

计划烧除对滇中云南松林植物多样性的影响

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摘要:

背景: 云南松(*Pinus yunnanensis*)林是我国西南地区特有的重要植被类型。然而, 受云南松独特的自然整枝效应及其分布区气候特征的影响, 云南松林区极易发生森林大火, 计划烧除是降低森林大火发生的有效手段, 其在云南松林分布区广为应用引起的它容易受到频繁火灾的影响。然而, 计划烧除对云南松林植物多样性的影响尚不明确。本文采用对比分析的方法, 分别在滇中新平照壁山云南松林分布区实施计划烧除和未实施计划烧除区域布设样地, 探讨计划烧除对滇中云南松林植物多样性的影响, 以便制定更加科学合理的既不对云南松林植物多样性造成显著影响又能预防森林大火发生的计划烧除方案。

数据分析: 为了评价云南松森林群落的结构和组成, 测量了植物重要值、物种丰度和高度。利用 α 多样性指数, 如 Shannon-Winner 多样性指数(H')、Simpson 优势度指数(D)、Pielou 均匀度指数(E_H)和 Margalef 丰富度指数(F)来评价群落多样性。同时, 利用 Wilcoxon 秩和检验分析了物种丰度、盖度、高度和物种多样性指数的差异。除此之外, 采用 NMDS 分析了火烧区和未火烧区林下群落结构的差异; Spearman 相关性分析了 α 物种多样性的影响因素; 多元回归分析(MLM)分析各因子对 α 多样性指数的相对贡献; 最后, 利用结构方程模型(SEM)分析了林火、海拔、上层植被特征和土壤养分等环境因子对物种组成的影响。

结果: 计划烧除对林冠层树木的无影响, 在一定程度上改变了林下植物群落特征。林下灌木层物种由未过火区的 26 种减少到 19 种, 优势树种由未过火区的光叶柯(*Lithocarpus mairei*)和云南松(*Pinus yunnanensis*)幼苗转变为烧除区的杜鹃花(*Duhaldea cappa*)和金叶子(*Craibiodendron stellatum*), 计划烧除部分改变了物种的多度, 并降低了灌木层植物的平均高度; 计划烧除使得草本物种的数量由 27 种增加到 40 种, 但对草本层植物的多度、高度和重要值的影响不显著。计划烧除对灌木和草本物种多样性指数的影响表现为, 烧除显著降低了灌木层植物的 α 物种多样性, 但对草本层植物的 α 物种多样性指数影响较小。 β 多样性指数表明火烧区和未火烧区的物种组成相似。NMDS 分析和结构方程模型(SEM)均表明, 计划烧除对云南松林灌木层植物的影响高于草本层植物, 计划烧除是影响灌木层物种多样性指数的主要因素, 而海拔、林分结构和土壤养分含量对草本层物种多样性指数的影响较大。

结论: 计划烧除对云南松(*Pinus yunnanensis*)林的乔木层无影响, 显著降低了灌木层植物物种数量和高度, 增加了草本层植物种类, 并对草本层高度有轻微的促进作用。计划烧除造成的灌木层物种多样性和高度的变化可能会在较长时间内影响未来森林演替和植物群落的变化。

Effects of prescribed burning on species diversity of understory in *Pinus yunnanensis* forests of the central region of Yunnan

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Abstract:

Background The *Pinus yunnanensis* forest in southwestern China is a unique and significant vegetation type. However, it is susceptible to frequent fires. To mitigate the risk of hazardous fires, prescribed burning has often been employed in these forests. Nevertheless, it is important to consider the potential impact of prescribed burning on the structure of plant communities and species diversity in *Pinus yunnanensis* forests. To investigate the specific changes in plant community characteristics of caused by prescribed burning, a study was conducted in the *Pinus yunnanensis* forest located in Zhaobi Hill, Xinping county.

Methods We utilized the Wilcoxon Rank Sum Test (WX) to identify disparities in species abundance, coverage, height, and species diversity index. Additionally, we employed NMDS to explore differences in understory community structure between the burned area and unburned area. We identified the influential factors of α species diversity by using Spearman correlation. Furthermore, we conducted multivariate regression analysis (MLM) to analyze the relative contribution of factors to the α diversity indexes. Finally, the structural equation model (SEM) was investigated the associations between species composition and various environmental factors, including fires, altitudes, upper vegetation characteristics, and soil nutrients.

Results Prescribed burning has had minimal effects on canopy trees, but has partially altered the characteristics of the understory community. It has decreased the number of shrub species from 26 to 19, with a shift in dominance from saplings of *Lithocarpus mairei* and *Pinus yunnanensis* in the unburned area to *Duhaldea cappa* and *Craibiodendron stellatum* in the burned area. Additionally, prescribed burning has partially altered the abundance of species and reduced the average height of shrubs. Furthermore, prescribed burning has increased the number of herb species from 27 to 40, but has had minimal impact on their abundance, height, and importance value. It is worth noting that prescribed burning has different impacts on the species diversity of shrubs and herbs. It significantly decreases the α species diversity of shrubs, but only has minimal effects on the α species diversity indices of herbs. The β diversity indices indicate that the species composition in both burned and unburned areas is similar, but the impact of prescribed burning on shrubs is greater than on herbs. Overall, prescribed burning appears to be the primary factor affecting the species diversity index of shrubs, while altitude, forest structure, and soil nutrient content exert greater influences on the species

diversity index of the herbaceous layer.

Conclusions Prescribed burning had little impacts on overstory trees of the *Pinus yunnanensis* forest, it had slightly positive effects on the height of herbs, and increased species richness of herbs from 27 to 40. However, the effects of prescribed burning on the species diversity and the height of shrub layers were significant and negative. Prescribed burning was the dominant factor shaping the community structure and species diversity of the shrub layer, and the missing saplings of trees in shrub layers might influence future forest succession in a long time.