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Estimating and Monitoring Effects of Fire Severity on Ecosystem Components of Siberian Scots pine forests

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Fire is one of the main forest disturbance factors covering up to several million hectares of boreal forests annually, most of them in Eurasia. Surface fires of varying severity are most common in Siberian forests. Fire influences all forest ecosystem components including the overstory, living ground vegetation, soil structure, microorganisms, and invertebrates. Monitoring of forest ecosystem regeneration after varying-severity fires of known behavior was first carried in Scots pine forests of Siberia. Fire-caused changes of spatial ground vegetation patterns depended on fire intensity, depth of burn, and pre-fire ground vegetation composition. The canopy and subcanopy vegetation vigor was estimated to show tree mortality to be the highest during the first three years following fire. Subcanopy vegetation differed in species composition at the initial stage of post-fire vegetation succession. In Scots pine stands, fire resulted in reduction of ground vegetation species after fire, in decreasing ground vegetation biomass and coverage, which did not recover to the pre-fire levels over the 5-year period of post-fire observations. Three-five years after fire, soils on burned plots were characterized by less pronounced forms of acidity and greater amounts of absorbed bases compared to control plots. Other soil chemical and physical properties differed less considerably between burned and control plots due to gradual wash of fire-caused alkaline products out of soil horizons, primarily duff. Post-fire soil carbon and total nitrogen contents increased due to burned plant root dieback. Post-fire changes of quantity, biomass, and activity of soil microorganisms during first several years after fire depended mainly on depth of burn. Soil microbial communities recovered in one – two years following low-intensity fires, since these fires had minimal influence on soil microbial biomass and basal respiration. High- and moderate-intensity fires induced considerable changes of soil microbial community functioning. Seven years after fire, duff microbial biomass carbon content was 35-40% lower than on the control plot. Soil microarthropod amount at southern taiga Scots pine plots burned by moderate-intensity fire approached the amount measured on control plots in the fourth post-fire year. Microarthropod density did not recover back to the pre-fire level five years after high-intensity fires. Post-fire invertebrate groups differed in density from those found on control plots. In the first several years after fire, the above-ground biomass still appeared to be strongly controlled by fire intensity. Later, the influence of burning intensity on organic matter accumulation was determined to decrease with time. Fire frequency has increased in boreal forests over the past several decades and is expected to increase more under climate change. This would result in changes of Siberian forest ecosystems. The authors gratefully acknowledge financial support of the investigations from the NASA NEESPI and ISTC (#3695) projects.