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| **Estimating the integrated and individual impacts of the human footprint on forest ecosystem structure and function.** |
| Anthropogenic pressures on forested ecosystems are globally increasing, leading to marked impacts on biodiversity and ecosystem services. There is a need to assess to what degree the human footprint, a measure of anthropogenic pressures such as population density, roads, and industrial activity, influences forest biodiversity metrics. This would allow management and policy makers to locate heavily impacted areas in need of ecological restoration or high-quality unimpacted areas which could be suitable for integration into the protected area network. Satellite-informed datasets on forest structural and functional attributes, as well as measures of the human footprint on the environment, are becoming available at increasingly finer spatial scales.  Here, we describe a new methodology to assess the impact of human footprint on forest structure and function via its combined and individual components. Focusing on British Columbia, the province with the largest environmental gradients in Canada, we use forest structural attributes imputed from airborne lidar data and Landsat imagery including canopy height, cover, structural complexity, and aboveground biomass. We also focus on the Dynamic Habitat Indices (DHIs), including the cumulative, minimum, and variation in energy available throughout the year.  We used impact evaluation techniques to match all pixels in the province with unimpacted counterfactuals based on similar terrain and climate. We calculated forest structure and function reference states for unimpacted areas (protected pixels with low human footprint score) using a bootstrapping approach and assessed how varying human footprint components impact forest structure and function. This approach allows for the identification of both relatively unimpacted forest areas and their respective attributes, as well as the relative changes in traits associated with increasing human footprint.  Results indicate that the combined pressures of the human footprint are greater than the sum of the individual pressures. As the combined human footprint increases, the distance from the reference state for forest structural traits increases, while forest ecosystem function generally remains similar to the reference state. We also demonstrate that the method presented herein allows for the complete spatial reconstruction of matching outcomes. This facilitates protected area managers to identify locations with traits in need of restoration (outside the reference state and heavily impacted by anthropogenic pressures) or protection (within the reference state with low/no anthropogenic pressures), thereby improving the capacity for management. |

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