Maine Soil Carbon Incentives Study Policy Recommendations
September 1, 2022

AVOIDED DEVELOPMENT

1. Support and expand programs that conserve natural and working lands and prevent their conversion to development.

Implementation:

A. **Provide ongoing funding for the Lands For Maine's Future Program and the Maine Outdoor Heritage Fund to support the conservation of natural and working lands.**
B. **Develop priorities for conservation land acquisitions and easements to prevent the development of working agricultural and forest lands, as well as wetlands and natural lands of importance, to enhance soil carbon sequestration and storage. Identify how the suite of conservation tools, including fee ownership, easements, and ecological reserve management can support Soil Organic Carbon (SOC) goals.**
C. **Establish Best Management Practices (BMPs) which promote SOC storage for land managers and conservation funders to inform management planning and program guidance (in support of 1A and 1B). Identify how state-owned lands can demonstrate BMPs for SOC.**

Rationale: Maine's percentage of conserved lands is estimated at 20.4 percent, and the biennial state budget has allocated $40 million for the Land for Maine's Future Program to support the Maine Climate Action Plan's land conservation goal of 30% of the state by 2030. Since 1987, Maine has committed over $150 million and stimulated many public, nonprofit, and private partnerships for land conservation.

Maine has a higher total area of wetlands than all other New England states and New York combined, as well as 89% of its land cover in forests. Land conversion from natural ecosystems typically depletes SOC stocks due to factors including lower carbon inputs from plant biomass, increased erosion and leaching, accelerated decomposition of organic matter, and greater variation in soil moisture and temperature. There is a significant loss of SOC when natural and working lands are converted to development.

Peatlands and other wetlands including tidal marshes store high amounts of organic carbon and are among the largest natural carbon sinks of all terrestrial ecosystems, particularly on a per unit area basis. Forest soils also store substantial amounts of SOC, provided the soils are not disrupted by wildfire, invasive pests, or forestry practices that result in significant disturbance. Likewise, certain land management activities in agriculture can enhance soil carbon storage, such as soil health and conservation practices, whereas others can be a source of carbon release. Maine's Climate Action Plan recognizes the importance of working lands for carbon sequestration in soils and biomass, as well as the positive carbon benefits of wood-based building construction and local food production.

2. Provide model policy and implementation guidance to municipalities to encourage municipal and landowner conservation of forests, agricultural lands, and wetlands.

Implementation:

A. **Increase coordination between the Maine Department of Agriculture, Conservation and Forestry (DACF) Municipal Planning Assistance Program, Bureau of Agriculture, Food & Rural Resources, Maine Forest Service, the Maine Department of Environmental Protection, and the Maine Department of Inland Fisheries & Wildlife's Beginning with Habitat Program to provide additional technical support and education to select boards, local planning boards, conservation commissions, and municipal officers on the value of natural and working lands.**

Rationale: Local and state land use planners and regulators are facing heavy demands for economic, housing, and energy development. Municipal officials need more educational and technical resources to demonstrate the value of natural and working lands in community planning. Open or reverting fields that are not currently in active agricultural use are prime targets for conversion to development. Technical support is needed to justify the protection of open spaces to address current opportunities for carbon sequestration and future demands for agricultural production and forestry.

AGRICULTURE

3. Expand funding for state-funded cost-share programs to incentivize practices that enhance soil carbon storage.

Implementation:

A. **Provide annual funding to the Healthy Soils Fund to establish an ongoing state program of cost-sharing for cover crops, reduced tillage, no-till, increased crop rotations, and other soil health practices such as agroforestry and silvopasture, consistent with Natural Resource Conservation Service (NRCS) technical standards.**
B. **Coordinate with NRCS and agricultural interest groups to develop a strategic plan for coordinated implementation of funding for soil health practices.**
C. **Expand the scope of the Nutrient Management Loan Fund to allow loans for capital investment in specialized equipment needed to implement soil health practices.**
D. **Capitalize on existing financial incentives (i.e., NRCS Conservation Stewardship Program funding) to enhance incentives for riparian buffer management in agricultural settings.**
E. **Develop eligibility criteria in relevant DACF agriculture and forestry grant programs to support the acquisition of cultivation and harvesting equipment that decreases soil C disturbance for farmers and loggers.**

Rationale: Reduced tillage, no-till, and cover crop practices are well-established pillars of existing soil health programs and represent win-win best practices for carbon sequestration and storage as well as overall agroecosystem health, with potentially even greater benefits when these practices are applied together. Regenerative agriculture practices such as intensive rotational grazing, agroforestry, and silvopasture are emerging new options for developing agricultural resilience and productivity.

There are existing programs to support the use of these soil health practices, but these programs are underfunded and only able to support a fraction of the requests. Despite 80 years of federal investment in soil conservation, 75% of Maine's croplands are still not using primary soil health practices.

Funding limitations mean that approximately two-thirds of requests for NRCS financial assistance do not receive funding each year, and the buying power of NRCS and Conservation Districts has declined by about 20% since 2017 due to inflation and relatively flat levels of funding. Fully funding such programs represents "low hanging fruit" to quickly implement proven and effective practices through an established program that would improve SOC sequestration and storage on Maine farms.

4. Develop or expand technical assistance programs to help farmers implement soil health practices tailored to their individual farms.

Implementation:

A. **Provide additional annual appropriations to support soil health outreach and peer-to-peer learning opportunities offered by Soil & Water Conservation Districts (SWCDs) as part of the Healthy Soils Program.**
B. **Seek federal funding support for the Soil & Water Conservation Challenge Grant Fund to allow for soil health outreach demonstrations by Soil & Water Conservation Districts.**
C. **Utilize DACF's State Soil Scientist and Forest Carbon Specialist to review and update BMP's for forestry and agricultural production to incorporate relevant practices outlined in the Soil Carbon Incentives Study technical report (agriculture - see pp. 9-16; forestry – see pp. 20-25).**
D. **Support funding for DACF's Healthy Soils Program and Fund as established by LD 437, enacted in 2021. DACF will convene program stakeholders, including NRCS, Cooperative Extension, DEP, SWCDs, and nonprofit efforts such as the Soil Health Network, to promote the adoption and implementation of relevant soil health BMPs.**

Rationale: Existing croplands often have significant potential for increased soil conservation and SOC sequestration. Practices that increase SOC also typically have numerous co-benefits for soil health and may increase agricultural production, improve soil moisture holding capacity (thereby increasing drought resilience), reduce stormwater runoff (thereby protecting water quality and flood resilience), reduce soil erosion that depletes the most productive soil at the

soil surface, and increase biological diversity (resulting in more stable and pest-resilient ecosystems).

The efficacy of individual practices is context-dependent, so there is no one-size-fits-all best management practice for improving SOC storage capacity. However, success across a range of contexts can be achieved by thoughtfully applying the following general soil health principles:

- Continuous, year-round soil cover using crop residues, mulch, and cover cropping;
- Applying integrated nutrient management to replace nutrients lost through crop harvest;
- Improving soil structure; and
- Reducing SOC losses from erosion, volatilization, or leaching.

Some specific practices that may be applicable include the use of natural mulches, cover crops, and additions of organic amendments (including manure and biochar), as well as no-till and reduced-tillage cropping practices, and conversion of land from annual to perennial crop production.

5. Develop on-farm research programs that provide financial and technical support for farmers to trial innovative practices to advance the current understanding of management effects on soil organic carbon.

Implementation:

A. Support the University of Maine Cooperative Extension in seeking funding to organize and support innovative soil health practices for a variety of agricultural production systems.

Rationale: There is a major need for research on the practical implications of management to enhance SOC sequestration in Maine farm settings. Little is known about the long-term effects of management practices on SOC dynamics or how effects may differ between different farm environments in Maine. Research is needed on the influence of a changing climate on the response of agroecosystems to management and how combinations of practices interact to affect SOC in different ways.

State-funded programs such as Healthy Soils Hawaii and the California Healthy Soils Demonstration Projects have shown great success in using on-farm data collection to inform soil health research efforts. Farmers participating in research can make data-driven management decisions with the information gained, while researchers gain valuable insights to inform outreach and future studies. Providing incentives for participating farmers to demonstrate innovative practices within their communities, as in the California HSDP, also increases the likelihood of practice adoption across a wider scale. Similar program frameworks could be used in Maine to promote research and adoption of SOC-friendly practices.

FORESTS

6. Consider belowground carbon as part of overall forest ecosystem when setting policy that impacts forest harvesting practices.

Implementation:

A. **Utilize DACF's State Soil Scientist and Forest Carbon Specialist to review and update BMP's for forestry and agricultural production to incorporate relevant practices outlined in the Soil C Study technical report (agriculture - see pp. 9-15; forestry – see pp. 21-26) (see Recommendation 4C). Share BMPs with conservation funding program directors and land managers (see Recommendation 1C)**
B. **Encourage prompt revegetation of landings and trails with native species.**
C. **Encourage improved forest management practices that aim to address multiple management objectives, such as maintaining or improving yields while reducing environmental impacts.**

Rationale: Forest soils represent a large carbon stock – often many times the amount of carbon found above ground in forests. Research has shown that forest SOC is impacted by the intensity of disturbance, including harvesting, ranging from significant SOC loss to no significant loss using suitable sustainable forest management practices. Results are also highly variable and a function of soils, forest type, management, and other factors. Aboveground carbon in forests also represents a significant long-term stock of carbon and is directly subject to management. Therefore, developing a program to conserve and enhance forest SOC in Maine should be carried out as an integrated component of a whole-forest approach to carbon sequestration in the forest sector.

7. Increase funding for Maine Forest Service's cost-share program for forest management plans to enable greater participation by small forestland owners. Promote and incentivize the use of lower ground-pressure equipment to be more accessible to all types of logging contractors.

Implementation:

A. **Increase funding for Maine Forest Service's cost-share program for forest management plans, specifically prioritizing assistance to enable greater participation by small forestland owners, including farmers.**
B. **Explore funding options to provide greater availability of reduced-interest loans for equipment that will minimize soil compaction and disturbance of forest soils through the Maine Agriculture, Food & Forest Products Infrastructure Investment Fund and the Direct Link Program (DEP Clean Water State Revolving Fund).**

Rationale: Forestry BMPs which protect water quality in silvicultural operations can protect and stabilize soil, thereby reducing potential loss of SOC. Practices that protect soil from compaction, such as timber mats, using skid trails, and encouraging harvest in winter months or

very dry ground conditions can be useful in reducing SOC losses from harvest or thinning. Identifying and targeting areas that are particularly prone to compaction, such as the soil alongside trails near landings in northern Maine forests, could further reduce losses of SOC. Strategically leaving residue behind after harvest can also reduce SOC losses. The Maine Forest Carbon Task Force has also recommended identifying incentives for high-quality, on-the-ground performance by loggers and promoting the use of low-impact harvesting equipment.

Ontl et al. (2020) developed the Forest Carbon Management Menu which offers landowners a useful framework for decision-making and could serve as the basis for coupling incentive and technical assistance programs.

8. Incentivize reforestation and subsequent protection on lands that have the highest potential for substantial increases in SOC.

Implementation:

A. **Identify specific conservation funds (e.g., NRCS Environmental Quality Incentives Program, Conservation Stewardship Program) as well as other tools that could promote increased reforestation and subsequent protection within riparian zones.**

Rationale: Although SOC stocks remained significantly lower in reforested areas than in natural forests (and thus reforestation is no substitute for conservation of intact forests), cropland conversion to forests often yields significant increases in SOC stocks and initial periods of high rates of SOC sequestration. However, expansion of cropland to increase locally-produced food is also needed to ensure that Maine addresses the carbon footprint of its current food production and procurement practices. Reforestation of riparian zones, highly erodible lands, and steep slopes has the potential for improving stores of SOC and can yield a suite of other ecosystem service co-benefits.

9. Develop and promote extreme weather management guidelines for timber harvesting.

Implementation:

A. **Coordinate with the State Climatologist, Cooperative Extension, and other University of Maine researchers to develop real-time meteorological and climate data that could assist in the planning and implementation of silvicultural practices.**

Rationale: The risk of soil loss is increasing as Maine experiences more heavy precipitation events, warming winters with more frequent freeze/thaw conditions, and increased risk from other disturbances such as wildfire, ice storms, insects, and disease. Management also is more challenging as climate and weather extremes increase. Expanded monitoring and real-time reporting of weather and soil conditions could assist loggers, foresters, and landowners in scheduling forestry operations when soil disturbance can be minimized. This could build on the weather-based decision-support systems already being utilized for agriculture (e.g., Ag-Radar).

WETLANDS

10. Support and incentivize programs that conserve and restore wetlands, and comprehensive planning initiatives that improve wetland connectivity, restoration, and conservation.

Implementation:

A. **Incentivize tidal and subtidal blue carbon habitat (specifically saltmarsh and eelgrass) conservation and restoration through existing grant programs (Lands For Maine's Future, Maine Natural Resource Conservation Program, North American Wetlands Conservation Act (NAWCA)).**
B. **Seek federal funding support for increased technical assistance by supporting the CoastWise Approach led by the Maine Coastal Program and the Smart Team marsh assessment technical experts led by the USFWS Rachel Carson National Wildlife Refuge.**
C. **Incentivize StreamSmart efforts and enhance focus on municipalities and MDOT on streamflow and tidal restrictions.**
D. **Prioritize wetland conservation actions through Beginning with Habitat focus areas through the lens of connectivity and climate adaptation.**
E. **Seek federal funding support to allow the Department of Environmental Protection to upgrade the National Wetland Inventory (NWI) mapping program in Maine.**
F. **Encourage and facilitate "living shorelines" where appropriate.**
G. **Provide technical assistance to municipalities and landowners on best management practices that enhance the use of natural buffers and limit nutrient runoff into wetlands.**

Rationale: Natural or restored wetlands have significant carbon storage potential. Policies, ordinances, or landowner incentives that maintain or increase the protection of wetlands and incorporate anticipated changing conditions due to climate change such as rising sea level, marsh migration, and increased rainfall intensity will help prevent future impacts on wetlands and increase their carbon sequestration and storage capabilities. Conservation plans and practices should include the protection of wetlands, floodplains, and associated upland buffers (in particular, more extensive, physically connected wetland systems) to take a more holistic approach to preserving SOC storage functions.

The restoration of tidal exchange to restricted marshes has been identified as a powerful tool in mitigating GHG emissions and climate change. In Maine, a recent census suggests that about 90% of roads that cross tidal wetlands restrict tidal flow, representing a key opportunity for restoration efforts. Rising sea levels will require the removal of these restrictions to maintain marshes.

The Tidal Restriction Atlas created by the Maine Coastal Program provides further insights into opportunities for tidal wetland rehabilitation and climate resilience for coastal communities in

Maine. Modeling of projected benefits to upstream tidal marshes (including carbon storage versus greenhouse gas emissions) should be included with prioritization and planning for tidal restoration, and barrier removals should follow guidelines outlined by Maine's CoastWise Program.

Promoting the accumulation of blue carbon, the carbon stored in coastal wetlands, is a growing focus of conservation programs. Policies and practices that encourage and incentivize living shorelines (a type of green infrastructure) to prevent shoreline erosion also support a suite of ecological services associated with coastal habitats, including natural sedimentation and vegetation growth needed for carbon burial. State-level permitting specific to living shorelines is needed to better accommodate this practice.

Nutrient inputs degrade the health of wetlands including their carbon storage potential. Recommended actions to avoid exposure of tidal and non-tidal wetlands to excess nutrient inputs that degrade ecosystem function include reductions in fertilizer use, the promotion of green infrastructure (and/or policy changes that incentivize projects to consider green infrastructure first, before other kinds of infrastructure can be considered) and strengthened stormwater management tools and practices that integrate increased rain and storm events and other climate change-related impacts for healthier watersheds.

MONITORING AND RESEARCH

11. Develop a first-in-the-nation SOC monitoring network to evaluate the efficacy of programs and practices and to provide data to inform improvements to soil carbon mitigation efforts.

Implementation:

A. Explore opportunities to support the development of a regional network of soil carbon monitoring through coordination with entities such as the US Climate Alliance and the USDA Northeast Climate Hub.

Rationale: Long-term data on SOC dynamics and management effects in agricultural, forest, and wetland systems represents a major need for future policy and management decision-making. Integrating multiple SOC estimation techniques and data sources in an ongoing monitoring network can provide vital SOC monitoring data and help overcome the current data needs. Using multiple monitoring approaches would enable SOC quantification across a range of spatial scales and levels of replication, which are important factors in determining variation and predictors of SOC stocks. Despite the need and the potential for useful frameworks highlighted in the literature, there are currently no large-scale soil carbon monitoring networks of this kind in the United States; thus, this represents an opportunity to be first in the nation in developing such an approach.

12. Advance understanding of the best methods and practices for enhancing soil carbon sequestration and storage.

Implementation:

A. Identify research opportunities to better understand the best methods and practices to enhance soil carbon sequestration and storage.

Rationale: As noted in the accompanying technical report, there are many needs for future research on soil carbon dynamics and management in agriculture (pp. 17-18), forestry (pp. 25-26), and wetlands (p. 32). DACF staff (particularly the MFS Forest Carbon Specialist and BAFRR Soil Scientist) should collaborate with the University of Maine and other academic institutions to develop a regional network of soil carbon monitoring, as well as other research. Examples might include:

- Build on the model of programs like The Maine Soil Health Network, Climate Adaptation Fellowship, and the Northeast Climate Adaptation Science Center to provide long-term research and training in soil health practices;
- Measure and monitor soil carbon as part of Maine's long-term Ecological Reserve Monitoring. The addition of soil carbon to these protocols would inform understanding of soil carbon dynamics in Maine's forests and wetlands;
- Integrate essential long-term research on soil carbon with related interests in contaminant amelioration such as PFAS chemicals and their interactions to understand risks and opportunities for soil health;
- Develop metrics for determining and measuring soil carbon targets;
- Explore methods for limiting the spread of invasive earthworms in Maine's forests. Invasive earthworms have been found to reduce soil carbon and are now evident in northern Maine (Puhlick 2021);
- Conduct focused research on Maine's wetland (freshwater, tidal, and eelgrass) carbon sequestration rates and above and below-ground carbon stocks based on environmental and human-induced stress variables (e.g., tidal barriers, nutrient influx);
- Investigate the long-term effects of BMP use on forest soil organic carbon.

13. Support research on biochar to verify real-world efficacy in Maine before developing further policy mechanisms to incentivize its use by stakeholders.

Implementation:

A. Coordinate with NRCS on planning for any applications of biochar as a soil health conservation practice.
B. Explore financial assistance for portable biochar facilities that could allow farmers and woodlot owners to produce small amounts of biochar from on-site biomass sources.
C. Provide funding to allow third-party monitoring of biochar applications to determine efficacy in carbon sequestration and overall impacts on soil health.

Rationale: Biochar has a high theoretical potential for SOC sequestration and soil health improvement but is not widely used in Maine. Many variables and unknowns hamper the development of policy initiatives to promote its use. Applied research is needed to improve the efficacy, cost-effectiveness, and wider applicability of biochar and should involve:

- Biochar characterization standardization to avoid contaminants and improve the predictability of biochar effects;
- Incorporating biochar into other profitable inputs, such as fertilizers, that provide additional benefits to plant and soil health; and
- Adopting a circular economy approach to biochar production.