# The New York Forest Carbon Assessment

# Outputs, Applications & Insights for Adirondack Research & Stewardship

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Adirondack Park Agency
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# Overview

**Background**

- Objective
- Approach

**Functions & Outputs**

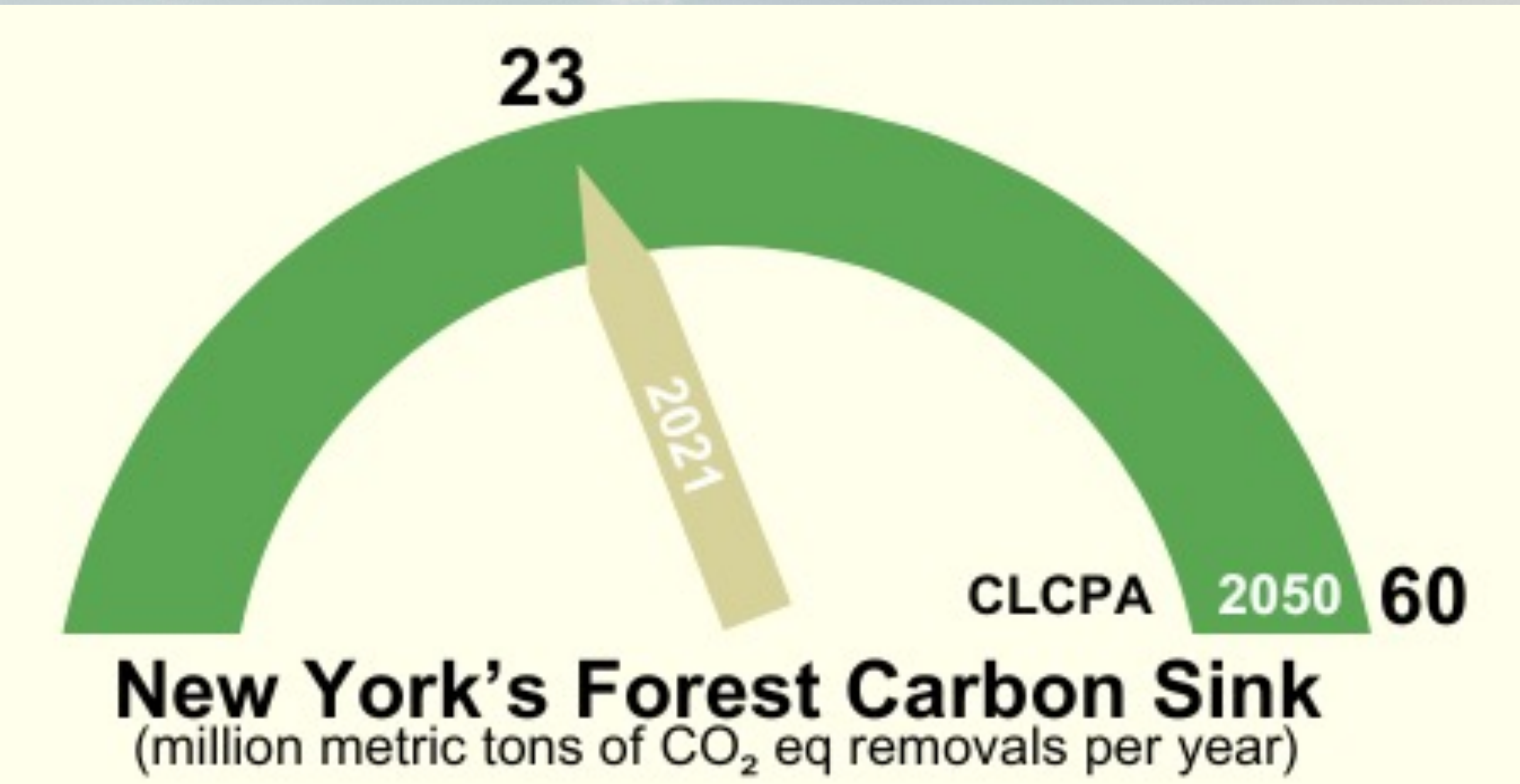
- AGB & C Mapping
- Stock-Change
- Monitoring
- Change Detection
- Uncertainty

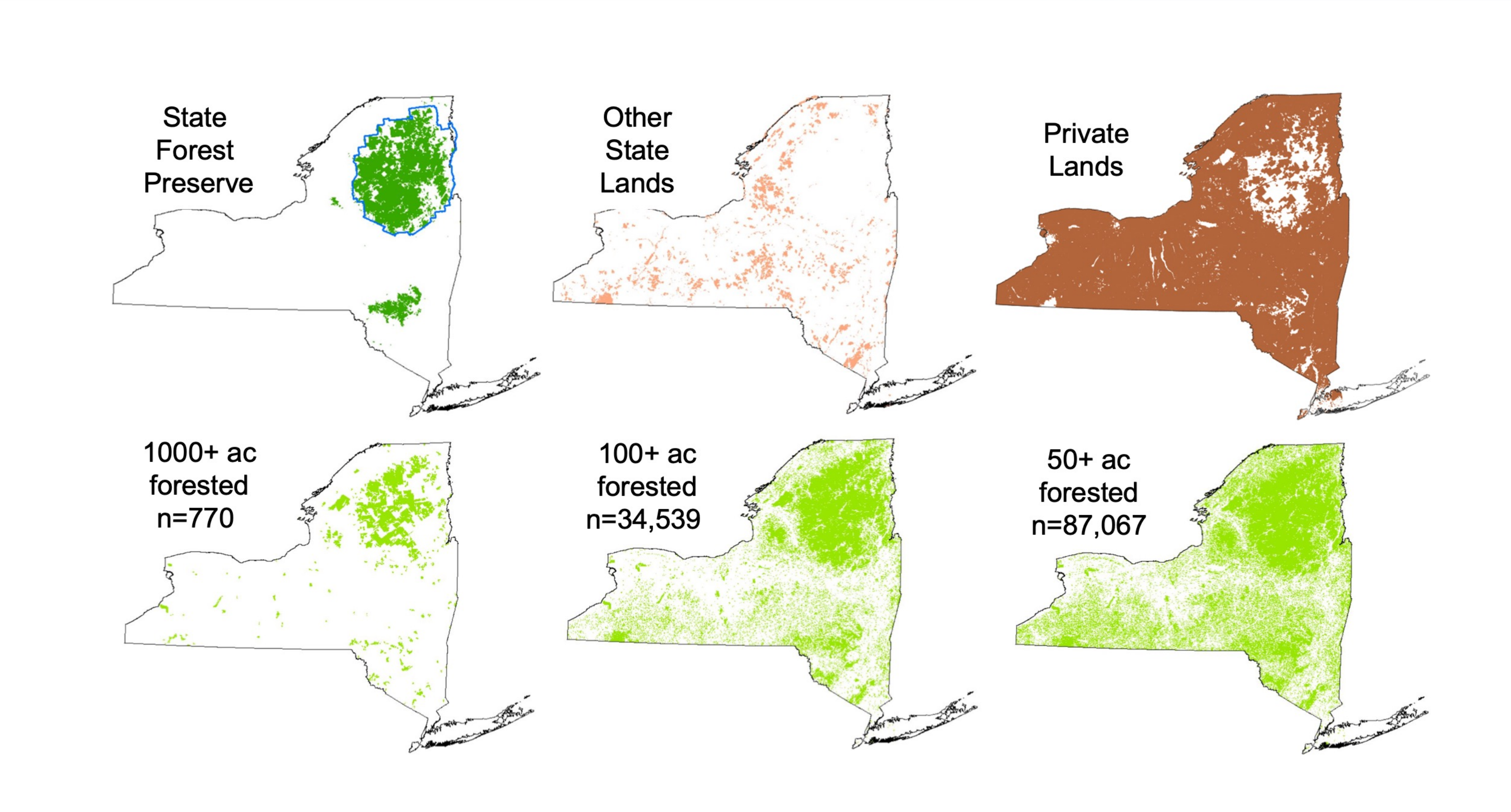
**Applications**

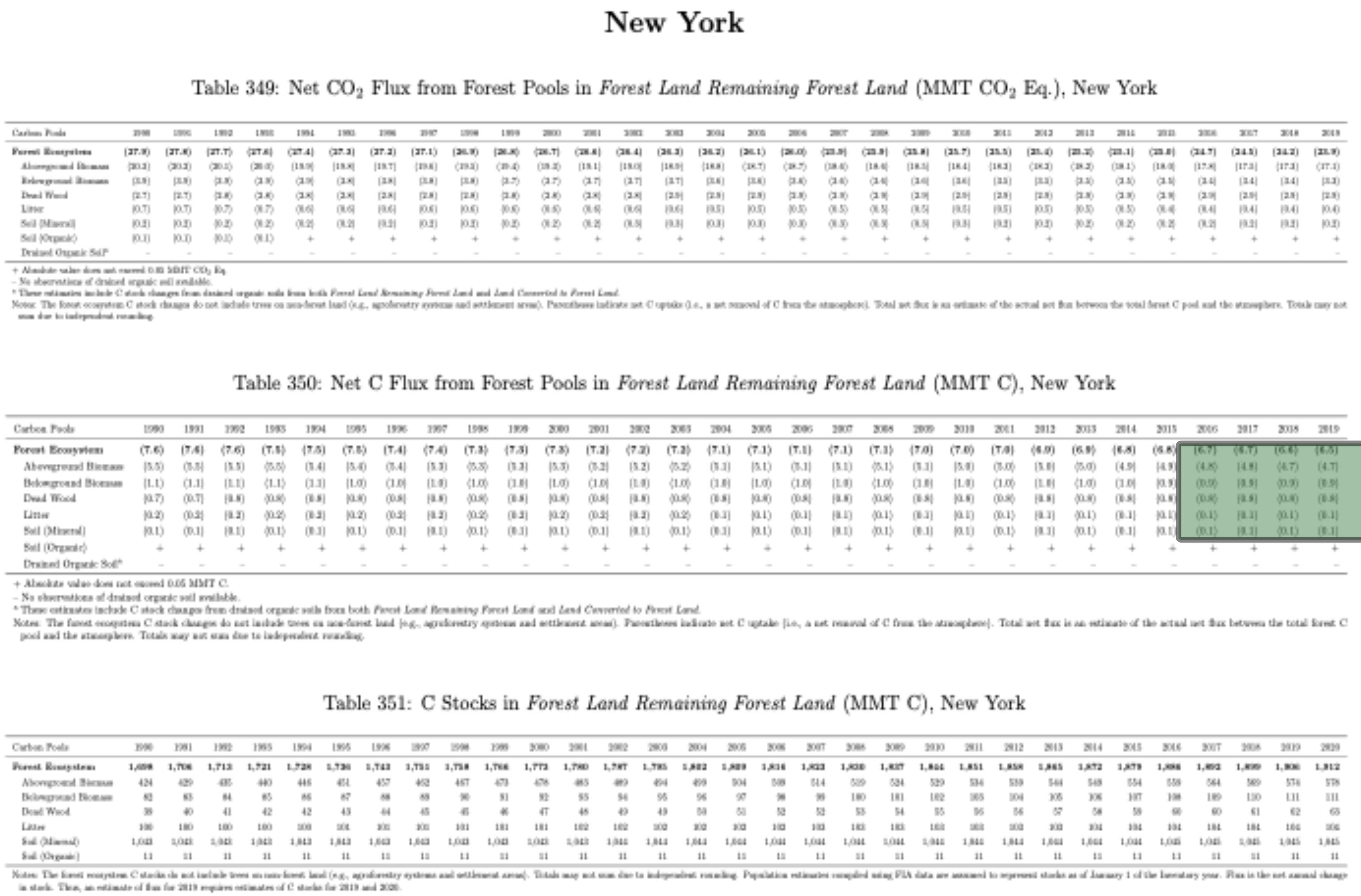
- Parcel-level analysis
- Solar facility siting
- Statewide MRV
- GHG Inventory

**Insights**

- Disturbance trends
- C benefits on public vs private ADK lands



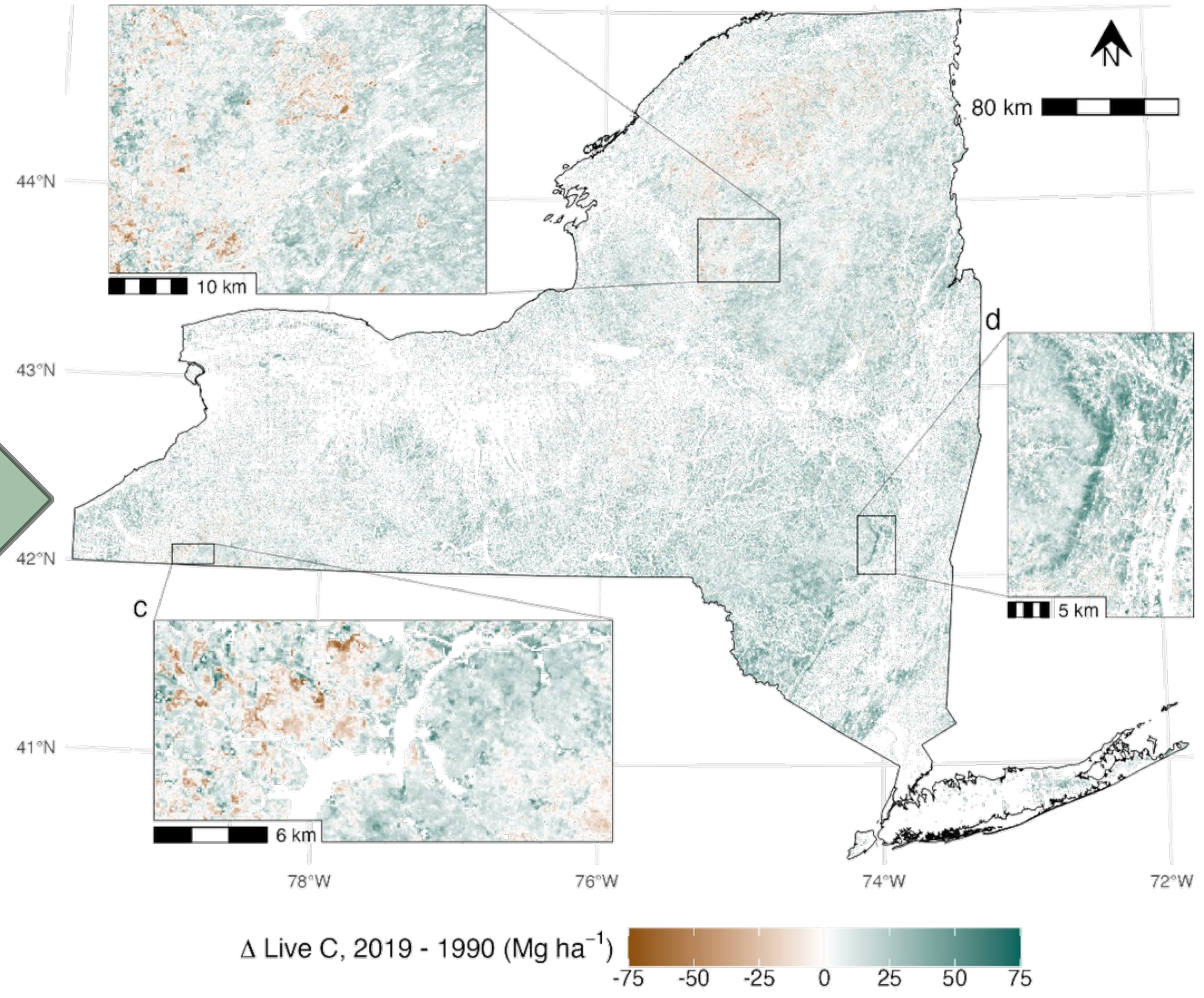


## New York

Table 349: Net $CO_2$ Flux from Forest Pools in *Forest Land Remaining Forest Land* (MMT $CO_2$ Eq.), New York

Table 350: Net C Flux from Forest Pools in *Forest Land Remaining Forest Land* (MMT C), New York

Table 351: C Stocks in *Forest Land Remaining Forest Land* (MMT C), New York



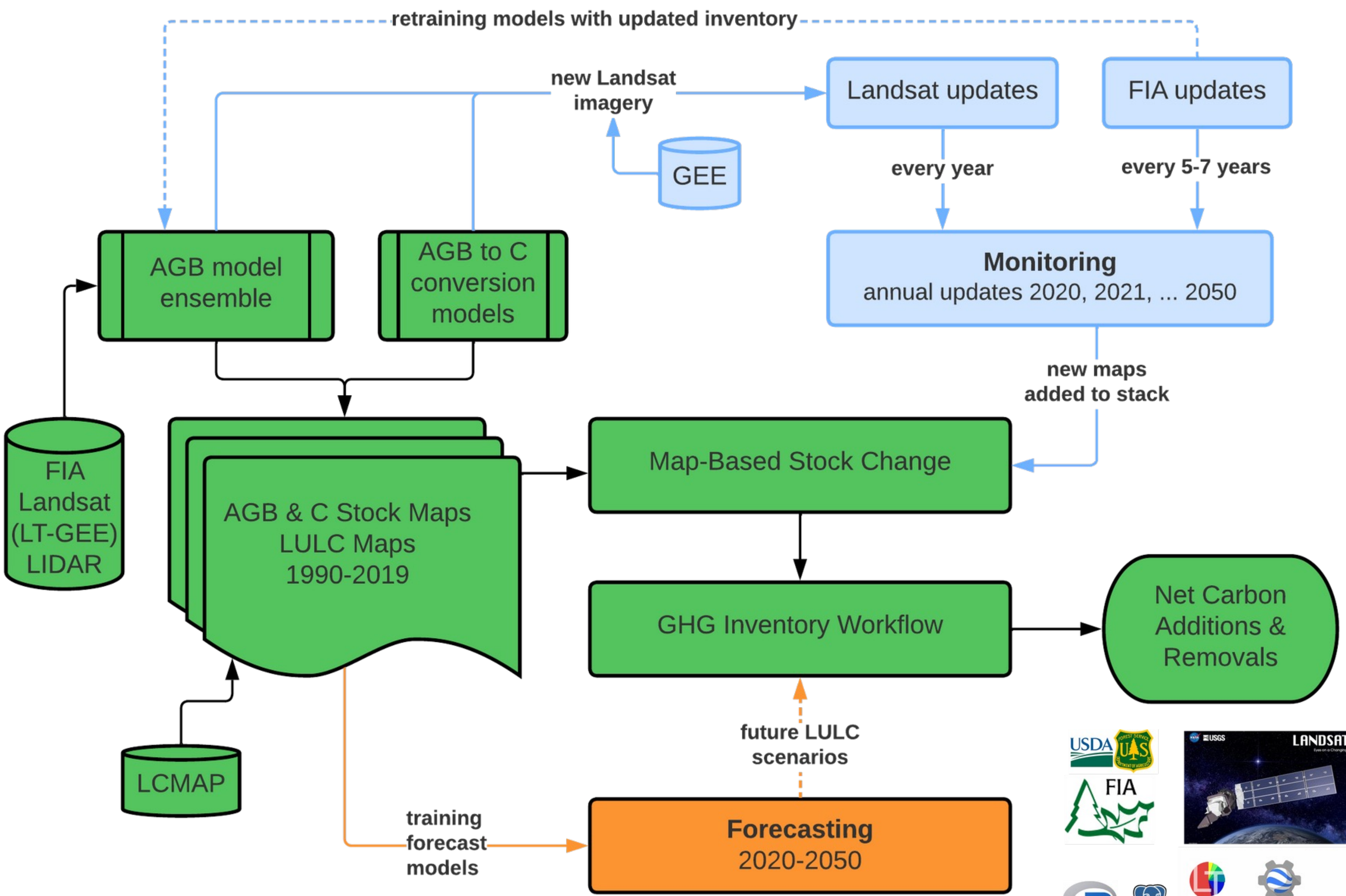

# Objective

To build a map-based forest carbon accounting system for NYS that replicates USFS/EPA methods for GHG inventory and supports <u>scale-relevant</u> public and private-sector decision-making for climate solutions

Integrated basis for

- **AGB & C Mapping**
- **Stock Change**
- **GHG Inventory**
- **Monitoring**
- **Forecasting**

Built on freely available data* and open-source computational tools




# Approach

*excludes FIA plot coordinates!

Ensemble machine-learning models, trained on FIA plots and EO data (LIDAR/ALS, Landsat C2, LT-GEE)

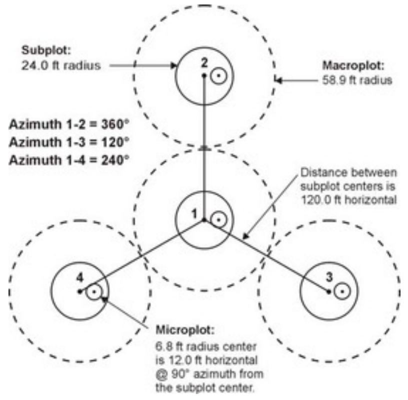
Created 30m annual AGB maps 1990 to 2019 statewide

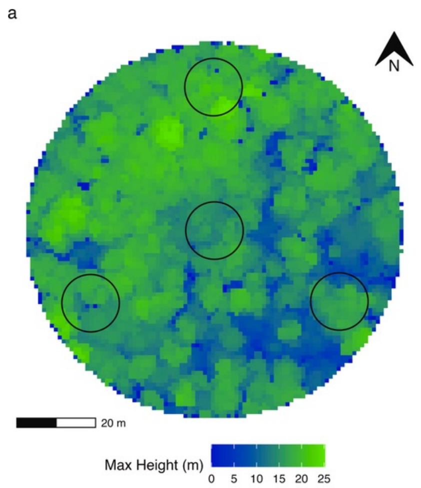
AGB maps converted to ‘live C’ maps using FIA allometrics

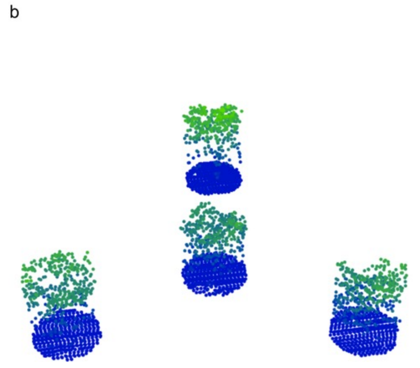
Soil, litter, deadwood C pools mapped with models trained on FIA Phase 3 and EO data

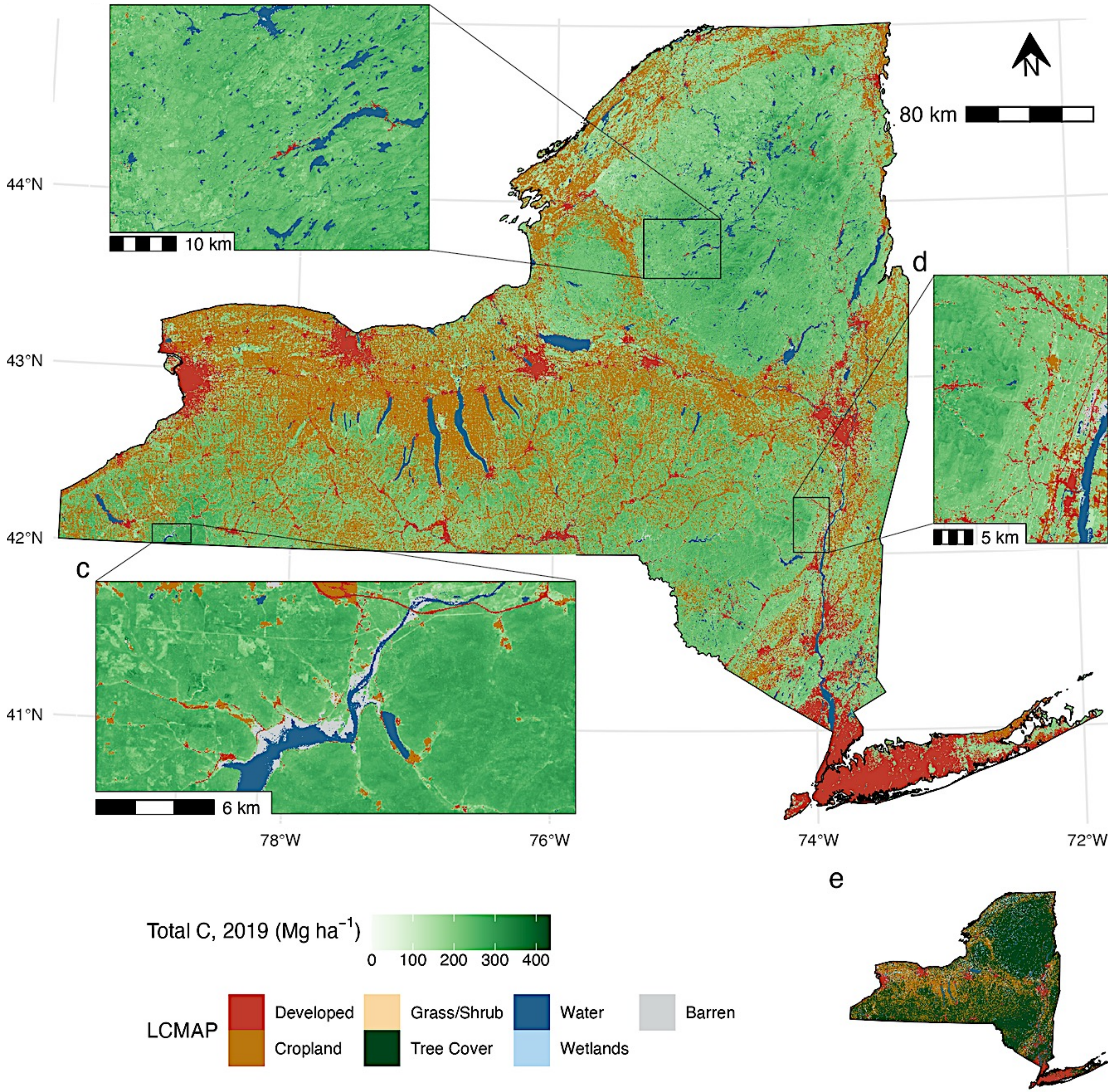
Annual 30m C pools mapped only for forested pixels

# AGB & C Mapping



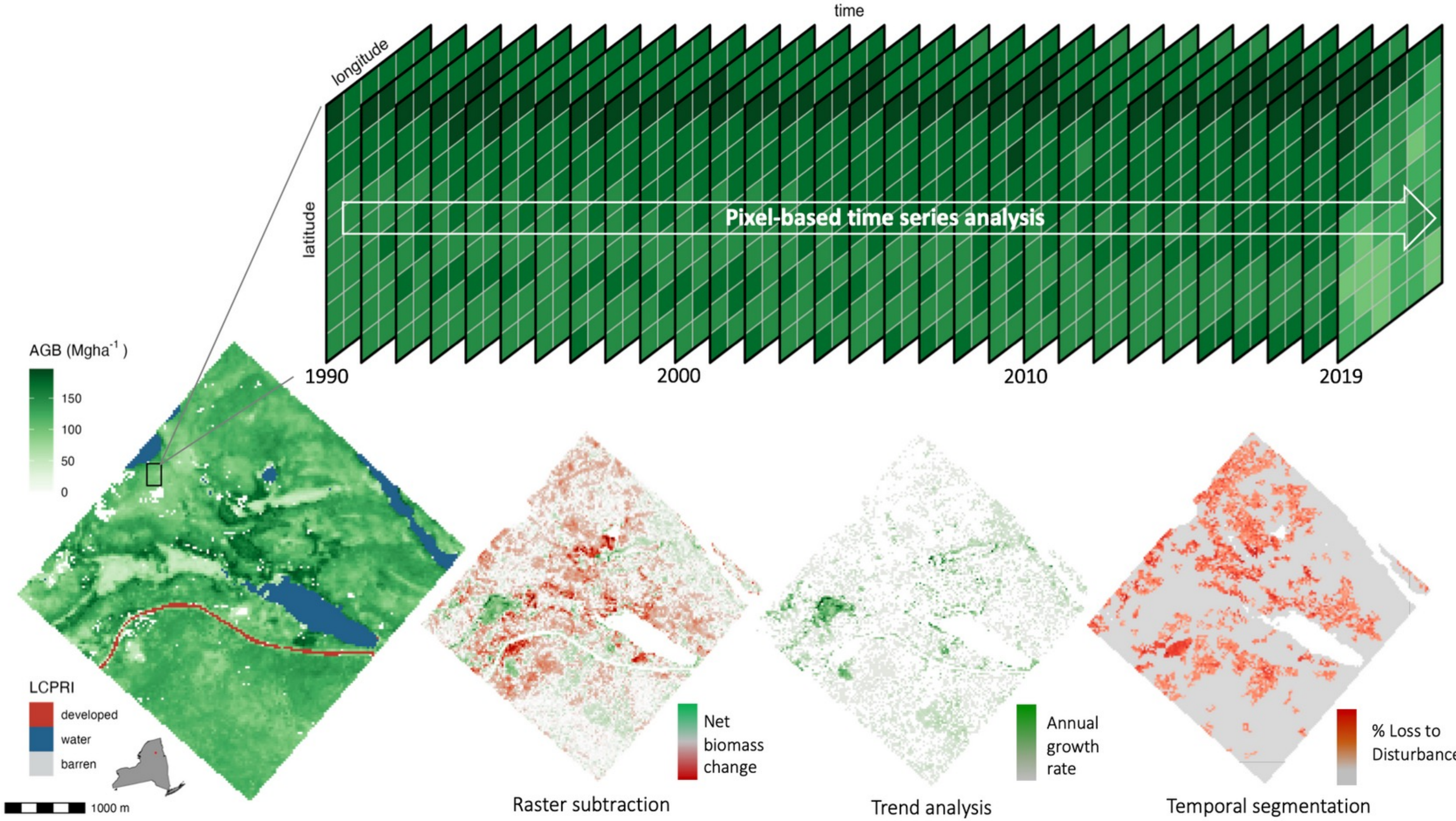



Compiled raster stacks of 30m annual AGB/C maps

Flexible basis for stock-change analysis using raster operations:

- simple differencing
- trend analysis
- temporal segmentation

Next step: spatiotemporal segmentation for object-based (i.e., stand-level) analysis and forecasting




## Stock-Change

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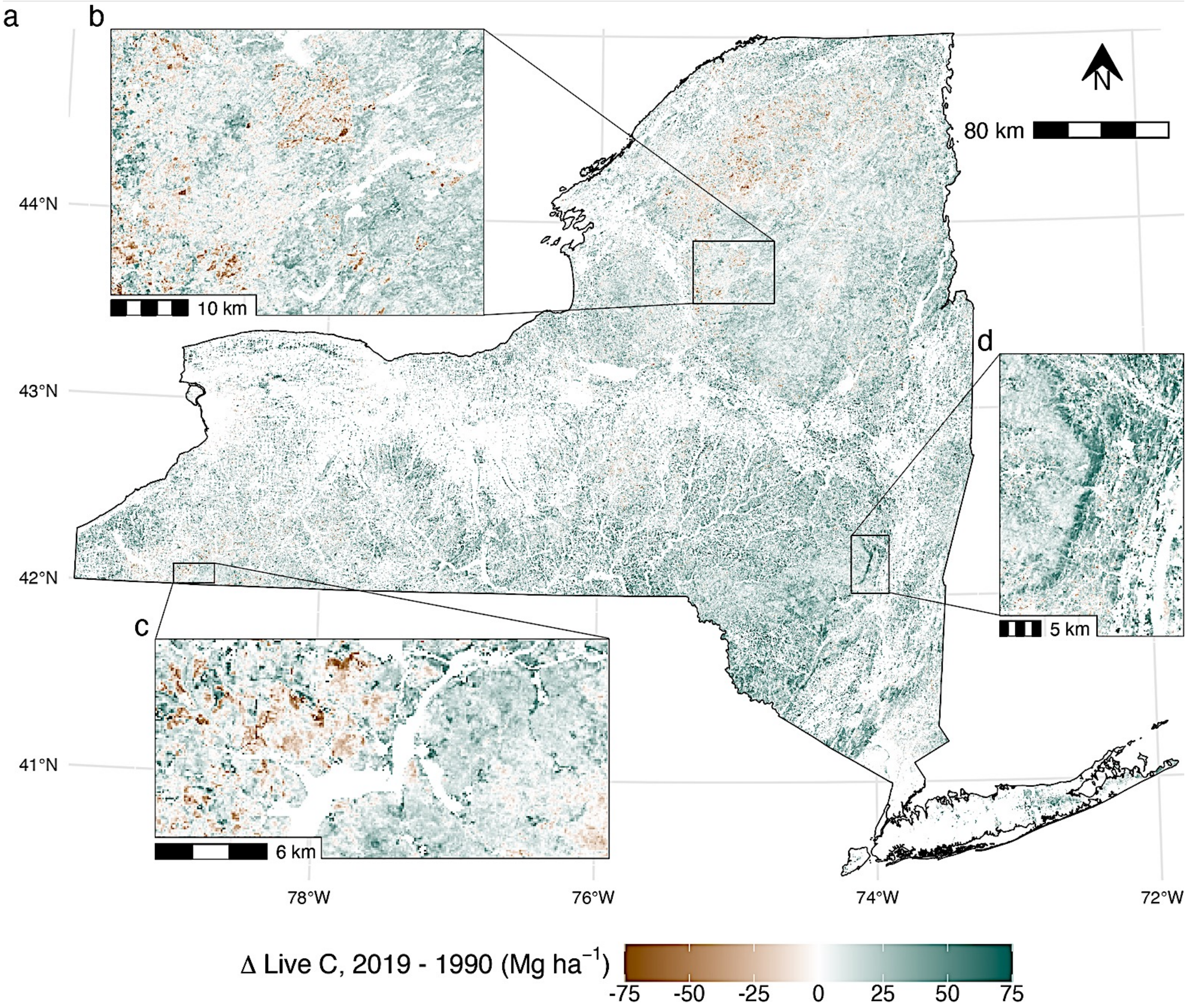

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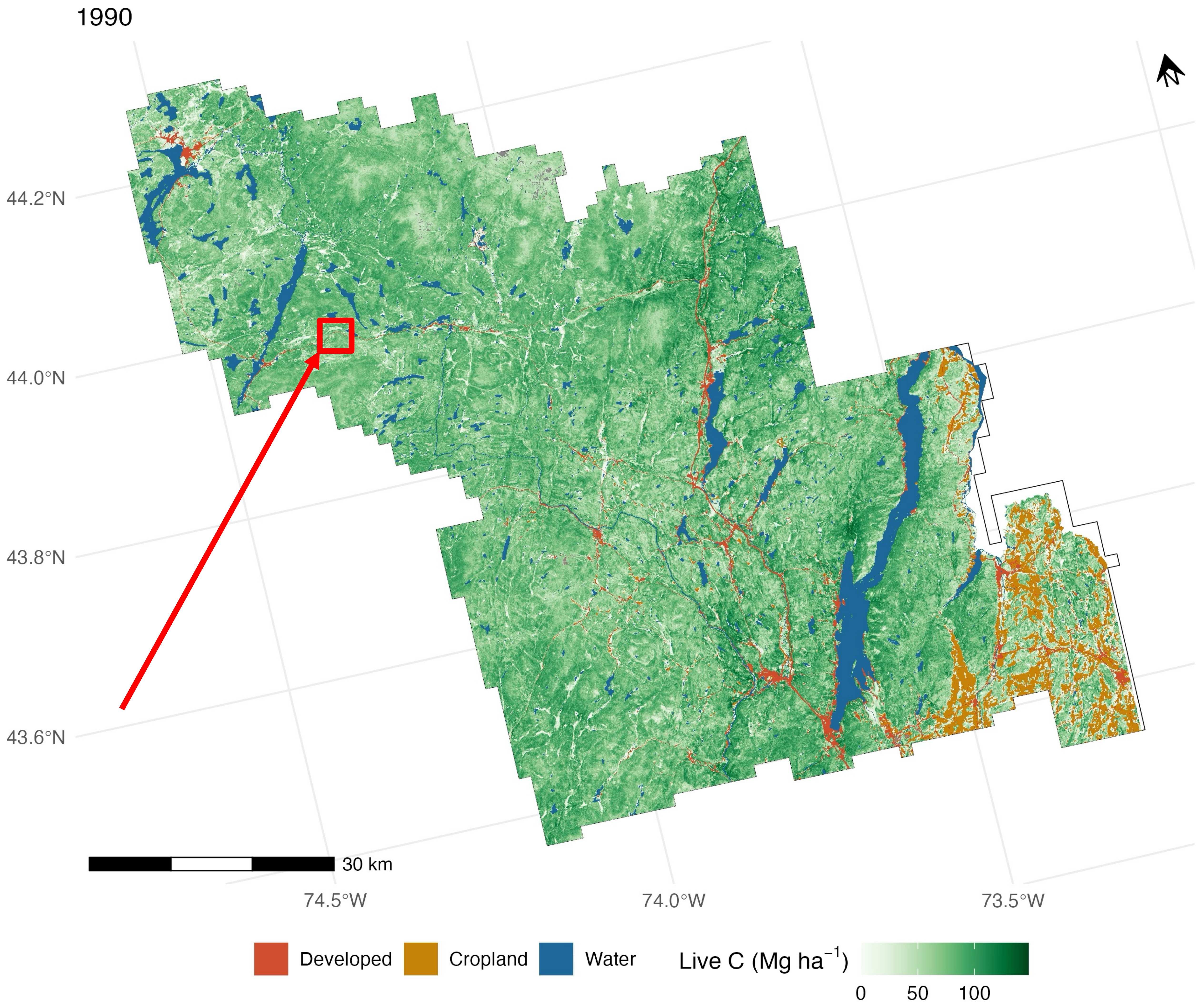
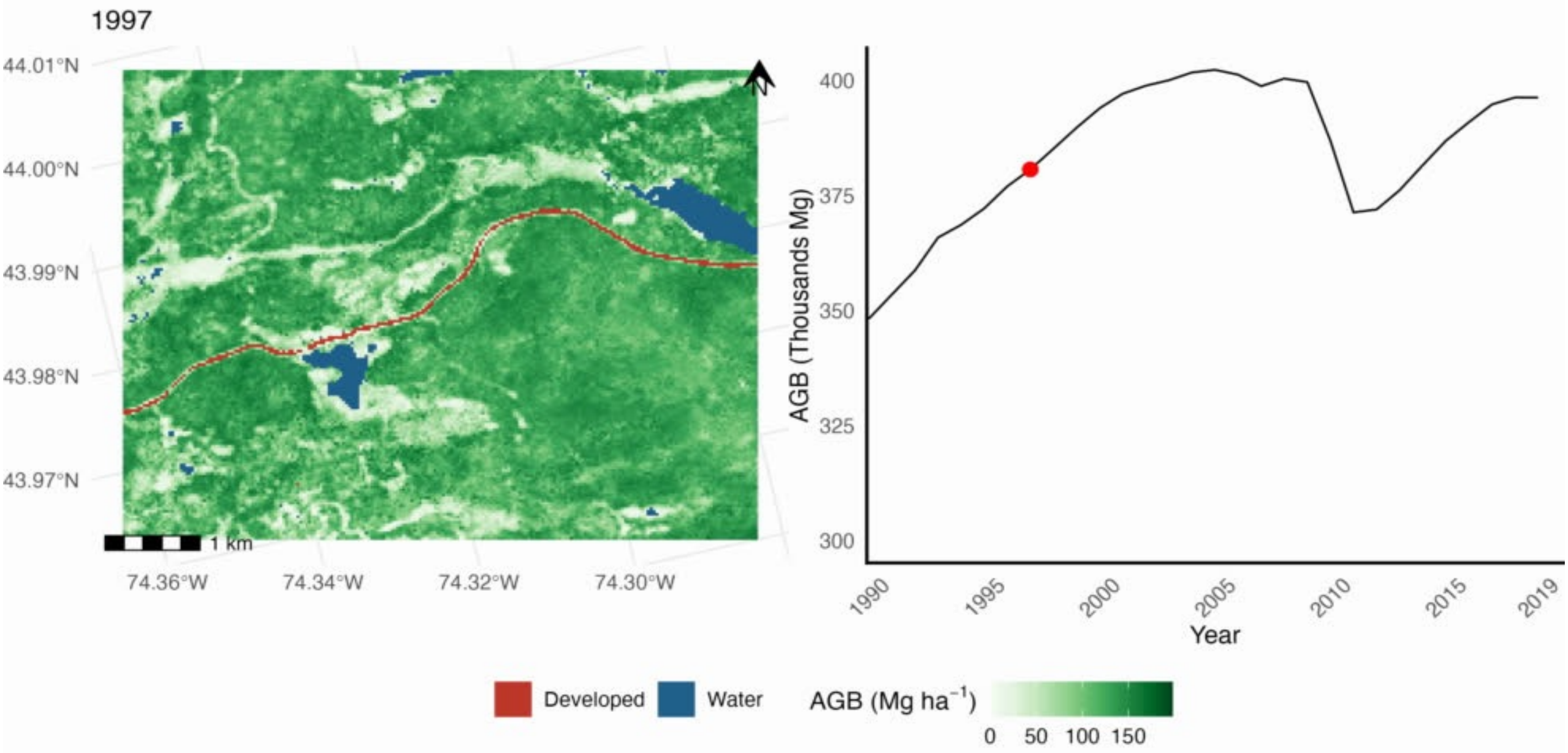
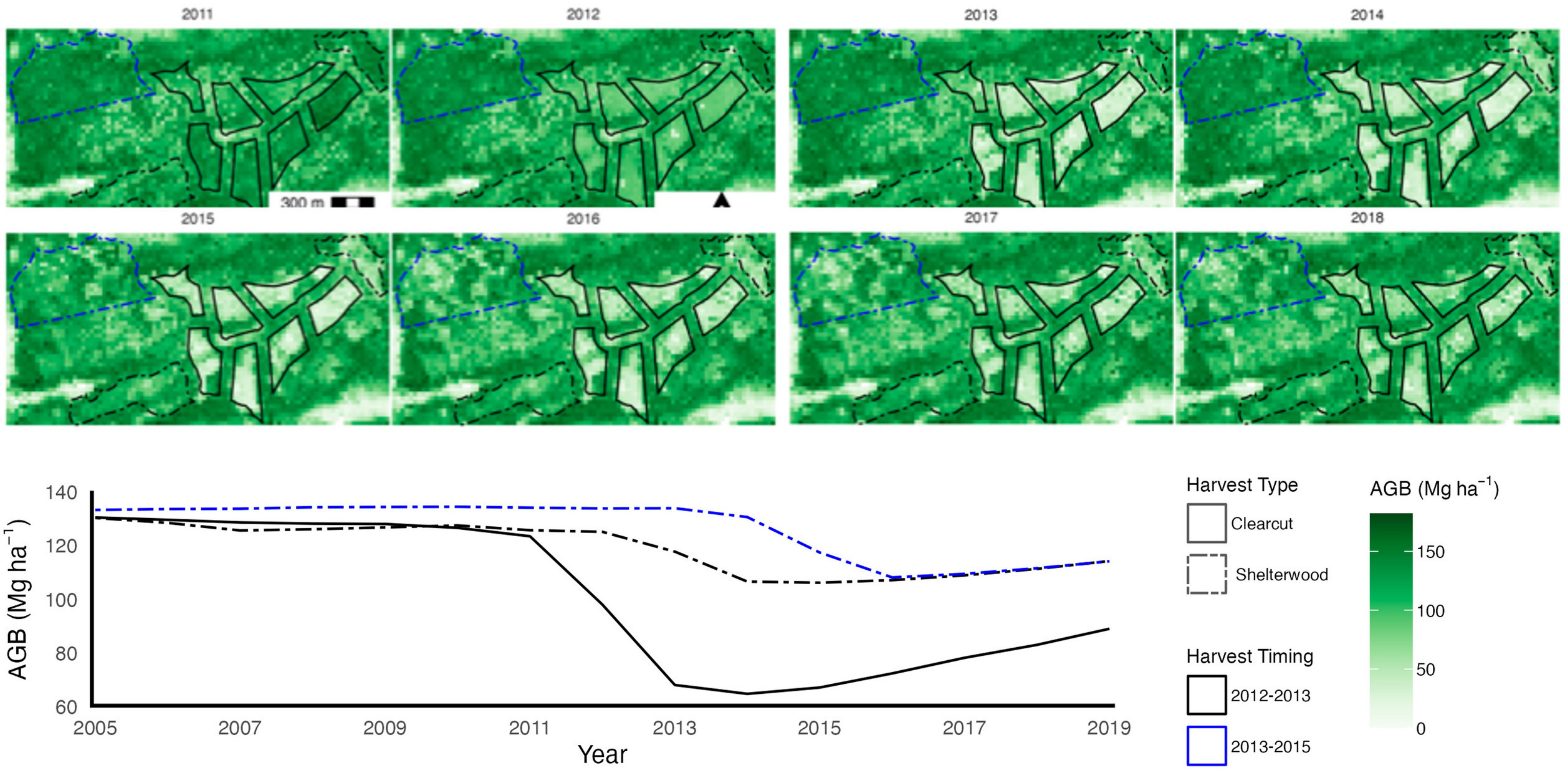
# Stock-Change






## Monitoring

As new Landsat imagery is released, we use the same ensemble models to produce annual 'update' maps of AGB and C stocks. The update maps are added to our raster stacks and stock-change metrics are recalculated. Core models will be re-trained and ensembles updated based on the FIA panel schedule (i.e., every 7 years in NYS).




# Monitoring

Time-series maps accurately capture harvest and regeneration dynamics, based on ground-referencing with management records provided by industrial landowners

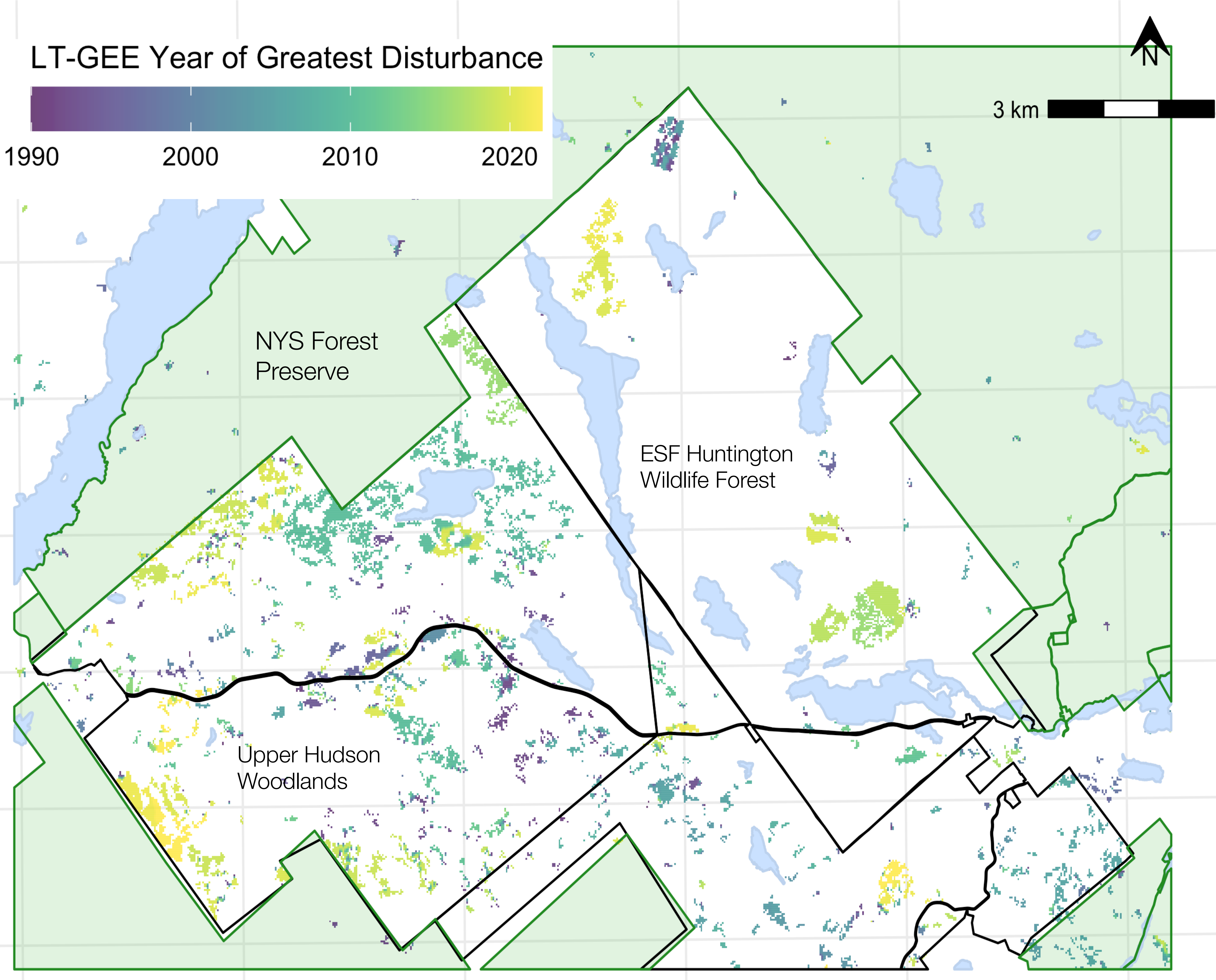
Models likely underpredict biomass removals and overpredict early regeneration rates

Ground-truthed change detection tools based on Landsat time-series imagery and harvest maps

Landtrendr on Google Earth Engine (LT-GEE) was ‘tuned’ on ~400K ac of ADK harvest maps/records provided by industrial landowners

Trained a change attribution model based on spatial and temporal attributes of harvests vs. natural disturbances (on Forest Preserve)

Can classify harvest/non-harvest with ~95% accuracy, but cannot classify among ‘natural’ causes

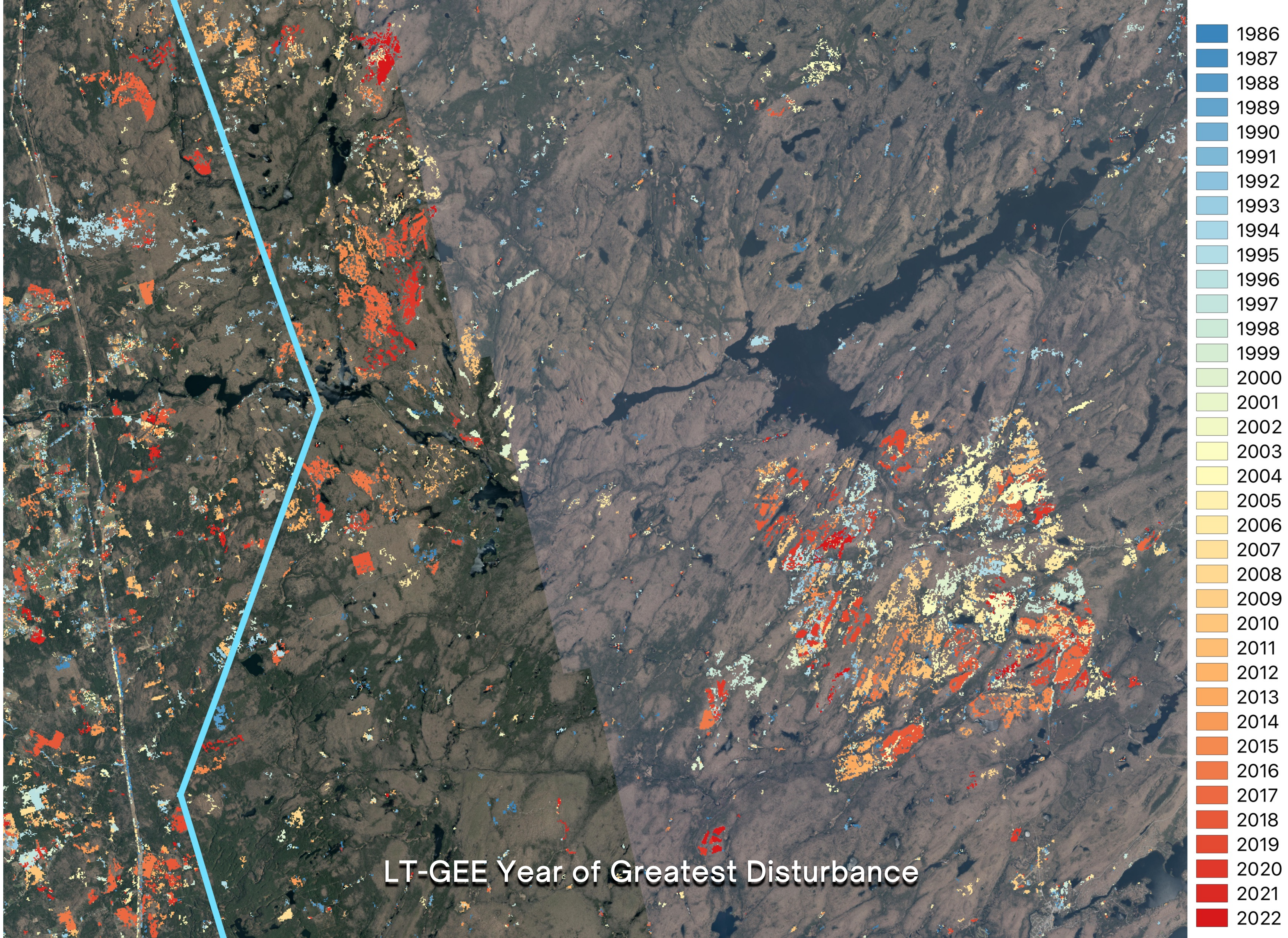



# Change Detection

Change detection and attribution tools allow mapping of historical land use and disturbance (back to 1990)

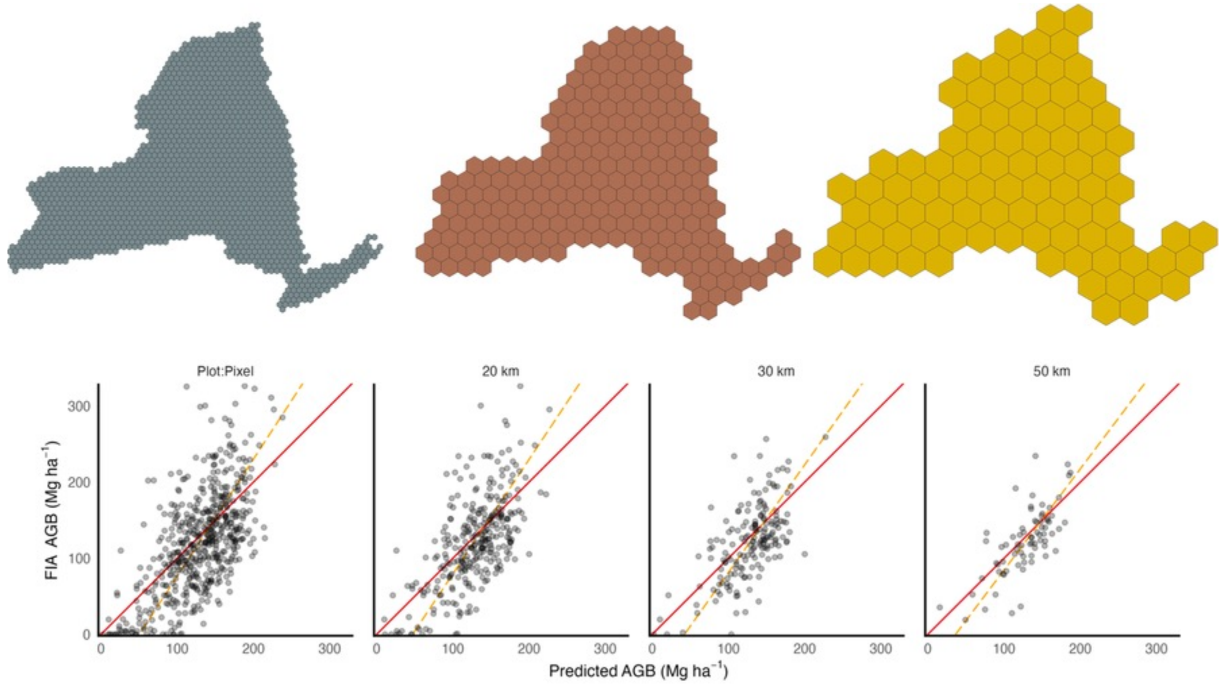
Reconstruct recent patterns of forest management, including areas with multiple entries

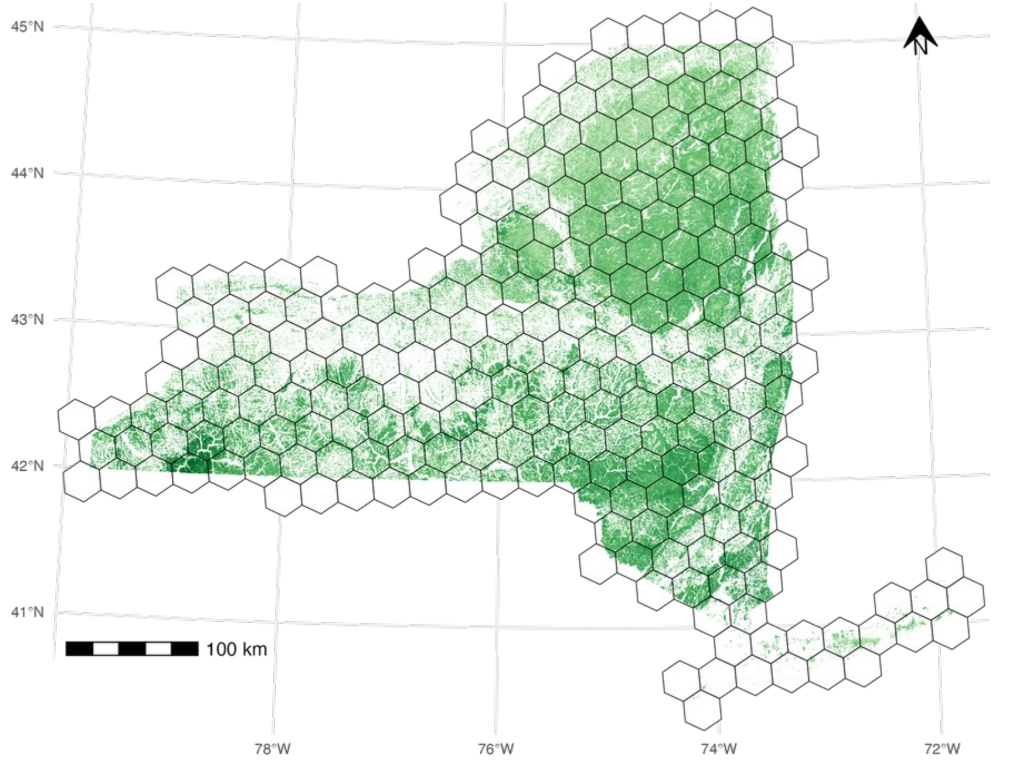
Next step: training models to estimate harvest yields by species & grade, for use in spatial life-cycle assessment of the GHG balance of NYS harvested wood products (HWP)



# Model

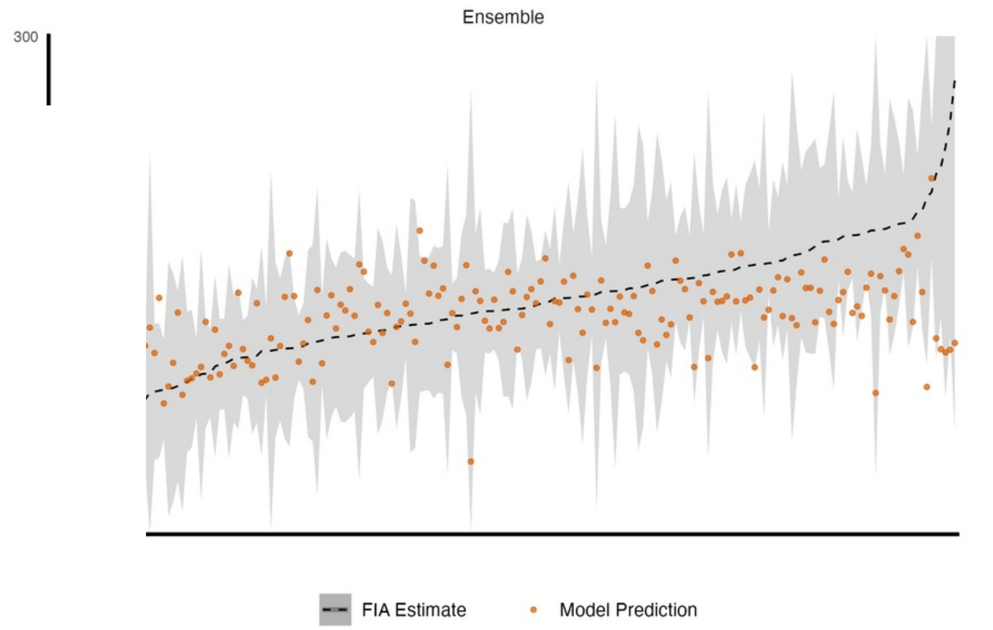
Prediction accuracy on 70/30 training holdout plots; k-fold cross-validation, hyperparameter tuning; ensembling



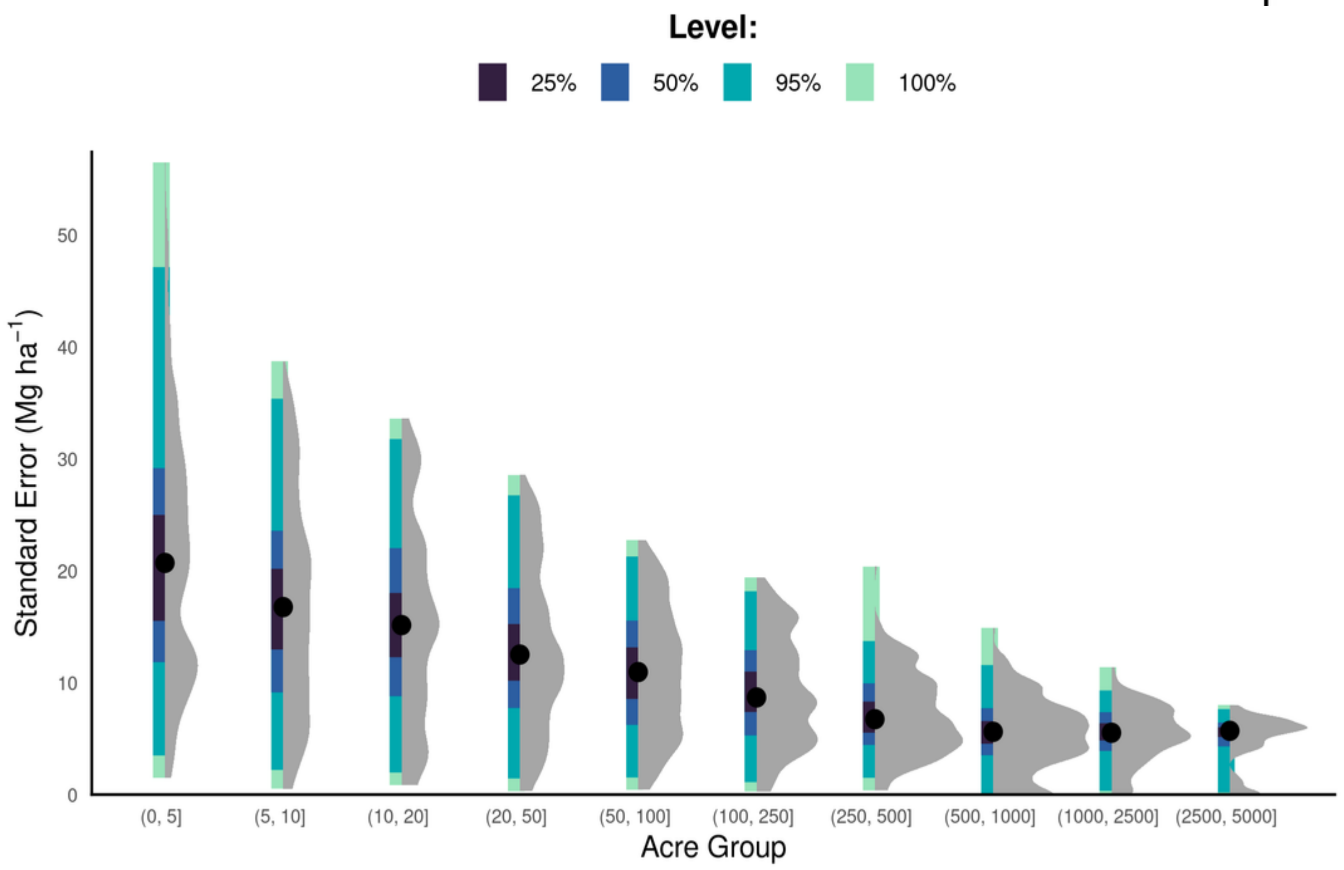

# Map

Plot-to-pixel comparisons aggregated to variable scales and LULC-corrected validation against FIA small-area map estimates (60,000 ha hexagons)

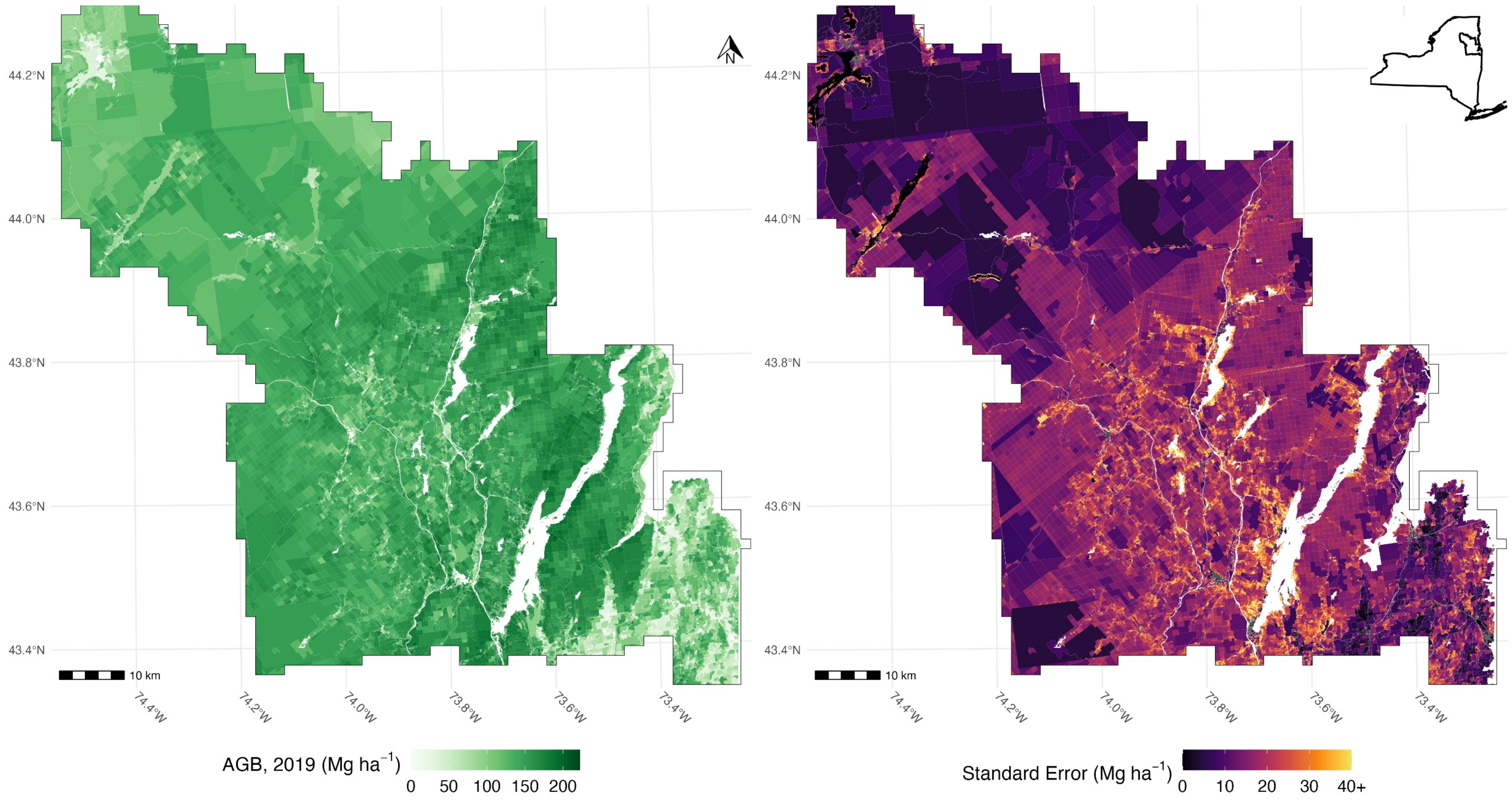



# Scale

Bootstrapped cumulative uncertainty from reference plots, allometrics, model residuals, spatial autocorrelation, etc;




# Uncertainty




# Uncertainty

We can rapidly estimate the standard error (SE) of our map predictions of biomass and carbon stocks for individual parcels (and any other arbitrary areas within NYS)

Provides easy to understand 'error bars' for decision-support applications

## Parcels

Screening/prioritizing forest parcels for enrollment in voluntary programs, tax incentives, conservation easements, land acquisitions, offsets, etc.

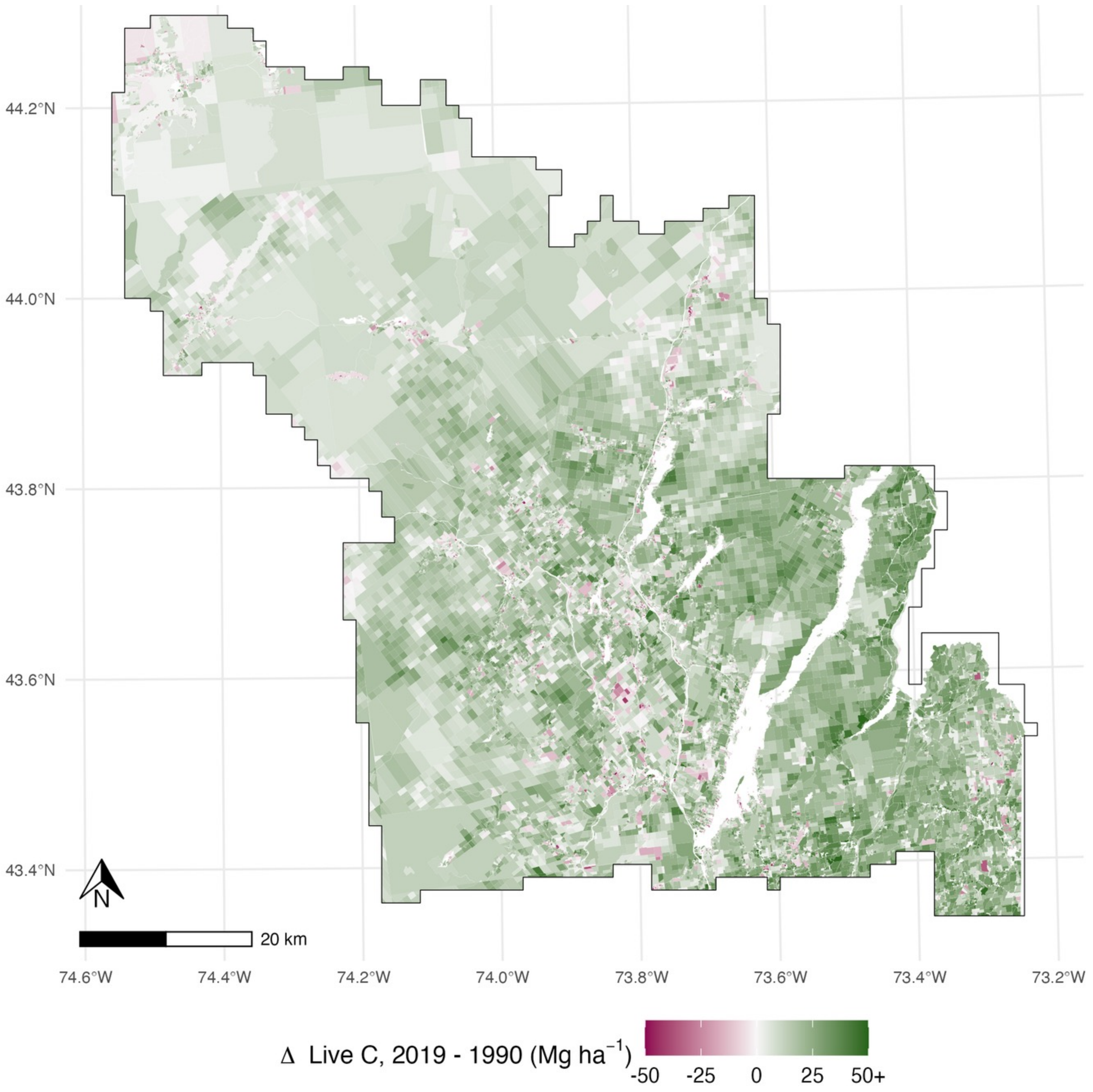
## MMRV

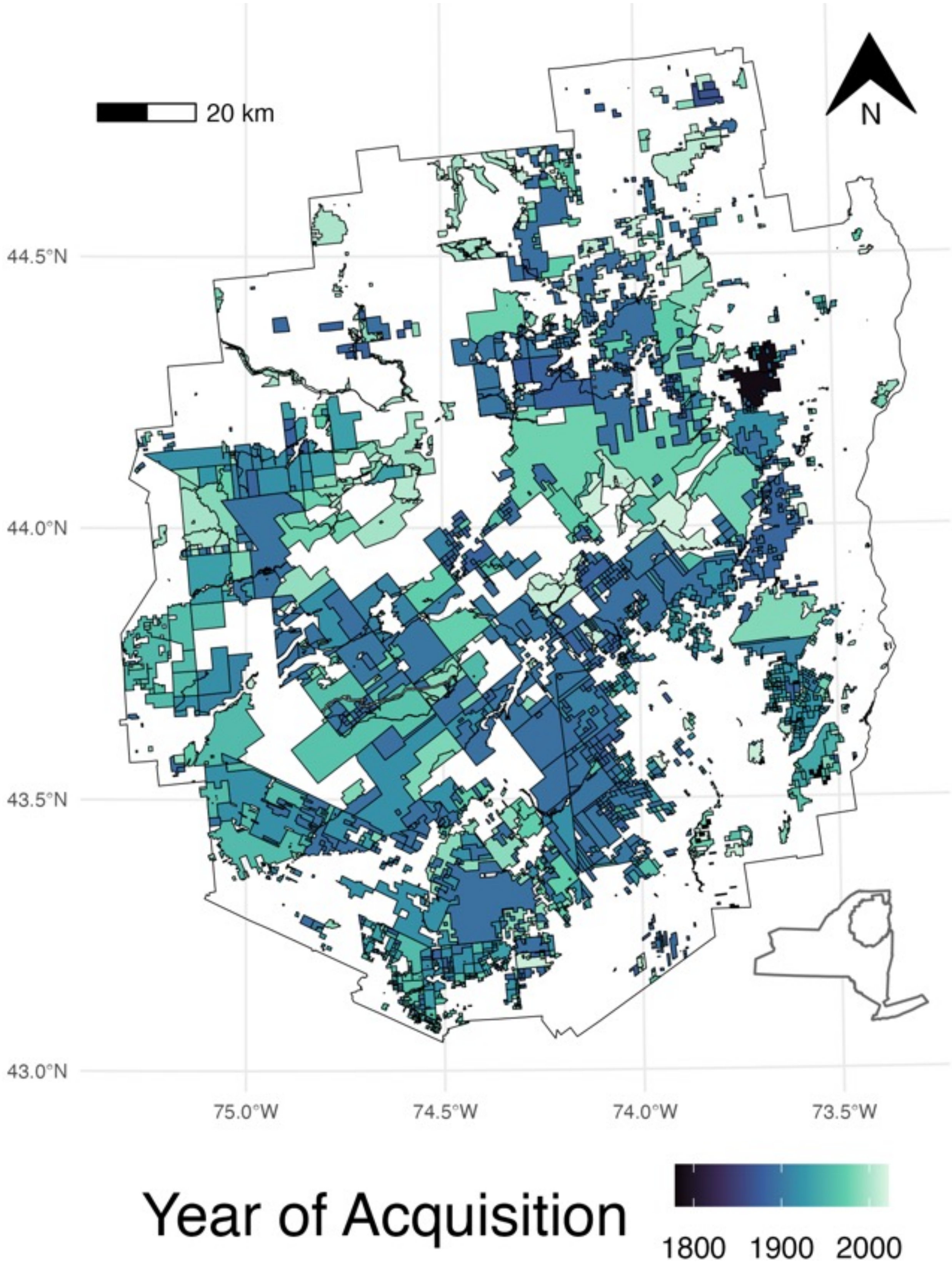
NY Connects: USDA Climate Smart Commodities project will invest $13M into forestry practices via DEC's RegenerateNY program over next 5 years

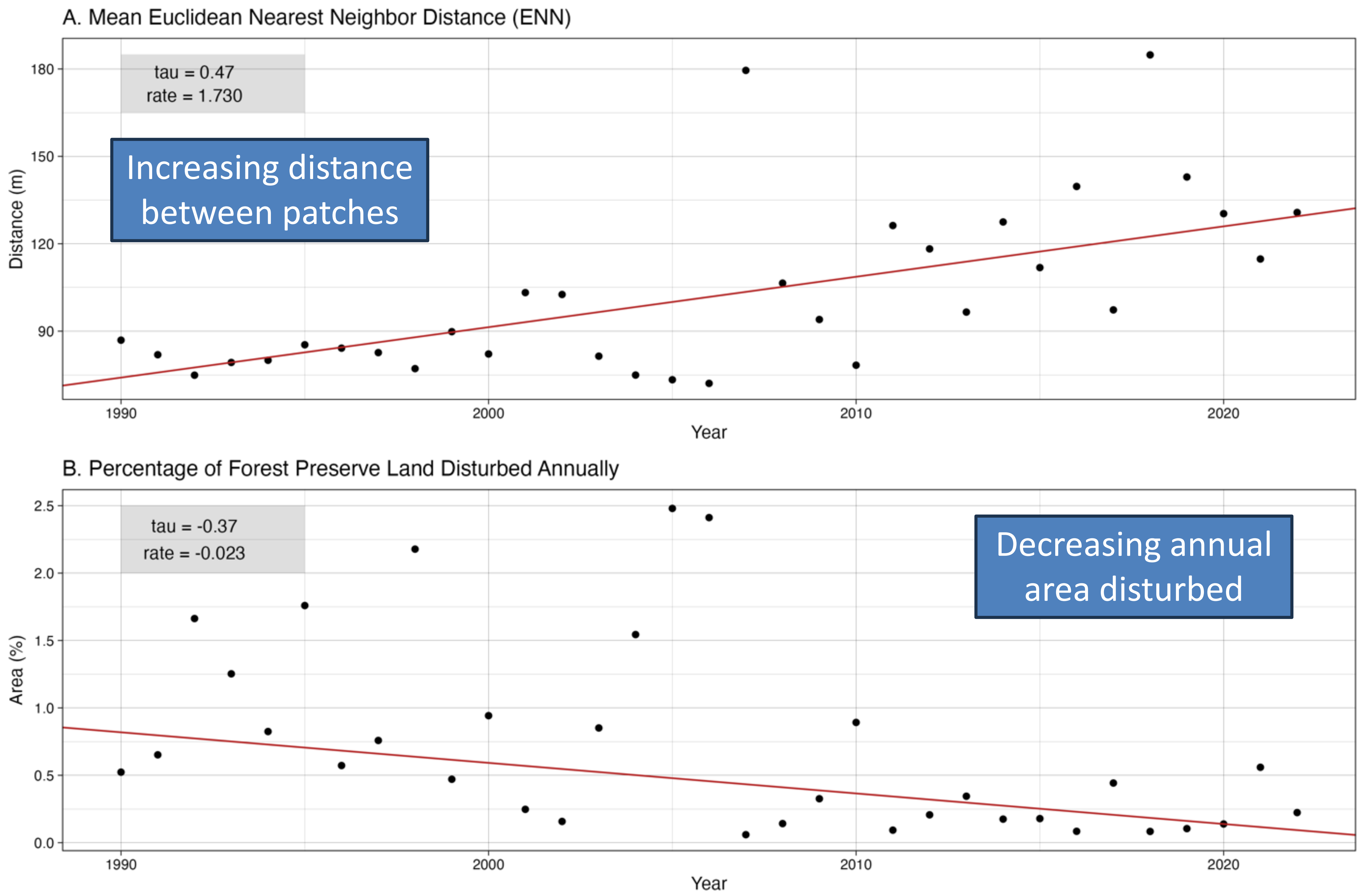
## Solar

Rapid assessment of proposed solar facilities for NYSERDA's Solar Scorecard, to minimize forest loss, C emissions due to land clearing for solar farms

# Applications



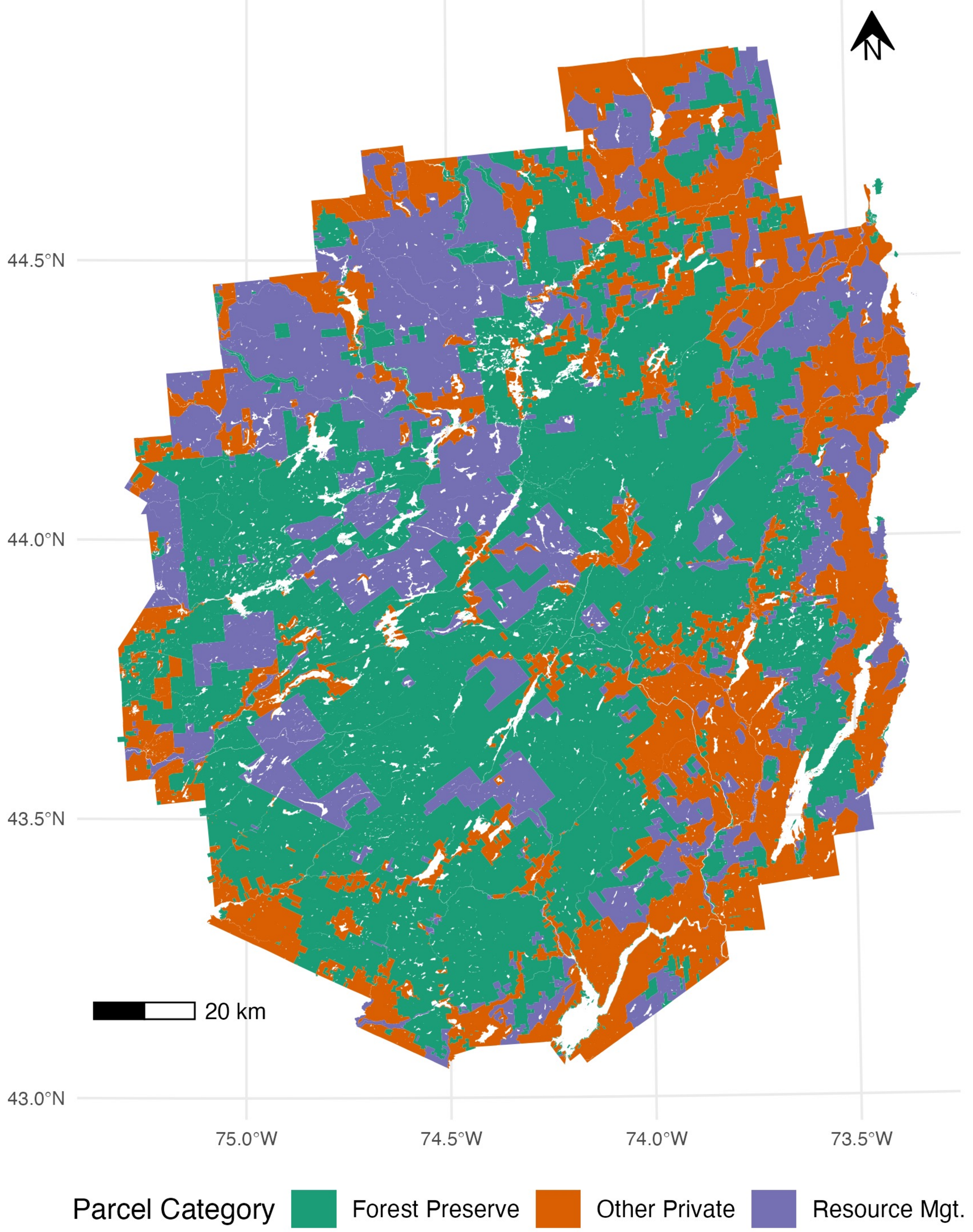


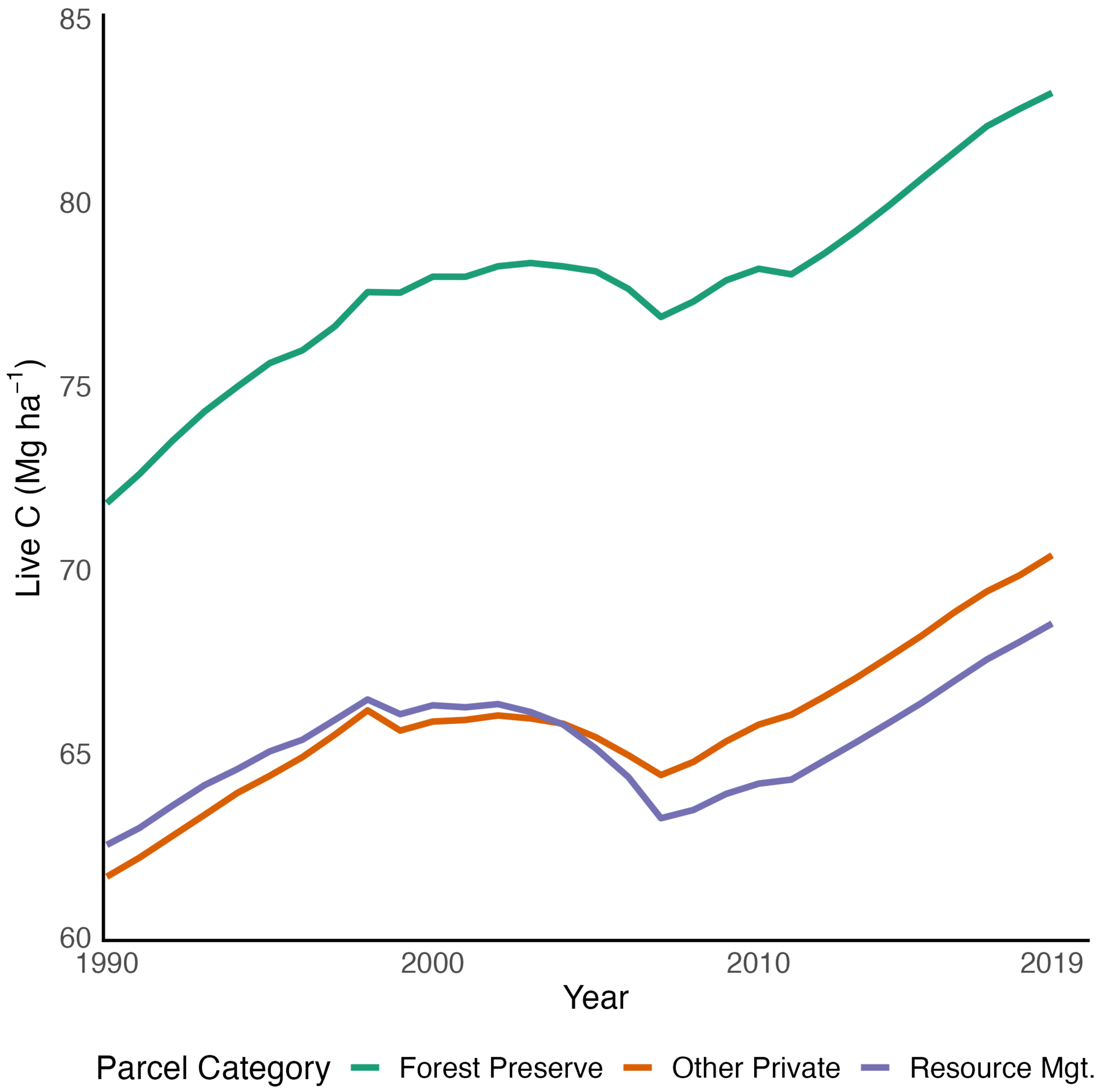




## Insights

We reconstructed forest disturbance history and assessed trends across the Forest Preserve.

Contrary to expectations, we found no evidence of an intensifying disturbance regime, but observed <u>decreasing</u> frequency of canopy loss (based on annual % area disturbed) since 1990.




# Insights

On average, Forest Preserve lands have greater live C stocks than privately-owned ADK lands

Based on stock-changes, working and reserve lands across the ADK Park have **very similar average rates of C sequestration** (net CO2 eq removals) over the last 15 years

# Thanks. Questions?

## Contributors

Steve Stehman (ESF), Eddie Bevilacqua (ESF), John Battles (Cal), Michelle Brown (TNC-NY), David Saah (UCSF/SIG)

## Partners

NYS DEC, US Forest Service, Lyme Adirondack Forest Co, F&W Forestry, NYS GIS Program Office (GPO)

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