

东北东部年龄序列次生林碳通量格局

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摘 要:【目的】本文旨在量化温带森林恢复进程中土壤呼吸及其分配,比较干扰后碳汇年龄效应。【方法】本研究以东北帽儿山干扰后形成的年龄序列次生林为研究对象,包括林木采伐一次近熟林(NS,林龄 64 年)、采伐两次中龄林(MS,林龄 32 年)、采伐两次幼龄林(YS,林龄 9 年),采用森林清查和异速生长方程结合的方法,得到生态系统及各组分净初级生产力(NPP),利用 LI-8100A CO₂ / H₂O 分析仪于 2021 年 5 月开始至生长季结束每半个月测定土壤呼吸,利用二者差值得到净生态系统生产力(NEP)。【结果】温带次生林不同恢复年限温带次生林土壤呼吸同土壤 5 cm 温度存在显著的正相关关系,2021 年、2022 年土壤表面年碳通量波动范围在:754.87~934.64、664.59~865.41 g·m⁻²·a⁻¹,随着演替时间出现下降再上升的趋势,异养呼吸逐年降低但差异并不显著。不同阶段次生演替森林净生态系统生产力各组分中除了草本生产力外,其他均没有显著差异($P>0.05$)。帽儿山年龄序列次生林 NEP 在森林类型之间并不存在显著差异($P=0.38$),随恢复呈现出先升后降的趋势。【结论】土壤呼吸随着土壤 5 cm 温度增加呈现指数上升的趋势,在次生林的净初级生产力中,木质组织和细根生产力是主要贡献者。干扰后在短期内促进森林生态系统碳汇,本研究为东北温带森林生态系统固碳及其经营的评价和估测提供数据支持和理论依据。

关键词: 碳通量; 土壤呼吸; 净生态系统生产力; 净初级生产力; 年龄序列

The pattern of carbon flux in age-series secondary forests in northeast, China

Abstract: 【Objective】 The study is to quantify soil respiration and its allocation during the restoration process of temperate forests, and to compare the post-disturbance carbon sink age effect. 【Method】 In this study, we used the age series of secondary forests formed after the disturbance of maoershan area, northeast of China, including forests harvested once for near-mature forest (NS, 64 years old), harvested twice for middle-aged forest (MS, 32 years old), and harvested twice for young-aged forest (YS, 9 years old), and we used a combination of forest inventories and anisotropic growth equations to get the ecosystems and the Net Primary Productivity (NPP) of each component. Soil respiration was measured every half month from the beginning of May 2021 to the end of the growing season using the LI-8100A CO₂ / H₂O analyzer, and the difference between the two was used to obtain the net ecosystem productivity (NEP). 【Result】 Soil respiration in temperate secondary forests of different restoration years had a significant positive correlation with soil 5 cm temperature, and the annual carbon fluxes on the soil surface fluctuated in the ranges of 754.87-934.64 and 664.59-865.41 g·m⁻²·a⁻¹ in 2021 and 2022, and the heterotrophic respiration decreased year by year with the trend of decrease and then increase with the successional time. However, the difference was not significant. There were no significant differences in the net ecosystem productivity of forests at different stages of secondary succession except for herbaceous productivity ($P>0.05$). The NEP of secondary forests in the age series did not differ significantly among forest types ($P=0.38$), which showed a tendency of increasing and then decreasing with recovery. 【Conclusion】 Soil respiration showed an

exponential increasing trend with increasing soil 5 cm temperature, and woody tissue and fine root productivity were the main contributors in the net primary productivity of secondary forests. After the disturbance, the forest ecosystem carbon sink was promoted in the short term, and this study provides data support and theoretical basis for the evaluation and estimation of carbon sequestration in northeast temperate forest ecosystems and their management.

Key words: carbon flux; soil respiration; net ecosystem productivity; net primary productivity; age series.