

森林生长发育阶段划分方法综述

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摘要:【目的】辨识森林的生长发育阶段是实现森林全周期经营的前提,本研究系统梳理了森林生长发育阶段划分的主要方法,提出了各类方法的优势、局限及其应用场景,为森林全周期精准经营提供科学依据,推动森林经营的可持续发展。研究分为单木生长发育阶段划分和林分生长发育阶段划分两大部分,分别介绍了各自的五大主要方法。【方法】在单木生长发育阶段划分中,克拉夫特分级法、寺崎分级法、霍莱分级法、Dunning 分级法和林木分级指数法是常用的五种方法。克拉夫特分级法是最经典的划分方法,基于树木生长势和树冠形态,将林木分为五个等级,具有操作简便、适用性强的特点,尤其适合同龄纯林。尽管它忽略了树干缺陷,但因其操作简单和广泛应用,成为森林经营中的重要工具。寺崎分级法和霍莱分级法则分别适用于针叶纯林和阔叶混交林,前者更关注树冠形态,后者则侧重树木在林冠中的竞争状态。Dunning 分级法适合异龄混交林,基于林木年龄、树冠发育等多项指标进行划分,但应用较复杂。林木分级指数法则通过量化的分级模型,结合竞争指数等指标,为复杂林分提供了量化依据,是较为创新的分类方法。在林分生长发育阶段划分方面,研究介绍了龄组划分法、森林循环阶段划分法、正向演替阶段划分法、发育演替阶段划分法和基于数学方法的阶段划分法。龄组划分法基于林木年龄特征,操作简便,适用于人工林,但对异龄天然林的描述较为局限。森林循环阶段划分法主要适用于天然林,通过森林动态循环的概念划分生长阶段,尤其适合未受干扰的原始林区。正向演替阶段划分法通过次生演替中的物种更替过程划分多个阶段,尽管能够解释演替规律,但在森林经营中的直接应用较为有限。发育演替阶段划分法结合了自然演替和森林经营需求,既反映了生态过程,又为人工林和天然林的多功能管理提供了实际指导,具有较高的应用价值。基于数学方法的阶段划分法运用大数据和建模技术,如最优分割法、聚类分析法、TWINSpan 双向指示种分析法等,提升了阶段划分的客观性和精确性,但生物学解释性不足,仍需进一步优化。【结论】总体而言,克拉夫特分级法和发育演替阶段划分法因其理论完善、应用广泛,在实际经营和研究中更具实用价值,但相关的标准体系还需进一步完善。随着大数据和人工智能技术的发展,未来的阶段划分方法可将数学方法与生物学理论相结合,提高划分阶段的适用性和生物学意义,并推动森林生长发育阶段划分方法的优化与推广应用,为森林可持续经营提供更加精确的技术支撑。

关键词: 发育阶段、龄组、森林演替、林木分级、生命循环

中图分类号 Q958.15

文献标识码: A

文章编号:

Summary of classification methods of forest growth and development stages

Abstract: 【Objective】 Identifying the growth and development stages of forests is the prerequisite for realizing the full-cycle management of forests. This study systematically sorted out the main methods for dividing the growth and development stages of forests, proposed the advantages and disadvantages of various methods and their application scenarios, and provided scientific basis for the accurate management of the full-cycle of forests and promoted the sustainable development of forest management. The research is divided into two parts: the division of growth and development stage of single tree and the division of growth and development stage of stand. The five main methods are introduced respectively. 【Method】 Kraft grading, Terazaki grading, Holley grading, Dunning grading and tree grading index are commonly used in the classification of growth and development stages of individual trees. Kraft grading method is the most classic classification method, based on tree growth potential and crown form, trees are divided into five grades,

with easy operation and strong applicability, especially suitable for pure forests of the same age. Although it ignores trunk defects, it has become an important tool in forest management because of its simple operation and wide application. Terasaki grading method and Holley grading method are applicable to coniferous pure forest and mixed broad-leaved forest respectively. The former pays more attention to the crown form, while the latter focuses on the competition state of trees in the crown. Dunning grading method is suitable for mixed forests of different ages, which is based on many indexes such as tree age and crown development, but the application is complicated. The law of tree classification index provides quantitative basis for complex stands through quantitative classification model and competition index, which is a relatively innovative classification method. In terms of the division of growth and development stages of stand, the age group division, forest cycle stage division, forward succession stage division, development succession stage division and stage division based on mathematical methods were introduced. Based on the age characteristics of trees, the age group classification method is simple and suitable for artificial forests, but the description of natural forests of different ages is limited. The classification method of forest cycle stage is mainly applicable to natural forest, and the growth stage is divided by the concept of forest dynamic cycle, which is especially suitable for undisturbed virgin forest area. The forward succession stage division method divides multiple stages through the species replacement process in secondary succession. Although it can explain the succession law, its direct application in forest management is limited. This method combines natural succession and forest management. It not only reflects the ecological process, but also provides practical guidance for the multifunctional management of plantation and natural forest. It has high application value. The mathematical method of stage division uses big data and modeling techniques, such as optimal segmentation, cluster analysis, TWINSpan bidirectional indicator analysis, etc., to improve the objectivity and accuracy of stage division, but the biological explanation is insufficient and needs further optimization. 【Result】 In general, the Kraft grading method and the developmental succession stage classification method are more practical in practice and research because of their perfect theory and wide application, but the relevant standard system needs to be further improved. With the development of big data and artificial intelligence technology, the future stage division method can combine mathematical methods with biological theories, improve the applicability and biological significance of stage division, and promote the optimization and popularization and application of forest growth and development stage division method, so as to provide more accurate technical support for sustainable forest management.

Key words: Developmental stage; age group; forest succession; tree classification; life cycle