Forestland Protection Initiative — Acquisition

Initiative Summary:
This policy initiative analyzes three scenarios aimed at reducing the permanent loss of forest acreage through direct acquisition. The GHG benefit is twofold: avoided carbon emissions that might otherwise have taken place on converted acreage, and carbon storage on cumulative protected acreage.

Goal:
Protect private forestland conversion and reduce the likelihood of forestland conversion to developed use through direct acquisition.

Scenarios:

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Implementation Period: 2013–2020

Data Sources/ Assumptions/ Methods:
GHG benefits 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.

In PA, the Natural Resources Inventory (NRI) estimated roughly 15.5 million acres of forest in 1997. Between 1982 and 1997, 902,900 acres of forest were converted to non-forest use (61,393 acres annually). Of this total, 597,900 acres were converted to developed use for a net annual loss of 39,860 forested acres to development statewide.

This corresponds to a net forest loss of 0.40% per year to all non-forest uses, or 0.26% loss annually to development alone. In this analysis, a baseline conversion rate of 39,860 acres per year was used, representing the rate at which forestland was lost to development annually between 1982 and 1997. Updated data on land conversion trends have not been released by NRI as of May 2009.

Analysis for each of these types of carbon savings (avoided emissions and sequestration on protected acreage) was conducted each scenario. The scenarios differ with regard to the number of acres not converted to development each year (see Table 1). In all scenarios, 50% of preserved forests is assumed to be Oak-Hickory and 50% is assumed to be Maple-Beech-Birch. These forest types were used because they are predominant in PA, each making up about 44% of total forest cover in PA (FIA).

Table 1. Alternative Acreage Scenarios Used to Quantify Carbon Savings From Avoided Forest Conversion to Developed Use

Scenarios	Goal and Cumulative Acreage Protected 2013–2020 (acres)	Annual Incremental Acreage Protected to Reach Goal (acres/ year)
Scenario 1: Reduce conversion rate by 25% by 2020	9,965	1,246
Scenario 2: Reduce conversion rate by 50% by 2020	19,930	2,491
Scenario 3: Achieve no net loss of forest to development by 2020	39,860	4,983

1. Avoided Emissions

The forest carbon stocks (tons of carbon per acre) and annual carbon flux (annual change in tons of carbon per acre) data are based on default carbon sequestration values for Maple-Beech-Birch forest types in the northeastern United States (USFS GTR-343, Table A2). Annual rates of carbon sequestration (metric tons of carbon sequestered per acre per year) were calculated by subtracting total carbon stocks in forest biomass of 125-year-old stands from total carbon stocks in forest biomass of new stands and dividing the remainder by 125. Soil carbon density was assumed constant, and is not included in the annual carbon flux calculations because default values for soil carbon density are constant over time in USFS GTR-343. See Table 2 for an overview of forest carbon storage and sequestration information used in this analysis.

Table 2. Annual Sequestration Potential in Protected Forests

Year	Cumulative Acres Preserved			C Storage in Protected Acreage ($MMtCO_2e$)		
	Scenario 1	Scenarios 2	Scenario 3	Scenario 1	Scenarios 2	Scenario 3
2013	830	1,661	3,321	0.00	0.00	0.01
2014	2,490	4,983	9,963	0.01	0.01	0.02
2015	4,980	9,966	19,926	0.01	0.02	0.04
2016	8,300	16,610	33,210	0.02	0.04	0.07
2017	12,450	24,915	49,815	0.03	0.06	0.11
2018	17,430	34,881	69,741	0.04	0.08	0.15
2019	23,240	46,508	92,988	0.05	0.10	0.21
2020	29,880	59,796	119,556	0.07	0.13	0.27
Total	**29,880**	**59,796**	**199,556**	**0.22**	**0.44**	**0.88**

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

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 Survey1 with land use conversion data from the 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

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

lost on 67% of the converted acreage. For each scenario it was assumed that 100% of the protected land would otherwise have been converted to a developed use. Thus, the avoided emissions calculation was made on 100% of the protected 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, this estimated C loss was 56.2 tC/ac; in Oak-Hickory forests, it was 49.2 tC/ac. 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 MMtCO2e. While some of the biomass lost during clearing might be used for bioenergy production, the effect was not quantified in this analysis.

2. Sequestration in Protected Forest

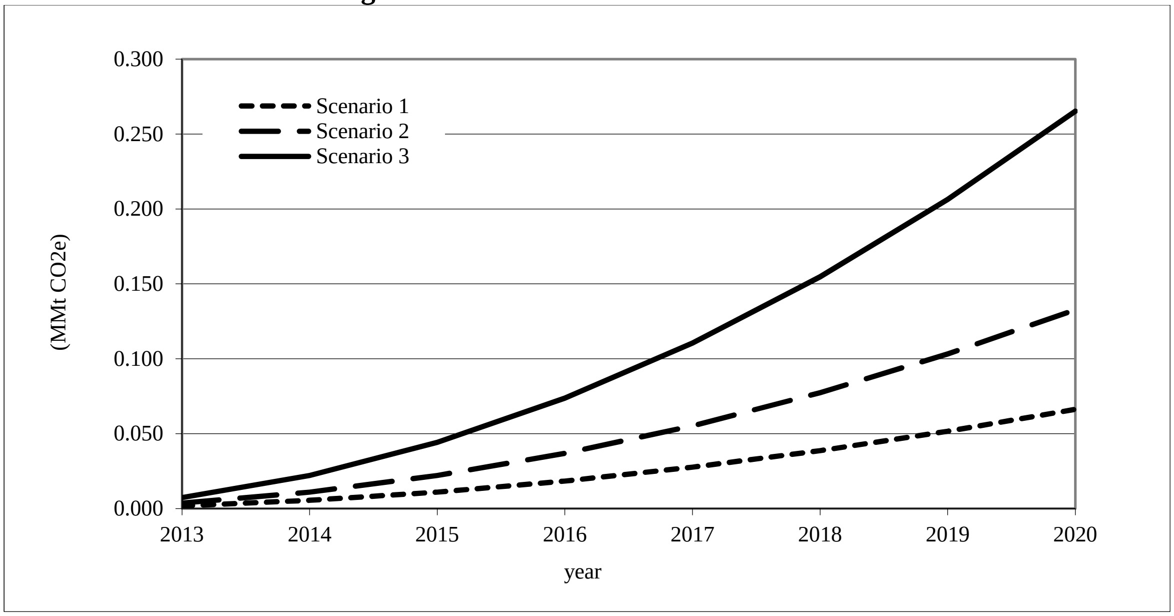
Forests not converted in a given year continue to sequester carbon each year they remain in a forested use. Thus, the carbon sequestration in protected forestland is calculated as annual sequestration in cumulative protected acreage. Annual sequestration for PA forest (tC/ac/yr) is calculated from NE-GTR-343 and is given in Table 3. As with avoided emissions from initial conversion, it is assumed that half of the protected forest acreage is in Maple-Beech-Birch forest and half is in Oak-Hickory forest. Because acres protected in one year continue to store carbon in subsequent years, annual benefits of forest protection tend to accrue in later years of policy implementation (Figure 1).

Table 3. Summary of Avoided One-Time Emissions and Sequestration in Protected Forest Due to Reduced Forest Conversion (2013–2020)

Scenarios	Cumulative Acres Protected (acres)	Cumulative GHG Benefit From Avoided One-Time Emissions ($MMtCO_2e$)	Cumulative GHG Benefit From Carbon Sequestration ($MMtCO_2e$)	Total Carbon Reductions (MMtCO2e)
Scenario 1	29,880	5.81	0.33	6.14
Scenario 2	59,796	11.61	0.66	12.28
Scenario 3	199,556	23.22	1.33	24.55

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

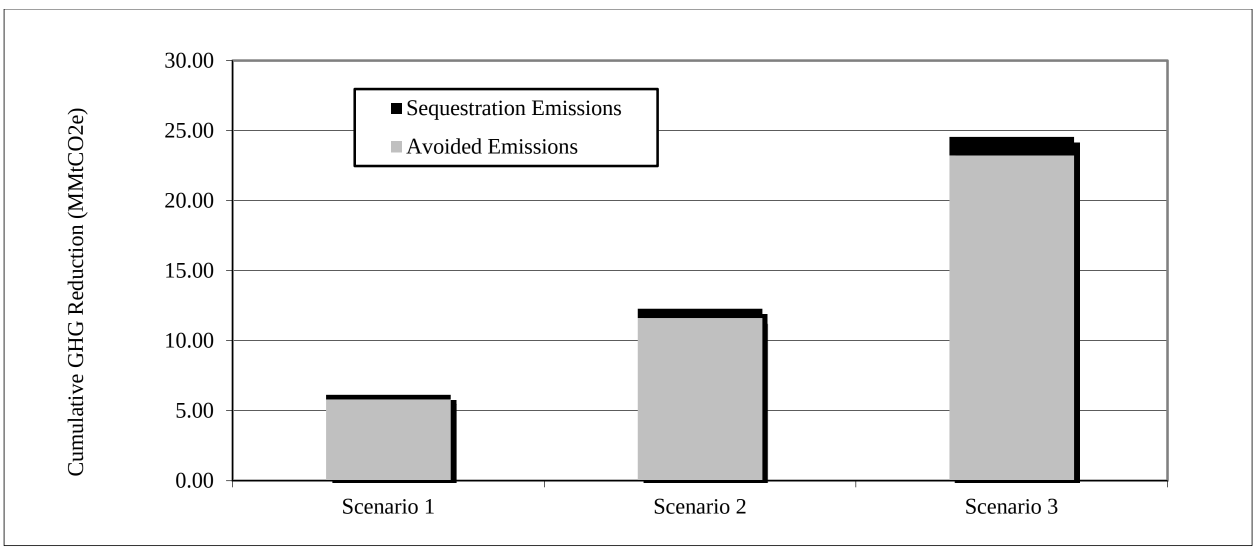
Figure 1. Impact of Forest Protection From Conversion on Annual Carbon Sequestration in Cumulative Protected Acreage.



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

For Scenarios 1–3, the relative impact of avoided one-time emissions due to reduced forest conversion is roughly 14 times the impact of cumulative sequestration in protected acreage for all scenarios (Table 3 and Figure 2).

Figure 2. Cumulative Effect of Five Scenarios on GHG Emissions Between 2013 and 2020



$MMtCO_2e$ = million metric tons of carbon dioxide equivalent.

<u>Economic Costs</u>:

The economic cost of avoiding conversion was calculated as the cost of acquiring land minus the costs of land clearing and site grading. The cost per acre for acquisition is estimated at $3,500 per acre. The cost for land clearing was estimated at $3,000 per acre ($2,000 clearing + $1,000 site grading). The results of the economic analysis, without discounting, are shown in Table 4.

A summary of the discounted and non-discounted costs is shown in Table 5, and overall results of the analysis are given in Table 6. Discounted costs were calculated assuming a 5% discount rate and 2010 dollars. The net present value (NPV) of each scenario is the sum of the discounted costs between 2013 and 2020. Levelized cost-effectiveness is calculated as the cost associated with avoiding or storing each tCO2e. The levelized cost-effectiveness for all scenarios is $2.52 per metric ton CO2e.

Table 4. Net Economic Costs of Avoided Forest Conversion (not discounted)

Year	Scenario 1	Scenario 2	Scenario 3
2013	$622,813	$1,245,625	$2,491,250
2014	$1,245,625	$2,491,250	$4,982,500
2015	$1,868,438	$3,736,875	$7,473,750
2016	$2,491,250	$4,982,500	$9,965,000
2017	$3,114,063	$6,228,125	$12,456,250
2018	$3,736,875	$7,473,750	$14,947,500
2019	$4,359,688	$8,719,375	$17,438,750
2020	$4,982,500	$9,965,000	$19,930,000
Cumulative	$22,421,250	$44,842,500	$89,685,000

Table 5. Summary of Economic Costs of Each Scenario

Types of Economic Costs	Scenario 1	Scenario 2	Scenario 3
Net Economic Costs (non-discounted) ($ million)	$22.42	$44.84	$89.69
Net Economic Costs (NPV) ($2010) ($ million)	$15.50	$30.99	$61.99

NPV = net present value.

Table 6. Summary of GHG Benefits and Economic Costs for Each Scenario

Scenarios	GHG Reduction in 2020 ($MMtCO_2e$)	Cumulative GHG Reduction 2013–2020 ($MMtCO_2e$)	Cost-Effectiveness ($2010 per tCO_2e)
Scenario 1: Reduce rate of conversion by 25% by 2020	1.39	6.14	$2.52
Scenario 2: Reduce rate of conversion by 50% by 2020	2.78	12.28	$2.52
Scenario 3: Achieve no net forest loss by 2020	5.56	24.55	$2.52

$MMtCO_2e$ = million metric tons of carbon dioxide equivalent; tCO_2e = metric tons of carbon dioxide equivalent.

Key Assumptions: Forest protection will occur via acquisition at an approximate cost of $3,500/acre; 50% of protected forest will be in a Maple-Beech-Birch forest type, and 50% of protected forest will be in an Oak-Hickory forest type. Conversion threat values may range from 10% to 100%.

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 planned PA electronic map program (PAMAP), which will use 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. 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. 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.

Create financial incentives for landowners and land trusts to accomplish the objectives described above.

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 the 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.
- Strong, T.F. 1997. "Harvesting intensity influences the carbon distribution in a northern hardwood ecosystem." U.S. Department of Agriculture (USDA) Forest Service North Central Forest Experiment Station Research Paper NC-329.
- Austin, K. 2007. "The Intersection of Land Use History and Exurban Development: Implications for Carbon Storage in the Northeast." Undergraduate Thesis, Brown University.