An intuitive way to assess forest management intensity. Potential and caveats

Francesco Maria Sabatini

1Department of Environmental Biology, Sapienza, University of Rome. P.le Aldo Moro 5, 00185, Rome, Italy
francescomaria.sabatini@uniroma1.it

Introduction

Forests provide a variety of benefits to people, including essential raw materials whose demand is increasing globally (MEA 2005). The management of forests for wood production may affect biodiversity and ecosystem functioning, although the magnitude of this effect is strongly dependent on the intensity of management. Forest management intensity shows broad-scale patterns depending on a wealth of underlying socio-economic, cultural and ecological drivers (Levers et al. 2014). The development of tools for the objective quantification of forest management intensity may help describe its patterns and interpret the underlying drivers. This would lead to an improved understanding of the trade-offs between forestry and conservation, with consequent positive repercussions on the implementation of more sustainable forestry system.

Quantifying forest management intensity is a difficult task, since it encompasses multiple scales and attributes. A range of indicators have been developed, each one focusing on different aspects of management intensity (Schall and Ammer 2013). In a recent contribution, Kahl and Bauhus (Kahl and Bauhus 2014) added a new tool to the forester toolbox. They developed a new multi-criteria index (called ForMI: Forest Management Intensity) with the aim of quantifying forest management intensity. This index looks particularly convenient: when compared to other indices (e.g. those in Luyssaert et al. 2011, Schall and Ammer 2013), ForMI is easier to calculate and it needs less assumptions, for instance about stand carrying capacity. ForMI is composed by the sum of three components which respectively account for: i) the proportion of harvested biomass; ii) the proportion of species which are not part of the potential natural vegetation (i.e. human-induced changes of tree species composition), and iii) the proportion of dead wood showing signs of saw cuts. The performance of the index was tested against a set of 148 forest experimental plots of the German Biodiversity Exploratories (Fischer et al. 2010), in which ForMI successfully distinguished between managed and unmanaged stands.

Merits

Quantifying management intensity in a reproducible way is necessary in order to evaluate the effects of management on forest composition, structure and functioning. The ForMI index is easy to calculate and to understand. Its calculation is based on commonly collected inventory data, whereas neither previous estimations of site quality or stand age, nor further assumptions on stand carrying capacity are needed.
Although the occurrence of cut stumps has often been considered when assessing the naturalness of a stand (McRoberts et al. 2012), the idea of using the proportion of dead wood biomass showing saw cuts as a metric of management intensity is original and noteworthy.

Critique

Kahl and Bauhus (2014) assume that the sum of the 1. living standing tree biomass, 2. harvested tree biomass removed from the stand, and 3. deadwood biomass of trees that do not show signs of chain saw cuts, can be used as a proxy for the potential cumulative merchantable volume of a stand. This approach may be reasonable, although it may not be applicable to some circumstances, for instance where deadwood is systematically collected by local people for fuel, or in those ecosystem subject to recurrent high to moderate frequency ground-fire regimes. The main concern, however, is related to the estimation of harvested biomass from cut stumps. The authors assume 30-40 years as a realistic stump turnover time. Stump decay rates, however, are highly variables and may depend on climate, stump size and tree species.

Lombardi et al. (2008) reported a very high variability in stump decomposition rates in central Italy, and found some 70 years old beech stumps still sound enough to allow dendro-chronological analysis. This is noteworthy since, for climatic reasons, decay rate in central Italy is likely higher than that observed in central Europe. This consideration suggests that the assumption of a maximum stump turnover time of 30 to 40 years may represent an underestimation and a possible source of bias when accounting for harvested biomass.

Although conflicting evidence exists, also stump size exerts a critical influence on stump turnover time. It means that the legacies of a silvicultural intervention aimed at removing small- to intermediate-sized trees (e.g. thinning from below) likely disappear earlier than those of an interventions which removes intermediate- to large-sized trees (e.g. selection cutting). In this case, the ForMI of an actively managed stand subject to recursive thinning practices may thus be substantially lower than the index calculated on a selection forest that was abandoned for 3-4 decades. Furthermore, as correctly observed by Kahl and Bauhus, stumps of decay resistant species (such as oak) may last longer than other. Indeed, the wood produced by different species varies substantially in chemical, micro- and macro-morphological traits which may influence the colonization of deadwood by microbes and fungi, with cascading effects on deadwood turnover rate. For instance, lower decomposition rates were reported for conifers when compared to deciduous broadleaved trees, probably due to differences in C:N and lignin:N ratios (Cornwell et al. 2009). Consequently, ForMI may show upward bias when the management intensity of coniferous stands is evaluated, in comparison to deciduous stands with the same age and management history.

The potential biases when comparing stands with different composition (e.g. deciduous vs coniferous), subject to different silvicultural regimes (e.g. thinning from below vs selection cuttings), or in different climatic conditions (e.g. mediterraneae vs temperate) suggest that the application of ForMI should be cautious and limited only to regional scale comparisons of forest management intensity, as correctly stated by Kahl and Bauhus.

Discussion

ForMI index provides a simple yet effective means of ranking stands along a management intensity gradient. This is an important issue, since silvicultural stand management affects the compositional, horizontal and vertical structure of forest stands, as well as its functioning in several ways (Schall andammer 2013). I believe that those researchers interested in quantifying the effect of forest management intensity on important ecosystem features such as biodiversity, carbon storage or resilience, may take advantage by the use of ForMI. However, the concerns raised above suggest caution in its application, since further testing is required to assess the actual potential of this index on a wider range of forest types, climatic regions and silvicultural management systems.
References


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