Benefits and Costs of Maine's Natural Climate Solutions Part 2: Forestry

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USDA Climate Hub Webinar Series

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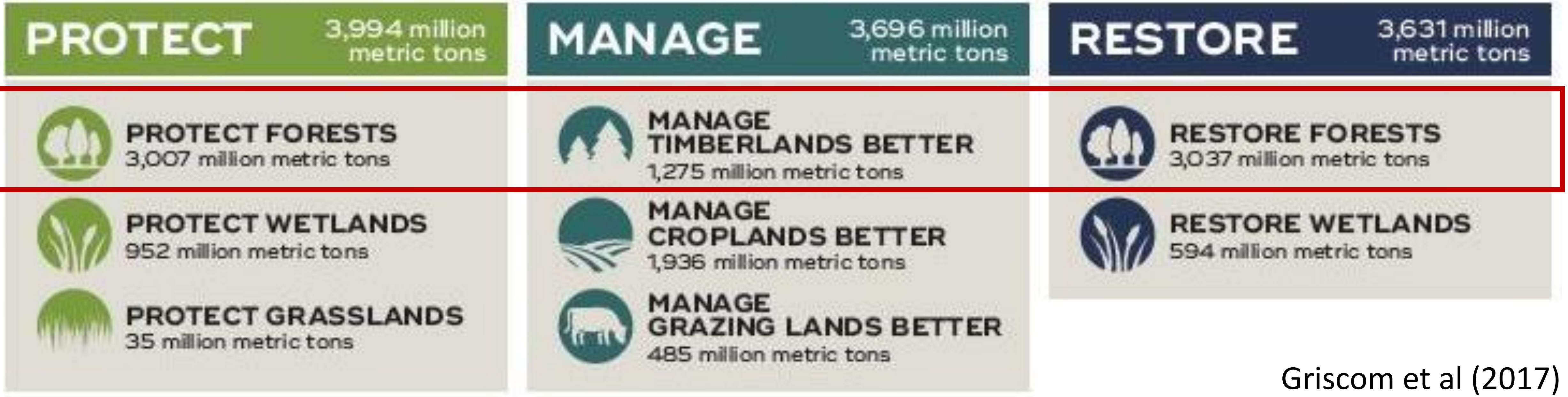
What are "Natural Climate Solutions"?

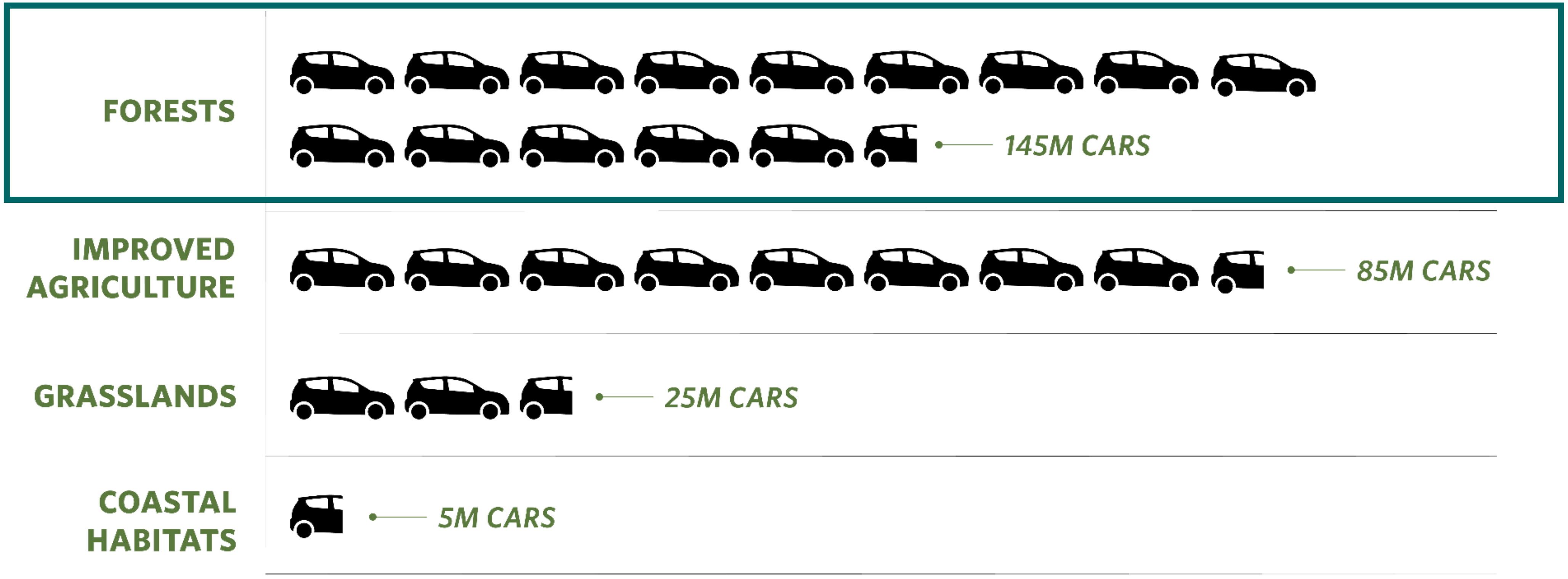
Any action that **conserves**, **restores** or improves the use or **management** of forests, wetlands, grasslands, and agricultural lands, while simultaneously **increasing carbon storage** or **avoiding greenhouse gas emissions**.



Griscom et al (2017)

NATURAL CLIMATE SOLUTIONS

In the U.S., nature has potential to remove **21% of the nation's carbon pollution**—equivalent to removing emissions from **ALL cars and trucks on the road**...and then some.



56% of total NCS

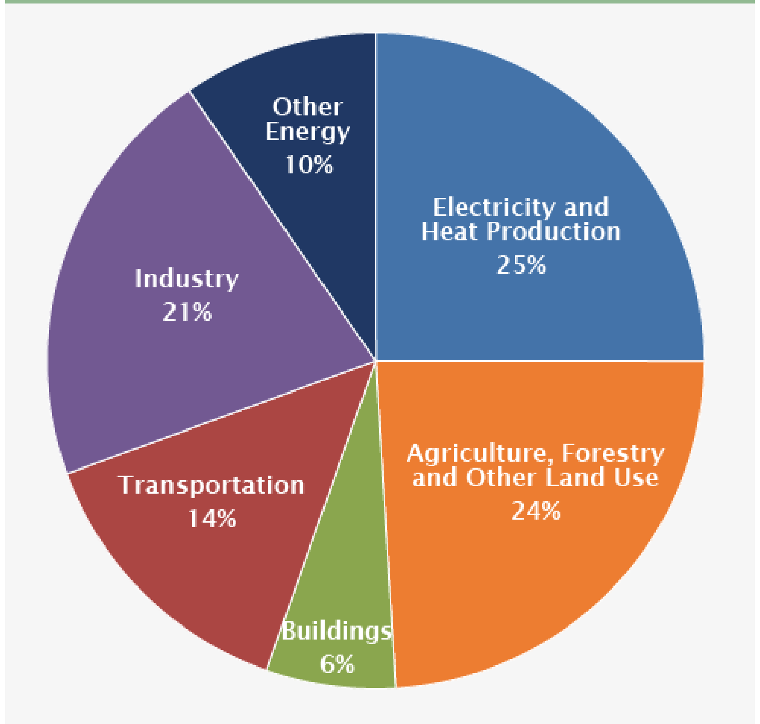
U.S. Mitigation Potential: Approximate Number of Cars Removed Each Year in Millions

= 10M cars

Source: Fargione et al (2018)

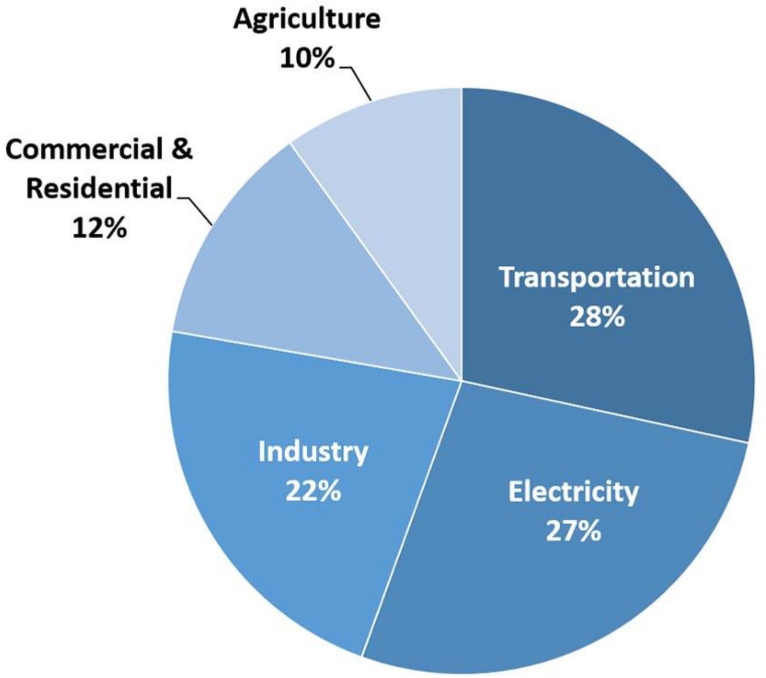
But, agriculture, forest and other land use greenhouse gas (GHG) emissions vary depending on where and what you measure…

Total Global GHG Emissions by Economic Sector in 2014



Global Ag & Forest: +24% total GHGs

Total Global GHG Emissions by Economic Sector in 2018



US Forests: -11%

Total Maine GHG Emissions by Source Category in 2017

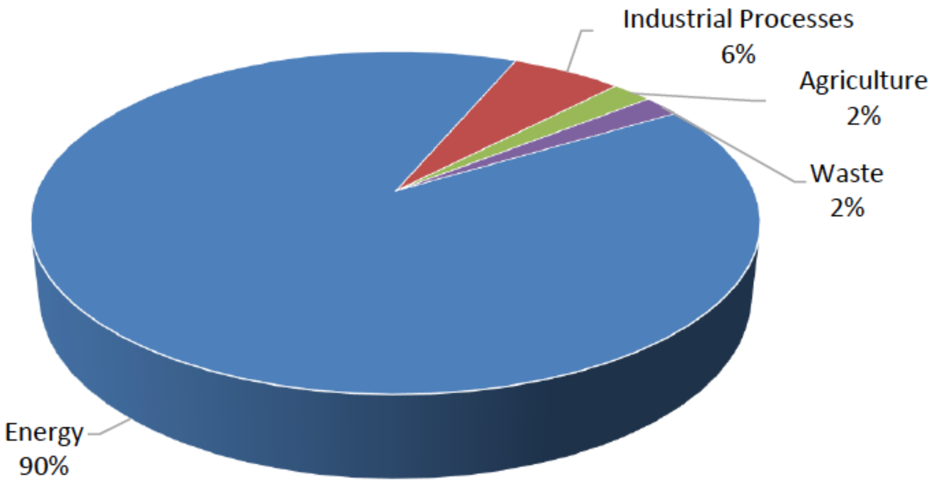
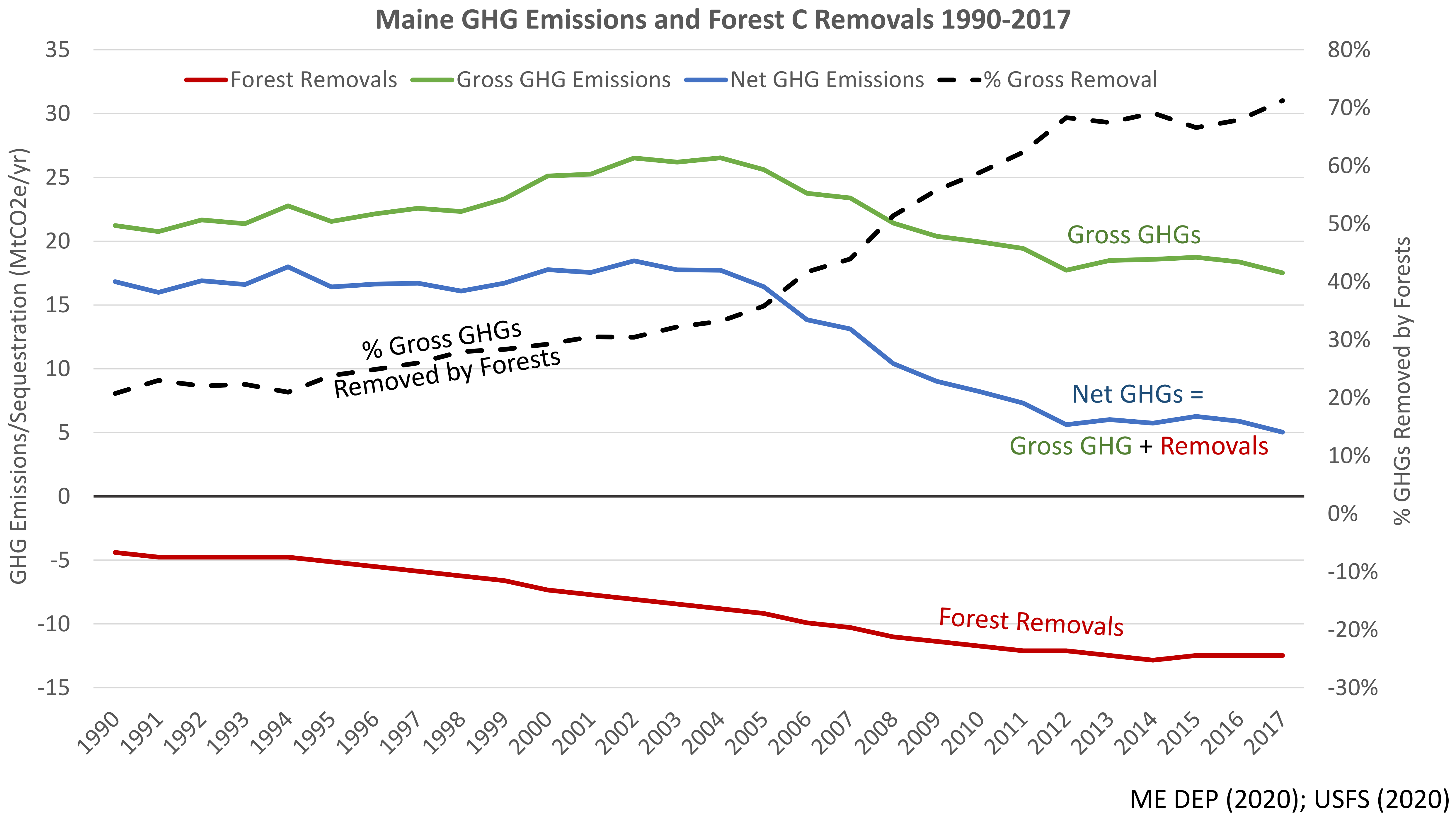


Figure 2. Emissions by source category for 2017 (data in Appendix A)

ME Forests: -70%


Maine GHG Emissions and Forest C Removals 1990-2017
Forest Removals
Gross GHG Emissions
Net GHG Emissions
% Gross Removal
GHG Emissions/Sequestration (MtCO2e/yr)
% GHGs Removed by Forests
35
30
25
20
15
10
5
0
-5
-10
-15
80%
70%
60%
50%
40%
30%
20%
10%
0%
-10%
-20%
-30%
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Gross GHGs
% Gross GHGs
Removed by Forests
Net GHGs =
Gross GHG + Removals
Forest Removals
ME DEP (2020); USFS (2020)

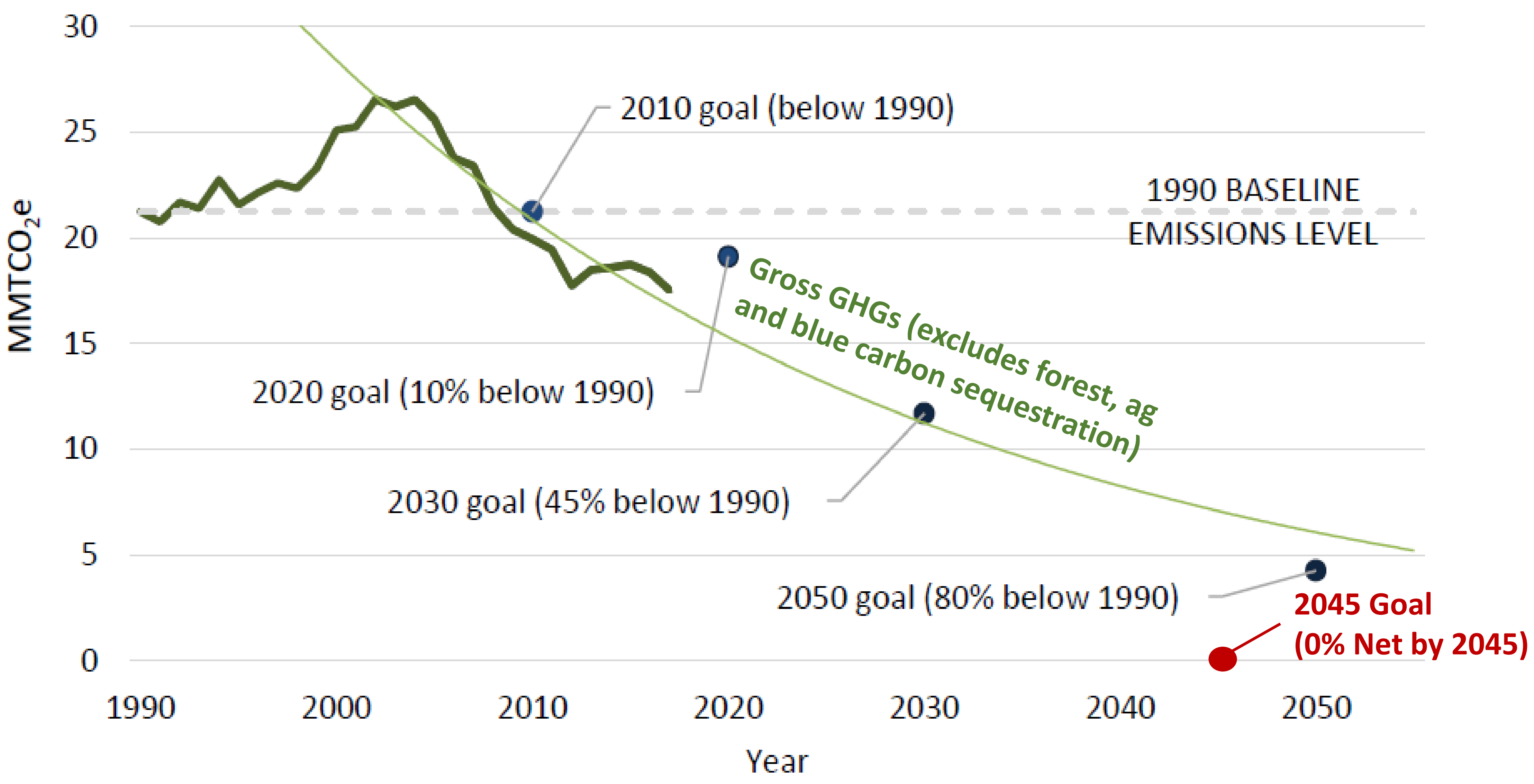


Figure 11. Maine's greenhouse gas emissions 1990-2017 with 2020, 2030, and 2050 reduction and emissions goals

Source: ME DEP (2020)

How do we estimate NCS mitigation benefits and costs?

1. Define ‘baseline’ or ‘business as usual’ pathway
2. Establish list of acceptable mitigation practices
3. Estimate ‘cost’ and ‘effectiveness’ of implementing practices

Estimating Costs and Benefits of NCS

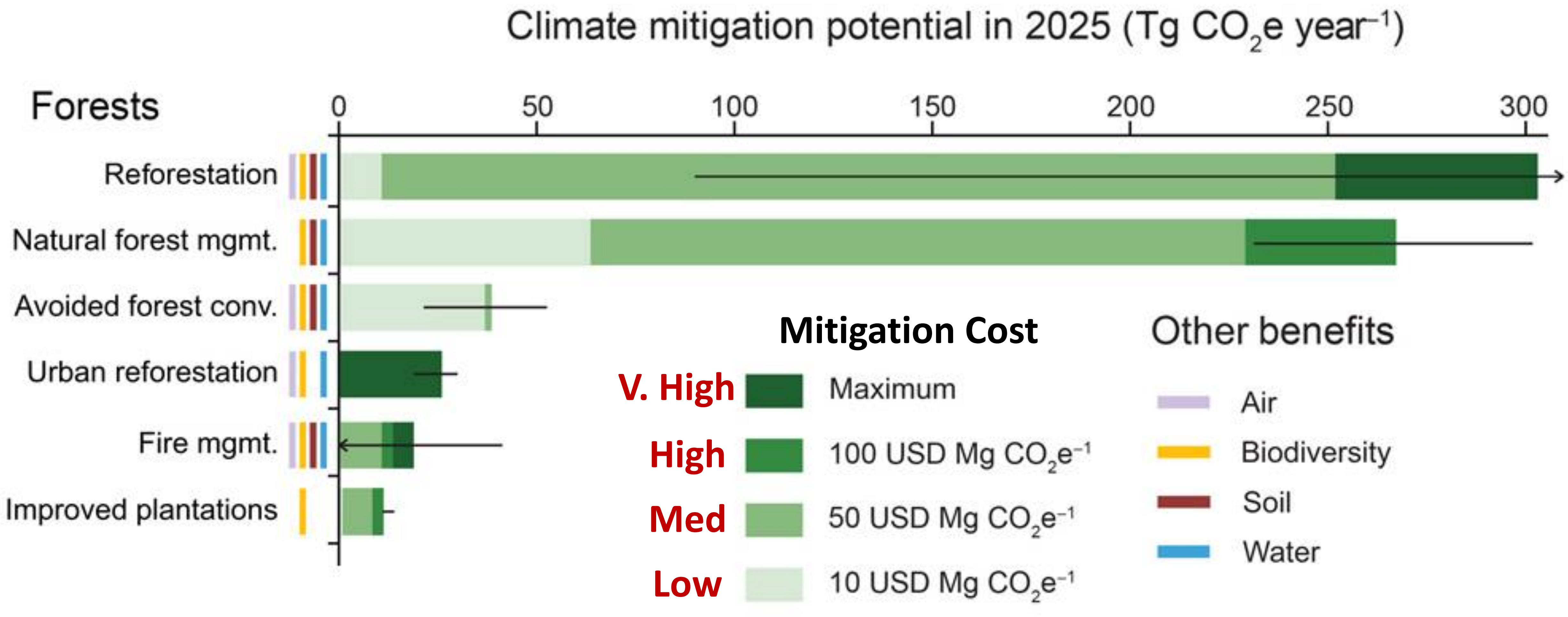
Costs

- Opportunity
  - Growth & yield reductions
  - Harvestable area + products
- Capital/equipment
- Labor
- Maintenance
- Other environmental costs?

Benefits

- Increased C sequestration
- Yield improvements
- Diversified income stream
- Cost-savings
- Other environmental co-benefits?

US Forest GHG Mitigation Potential

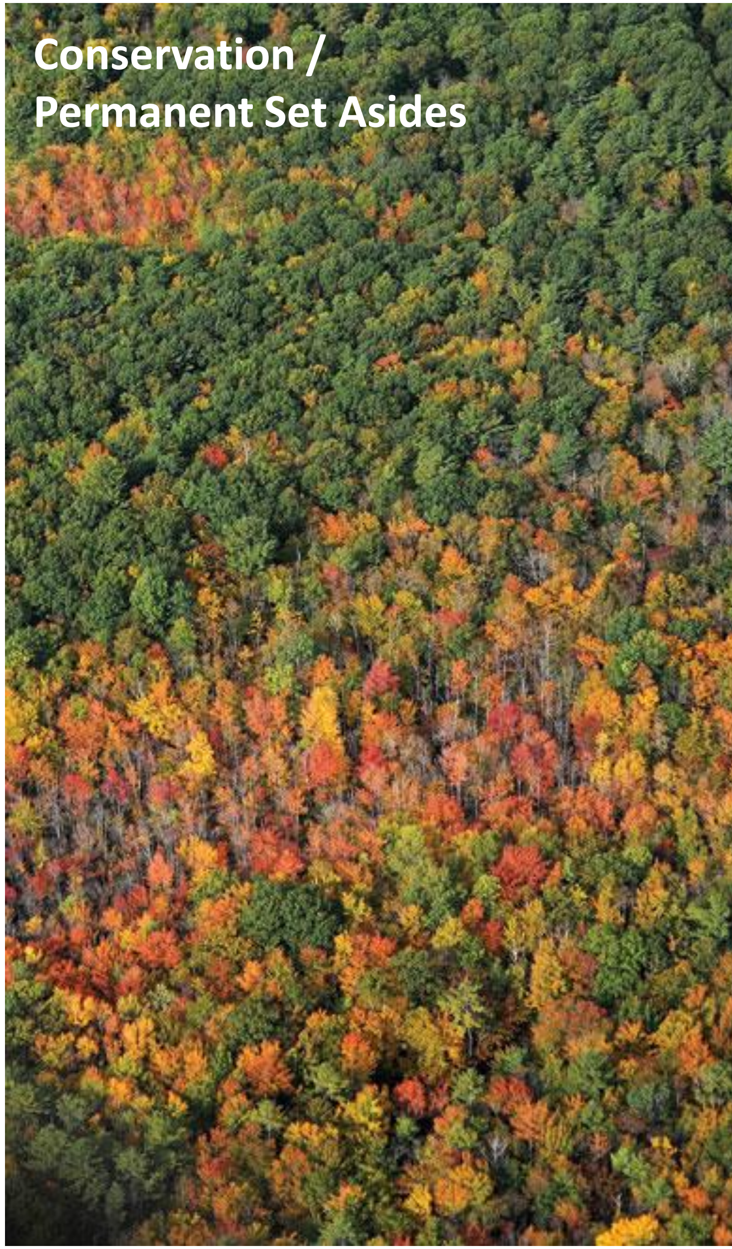


Fargione et al (2018)

What about Maine?

- To date, most studies are global and national-scale
- State-level estimates often reliant on assumptions more applicable elsewhere
- Practices covered often typical of more conventional forest management systems (e.g., clearcuts)
- Specific implementation barriers?

Some forestry practices to consider…



Forest Carbon + Cost Estimation

- *Forest Carbon Sequestration Components*
  - **Forest C**: Annual change in aboveground growing stock
  - **Harvest C**: Removal timber stored in harvested wood products & landfills (~20% removals)

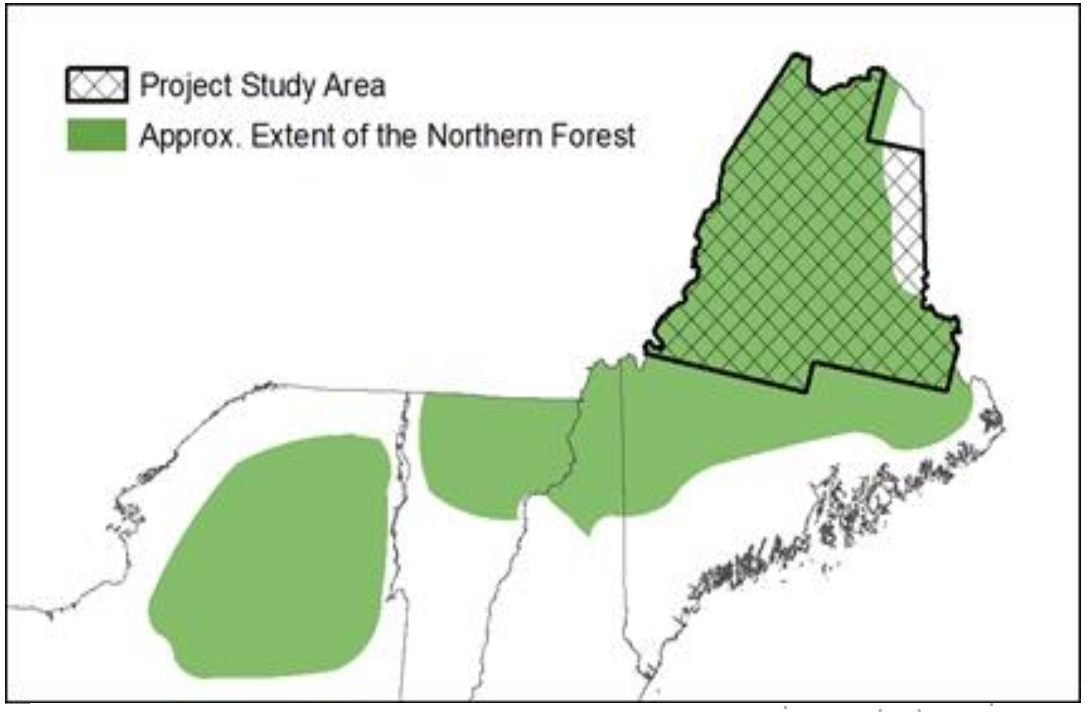
Total C = Forest C + Harvest C

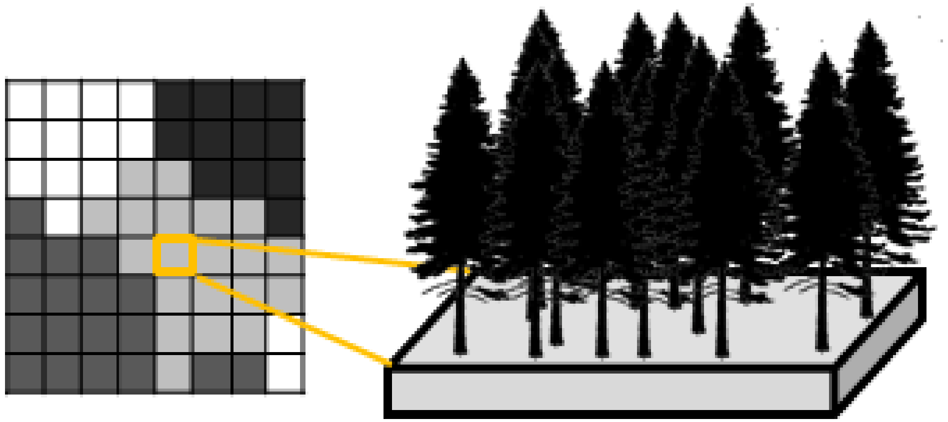
- *Economic Costs and Benefits Components*
  - **Harvest value**: Harvest x state mean stumpage price (by product)
  - **Opportunity cost**: Change in harvest revenue relative to BAU (can be positive)
  - **Planting cost**: seedling ($0.37/plant), site prep + spraying ($250/ac) = $509/ac
  - **Land Cost/Rent**: varies by current or highest and best use

Total Cost = Opportunity + Planting Cost + Land Cost

Forest landscape model

- LANDIS-II
- Extent: 9.1 million acres
- Resolution: 30 meters
- Timespan: 2010 to 2100
- System drivers:
  - Timber harvest
  - Wind
  - Succession
  - Climate change (impacts to tree species productivity and probability of establishment)





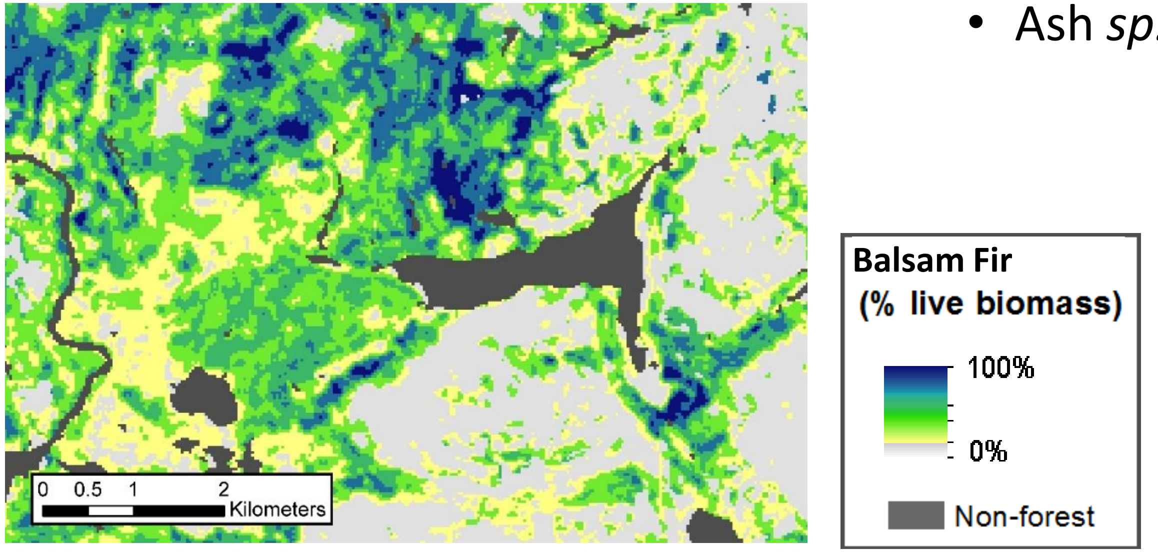
Figurative example of the cell-based system used by LANDIS-II to represent a single species (e.g., Red spruce) even-aged area of forest. Stands are formed by groups of like cells.

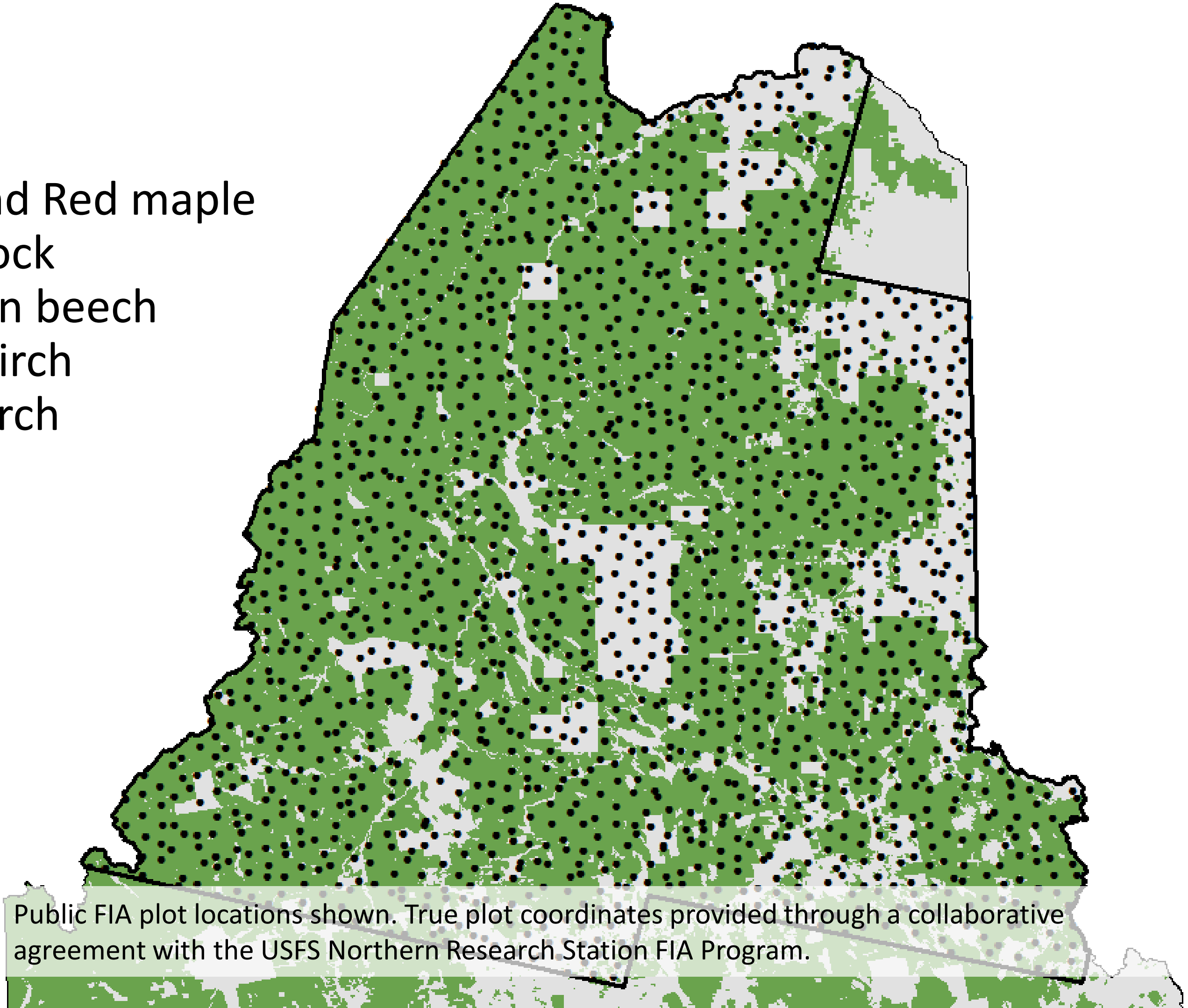
Initial Forest Conditions

- Mapped using USFS FIA plot data and Landsat satellite imagery

Species abundance (% biomass):

- Balsam fir
- Red, white, black spruce
- E. White pine
- N. White cedar
- Sugar and Red maple
- E. Hemlock
- American beech
- Yellow birch
- Paper birch
- Ash *sp.*

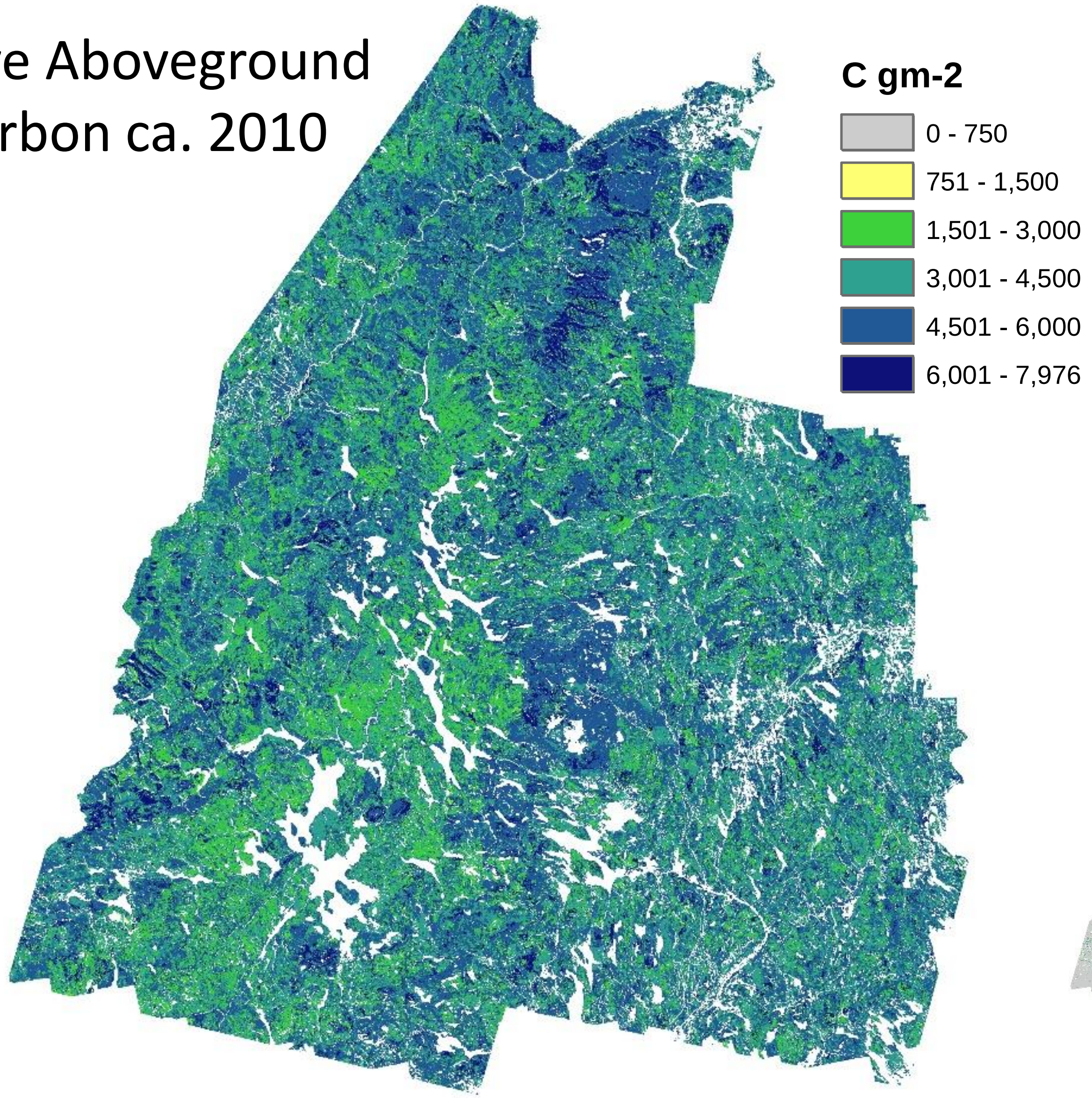


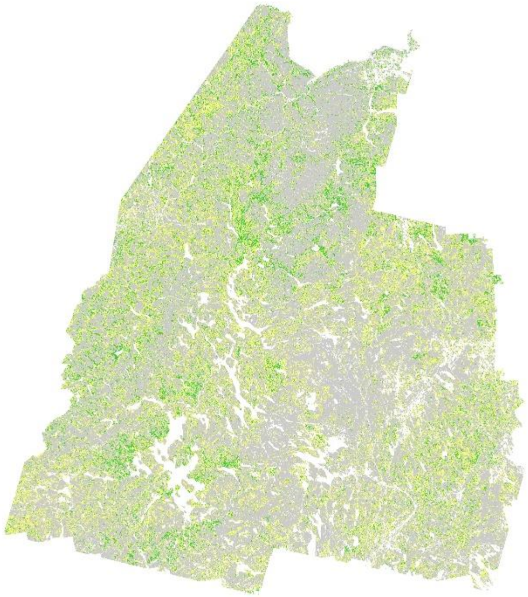


Public FIA plot locations shown. True plot coordinates provided through a collaborative agreement with the USFS Northern Research Station FIA Program.

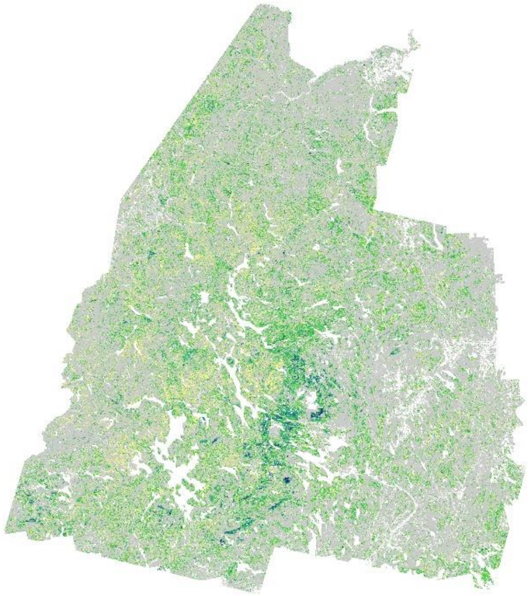
Estimated Carbon Density

Live Aboveground Carbon ca. 2010

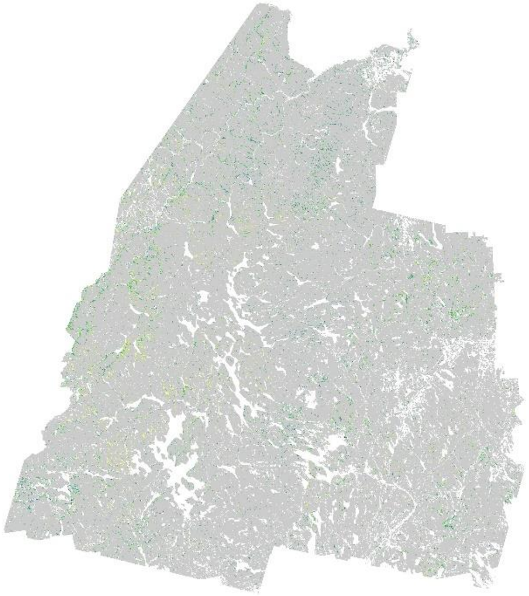




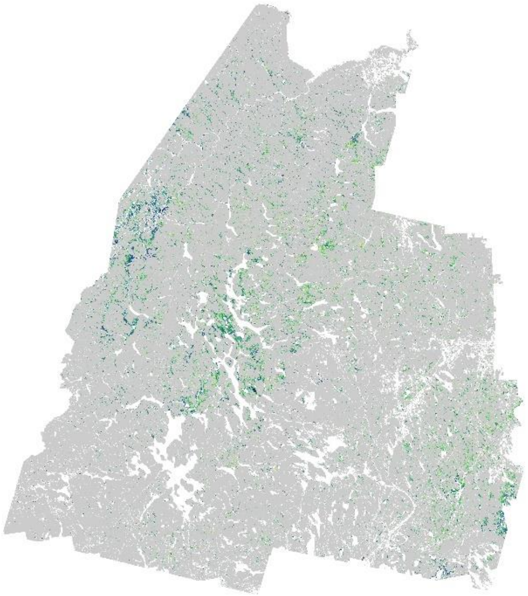
Balsam fir



Red spruce



White spruce



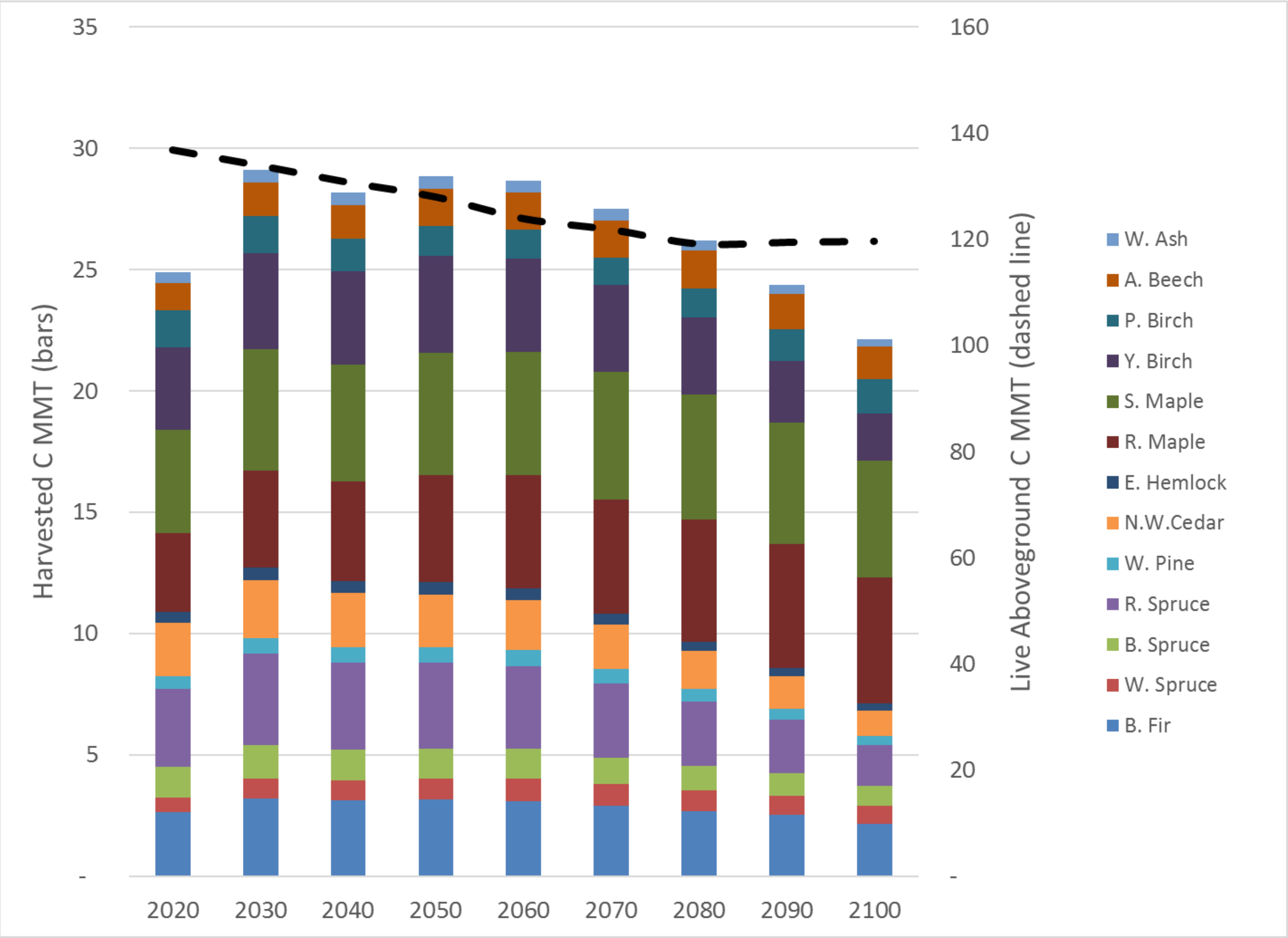
Black spruce

Baseline/Business as Usual (BAU) Scenario

- Emulated the average rate of harvesting in the study area from 2000-2010
  - Observed rates calculated from Landsat satellite time series
  - ~2.5% managed forest area harvested per year
- Harvested area ratio
  - 90% partial harvest, 10% clearcut
- Minimum mean stand age eligible for harvest
  - 50 years
- Supply target
  - Maintain harvest levels 2010-2100
  - ± 5-15% C removed

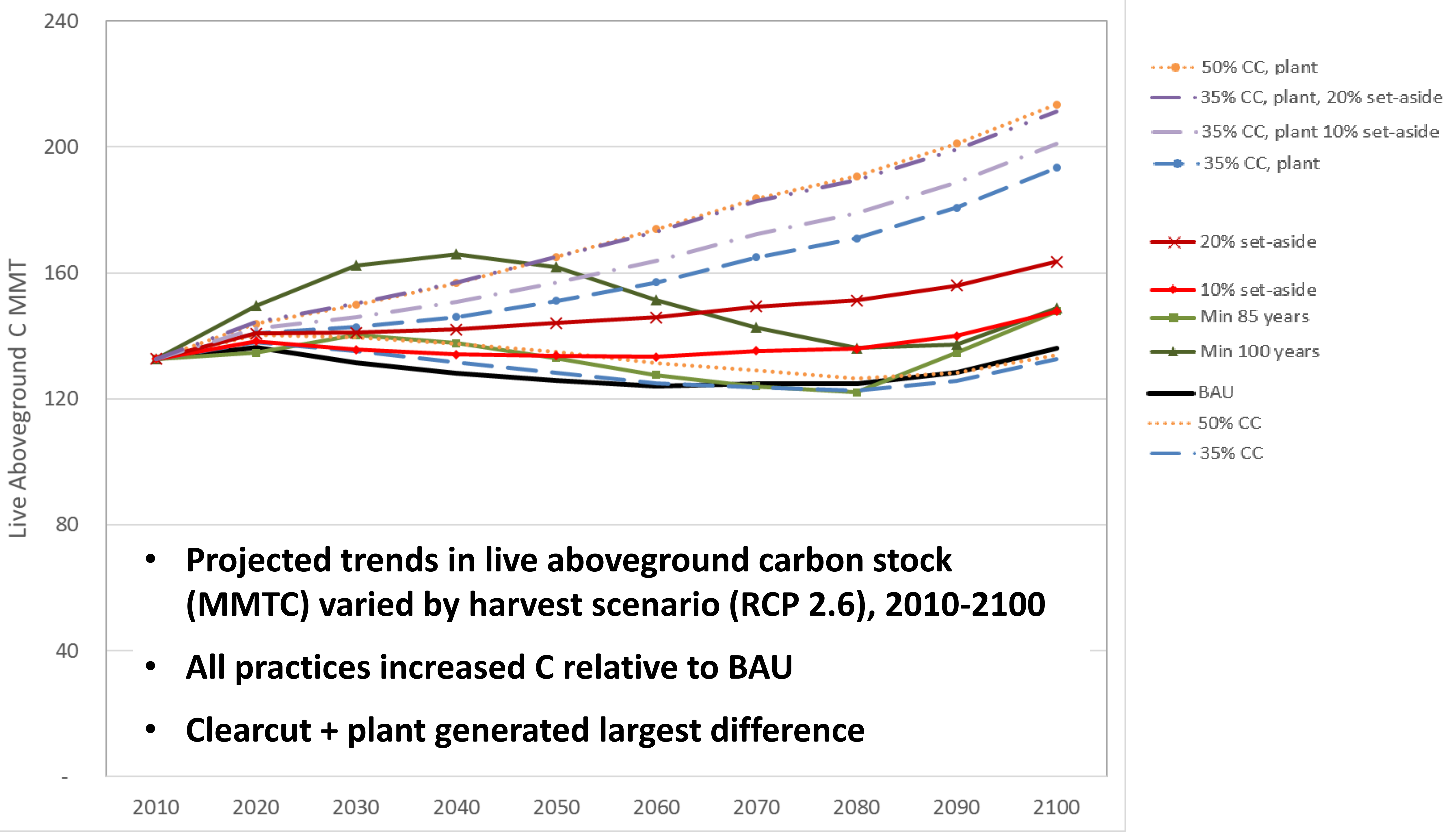
Harvested and Standing C, 2010-2100

- BAU and RCP 2.6 (low emission)



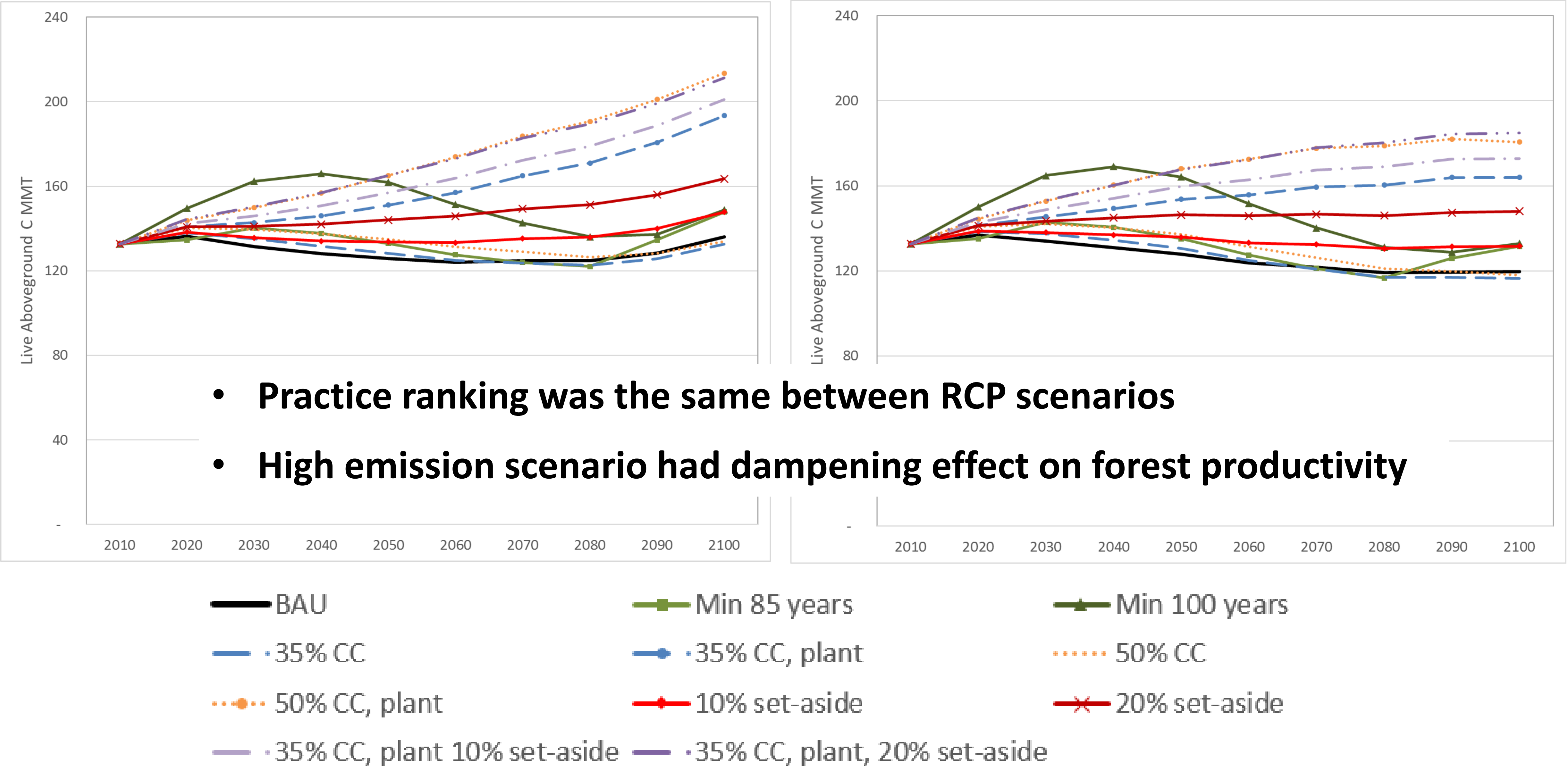
Forest NCS Practices Modeled

1. ***Extended Rotation**:* increased minimum stand age eligible for harvest (from 50 year to 70, 85, or 100 years).
2. ***Clearcut/Partial harvest distribution**:* increased % of the harvest area clearcut (from 10% to 35% or 50%). Wood supply was held (close to) constant by reducing overall harvest footprint.
3. ***Planting:*** added planting (artificial regeneration) after clearcut, with a 700 tree per acre mix of red and white spruce.
4. ***Set-aside:*** increased reserve landbase to 10% or 20% of area.
5. ***Triad***: Mix of set asides, clearcut+plant, and BAU.
6. ***Avoided Forest Conversion:*** Hold 2010 forest area constant via renting land at cost of highest and best use if converted.
7. ***Afforestation:*** Plant trees in eligible areas not forested since at least 1990.



- **Projected trends in live aboveground carbon stock (MMTC) varied by harvest scenario (RCP 2.6), 2010-2100**
- **All practices increased C relative to BAU**
- **Clearcut + plant generated largest difference**

Live aboveground C – RCP 2.6 vs RCP 8.5



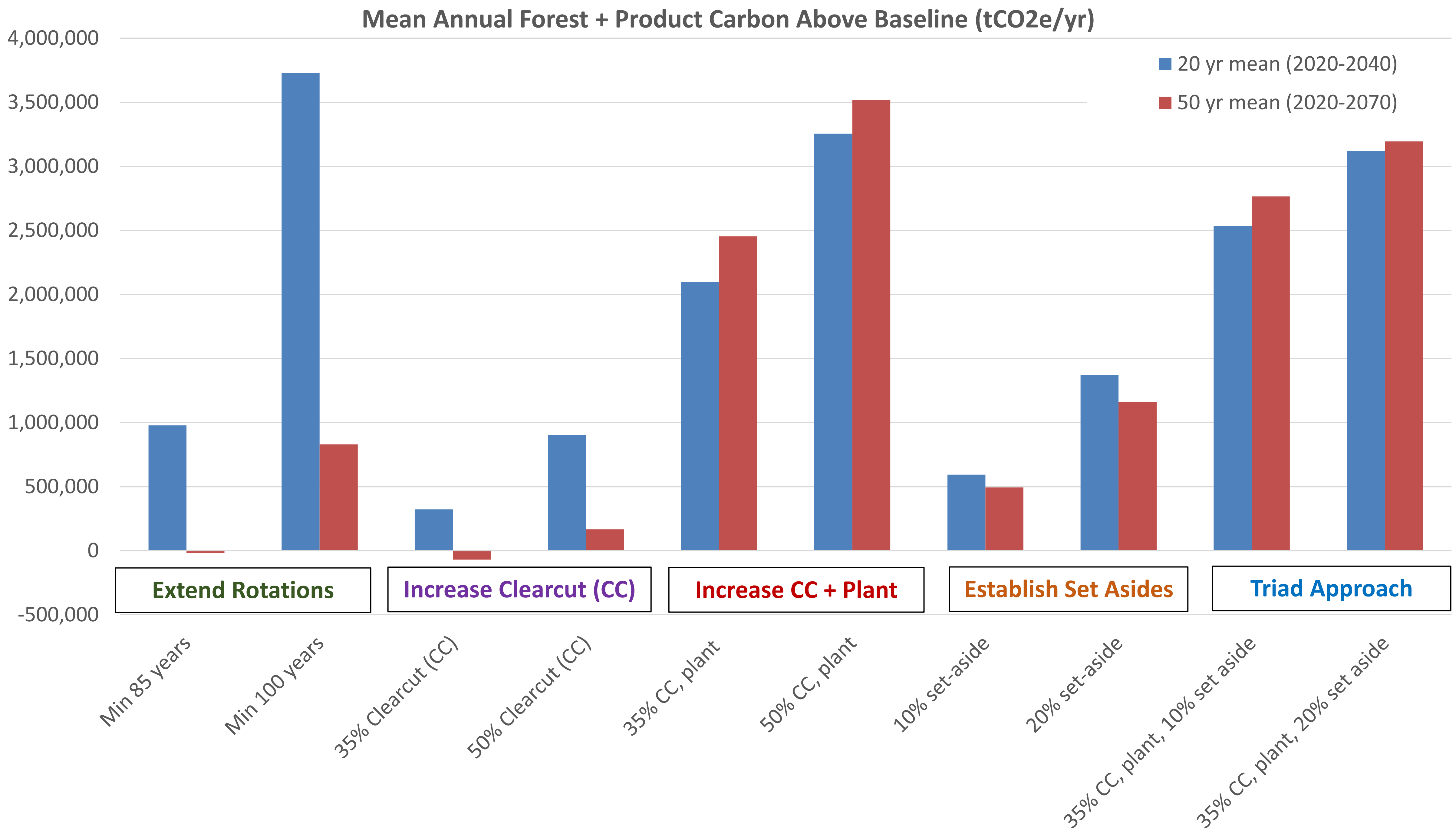
- **Practice ranking was the same between RCP scenarios**
- **High emission scenario had dampening effect on forest productivity**

Biodiversity & Tradeoffs

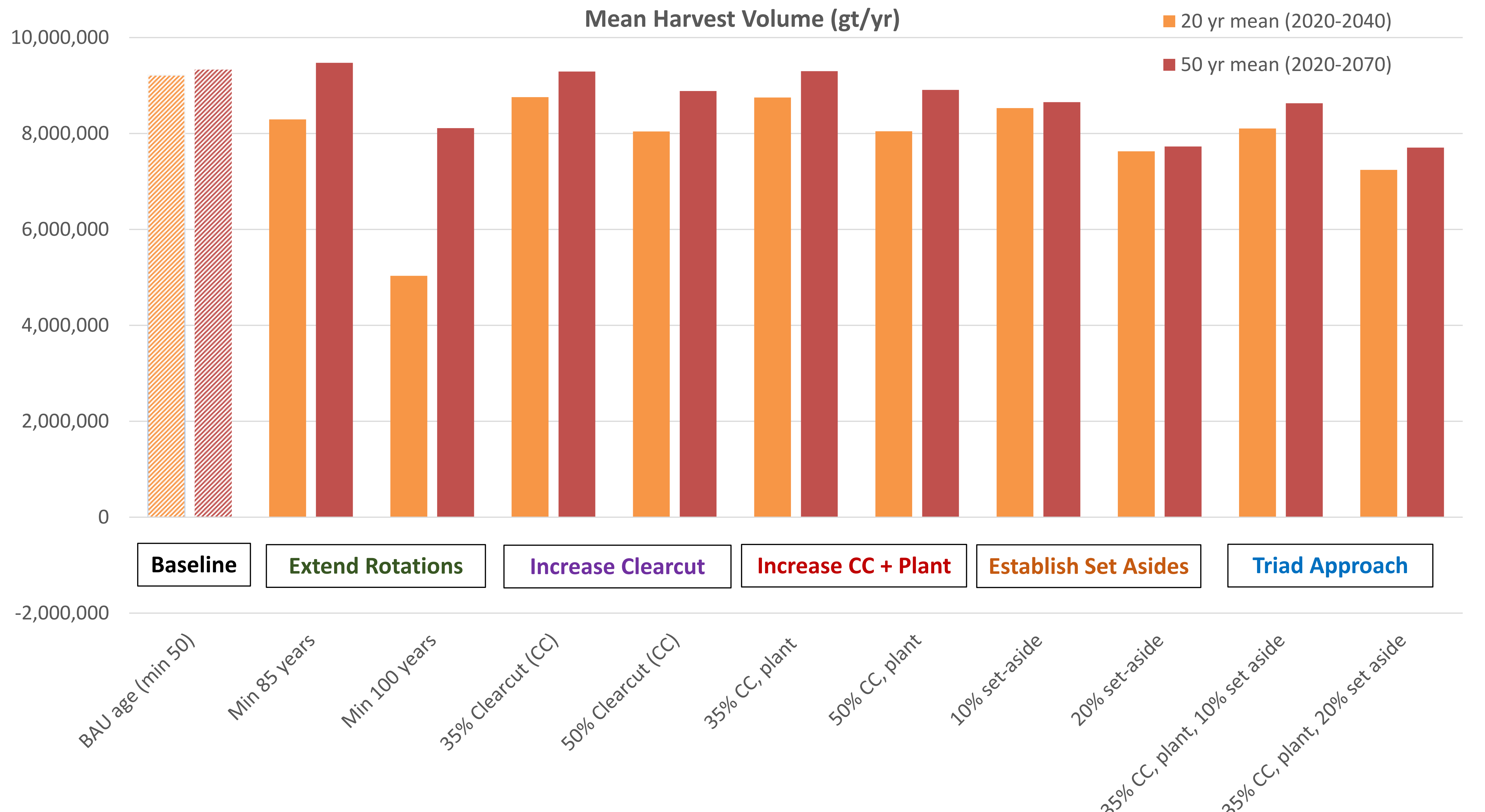
% difference relative to BAU under RCP 2.6 ca. 2060

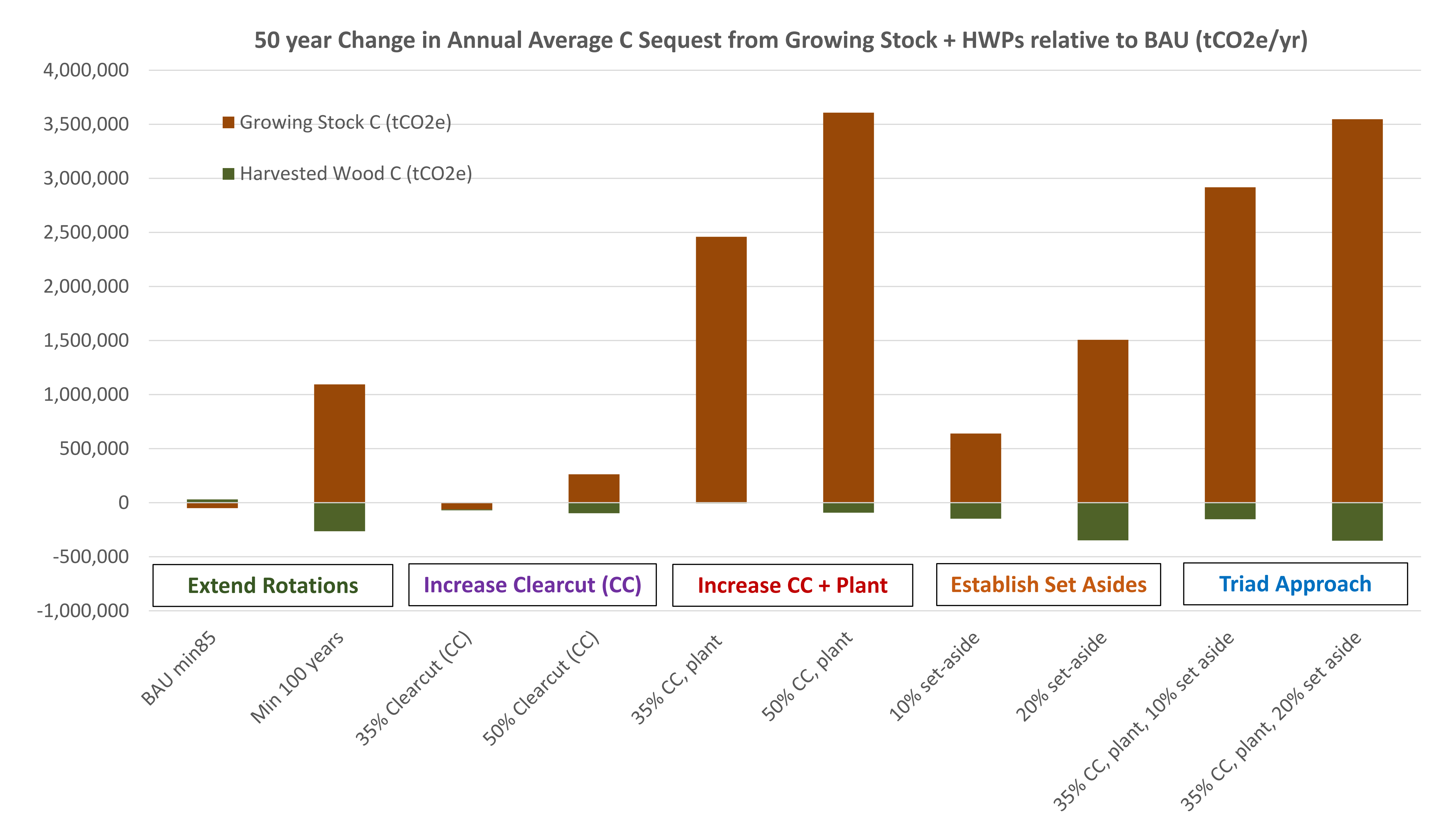
Scenario	Total harvest 2010-2060	Spruce-Fir C	Late-Successional Forest		Lynx habitat	Break even carbon price ($/t$CO_2$e)
			Spruce-Fir	N. Hardwood		
Min 100 years	-13%	33%	-8%	-13%	-25%	$12
10% set-aside	-7%	10%	4%	4%	-3%	$20
35% CC*	-0.4%	-4%	-12%	4%	33%	$6
35% CC* + plant	-0.3%	117%	9%	-7%	487%	$14
35% CC* + plant + 10% set-aside	-8%	118%	-4%	0%	427%	$12

*assumes all clearcuts (CC) target forest with spruce-fir relative abundance >50%

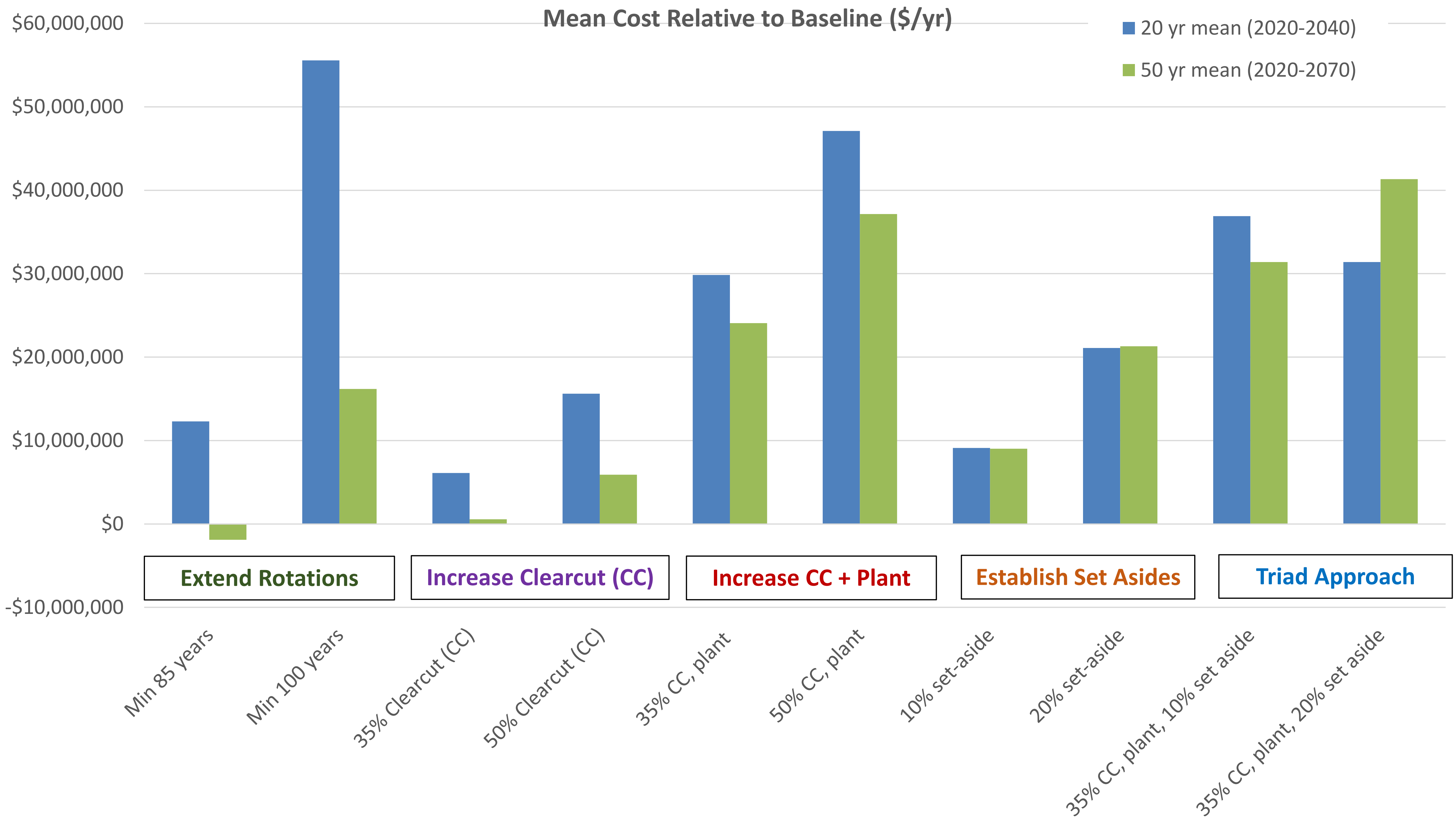


Mean Annual Forest + Product Carbon Above Baseline (tCO2e/yr)
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
-500,000
20 yr mean (2020-2040)
50 yr mean (2020-2070)
Extend Rotations
Increase Clearcut (CC)
Increase CC + Plant
Establish Set Asides
Triad Approach
Min 85 years
Min 100 years
35% Clearcut (CC)
50% Clearcut (CC)
35% CC, plant
50% CC, plant
10% set-aside
20% set-aside
35% CC, plant, 10% set aside
35% CC, plant, 20% set aside

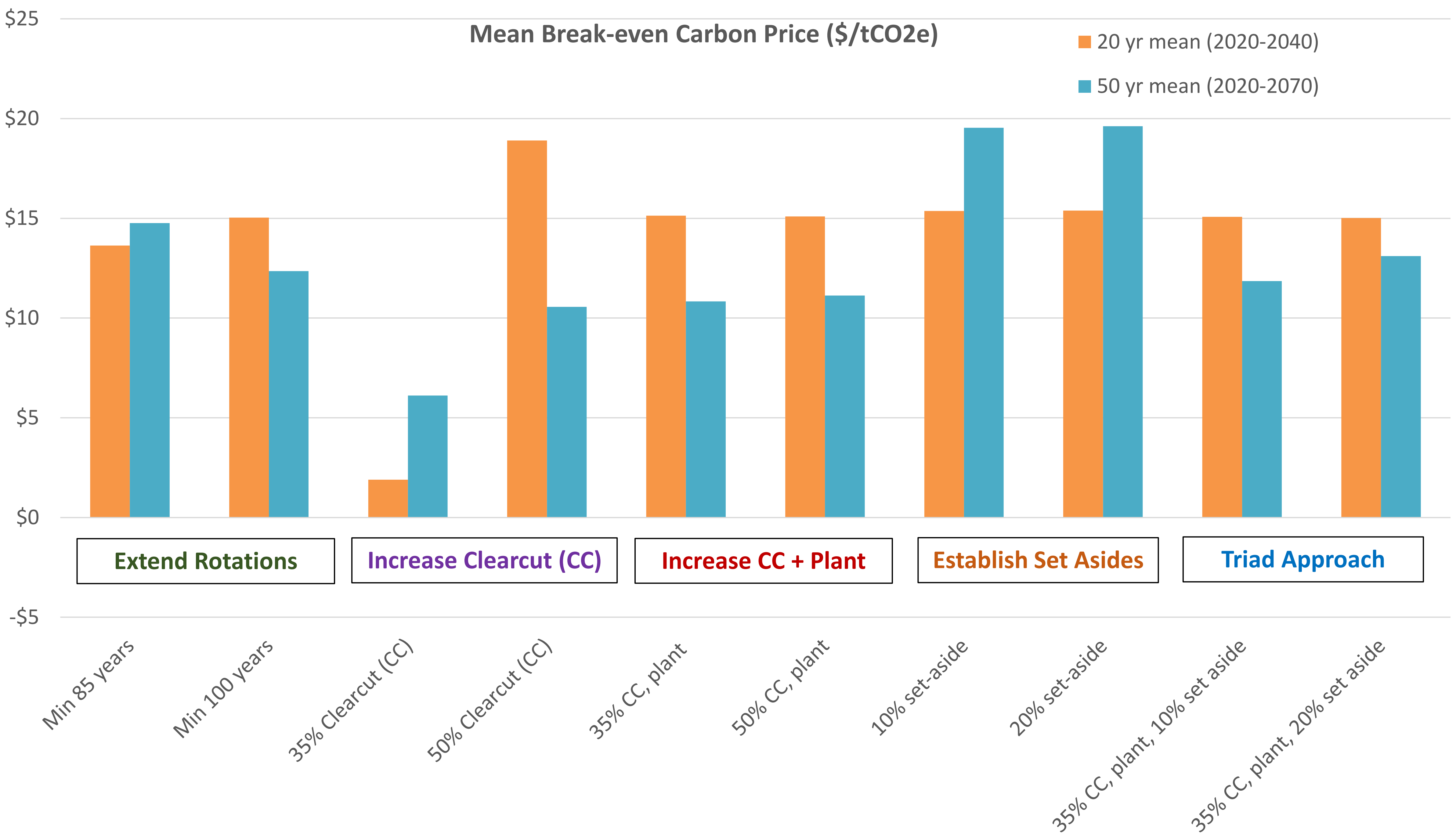

Mean Harvest Volume (gt/yr)
20 yr mean (2020-2040)
50 yr mean (2020-2070)
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
-2,000,000
Baseline
Extend Rotations
Increase Clearcut
Increase CC + Plant
Establish Set Asides
Triad Approach
BAU age (min 50)
Min 85 years
Min 100 years
35% Clearcut (CC)
50% Clearcut (CC)
35% CC, plant
50% CC, plant
10% set-aside
20% set-aside
35% CC, plant, 10% set aside
35% CC, plant, 20% set aside



50 year Change in Annual Average C Sequest from Growing Stock + HWPs relative to BAU (tCO2e/yr)
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
-500,000
-1,000,000
Growing Stock C (tCO2e)
Harvested Wood C (tCO2e)
Extend Rotations
Increase Clearcut (CC)
Increase CC + Plant
Establish Set Asides
Triad Approach
BAU min85
Min 100 years
35% Clearcut (CC)
50% Clearcut (CC)
35% CC, plant
50% CC, plant
10% set-aside
20% set-aside
35% CC, plant, 10% set aside
35% CC, plant, 20% set aside



Mean Cost Relative to Baseline ($/yr)
20 yr mean (2020-2040)
50 yr mean (2020-2070)
$60,000,000
$50,000,000
$40,000,000
$30,000,000
$20,000,000
$10,000,000
$0
-$10,000,000
Extend Rotations
Increase Clearcut (CC)
Increase CC + Plant
Establish Set Asides
Triad Approach
Min 85 years
Min 100 years
35% Clearcut (CC)
50% Clearcut (CC)
35% CC, plant
50% CC, plant
10% set-aside
20% set-aside
35% CC, plant, 10% set aside
35% CC, plant, 20% set aside



Mean Break-even Carbon Price ($/tCO2e)
20 yr mean (2020-2040)
50 yr mean (2020-2070)
$25
$20
$15
$10
$5
$0
-$5
Extend Rotations
Increase Clearcut (CC)
Increase CC + Plant
Establish Set Asides
Triad Approach
Min 85 years
Min 100 years
35% Clearcut (CC)
50% Clearcut (CC)
35% CC, plant
50% CC, plant
10% set-aside
20% set-aside
35% CC, plant, 10% set aside
35% CC, plant, 20% set aside

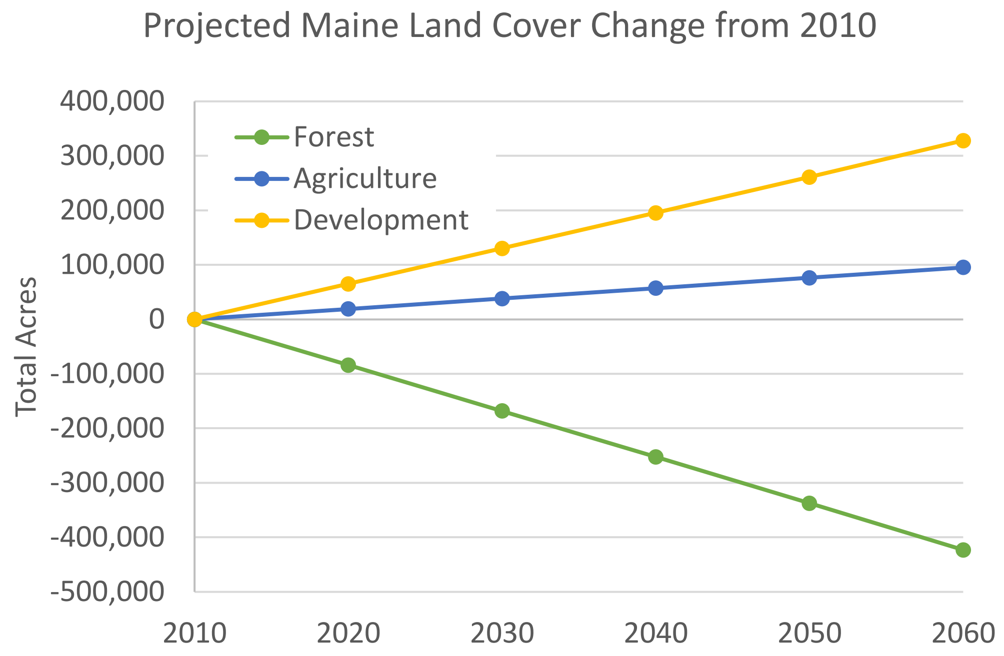
Methods (non-LANDIS)

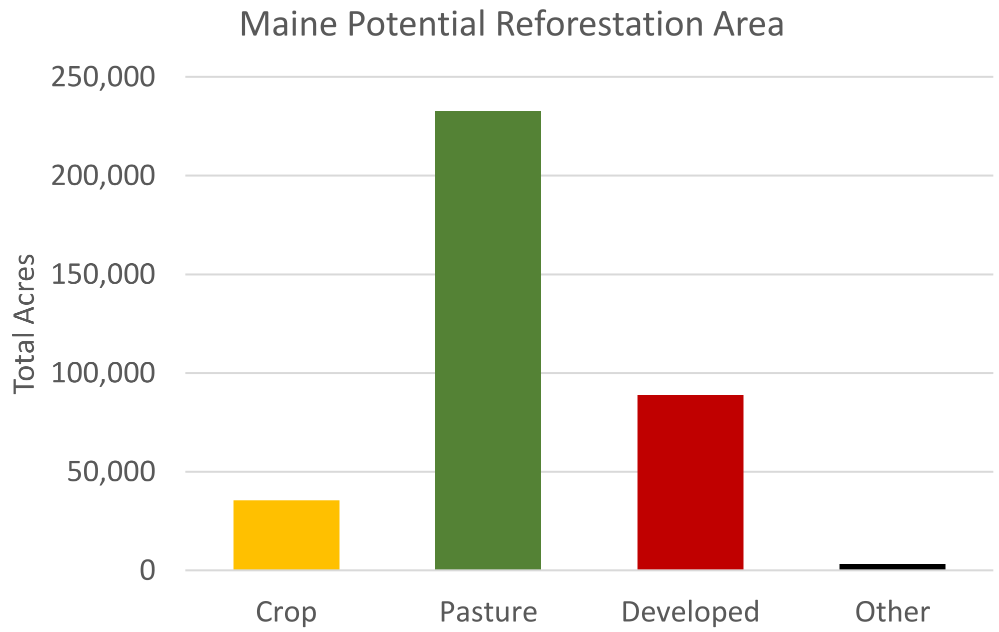
Avoid conversion

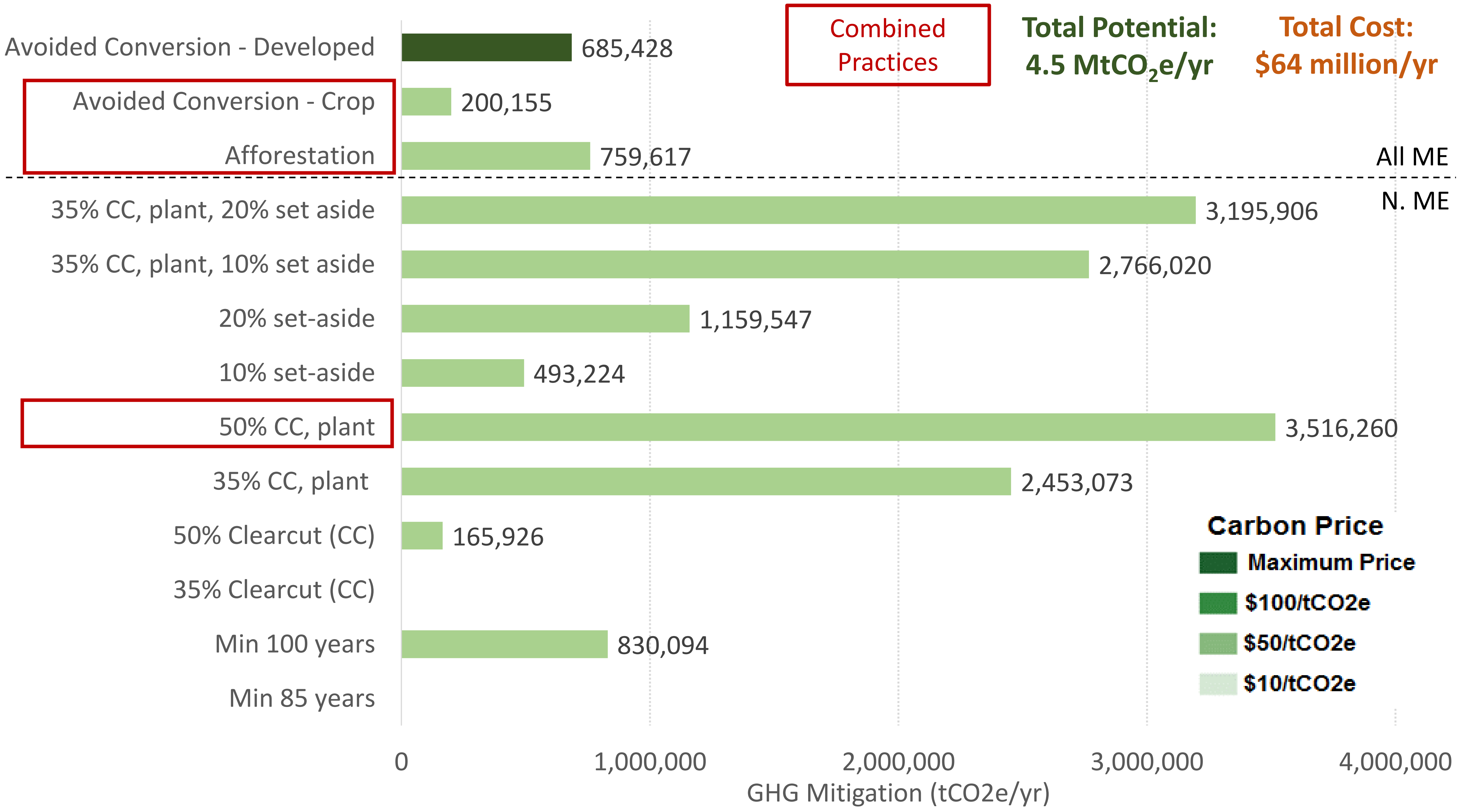
- Projected loss of forest to developed and agricultural land based on historical land cover change patterns
- Landowners receive ‘rental payments’ to keep forest as forest in perpetuity

Afforestation

- Plant trees in areas not forested since at least 1990 and considered ‘eligible’ for forestry
- Landowners pay for land based on relative use value



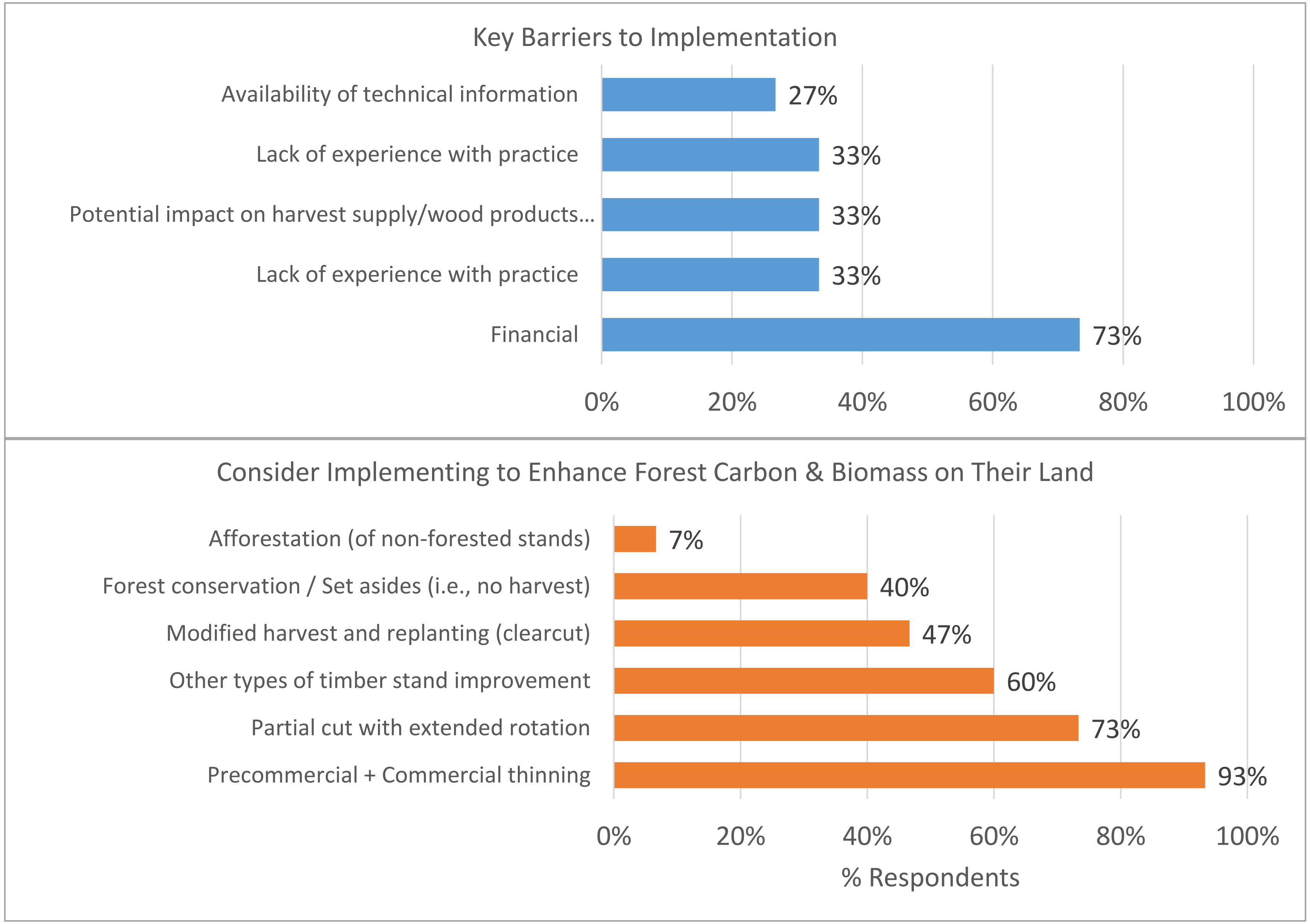



Combined Practices
Total Potential:
4.5 $MtCO_2e/yr$
Total Cost:
$64 million/yr
Avoided Conversion - Developed
685,428
Avoided Conversion - Crop
200,155
Afforestation
759,617
All ME
N. ME
35% CC, plant, 20% set aside
3,195,906
35% CC, plant, 10% set aside
2,766,020
20% set-aside
1,159,547
10% set-aside
493,224
50% CC, plant
3,516,260
35% CC, plant
2,453,073
50% Clearcut (CC)
165,926
35% Clearcut (CC)
Min 100 years
830,094
Min 85 years
Carbon Price
Maximum Price
$100/tCO2e
$50/tCO2e
$10/tCO2e
0
1,000,000
2,000,000
3,000,000
4,000,000
GHG Mitigation (tCO2e/yr)

Implementation Barriers and Opportunities

Jan – Feb ’21 Focus Groups:

- Large forest landowners
- Small forest landowners
- Forest managers
- NGOs, State officials, other stakeholders



Implementation Barriers and Opportunities

Regulation v. Voluntary

- Both small and large landowners would prefer a voluntary carbon market or incentive programs and oppose state regulation

Intermediate Treatments

- Large landowners would implement Pre-Commercial Thinning and other intermediate treatments (PCT) with sufficient financial incentives
- PCT little interest to small landowners as financial and technical barriers

Multi-objective Forest Management

- Small (and most large) landowners have many values beyond revenue and carbon storage that limit which options they will consider (e.g., clearcut)

Public Perception

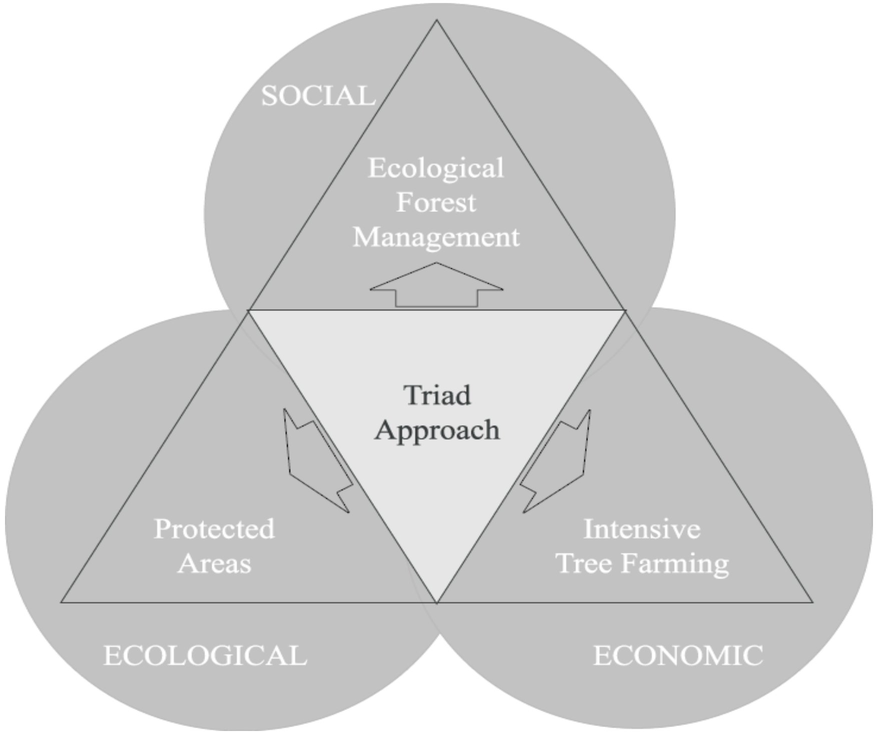
- Large landowners hesitant about public perception of clearcuts

Sustainable Timber Supply

- Concern that too much emphasis on carbon storage could harm the viability of the timber industry (not enough harvesting to sustain industry in Maine)

ME Forest NCS Summary

- Top Forest NCS for Maine: Mix of **intensive harvest**, **planting**, and **set-asides**
- Most NCS allow **harvests close to historical trends**
- Harvests close to BAU → **minimal risk of ‘leakage’**
- **Habitat tradeoffs** with increased clearcut & planting v. natural regeneration
- **Costs are relatively cheap** compared to typical carbon prices for other sectors of economy (often $40+/tCO2e or more)
- Will require **financial incentives** and **technical assistance** for widespread adoption



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Dr. Sonja Birthisel
Ms. Jen Carroll

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USCA States United for Climate Action
NSF
Maine Farmland Trust
Forest Climate Change Initiative
School of Forest Resources forest.umaine.edu
1865 The University of Maine
Senator George J. Mitchell
Center for Sustainability Solutions
NASA

Want to know more about Maine's Natural Climate Solutions?

Visit the UMaine Forest Climate Change Initiative's website for full report, fact sheets, and more!

https://crsf.umaine.edu/forest-climate-change-initiative/ncs/

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