Project Title: Toward operational FIA model-based estimation of high-dimensional forest inventory parameters to support inference at user-defined spatial scales.

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Period of Report: July 1, 2024 to Dec. 31, 2024

1   Progress

This has been a productive reporting period. With two papers published, four in review, and several in preparation.

Published:

1. Shannon, E.S.[1], A.O. Finley, P.B. May, G.M. Domke, H.-E. Andersen, G.C. Gaines, and S. Banerjee. Toward spatio-temporal models to support national-scale forest carbon monitoring and reporting. 2025 *Environmental Research Letters*, 20:014052. Focused on methods and applications directly associated with proposed deliverables.

2. Zhang, L., Finley, A.O., Nothdurft, A. and S. Banerjee. (2024) Bayesian modeling of incompatible spatial data: A case study involving post-Adrian storm forest damage assessment, *International Journal of Applied Earth Observation and Geoinformation*, 45. Focused on methods for SAE.

In review:

1. Itter, M.S. and Finley, A.O. Toward improved uncertainty quantification in predictions of forest dynamics: A dynamical model of forest change. *Ecological Applications*. Preprint at: `https://doi.org/10.1101/2024.07.22.604669`. Methods for estimating and predicting forest demography.

2. Itter, M.S., A.O. Finley, and A. Weiskittel. Connecting growth and yield models to continuous forest inventory data to better account for uncertainty. *Forest Ecology and Management*. Extension of the previous paper noted above. Submitted to the FIA Symposium Special Issue.

3. Crisp, A.D. Taylor-Rodriguez, and A.O. Finley. Clustering the Nearest Neighbor Gaussian Process. *Journal of Machine Learning Research* Preprint at: `https://arxiv.org/abs/2501.10656`. Methodological advancements to make the NNGP more computationally efficient.

4. Peruzzi, M., S. Banerjee, D.B. Dunson, and A.O. Finley. Grid-Parametrize-Split (GriPS) for improved scalable inference in spatial big data analysis. *Bayesian Analysis*. Preprint at: `https://arxiv.org/abs/2101.03579`.

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[1] PhD student here at MSU working on a dual PhD in Forestry and Statistics.

On-going work:

- Development of a model specification that should be more efficient than the Fay–Herriot model used in the Shannon et al. (2024) paper. Initial results look very promising and we're aiming to submit a paper describing this model and CONUS county-year results the upcoming Forest Ecology and Management special issue.

- Development of a multivariate extension to the univariate model noted above. The model formulation and software development is underway and initial results look good.

- The above two papers are discrete space and time models (i.e., county-level annual time step). We are also experimenting with how these model compare to equivalent point-referenced space-time models (e.g., using county centroids and continuous time).

- We are testing a range of zero-inflated SAE models using simulated populations in WA and NV. This paper will also be submitted to the Forest Ecology and Management special issue.

2 Next Period Plans

Continue progress on all points above. Additionally we are starting work on methods for highly-multivariate spatial and spatial-temporal outcomes, as outlined in the proposal.

3 Problems/Delays

None.