Executive Summary of Carbon Revenue/ Sequestration Potential in OBR

Outline

1. Land Cover
2. Carbon Statistics
    1. Current Carbon Stock
    2. Projected Stock
    3. Economic Potential
3. Carbon Credits and Carbon Markets
    1. Carbon Credit Types
    2. Voluntary vs. Compliance Markets
    3. Carbon Market Case studies
        1. Michigan Markets
        2. Successful Markets
        3. Failed Markets
4. Controversy
5. Ecosystem Management
    1. Management practices
    2. Sequestration to credits
6. Conclusion

Statement of Intent

This report is intended to provide concerned parties with a look at carbon sequestration and economic potential in the region. It is meant to start conversations about the idea of an OBR Carbon Market. All Carbon estimates and maps have been taken from The Nature Conservancy's Resilient Land Mapping Tool.

1. Land Cover

1. Area in Acres

Total Area: 5,921,277.6 acres (5,652,779.2 land, 268,498.4 open water) in the Great Lakes and Tallgrass Prairie study area(s) in the Great Lakes ecoregion(s).

The biosphere region includes **2,231,695** acres of existing conservation land.

2. Land Cover 2019

32.2% **woody wetlands** 1,825,316 ac

25.2% **deciduous forest** 1,428,592 ac

8.8% **evergreen forest** 497,889 ac

7.8% **mixed forest** 441,099 ac

6.7% **herbaceous** 337,826 ac

5.7% **cultivated crops** 325,730 ac

3.3% **hay/pasture** 188,050 ac

3.6% **developed, open space** 203,077ac

2.1% **developed low intensity** 120.570 ac

1.9% **shrub/scrub** 105,327 ac

1.7% **emergent herbaceous wetlands** 98,598 ac

0,.8% **barren land** 43,546 ac

0.8% **developed medium intensity** 46,977 ac

Based on these land cover estimates, 74% of Obtawaing Biosphere Region is forested land.

2. Carbon Statistics

TNC Resilient Land Mapping Tool Carbon Estimates 2010

Forest Carbon: Estimates of 2010 forest carbon stock and components (aboveground, coarse woody debris, and soil/other) are from Williams et al. (2021b) following methods described for the Southeast US in Gu et al. (2019). To estimate carbon stock, attributes were determined for all forested 30-m pixels in the continental United States. A forest carbon cycle model trained to match. Forest Inventory and Analysis (FIA) data was used to predict carbon stocks for 2010 based on site-level attributes of forest type

group, years since disturbance, and site productivity class. Results were iterated backward in time to provide continuous, annual reporting of forest carbon dynamics for each pixel. Most prior studies lacked spatial detail on the age of forest stands that persisted in a forested condition during the satellite data era, but this study used remotely sensed biomass to estimate the stand age condition of these persisting, intact forests, distinguishing relatively young stands (e.g., 30 to 50 years old) from older stands.

Williams, C. A., N. Hasler, H. Gu, and Y. Zhou. 2021b. Forest Carbon Stocks and Fluxes from the NFCMS, Conterminous USA, 1990-2010. ORNL Distributed Active Archive Center

Gu, H., Williams, C. A., Hasler, N., & Zhou, Y. (2019). The carbon balance of the southeastern U.S. forest sector as driven by recent disturbance trends. Journal of Geophysical Research: Biogeosciences, 124, 2786– 2803. https://doi.org/10.1029/2018JG004841

The estimates of 2050 forest carbon stock and sequestration project forest growth into the future absent major disturbances and do not account for potentially improved management practices nor increases in the frequency and severity of climatic disturbances.

1. Current Forest Carbon

Belowground	Coarse Woody Debris	Aboveground	**Total Forest Ecosystem Carbon**	**Average Forest Ecosystem Carbon**
110,048,526 mt	213,783,682 mt	70,264,663 mt	**213,783,682 mt**	**51.6 mt/acre**

The Obtawaing Biosphere Region has 213,783,682 metric tonnes of forest carbon in forested areas plus 19,193,564 metric tonnes of soil carbon in non-forested areas. Total Stock 2010 = 232,977,246.

Total forest ecosystem carbon in the biosphere region amounts to **213,783,682 mt,** and the average forest ecosystem carbon amounts to **51.6 mt / ac.** These numbers don't tell the whole story, as you can see in the map above, not all forests are equal in terms of carbon sequestration, there are hotspots and entire regions of overall higher or lower carbon.

From looking at the map above, we can see that the carbon stock in the **lower peninsula region** of the Obtawaing Biosphere ha**s more than 50% of its area** containing over **60 metric tonnes of carbon per acre**. There are especially concentrated carbon stock on the western coast of the LP. Some hot spots, defined as areas containing more than 80 mt/ acre, are **Lake Leelanau**, with areas reaching **108 mt/ acre**, the **Sleeping Bear Dunes** at **97mt/ ac**, and **Crystal Lake** at **101 mt/ acre.**

In contrast, the upper peninsula region of Obtawaing has **more than 50% of its area** containing **less than 50 mt/ac** of carbon with much fewer hot spot areas. Two are **Perland township** with **86 mt/acre** and **Little Brevort Lake** with **80 mt/acre.** There don't seem to be any spots in the upper peninsula distribution of Obtawaing containing more than 90 mt/ acre.

2. Future Carbon

The Forest Carbon 2050 (Williams et al. (2021b)) applies only to forested pixels only and uses the same model as the Total Forest Carbon 2010 but runs the model to 2050, assuming no disturbance (conversion, harvest, fire). Actual sequestration may be lower if the forest is disturbed. Annual sequestration rate is estimated as: (Carbon 2050 – Carbon 2010)/40 years.

Projected Total Carbon	**Projected ABG Carbon**	**Projected Avg. C/Acre**
247,107,605 mt	89,061,014mt	59.7 mt/ac

The projected carbon stock for OBR in 2050 amounts to a total of 247,107,605 mt of carbon, **33,323,923** more mt Carbon than the 2010 **total**, an **aboveground carbon** stock of 89,061,014mt, which is an additional **18,796,351**mt than the 2010 stock, and an average of 59.7 mt/ac, **8.6 mt** of carbon per acre more than the 2010 **average**.

3. Economic Potential

Most of the Carbon Credits purchased in voluntary markets fall between 40 and 80$, below are some pricing scenarios that illustrate the economic potential of the region using the carbon stock from 2010.

At 40$ per metric tonne

The entire region has the potential to generate

$8,550,000,000

Using just aboveground carbon,

$2,810,000,000

At 60$ per metric tonne

The entire region has the potential to generate

$12,827,020,920

Using just aboveground carbon,

$ 4,215,879,780

At 80$ per metric tonne

The entire region has the potential to generate

$17,102,694,560

Using just aboveground carbon,

$ 5,621,173,040

A look at Future Carbon Revenue

Additional Total mt	**additional ABG mt**	**Pricing**	**$$ Total**	**$ additional ABG**
33,323,923	18,796,351	40	$1,332,956,920	$751,854,040
33,323,923	18,796,351	60	$1,999,435,380	$1,127,781,060
33,323,923	18,796,351	80	$2,665,913,840	$1,503,708,080

3. Carbon Credits and the State of the Markets

Carbon credits play a crucial role in mitigating climate change and promoting sustainable practices. Some of their benefits include:

1. **Financial Incentives**: Carbon credits provide a **financial incentive** for businesses and individuals to invest in clean technologies such as solar power and fuel-efficient vehicles1. By reducing greenhouse gas emissions, companies can earn credits that have real-world value.
2. **Creating a Carbon Market**: Carbon credits establish a **carbon market**, allowing companies to **buy and sell credits**. This market incentivizes emission reduction efforts and encourages businesses to adopt environmentally friendly practices1.
3. **Biodiversity and Renewable Energy**: Many carbon crediting projects also benefit **biodiversity** and promote the use of **renewable energy sources**. These projects contribute to a healthier planet by protecting ecosystems and supporting sustainable development2.
4. **Cost Savings**: For businesses, carbon credits offer **significant cost savings**. Companies can use credits to offset emissions while simultaneously taking cost-effective actions to reduce future emissions through innovative business models3.

It's essential to ensure transparency, rigorous auditing, and continuous improvement in all carbon credit projects to maximize their benefits2

1. Carbon Credit Types

Carbon credit projects come in various forms, each contributing to **climate change mitigation** and often offering additional environmental or social benefits. Some examples:

1. **Forestry Projects**:
    - These projects focus on **forest conservation**, **improved forest management**, and **afforestation, reforestation, and revegetation (ARR)**.
    - Forest conservation efforts protect existing forests from logging or deforestation.
    - Improved forest management involves sustainable practices to maintain healthy forests.
    - ARR projects restore degraded forest land, reforest previously forested areas, or convert non-forest land into forests through human intervention1.
2. **Agricultural Projects**:
    - These projects promote **regenerative agriculture** practices that sequester soil carbon. Examples include low-till or no-till farming, cover crop rotation, and biochar usage.
    - Activities to reduce emissions of methane and nitrous oxide, such as better livestock and fertilizer management, also fall under this category1.
3. **Renewable Energy Initiatives**:

- Projects like **wind farms**, **solar power installations**, and **biomass energy** contribute to reducing fossil fuel emissions.
- By generating clean energy, these projects offset carbon emissions from conventional power plants2.

4. **Energy Efficiency Projects**:
    - These focus on improving energy efficiency in various sectors.
    - Examples include distributing more efficient cooking stoves, LED lighting, and building insulation.
    - By reducing energy consumption, these projects indirectly decrease greenhouse gas emissions2.
5. **Negative Emission Technologies**:
    - These innovative projects aim to **capture and store carbon** directly from the atmosphere.
    - Technologies like **biochar**, **carbonated building elements**, and **geologically stored carbon** play a crucial role in achieving negative emissions2.
6. **Community Reforestation**:
    - Nature-based solutions involve **restoration** and growing forests.
    - These projects not only capture carbon but also protect ecosystems, wildlife, and social heritage1.

2. Voluntary vs. Compliance Markets

The difference between **voluntary** and **compliance markets** for **carbon credits**:

1. **Carbon Credits vs. Carbon Offsets**:

- **Carbon Credits**: These function as **permission slips for emissions** within the regulatory market. They are issued by national or international governmental organizations. Companies receive a certain number of credits (usually from the government) that allow them to generate one ton of CO_2 emissions. The revenue flow is **vertical**, from companies to regulators.
- **Carbon Offsets**: These flow **horizontally** between companies. When a company avoids or removes a unit of carbon (1 CO_2e ton) from the atmosphere through its business activities, it can generate a carbon offset. Other companies can then purchase these offsets to reduce their own carbon footprint. Carbon offsets are issued by companies with lower carbon intensity activities1.

2. **Voluntary vs. Compliance Markets**:
    - **Compliance Markets**:
        - These markets are **regulated** by mandatory national, regional, or international carbon reduction regimes.
        - Companies and governments are **legally obligated** to account for their greenhouse gas (GHG) emissions.
        - Carbon credits or offsets are issued per company and per year.
        - Compliance markets turn CO_2 emissions into a **commodity** with a price12.
    - **Voluntary Markets**:
        - These markets operate **outside** of compliance markets.

- Companies and individuals can **voluntarily** purchase carbon offsets.
- The intention is not for compliance but rather to support environmental initiatives.
- Voluntary carbon markets enable businesses and individuals to take **proactive steps** toward sustainability by offsetting their emissions13.

In summary, compliance markets are mandatory and regulated, while voluntary markets allow participants to make environmentally conscious choices beyond legal requirements. Both contribute to addressing climate change by valuing carbon reduction efforts4.

In the **voluntary carbon markets** within the US, the prices for carbon credits can vary based on several factors.

1. **Voluntary Carbon Markets Overview**:
    - Voluntary carbon markets allow **carbon emitters** to purchase credits awarded to projects that **remove or reduce atmospheric carbon**.
    - These credits offset emissions as part of a **voluntary commitment** to reduce "net" emissions.
    - Each credit typically corresponds to **one metric ton** of reduced, avoided, or removed carbon dioxide or equivalent greenhouse gas1.
2. **Market Growth and Importance**:

- The importance of voluntary carbon markets is **growing** significantly.
- According to the Taskforce on Scaling Voluntary Carbon Markets, these markets need to **expand by over 15-fold by 2030** to support the investment required for achieving the Paris Agreement's goal of limiting global average temperature increase to below 1.5°C above pre-industrial levels1.

3. **Recent Trends**:
    - Data from 2021 shows that voluntary carbon markets had already posted **$748.2 million USD in sales** for **239.3 million credits** (each representing one ton of carbon dioxide equivalent).
    - This reflects a **58% year-to-date jump in value** compared to the previous year, with growth in credit volume of **27%**2.
4. **Regulatory Interest**:
    - U.S. regulatory bodies, including the **Commodity Futures Trading Commission (CFTC)** and the **Securities and Exchange Commission (SEC)**, are increasingly interested in carbon markets.
    - The CFTC has established a **Climate Risk Unit** to address derivatives' role in understanding and addressing climate-related risk1.
5. **Context Matters**:
    - Prices can vary based on the specific project, location, and quality of the offset.

- High-quality projects with robust verification may command higher prices.

In summary, voluntary carbon credit prices in the U.S. depend on market dynamics, regulatory developments, and the specific context of each credit13.

3 . Carbon Market Case Studies

i. Michigan Markets

Michigan has taken significant steps toward **carbon neutrality** and participation in carbon markets. Some examples include:

1. **Family Forest Carbon Program**:
    - The **American Forest Foundation** and **The Nature Conservancy** offer a **shared Family Forest Carbon Program** in select counties in Michigan.
    - Landowners with as few as **30 eligible acres** can enroll small tracts of forestland in this program, contributing to carbon sequestration2.
2. **Carbon Offset Deals**:
    - Michigan's **Department of Natural Resources** has limited logging in the **Lower Peninsula forest** known as the "Big Wild" over the next four decades to create **carbon offsets**.
    - These offsets serve as a climate-change currency that companies use to compensate for emissions3.
3. **Issuance of Carbon Credits**:

- Michigan has issued its **first carbon credits** from the **Michigamme Highlands carbon project**. This project spans over **13,655 acres** and involves forest conservation efforts4.

ii. Successful Carbon Markets

Carbon markets play a crucial role in addressing climate change and promoting sustainable practices. Some examples of successful carbon markets:

1. **Agerpoint**
    - Agerpoint aims to provide credibility and transparency to the Natural Climate Solutions (NCS) voluntary carbon marketplace1. Their innovative approach helps channel investments into nature-based solutions.
2. **Indigo Carbon**
    - Indigo Carbon is an example of a company that facilitates carbon farming. They work with farmers to sequester carbon in soil through regenerative agricultural practices2.
3. **Nori**
    - Nori is a platform that allows individuals and companies to directly purchase carbon removal credits from farmers who adopt carbon-friendly practices. It incentivizes carbon sequestration through reforestation, soil health, and other methods2.
4. **Truterra's TruCarbon program**

- Truterra focuses on soil health and carbon sequestration. Their program encourages farmers to adopt sustainable practices and rewards them for sequestering carbon in their soils2.

5. **Soil and Water Outcomes Fund**
    - This fund supports projects that enhance soil health and water quality. By investing in practices like cover cropping and reduced tillage, they contribute to carbon sequestration and environmental benefits2.
6. **Ecosystem Services Market Consortium (ESMC)**
    - ESMC is a collaborative effort involving farmers, ranchers, and other stakeholders. It aims to create a marketplace for ecosystem services, including carbon sequestration, water quality, and biodiversity conservation2.

iii. Failed Markets

Here are examples of failed carbon markets:

1. **EU Emissions Trading System** (EU-ETS)
    - The EU-ETS, one of the most prominent carbon markets, has encountered serious issues. It is currently oversupplied with carbon allowances due to factors like the recession and industry lobbying. As a result, power stations and factories have more allowances than needed, and the price of carbon is so low that it does not encourage investments in low-carbon technologies1.
2. **Clean Development Mechanism** (CDM)

- The UN's CDM, designed to offset emissions through projects in developing countries, has also faced challenges. A flood of cheap CDM carbon credits has contributed to the low carbon price, rendering it ineffective in driving meaningful change. Financial institutions have scaled back their involvement in carbon trading, and some companies prioritize profits from fossil fuels over mitigation efforts1.

3. **Lack of Additionality**
    - Both voluntary and offset markets have struggled to demonstrate "additionality," meaning a net reduction in carbon emissions. While these markets fund conservation forests and other initiatives, the overall impact remains uncertain2.
4. **Social Cost vs. Permit Prices**
    - Carbon markets often undervalue the actual social cost of emissions. The cost of permits does not align with the true environmental impact, which can hinder long-term incentives for innovation3.

Renewed Hope Despite Failures: Surprisingly, new carbon markets are being introduced in places like California, Australia, Japan, and Canada. The World Bank has also promoted carbon markets in developing countries. However, skepticism remains about their effectiveness in addressing climate change1.

4. Controversy

The world of **carbon credits** is not without its controversies. Let's explore some of the key points:

1. **Hyper-Financialization and Skepticism**:
    - Carbon credits have become increasingly popular, with companies and individuals buying them to offset their emissions.
    - However, concerns have arisen that offsetting might be little more than a **"sugar hit for the conscience."**
    - Critics argue that it's a **fraud** and amounts to a **"license to pollute"** without significant impact on the planet's health1.
2. **Lack of Standardization and Verification**:
    - Until recently, there was no standardized way to trade carbon credits, and verifying the offsetting activity behind them was challenging.
    - Environmental groups have criticized the process, which they say has been **"fraught with scandals."**
    - Some countries allegedly increased emissions intentionally to get paid for cutting them2.
3. **Overestimated Claims and Non-Existence**:
    - Scientific research has repeatedly shown that claims of reduced emissions under carbon credit schemes are often **overestimated** or **non-existent**.
    - The concept behind carbon credits has taken a hit due to these findings3.
4. **Controversial Projects and "Carbon Cowboys"**:

- Certain projects have generated substantial revenue from selling carbon credits equivalent to a country's emissions.
- Critics refer to these entities as **"carbon cowboys."**
- One such project in Zimbabwe reportedly generated over €100 million from selling carbon credits4.

In summary, while carbon credits can contribute to climate action, it's essential to address these controversies, ensure transparency, and rigorously verify the impact of offsetting efforts15.

5. Land Management

Here are some management practices that enhance carbon storage in different ecosystems:

1. **Forest Management**:
    - **Afforestation and Reforestation**: Planting trees on deforested or degraded land helps sequester carbon.
    - **Sustainable Logging**: Implementing selective logging practices to maintain forest health and preserve carbon stocks.
    - **Avoiding Clear-Cutting**: Reducing large-scale clear-cutting helps retain existing carbon in forests.
    - **Climate-Adaptive Planning**: Integrating climate change information into forest management plans to identify actions that benefit both carbon storage and adaptation1.
2. **Soil Carbon Sequestration**:

- **Cover Cropping**: Planting cover crops during fallow periods enhances soil organic carbon.
- **No-Tillage Agriculture**: Reducing soil disturbance minimizes carbon loss.
- **Crop Rotation**: Diverse crop rotations improve soil health and carbon sequestration.
- **Organic Matter Incorporation**: Adding organic materials (such as compost) to soil increases carbon content2.

3. **Agricultural Practices**:
    - **Reducing Soil Disturbance**: Minimizing tillage, stubble burning, and heavy grazing decreases carbon loss.
    - **Increasing Carbon Inputs**: Retaining crop residues (stubble), using C-rich amendments, and practicing integrated nutrient management.
    - **Agroforestry**: Combining crops with trees on the same land enhances carbon storage.
    - **Increasing Crop Diversity**: Different crops contribute to varied carbon inputs3.
4. **Wetland Restoration**:
    - **Peatland Restoration**: Protecting and restoring peatlands prevents carbon release.
    - **Wetland Creation**: Constructing wetlands helps sequester carbon through vegetation and soil processes.
5. **Grassland Management**:

- **Rotational Grazing**: Proper grazing management maintains grassland health and carbon stocks.
- **Native Grass Planting**: Replacing non-native species with native grasses enhances carbon storage.

6. **Urban Green Spaces**:
    - **Urban Forests**: Planting trees in cities contributes to carbon sequestration.
    - **Green Roofs and Walls**: Vegetated surfaces in urban areas store carbon.

1. Forest Management

Forest management plays a critical role in **carbon sequestration** and climate adaptation. Here are some key aspects of forest management for enhancing carbon storage:

1. **Forest Carbon Management Menu**:
    - Developed to translate broad carbon management concepts into actionable tactics.
    - Helps managers reduce risk from expected climate impacts while meeting management goals.
    - Integrates climate change information to identify actions benefiting both forest carbon and other project objectives1.
2. **Actions for Carbon Storage**:

- **Tree Density and Age Structure**: Adjusting the number of trees per acre and promoting diverse age classes can encourage more carbon sequestration.
- **Sustainable Forestry Practices**: Implementing protocols that sustainably manage forests to increase total carbon gains over time2.

3. **Silvicultural Practices**:
    - **Old-Growth Forest Conservation**: Preserving old-growth forests results in greater soil carbon storage compared to extensive or intensive management3.
    - **Selective Logging**: Carefully harvesting specific trees while maintaining overall forest health.
    - **Afforestation and Reforestation**: Planting trees on deforested or degraded land to sequester carbon.
4. **Extended Timescales and Climate Risks**:
    - Consider long-term implications of management actions.
    - Account for climate vulnerability and adaptability.
    - Identify synergies between adaptation and mitigation goals1.
5. **Policy Implications**:
    - Policymakers can use the Forest Carbon Management Menu to identify carbon-friendly practices.
    - Supports mitigation efforts on forested landscapes and lands suitable for reforestation and agroforestry.
6. **Critical Role of Forests**:

- Forests store approximately 68% of US terrestrial carbon stocks.
- They offset about 15% of total US fossil fuel emissions.
- Managing forest carbon stocks is essential for mitigating rising atmospheric CO2 concentrations1.

2. Forest Carbon Sequestration

Forest carbon sequestration plays a crucial role in **carbon markets** by contributing to climate change mitigation and creating economic opportunities. Let's explore its significance:

1. **Carbon Credits from Forests**:
    - Forests act as **carbon sinks**, capturing and storing carbon dioxide (CO2) through photosynthesis.
    - When forests sequester more carbon than they emit, they generate **carbon credits**.
    - These credits can be sold in carbon markets to entities aiming to offset their emissions.
2. **Generating Income for Landowners**:
    - **Farmers, ranchers, and forest landowners** can adopt practices that enhance carbon storage on their land.
    - By doing so, they create carbon credits that can be sold, providing **new income opportunities**.
    - Companies seeking to achieve voluntary greenhouse gas reduction goals can purchase these credits.
3. **Climate Benefits and Credibility**:

- Ensuring that carbon credits represent **credible climate benefits** is essential.
- Sound science and rigorous quantification are necessary to make carbon markets work effectively.
- Forests play a critical role in achieving this credibility.

4. **Barriers and Solutions**:
    - Barriers to forest participation in carbon markets include **high transaction costs** (quantification, verification, reporting).
    - Solutions involve addressing these barriers to encourage more beneficial participation by farmers and landowners.
    - Federal agencies, scientists, and partners collaborate to foster confidence and landowner engagement.

Sources:

1. USDA Assessment on Agriculture and Forestry in Carbon Markets
2. CRS Reports on Forest Carbon Markets
3. NCSL: The Role of Forests in Carbon Sequestration and Storage

6. Conclusion

Establishing a carbon market in OBR is a project that would take time and energy and extensive conversation. The most important thing to consider is how the people of OBR feel about carbon markets. There are a number of controversies surrounding carbon markets and yet this is still an endeavor that is not going way soon. Thus, addressing the failures and controversies of carbon markets is essential to moving forward. I hope this document will provide more context to carbon markets and to address some

common questions and concerns about Carbon credit systems as well as illustrate the economic potential of our region if we did embark on a carbon market system.