D. Sequestering Carbon on Vermont's Farms and in Its Forests

Vermont's working lands can be managed to "reverse" greenhouse gas emissions, and it's already occurring in places. With Vermont's traditional land uses of farming and forestry, Vermonters who manage those lands can reap a variety of benefits while accumulating carbon in the soil.

Primarily composed of carbon, the organic matter in soils plays a role in four important ecosystem services: resistance to soil erosion, soil water-holding capacity, soil fertility for plants, and soil biodiversity. Around the world, efforts are being targeted at decreasing soil disturbance, reducing erosion, increasing organic matter inputs to soil through crop residues and organic nutrient sources, and maintaining continuous living plant cover as much as possible throughout the year.

Over the last decade, adoption by Vermont farmers of these soil-building practices has resulted in the rebuilding of soil health. These soil health improvements have the co-benefits of improving water quality and enhancing flood resiliency while increasing sequestered carbon in the soil and decreasing greenhouse gas emissions from agricultural lands. New regulations (Vermont Clean Water Act) have promoted these practices for their water quality value and have increased funding for implementation and education. Vermont farmers also lead in trying innovative practices like a roller crimper that increases the return of organic matter in cover crop residues to a field, with lower chemical inputs.

These practices also provide longer term benefits to farmers by enhancing productivity, decreasing fuel and fertilizer costs, and reducing volatility of weather-related yield swings – essentially creating cropping systems that are more resilient to the impacts of climate change. Many farmers have adopted these practices voluntarily, but there is still a financial cost to farm businesses. It is critical that these practices continue, once implemented, as research shows reverting to previous conditions can quickly reverse nearly all the prior gains. Since the potential for capturing annual CO_2 emissions, both locally and globally, through agriculture is high, and so clearly connected to other co-benefits, our policies must be designed to support the transition to these practices. Education and demonstration of such conservation practices that allow for farmer-to-farmer communication are also critical for increased adoption and have been shown to one of the most effective means of changing management. Recent studies (Galik, et al., 2018) have suggested that policies that promote early action can promote innovation and reduce the lags in benefits associated with inaction.

Opportunity: Carbon in Our Forests

Forests cover roughly 78 percent of the land area of state. They are also a major carbon store or "sink" – both above and below ground. Estimates suggest more than half our state's annual CO2 emissions are being absorbed by the annual growth of these forests, and over 200 years of emissions are stored there. Recent data indicate our net annual sequestration is declining slightly, and – for the first time in over 100 years – our forested land base is declining (Morin, et al. 2017). While these data suggest our forests are changing, the reasons for that change are complex. One aspect of the future is relatively certain: climate change will increase management costs for forest landowners from a host of expected impacts including invasive plants and insect control, increased drainage and road infrastructure costs, storm damage, and potential reductions

in health and productivity. To climate impacts add increasing property taxes, parcellization, weakening markets, and the shifting demographics of ownership and the stability of our future forest land base becomes even less secure.

Already risky and marginal, the profitability of forest ownership is likely to decline, jeopardizing many of the benefits we have come to expect from our forests – benefits that include clean air, clean water, flood resilience, and carbon storage, along with more conventional forest products. Vermont has been proactive in informing both landowners and policy makers about this growing list of threats. Forest managers have access to regular reporting on forest health and markets. Planners have new legislative mandates requiring they consider the benefits of forests in regional and municipal plans. Workshops encouraging planning for ownership succession are ongoing. The Department of Forest, Parks, and Recreation has developed a suite of tools supporting the adaptation of management in the face of a changing climate. However, none of these laudable actions generate additional revenues to landowners.

One alternative revenue stream is gaining ground in much of the country: programs that allow for forest landowners to monetize forest growth as carbon offsets – generating payments for some of the ecosystem services forests provide. Carbon offset programs not only promote additional sequestration, but by providing a new annual income stream to landowners may well play a role in keeping the major forest carbon sink intact. As with agriculture, co-benefits from habitat protection and sustainable management are additional dividends to the public. Yet, turning carbon in trees into a fungible "security" is far from simple. Program rules are complicated, and the expertise required to develop forest carbon projects is expensive. Larger tracts (more carbon revenue) cover more of these fixed costs, which partially explains why most projects have occurred where parcel size is larger or growth is faster, compared to Vermont. Only one forest carbon project has been initiated in Vermont to date.

Managing forests for carbon sequestration is compatible with all other forms of responsible forest management. The potential for income from trading forest carbon offsets is likely to continue to generate interest, both from policy makers and landowners. Nationally, forest carbon offsets from across the country supply the bulk of traded offsets for the California cap and trade mechanism. Whether these programs will continue to grow is unclear, but of all the types of offsets available, forest-based offsets display substantial demand and some of the highest prices.

The potential loss of carbon from the loss of forestland is real and substantial. Every acre of forest lost to development has the potential to release a hundred metric tons of carbon dioxide equivalent into the atmosphere – like adding 25 cars for a year.

The carbon in our forest soils is relatively stable, presuming soil disturbance is minimized and the forest growing above remains reasonably intact. For decades, the "live" carbon in Vermont forests have seen a positive net change. Growth of biomass consistently exceeds loss from mortality and harvesting, consistently extracting carbon dioxide from the atmosphere and converting it into solid carbon. Research is ongoing regarding optimal management strategies that balance both the preservation of the sink and sequestration from growth. In all likelihood, the introduction of offset trading will not have major effects on either the level of currently

sequestered carbon or the accretion of additional carbon through growth. It would reward landowners who protect the existing carbon and for new sequestration.

Vision: Increased Carbon Sequestration in Agriculture and Forestry

In the Commission's view, the opportunity for an evolving relationship with our working lands suggests a vision for the future that embodies action. Landowners of agricultural and forest land embrace the role their management plays in the mitigation of climate change impacts. Information about the scale and extent of their impact is evident and informs their actions to preserve stored carbon in trees and soil and adopt practices that increase carbon sequestration. They are motivated by ethical, practical, and financial incentives. In addition, they understand that Vermonters value their contribution to efforts that meet State greenhouse gas emission reduction goals while providing co-benefits, including protection of Vermont's surface and ground water and flood resilience.

Achieving the Vision of Increased Carbon Sequestration in Agriculture and Forestry

I. Agriculture

Our recommendations identify key leverage points and policy actions needed to systematically recognize and advance the existing and potential contributions of agriculture to achieve the State's climate goals. The goals stated in the CEP include reducing greenhouse gas within the state and from outside the state's boundaries caused by using of energy within the state by 50 percent by 2028 and 75 percent by 2050. To a large extent, sequestration, or "reverse emissions," are overlooked. The CEP mentions carbon sequestration mainly in the context of forests. Agricultural practices that can increase carbon sequestration in soils can be significant, as can the contribution of both forestry and agriculture to our climate goals, especially given the many co-benefits.

Extrapolating under reasonable assumptions[6], practices that promote carbon storage in agricultural soils have the potential to offset two percent of our annual state emissions.

II. Forestry

The CEP recognizes the importance of intact forests and discusses the role of wood fuel for heat and energy. The CEP does not acknowledge the role of or the potential for sequestration in Vermont forests, though it does acknowledge the forests as a carbon sink. The Commission will identify actions the legislature and administration can undertake to support and promote additional sequestration in forests by landowners and communities. It will also consider recommendations that promote maintaining and enhancing the value of the large carbon sink represented by our current forests.

[6] Our analysis assumes a 1 percent annual increase in organic matter per year across a distribution of soil types and practices. We also assumed these practices would be achieved on roughly one-third of agricultural acres and be sustained for a period of 20 years. Across all soils, this resulted in average carbon per acre changing from 25 to 30 tons over the 20-year period.

Sequestering Carbon Recommendations

The recommendations below are prioritized in the following way:

- Get a baseline of carbon sequestration and set goals in State planning documents
- Look to market-based mechanisms for the sale of carbon credits from sequestration
- Track rates of carbon sequestration occurring through water-quality initiatives and payments
- Maintain current forested land:
    - maintain water-quality initiatives and emphasize the benefits of sequestration for soil health and flood resilience
    - Keep forested land forested– avoid conversion of forests for development

The Commission identified that certain agricultural practices allow for the accumulation of organic matter that results in carbon stored in agricultural soils. If these practices are put in place across the 170,000 acres of currently managed farmlands, carbon sequestration can take place at the rate of greater than 50,000 metric tons per year.

Category	Overall GHG Impact
Sequestering Carbon	CO_2 CO_2

Key			
GHG Impact	The total amount of reductions in greenhouse gas emissions	CO_2 CO_2 CO_2 CO_2 CO_2 CO_2 CO_2 CO_2 CO_2 CO_2	High = > 484 MTCO2e Med = 242 – 484 MTCO2e Low = 121-242 MTCO2e Lowest = < 121 MTCO2e
		U	Unmeasurable
		NYM	Not yet measured
		P	Preventative
Savings Impact	Annual savings achieved if recommendation is implemented	$ $ $ $ $ $	High = > $10 million/yr Med = $2 - $10 million/yr Low = < $2 million/yr
Investment Needed	The investment required to deliver the GHG reductions, financial savings, and social benefits for Vermonters	$ $ $ $ $ $	High = > $5 million Med = $500K - $5 million Low = < $500K
Ease	Considering administrative, financial, and political feasibility.	👍 👍 👍 👍 👍 👍	High Med Low
	This icon conveys that this action is necessary to unlock potential for additional GHG impact and cost savings		

Recommendation 35 Investigate opportunities for the sale of carbon offsets and other mechanisms that leverage private finance	GHG Impact (Cumulative for the Category)	Savings Impact	Investment Needed	Ease
Action Step(s)			Designated Lead (other stakeholders)	
1. Characterize carbon offset opportunities for forestry in Vermont, voluntary and compliance, existing and emerging. Identify active and likely private finance organizations			UVM (FPR, ACCD, Coalition for Green Capital)	
2. Characterize carbon offset opportunities for agriculture and forestry in Vermont, voluntary and compliance, existing and emerging. Identify active and likely private finance organizations			UVM (DEC, AAFM, ACCD, Coalition for Green Capital)	
3. Consolidate and summarize above characterization and recommend type of State of Vermont participation and/or next steps and person(s) responsible for those actions			UVM (DEC, AAFM, ACCD, Coalition for Green Capital)	

Background:

Carbon offsets are emerging as a potential mechanism to reward landowners for activities that sequester carbon. There are options for both agricultural and forest lands, but the market for forest offsets is more mature and robust. An initiative led by the Vermont Land Trust and UVM's Rubenstein School is working to develop a "pilot" project to demonstrate the feasibility of carbon offsets trading for smaller private forest landowners in Vermont. There is considerable interest on the part of landowners, yet these carbon projects are complex. This pilot will inform the potential for the sale of offsets to increase landowner income, and its potential as a new conservation finance tool. This pilot represents an opportunity for state land managers to participate and answer questions that affect the feasibility of similar projects, either on other private lands (for example, compatibility with the Current Use rules) or on State lands. As the trading of forest carbon offsets becomes more common, county foresters and state land managers will need to have the information and experience to interpret current rules and mandates for landowners. AAFM and FPR along with the ACCD should evaluate the potential for a fund that would mitigate the risk of investments in these programs, in the hopes of attracting capital to support private efforts. The results of this review can become the basis for recommendations to the State legislature for targeted funding.

Recommendation 41 Continue funding the Vermont Housing and Conservation Board for conservation easement purchases on forestland; prioritize projects that emphasize aggregation to maximize conservation and set the stage for carbon offset projects	GHG Impact  (Cumulative for the Category)	Savings Impact 	Investment Needed 	Ease 
Action Step(s)			Designated Lead (other stakeholders)	
1. Review criteria (in any form) used to choose forestry conservation projects.			FPR (AAFM, VHCB, Legislature)	
2. Draft recommended changes that would be incorporated as VHCB policy			FPR (AAFM, VHCB)	
Background: Developing forest or farmland eliminates much of the stored carbon. Conservation easements are a valuable tool for keeping agricultural and forest land undeveloped. Funding for the Vermont Housing Conservation Board should be continued, with priority given to projects that emphasize the aggregation of like-minded and neighboring landowners to maximize the conservation values and set the stage for future aggregated forest carbon offset projects				