Roadless space is greatly diminished by logging in intact forest landscapes of the Congo Basin

Fritz Kleinschroth1,2\*, John R. Healey2, Sylvie Gourlet-Fleury1, Frédéric Mortier1 and Radu S. Stoica3,4

1CIRAD, Biens et Services des Ecosystems Forestiers Tropicaux, 34398 Montpellier, France

2Bangor University, School of Environment, Natural Resources and Geography, Bangor Gwynedd, LL572UW, UK

3Universite de Lille 1, Laboratoire Paul Painleve, 59655 Villeneuve d’Ascq, France;

4Institut de Mécanique Céleste et de Calcul des Éphémérides, Observatoire de Paris, 75014 Paris, France

\*To whom correspondence should be addressed. Email: [fritz.kln@gmail.com](mailto:fritz.kln@gmail.com)

**Abstract**

Forest degradation in the tropics is often associated with roads built for selective logging. The protection of Intact Forest Landscapes (IFL) that are not accessible by roads is high on the biodiversity conservation agenda, a challenge for logging concessions certified by the Forest Stewardship Council (FSC). A frequently advocated conservation objective is to maximise the retention of “roadless space”, a concept that is based on distance to the nearest road from any point. We developed a novel use of the empty space function – a general statistical tool based on stochastic geometry and random sets theory – to calculate roadless space in a part of the Congo Basin where there has recently been rapid expansion of road networks. We compared the temporal development of roadless space in certified and non-certified logging concessions inside and outside areas declared as IFL in the year 2000. Between 1999 and 2007, rapid road network expansion led to a marked loss of roadless space in IFL. After 2007, this trajectory levelled out in most areas, due to an equilibrium between newly built roads and abandoned roads that became revegetated. However, concessions within IFL that have been certified by FSC since around 2007 showed continued decreases in roadless space, thus reaching a level comparable to all other concessions. Only national parks remained mostly road-free. We recommend that forest management policies make the preservation of large connected forest areas a top priority by effectively monitoring – and limiting – the occupation of space by roads that are permanently accessible.

**Keywords:** forest certification, road networks, Central Africa, random sets, logging concessions, sustainable forest management, road density, biodiversity

**Running head:** Roadless space in intact forest landscapes

**Word count:** 6288

**Acknowledgments:** This study was funded by the European Union Erasmus Mundus joint doctorate programme FONASO. We thank M. N. M. van Lieshout for essential advice on the methodology and Alain Karsenty for helpful comments on the manuscript. We are grateful for thoughtful and constructive comments of three anonymous reviewers.