Dead wood and stand structure - relationships for forest plots across Europe

Walter Seidling [(1)], Davide Travaglini [(2)], Peter Meyer [(3)], Peter Waldner [(4)], Richard Fischer [(5)], Oliver Granke [(6)], Gherardo Chirici [(7)], Piermaria Corona [(8)]

Dead wood and stand structural parameters were sampled in eleven countries using standardized methods at about 90 intensive forest monitoring sites across large parts of Europe. Besides descriptions and correlation analyses of dead wood and stand structure parameters, a joint evaluation of both fields was performed by principal component analysis (PCA). The extracted principal components were subsequently regressed against important numerical and categorical site-related parameters like soil pH, altitude, or forest type. Dead wood volumes varied largely across plots, however, 77 percent of them had volumes below 25 cubic meter per hectare. While all fractions of dead wood - except cut stumps - reveal high intercorrelation, different aspects of stand structure varied more independently. Clark-Evans index, number of tree species and standard deviation of tree trunk diameters revealed as most self-contained. The 1st PCA axis covered 46 percent of the total variance and was mostly loaded by total dead wood volume denoting it as the feature differentiating forests most. The 2nd axis was primarily loaded by tree species diversity together with stem density and the Clark-Evans index. On the 3rd axis diameter differentiation of trees together with the volume of cut stumps prevailed, while the 4th was mainly related to the decay class of woody debris. Bivariate *ex post* analyses revealed country as a significant predictor of all PCA axes, underlining national forest legislations and management rules as crucial for all investigated structural features of forests. Forest type was related only to the 3rd and 2nd axis. Only the 3rd axis revealed significant relationships with some ecological site factors (age, number of tree layers, latitude, altitude). The outcome underlines the significance of nationally enacted forest legislations for both important structural and biodiversity-relevant features of forest ecosystems and encourages similar approaches with data from national forest inventories or monitoring systems.

Keywords: Structural Diversity, Principle Component Analysis, Forest Monitoring, ICP Forests, ForestBIOTA

Introduction

Both, living trees and its remains, decaying wood, constitute the main structural compounds of any forests. Stand structure has often been mentioned as an important driving force for species diversity in forests and close relationships between structural attributes of tree stands and their faunal diversity have been shown for several systematic groups or ecological guilds (*e.g.* carabid beetles: Fahy & Gormally 1998; bats and birds: Gerell 1998; birds, saproxylic beetles and fungi: Müller et al. 2007; oscine birds: Müller et al. 2009; a felid: Schmidt 2008; general habitat functions: Frank et al. 2009). Diversity of ground vegetation may also be linked to aspects of stand structure (Hermy 1988, Økland et al. 2003). Berg et al. (1994) identified in particular structural features of old forests as critical elements for threatened species in Sweden. Moreover, structural diversity may influence productivity, stability and resilience of forests (Lähde et al. 1994, Tilman 1999, Pretzsch 2003, 2005) and living trees are carrying for the most part carbon sequestration of forests.

Dead wood constitutes habitats for many species of invertebrates like saproxylic beetles, amphibians, mammals, birds, fungi, lichens, bryophytes, and even tree saplings (*e.g.*, Harmon et al. 1986, Raymond & Hardy 1991, Szewczyk & Szwagrzyk 1996, Mikusinski & Angelstam 1997, Martikainen et al. 2000, Siitonen 2001, Ódor & Standovár 2001, Humphrey et al. 2002). Dead wood also represents a notable, albeit in large part transient carbon pool (Barford et al. 2001), as well as a source of mineral elements in soils (Hagan & Grove 1999), since decomposing tree trunks are true slow-releasing fertilizer pools (Carey 1980, Schaetzl et al. 1989).

Forest management has a direct effect on stand structures and dead wood by planting, tending and harvesting trees. Compared to unmanaged stands this may result in changes of tree species composition, vertical layering, dbh distribution, dead wood amount and other structural attributes (Siitonen et al. 2000, Wirth et al. 2009, Schall & Ammer 2013). Historical and recent forest management interventions exert negative and/or positive effects on biodiversity depending on forest type, species group considered, or management measures applied (Bengtsson et al. 2000, Ódor et al. 2006, Paillet et al. 2010, Boch et al. 2013). The number of old big trees is usually lower in managed than unmanaged forests, because classical forest management is based on rotations shorter than species' longevity (Hahn & Christensen 2004). In managed stands dead wood is often removed to avoid outbreaks of pest insect populations, to eliminate or reduce physical obstacles to silvicultural activities, or to reduce the risk of forest fires (Montes & Cañellas 2006). As a result, the amount of dead wood typically is about 70% to 98% lower in managed forests than in comparable unmanaged forests (Guby & Dobbertin 1996, Green & Peterken 1997, Kirby et al. 1998, Fridman & Walheim 2000).

Since the United Nations Conference on

(1) Thünen Institute of Forest Ecosystems, Eberswalde (Germany); (2) Dipartimento di Gestione dei Sistemi Agrari, Alimentari e Forestali, University of Florence (Italy); (3) Northwest-German Forestry Research Station, Goettingen (Germany); (4) WSL, Swiss Federal Institute for Forest, Snow and Landscape Research, Birmensdorf (Switzerland); (5) Thünen Institute of International Forestry and Forest Economics, Hamburg (Germany); (6) DigSyLand, Husby (Germany); (7) Dipartimento di Bioscienze e Territorio, University of Molise, Pesche (Italy); (8) Consiglio per la ricerca e la sperimentazione in agricoltura, Forestry Research Centre, Arezzo (Italy)

@ Walter Seidling (walter.seidling@ti.bund.de)

Received: Jun 24, 2013 - Accepted: Feb 27, 2014

Citation: Seidling W, Travaglini D, Meyer P, Waldner P, Fischer R, Granke O, Chirici G, Corona P, 2014. Dead wood and stand structure - relationships for forest plots across Europe. iForest 7: 269-281 [online 2014-04-14] URL: http://www.sisef.it/iforest/ contents/?id=ifor1057-007

Communicated by: Enrico Marchi