

## Potential forest fire prevention by management - An analysis of fire damage in pine forests

Anne Gnilke<sup>1</sup>, Jakob Liesegang<sup>2</sup>, Tanja Sanders<sup>1</sup>

- Pure pine compared to stands with at least one broadleaf tree species showed significant differences in the severity of fire damage
- The severity of fire damage decreases as the proportion of hardwoods increases
- Clear differences between tree species: pines show the highest scorch marks and the most severe loss of vitality, whereas red oak show the lowest scorch heights

### Background

During the drought years 2018 and 2019, a total of 5,060 ha forest burned in Germany – the largest total area burned since 1992. The forest fire near Lübtheen in July 2019, which burned a total of 950 ha, was the largest single area burned in the last 26 years (BLE 2019, 2020). In both years, more than half of the damaged areas were situated in Brandenburg – 71% in 2018 and 51% in 2019 respectively. Twenty fires reached a size of over 10 ha. The years 2018 and 2019 were characterised by extreme weather conditions: along with Saxony-Anhalt and Berlin, Brandenburg recorded the lowest precipitation nationwide (below 390 mm in 2018, below 495 mm in 2019), with record temperatures at the same time (only North Rhine-Westphalia was warmer in 2018). Brandenburg was by far the warmest federal state in 2020 (DWD 2018, 2019, 2020).

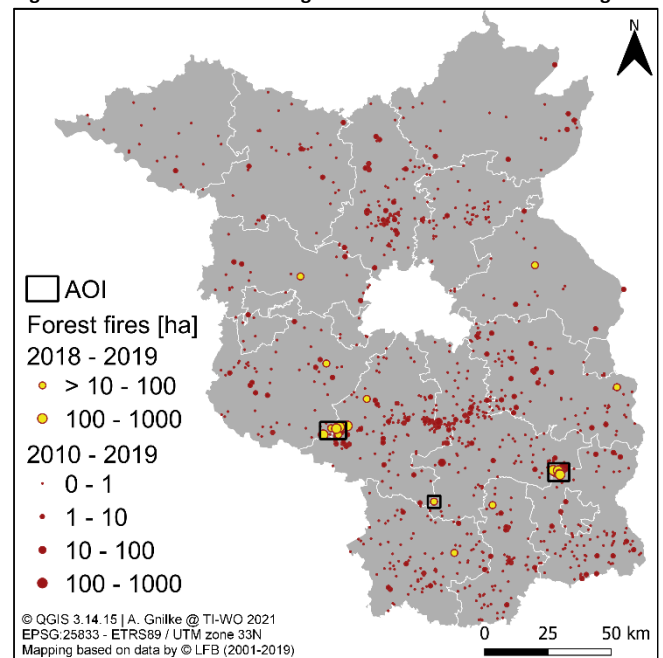
### Study aim

Weather and topography have a great influence on the development of a forest fire but can only be analysed for a prediction on the area at risk of ignition. Vegetation, on the other hand, can be directly influenced by management. Forest management determines the tree species composition and structure of stands and thus influences the mass and moisture in the ground litter, herbaceous vegetation and deadwood supply (Peringer et al. 2019). While oxygen supply and ignition temperature can only be reduced by extinguishing measures after the outbreak of a fire, the amount of combustible material, which is defined by the existing plants and their dead remains, can already be manipulated in advance (Omi 2005).

### Approach

Following the question of what influence forest structure and composition have on the development and damage extent of forest fires in pure and mixed pine stands, recordings were carried out on three forest fire areas in southern Brandenburg: Treuenbrietzen (2018, 404 ha) in the west, Altsorgefeld (2019, 15 ha) in the centre of South Brandenburg and Lieberose (2019, 121 ha) in the east of the region (Fig. 1). Pine (*Pinus sylvestris*) was the predominant tree species on all investigated areas.

Figure 1: Locations of the investigation areas in South-Brandenburg



Source: © LFB (2010-2020)

The area near Treuenbrietzen is dominated by old-growth pine forest. The main area near Altsorgefeld is located in old-growth pine forest with a minor part in a red oak (*Quercus rubra*) stand. The 2019 fire near Lieberose effected forest consisting of pine old-growth stands under which multi-layered regeneration has developed. Further characteristics on the respective growth conditions are summarized in Table 1.

Table 1: Growth and site conditions in the areas of investigation

Burned Area	Treuenbrietzen	Altsorgefeld	Lieberose
Nutrient supply:	moderate nutrient-supply	moderate to rather poor nutrient-supply	moderate to rather poor nutrient-supply
Dominant soil type:	podsol and brown-soil	aeolian fine- and medium-sand	podsol and brown-soil
Climatic zone: (annual mean precipitation)	dry (500 – 560 mm)	moderate dry (580 – 660 mm)	moderate dry (580 – 660 mm)

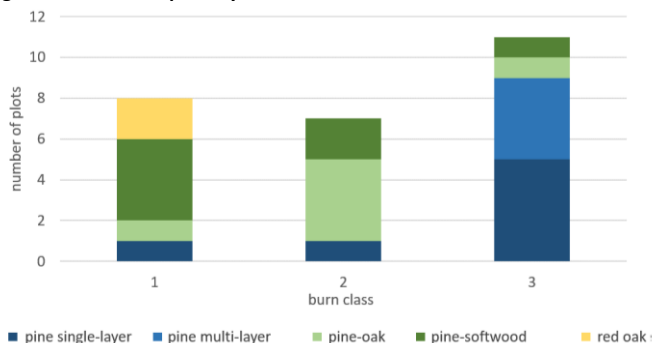
Source: © LFB (2010-2020)

On a total of 26 random samples with a circular area of 500 m<sup>2</sup> each, trunk base coordinates, tree species, breast height diameter (DBH) and tree top heights were recorded. Further parameters recorded were crown height and needle loss as well estimated basal area per hectare (relative stand density). The burn severity, also referred to as relative fire intensity, was determined with the help of the scorch mark height - measured on the downwind side of the trunk. Based on the mean scorch mark heights of the pines (mVH), the individual sample areas were grouped into three burn severity classes; 1 (pine stems are only partially scorched), 2 (all pine stems on a given plot are scorched and mVH < 2 m) and 3 (all pine stems on a given plot are scorched and mVH > 2 m) according to Adámek et al. (2016).

### First results

Figure 2 shows the distribution of the differently structured recorded stands among the burn classes: sample plots assigned to burn class 3 are mainly single- and multi-layered pure pine stands; the majority of sample plots assigned to burn class 2 consisting of mixed pine-oak stands, while the largest proportion of plots assigned to burn class 1 consists of mixed pine-conifer stands; the red-oak plots solely come from recordings in Altsorgefeld.

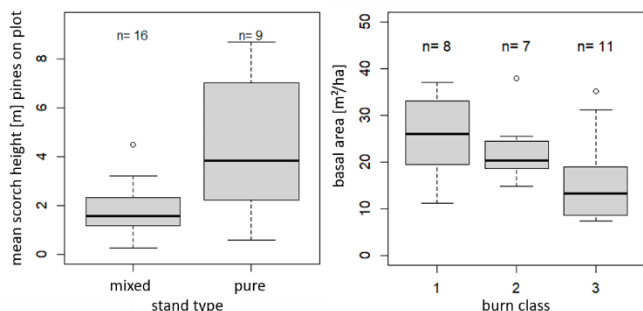
Figure 2: Number of plots by stand structure and burn class



Source: Data collection and analysis (J. Liesegang, 2021)

The comparison of mean scorch mark heights between pines in pure stands and stands with at least one other deciduous tree species shows significant differences (Fig. 3, l.). In pure stands, the mean scorch height of pines is 4.4 m (22% relative standard error of the mean SE), in mixed stands it is only 1.5 m (SE 19%). With increasing burn classes, the basal area decreases, in burn class 3 it is significantly lower than in burn class 1 (Fig. 3, r.).

Figure 3: Comparison of mean scorch mark heights on pines in pure or mixed stands (l.) and basal area by burn class (r.)

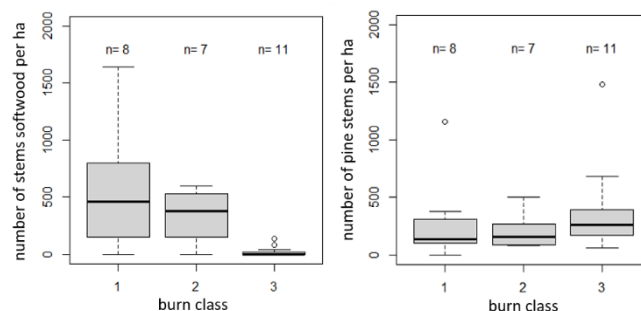


Source: Data collection and analysis (J. Liesegang, 2022)

The comparison of stem numbers grouped by tree species, the proportion of hardwood decreases with increasing burn class, with pine showing significantly higher scorch marks than the other tree species. In contrast, significantly lower scorch marks were recorded for red oak than for all other tree species.

The stem number of pine trees per hectare hardly differs between the plots of the respective burn class (Fig. 4, l.). However, the number of hardwood stems is significantly lower in burn class 3 than in burn class 1 (Fig. 4, r.).

Figure 4: Number of stems by burn class for softwood (l.) and pines (r.)



Source: Data collection and analysis (J. Liesegang, 2022) (BLE, 2021)

In general, a high variability of the mean scorch mark height was found for pine in plots with a low hardwood basal area. From a hardwood basal area of approx. 3 m<sup>2</sup>, no more scorch mark heights with a mean above 3 m were present.

### Summary

The recordings show that the forest composition and the tree species admixture is an important structural feature influencing fire spread and fire development within a forest stand. On the investigated plots, there are clear differences both between the stand types and in the tree species composition: the highest scorch marks were recorded in pure pine stands, pines in mixed stands with hardwoods showed significantly lower scorch marks, and also reached only half of the maximum scorch mark heights, with the lowest scorch mark heights occurring on red oak. The data also show that the residual vitality decreases with increasing scorch mark heights, and that mortality is highest in burn class 3.

### Conclusions and outlook

Climate forecasts for Brandenburg show a tripling of heat days with temperatures > 30 °C by the end of the 21st century, based on the reference period 1971 - 2000. Furthermore, an increase in consecutive dry days with precipitation < 1 mm from 38 to 45 days is expected (Wenzel et al. 2015), which is likely to lead to a further aggravation of the forest fire risk situation that cannot be fully compensated by silvicultural changes in the stands. Considerations on forest fire prevention should be integrated in forest management, especially where high risk and limited extinguishing possibilities coincide. In Brandenburg, this applies in particular to pure pine stands located in areas contaminated by explosive ordnance and belonging to administrative districts of [forest fire hazard class A<sub>1</sub>](#).

## Further information

### Contact

<sup>1</sup> Thünen-Institute of Forest Ecosystems  
Anne.Gnilke@thuenen.de  
Tanja.Sanders@thuenen.de  
[www.thuenen.de/wo](http://www.thuenen.de/wo)

<sup>2</sup> Georg-August University Göttingen  
Faculty of Forest Science and Ecology

DOI:10.3220/PB1661178158000

### Project

<https://www.thuenen.de/en/fachinstitute/waldoekosysteme/projekte/waldoekologie/projekte-waldoekologie/erwin/>



### Duration

6.2020-9.2023

### Project-ID

2278

### Funded by

