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**Review Report on PhD dissertation submitted to  
Institute of Nature Conservation, Polish Academy of Sciences, Kraków**

**Candidate's Name:** MGR. MONIKA TERESA HOFFMANN

**Dissertation Title:** ROADLESS AREAS AS TOOLS FOR THE CONSERVATION OF  
FUNCTIONAL ECOSYSTEMS

**Dissertation Supervisor:** DR. HAB. NURIA SELVA FERNÁNDEZ

**Reviewer:** DR. HAB. KATARZYNA NOWAK

**DISSERTATION EVALUATION**

Roads are a root cause of biodiversity loss. This publication-based dissertation—consisting of three published articles about roadless areas, their location, conservation status and value, including as a key approach to ecosystem conservation—tackles the challenging subject of roads. This thesis holds original and scientific merit, contributes to new knowledge in the field of conservation, and ranks as very good. The methodology is scientifically sound and the PhD candidate—Mgr. Monika T. Hoffmann—has demonstrated an in-depth understanding of the research area.

Hoffmann is lead author on two and second author on one of the three publications making up this thesis. In the first (Ibisch et al. 2016), we learn how roadless areas are defined, the main source of data on their spatial extent—Open Street Map (OSM), and an index that takes ecosystem functionality, roadless area patch size and connectivity, into account—the Ecological Value Index of Roadless areas (EVIRA). Nearly two-thirds of roadless areas around the world have medium to high EVIRA values and most of these are not formally protected. In the second publication (Hoffmann et al. 2020), forest ecosystems are the main focus. The authors advocate that existing tracts of large roadless forest (mostly found in boreal and tropical regions) need protection from road-induced fragmentation; meanwhile, mixed and broadleaf forest areas are of special priority when it comes to restoration given their high road density. In the third paper (Hoffmann et al. 2024), the completeness of road data in OSM 2020 is examined and, once data gaps are manually filled, a decline in roadless areas in two regions is found: by 27% in boreal Canada and 28% in Central Europe (two vastly different regions in terms of road density with Central Europe 11 times more road-dense than boreal Canada).

Broader relevance and applications of this highly original and far-sighted work are clearly defined. Roadlessness can serve as a measurable proxy for functional ecosystems and should feature in sustainable development plans and legal frameworks. Incorporating roadlessness into policy and committing to maintaining roadless areas would help us preserve what remains of relatively high integrity ecosystems and biodiversity. Certainly, this work is of great relevance to land use planning and I hope it is or will be widely shared with land use planning councils around the world (e.g., <https://planyukon.ca/>). This work further addresses how roadless area conservation is in conflict or alignment with the UN Sustainable Development Goals, such as SDG 9 on resilient infrastructure, sustainable industrialization and innovation and SDG 15 on life on land and protection, restoration and promotion of sustainable use of terrestrial ecosystems including forests. While roadless area protection is overall congruent with five SDGs, it conflicts with four others revealing how we have construed sustainable development without roadlessness in mind.

Thank you for the opportunity to review this high-quality, interesting and timely work. My comments and questions are organized below by section of the thesis: the front material consisting of a summary, general introduction, research objectives and questions; published papers 1-3; and conclusions.

### **Front sections (pp. 1-24)**

#### *Comments*

It is a major finding that only 9% of roadless areas are within protected areas and of these less than half are strictly protected. This also begets the questions of 1) how roadless are most protected areas and 2) if strategies other than protection can be effective at maintaining roadless-ness.

#### *Questions*

What can other countries learn from the USA and Greece, the only countries with active roadless area conservation? Can the candidate comment on the roles of legislation and political will in these two countries in their conservation of roadless areas?

Roads beget roads (and other anthropogenic disturbances). What are the candidate's own observations of this contagion effect over the course of work on this thesis? In light of contagion, do most cumulative effects of roads ultimately extend beyond the "1 km road effect zone"?

In what ways are roadless areas good benchmarks or reference points for adaptive conservation and management?

## **Paper 1 (pp. 25-89)**

**2016**

### **A global map of roadless areas and their conservation status.**

#### ***Science***

##### *Comments*

The supplementary information accompanying this paper is extensive and very interesting, especially Table S2 of studies on road effects organized by, for example, changes in species abundance, behavior, species richness and diversity. It demonstrates and serves as an extensive literature review of the subject matter. The synergies and conflicts between SDGs, Aichi Targets and roadless area conservation should be of special interest to persons working in the international conservation policy realm as it is exactly such analysis that is needed when preparing large landscape conservation strategies which incorporate local communities (and people's access to education, emergency medical care/ambulances, nutrition and markets to sell and buy farm goods, and so on). The potential threat posed by roads to Traditional Ecological Knowledge of Indigenous Peoples is a further topic for thought and I am glad that the authors included it; it makes me wonder the position on road development of, for example, the Conservation through Reconciliation Partnership (<https://conservation-reconciliation.ca/>) or Healthy Country planners in Australia.

##### *Questions*

Why is Australia unique in being the only continent with large tracts of protected high EVIRA value roadless areas (it has to my knowledge no history of actively targeting roadless areas for protection and while it has some tropical forest it of course does not have boreal forest areas which exhibit the highest EVIRA values elsewhere)?

Can you explain the reasons behind low EVIRA values in one-third of roadless areas?

You mention CIFOR overestimation of existing logging roads because these roads become overgrown by forest; can you comment over what kind of time period this occurs (until such logging roads are no longer visible on Google Earth satellite images)?

If you were to make a continuum of road adversity, which taxa would be among the most road-adverse and why?

## **Paper 2 (pp. 91-103)**

**2020**

### **Roadless areas as key approach to conservation of functional forest ecosystems**

#### **In *Encyclopedia of the World's Biomes*, vol. 3**

##### *Comments*

A very clearly written paper that represents an excellent reference on road impacts and importance of roadless areas for conservation biology students as well as policy makers working in conservation, on ecological connectivity, and forest management. The overview of road effect zones (REZ) across different types of ecosystems is very useful for showing how different factors figure into REZ (and therefore likely also into ecosystem-specific maximum

thresholds of ecologically tolerable road densities). The messages for policy makers are excellent with the most proactive measure clearly stated: moratoria on constructing roads in high priority roadless areas. I assume high EVIRA = high priority?

#### *Questions*

Can you briefly discuss one direct and one indirect effect of roads on forest ecosystems?

Can you discuss one roadless mobility option specifically for forested regions?

### **Paper 3 (pp. 104-144)**

**2024**

#### **Mapping roadless areas in regions with contrasting human footprint**

##### ***Scientific Reports***

##### *Comments*

In this paper, the vast wilderness of boreal Canada is compared with temperate Central Europe with 85% and 0.4% roadless coverage respectively. Despite these differences, a similar rate of loss of roadless surface is found once unmapped roads are added to randomly chosen roadless areas in each focal region. This finding testifies to, as the authors note in their discussion, the dynamic growth of the road network, limited resources to keep pace when it comes to updating maps and road data, and therefore underestimation of the extent of roads. In regions such as Central Europe, even small roadless areas are of ecological importance (I would have liked to hear about a couple of these).

#### *Questions*

Why do you think Czechia has a high % of plots with correctly mapped OSM roads (is their user base somehow unique/more active of the Central European countries considered)?

If you were to use the latest OSM data, what would you expect to find (in light also of how the OSM dataset of 2013 compared with 2018 shows a doubling of data on roads in this period)?

What are some of the major challenges of road reclamation and remediation processes in Europe?

Can you comment on the evolution of automated road detection methods over the course of your thesis work and on its current state of advancement?

**Conclusions (pp. 145-147)**

*Comments*

This is a short list of five general conclusions. In addition, I would have liked to read a slightly lengthier narrative overview by Hoffmann at the end.

*Questions*

To preserve roadlessness, are there alternatives to traditional protection in certain anthromes? For example, according to your Table S7 (p.75-76), some rangelands (not only remote but also those that are populated) have large roadless tracts. Can roadlessness in some such areas be preserved without any active protection measures or even by allowing these places to be or become “working” landscapes inclusive of people and livestock?

One suggestion for future research: How roadless are country borders versus non-borders? Were border roads (roads along international borders) counted in your analysis as regular roads (you note in your conclusions that “all road types were considered” so I assume border roads were too)?

You mention the Roadless Initiative in one of your acknowledgements which piqued my interest. Can you say a little about this initiative? At first thought, it makes me think of Dark Sky International and makes me wonder how much of dark skies are owed to roadless areas.

What is an important future direction for roadless ecology?

**Recommendation**

The research both carried out collaboratively and led by Hoffmann is extremely thorough and original, with practical and important applications to the field of conservation.

I commend this PhD candidate and recommend that her PhD be conferred following a successful defense.

In conclusion, I declare that the doctoral dissertation submitted for review, whose author is Monika Teresa Hoffmann, meets the criteria for doctoral dissertations pursuant to art. 187 of Act of 20 July 2018, Law on Higher Education and Science (Journal of Laws of 2018, item 1668, as amended) and I put forward a motion to the Scientific Council of the Institute of Nature Conservation of the Polish Academy of Sciences in Kraków to admit Mgr. Monika T. Hoffman to further stages of the doctoral dissertation.

June 10, 2024

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Date

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Reviewer’s signature