Prediction of tree age distribution based on survival analysis in natural forests: a case study of preserved permanent plots in the University of Tokyo Hokkaido Forest, northern Japan

Pavithra Rangani Wijenayake [1,*] and Takuya Hiroshima [2]
[1] Department of Forest Science, Graduate School of Agricultural and Life Sciences, The University of Tokyo, 1-1-1 Yayoi, Bunkyo-ku, Tokyo, 113-8657, Japan, rangani@g.ecc.u-tokyo.ac.jp
[2] The University of Tokyo Hokkaido Forest, Graduate School of Agricultural and Life Sciences, The University of Tokyo, 9-61, Furano, Hokkaido, 079-1563, Japan, hiroshim@uf.a.u-tokyo.ac.jp
*****Correspondence: rangani@g.ecc.u-tokyo.ac.jp

Abstract

In forests, tree mortality is strongly determined by complex interactions between multiple biotic and abiotic factors, and analysis of tree mortality is widely implemented in forest management. However, age-based tree mortality remains poorly evaluated quantitatively at the stand scale. The objective of this study is to predict the age distribution of living and dead trees based on survival analyses. We used a combination of tree-ring and census data from the two preserved permanent plots in the University of Tokyo Hokkaido Forest in pan-mixed and sub-boreal natural forests, northern Hokkaido, Japan, to derive site-specific survival models. All the living trees (diameter at breast height ≥ 5 cm in 2000) were targeted to identify tree ages using a RESISTOGRAPH, a semi non-destructive device. Periodical tree age data with a 10-year age class were used during two observation periods of 2000–2009 and 2010–2019, and all the changes (i.e., death and new in-growth) during the periods were recorded. In the analyses, one plot was affected with a typhoon in 2016, so wind caused tree deaths were excluded from the plots to maintain the time stabilities of survival functions between the periods. The results showed that the parametric survival analysis with Weibull distribution successfully yielded the mortality rate, mortality probability and survival probability in each plot. In addition, the calculated mean lifetime of each plot was facilitated to make decisions on biological mortality of the uneven forest stands. Finally we predicted the future age class distribution of living and dead trees of each plot based on the results of survival analyses and discussed its management implications.

Keywords: natural forest; survival analysis; tree age distribution