousand acres land have been passed by fires.

Is this kind of problem exists in Russia? Of course, yes, but here it is very little data. Many people believe that if there are no data there would be no problem. However, there are some historical data. In 1921 massive catastrophic fires in Mari Republic (Russia) 60 small villages were destroyed, 35 people and 1000 cows were killed. 1972 catastrophic forest fires in five regions of European part of Russia destroyed 19 small villages.

According to data from NOAA satellites received by the Institute of Forest 2.4 million hectares were passed by forest fires in Khabarovsk Region and Sakhalin Island in 1998. In Sakhalin small village Gorki was burned out. 680 people lost their homes, three people died and dozens of houses were burned in several populated areas.

Why these kinds of catastrophes arise? Like in America people in Russia also want to live near the forest or in the forest not knowing that life in paradise can cost. Residents doesn't suspect of danger concealed in their lovely pine stand. Catastrophic fire arising in stand can take their homes and even their lives. These fires actively were protected from fires many decades. And fuel load in them exceeds 30 tons per hectare. These great fuel loads lead to high intensity surface forest fires. Regrowth of first and second age class, small height of crowns lower part are the steps to crowning. Ahead of crown fire there are hundreds of flying burning particles capable to burn out wooden properties. Due to our studies burning coals and smouldering bark and wood pieces are blown by wind to the distance more than 500 m. Therefore, glades and fuel breaks do not prevent forest fires. Fuel breaks only increase wind velocity near surface and complicate fire suppression due to dense smoke near the ground.

What kind of measures must be undertaken to prevent this kind of catastrophes?

Organizational measures: First, it is needed to develop cooperation system for Forest Service, EMERCOM, City fire protection system. Second, to develop responsibility zones for each service. Third, to define danger zones where all three services unite and act under one supervisor. Forth, to determine intensive fire protection zones in wildland-urban interface. The width of this zone must be more than 500 m.

Forestry measures: To form one storied forest stand structure and transform it into park like forest without regeneration and understory with minimal surface fuel load. Mechanical facilities can be used for that along with prescribed fire technologies. We strongly believe that last one is more effective and economical.

It is developed a prescribed fire technology allowing under definite weather conditions, combustion regimes to decrease forest fuel load up to prescribed level and remove regrowth with definite DBH not destroying main stand.

The creation of park like stand without regrowth and understory with minimal surface fuel load will exclude catastrophic forest fires.

References

Ivanova, G.A., and V.D. Perevoznikova. 1994. Types of logged areas of low part of East Sayan and its fire danger. Geography and Natural Resources No. 1, 54-60 <in Russian>.

Kulikov, M.I. 1965. Reforestation in Siberian moth killed forests of Chulim river. Forest Management No. 7, 23-26 <in Russian>.

Shabalina, O.M., V.G. Raznobarskii, and D.L. Grodnickii. 2001. Ground cover and tree regeneration in Siberian moth dead forests of taiga. Siberian Ecological Journal <in Russian>.