STATE NATURAL & WORKING LANDS INITIATIVE

BRIEFING PACKET: North Carolina Opportunity Assessment

Contributors

- Adam Daigneault, University of Maine
- Brent Sohngen, Ohio State University
- Tyler Lark and Seth Spawn, University of Wisconsin-Madison (avoided grassland conversion; grassland restoration)
- Christopher Williams, Clark University (avoided forest conversion)
- Kevin Kroeger, U.S. Geological Survey (tidal wetland restoration)
- Marci Baranksi and Jan Lewandrowski, U.S. Department of Agriculture (manure management)
- Peter Woodbury, Cornell University (cropland nutrient management)
- Matt Hurteau, University of New Mexico (fire management)
- **The Nature Conservancy:** Joe Fargione, Susan Cook-Patton, Bronson Griscom, Peter Ellis, Chris Zganjar, Trisha Gopalakrishna, Steve Bassett, Timm Kroeger, Tim Boucher, Rob McDonald
- **World Resources Institute:** David Gibbs, Nancy Harris, James Mulligan, Gretchen Ellison

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Background

This packet summarizes the results of an assessment of carbon gain potential for ten "natural climate solutions" pathways on natural & working lands in North Carolina.

1) **Reforestation:** The conversion of non-forested land to forested land where there was forest historically.
2) **Agroforestry**
    a. **Riparian buffers:** Reforesting areas near streams to help shade and partially protect streams from the impact of adjacent land uses.
    b. **Silvopasture**: The intentional combination of trees, forage plants, and livestock together as in integrated, intensively-managed system. This pathway examined the opportunity to increase carbon storage by planting trees in pasture land.
    c. **Wind breaks:** Tree plantations made up of rows of trees planted to provide shelter from the wind and to protect soil from erosion. They are commonly planted around the edges of fields on farms.
3) **Forest carbon management:** A broad set of practices that can increase carbon storage in existing forestlands; this assessment examined two practices—extending rotation lengths and restocking understocked forest stands.
4) **Urban reforestation:** Planting trees along streets and in parks and yards.
5) **Avoided forest conversion:** Retaining existing forests that would otherwise be converted to other land uses (e.g., pasture, cropland, development).
6) **Avoided grassland conversion:** Retaining grasslands that would otherwise be converted to cropland.
7) **Grassland restoration:** The conversion of croplands to grasslands to build carbon in soils and root biomass.
8) **Cover crops:** Additional soil carbon sequestration gained by growing a cover crop in the fallow season between market crops.
9) **Cropland nutrient management:** Avoided nitrous oxide emissions due to more efficient use of nitrogen fertilizers and avoided upstream emissions from fertilizer manufacture.
10) **Tidal wetland restoration:** Restoring tidal flows to salt marshes that have been disconnected from the ocean, thereby reducing methane emissions.

The assessment was conducted by The Nature Conservancy (TNC) and World Resources Institute (WRI), in collaboration with leading academic experts from Ohio State University, the University of Maine, the University of Wisconsin-Madison, Clark University, the U.S. Geological Survey, and Cornell University.

How to Use this Assessment

This opportunity assessment is intended to illustrate order-of-magnitude potential for carbon gain and associated cost within your state. Results can be used to prioritize efforts on the most impactful pathways, to understand the county-by-county hotpots for individual pathways, and for considering appropriate state-wide mitigation targets. Results should not be used for project-level planning.

For each pathway we present an average annual rate—metric tons of carbon dioxide equivalent (tCO_2e) per year. The annual rate represents a snapshot of what could be achieved in a given year in the near future (e.g., 2025). For many pathways, rates fluctuate over time (e.g. reforestation). Here we present the average annual rate based on the first twenty years following implementation.

Some of the individual pathways modeled cannot be simply added together to arrive at a total potential estimate; some pathways overlap significantly in that they would involve conflicting land uses on overlapping areas of land.

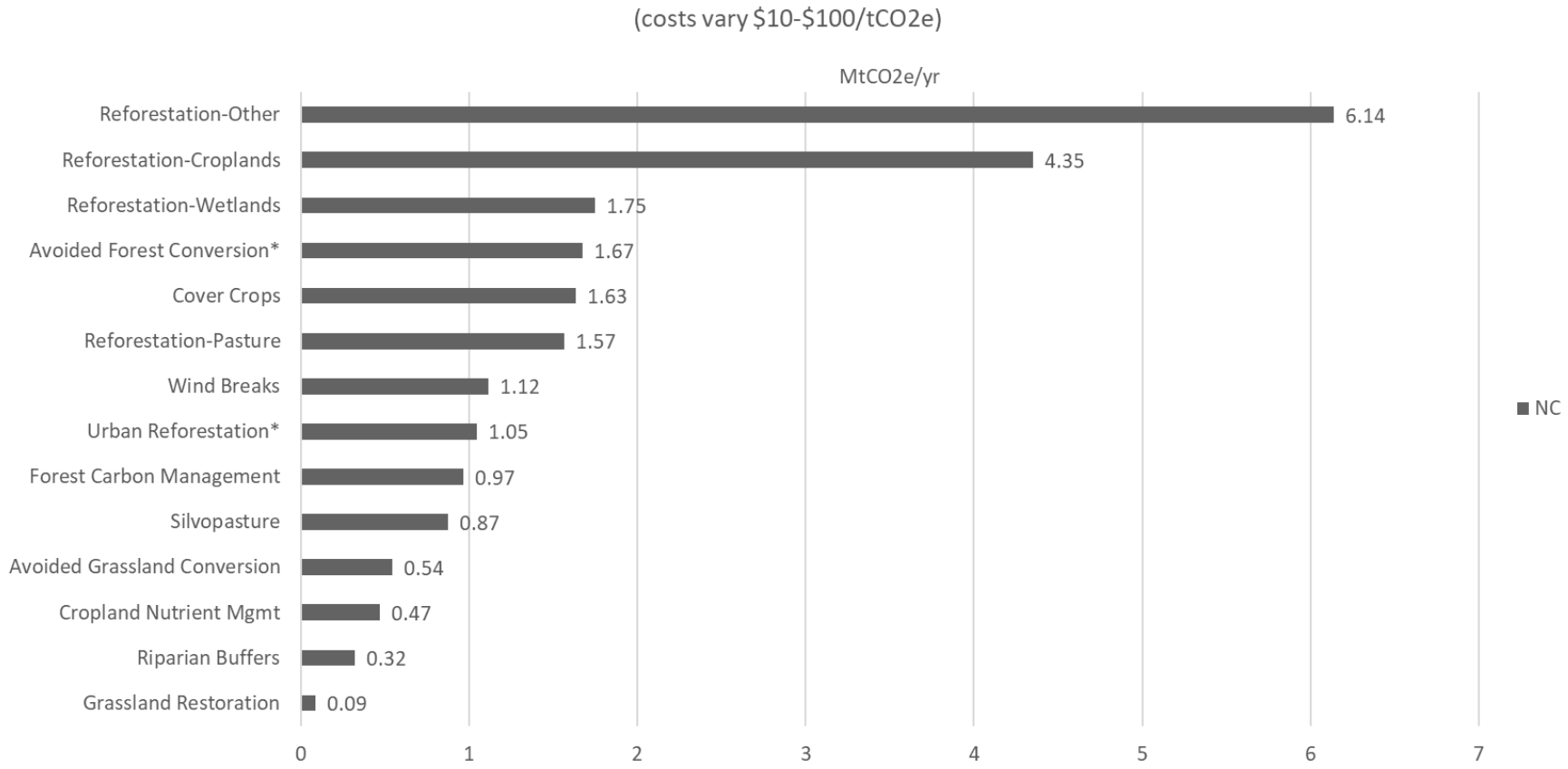
This opportunity assessment was scoped and executed using data and methods available to the Natural & Working Lands (NWL) technical assistance group within the time available. Although these data and methods are grounded in the peer-reviewed literature, results for each pathway are a product of several assumptions and are subject to varying degrees of uncertainty from a variety of sources. The pathways included in this assessment are also **not comprehensive.** Modeled pathways were selected to reflect the most promising opportunities for which the data and methods were available for state-level modeling with national datasets.

Also note that indirect land use change ("leakage") can reduce the true impact of efforts that affect land use. Leakage dynamics are not accounted for in this assessment. In addition, some pathways are susceptible to various risk related to climate change and socio-economic factors.

The technical assistance group can help state staff and stakeholders understand key areas of uncertainty and potential implications in their state.

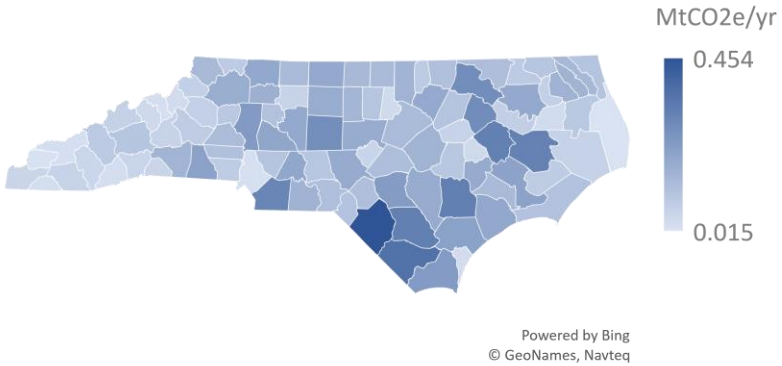
Preliminary Results

The potential to reduce emissions and increase carbon storage in natural and working lands in North Carolina is significant. Several of the pathways—both forest- and agriculture-related—cross the "million ton" threshold for carbon gain potential. Reforestation appears to offer large potential. While some of this potential would require displacing agricultural land uses, there appear to be opportunities to restore forested wetlands and to reforest non-agricultural lands. Adopting silvopasture on pasture lands and integrating windbreaks and riparian buffers into croplands also offer meaningful potential without displacing land uses. On agricultural lands, improved manure management and cover cropping appear to have major potential. Tidal restoration results at the state-level are forthcoming.

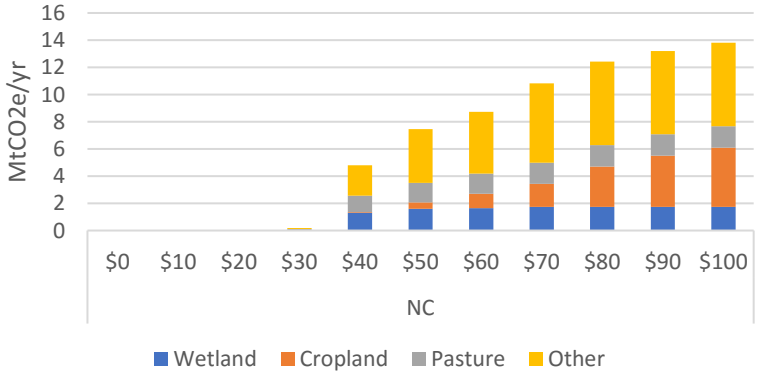


*Pathway includes some carbon gain potential that is only cost-effective at prices greater than $100/$tCO_2$e.

Reforestation: 13.8 $MtCO_2e/yr$



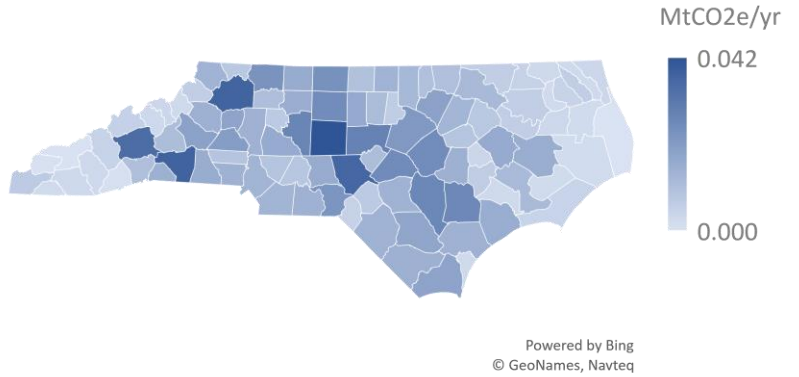
Our results show a wide range of reforestation potential in North Carolina at different cost thresholds and across different land uses, as shown in the graph below. The estimates include reforestation on a combination of wetlands, cropland, pasture, and "other" lands that were historically forested but currently have less than 25 percent tree cover. Areas with intensive human development were excluded (e.g., major roads, impervious surfaces, urban areas). The carbon gain rate represents the annual average over the next 20 years, and accounts for growth potential that is specific to forest type and region.



Note that the "other" land use category includes a wide variety of land uses such as abandoned mine lands, post-burn forest area, roadsides, power line rights of way, parks, golf courses, and other areas. The feasibility or opportunity cost of reforesting some of these areas are unclear. In North Carolina, **3.5 million acres** fit in this "other" category.

Assuming reforestation via active planting and maintenance, reforestation begins to be cost-effective starting at **$30-40/tCO₂e,** with steady increases in potential through the modeled cost curve to **$100/tCO₂e**. If a portion of the reforestation can be achieved with natural regeneration, more carbon gain could be attained at lower cost, but the total potential at $100/tCO₂e is not appreciably higher. Estimated costs include the opportunity cost of displaced land uses. The future value of timber harvest on reforested parcels is not accounted for.

Avoided Forest Conversion: 1.67 $MtCO_2e/yr$

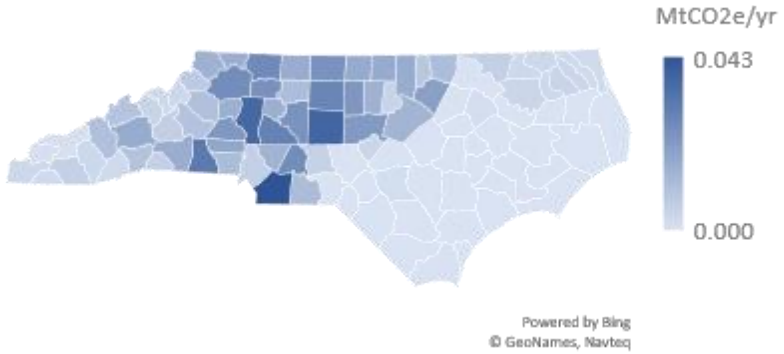


This estimate can be interpreted as the additional forest carbon storage that would be retained by eliminating all forest loss to other land uses, assuming the future rate and pattern of forest loss would otherwise continue as it did in the 1986-2000 period. The opportunity

cost of avoiding conversion **to non-developed land uses** is estimated to be **$10/tCO₂e**. However, **avoided conversion of forest to development** is associated with much higher opportunity costs **(over $100/tCO2e)**.

We advise complementing this estimate of potential with other projections of forest loss in North Carolina, and considering realistic goals for how that rate of loss may be reduced through policy.

Cover Crops: 1.5 MtCO₂e/yr



The assessment isolated cover cropping potential on the five major crops in the U.S. (corn, soy, wheat, rice, and cotton). Mean sequestration rates quantified in a recent meta-analysis (about half a metric ton of CO_2 per acre per year) were applied to available acreage in the state. The literature indicates that cover crops can boost yields, control weeds, and reduce herbicide costs, providing a net benefit to farmers. As a result, all of the estimated carbon gain potential is assumed to be achievable at net zero cost. However, while adoption of cover crops is increasing, it is still a small percentage of farmers and acres that use it. Not all farmers feel they have the time, equipment, or expertise necessary to adopt cover crops.

Urban Reforestation: 1.05 MtCO₂e/yr

This estimate was derived through extrapolation to North Carolina municipal areas from a high-resolution analysis of the potential increase in tree cover in 27 U.S. cities, excluding sports fields, golf courses, and lawns. Note that urban reforestation can be costly. All of the potential estimated here exceeds **$100/tCO₂e**. However, urban forests can also provide significant energy savings, improved air quality and quality of life, and other benefits that are not considered in this assessment.

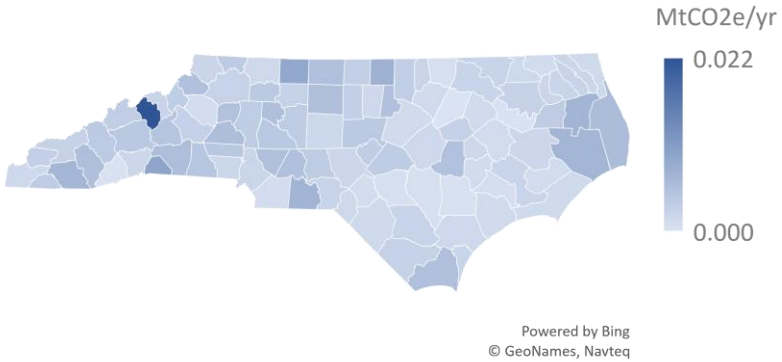
Urban reforestation results are based on average U.S. sequestration rates for forest patches, and reflect carbon potential *in 2025*. The analysis accounts for aboveground and belowground biomass, but does not assume any soil carbon benefit. The analysis also accounts for the fact that urban trees experience higher mortality.

Forest Carbon Management: 970,000 tCO₂e/yr

The assessment evaluated restocking understocked forests. All of this potential can be achieved at **less than $20/tCO₂e,** and the vast majority **at less than $10/tCO₂e.**

The restocking analysis isolates existing public and private forest lands currently understocked, as estimated by the USFS Forest Inventory & Analysis (FIA). Forests with stocking levels below 25 percent were excluded from this analysis to avoid likely double-counting with the reforestation pathway. Costs include the direct cost of planting. The annual rate of carbon gain represents an annualized average.

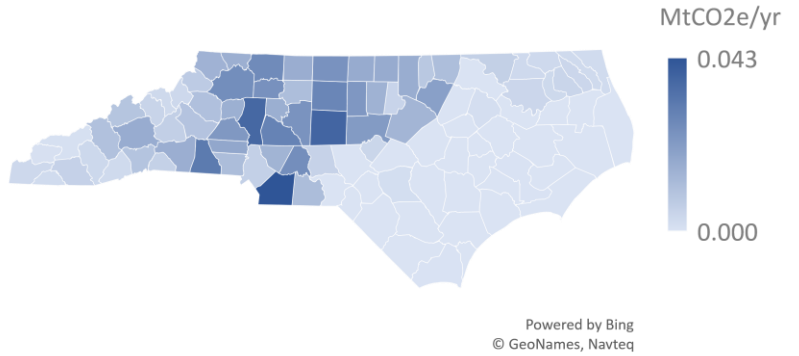
Riparian Buffers: 92,000-323,000 tCO_2e/yr



The low end of this range reflects 10ft forested buffers on all streams in the state, while the high end reflects 30ft buffers. If buffers must be actively planted, the vast majority of estimated potential is achievable at **$20/$tCO_2e$**. These costs include the opportunity cost of displaced land uses. This pathway is a subset of the reforestation pathway. The annual rate of carbon gain represents an annualized average over the next 20 years.

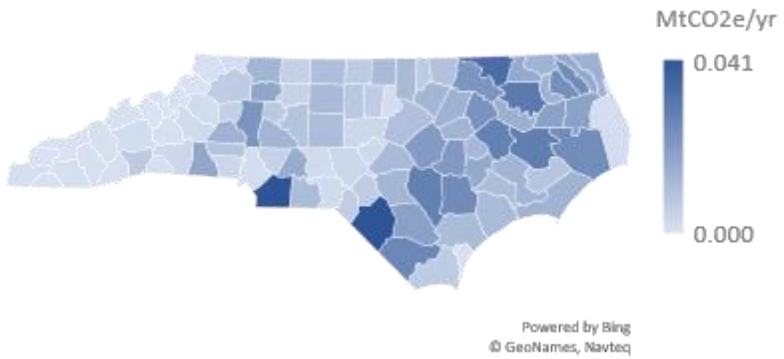
Note that although the assessment attempts to account for existing riparian buffers, coarse resolution (30m) precluded fine-grain accounting. Riparian areas immediately adjacent to lakes, reservoirs, and some coastal areas are also excluded from the assessment, likely resulting in an underestimation of reforestable area.

Silvopasture: 872,000 tCO_2e/yr



The vast majority of this potential is achievable at **$70/$tCO_2e.** These costs include active tree planting and maintenance costs but exclude any value from future harvest or tree crops. Only existing pasture lands were included in this assessment. This pathway is a subset of the reforestation pathway. Carbon gain was downscaled from the reforestation estimates by assuming 5 percent of the area in pasture would be available for tree planting. The annual rate of carbon gain represents an annualized average over the next 20 years.

Wind Breaks: 1.1 $MtCO_2e/yr$



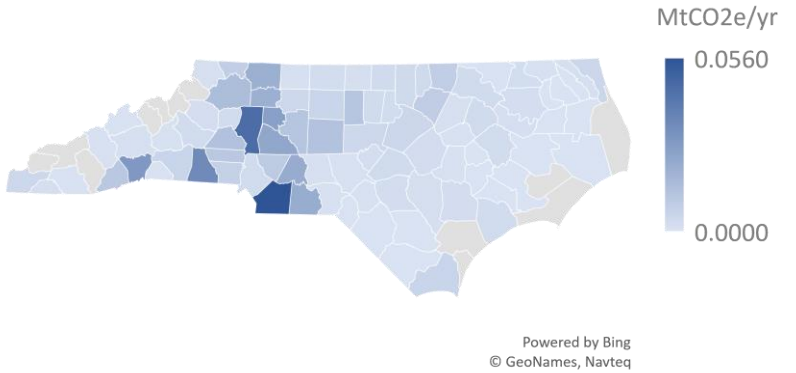
A little more than half of the estimated potential is achievable at **$50/tCO₂e**. The remainder of the estimated (sub-$100) potential becomes available through the modeled cost curve to **$100/tCO₂e**. These costs include active tree planting and maintenance costs but exclude any value from future harvest or tree crops. Only existing croplands were included in this assessment. This pathway is a subset of the reforestation pathway. Carbon gain was downscaled from the reforestation estimates by assuming 5 percent of the area in cropland would be available for tree planting. The annual rate of carbon gain represents an annualized average over the next 20 years.

Cropland Nutrient Management: 471,000 tCO_2e/yr

Farmers can reduce on-farm and upstream nitrous oxide emissions by using nitrogen fertilizers more efficiently. The assessment considered four improved management practices: 1) reduced whole-field application rate, 2) switching from anhydrous ammonia to urea, 3) improved timing of fertilizer application, and 4) variable application rate within field. Based on these four practices, we found a maximum potential 22 percent reduction in nitrogen use, which leads to a 33 percent reduction in field emissions and a 29 percent reduction including upstream emissions. The assessment focuses on potential in the year 2025.

Cropland nutrient management is generally low-cost in part due to savings from reduced use of fertilizer. The majority of the emission reduction potential in North Carolina in this pathway is available at **net zero costs or net savings**. Additional potential becomes available throughout the modeled cost curve to **$100/tCO₂e**. Switching from anhydrous ammonia to urea does not become cost-effective until **$100/tCO₂e**, and provides just 10,000 tCO_2e per year.

Avoided Grassland Conversion: 544,000 tCO_2e/yr



This estimate can be interpreted as the additional carbon storage in grasslands that would be retained by eliminating all grassland conversion to cropland, assuming the future rate and pattern of grassland conversion would otherwise continue as it did in the 2008-2012 period. Estimated potential in North Carolina is largely achievable at less than **$30/tCO₂e**.

Grassland Restoration: 88,000 tCO_2e/yr

The assessment examined the potential to increase carbon storage by converting croplands to grasslands. The assessment constrained the potential to the acreage of grassland that was converted to cropland in the 2008-2012 period. The majority of estimated

potential in North Carolina is achievable at less than **$60/tCO$_2$e**, based on the opportunity cost of forgone crop production, but additional potential becomes available through **$90/tCO$_2$e**.

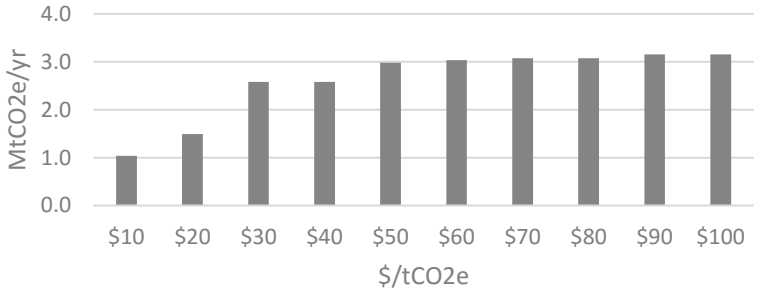
Additional Pathways and Practices

Aside from the pathways detailed here, there may be additional pathways and practices on natural and working lands that, while not modeled in this assessment, could provide the state with significant carbon gain.

Appendix

Improved Manure Management: 3.15 $MtCO_2e/yr$

The assessment evaluated the potential for emissions reductions from improved manure management on dairy farms with over 300 cows and hog farms with over 825 hogs. In 2010, confined dairy and swine operations that use anaerobic lagoon, deep pit, or liquid/slurry systems accounted for about 85 percent of total methane emissions from livestock manure management in the United States.



In North Carolina, a third of the estimated emissions reduction potential is achievable at less than **$10/$tCO_2e$**. The majority of the remainder becomes available by **$30/$tCO_2e$**.

Tidal Wetland Restoration: Forthcoming

Fringing the coast of the contiguous U.S. are 3.6 million hectares of salt marsh and other tidal wetlands. Widespread in all coastal states are many opportunities to reduce anthropogenic GHG emissions in degraded wetlands by restoring tides to reduce emissions of methane and CO_2 and enhance future carbon sequestration, while simultaneously restoring critical habitat and coastal protection benefits. The magnitude of the opportunity in the U.S. is likely to be substantially larger than 12 $MtCO_2e$. Refined, state-level evaluations are pending, and will be provided separately.