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 for report: ~Nov. 1, 2023 - Jan. 31, 2024.

Progress: We made progress in several areas listed below.

1) Personnel:
    a) MSU, PhD student Elliot Shannon is planning to focus several chapters of his dissertation on SAE topics and applications to FIA. Elliot is pursuing a dual degree in Forestry and Statistics.
    b) MSU, PhD student Grayson White is also planning to focus several chapters of his dissertation on SAE topics and applications to FIA. Grayson is pursuing a degree in Forestry.
2) Research:
    a) The manuscript entitled “Models to support forest inventory and small area estimation using sparsely sampled LiDAR: A case study involving G-LiHT LiDAR in Tanana, Alaska” by A.O. Finley, H.-E. Andersen, C. Babcock, B. Cook, D. Morton, and S. Banerjee was accepted for publication in the *Journal of Agricultural, Biological, and Environmental Statistics*. This manuscript will acknowledge SAE project support. A preprint is available at https://arxiv.org/abs/2302.06410.
    b) We have a draft manuscript that outlines methods and results for a FH SAE model for annual county-level FIA population parameters over CONUS. Initial results show the proposed model, which includes spatial-temporal random effects as well as space-varying coefficients on key predictors variables, performs very well and provides substantial improvement over FIA design-based estimates. The manuscript will focus on modeling various carbon pools. We are considering submission to Nature Methods if results continue to look promising. Initial results are for CONUS live biomass (Mg/ha). We’re currently conducting extensive simulation studies that compare qualities of design-based estimates to the proposed full model and various submodels. The proposed model also facilitates estimates of change at the county level. A few example figures are attached. Authors on the current work are E.S. Shannon, A.O. Finley, P.B. May, G.M. Domke, H.-E. Andersen, and S. Banerjee.
    c) We are assessing a suite of unit-level SAE models that couple FIA plot data with NAIP 3D over Maine and Washington to deliver high-resolution (and small area summaries) of forest biomass. Initial authors on this work include G. White, A.O. Finley, and A.R. Weiskittel.

d) We have developed a zero-inflated joint species distribution model that delivers probability of species occurrence and associated biomass (or other continuous variable). The model software is written and is being applied to FIA data over the western half of CONUS. This work is being led by J. Doser and A.O. Finley is an extension of methods detailed in https://arxiv.org/abs/2308.02348.

Next period plans: Continue working on manuscripts and methods detailed above.

Problems or delays: None experienced.

Some figures from initial results for the study described in 2b.

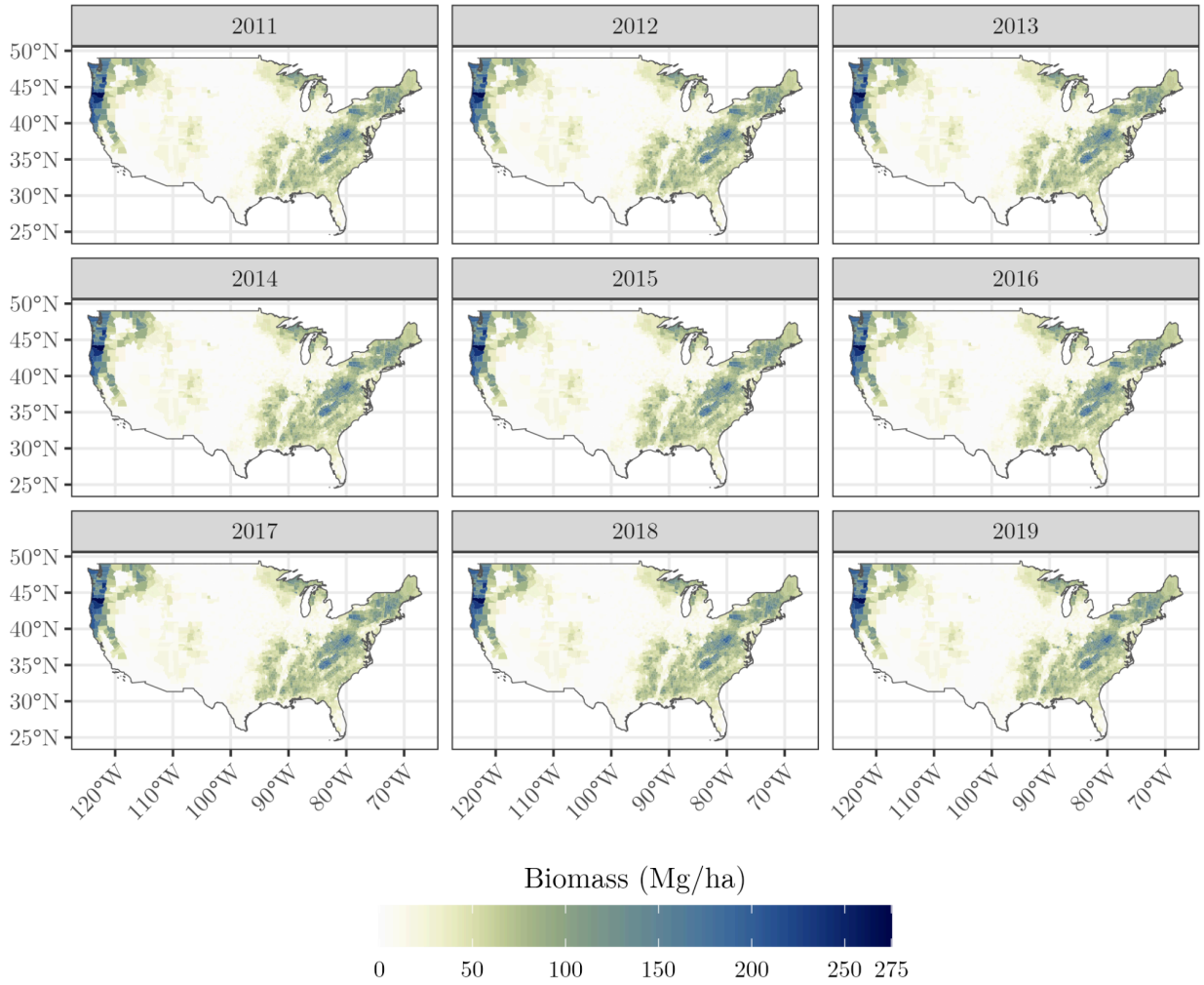

Figure 1. Map of biomass (Mg/ha) posterior distribution mean from the spatio-temporal FH SAE model.

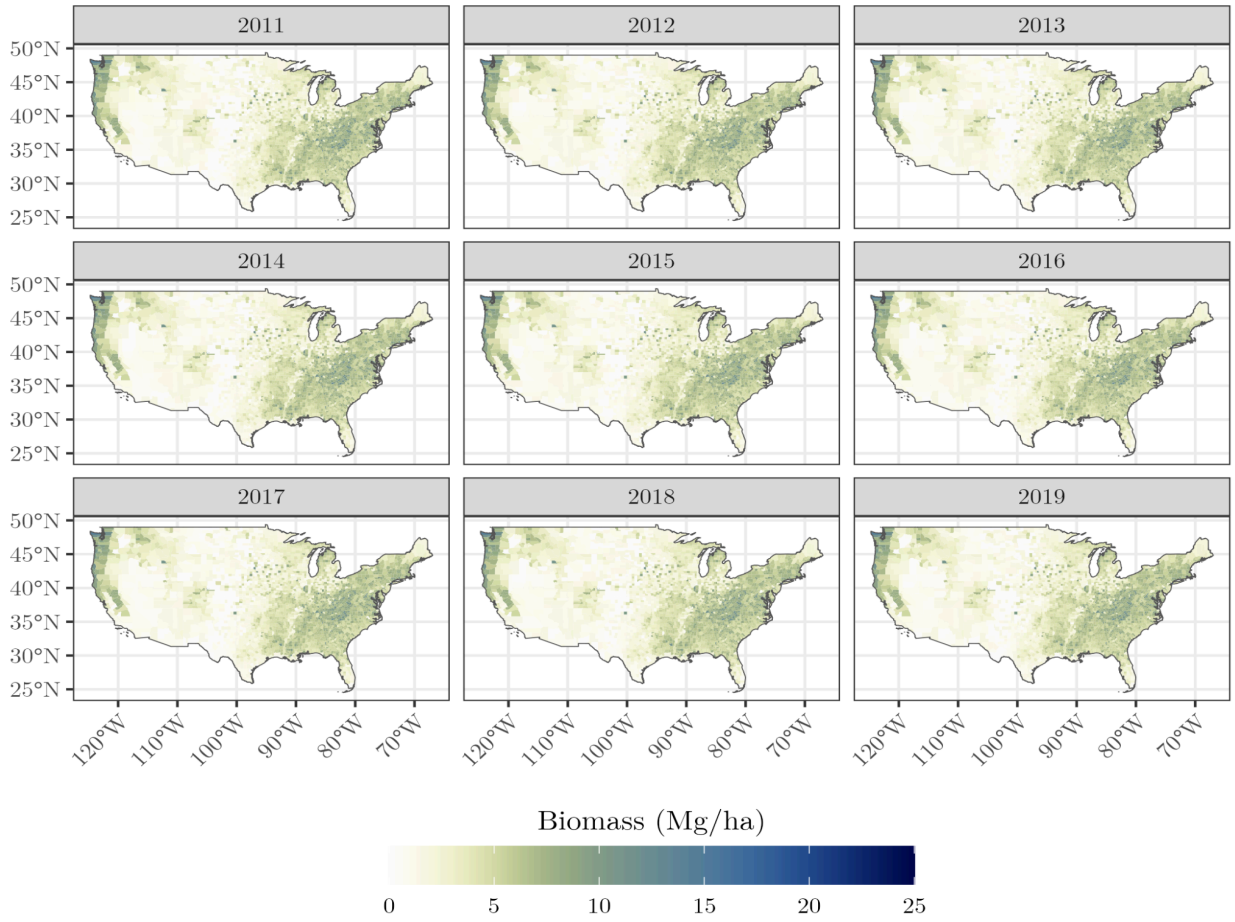

Figure 2. Map of biomass (Mg/ha) posterior distribution standard deviation from the spatio-temporal FH SAE model.

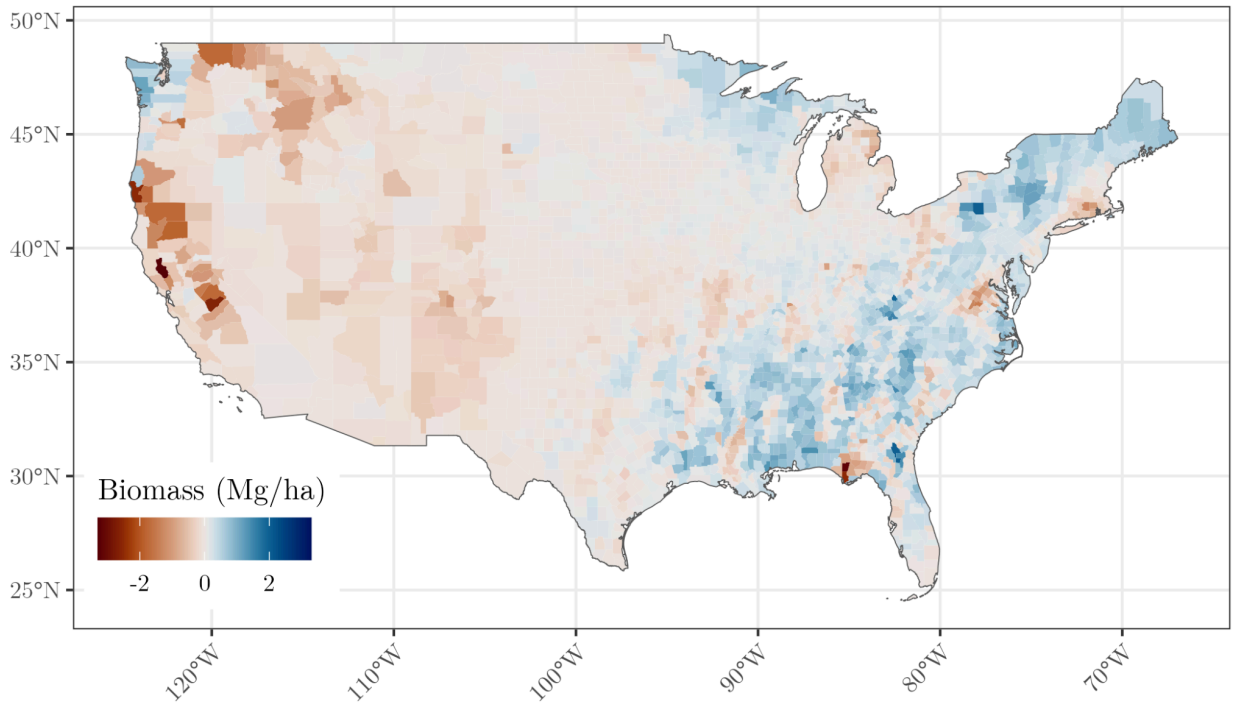

Figure 3. Posterior distribution of county specific linear change in the spatio-temporal FH SAE model biomass estimates.

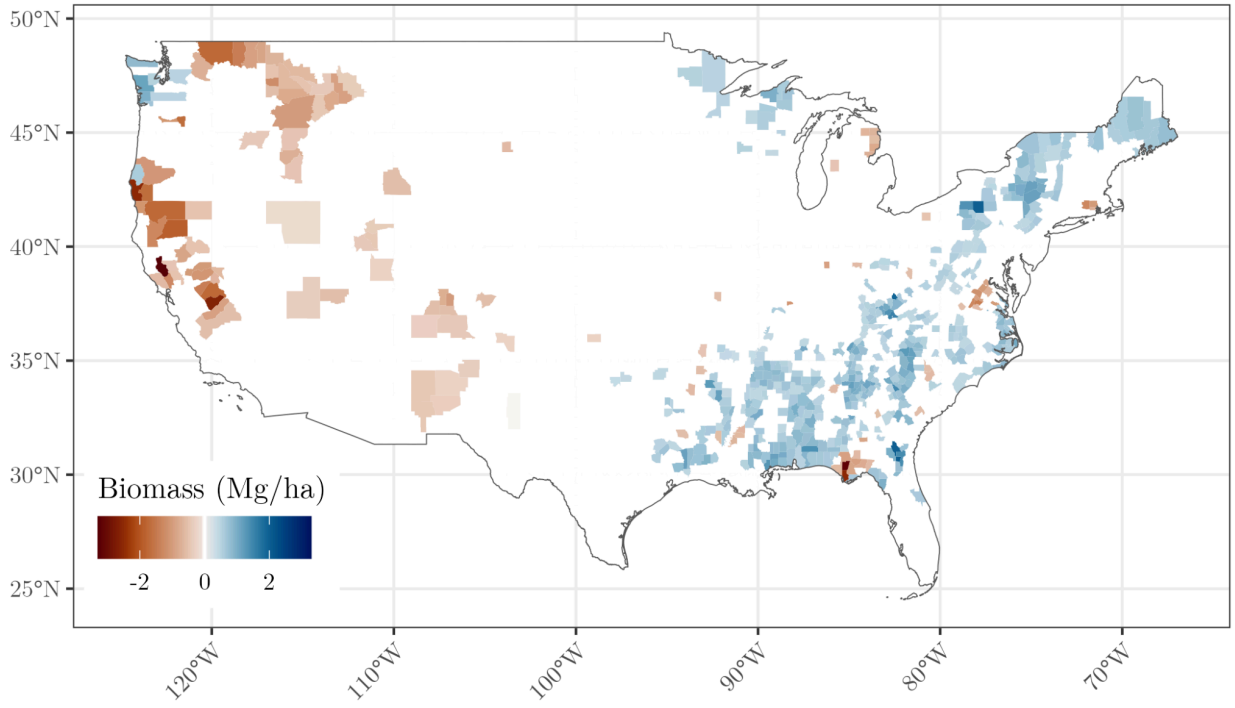

Figure 4. "Statistically significant" posterior distribution of county specific linear change in the spatio-temporal FH SAE model biomass estimates. These are counties with substantial change.

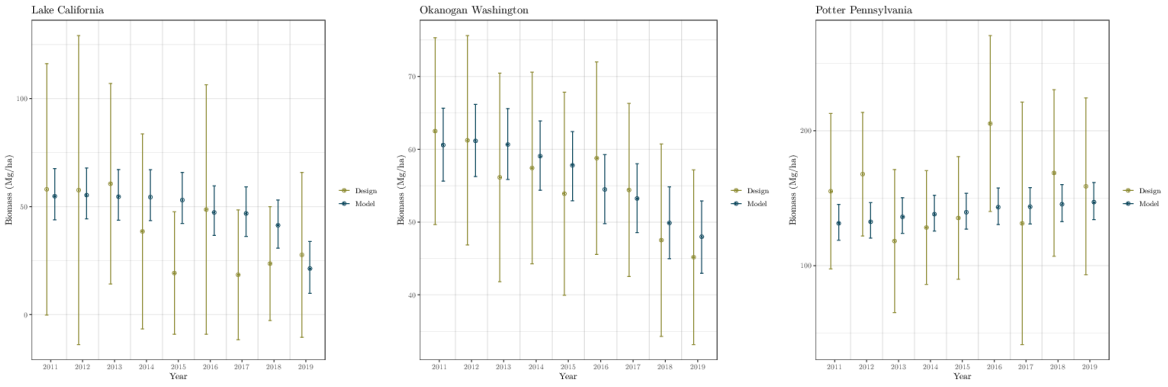

Figure 5. A few counties highlighted in Figure 4 with large change over time. Points and bars are the FIA design-based and spatio-temporal FH SAE model-based mean and 95% CIs. These figures also illustrate how the proposed model provides improved uncertainty quantification for the small areas.