森林色谱的构建及色彩斑块指数对人眼识别准确度的影响

韩文静[1,2,3]，张 昶[1,2,3*]，王 成[1,2,3]，殷鲁秦[1,2,3]

（1.中国林业科学研究院 林业研究所，北京100091；2.国家林业和草原局林木培育重点实验室，北京100091；3.国家林业和草原局城市森林研究中心，北京100091）

摘 要:【目的】构建符合森林实际情况的色谱，探讨不同森林颜色及其空间分布对人眼识别能力的影响，以指导森林景观中色彩的选择及配置。【方法】首先，通过对 40 个国家森林公园的 986 张森林图像的色彩信息进行 K-Means 聚类，绘制了森林色谱。然后，采用 Kruskal-Wallis 检验分析了林内和远林景观色彩识别准确度和敏感度在不同人群、不同颜色间差异。最后，采用多元逻辑回归模型，探讨了林内和远林景观中森林色彩斑块指数对色彩识别准确度的影响。【结果】森林色彩划分为 8 个色系，包括橙色系、黄色系、黄绿色系、绿色系、蓝绿色系、蓝色系、紫色系和红色系。色彩识别准确度在不同颜色间存在显著差异，绿色识别准确度最高，蓝绿色识别准确度最低。在林内景观中，色彩斑块平均面积指数（ARP）、色彩斑块平均分维度指数（FRAC）对色彩识别准确度呈显著积极影响，而色彩斑块数量（NP）、色彩斑块密度（PD）对其呈显著消极影响。在远林景观中，色彩斑块密度（PD）、色彩斑块多样性指数（SHDI）对色彩识别准确度呈显著积极影响，色彩斑块数量（NP）、色彩斑块边缘密度（ED）、色彩斑块分割度指数（DIV）、色彩斑块结合度指数（COH）对其呈显著消极影响。【结论】我们建议在林内景观营造时，增加色彩斑块形状的复杂度，适当降低林分密度及灌草盖度。在远林景观营造时，适当增加植物种类多样性，注重色彩搭配的多样性和均衡性。未来研究可进一步扩大森林图像的收集途径，增加图像样本数量，使用更合适的算法处理色彩信息，为森林色彩量化研究提供更有力的数据支持，构建更准确的森林色谱。

关键词: 森林图像；K-Means 聚类；森林色谱；视觉；人眼色彩识别；色彩斑块指数；中国

Constructing a Forest Color Palette and the Effects of the Color Patch Index on Human Eye Recognition Accuracy

Han Wenjing[1,2,3], Zhang Chang[1,2,3*], Wang Cheng[1,2,3], Yin Luqin[1,2,3]

(1. Research Institute of Forestry, Chinese Academy of Forestry, Beijing100091, China;2. Key Laboratory of Tree Breeding and Cultivation, State Administration of Forestry and Grassland, Beijing,100091, China;3. Urban Forest Research Center, State Administration of Forestry and Grassland, Beijing,100091)

Abstract:【Objective】The aim of this study was to construct a color palette that matches the actual situation of a forest, and to clarify how different forest colors and their spatial distribution affect human eye recognition, which will be used to guide the selection and spatial configuration of colors in forest landscape creation. 【Method】We constructed a forest color palette using k-means clustering based on the color information of 986 forest images from 40 national forest parks in China. The Kruskal–Wallis test was used to analyze the differences in color recognition accuracy and sensitivity among populations and colors. At last, multiple logistic regression was used to explore the effect of forest color patch indices on color identification accuracy for interior and distant forest landscapes.【Result】Forest color could be divided into eight color families—orange, yellow, yellow-green, green, blue-green, blue, purple, and red. For humans, the recognition accuracy was highest for green and lowest for blue-green. For interior forest landscapes, the mean area proportion and fractal dimension of the color patches showed significant positive effects on color recognition accuracy, whereas the number and density of color patches showed significant negative effects. For distant forest landscapes, the density and Shannon’s diversity index of the color patches showed

significant positive effects for color recognition accuracy, whereas the number, edge density, division index, and cohesion of the color patches showed significant negative effects.【Conclusion】We suggest that it is necessary to increase the complexity of the color patch shape when creating interior forest landscapes and to focus on the diversity and balance of color matching when creating distant forest landscapes. In future studies, the collection pathways for forest images should be expanded, and color information extraction algorithms that incorporate human perception should be selected. This will improve the data available for forest color studies and enable the construction of a more accurate forest color palette.

Key words: forest landscape; k-means clustering; forest color palette; vision; human color recognition; color patch index; China