Carbon Sequestration Activities in the National Wildlife Refuge System

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1. Directives that call for the consideration of biological carbon sequestration (BCS) <u>co-benefits</u>.

2. How might BCS considerations align with restoration? (case examples)

3. What are challenges and opportunities?

DOI Restoration Workshop – April 30, 2014

U.S. FISH & WILDLIFE SERVICE

DEPARTMENT OF THE INTERIOR

USGS

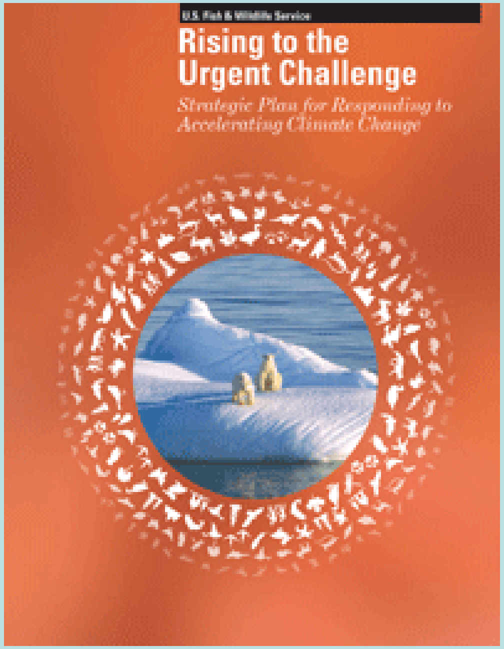
science for a changing world

Strategic Goals and Objectives Relevant to NRDAR Practice

ENGAGEMENT

ADAPTATION

MITIGATION



September 2010

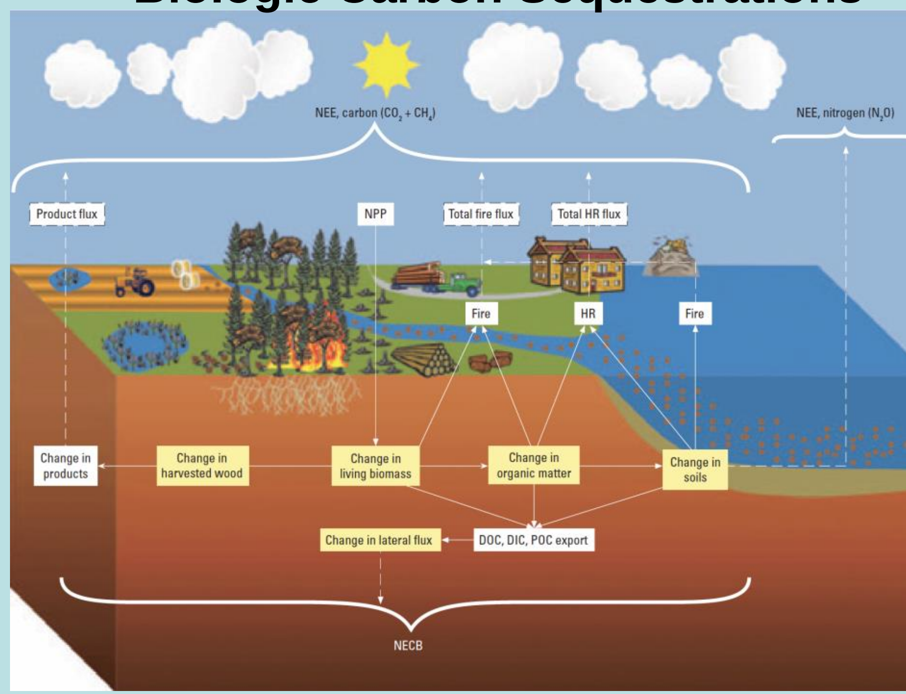
http://www.fws.gov/home/climatechange/pdf/ccstrategicplan.pdf

What is carbon sequestration?

Storage of CO2 removed from the atmosphere in long-term pools such as soils, aboveground biomass, sediments, or underground formations

Geologic CO_2 Sequestrations

Biologic Carbon Sequestrations



Why should carbon sequestration actions be considered in NRDAR?

DOI **Secretary's Order 3226** (Amendment 1) – January 2009

Sec. 5 **Carbon Sequestration Program.** The BLM, BIA, NPS, USFWS, BOR shall each, consistent and compatible with their respective missions:

a. Identify a terrestrial sequestration program … aimed at reducing greenhouse gases, including carbon dioxide;

b. Utilize existing policies and regulations, programs, … identify opportunities to restore habitat while helping to offset greenhouse gas emissions; and

c. In accordance with the Energy Security Act of 2007, work with the USGS to inventory and characterize lands managed or regulated, as appropriate, by the bureau for possible geological and biological greenhouse gas sequestration.

Why should carbon sequestration actions be considered in NRDAR?

DOI Secretary’s Order 3289 – September 2009

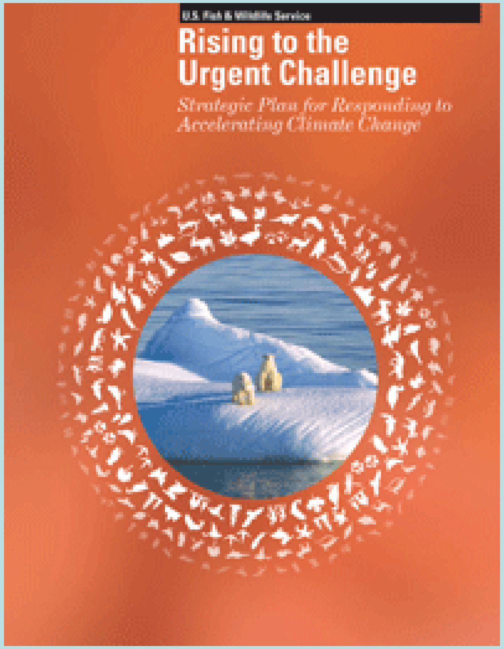
Sec. 4 **Additional Departmental Action to Mitigate Climate Change.**

Under the authority of The Energy Independence and Security Act of 2007, this Order establishes the DOI Carbon Storage Project which, “…gives the Department statutory responsibility to develop carbon sequestration methodologies for geological and biological carbon storage. The USGS has the lead in administering the project, but will work closely with other bureaus and agencies in the Department and external partners to enhance carbon storage in geological formations and in plants and soils in a manner consistent with the Department’s responsibility to provide comprehensive, long-term stewardship of it resources.”

Why should carbon sequestration actions be considered in NRDAR?

USFWS - Rising to the Urgent Challenge

September 2010



Objective 6.1: Develop Biological Carbon Sequestration Expertise

Objective 6.2: Develop Standards, Guidelines, and Best Management Practices for Biological Carbon Sequestration

Objective 6.3: Integrate Biological Carbon Sequestration Activities into Landscape Conservation Approaches

http://www.fws.gov/home/climatechange/pdf/ccstrategicplan.pdf

Why should carbon sequestration actions be considered in NRDAR?

The President's **Climate Action Plan** - June 2013

Executive Order **13653** – November 2013

"*Conservation and sustainable management can help to ensure our forests continue to remove carbon from the atmosphere while also improving soil and water quality, reducing wildfire risk, and otherwise managing forests to be more resilient in the fact of climate change.*"

- Carbon sequestration is a key strategy for climate mitigation. It is also frequently a strategy for maintaining the health of our habitats (e.g. refuge acquisition, ecosystem productivity, maintaining natural conditions, soil protection, etc.) So we are already doing this.

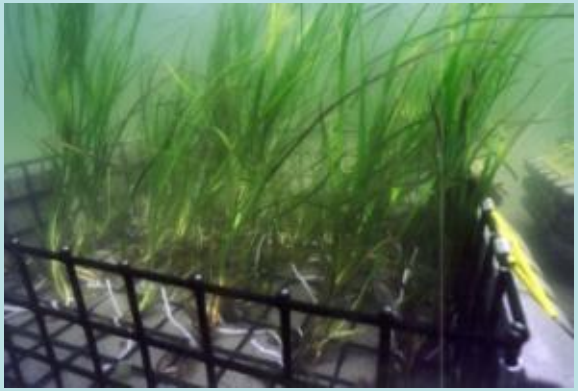
- Ecosystem restoration fits well with the ideas of a carbon offset market in terms of carbon credits through additional restorations or avoided loss of natural resources

Ultimately, considering carbon sequestration is (often) consistent with ecosystem restoration objectives

A restored salt-marsh site in San Francisco Bay, annual C sequestration ~ 100 gC/m^2/yr, or vertically ~ 0.07” accretion per year (sea level rise implication)

As an example, increasing coastal marshland C stock is the same as increasing its coverage and health, which helps 1) restore and improve water quality near communities, 2) improve resilience against sea level rise, 3) mitigate emissions

How to incorporate carbon benefits in policies?



- A study examined 6 federal policies (including NRDAR process) to determine if C sequestration could be included in their implementation
- Determined: No new regulations needed, i.e. benefits could be incorporated into implementation of all policies without statutory changes
  - Example: To include it in NRDA we need agreed-upon methods for valuing carbon, and capacity and expertise needed to quantify the counterfactual (i.e., without damage) levels of carbon storage and sequestration
- But carbon is <u>not currently included in any implementation</u> critical climate mitigation benefits provided by ecosystems are not being protected or fully restored after damage
- **If carbon were included, it could change decisions and lead to more/better habitat conservation**

Sutton-Grier et al. 2013. Marine Policy

Pendleton & Sutton-Grier et al. 2013. Coastal Management

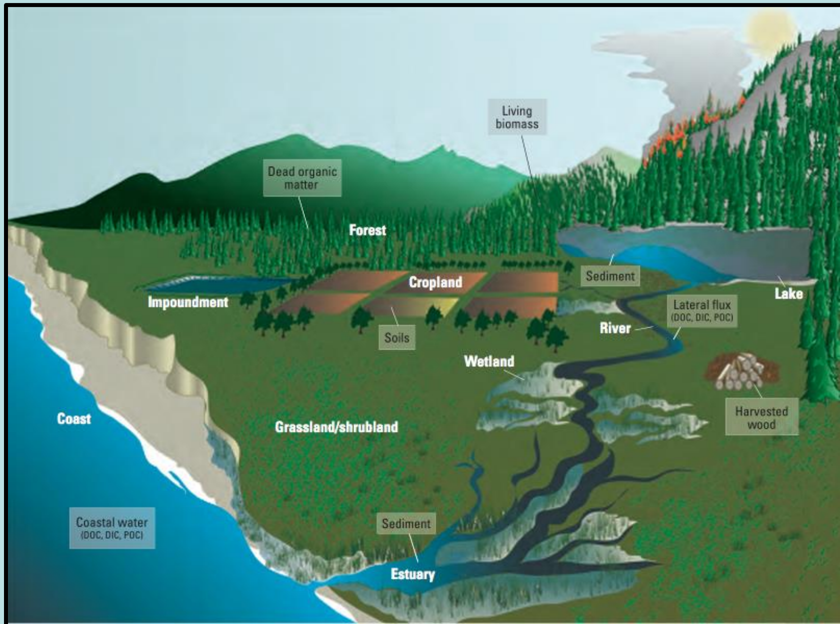
Considering BCS as a Co-Benefit in NRDAR Practice

- Revegetation, afforestation, & reforestation to maximize carbon sequestration – both immediate and long term
- Soil amendment and management practices to increase carbon sequestration in the soil environment
- Restoration banking with climate change mitigation value
- Evaluate ecosystem services and performances, including C sequestration as one of the services to be evaluated
- Develop and implement a long-term monitoring system on site
- Verified carbon standards (if engaging in offset markets)

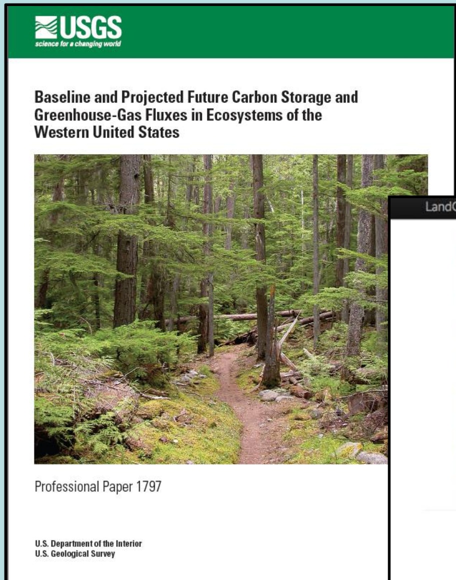
Coarse national data from USGS LandCarbon project

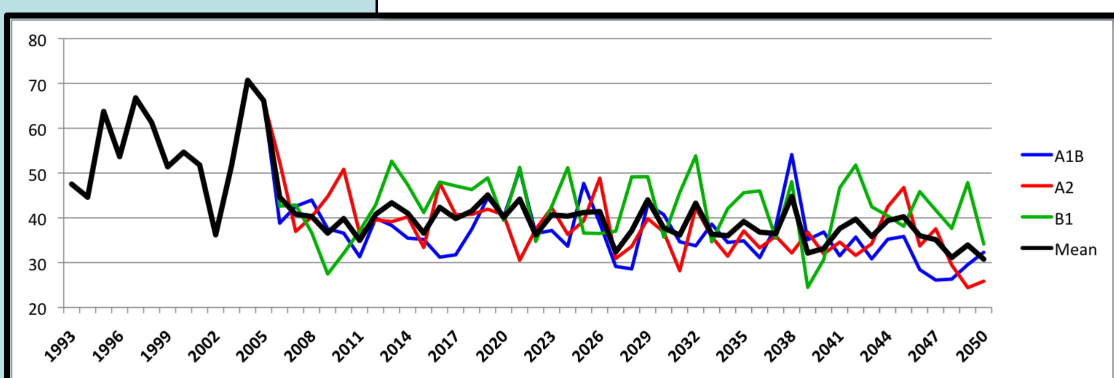
The USGS national biologic carbon sequestration assessment (the LandCarbon project) is funded by the Energy Independence and Security Act, which required USGS to:

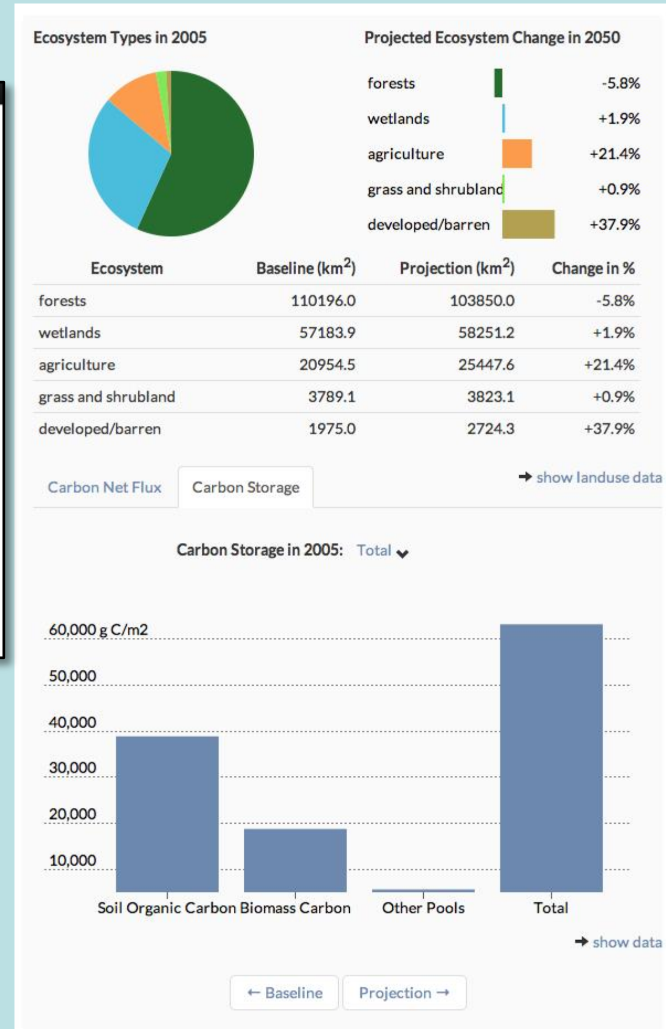
- Conduct national assessment: all major terrestrial and aquatic ecosystems
- Determine the current C stock and fluxes
- Estimate potential capacity to increase C sequestration
- Consider policy applications (e.g. adaptation and mitigation applications)
- Consider effects of climate change and other controlling processes such as land use and ecosystem disturbances
- Consult with DOI agencies and other organizations



National coarse-resolution data available from the USGS biologic C sequestration assessment







Require regional to landscape scales?

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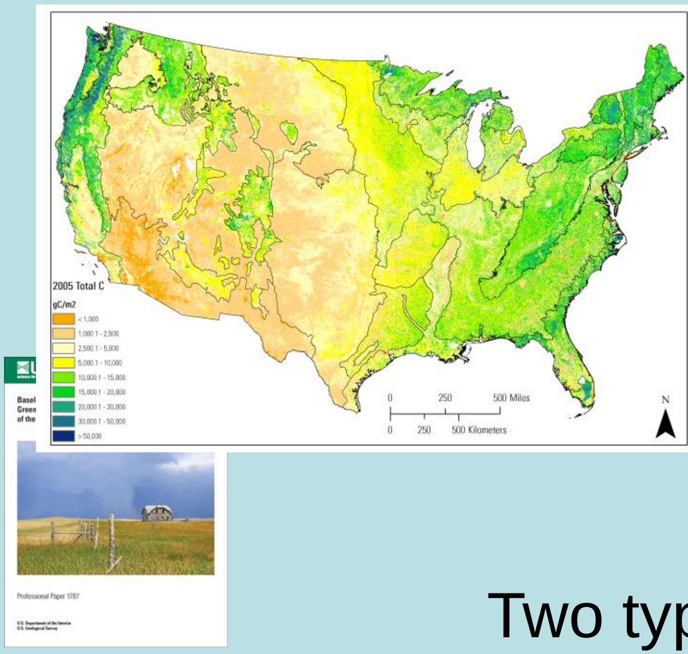
Three examples

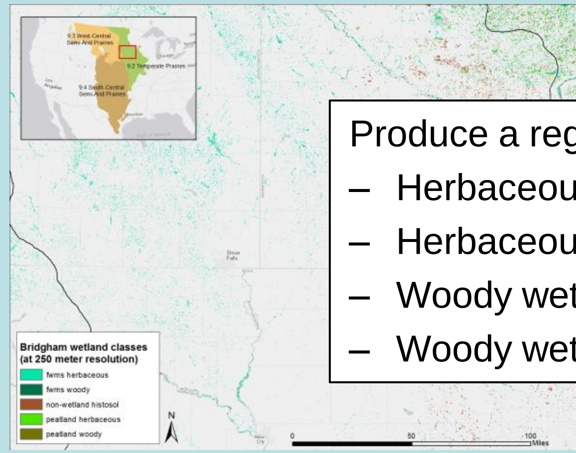
Example 1: regional-scale analysis of suitable conservation targets – the general idea

- USGS produced national carbon stock and sequestration maps for all ecosystem types, based on land use change and climate change
- Further analysis focused on different wetlands at a regional scale for the Great Plains
- Asking the question: what may be the potential loss in wetland carbon from land conversions if mitigation is not implemented?
- Asked differently: what wetlands may be C rich, but are also competitively priced to be relatively easily protected for conservation – hence avoiding the loss of C stock?

Byrd, et al. 2013. Mitigation and Adaptation Strategies for Global Change:1-27.

Example 1: regional-scale analysis of suitable conservation targets – input data





Produce a regional wetland type map:

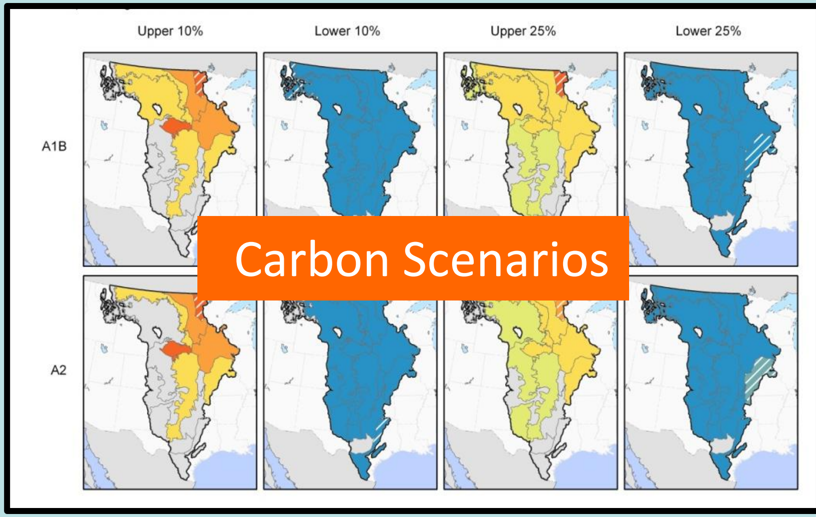
- Herbaceous freshwater mineral soil
- Herbaceous peatland
- Woody wetland freshwater mineral soil
- Woody wetland peatland

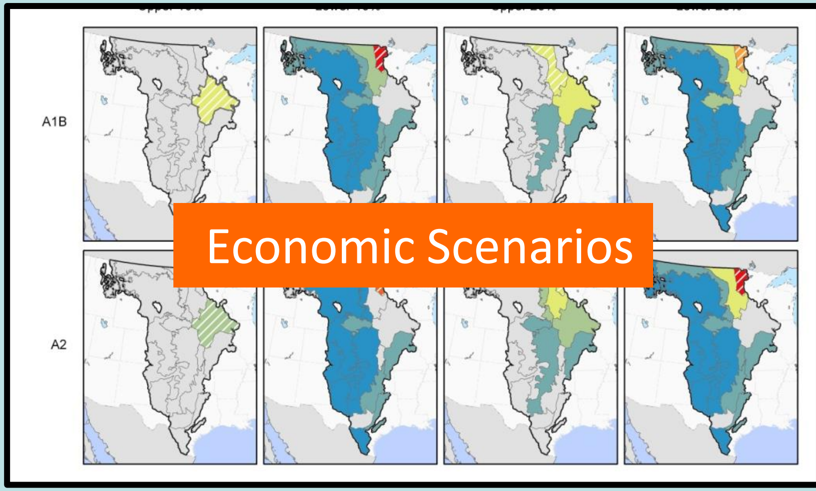
Two types of scenarios:

1. How much C is in wetland soils?
2. How expensive are the wetlands?

Byrd, et al. 2013. Mitigation and Adaptation Strategies for Global Change:1-27.

Example 1: regional-scale analysis of suitable conservation targets – results and implications



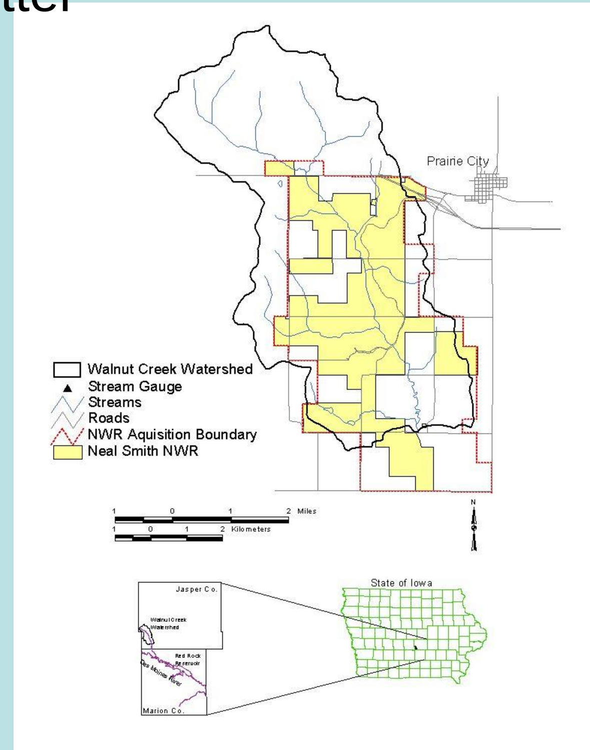


- Up to 3420 km^2 of wetlands may be lost in the region by 2050, mainly due to conversion of herbaceous wetlands to croplands where soil organic carbon (SOC) is highest.
- However, among wetlands vulnerable to conversion, wetlands in the Northern Glaciated Plains and Lake Agassiz Plains ecoregions exhibit very high mean SOC and on average, relatively low land values, potentially creating economically competitive opportunities for avoided carbon loss.
- Results can help prioritize/optimize restoration options.

	Carbon Scenario: Soil Organic Carbon (Tg C)				Economic Scenario: Non-irrigated Land Value (Tg C)			
Scenario	**Upper 10%**	**Lower 10%**	**Upper 25%**	**Lower 25%**	**Upper 10%**	**Lower 10%**	**Upper 25%**	**Lower 25%**
A1B	6.13	0.40	12.6	2.29	1.26	1.75	3.27	4.64
A2	3.46	0.22	7.0	1.26	1.33	0.32	2.65	1.43

Example 2: Neal Smith NWR native prairie restorations: what's the carbon benefit?

- Neal Smith has been adding unproductive farmlands and restoring them to native prairie lands
- Prairie restoration activities ongoing (about 20 years)
- The idea is that reconstructed prairies can foster C sequestration by increasing C storage in roots and soil organic matter
- Note: much refined landscape scale

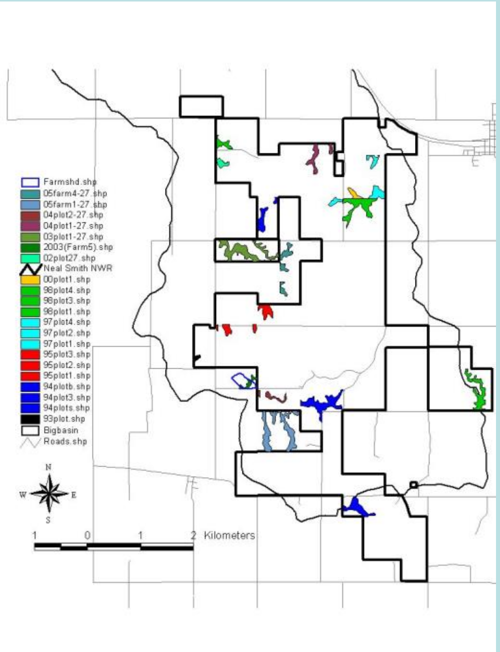


Cambardella et al, in preparation

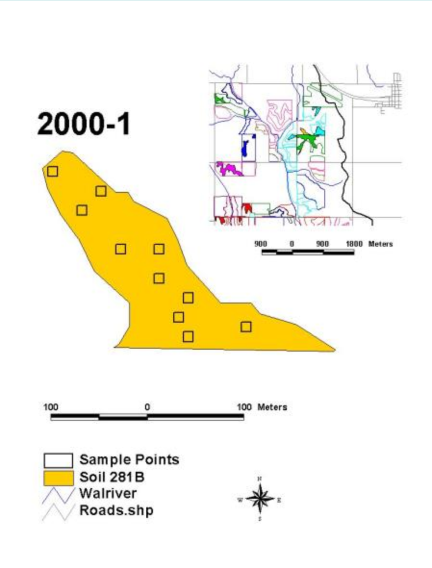
Example 2: Neal Smith NWR native prairie restorations: data and analysis

- Use the chronosequence method to define the relations between the age of restoration and soil C content, and hence the rate of C sequestration
- Sampling of different restoration ages, plus 2 farms (reference conditions)

Stratified sampling



10-20 soil cores for each restoration age

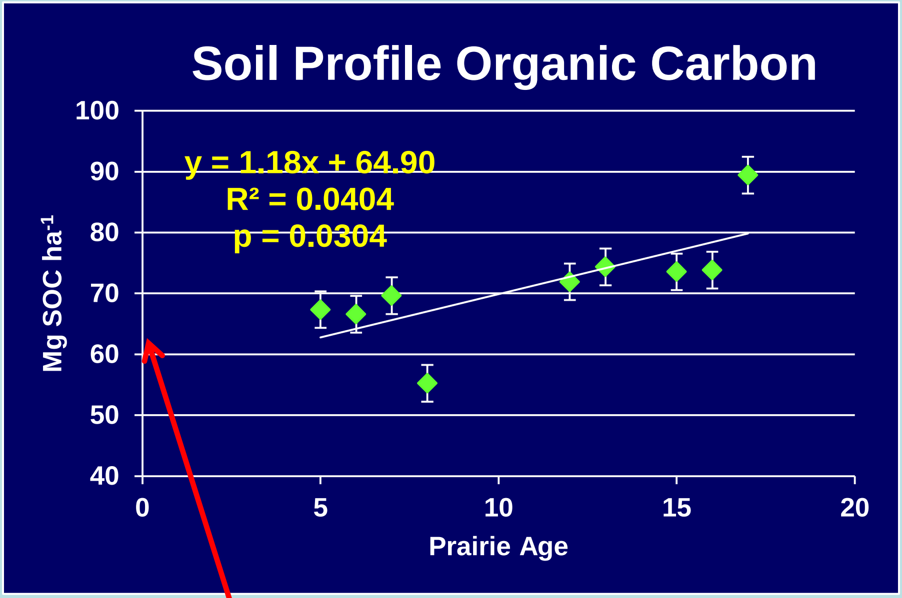


Soil coring to 120 cm

Cambardella et al, in preparation

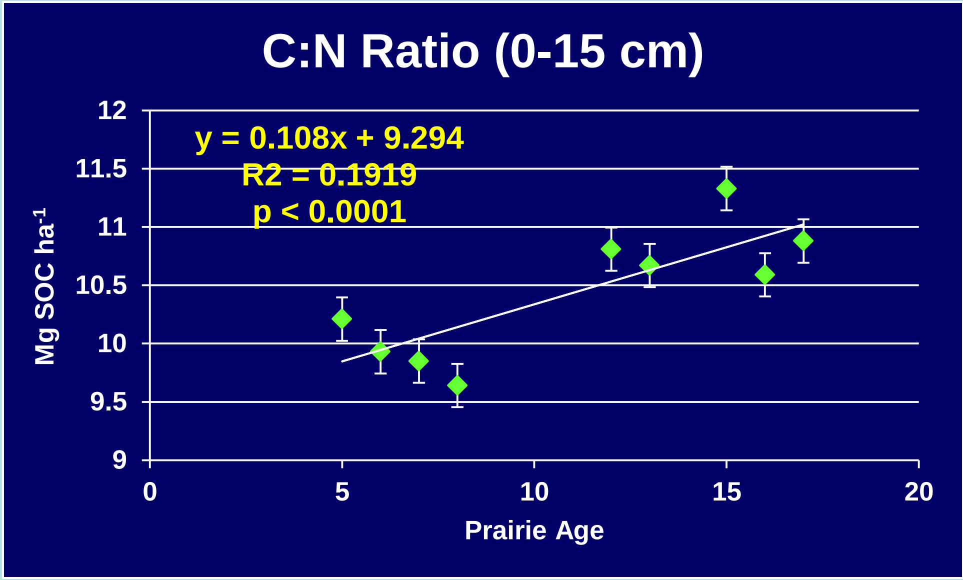
Example 2: Neal Smith NWR native prairie restorations: preliminary results

2010 sample data,
indicating 1.2 Mg/ha/yr



Farm sample (reference conditions)

C:N ratio indicating organic matter quality.
SOC quality increases with prairie age



Cambardella et al, in preparation

Example 3: Supporting Atlantic coastal wetland restoration (a new project between FWS and USGS)

Great Dismal Swamp, Pocosin Lakes, Alligator River NWR

Example 3: Atlantic coastal wetland restoration (Great Dismal Swamp): major needs

As the refuge implements a rewetting regime to restore peat soils,

1) Estimate a relatively complete carbon budget (e.g. carbon *i/o* of the systems)
2) Relate C sequestration in peat soils with hydrologic management to provide a potential mitigation standard
3) Integrate the GHG, C, and refuge management objectives in an ecosystem service assessment model to support management decisions.

Example 3: Atlantic coastal wetland restoration: proposed methods

<u>A: Refuge wide:</u>

1. Digital maps of aboveground biomass, fire, and peat depth using remote sensing
2. Working with refuge staff to collect management data
3. Ecosystem service modeling and assessment incorporating management needs
4. Upscaling all GHG and C estimates for an analysis of C budget in relation to hydrologic and restoration management objectives/actions
5. Integrating all components in an ecosystem service decision-support model

<u>B: a stratified sampling grid</u>

1. Plots will be drawn considering biophysical and vegetation characteristics, distance, and existing wells/gages (All)
2. Aboveground biomass and annual change
3. Additional peat depth sampling using probing and ground penetrating radar

<u>C: A subset of the B level plots</u>

1. Surface subsidence, soil carbon sequestration, sedimentation
2. Seasonal and annual CO2 and CH4 fluxes
3. Ground water, water quality, other hydrologic parameters
4. Peat depth, C density, long-term C storage analysis in relation to management and hydrologic age structure

Blue Carbon

- Three coastal habitats: mangrove, salt-marsh, sea grasses
- High-salinity = low methane emission and high C sequestration
- Two C sequestration standards available for the habitats

http://www.habitat.noaa.gov/coastalbluecarbon.html

http://thebluecarboninitiative.org

Opportunities and Challenges

- NWR manage a huge number of wetlands, wetlands store more C per unit area than terrestrial forest ecosystems.
- The C is accumulated over many years, but is vulnerable to releasing to the atmosphere rather quickly if disturbed or converted.
- If the C is lost, then we also lose associated social and ecosystem benefits, thus there is a global impact.
- Improved management or restoration actions can reduce the vulnerability and increase carbon sequestration.
- Benefits from including carbon sequestration in restorations can be measured and demonstrated – more data can improve management decision making and reduce uncertainty

Questions?

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