Nature Conservation 4: 29–33 (2013)
doi: 10.3897/natureconservation.4.5116
http://www.pensoft.net/natureconservation

FORUM PAPER

A peer-reviewed open-access journal
Nature Conservation
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Retention forestry and biodiversity conservation: a parallel with agroforestry

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Academic editor: *K. Henle* | Received 12 March 2013 | Accepted 12 March 2013 | Published 14 March 2013

Citation: Roberge J-M, Mönkkönen M, Toivanen T, Kotiaho JS (2013) Retention forestry and biodiversity conservation: a parallel with agroforestry. Nature Conservation 4: 29–33. doi: 10.3897/natureconservation.4.5116

In forested landscapes two general management systems – retention forestry and agroforestry – have been proposed as potentially efficient components of landscape approaches to ease the conflict between biodiversity objectives and human needs. In two recent reviews, Gustafsson et al. (2012) and Lindenmayer et al. (2012) provide a global overview of current knowledge about the practice and ecological roles of retention forestry. A few years ago, Bhagwat et al. (2008) produced a similar review addressing the role of agroforestry in biodiversity conservation. Here we draw a parallel between research on the ecological effects of retention forestry and agroforestry. We argue that conservation science and practice would benefit from bridging these two separate fields and the experiences achieved.

Gustafsson et al. (2012) defined retention forestry as "an approach to forest management based on the long-term retention of structures and organisms, such as live and dead trees and small areas of intact forests, at the time of harvest". The retention approach is broadly applicable to tropical, temperate and boreal forests (Lindenmayer et al. 2012). Agroforestry is defined as "intentional management of shade trees with agricultural crops" (Bhagwat et al. 2008). The agricultural component of agroforestry systems may also consist of pasture (Mosquera-Losada et al. 2008). Agroforestry systems are widespread in the tropics but also relevant to temperate regions (e.g. Gordon and Newman 1997; Mosquera-Losada et al. 2008). In even-aged forest management, there are typically three possible management regimes for a given stand: clearcutting (or shelterwood without long-term tree retention), harvesting with retention, and no harvesting. Analogously, in the context of agriculture, three broad types of local land use are likely in regions where the natural vegetation is forest: intensive agriculture or plantation, agroforestry, and no management (i.e. forest).

There are important similarities between retention forestry and agroforestry, the most salient being that they both result in a tree cover which is intermediate between treeless vegetation and continuous forest. The original reasons for leaving some tree cover may differ between the two approaches, but from the biodiversity conservation perspective they still share many important features: both approaches (1) maintain or restore compositional, structural and functional diversity within ecosystems, (2) facilitate dispersal in fragmented landscapes through increased connectivity for forest-dwelling species, (3) provide habitat for tree-dependent species outside forest, and (4) minimize off-site impacts of management on, for example, aquatic systems (Bhagwat et al. 2008, Jose 2009, Gustafsson et al. 2012). There are also differences between the two approaches as regards biodiversity conservation. For example, in even-aged forestry retention trees may play a temporary life boating role over the first stages of forest succession (Gustafsson et al. 2012) as opposed to a more static function in most agroforestry systems. In retention forestry, the level and spatial patterning of retention is usually based on conservation objectives (and influenced by operational limitations), whereas the tree cover characteristics in agroforestry systems has traditionally been influenced mostly by agricultural production objectives. Nevertheless, the large overlap in the features important for biodiversity conservation implies a clear potential for bridging the two fields. For example, although the two approaches are relevant to both temperate and tropical regions, the biodiversity benefits of retention forestry have mostly been studied in temperate and boreal ecosystems. Hence, tropical retention forestry could benefit not only from the knowledge about retention forestry outside the tropics, but also from some of the experiences acquired in tropical agroforestry.

How have retention forestry and agroforestry succeeded at conserving biodiversity in practice? Bhagwat et al. (2008) compared species richness and composition between tropical forest reserves and agroforestry systems, and concluded that the latter may help conserve a large proportion of tropical biodiversity in the face of an increasing land-use pressure. Research on retention forestry has shown that species richness may be relatively high on retention sites, but that several specialized species requiring interior-forest conditions cannot persist there (Rosenvald and Lõhmus 2008). Bhagwat et al. (2008) also raised the issue that agroforestry systems may be impoverished in specialist and endemic species, an area which clearly requires more research. Hence, the use of coarse-resolution biological response variables such as total species richness or abundance within higher taxa may not be sufficient for evaluating the conservation value of the two management systems (Waltert et al. 2011). To guide conservation, we need better knowledge about which particular groups of species tend to be systematically absent or underrepresented in various types of retention sites and agroforestry systems relative to naturally dynamic forest and traditional woodlands (e.g. ancient tree-bearing cultural systems; Kirby and Watkins 1998). Other important areas for future research include the role of tree species, density and spatial configuration, effects on the reproductive success of threatened species, and modeling of the long-term effects of the two management systems on biodiversity in complex landscapes (see e.g. Ranius and Roberge 2011 for tree retention).

Given that retention forestry and agroforestry imply different costs and benefits compared to their respective alternatives, integrated cost-effectiveness analysis (Hughey et al. 2003) is necessary to assess their feasibility for conservation practice. For example, Mönkkönen et al. (2011) compared the cost-effectiveness of a number of alternative conservation approaches – including tree retention – for long-term conservation of boreal forest biodiversity. Some attempts have recently been made to assess the cost-effectiveness of agroforestry systems in the context of climate change mitigation (e.g. Makundi and Sathaye 2004), but surprisingly little has been done in relation to biodiversity conservation outcomes. An important question is whether it is possible to develop high-biodiversity approaches which simultaneously provide high economic returns (Clough et al. 2011, Tikkanen et al. 2012). Ideally, cost-effectiveness analyses should consider not only the local scale but also the management systems' roles as part of wider landscape-scale strategies (e.g. Côté et al. 2010).

Notwithstanding the importance of protected forests, we concur with Lindenmayer et al.'s (2012, see also Franklin and Lindenmayer 2009) and Bhagwat et al.'s (2008) conclusions that the matrix deserves increased attention, and that retention forestry and agroforestry are likely to constitute crucial tools for matrix management and restoration. We call for further research about the cost-effectiveness of retention forestry and agroforestry as complements to other existing approaches in various socio-ecological systems for the conservation of biodiversity. To this aim, we encourage increased collaboration between researchers and practitioners across the two fields.

Acknowledgements

We thank six anonymous reviewers from Peerage of Science for their insightful suggestions which helped improve the manuscript. We are also grateful to Panu Halme for valuable discussions and input on the topic.

References

Bhagwat SA, Willis KJ, Birks HJB, Whittaker RJ (2008) Agroforestry: a refuge for tropical biodiversity? Trends in Ecology and Evolution 23: 261–264. doi: 10.1016/j.tree.2008.01.005

Clough Y, Barkmann J, Juhrbandt J, Kessler M, Wanger TC, Anshary A, Buchori D, Cicuzza D, Darras K, Dwi Putra D, Erasmi S, Pitopang R, Schmidt C, Schulze CH, Seidel D, Steffan-Dewenter I, Stenchly K, Vidal S, Weist M, Wielgoss AC, Tscharntke T (2011)

Combining high biodiversity with high yields in tropical agroforests. Proceedings of the National Academy of Sciences of the United States of America 108: 8311–8316. doi: 10.1073/pnas.1016799108

Côté P, Tittler R, Messier C, Kneeshaw DD, Fall A, Fortin M-J (2010) Comparing different forest zoning options for landscape-scale management of the boreal forest: possible benefits of the TRIAD. Forest Ecology and Management 259: 418–427. doi: 10.1016/j.foreco.2009.10.038

Franklin JF, Lindenmayer DB (2009) Importance of matrix habitats in maintaining biological diversity. Proceedings of the National Academy of Sciences of the United States of America 106: 349–350. doi: 10.1073/pnas.0812016105

Gordon AM, Newman SM (1997) Temperate agroforestry systems. CAB International (Wallingford, UK): 1–269.

Gustafsson L, Baker SC, Bauhus J, Beese WJ, Brodie A, Kouki J, Lindenmayer DB, Lõhmus A, Martínez Pastur G, Messier C, Neyland M, Palik B, Sverdrup-Thygeson A, Volney WJA, Wayne A, Franklin JF (2012) Retention forestry to maintain multifunctional forests: a world perspective. Bioscience 62: 633–645. doi: 10.1525/bio.2012.62.7.6

Hughey KFD, Cullen R, Moran E (2003) Integrating economics into priority setting and evaluation in conservation management. Conservation Biology 17: 93–103. doi: 10.1046/j.1523-1739.2003.01317.x

Jose S (2009) Agroforestry for ecosystem services and environmental benefits: an overview. Agroforestry Systems 76: 1–10. doi: 10.1007/s10457-009-9229-7

Kirby KJ, Watkins C (Eds) (1998) The ecological history of European forests. CAB International (Wallingford, UK): 1–373.

Lindenmayer DB, Franklin JF, Lõhmus A, Baker SC, Bauhus J, Beese W, Brodie A, Kiehl B, Kouki J, Martínez Pastur G, Messier C, Neyland M, Palik B, Sverdrup-Thygeson A, Volney J, Wayne A, Gustafsson L (2012) A major shift to the retention approach for forestry can help resolve some global forest sustainability issues. Conservation Letters 5: 421–431. doi: 10.1111/j.1755-263X.2012.00257.x

Makundi WR, Sathaye JA (2004) GHG mitigation potential and cost in tropical forestry – relative role for agroforestry. Environment, Development and Sustainability 6: 235–260. doi: 10.1023/B:ENVI.0000003639.47214.8c

Mönkkönen M, Reunanen P, Kotiaho JS, Juutinen A, Tikkanen OP, Kouki J (2011) Cost-effective strategies to conserve boreal forest biodiversity and long-term landscape-level maintenance of habitats. European Journal of Forest Research 130: 717–727. doi: 10.1007/s10342-010-0461-5

Mosquera-Losada M, McAdam JH, Romero-Franco R, Santiago-Freijanes J, Rigueiro-Rodríguez A (2008) Definitions and components of agroforestry practices in Europe. In: Rigueiro-Rodríguez A, McAdam J, Mosquera-Losada MR (Eds). Agroforestry in Europe: current status and future prospects. Advances in Agroforestry vol. 6, Springer (The Netherlands): 3–19. doi: 10.1007/978-1-4020-8272-6_1

Ranius T, Roberge J-M (2011) Effects of intensified forestry on the landscape-scale extinction risk of dead-wood dependent species. Biodiversity and Conservation 20: 2867–2882. doi: 10.1007/s10531-011-0143-8

Rosenvald P, Lõhmus A (2008) For what, when, and where is green-tree retention better than clear-cutting? A review of the biodiversity aspects. Forest Ecology and Management 255: 1–15. doi: 10.1016/j.foreco.2007.09.016

Tikkanen O-P, Matero J, Mönkkönen M, Juutinen A, Kouki J (2012) To thin or not to thin: bio-economic analysis of two alternative practices to increase amount of coarse woody debris in managed forests. European Journal of Forest Research 131: 1411–1422. doi: 10.1007/s10342-012-0607-8

Waltert M, Bobo KS, Kaupa S, Montoya ML, Nsanyi MS, Fermon H (2011) Assessing conservation values: biodiversity and endemicity in tropical land use systems. PLoS ONE 6(1): e16238. doi: 10.1371/journal.pone.0016238