CARBON STORAGE IN WISCONSIN'S LANDSCAPES

IDENTIFYING PRIORITIES AND POTENTIAL

SPRING 2021 REPORT

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A Report of the Climate & Energy Initiative of the Wisconsin Academy of Sciences, Arts & Letters

ABOUT THIS REPORT

This report is published by the Wisconsin Academy of Sciences, Arts & Letters through its Climate & Energy Initiative. Through peer learning events, large conferences and summits, and reports such as this one, the Academy's Climate & Energy Initiative seeks to understand and address Wisconsin's role in global climate change and explore diverse energy choices for a sustainable future. If you have questions or comments about this report or would like to contact report contributors, please write to **environment@wisconsinacademy.org.**

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PREFACE

Climate change, driven primarily by rising levels of atmospheric CO_2, continues to be one of the most serious social, economic, and environmental challenges of our time. This is true globally, nationally, and very much here in Wisconsin. In response to the challenges of climate change, the field of natural climate solutions is rapidly evolving. Natural climate solutions (NCS) are a broad portfolio of land conservation, restoration, and management practices that store carbon in, and/or avoid greenhouse gas emissions from, a diversity of landscape types. Many new players in the field have emerged, including carbon market entrepreneurs, government agencies, and land conservation organizations.

Despite the diversity within the field, the Wisconsin Academy's efforts with numerous stakeholders reveal broad general agreement regarding what characterizes high-quality land carbon sinks; the value of incorporating co-benefits (such as biodiversity, water quality, and flood prevention) in prioritizing sites for protection; and the importance of centering equity in decision-making. For any given forest, wetland, or agricultural field, carbon capture will be site- and soil-specific, but there is a suite of general practices that can optimize the potential for carbon storage. Moreover, land managers will benefit from tailored guidance for specific land types and locations.

Our goal with this project is to provide guidance and decision-making tools for identification of Wisconsin lands needing priority protection, along with recommendations for management practices and corresponding policies. Incremental progress on current management practices will be insufficient to achieve meaningful carbon drawdown and co-conservation goals. We need a transformational shift. As we look ahead, our priority must be to drive rapid implementation of land-based carbon storage strategies for the largest near-term impact in the state.

The work detailed in this report synthesizes the effort of numerous individuals representing a wide range of organizations, which include state agencies, tribal organizations, nonprofits, and academia. A collective synthesis has allowed for a diverse and more comprehensive consideration of NCS, and we are immensely thankful for their considerable hours of time.

Here at the Wisconsin Academy, our ongoing pursuit of innovative, Wisconsin-focused climate and clean energy solutions leads us to the promise and potential of NCS and more specifically climate-critical lands. We are especially grateful to the Sally Mead Hands and McKnight Foundations, as well as all who donate to the Wisconsin Academy, for their support of our important work in this area.

John M. Greenler
Director of Environmental Initiatives
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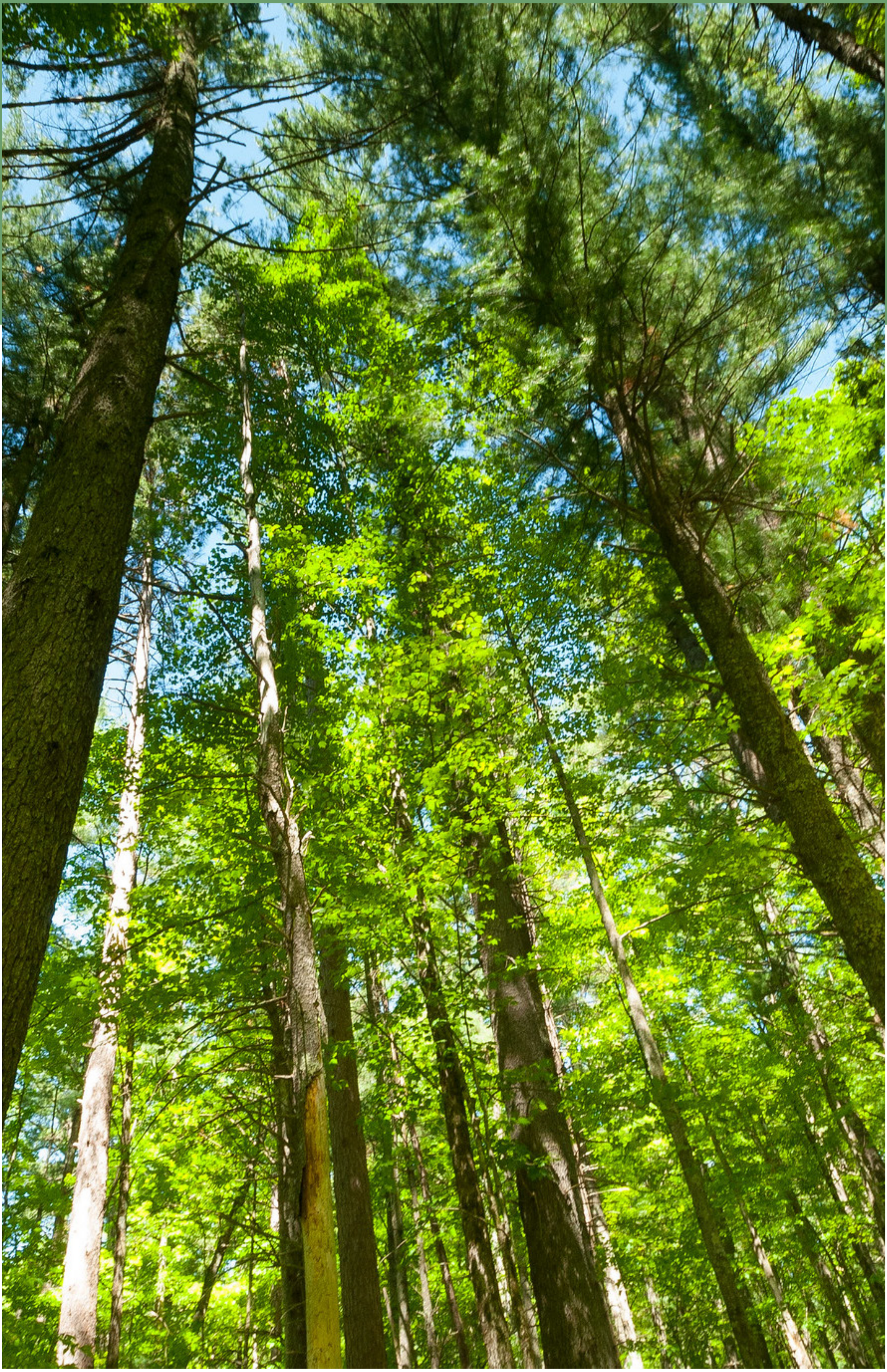
INTRODUCTION

Wisconsin's natural landscapes create an identity and a sense of place for residents and are some of the state's most significant resources. Forests, wetlands, and agricultural lands also play a large role in moving carbon into and out of the atmosphere, and thus in managing carbon emissions that can affect the climate.

A key climate goal is to maximize the amount of storage in carbon pools, which are reservoirs that have the capacity to take in as well as release carbon. Since land use decisions and management practices play a large role in determining carbon storage and movement in an ecosystem, this goal requires coordination of actions by numerous individuals and organizations on diverse lands across the state. The Academy's climate-critical lands (CCL) project aims to help maximize the benefits of these efforts by identifying the places and practices with the strongest potential to yield positive carbon storage outcomes.

This report is the first step in this process. The framework described here details critical questions and approaches that will help guide efforts for maximal impact and explains how to recognize other economic, environmental, health, and community benefits—collectively known as "co-benefits"— that may accompany climate-positive changes. It addresses how to categorize lands in the state with the largest current or future carbon storage capacity and outlines ways to reach the people who can make a difference on these lands: landowners, land managers, tribal representatives, government officials, policy makers, and more. Moreover, the report will help these people begin to identify policies and management practices that can best protect or improve Wisconsin's natural landscapes and working lands, and can simultaneously combat carbon emissions and climate change.



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1 IDENTIFYING CLIMATE-CRITICAL LANDSCAPES IN WISCONSIN

Identifying climate-critical landscapes is the first step toward being able to take action to protect or restore them. We propose a decision-making framework, based on a series of four questions, that can be used to identify priority lands and assess various ways in which they may contribute to the overall carbon budget.

1. Where is carbon currently stored—in significant amounts—in Wisconsin landscapes?

Identification of landscapes that hold significant levels of carbon is important from a climate perspective, for protecting these landscapes can mitigate the release of CO_2 into the atmosphere. Ideally, a "carbon map" built on empirical measurements could pinpoint such areas. Unfortunately, no such comprehensive map exists; developing one should be a priority for future efforts. In the absence of such a map, surveys can be made of existing landscapes, and corresponding extrapolations can be drawn from what we know about how carbon is stored in ecosystems. For example, mature forests and healthy wetlands contain high levels of carbon. Other types of landscapes, such as agricultural land and young forests, may be more variable; thus management practices can have a large effect on the amount of carbon stored. When evaluating the carbon density of a landscape, it is important to include carbon pools that are both above ground (e.g., plant matter) and below ground (e.g., soil).

2. Which landscapes have the potential to store more carbon than they currently do?

Lands with the capacity to store more carbon than they currently do can act as carbon sinks —that is, pools that can largely accumulate carbon versus releasing it. Some of these areas may include landscapes similar to those identified in the paragraph above, such as young forests and perennial cropland, on which less-than-optimal management practices have limited the amount of carbon stored to date. Marginal agricultural lands, such as low-yielding or unproductive sections of fields, typically have low soil carbon levels and could rapidly sequester additional carbon with a shift from annual row cropping to sustainably managed perennial crops, such as pasture or hay fields.

Time scale may play a role in this consideration, as some lands may be able to take up and store carbon rapidly, while others may acquire carbon slowly, over multiple decades, but have excellent long-term storage potential. For example, a forest with medium-aged trees is likely poised to sequester carbon rapidly, while newly planted trees can take decades to reach their peak carbon-absorbing capacity. Both short- and long-term storage can provide important climate benefits, but rapid results are critical for addressing the urgent need to reduce greenhouse gases in the atmosphere.

3. Where are current threats to existing carbon storage?

Land use change, especially the loss or development of landscapes with high current or potential carbon storage, can have a disproportionately large effect on net stored carbon. Moreover, some areas may face greater risk than others of losing their carbon storage potential. For instance, lands near cities or towns may be vulnerable to development due to suburban sprawl/encroachment. Fire-prone plant communities, such as barrens, can release carbon into the atmosphere if allowed to burn. (Note, however, that fire-adapted ecosystems such as prairies and barrens likely need intermittent burning to maintain ecosystem health, which should not be viewed as a climate-negative practice, despite temporary loss/reduction of carbon.) Landscapes that still contain ash trees may risk tree loss due to emerald ash borer. And areas at risk of extreme weather (e.g., coastal wetlands) could face infrequent but large-scale carbon loss after wind storms, torrential rains, or other extreme weather events.

In some cases, it may be possible to pinpoint specific threatened areas. For example, frac-sand mining operations affect landscapes in the west-central part of the state. And lands close to large urban centers, such as Milwaukee or Madison, are at risk of expansion and suburban development. In other cases, however, we may be able to make educated guesses about threatened areas if we have an accurate carbon map.

4. Does this land provide additional environmental co-benefits or ecosystem services?

Carbon storage is just one of many ecological benefits that landscapes can provide. Lands may support biodiversity by providing habitat or wildlife corridors for game, pollinators, and other important species. They may also improve water or air quality and support recreational opportunities such as hunting, fishing, or hiking. Well-managed agricultural landscapes can provide pollinator habitat and improve water quality, and wetlands can provide flood and drought resilience and protect against soil erosion.

In general, practices that increase co-benefits are also likely to have carbon-sequestering potential. Existing maps, such as a Wisconsin DNR map of ecologically significant places in Wisconsin[1] and a Nature Conservancy map of resilient and connected networks[2], can help identify sites where efforts to boost carbon storage may also have other ecologically beneficial effects. Not all services are equal, however. For example, pine barrens are typically carbon-poor but are critical for biodiversity and other ecosystem services. Thus giving priority to carbon storage over other services may have unintended negative consequences. Growing exotic invasive plants species, for example, may quickly sequester large quantities of carbon but can decrease overall biodiversity. For this reason, it is important to consider the balance of multiple co-benefits when evaluating the relative importance of carbon storage in a given landscape.

Scott Sauer

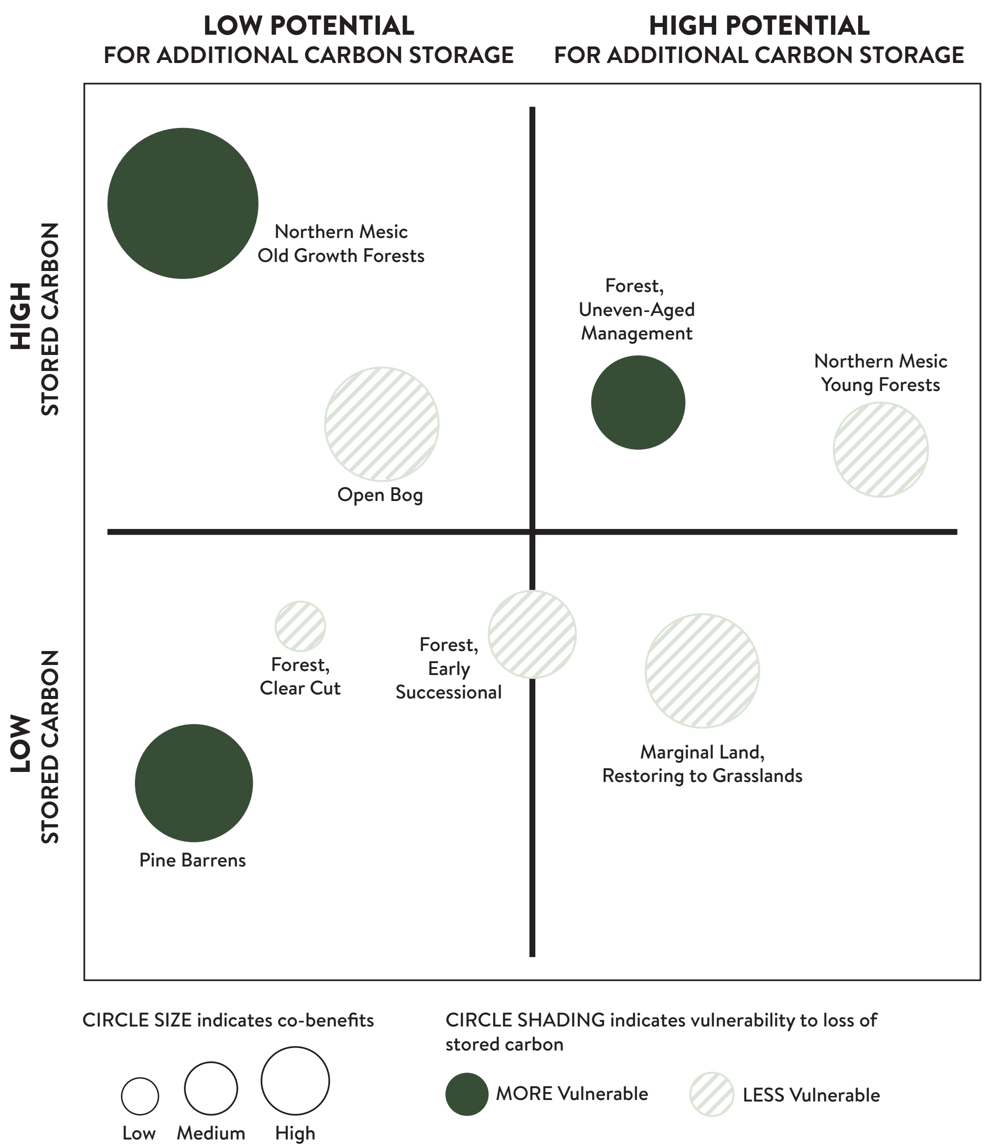
1 http://p.widencdn.net/rbiscs/Map_S7_ImpPlaces
2 http://maps.tnc.org/resilientland/

FOUR-SQUARE MODEL FOR EVALUATION

A four-square model may offer a useful decision-making tool to evaluate the relative climate impact and carbon importance of a land area. In this model (see page 11), which identifies four different variables, the different quadrants indicate the potential for additional carbon storage and existing stored carbon in a landscape. Shading within the data circles represents landscapes that are vulnerable to the release of stored carbon. Finally, the size of the data circle represents the magnitude of co-benefits. General land use/cover types—and specific locations for which sufficient information is available—can be roughly plotted within this framework to identify relative impacts and prioritize targeted management efforts.

In such a model, landscapes that hold a larger amount of carbon and have higher net absorption potential (e.g., northern mesic young forest) fall in the upper-right quadrant. Landscapes that currently store less carbon but have the ability to absorb more (e.g., marginal land, restoring to grasslands) fall in the lower-right quadrant. Landscapes that fall in the upper-left quadrant represent areas that currently store high amounts of carbon but have a low potential to store additional carbon (e.g., open bog). Finally, the lower-left quadrant indicates landscapes that currently store less carbon and do not have much potential to store additional carbon. Landscapes in the lower-left quadrant may hold less carbon but have high co-benefit opportunities (e.g., pine barrens). This evaluation can help identify the highest priority areas for protection or restoration actions to increase carbon storage or co-benefits.

Four-square model for identifying climate-critical landscapes



NOTE: This figure is for concept purposes only. The locations and sizes of the data circles are approximate.

Jim Klousia for *Edible Madison*

2 HOW CAN WE KEEP CARBON IN NATURAL SYSTEMS?

Once priority lands have been identified, the next step is to pinpoint specific policies and management practices that can enhance land-based carbon storage and increase co-benefits in a variety of contexts. In order to do this, we have compiled a list of useful practices that will optimize carbon storage in forests, agricultural lands, and wetlands while balancing co-benefits and co-harms.

PRIORITY PRACTICES

After considering potential impacts, co-benefits, and risks/challenges, we identified priority management practices with high potential to enhance carbon uptake and/or storage in each of the three main types of lands. The outcomes and benefits of specific practices can be context-dependent, so efforts may need to be adapted to fit individual areas.

Forests

- **Avoiding forest loss. (Impact: HIGH)** Avoiding loss of forest cover to other land uses, such as development or agriculture, provides one of the greatest carbon benefits of all practices due to the large sequestration rates and stores of forest cover.

- **Protecting existing forests and/or establishing reserves. (Impact: HIGH)** Reducing harvest in healthy forests can enable uptake of a large amount of carbon, with the highest overall impacts (including co-benefits) in sites with high species diversity, abundant large-diameter trees, or organic soils (i.e., carbon-rich sites), as well as sites adjacent to other protected areas or landscapes with low fragmentation.

- **Delaying harvest and/or extending rotations. (Impact: HIGH)** Extending rotations of even-aged stands and delaying harvest entry in uneven-aged stands are well-established carbon management practices that can maintain higher amounts of carbon stored in forests.

Agriculture

- **Expanding perennial polycultures. (Impact: HIGH)** Retaining existing perennials and converting current annual monocultures to diverse perennial crops (e.g., pasture and orchard) will increase soil organic carbon and provide additional benefits, such as reduced flood risk and improved infiltration. Perennials can be added to whole or parts of fields or made part of a crop rotation.

- **Implementing agroforestry practices. (Impact: MEDIUM to HIGH)** Adding windbreaks, riparian buffers, prairie strips, or silvopasture to farms or incorporating alley-cropping (interspersing rows of trees or shrubs with forage or agronomic crops) and woodland management practices will increase economic resilience and may offer other environmental benefits as well. However, some of these practices may require new machinery, technology, or infrastructure.

Lyssa Seefeldt/University of Wisconsin Extension

- **Planting cover crops. (Impact: LOW to MEDIUM)** Planting continuous living cover on fields will maintain or boost soil organic carbon and can reduce damages, such as erosion and nutrient loss. Depending on the species selected, cover crops can provide emergency forage as well. Cover cropping can be applied on a large scale with relatively little additional infrastructure.

Wetlands

- **Preserving, protecting, and restoring wetlands.** Caring for wetlands, which naturally hold high levels of carbon-rich organic matter, is crucial, for if allowed to dry, these landscapes will decompose and release that carbon into the atmosphere. Protecting existing, undisturbed wetlands should be given priority. But restoring wetlands that are partially or fully drained but still undeveloped will also help stop carbon emissions and begin to rebuild carbon storage.

- **Incentivizing and supporting conservation on privately owned lands.** Encouraging owners to conserve their wetlands is crucial, an estimated 75% of undisturbed wetlands in the state are privately owned, and the number is likely higher for restorable lands. Wetland practices provide a multitude of co-benefits and are eligible for many existing governmental management programs.

- **Improving management practices on publicly owned wetlands.** Optimizing management practices on public wetlands not only increases carbon storage and enhances co-benefits, it also provides an opportunity to conduct research and to educate by demonstrating best practices for protection of carbon storage and reduction of emissions.

Note: More research is needed to categorize impact levels for individual management practices in wetlands.

ROLE OF EXISTING PROGRAMS

Many of these recommended practices are reflected to some degree in existing state and federal land conservation programs and policies, such as the Wisconsin's Managed Forest Law, the USDA Conservation Reserve Program, the Conservation Stewardship Program, and the Environmental Quality Incentives Program. These and similar programs share several goals, generally promoting land stewardship practices that conserve natural resources on working lands and supporting community benefits, such as cleaner air and water, healthy soils, flood and drought resilience, wildlife habitat, recreational spaces, and sustainably grown food.

However, the administration of many of these programs and the policies associated with them can be inflexible and challenging. They do not encourage or accommodate innovative practices and may not credit a practice that is not specifically included in a land manager's plan, even if it achieves similar or greater benefits. To the best of our knowledge, no existing programs currently include carbon storage as a management goal.

Additionally, the complex paperwork and bureaucratic steps required for these incentive programs can be difficult to navigate and may cause accessibility inequities. Moreover, the lack of administrative and financial support for staff to provide oversight to implement these programs is a major barrier to realizing the intended outcomes.

Thus we see an opportunity here to reform and reimagine existing state and federal policies to build greater flexibilities into existing frameworks while better addressing stakeholder concerns and promoting the valuation of carbon storage in Wisconsin's landscapes. For example, incorporating carbon storage as an acceptable management goal in the Managed Forest Law could give landowners the option not to harvest.

Integration of carbon storage into existing programs could help landowners and managers better understand the benefits of keeping carbon in natural landscapes. Because it can be hard to conceptualize carbon movements in environments and their relation to long-term climate impacts, a focus on tangible ecological and economic co-benefits may be more readily understood by individuals who are weighing potential benefits and harms to make land management decisions.

One important consideration is that the federal policy landscape is wide-ranging and quickly evolving. Existing programs may change under the new presidential administration, and uncertainty about which changes may be permanent and which may be reversible can complicate long-term planning.

Wisconsin Department of Natural Resources

Wisconsin Department of Natural Resources

3 COMMUNICATING WITH STAKEHOLDERS

Stakeholders who can enact policies or implement management practices that will help build carbon storge across the state need to know which areas are climate-critical landscapes and what co-benefits exist in them. Thus this information must be communicated clearly and proactively. It will be essential to encourage and provide incentives for landowners and managers to adopt long-term behaviors that will keep carbon in natural sinks in Wisconsin landscapes. A parallel goal is to build public support for federal, state, and local policy changes that will drive rapid and lasting protection, management, and restoration of natural carbon sinks in forests, conservation areas, and agricultural lands in Wisconsin and beyond.

We believe the core people to reach for this effort are those who inform and make decisions about land management in Wisconsin—that is, land managers in multiple sectors, researchers and educators (including agricultural extension agents), elected officials, and representatives from state, federal, and tribal agencies.

Messages that focus on carbon storage and its importance for mitigating climate change may not be meaningful for some in these target groups. Thus it will be important to identify and communicate related information instead—messages that are clear and accessible and will resonate with the intended audiences and the values that they already hold. People have many different reasons for caring about the land. Some may feel a deep connection to working and maintaining land that has been in a family for generations. Others may be motivated by a sense of environmental responsibility to protect or restore ecosystems and thereby have a positive impact on the climate and planet. Still others may be seeking economic resilience by maintaining healthy forests, soils, and waters so they will continue to produce timber, crops, fish, and other resources.

Fortunately, many practices that encourage carbon storage will also keep landscapes healthy and resilient, both environmentally and economically. Such co-benefits are often far more tangible than climate benefits alone, so emphasizing them may be helpful when discussing how land-based climate solutions can also serve families, communities, and industries.

CONCLUSION

Climate change and its impacts increasingly threaten Wisconsin's people and places. Efforts to mitigate these harms must include storing more carbon in the state's forests, agricultural lands, and wetlands. With sustainable management practices, each of these landscapes has the potential to build carbon pools while enhancing environmental benefits, such as healthy soils, water, and air. However, the specific practices and management policies used will dictate how much carbon can be stored in a given ecosystem.

Wisconsin's people care about the land and its management for many different reasons; therefore, this report has attempted to lay the foundation for critical thought about where and how to store carbon most effectively and how best to engage land owners and managers with diverse relationships to the land and persuade them of the co-benefits that are possible in various working and conserved landscapes.

Land owners and managers need to know where carbon is currently stored and which landscapes have the greatest potential for additional rapid uptake. Further, identifying at-risk areas and current co-benefits will help determine which landscapes to prioritize. Certain landscapes are poised to sequester carbon rapidly, while others may need more time or offer primary benefits other than storing carbon. Thus it is crucial to highlight that proposed management strategies will vary across landscapes. These differences are the result of spatial, temporal, geographical, and social variations across the state.

Existing incentive programs are a useful starting point for land owners and managers, but rigid rules can create barriers for people who want to try new management practices or who are working on a small scale and therefore have less capacity to manage bureaucratic red tape. Future programs should adopt flexible management strategies to include carbon storage.

Through innovative management strategies and flexible incentive programs and policies, Wisconsin landscapes can play a significant role in adapting to, or even mitigating, a changing climate. New opportunities for increasing the resiliency of our communities can arise by incorporating these practices. This report serves as a catalyst for a thorough analysis of management practices in Wisconsin's forests, agricultural lands, and wetlands, and offers a policy foundation for building a more sustainable and just climate future.

GLOSSARY

alley-cropping
A farming practice that combines rows of trees or shrubs with rows of annual crops.

biodiversity
The variation of different living species in a specific place and time.

carbon budget
The accounting of carbon in a system such as a biological community.

carbon emission
The release of carbon into the atmosphere from burning a fossil fuel, biomass, or similar.

carbon pools
A reservoir of carbon, which usually has both inputs and outputs into a larger carbon cycle.

carbon sinks
A pool of carbon that predominantly is taking in carbon with little corresponding release.

carbon storage capacity
The ability of a reservoir/pool to store carbon.

cover cropping
An agricultural management practice to control and mitigate soil erosion and soil nutrient loss by planting crops in the offseason and/or in-between rows of crops to cover bare soil.

co-benefits
Other economic, environmental, health, and community benefits that tie into carbon storage.

fragmentation
The breaking up of a continuous landscape or forest.

marginal agricultural lands
Low-yielding or unproductive portions of a farm landscape.

monoculture
A field with one specific crop (e.g., corn).

perennial crop
A crop that lives multiple years and correspondingly does not need to be replanted annually.

prairie strip
A strip of native perennial plants (usually the grasses and wildflowers that covered prairies prior to cultivation) placed between rows of crops on a farm.

riparian buffers
A dense perennial vegetation strip along a stream or river bank that prevents erosion and mitigates nutrient runoff.

sequestering (carbon)
The absorption of carbon.

silvopasture
A combination of trees, and/or shrubs, and pasture that is deliberately integrated and works together to provide ecosystem services and food for livestock.

windbreak
A strip of dense and often tall vegetation, usually composed of trees and/or shrubs, that can withstand heavy winds and thereby prevent soil erosion.

About the Wisconsin Academy of Sciences, Arts & Letters

The Wisconsin Academy is a place for people to connect with experts and learn from each other. Founded in 1870 to gather, share, and act upon knowledge for the betterment of Wisconsin, the Wisconsin Academy today showcases contemporary Wisconsin art at our James Watrous Gallery, examines science and culture in *Wisconsin People & Ideas* magazine, and explores pathways to a sustainable future through the Wisconsin Strategy Initiatives. Our Academy Courses and public talks provide opportunities for lifelong learning and personal enrichment, and we recognize excellence through our annual Fiction & Poetry Awards for emerging writers and Fellows Awards for leadership in and across disciplines. We also support the Wisconsin Poet Laureate and other endeavors that help us to fulfill our mission: to create a better world by connecting Wisconsin people and ideas.
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