# Forest Protection Easements

**Initiative Summary**: Increase the carbon sequestration benefits of Pennsylvania's (PA's) forestland by preserving the existing forest base and conserving additional forestland.

**Goal:** Protect 2,000 acres of forestland each year from 2013 to 2020.

**Implementation Period**: 2013–2020

**Possible New Measure(s)**: The goal of the PA Forest Growth & Protection Initiative is to augment the carbon-sequestering benefits of PA's forests by preserving the existing forest base and conserving additional forestland. This will be accomplished in two ways:

- Assisting local partners in acquiring open space, such as parks, greenways, river and stream corridors, trails, and natural areas; and
- Acquisition of voluntary conservation easements with private landowners.

**Data Sources/ Assumptions/ Methods:**
Carbon savings from this option were estimated from two sources: (1) the amount of carbon that would be lost as a result of forest conversion to developed uses (i.e., "avoided emissions"); and (2) the amount of annual carbon sequestration potential that is maintained by protecting the forest area.

This initiative assumes that 50% of preserved forests are Oak-Hickory and 50% are Maple-Beech-Birch. These forest types were chosen because they are predominant in PA, each making up about 44% of total forest cover in PA (Forestry Inventory and Analysis [FIA]). The carbon sequestration rates for those types of forests were applied in deriving estimated sequestration totals.

**(1) Avoided Emissions**

Carbon savings, shown in Table 1, from avoided emissions were calculated using estimates of total standing forest carbon stocks in PA, provided by the USFS as part of the U.S. EPA's GHG State Inventory Tool 2012.

**Table 1. Carbon Pools in Predominant PA Forests**

| Forest Carbon Pool | Oak-Hickory | Maple-Beech-Birch |
|---|---|---|
| | **tC/acre** | **tC/acre** |
| Live tree | 35.8 | 36.7 |
| Standing dead tree | 1.6 | 2.6 |
| Understory | 0.7 | 0.7 |
| Down dead wood | 2.4 | 2.6 |
| Forest floor | 3.3 | 10.8 |
| Soils | 21.5 | 28.1 |
| **Total** | **65.3** | **81.5** |

tC = metric tons of carbon.

Loss of forests to development results in a large one-time surge of carbon emissions. In this case, it was assumed that 100% of the vegetation carbon stocks would be lost in the event of forest conversion to developed uses, with no appreciable carbon sequestration in soils or biomass following development. The soil carbon loss assumption is based on a study that shows about a 35% loss of soil carbon when woodlots are converted to developed uses (Austin, 2007). A comparison of data from the American Housing Survey[1] with land-use conversion data from the Natural Resources Inventory (NRI) suggests that, on average, two-thirds of the land area in a given residential lot is cleared during land conversion. Thus, it was assumed that, during forest conversion to developed use, 100% of the forest vegetation carbon and 35% of the soil carbon would be lost on 67% of the converted acreage.

To estimate avoided emissions, the total number of acres protected in a year was multiplied by the estimate of one-time carbon loss from biomass and soils due to development. In Maple-Beech-Birch forests, the estimated carbon loss was 56.2 tC/acre; in Oak-Hickory forests, it was 49.2 tC/acre. In both forest types, this estimate of carbon loss due to development is calculated as the sum of 100% of average standing vegetation carbon stocks (live + dead) and 35% of average soil carbon stocks (forest floor + mineral soil). This overall avoided carbon emissions estimate was then converted to $MMtCO_2e$ (Table 3).

**(2) Annual Sequestration Potential in Protected Forests**

The calculations below use default carbon sequestration values for Oak-Hickory and Maple-Beech-Birch forest types in the northeastern United States (U.S. Forest Service [USFS] General Technical Report (GTR)-343, Tables A2 and A3) (Table 2). Average annual carbon sequestration for these forest types was calculated over 125 years by subtracting carbon stocks in 125-year-old stands from carbon stocks in new stands and dividing by 125. Soil carbon density was assumed constant, and is not included in the calculation because default values for soil carbon density are constant over time in USFS GTR-343.

The total carbon savings associated with this option are summarized in Table 3.

**Table 2. Forest Carbon Sequestration Rates in Protected Acreage**

| Forest Types | tC/ac (0 yr) | tC/ac (125 yr) | tC/ac/yr (average) |
|---|---|---|---|
| Oak-Hickory | 23.0 | 110.7 | 0.7 |
| Map-Bee-Birch | 25.0 | 88.6 | 0.5 |

tC/ac/yr = metric tons of carbon per acre per year.

**Table 3. Carbon Avoided and Sequestered as a Result of Forest Protection Easements**

| Year | Cumulative Acreage Preserved | Avoided one-time C emissions (MMtCO2e/ yr) | C storage in Protected Acreage ($MMtCO_2e$/ yr) | Total C Savings (MMtCO2e/ yr) |
|---|---|---|---|---|
| 2013 | 2,000 | 0.259 | 0.004 | 0.263 |
| 2014 | 4,000 | 0.259 | 0.009 | 0.268 |
| 2015 | 6,000 | 0.259 | 0.013 | 0.272 |
| 2016 | 8,000 | 0.259 | 0.018 | 0.277 |

[1] U.S. Census, http://www.census.gov/hhes/www/housing/ahs/ahs.html.

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|---|---|---|---|---|
| 2017 | 10,000 | 0.259 | 0.022 | 0.281 |
| 2018 | 12,000 | 0.259 | 0.027 | 0.286 |
| 2019 | 14,000 | 0.259 | 0.031 | 0.290 |
| 2020 | 16,000 | 0.259 | 0.036 | 0.294 |
| **Total** | **16,000** | **2.072** | **0.160** | **2.231** |

C = carbon; $MMtCO_2e$ - million metric tons of carbon dioxide equivalent.

**Total Reductions:** 2.2 million metric tons of carbon dioxide equivalent ($MMtCO_2e$)

**Cost to Regulated Entities:**

The cost of protecting forestland through this policy initiative is calculated as the cost of easement purchase for private land. While in some regions of PA easement costs will be higher than in other regions, the estimated statewide easement cost is $1,000/ acre. Note that the easement cost calculated here could be used as a proxy for the "project implementation agreement" prescribed as part of the Climate Action Reserve forestry protocols. The cost-effectiveness of this option increases with time, as the acreage is preserved in the first four years of the program (Table 4). The levelized cost-effectiveness of the program over the full implementation period is $52.5 per metric ton of carbon dioxide equivalent ($tCO_2e$).

**Table 4. Economic Costs of Protecting Forestland**

| Year | Acres Protected This Year | Total Cost ($2010) | Discounted Costs ($2010) | Annual Cost-Effectiveness ($/t CO2e) |
|---|---|---|---|---|
| 2013 | 2,000 | $2,000,000 | $1,727,675 | $6.56 |
| 2014 | 2,000 | $2,000,000 | $1,645,405 | $6.14 |
| 2015 | 2,000 | $2,000,000 | $1,567,052 | $5.76 |
| 2016 | 2,000 | $2,000,000 | $1,492,431 | $5.39 |
| 2017 | 2,000 | $2,000,000 | $1,421,363 | $5.06 |
| 2018 | 2,000 | $2,000,000 | $1,353,679 | $4.74 |
| 2019 | 2,000 | $2,000,000 | $1,289,218 | $4.45 |
| 2020 | 2,000 | $2,000,000 | $1,227,827 | $4.17 |
| **Total** | **16,000** | **$16,000,000** | **$11,724,649** | **$5.96** |

**Implementation Steps:**

- Develop a set of criteria for evaluating proposed projects involving the protection of existing forestland to identify potentially significant carbon sequestration opportunities at low marginal costs and with associated environmental co-benefits.

- Consider using criteria, such as forest type/age and related carbon values—current and projected, landscape context (e.g., size, contiguity, connectivity), threat of conversion, economic analysis (e.g., opportunity, conversion and maintenance costs, potential credit eligibility), stocking levels/regeneration rates, ecological values, etc.
    - To the greatest extent possible, use data that are currently available (e.g., FIA, Natural Resources Conservation Service [NRCS], etc.).
- There is some potential applicability of the PA electronic map program (PAMAP), which uses periodic (~ every 3 years) remote sensing to detect land-use/land-cover change and could also be used to estimate changes in net biomass (or ecosystem) productivity.
- Through LIght Detection And Ranging (LIDAR)/high-resolution land-cover data, identify and characterize baseline information on priority carbon sinks—high-value natural sequestration areas, including the largest remaining intact blocks of ecologically and economically functional interior forest. (See also Related Policies/Programs in Place.)
- Consider enabling actions to reduce leakage and investigate ways to estimate and understand leakage issues, including improvements in data capabilities to track land-use change.
- Focus efforts of multiple programs/agencies to reach out to landowners in these priority areas in order to share information on funding/technical assistance/management options that create alternatives to parcelization/fragmentation.
- Create financial incentives for landowners and land trusts to accomplish the objectives described above.
    - Increase state (e.g., Community Conservation Partnership Program [C2P2]) funding for acquisition of priority forestland and for working forest conservation easements to protect forestland from conversion.
    - Consider re-tooling the state's Forest Legacy program to reward landowners for retaining carbon value.
    - Create a state tax credit for conservation of forestland by businesses and individuals.
    - Review the Clean and Green program to identify opportunities for improving benefits to forest landowners.
    - Explore opportunities for converting Conservation Reserve Enhancement Program (CREP) contracts and other forested riparian buffer projects to permanent riparian easements.
    - Encourage and assist counties and municipalities that are interested in creating funding for local forest conservation projects.
- Develop a model conservation easement that would incorporate carbon sequestration and trading and that would seamlessly work with emerging state and federal laws and regulations.
- Incorporate the land trust community's capacity and experience in monitoring and enforcing easements into emerging carbon monitoring programs to avoid reinventing the wheel.
- Beyond the objectives described above, determine how to interweave emerging PA and federal policy and carbon management mechanisms so that PA stakeholders can act expeditiously.
    - DEP, the Pennsylvania Department of Transportation (PennDOT), and DCNR might consider establishing a joint "Carbon Service" to assist nonprofits, businesses, and consumers in the same way that agriculture agencies assist farmers. Or perhaps the cooperative extension services, chambers of commerce, and other existing entities might assume this responsibility.
    - DCNR and the Pennsylvania Land Trust Association might consider creating a program to enlist private forest landowners in a PA carbon-trading co-op or similar entity.
    - Depending on the eventual makeup of a federal climate regulatory system, PA should consider complementary programs to enhance it and speed up its implementation. For example, if programs to avoid deforestation are insufficient at the federal level, PA should enhance that aspect to incentivize landowners to participate, much in the way that many PA counties add their own funds to the state agricultural preservation program.

Currently, the standard practice for development in wooded areas is to completely clear the land. Incentives, education, and regulations should be put in place at the state and local levels to alter this practice and require replacement sufficient to actually make a difference. This will necessitate expanding the current tree-planting infrastructure, which includes growers of native trees, recruitment of volunteers, and husbandry training for landowners in suburban and urban areas.

PA will need some adaptive structure(s) to monitor changes, disseminate information, and assist ecosystem managers as natural communities change as a result of a changing climate.

**Potential Overlap:** None.

**Data Sources:**


- J.E. Smith et al. 2006. *Methods for Calculating Forest Ecosystem and Harvested Carbon with Standards Estimates for Forest Types of the United States*, GTR NE-343. USFS Northern Research Station. (Also published as part of the U.S. Department of Energy (DOE) Voluntary GHG Reporting Program.)
- Data provided by the USFS for the PA Forestry Inventory and Forecast (I&F); program costs provided by DCNR.
- Austin, K. 2007. "The Intersection of Land Use History and Exurban Development: Implications for Carbon Storage in the Northeast." Undergraduate Thesis, Brown University.