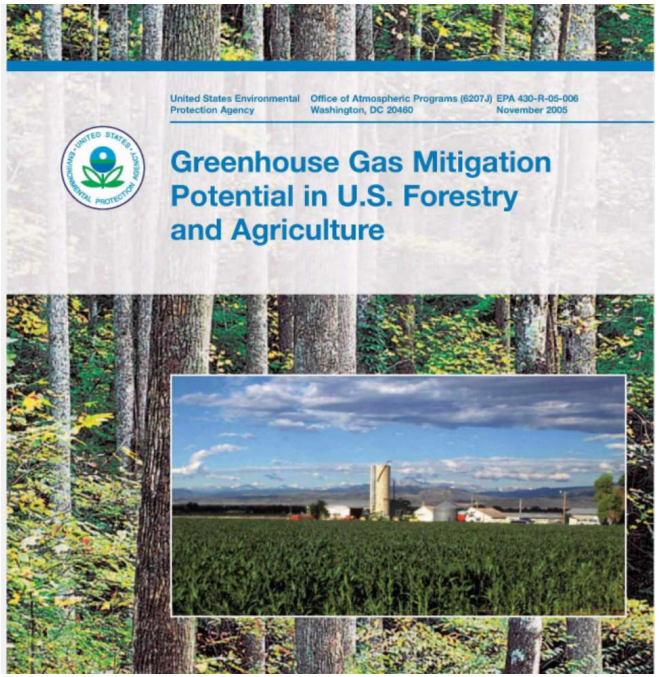
NC STATE UNIVERSITY

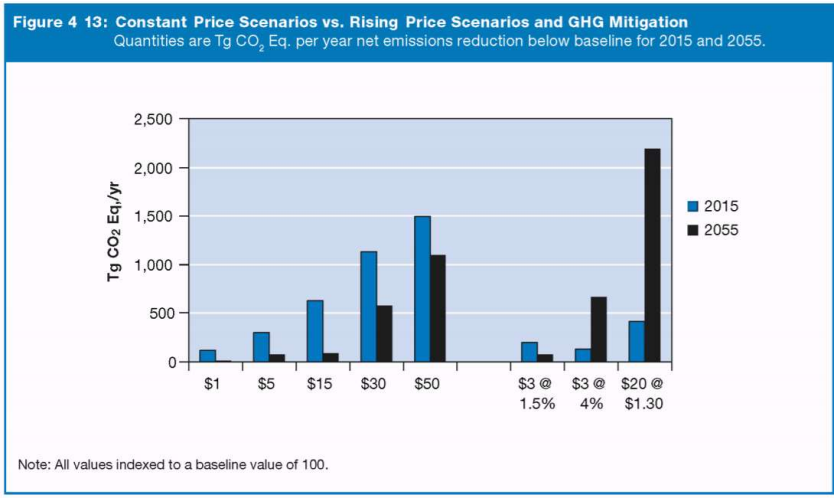
Climate Change Policy and the U.S. Forest Sector

Justin Baker and Chris Wade
NC State University
Associate Professor, Forestry and Environmental Resources
Director, Southern Forest Resource Assessment Consortium

Results from: Wade, C. M., Baker, J. S., Jones, J., Austin, K., Cai, Y., Bean, A., Latta, G., Ohrel, S., Ragnauth, S., Creason, J., McCarl, B. (2021). Projecting the impact of socioeconomic and policy factors on greenhouse gas emissions and carbon sequestration potential in U.S. forestry and agriculture. *In Press.*

Some History

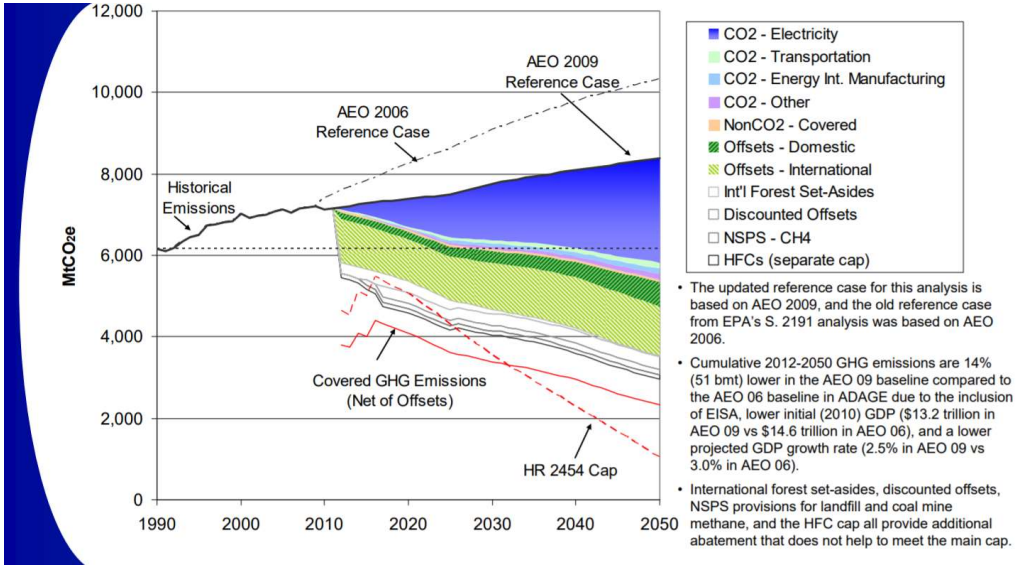




Source: EPA (2005)

Some History

- Waxman-Markey comprehensive climate legislation bill (HR 2454) in 2009
- Key potential role for agriculture and forestry offsets



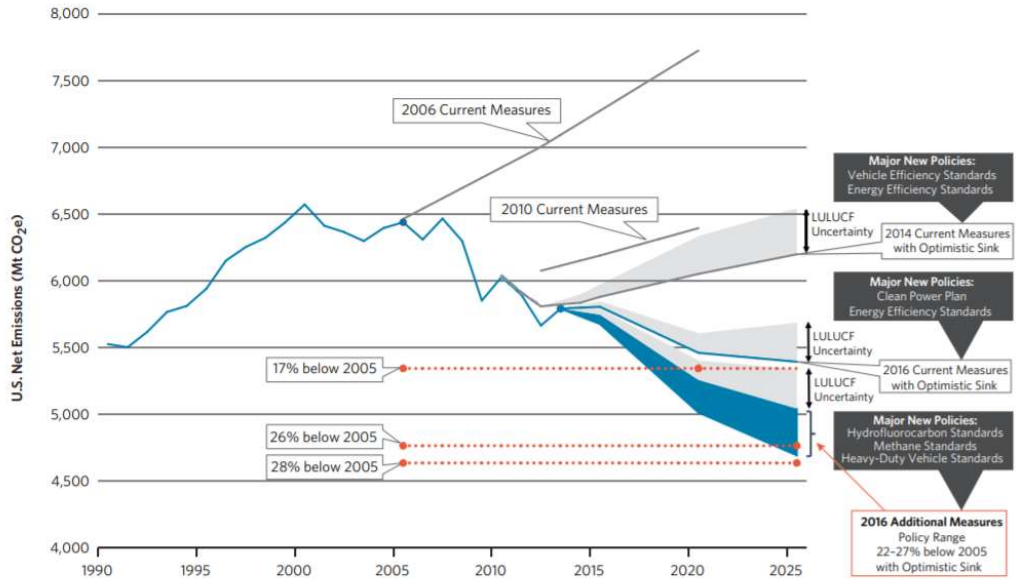
What happened after HR 2454?

- Biogenic CO2 debate
- Paris Agreement
- Clean Power Plan
  - limited role for land use sectors
- Mid-Century Strategy
- US out of the Paris Agreement

2016 US Biennial Report

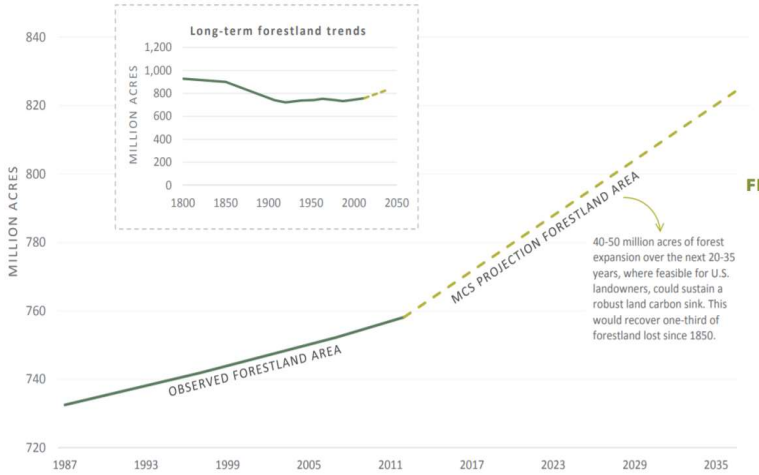
Figure 6 **U.S. Emissions Projections—2016 *Current Measures* Compared with Potential Reductions from *Additional Measures* Consistent with the *Climate Action Plan***

Also shown are previous projections from the 2006, 2010, and 2014 U.S. Climate Action Reports, which demonstrate the dramatic ratcheting down of projected U.S. emissions over the past decade.



US Mid-Century Strategy for Deep Decarbonization (2016)

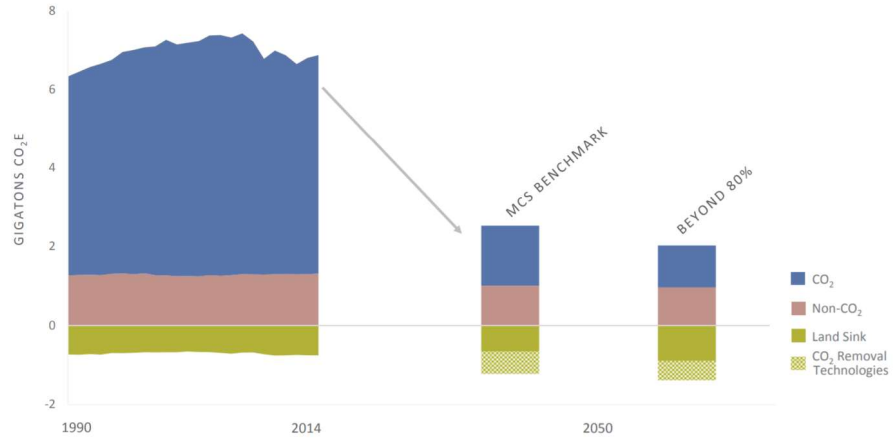
FIGURE E4: HISTORICAL FOREST EXPANSION COMPARED TO POTENTIAL MCS FOREST EXPANSION



Substantial role for afforestation

Bioenergy with CCS an important abatement source

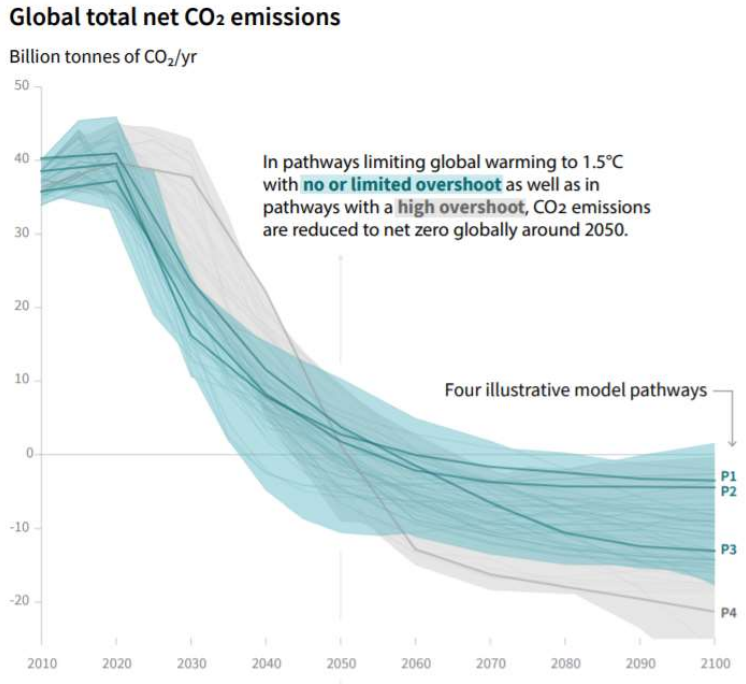
FIGURE 3.4: COMPONENTS OF ILLUSTRATIVE "BEYOND 80" SCENARIO



Global Warming of 1.5 Degrees – IPCC Special Report

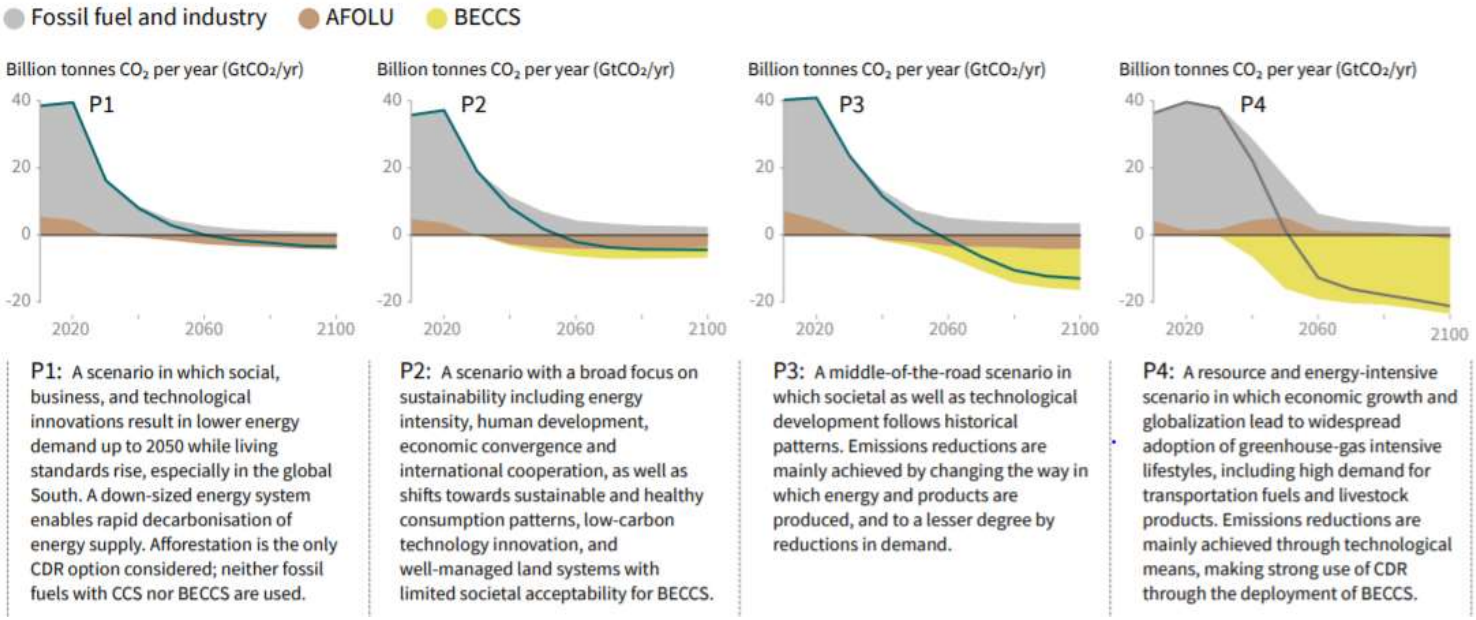
- 2018 report suggests near-term climate action is needed to avoid severe climate impacts

- Also offered several “pathways” for climate change stabilization



Global Warming of 1.5 Degrees – IPCC Special Report

- Pathways show large potential role for the land use sectors (AFOLU)
  - Increased sequestration and supply of bioenergy feedstock for BECCs



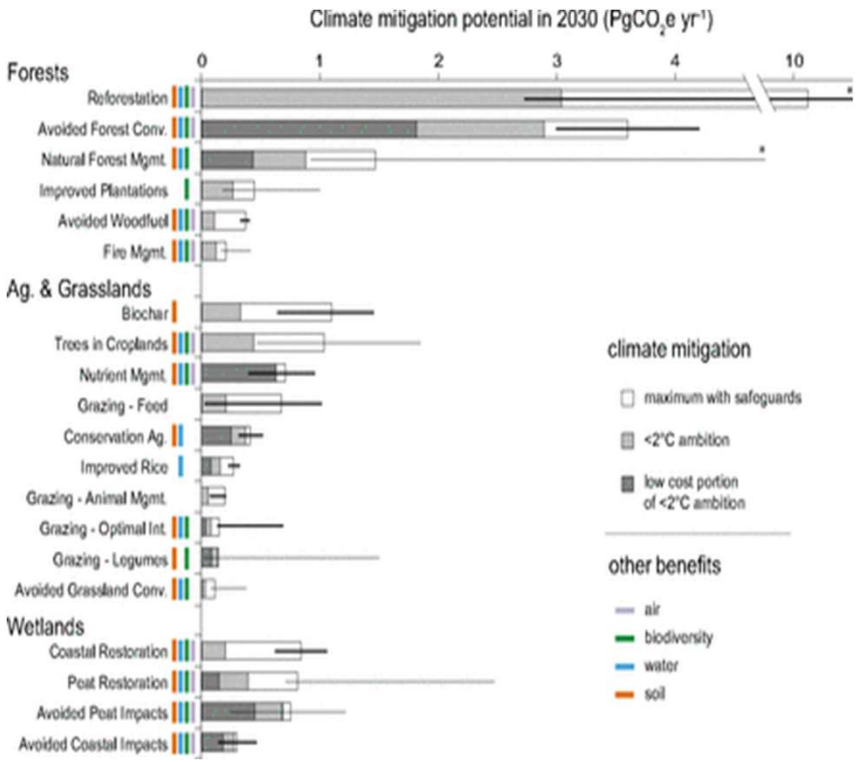
P1: A scenario in which social, business, and technological innovations result in lower energy demand up to 2050 while living standards rise, especially in the global South. A down-sized energy system enables rapid decarbonisation of energy supply. Afforestation is the only CDR option considered; neither fossil fuels with CCS nor BECCS are used.

P2: A scenario with a broad focus on sustainability including energy intensity, human development, economic convergence and international cooperation, as well as shifts towards sustainable and healthy consumption patterns, low-carbon technology innovation, and well-managed land systems with limited societal acceptability for BECCS.

P3: A middle-of-the-road scenario in which societal as well as technological development follows historical patterns. Emissions reductions are mainly achieved by changing the way in which energy and products are produced, and to a lesser degree by reductions in demand.

P4: A resource and energy-intensive scenario in which economic growth and globalization lead to widespread adoption of greenhouse-gas intensive lifestyles, including high demand for transportation fuels and livestock products. Emissions reductions are mainly achieved through technological means, making strong use of CDR through the deployment of BECCS.

Natural Climate Solutions (Griscom et al., 2017)

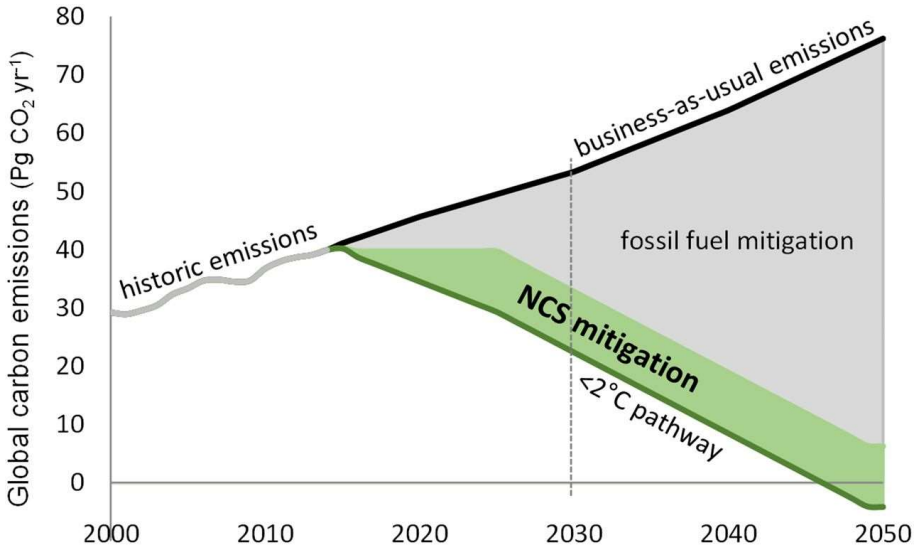


Source: Griscom et al. (2017)

- Assessment of global mitigation potential from various NCS (or land-based mitigation activities)
- ***Key result:***
  - ***NCS can provide ~11.3 $PgCO_2e$ $year^{-1}$ of abatement for <$100/$tCO_2e$***
- The NCS paper renewed focus on land-based mitigation strategies
  - New fundraising push by donor governments and foundations

Natural Climate Solutions

- NCS could supply ~1/3 of mitigation needed by 2030 for high probability of stabilization (<2 degree increase)
- However…
  - Assumes activities are mutually exclusive
  - No market feedback
  - Ignores role of management and interactions with bioenergy
  - Costs are average and constant over time



Current State of Policy

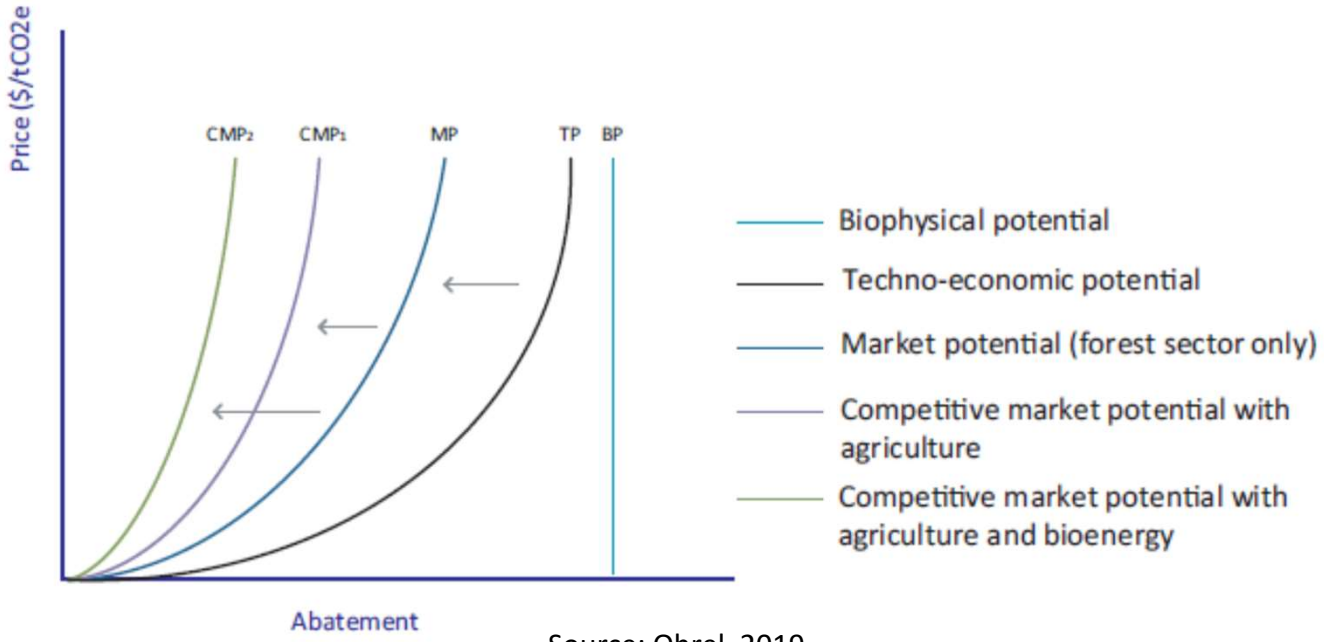
- Re-emergence of interest in carbon offsets, even without a national cap-and-trade scheme
  - private sector-led; role for federal govt?
- Wood pellet production continues to expand
  - Potential for domestic market?
- Complementary federal policies (e.g., REPLANT Act)

Some Economic Considerations

- Global perspectives may not capture nuance of regional market systems and mitigation opportunities
- NCS frameworks do not reflect market opportunity costs of mitigation investments
- ***Economic modeling can offer insight into mitigation opportunities, costs, and tradeoffs in US forestry***

Importance of Economic Modeling

- Captures market opportunity costs of mitigation investments



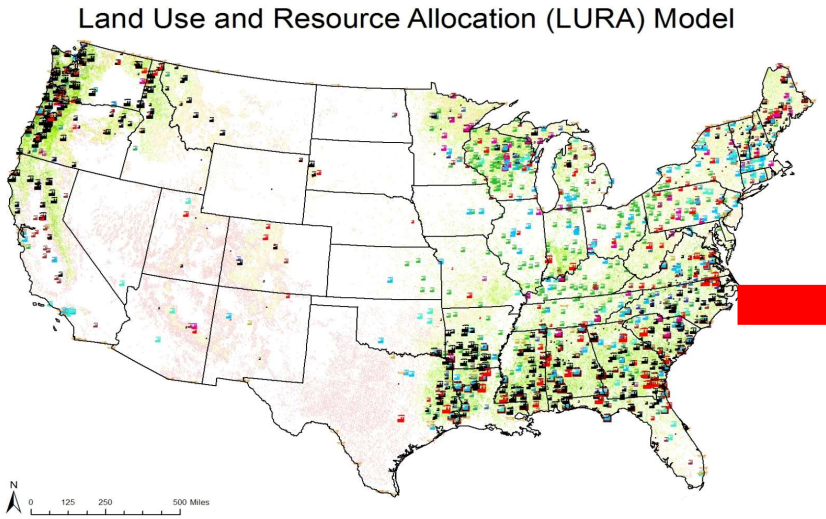
Source: Ohrel, 2019

Importance of Economic Modeling

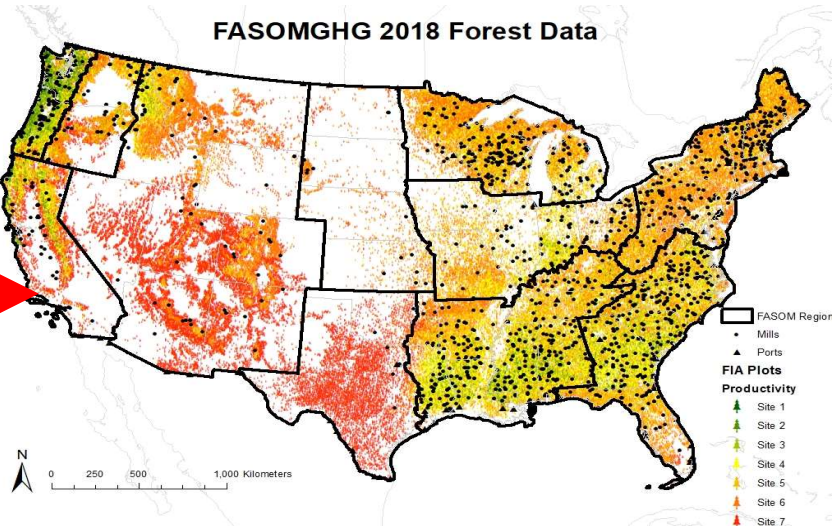
- Socioeconomic developments can alter land management and production patterns, affecting:
  - Baseline emissions
  - Marginal abatement costs
- We can use models to assess mitigation potential under alternative futures, while recognizing market tradeoffs

Modeling Approach

- Updated dynamic model of the U.S. ag and forestry sectors



Source: Adapted from Latta et al. (2018)



Source: Adapted from Jones et al. (2019)

Scenario Design

- Five alternative baselines aligned to Shared Socioeconomic Pathways:
  - **SSP1**: Sustainability
  - **SSP2**: Middle of the Road
  - **SSP3**: Regional Rivalry
  - **SSP4**: Inequality
  - **SSP5**: Fossil-fueled Development

- Mitigation scenarios:
  - $5, $20, $30, $50/tCO2e rising at 1% and 3%

Scenario Design

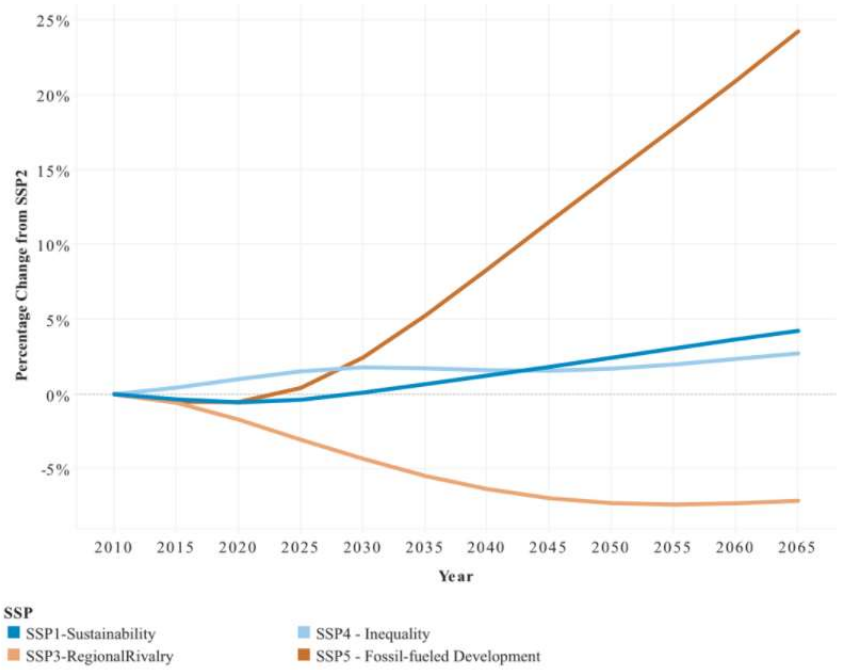
Sources of Variation across SSPs

- Income-driven demand growth for forest and agricultural products
- Dietary preferences
- Urban development
- Crop productivity growth
- Use of public lands

Mitigation Activities being Incentivized

- Increased forest C sequestration through preservation, expansion, and management
- Reduced non-CO2 emissions from crop and livestock production
- Increased soil carbon sequestration through management and land use

Shared Socioeconomic Pathways



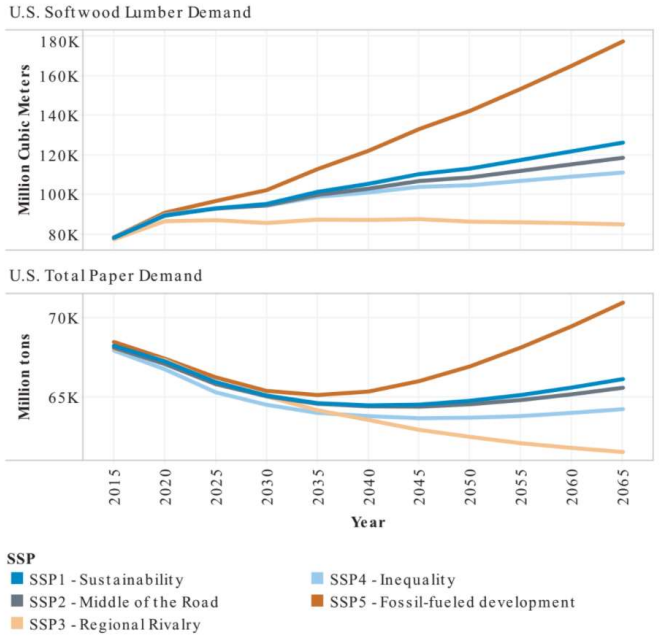


Figure 4: Demand curves for U.S. Softwood lumber (million m3) and paper product (million tons) across SSPs from 2015 to 2065.

Key Findings

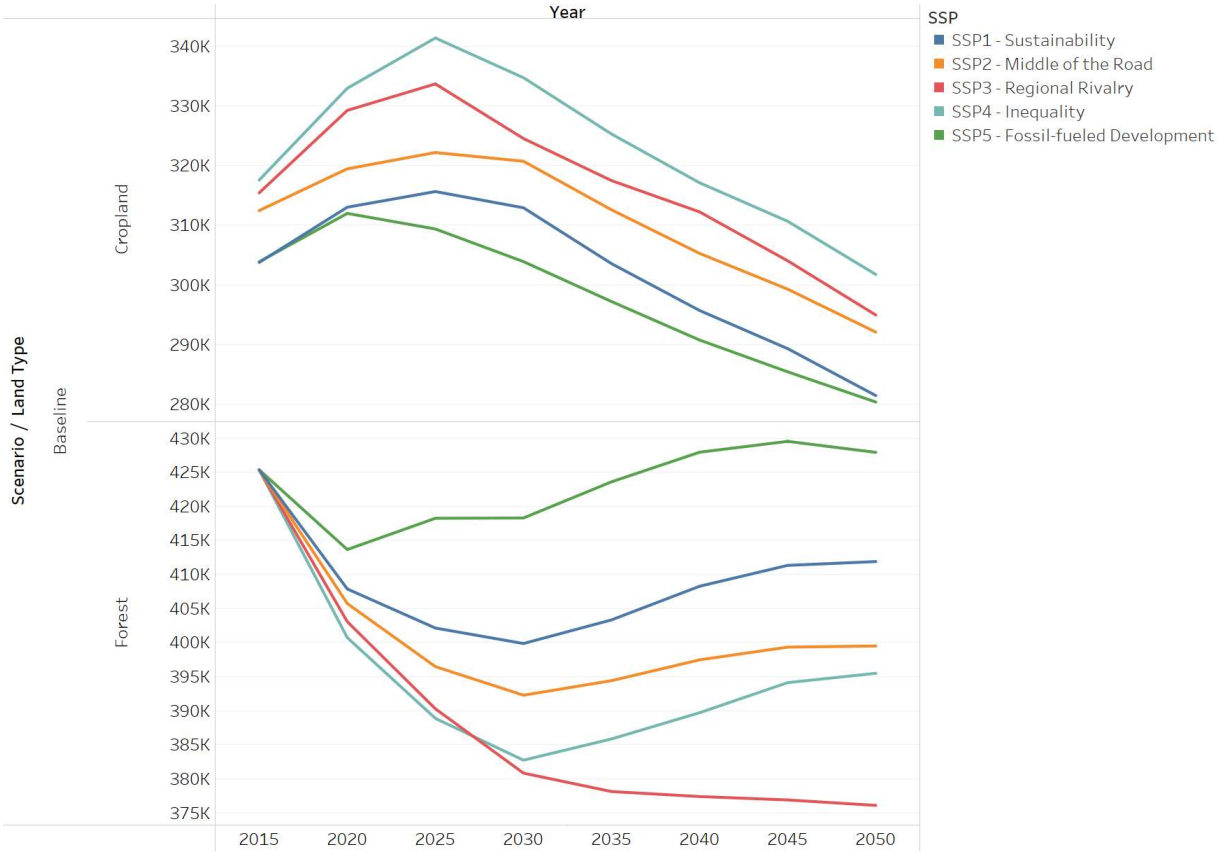
- Substantial mitigation potential from U.S. forestry and agriculture
  - Ranging ~**160-750 MtCO2e** per year by 2050
  - **5%-14%** of total mitigation needed to hit new US NDC targets in 2030

- Variation in projected mitigation driven by future socioeconomic development and policy assumptions

- Forest carbon sinks are closely linked demand growth

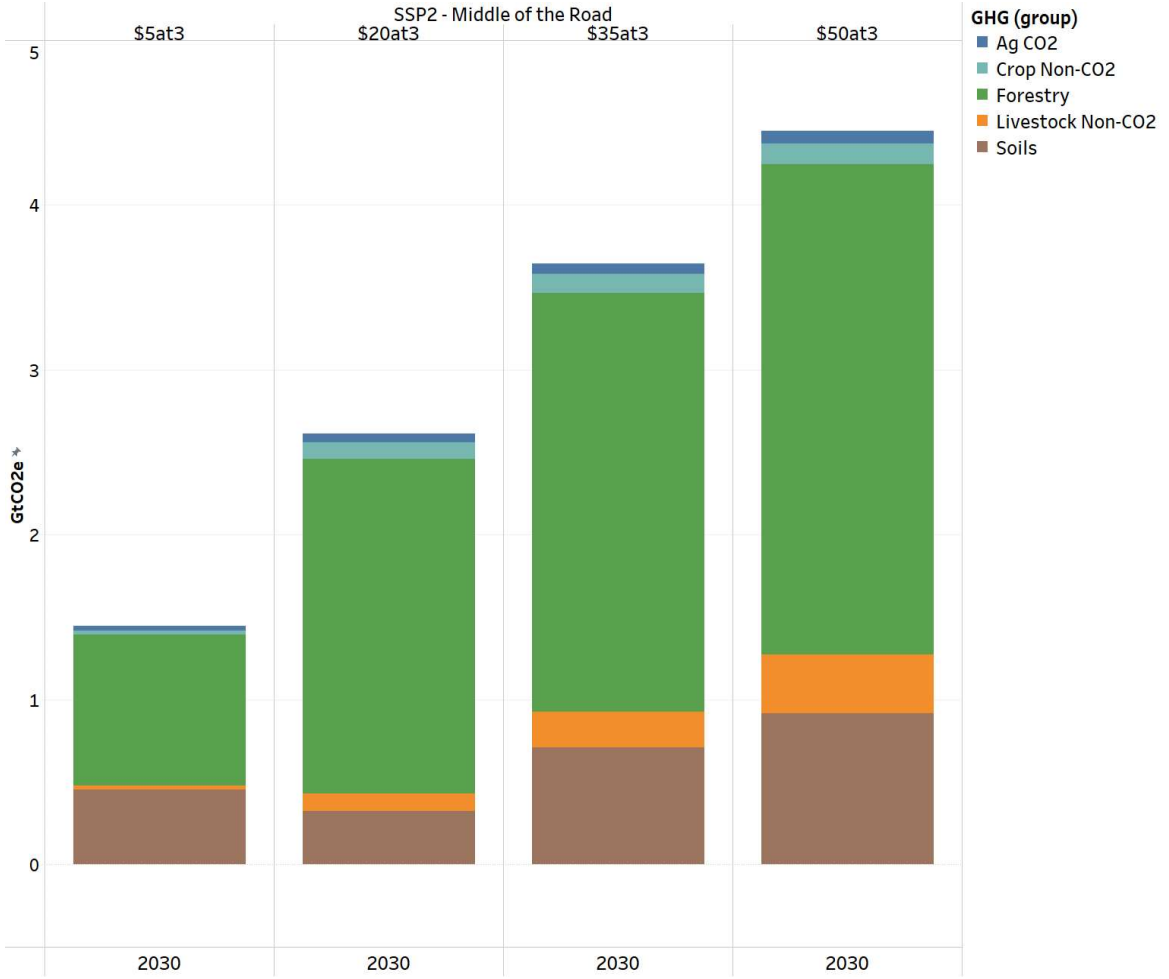
Baseline Comparison

- Land use and production trends vary substantially
- Higher income growth drives investment in new forests



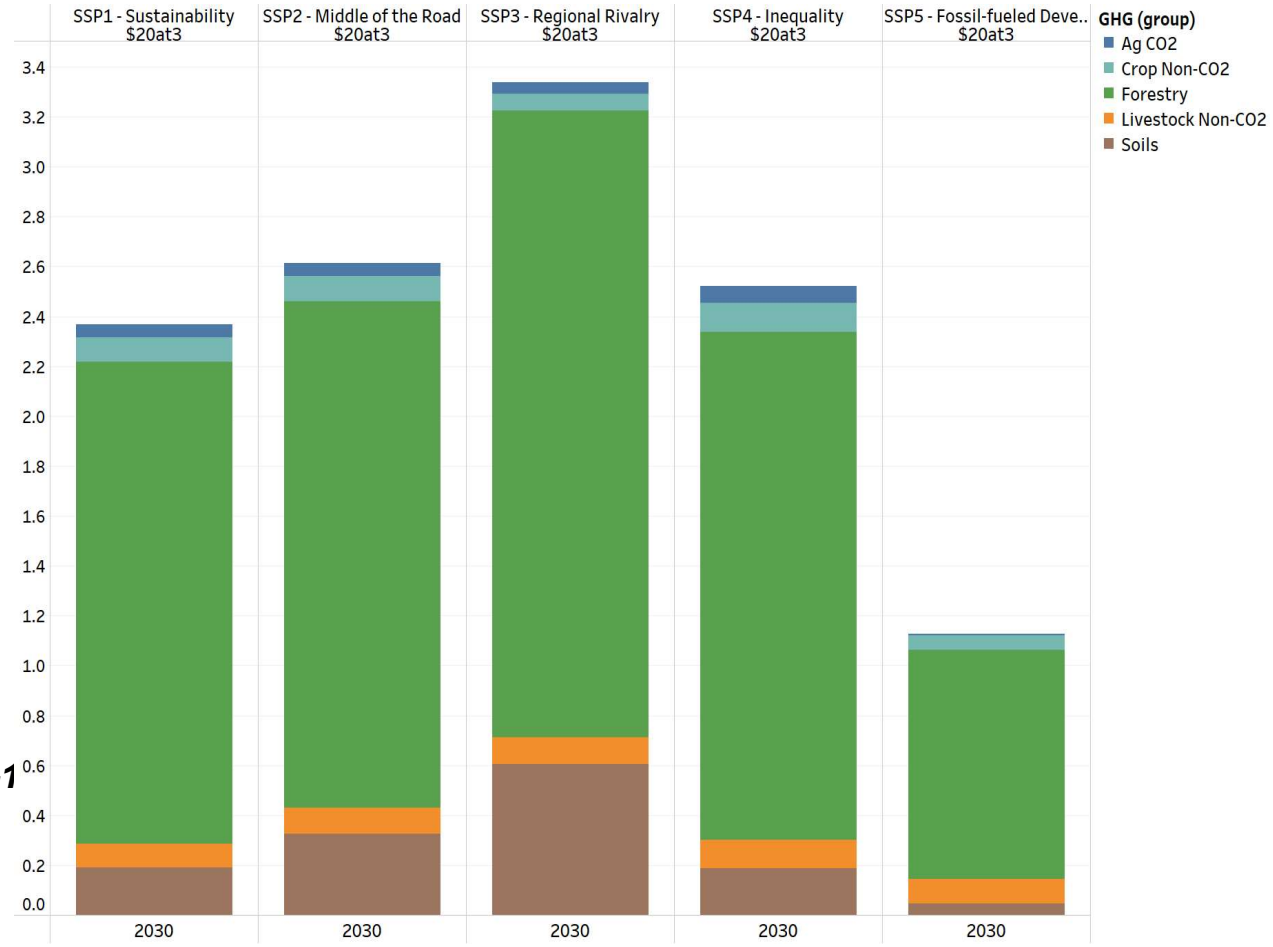
Cumulative Mitigation Potential (2030)

- Single baseline (**SSP2**), across price scenarios
- Projected mitigation for SSP2 ranges:
  - ***150-450 $MtCO_2e\ yr^{-1}$***



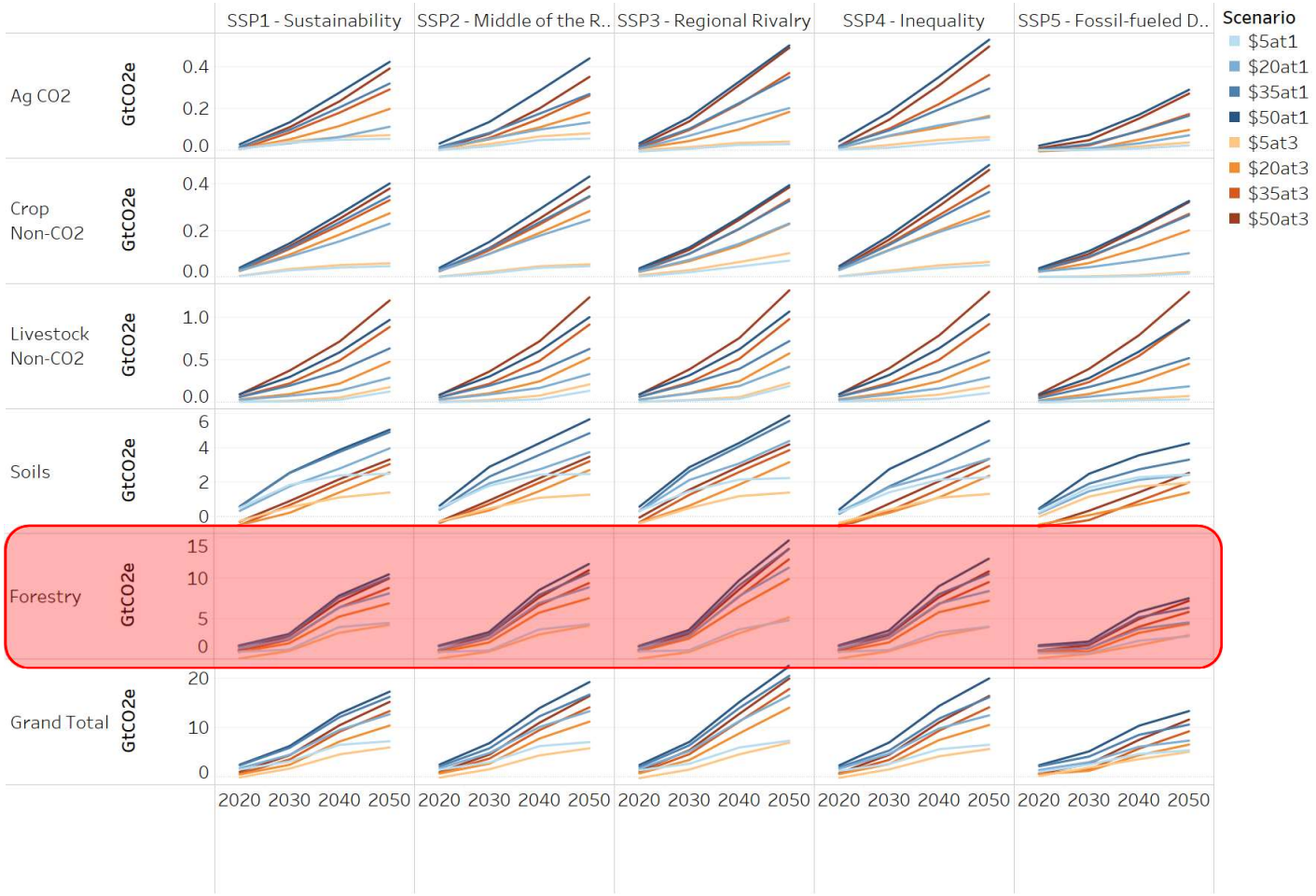
Cumulative Mitigation Potential (2030)

- All SSPs, single mitigation price **$20/tCO$_2$e**
- Projected mitigation across SSPs:
  - ***110-330 MtCO$_2$e yr^{-1}***



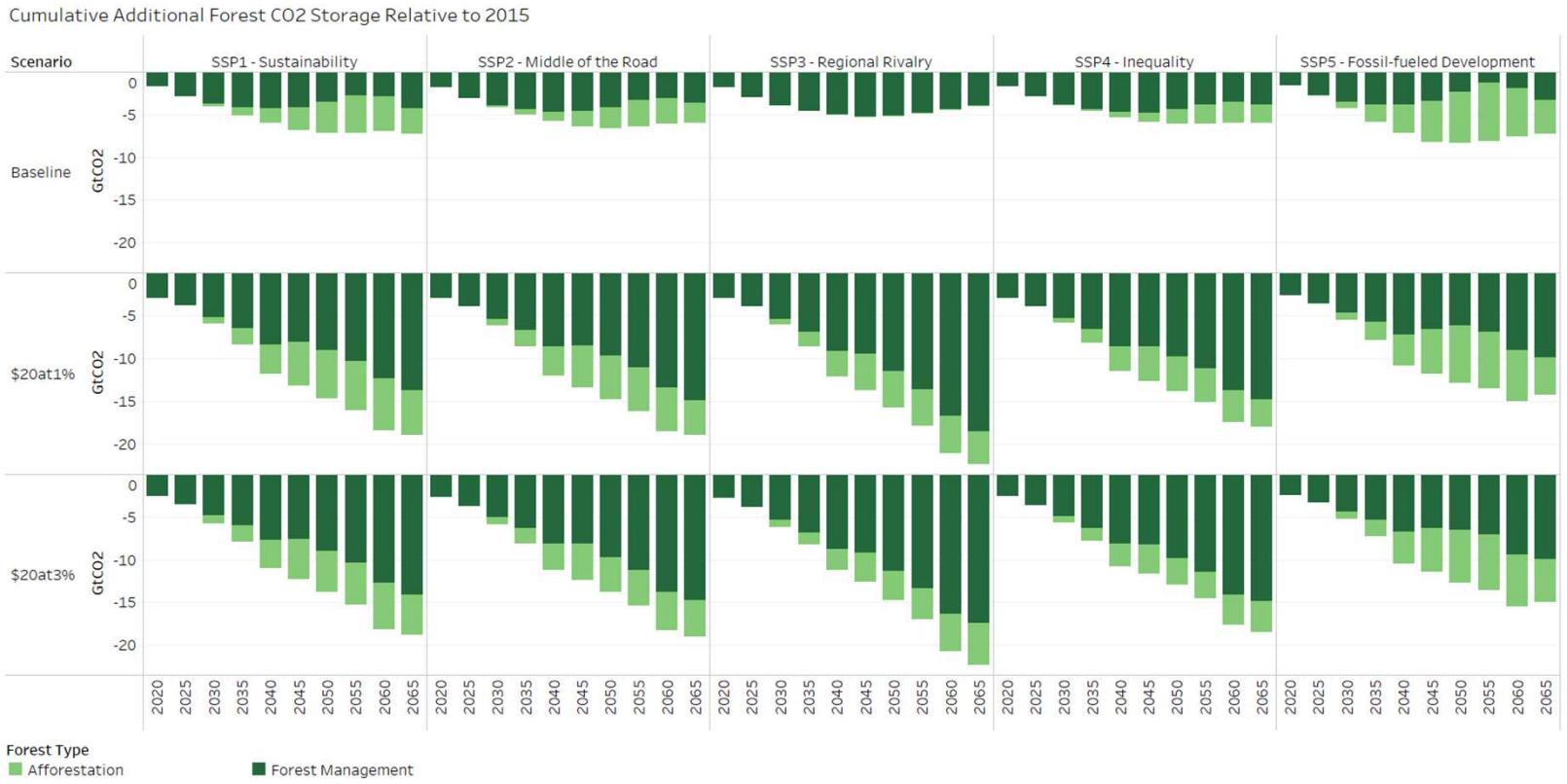
Key Takeaways

- Mitigation rises over time and at higher price incentives
- Range of mitigation across SSPs is substantial
  - Highest potential for pessimistic case (SSP3), lowest for high income and emissions case (SSP5)
- Greatest mitigation potential from forest management and afforestation (>60%)



Forestry dominates the mitigation portfolio

Source of Additional Forest C Sequestration



Market and Policy Induced Change in Forest C

Demand driven

Policy driven

Key Takeaways

- Demand an important driver of forest C storage under high income growth scenarios
  - More than 50% of C stock change is demand-driven in SSP5 by 2050

- Mitigation policy supports continued sequestration once demand-driven C sequestration plateaus
  - Demand-side policies can complement payments for carbon sequestration (Baker et al., 2019).

Conclusions

- Socioeconomic developments could influence future emissions and mitigation portfolios

- US AFOLU sectors are an important mitigation source
  - Ranging ~**160-750 MtCO2e** per year by 2050
  - **5%-14%** of total mitigation needed to hit new US NDC targets in 2030

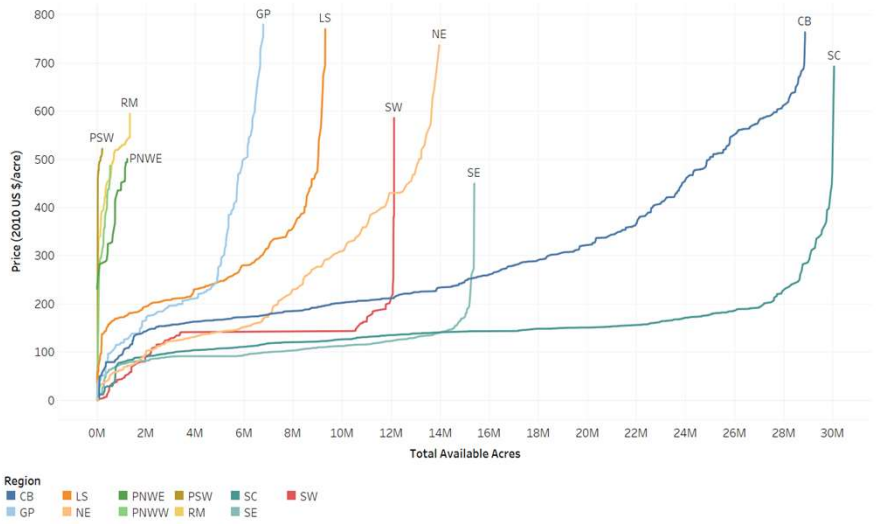
- Stimulating forest product demand in the U.S. can increase carbon storage and complement mitigation

Thank You!

- justinbaker@ncsu.edu

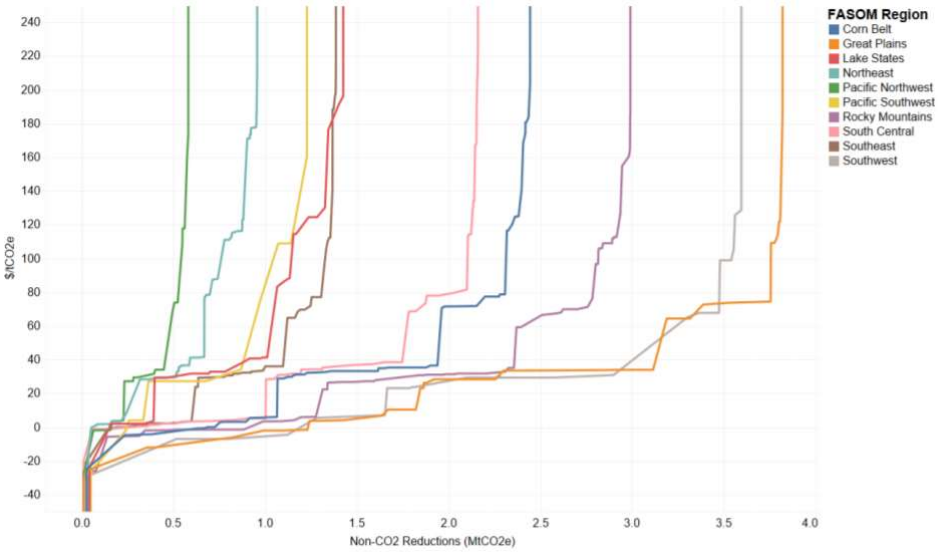
Updated Regional Abatement Costs

- Regional afforestation cost curves



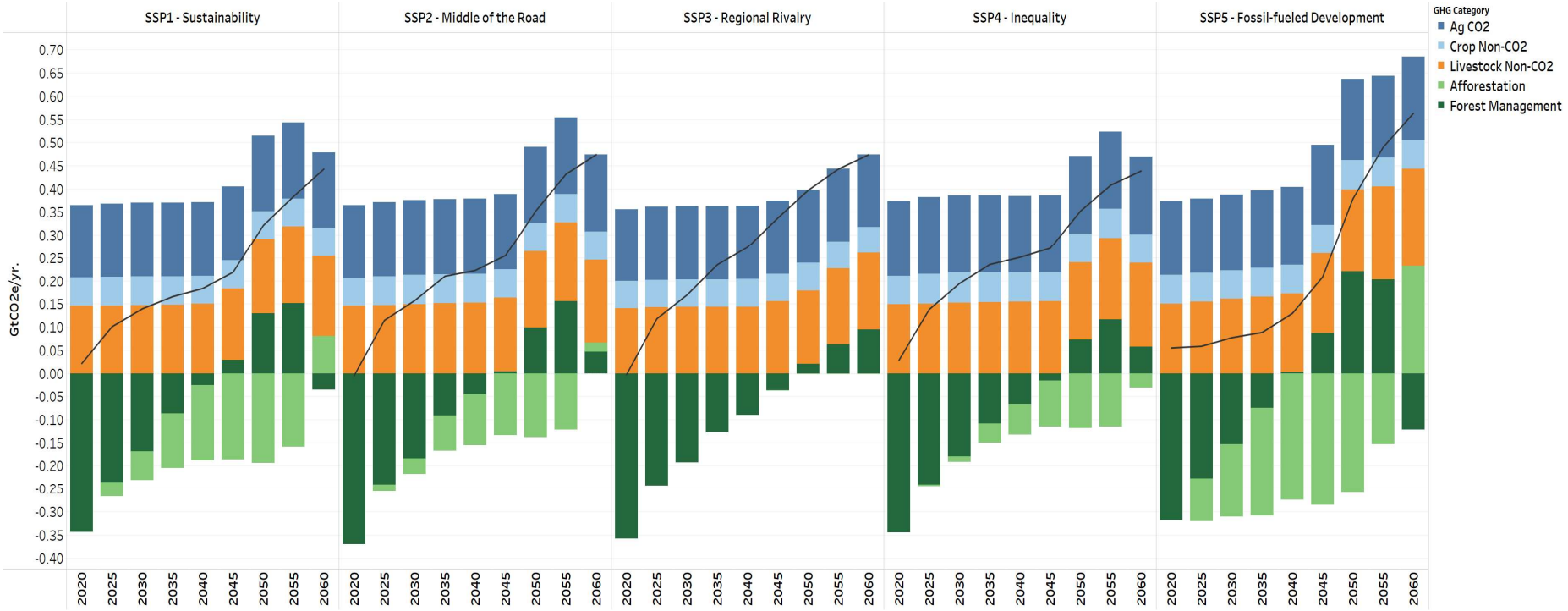
Source: adapted from Nielsen et al. (2014) and presented in Cai et al. (2018)

- Regional livestock sector MACCs



Source: adapted from EPA (2016), represents MACC curves for enteric fermentation abatement

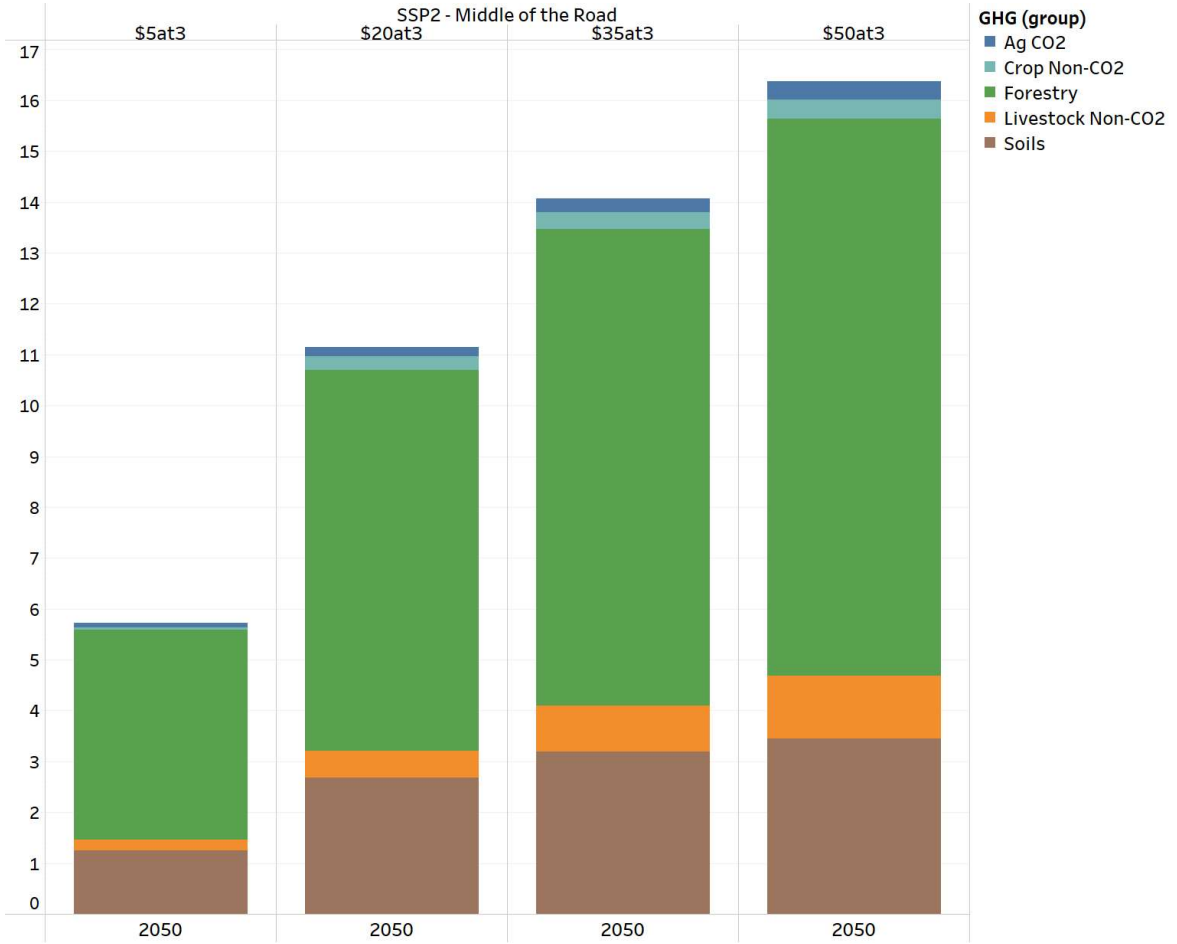
Baseline Emissions Projections



Forest C sequestration increases with income growth (SSP1, SSP5)

Cumulative Mitigation Potential (2050)

- Single baseline (SSP2), across price scenarios
- Projected mitigation for SSP2 ranges:
  - ***190-540 $MtCO_2e\ yr^{-1}$***



Mitigation Potential across Socioeconomic Futures

- All SSPs, single mitigation price
- By 2050, projected mitigation across SSPs:
  - ***216-460 $MtCO_2e\ yr^{-1}$***