Dear Editor:

We are submitting for your consideration our manuscript, “Change in Composition, Density, and Biomass since the Settlement Era (1800s) in the Upper Midwestern United States.”

This paper presents new analysis and synthesis of settlement-era forest composition and structure based on Public Land Survey (PLS) data from the Upper Midwestern United States. Our analysis substantially advances from prior PLS-based work by developing new methods for correcting for surveyor bias in a way that accounts for changing survey design throughout the region. This paper is also the first to provide PLS-based estimates of historical forest biomass at this broader regional scale. We aim to show the extent of change in forest composition, describe the spatial patterns of change, and quantify the relationship between ecological novelty and the spatial structure of remnant forests in the region.

We apply the new PLS-based dataset to contrast forest structure and composition prior to Euro-American settlement with modern forest structure from the Forest Inventory and Analysis database. Key findings include:

1. Contemporary forests in the upper Midwest have higher stem density but lower total basal area and biomass than settlement-era forests, likely because of the larger size of individual settlement-era trees and differential changes in landscape level processes between the northern and southern parts of the region.
2. Almost 30% of the modern forested landscape of the upper Midwest is compositionally novel relative to the PLS data, while 25% of forests in the PLS era have no modern analogues.
3. The loss of PLS forests is concentrated in central Wisconsin, near the Tension Zone, and is associated with a weakening of ecotones and an overall homogenization of forest cover across the region.
4. There is strong spatial structure in the presence of novel and remnant forests, with novel forests occurring further from remnant forest than expected by chance.

We anticipate that these PLS-based datasets will become the new standard for settlement-era forest composition and structure, and we are working closely with terrestrial ecosystem modellers to use this as a baseline dataset for a series of historical-to-21st-century experiments and modeling intercomparison protocols. The analysis and data provided here will be of interest to a broad range of researchers including paleoecologists, historical ecologists, ecologists, ecosystem modelers, geoscientists and statisticians. The breadth of our authorship team underscores this point. This paper is partner to a second submission to PLoS One (see below), a paper in revision with the Journal of Geophysical Research and a paper in preparation for resubmission to Quaternary Science Reviews.

Paciorek, C.; Goring, S. J.; Thurman, A.; Cogbill, C.; Williams, J.; Mladenoff, D.; Peters, J.; Zhu, J. & J.S., M. in review. Statistically-estimated tree composition for the northeastern United States at the time of Euro-American settlement. *PLoS One.*

This paper builds on recent analyses including:

Terrail, R.; Arseneault, D.; Fortin, M.-J.; Dupuis, S. & Boucher, Y. 2014. An early forest inventory indicates high accuracy of forest composition data in pre-settlement land survey records. *Journal of Vegetation Science, Wiley Online Library, 25*, 691-702

Thompson, J. R.; Carpenter, D. N.; Cogbill, C. V. & Foster, D. R. 2013. Four centuries of change in northeastern United States forests. *PloS one, Public Library of Science, 8*, e72540

**Data notes**: In this submission all the code required to run the analysis is provided as Supplement 1. Supplement 1 also includes files necessary to generate several of the figures used in this paper, including files from NaturalEarthData.org. The final submission will be accompanied by a public GitHub repository, and these NaturalEarth files will not be included since we do not have permission to distribute them. In their place will be direct web-links to the files. In addition, this submission contains only a subset of the full PLSS data. This subset should be sufficient to test the code and replicate most of the analysis. We have permission to use the PLS data from Wisconsin, Michigan and Minnesota, but do not have permission to distribute this data. Our final repository will include links to these datasets, along with the code necessary to link the data files together. Lastly, because of the inclusion of a large amount of primary data “Supplement 1” could not be uploaded to the PLoS System. It is available for download here: <https://www.dropbox.com/s/577bnxdrgm3sas0/Supplement1_RawCodeandData.zip?dl=0>

Thank you for your time and consideration.

Sincerely,

Simon Goring

Assistant Scientist

Department of Geography

University of Wisconsin - Madison