# Land Use Carbon Mitigation Options in the Northeastern US

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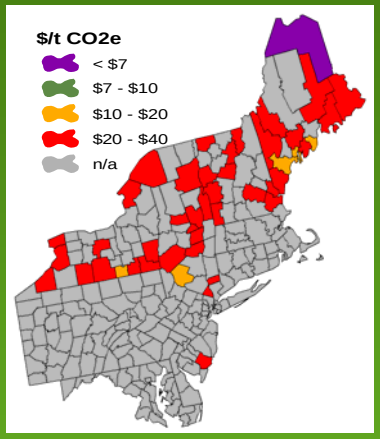
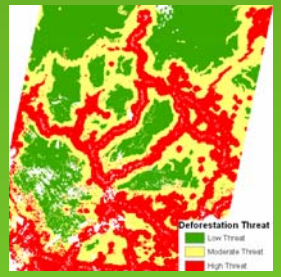
# Winrock International – Ecosystem Services

Regional and project scale carbon methodology and monitoring development

Knowledge Transfer


Regional scale assessments


Spatial carbon emission projection modeling

Advanced monitoring techniques – aerial imagery

# Acknowledgements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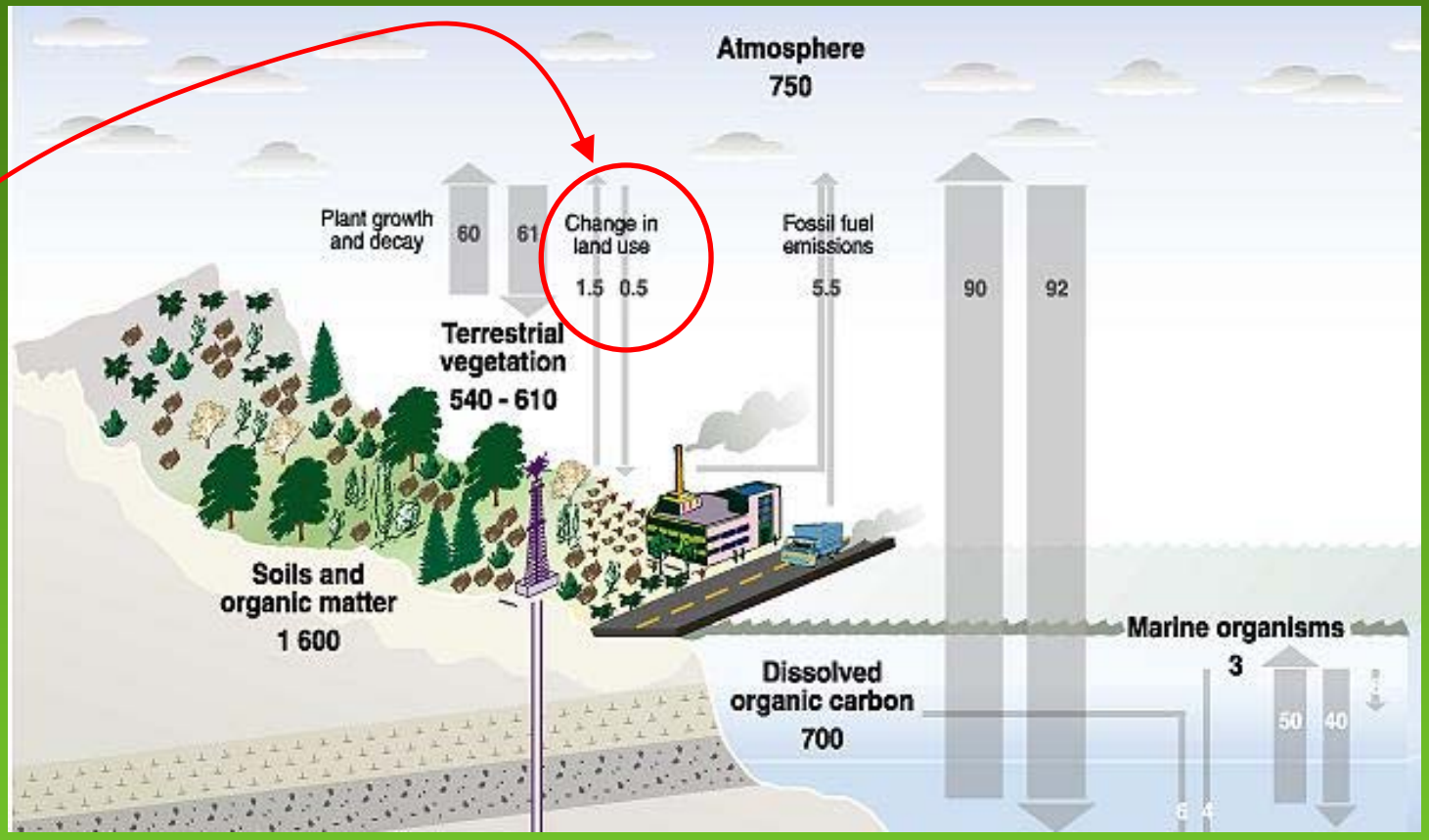
- Brent Sohngen of OSU
- Neil Sampson of The Sampson Group
- Bill Stanley and David Shoch of TNC

# Global Carbon Cycle



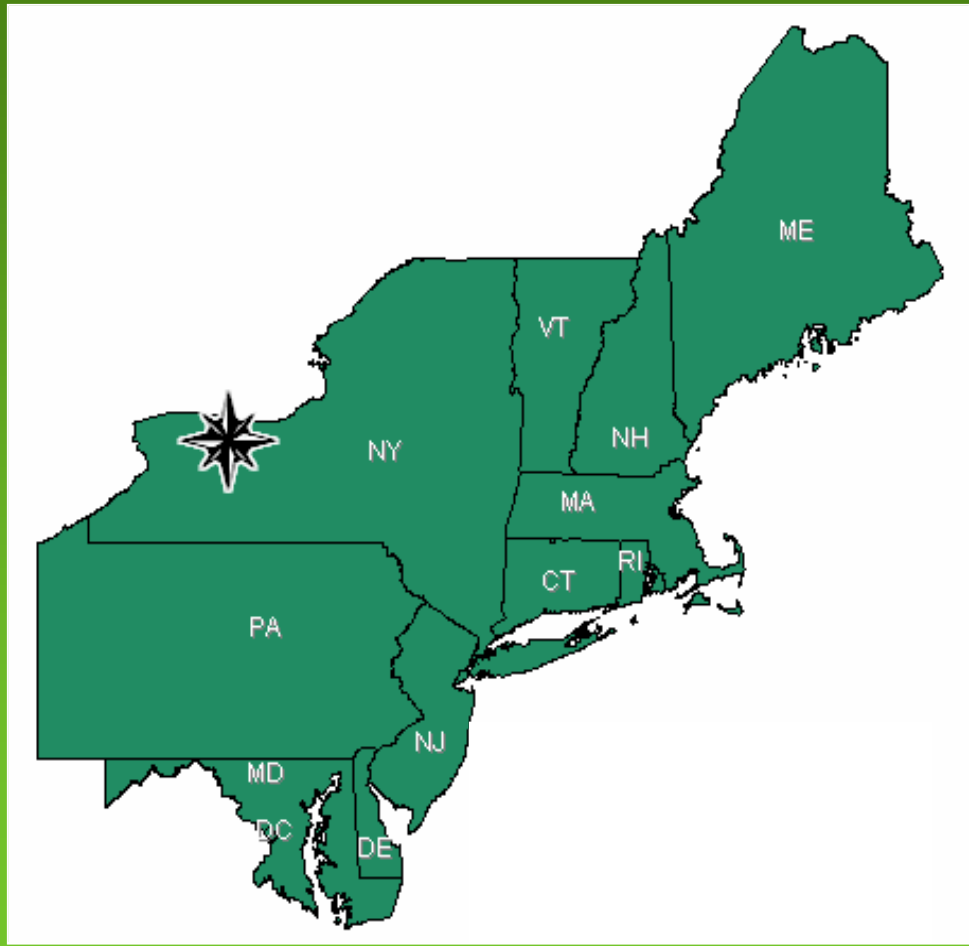

Study examined potential carbon mitigation through altering land management to increase sequestration and reduce emissions



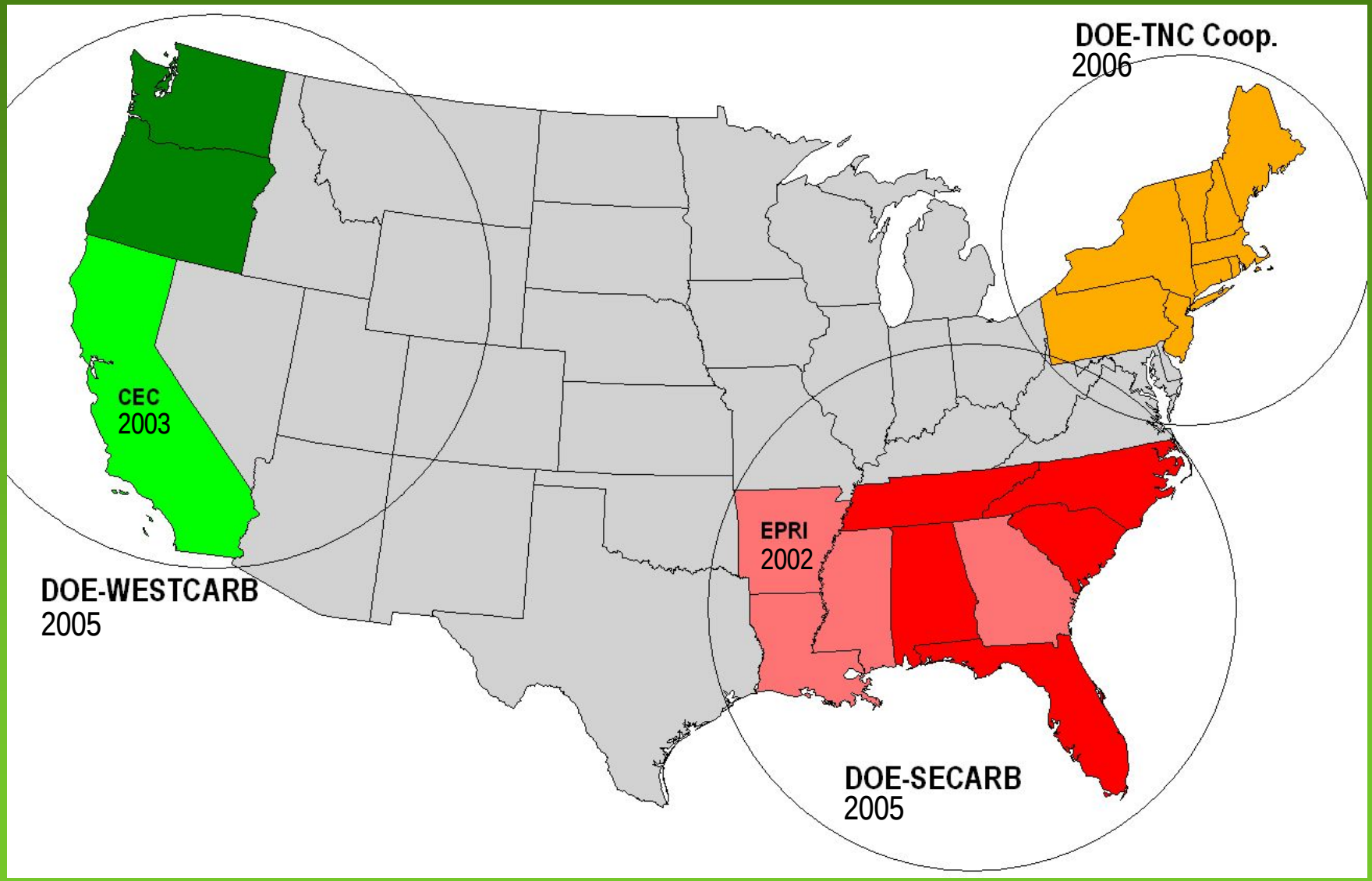
Source: Vital Graphics. GRID-Arendal 2001

# Terrestrial Carbon Research:

- Study covered eleven north east states
- Examines the potential in this large land area for carbon mitigation by changing current land use practices



# Terrestrial carbon mitigation potential analyzed across much of country:



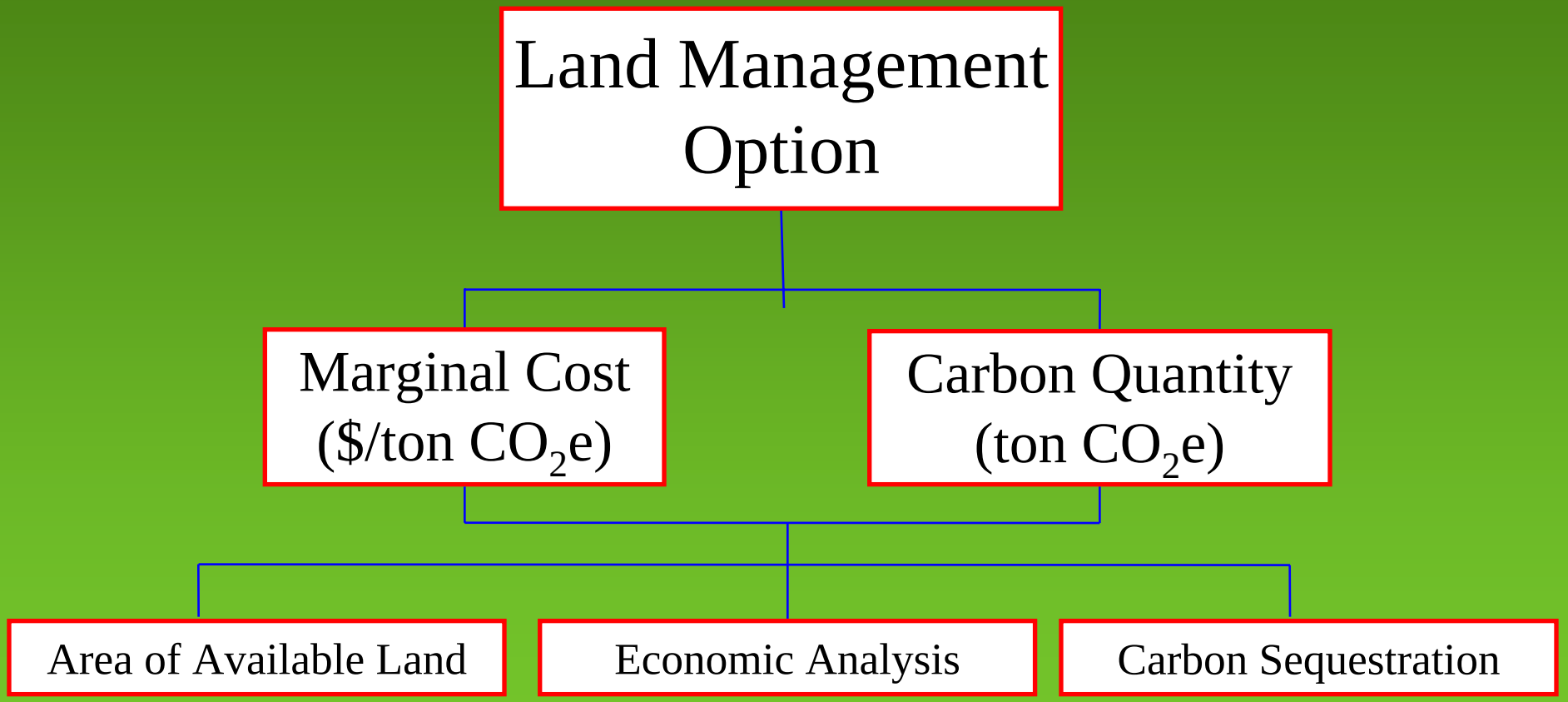
# Overall questions addressed:

- What options are there for changing land use and management practices on the land?
- What is potential quantity of carbon sequestered and where for each option?
- What is the price? (i.e. economic potential)

# Land management options examined:

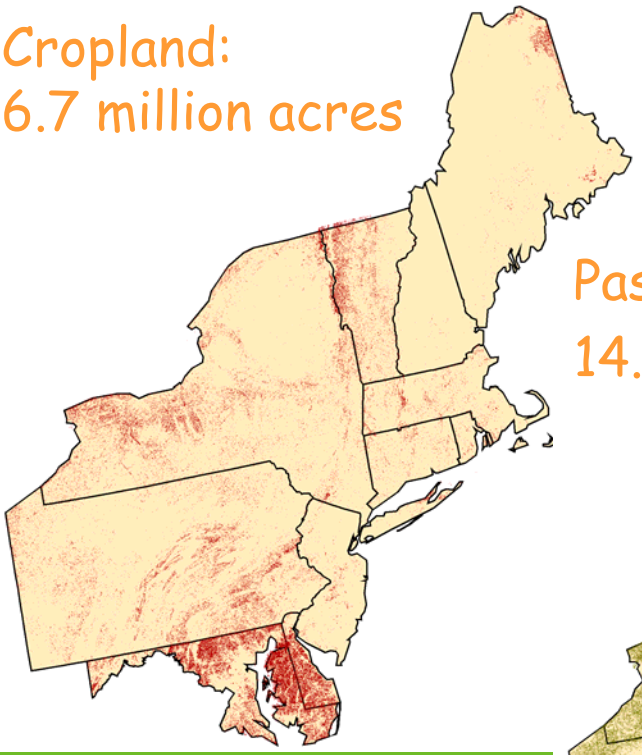
- Agricultural lands:
  - Afforestation of croplands
  - Afforestation of grazing lands
  - Conversion to no-till
  - Conversion to permanent vegetation crops
- Forest Lands:
  - Improving stocking conditions in poorly stocked stands
  - Extending the rotation age in softwood forests
  - Enhancing riparian zones along streams

# Overview of Approach for each land management option:

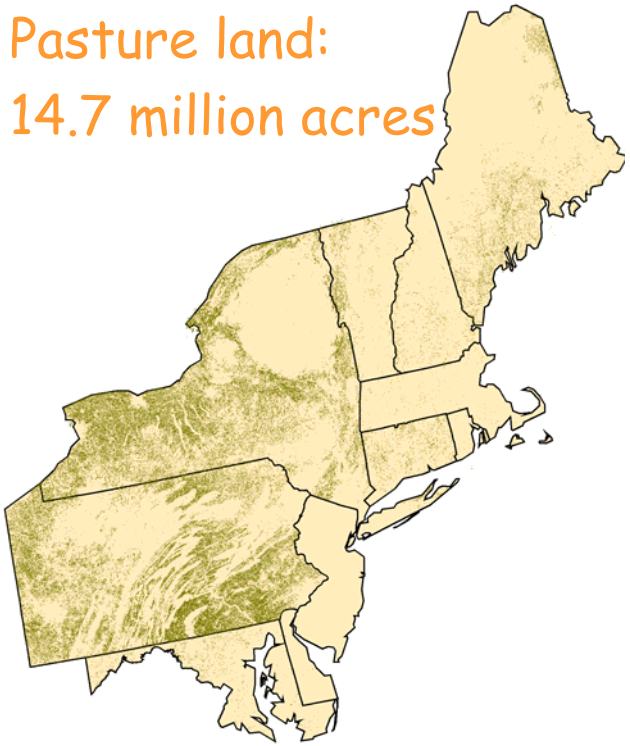


# Area of land available in region:

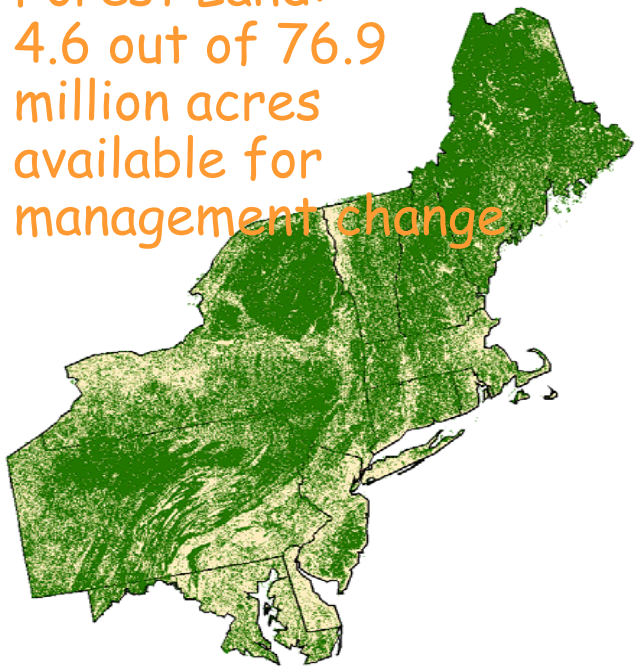
Cropland:
6.7 million acres



Pasture land:
14.7 million acres



Forest Land:
4.6 out of 76.9 million acres available for management change



No-till:
5.7 million acres

Permanent Crops:
6.1 million acres

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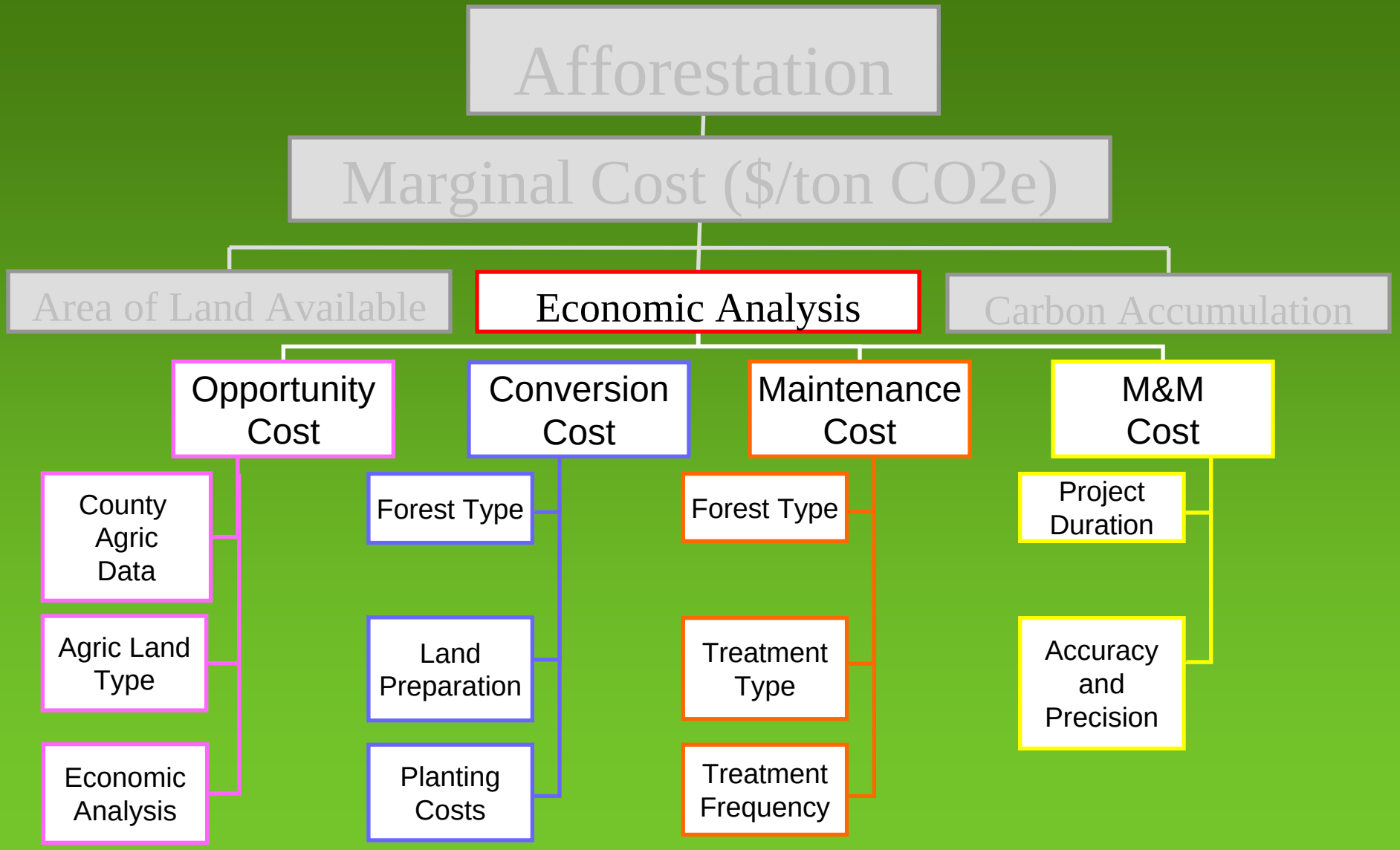
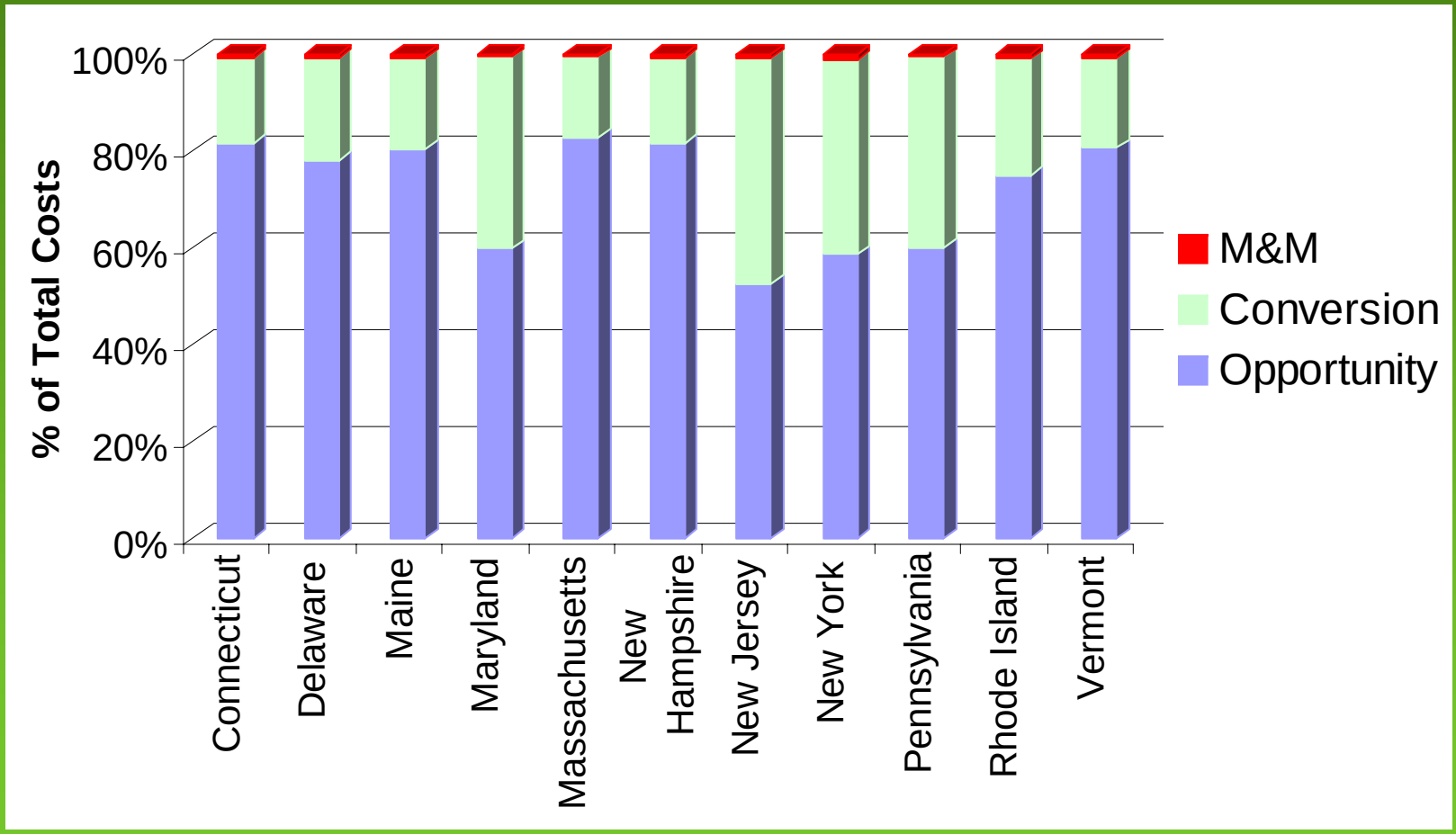
# Afforestation of agricultural lands

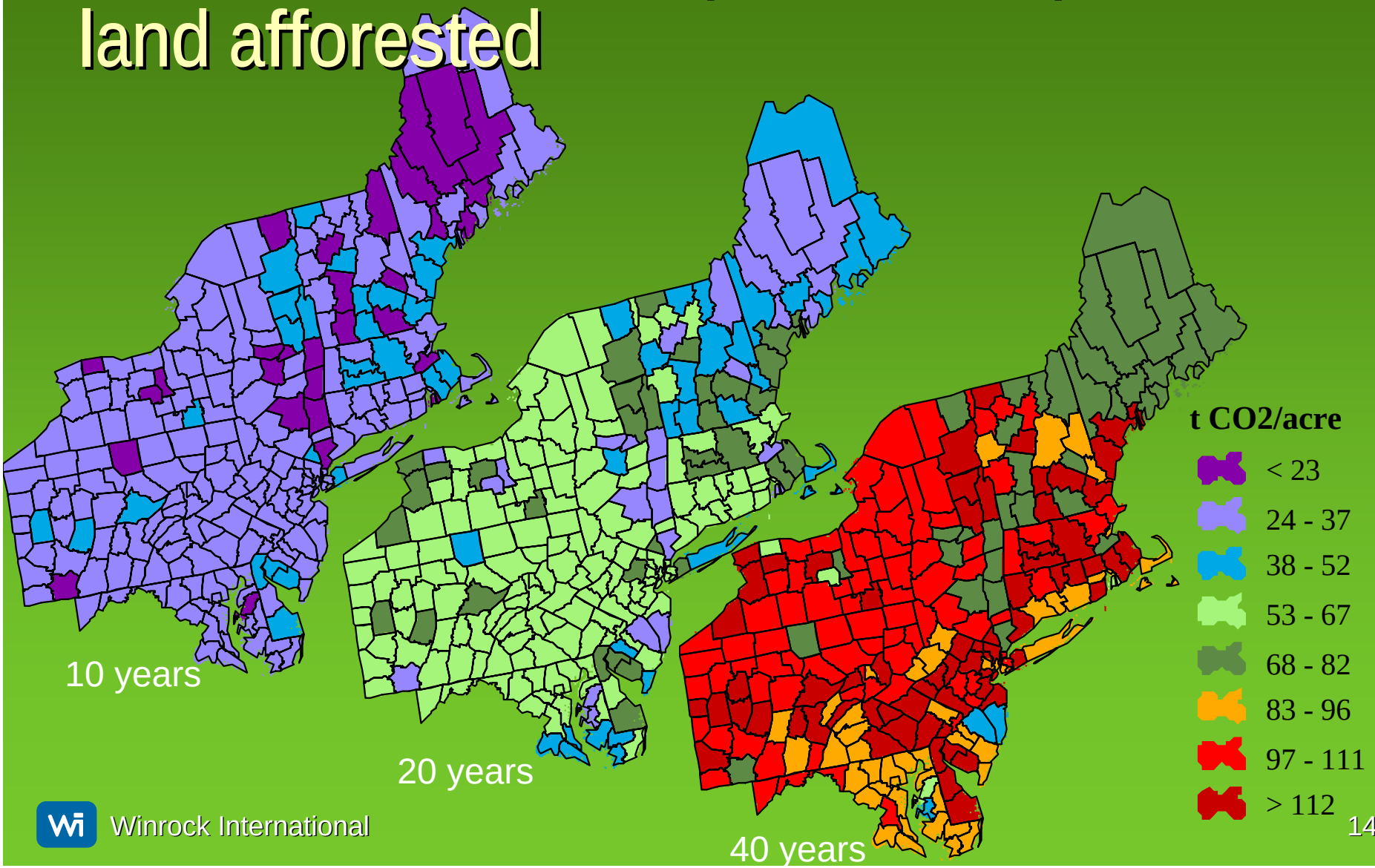
# Economic Analysis:



# Economic Analysis:
## Contribution of each cost component to total costs for 20 year period

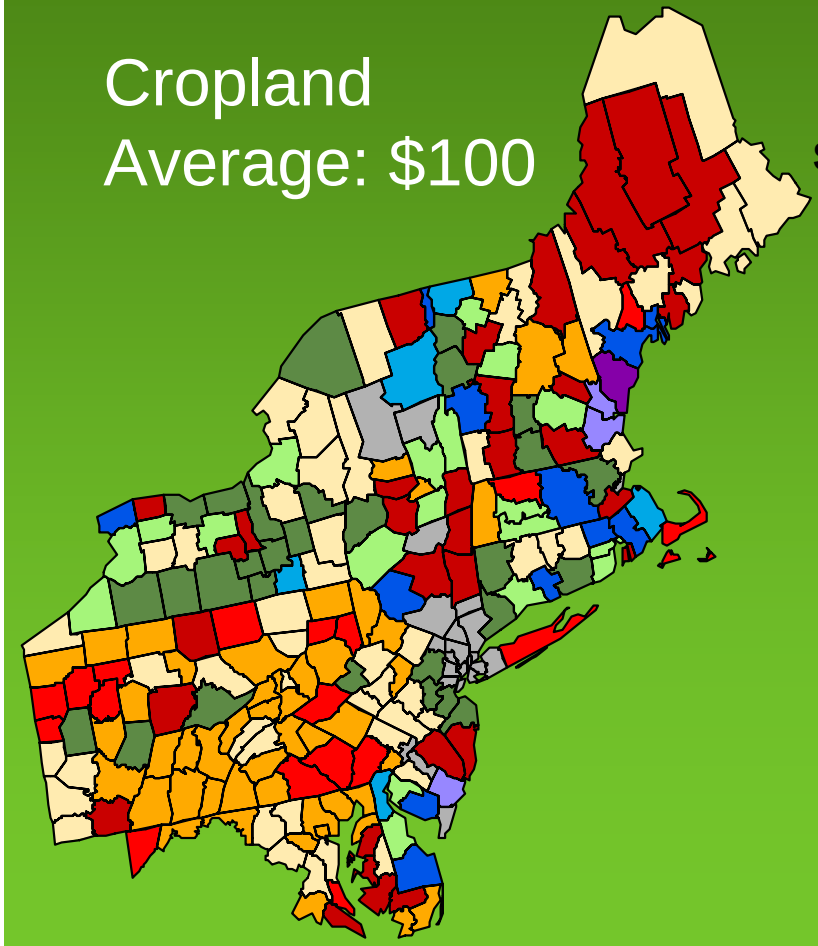


# Carbon accumulation:
## Potential carbon sequestration per area of land afforested



# Marginal Carbon Costs: 20 year period

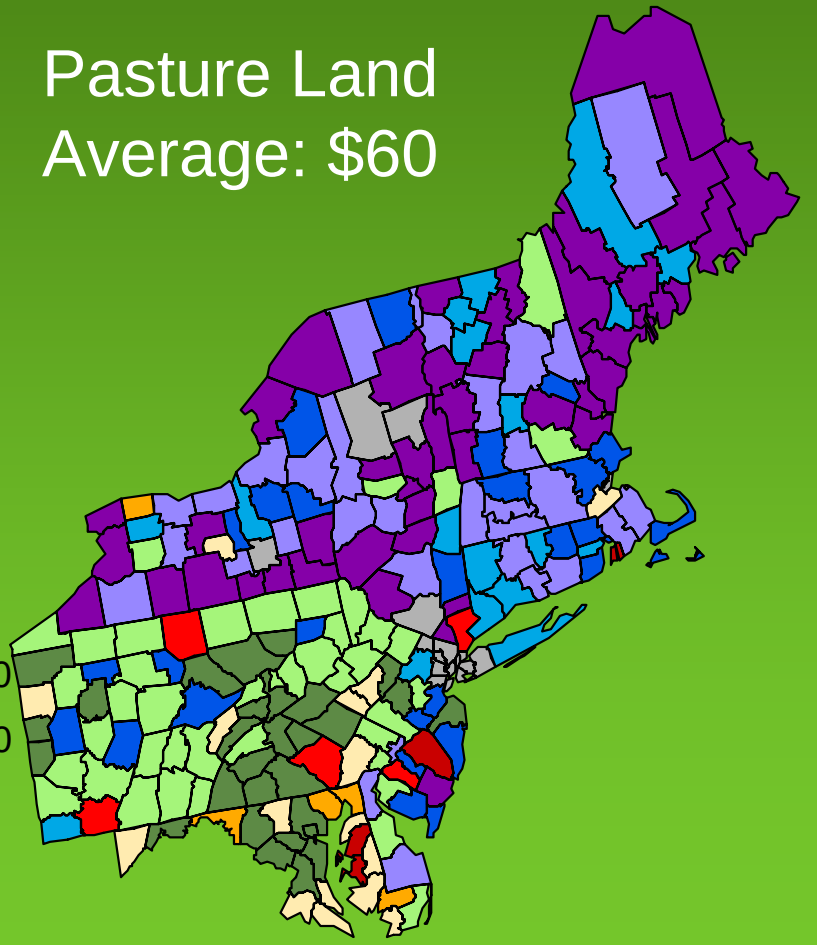
Cropland
Average: $100



**$/t CO2e**

- < $40
- $40 - $50
- $50 - $60
- $60 - $70
- $70 - $80
- $80 - $90
- $90 - $100
- $100 - $110
- $110 - $120
- > $120
- n/a

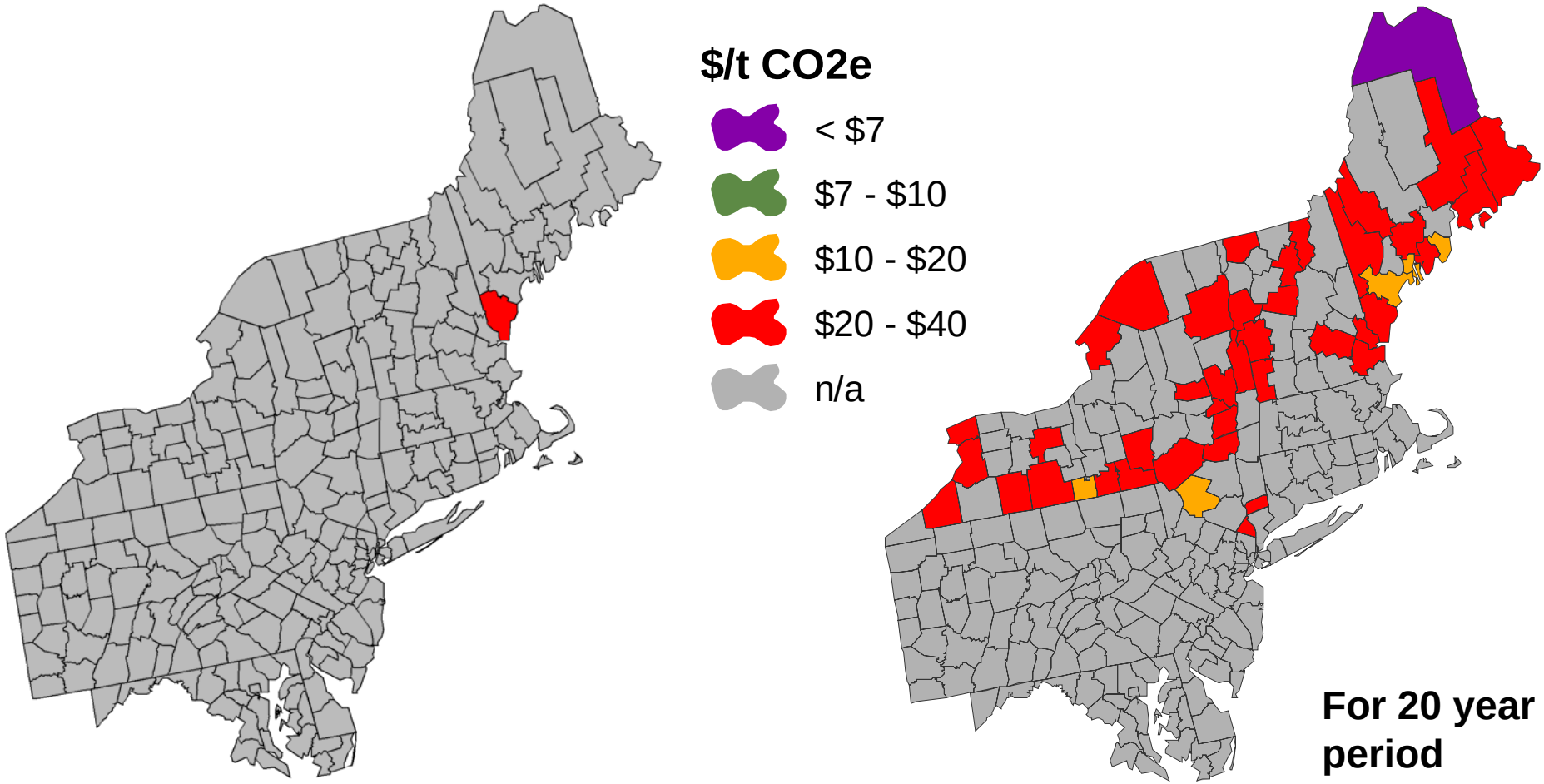
Pasture Land
Average: $60



# Counties where afforestation is economically attractive at lower prices:

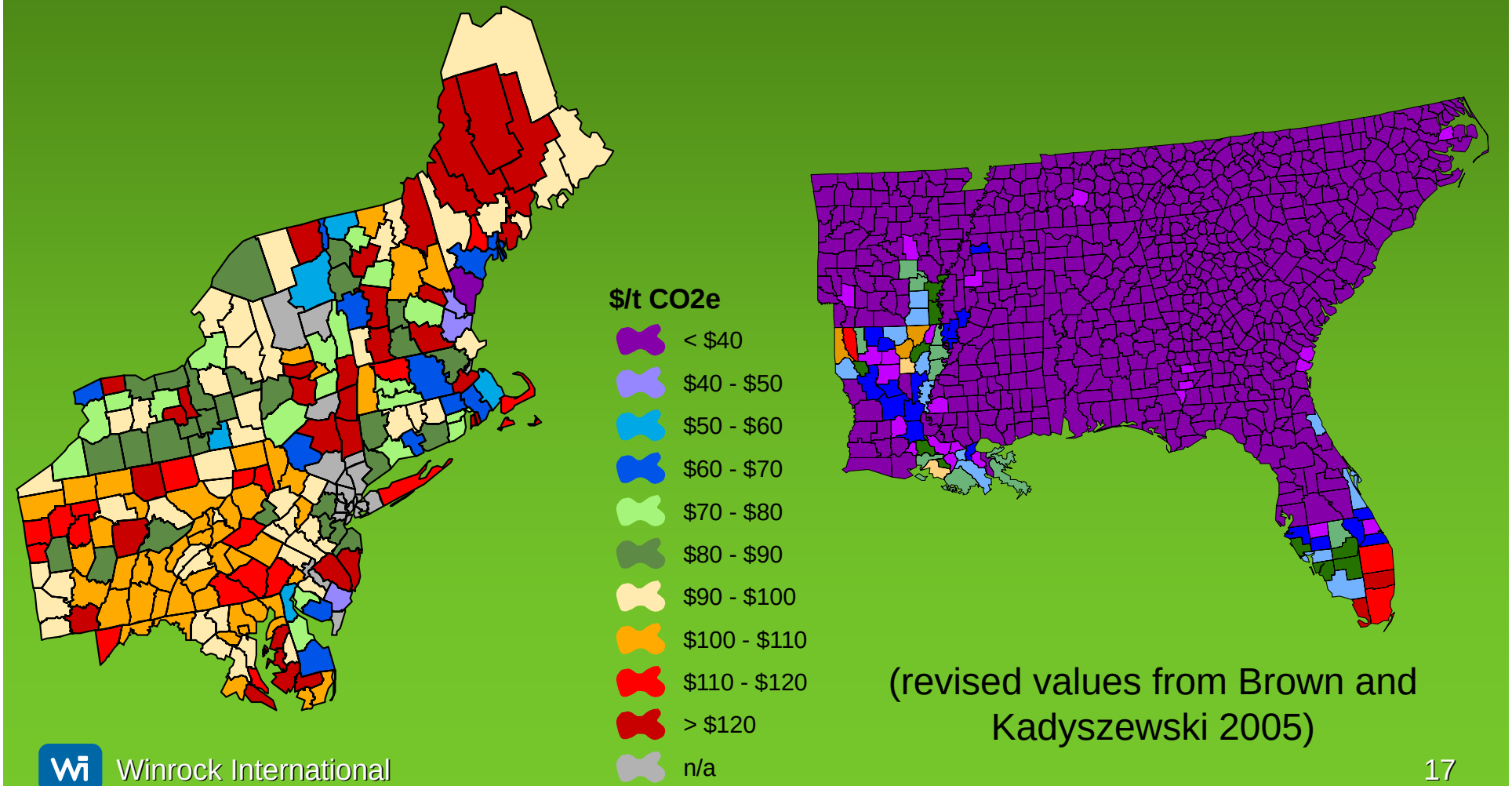
Cropland

Pasture land




**For 20 year period**

# Marginal Carbon Costs:
## Comparison on cropland between northeast and southeast for 20 year period




(revised values from Brown and Kadyszewski 2005)

# Altered Forest Management

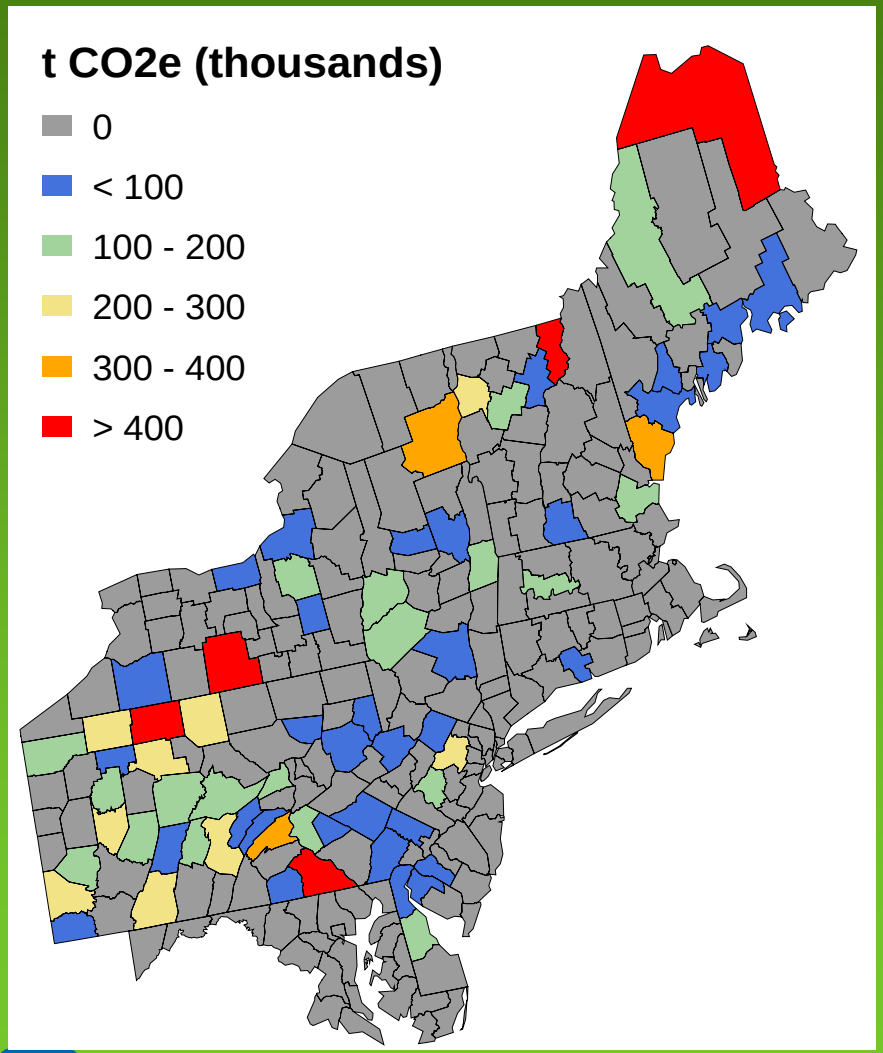
- All options assume:

  "permanent contracts"

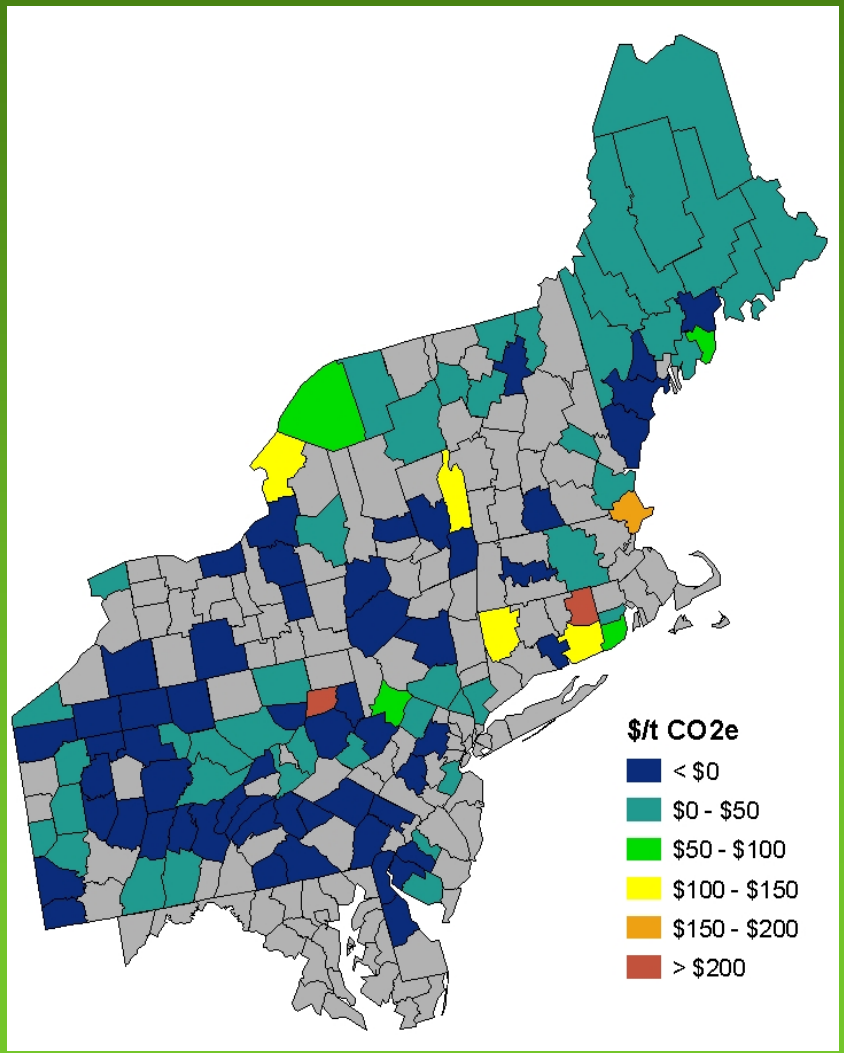
  e.g. once change the management then assume to change "forever"

# Re-stocking of under-stocked stands

Potential sequestration at <$10/t $CO_2e$

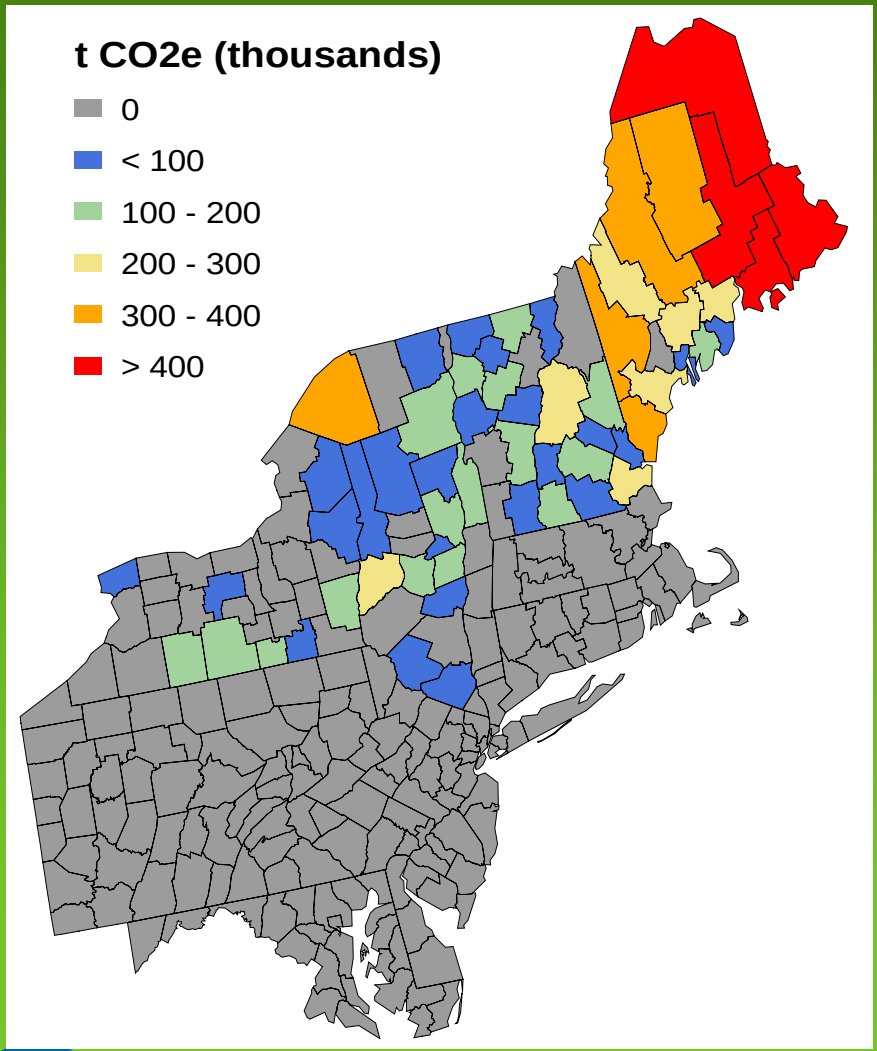



Marginal Costs

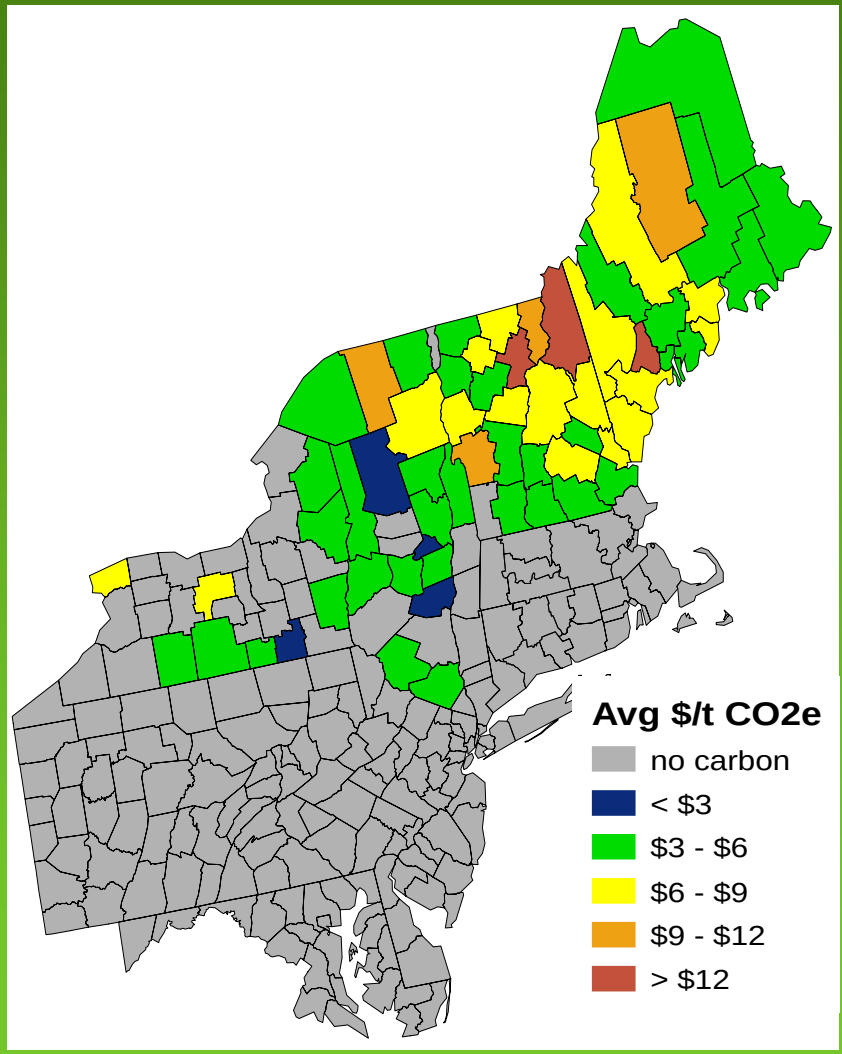


# 5 year rotation extensions - softwoods

Potential sequestration at <$10/t $CO_2e$




Marginal Costs



# Comparison of land use practices

# Estimated quantities of carbon sequestered after 20 years, t $CO_2e$/acre

| | Mean | Range |
|---|---|---|
| **Agricultural Lands** | | |
| Afforestation | 57 | 23-74 |
| No-till | 11 | 7-19 |
| Permanent Vegetation | 14 | 0-27 |
| **Forest Lands** | | |
| Restocking understocked Stands | 9 | <1-35 |
| 5 year Rotation Extension | 5 | 1-9 |
| Riparian Buffer | 4 | <1-22 |

# Total potential estimated tons of $CO_2e$ sequestered for each land use

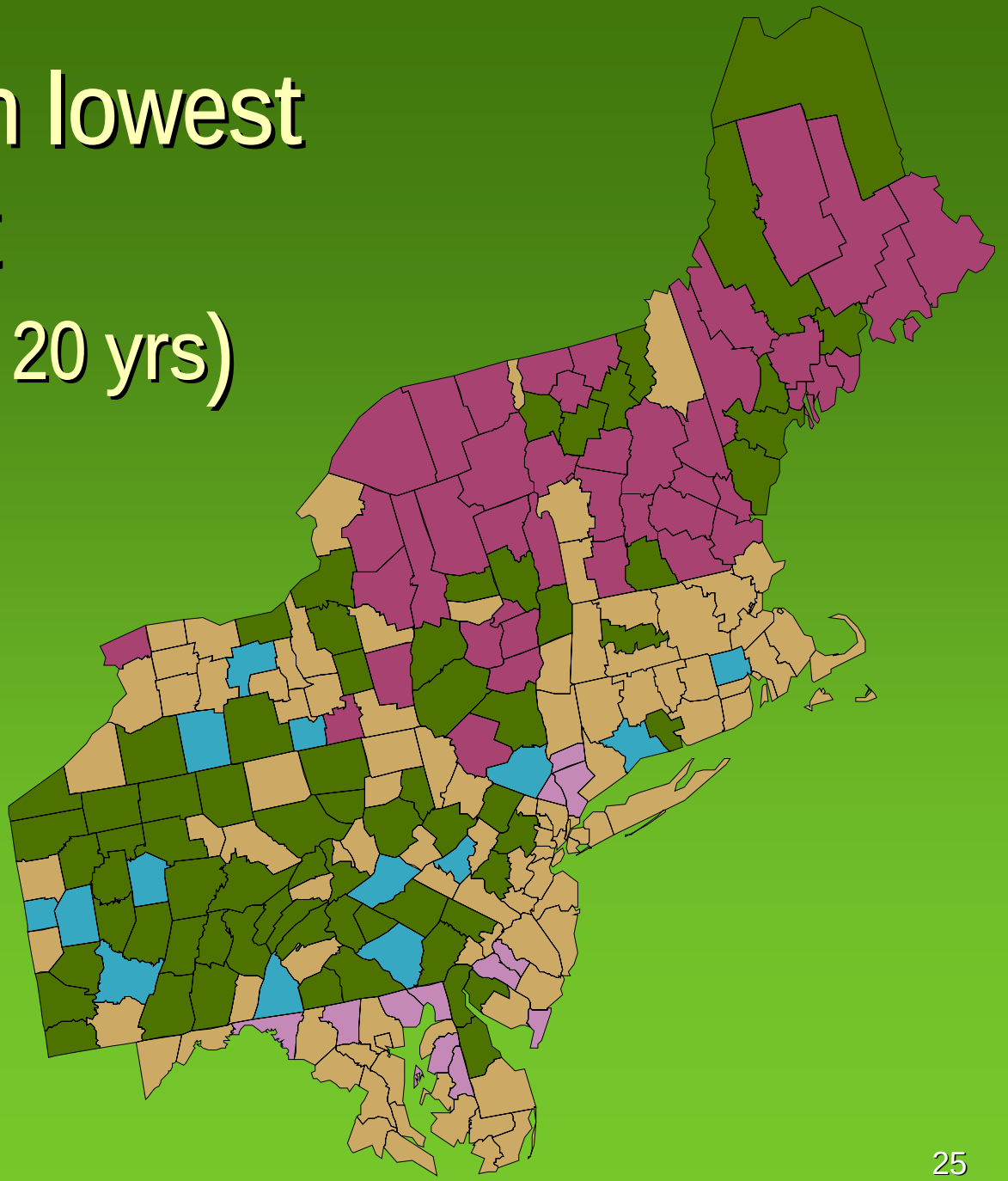
| | Agricultural Lands | | | | Forest Lands | | |
|---|---|---|---|---|---|---|---|
| | Afforestation of Cropland | Afforestation of Pasture | No-till | Permanent Vegetation | Restocking understocked Stands | 5 year Rotation Extension | Riparian Buffer |
| | million tons $CO_2e$ | | | | | | |
| Connecticut | 6.62 | 16.19 | 0.19 | 0.47 | 0.08 | | 0.08 |
| Delaware | 34.73 | 0.26 | 2.08 | 5.32 | 0.23 | | |
| Maine | 9.83 | 46.13 | 0.98 | 2.44 | 3.42 | 6.85 | 0.7 |
| Maryland | 92.2 | 12.35 | 6.07 | 15.78 | | | |
| Massachusetts | 14.55 | 5.95 | 0.4 | 0.99 | 0.19 | | 0.23 |
| New Hampshire | 0.9 | 12.02 | 0.13 | 0.33 | 0.25 | 1.3 | 0.42 |
| New Jersey | 4.46 | | 1.35 | 3.34 | 0.77 | | |
| New York | 98.06 | 339.54 | 7.94 | 19.18 | 2.29 | 2.73 | 0.88 |
| Pennsylvania | 85.85 | 386.74 | 12.92 | 32.2 | 6.18 | | 0.17 |
| Rhode Island | 1.32 | 0.8 | 0.01 | 0.03 | 0.05 | | 0.02 |
| Vermont | 30.32 | 16.62 | 0.68 | 1.64 | 1.19 | 0.96 | 0.14 |
| **All States** | **378.85** | **836.6** | **32.73** | **81.72** | **14.64** | **11.83** | **2.64** |
| Assuming 20 year period for agricultural lands, and permanent land management change in forest lands | | | | | | | |

# Area weighted mean marginal costs for all Land Uses examined (at 20 yrs)

| | Agricultural Lands | | | | Forest Lands | | |
|---|---|---|---|---|---|---|---|
| | Afforestation of Cropland | Afforestation of Pasture | No-till | Permanent Vegetation | Restocking understocked Stands | 5 year Rotation Extension | Riparian Buffer |
| | $/t $CO_2e$ | | | | | | |
| Connecticut | 87 | 52 | 18 | 168 | 404 | | 26 |
| Delaware | 70 | 52 | 22 | 120 | -6 | | |
| Maine | 100 | 31 | 11 | 168 | 11 | 6 | 150 |
| Maryland | 121 | 97 | 22 | 53 | | | |
| Massachusetts | 87 | 51 | 14 | 130 | 65 | | 34 |
| New Hampshire | 98 | 50 | 12 | 138 | -3 | 8 | 103 |
| New Jersey | 100 | 82 | 23 | 85 | -1 | | 4 |
| New York | 99 | 48 | 19 | 178 | -214 | 5 | 101 |
| Pennsylvania | 107 | 84 | 19 | 140 | -58 | | 28 |
| Rhode Island | 100 | 78 | 19 | 104 | 57 | | 28 |
| Vermont | 90 | 40 | 14 | 165 | -7 | 7 | 99 |
| **All States** | **103** | **64** | **18** | **139** | **-53** | **6** | **84** |
| Minimum | 36 | 13 | 10 | -137 | -1,434 | 3 | 0.11 |
| Maximum | 254 | 265 | 29 | 348 | 693 | 21 | 240 |

* Negative numbers in average cost estimates indicate that the projects would potentially generate profits over the cycle.

# Land Use with lowest marginal cost ($/ton $CO_2e$ at 20 yrs)



# Potential area and amount of emission reductions available at price points (at 20 yrs)

| Price Points | Afforestation | | Crop Management | | Forest Management | | |
|---|---|---|---|---|---|---|---|
| | Cropland | Pasture | No-till | Permanent Vegetation | Restocking Understocked Stands | 5 yr Rotation Extension | Riparian Buffers |
| potential t $CO_2e$ | | | | | | | |
| < \$7/t $CO_2e$ | | 8 million | | 6.6 million | 10 million | 8.4 million | 137,000 |
| < \$10/t $CO_2e$ | | 8 million | 1.2 million | 6.6 million | 10.8 million | 11 million | 143,000 |
| < \$20/t $CO_2e$ | | 21 million | 32 million | 7.6 million | 12.9 million | 11.6 million | 201,000 |
| < \$40/t $CO_2e$ | 116,000 | 215 million | 33 million | 13 million | 14.3 million | 11.8 million | 490,000 |
| potential area (acres) | | | | | | | |
| < \$7/t $CO_2e$ | | 169,000 | | 550,000 | 1 million | 1.4 million | 79,000 |
| < \$10/t $CO_2e$ | | 169,000 | 110,000 | 550,000 | 1 million | 1.9 million | 87,000 |
| < \$20/t $CO_2e$ | | 351,000 | 5.7 million | 636,000 | 1.3 million | 2.1 million | 123,000 |
| < \$40/t $CO_2e$ | 2000 | 3.6 million | 5.7 million | 1 million | 1.5 million | 2.2 million | 193,000 |

# Conclusions

- Afforestation has potential to sequester large amounts of $CO_2$, however has higher marginal costs
- No-till, restocking under-stocked stands, and rotation extension have lowest marginal costs
- Sub-optimally producing lands will be the locations where management for carbon maximization will have low or even negative marginal costs
- Regionally, potentially 19 million t $CO_2e$ could be sequestered for less than \$10/t $CO_2e$