Diversification of farmers markets to include carbon markets:

Slowing the rate of loss of mineral wetlands on human dominated landscapes

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Conserving Canada's Wetlands

Motivated by the challenges in understanding, predicting and managing water systems that are increasingly impacted by humans

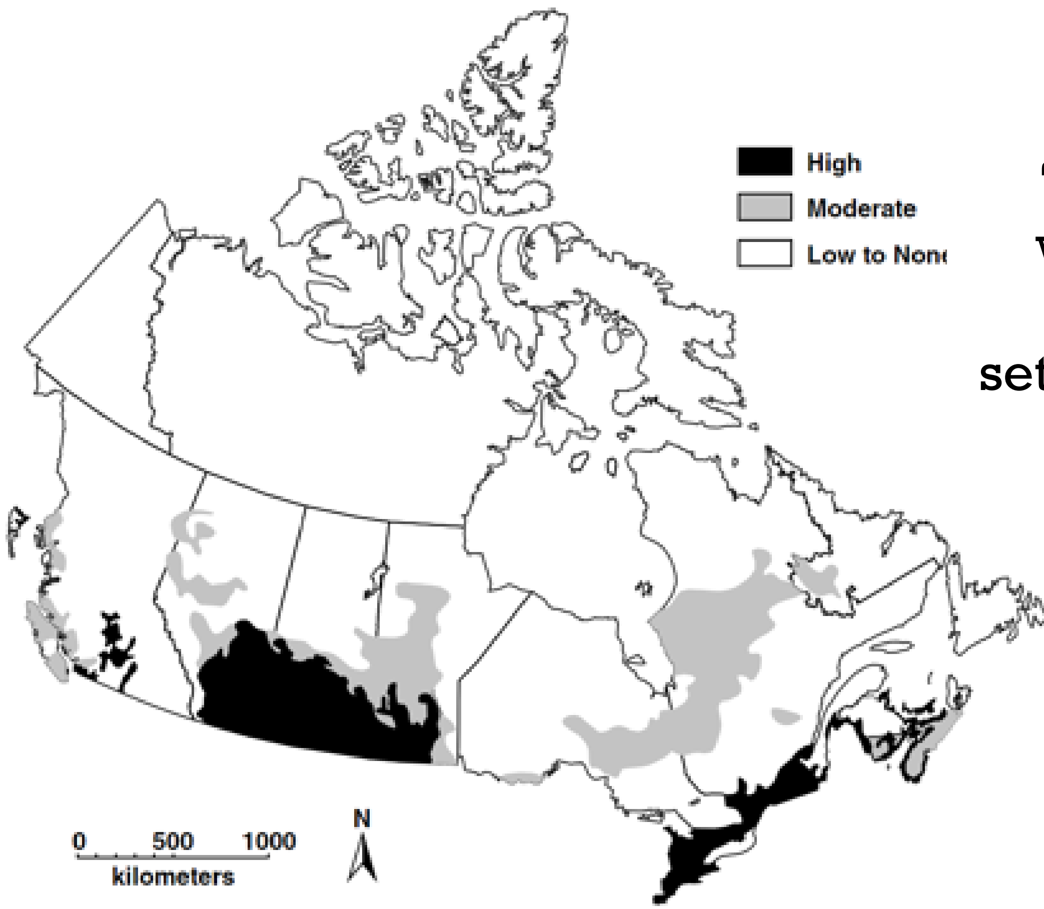
Our focus is on **mineral wetland water systems** in highly managed landscapes

Wetland provides important **ecosystem services**:

- Flood control
- Water purification (phosphorus and nitrogen retention)
- Carbon sequestration

We will show how farmers can increase the supply of ecosystem services by **restoring wetlands** that not only improve their livelihoods, but also the many people living within the regional watershed

wetlands are being lost at an alarming rate in domesticating landscapes



"up to 70 percent of wetlands have been degraded or lost in settled areas of Canada"

Warner, Asada. 2006. Knowledge gaps and challenges in wetlands under climate change in Canada. In: Price M, J Bhatti, M Apps (Eds). Climate change and managed ecosystems. CRC Press, Boca Raton, FL.

"domestication" of landscapes in Ontario agricultural intensification

Tockner, Pusch, Gessner, Wolter. 2011. Domesticated ecosystems and novel communities: challenges for the management of large rivers. Ecohydrol. Hydrobiol. 11:167-174

our **goal** is to provide alternatives to wetland drainage related to ecosystem services:

1 Policy:
Maintain wetlands

2 Management Action:
Restore wetlands to enhance nutrient retention

3 Leads to a change in water quality:
Reduce nutrients in runoff

4 Leads to a change in ecosystem services:
Increase carbon sequestration
Improve water quality

5 Leads to a change in ecosystem benefits:
Mitigate climate change
Improve swimming, fishing, drinking water supplies

6 Leads to change in value:
Value of carbon offset
Value of swimming, fishing and water quality improvement

our **objectives** are to:

1. Create a **drained wetland inventory**
2. Establish priorities for **restoration** of drained wetlands
3. Estimate **nutrient retention rate** since restoration
   a. Deepest point of wetland basin
   b. For entire wetland basin
4. Determine the influence of the **surrounding landscape matrix** on nutrient retention potential
5. Simulate the nutrient retention rate **under changing global conditions**

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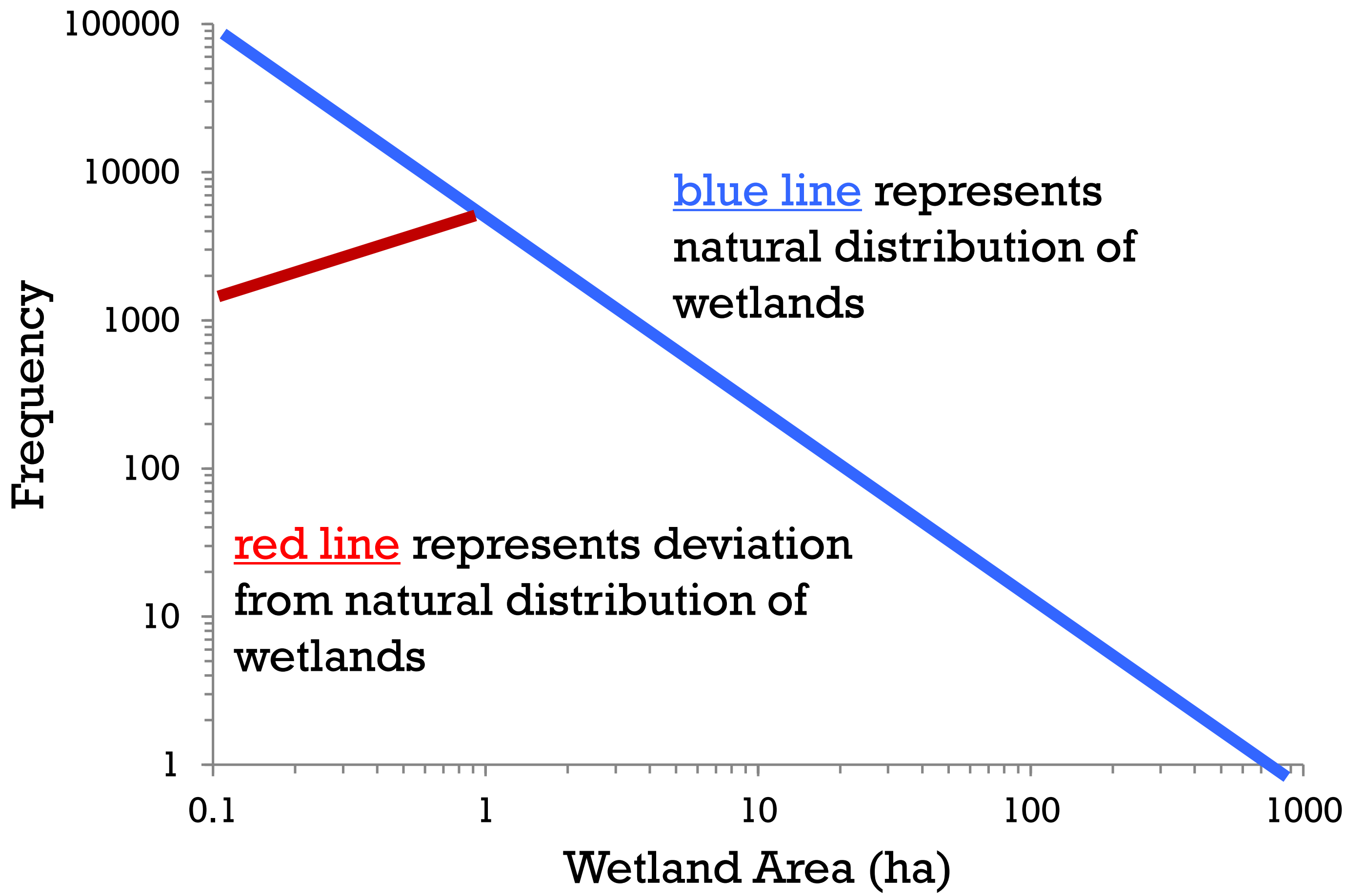
estimating drained wetlands using area-frequency power functions



Zhang, B., Schwartz, F.W., Liu, G. 2009. Systematics in the size structure of prairie pothole lakes through drought and deluge. Water Resourc. Res. 45, WR006878.

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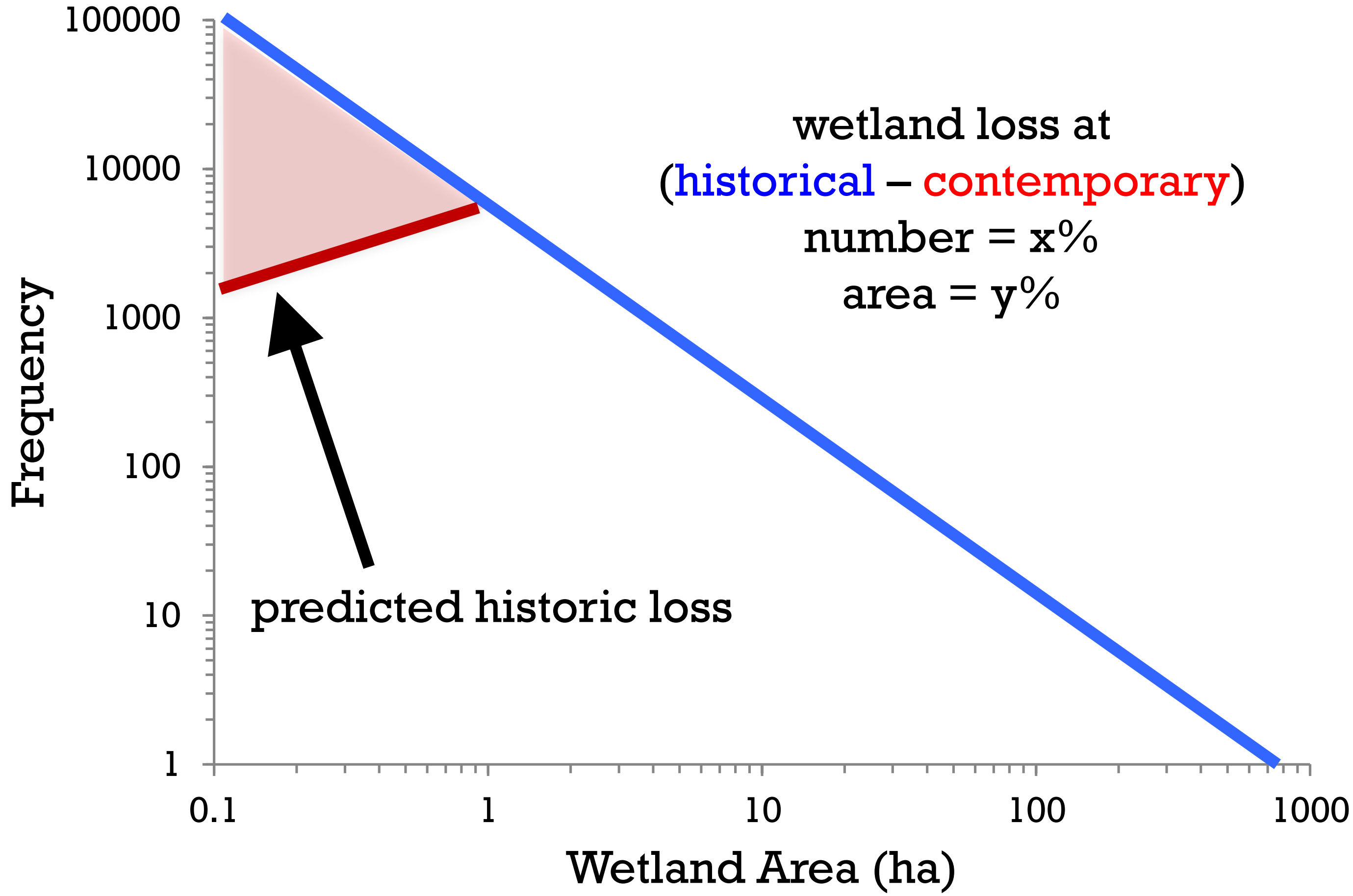

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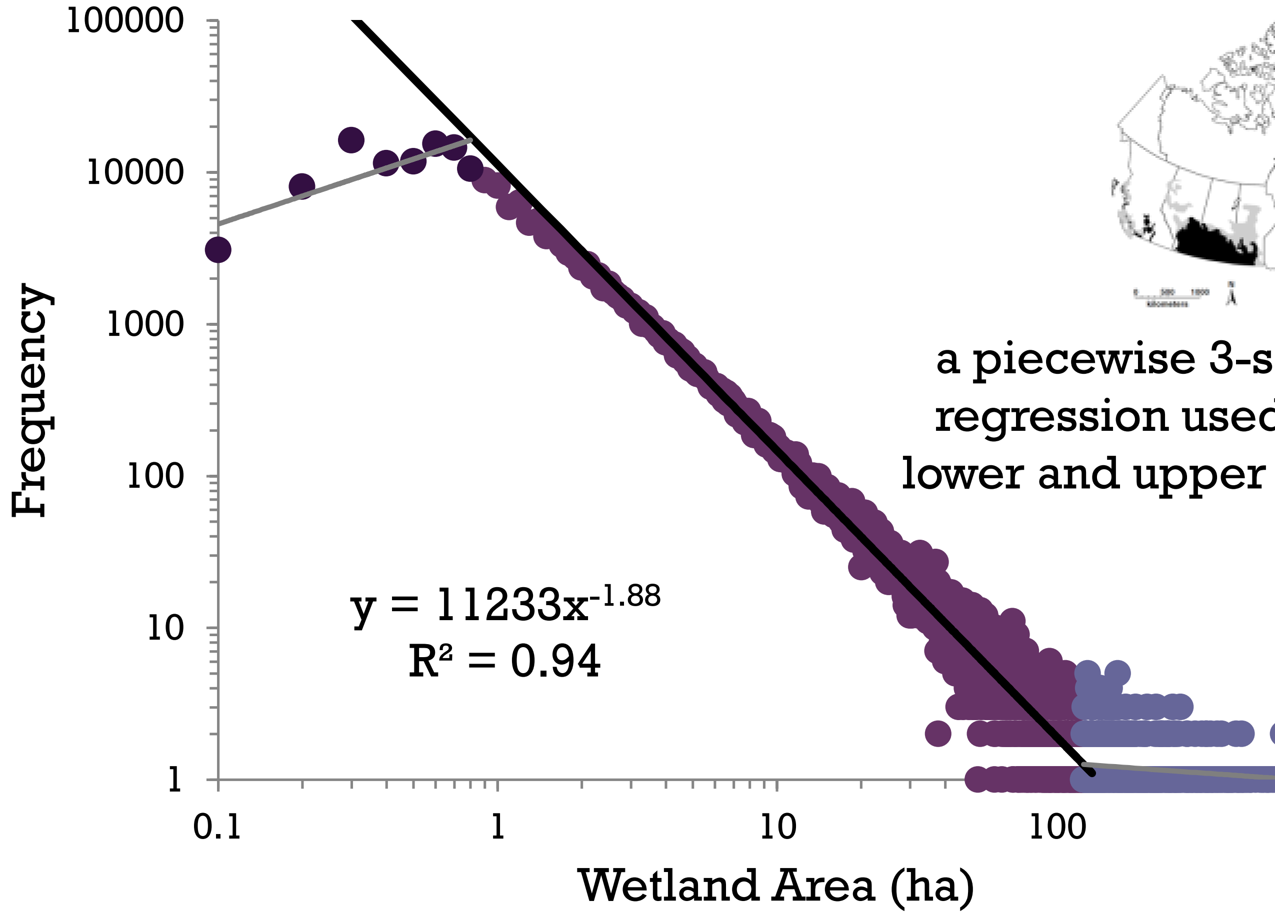
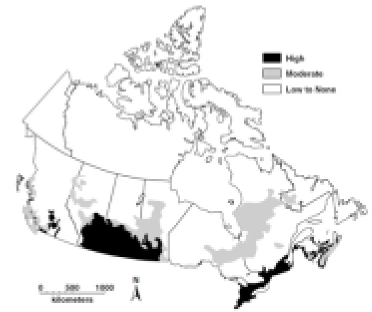
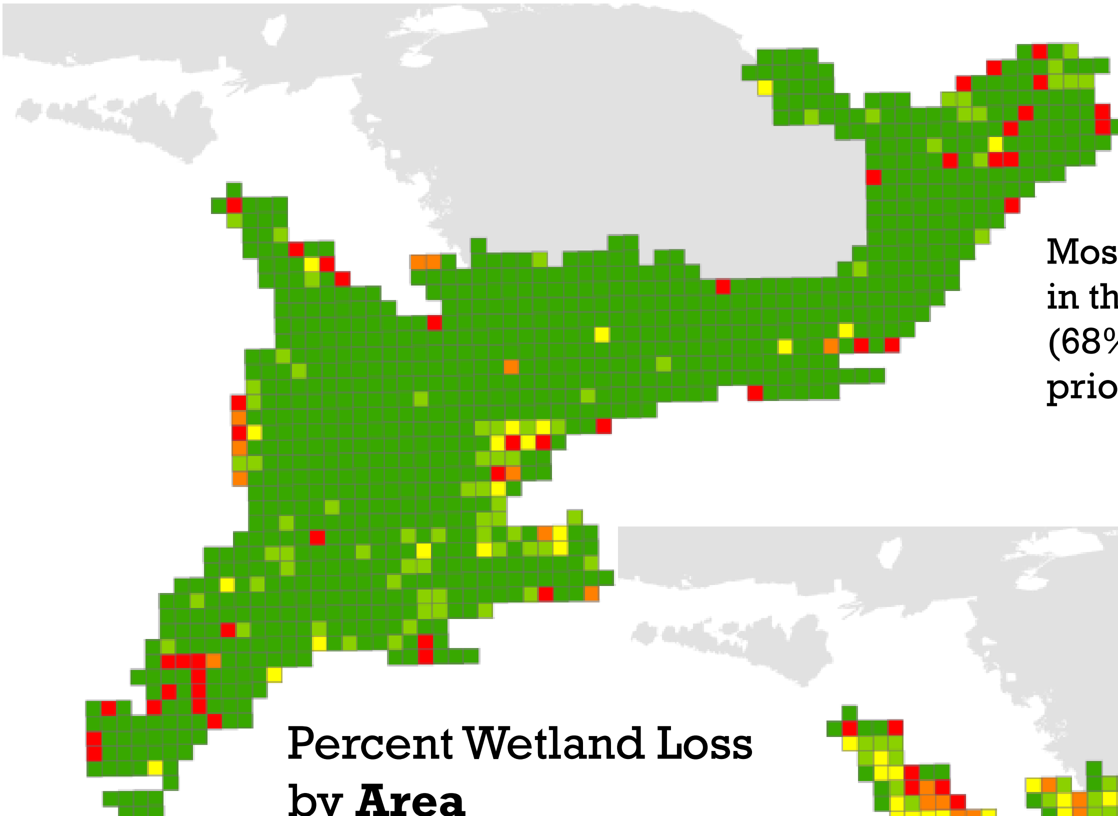




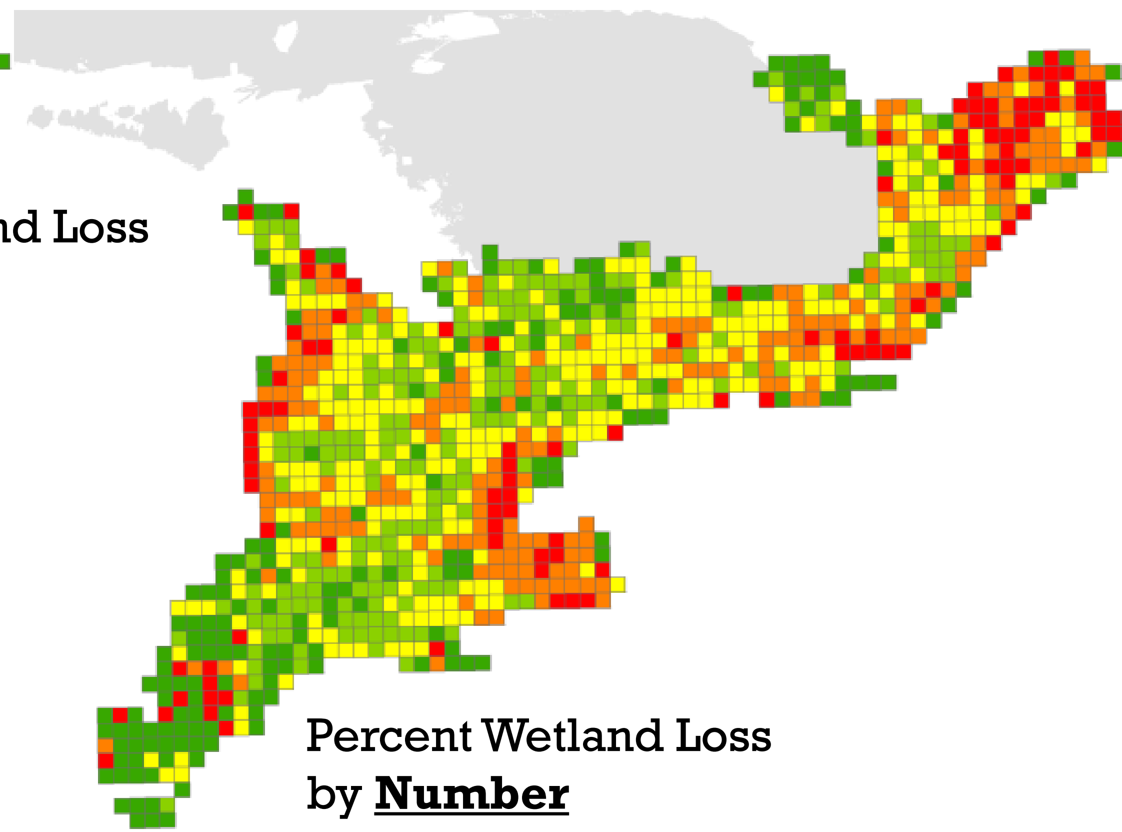
a piecewise 3-segment linear regression used to determine lower and upper area thresholds

Power Law Statistics (all wetlands)	
Percent number lost	**86%**
Percent area lost	**21%**

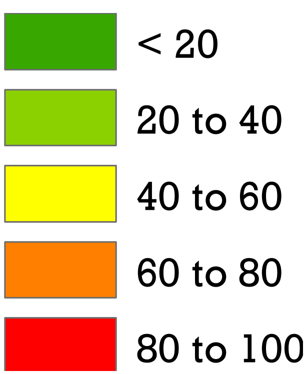
Most wetland conversion happened in the 19th and early 20th centuries (68% of wetlands were converted prior to 1967).



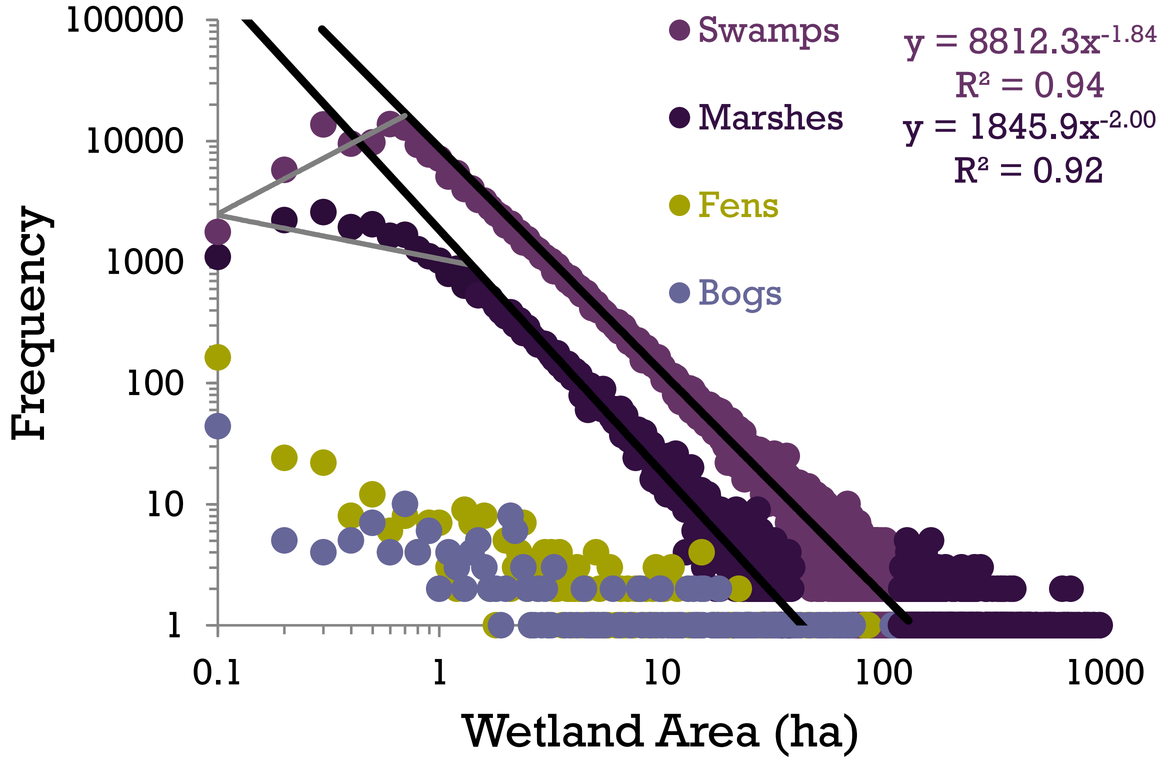
Percent Wetland Loss by **Area**



Percent Wetland Loss by **Number**



drained wetlands by type

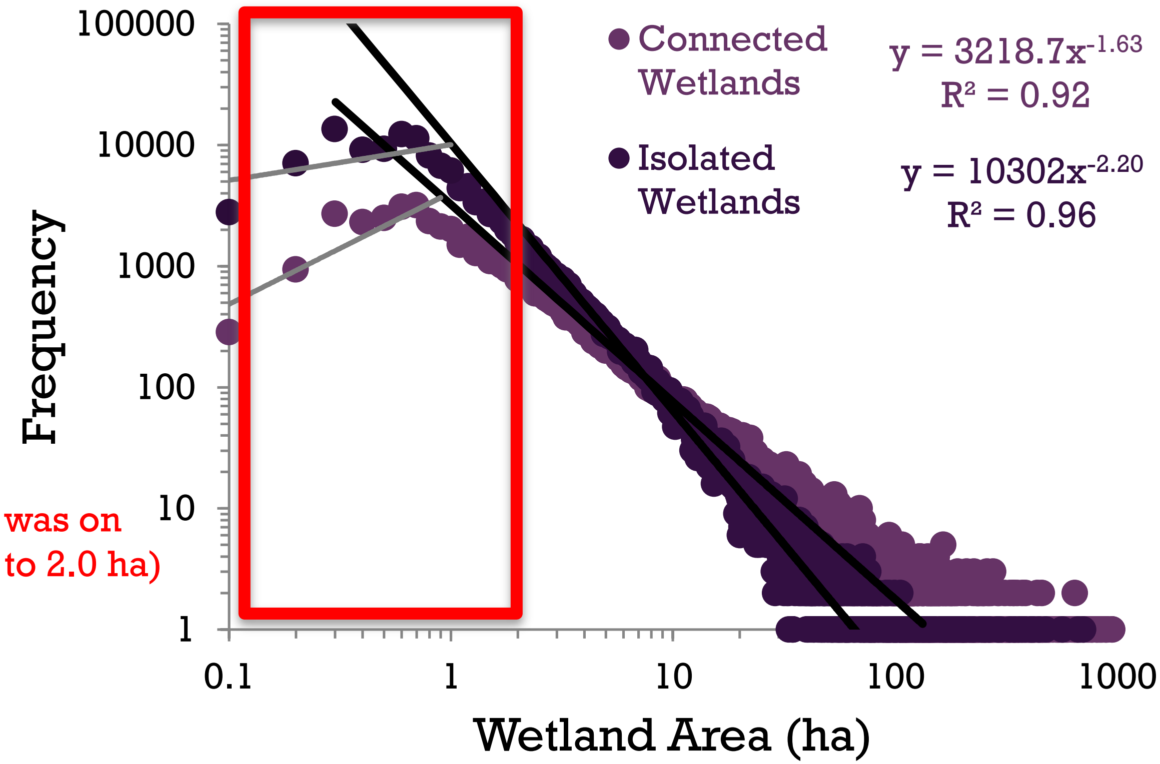


Power Law Statistics (swamps)	
Percent number lost	**84%**
Percent area lost	**18%**

Power Law Statistics (marshes)	
Percent number lost	**90%**
Percent area lost	**39%**




drained wetlands by connectivity

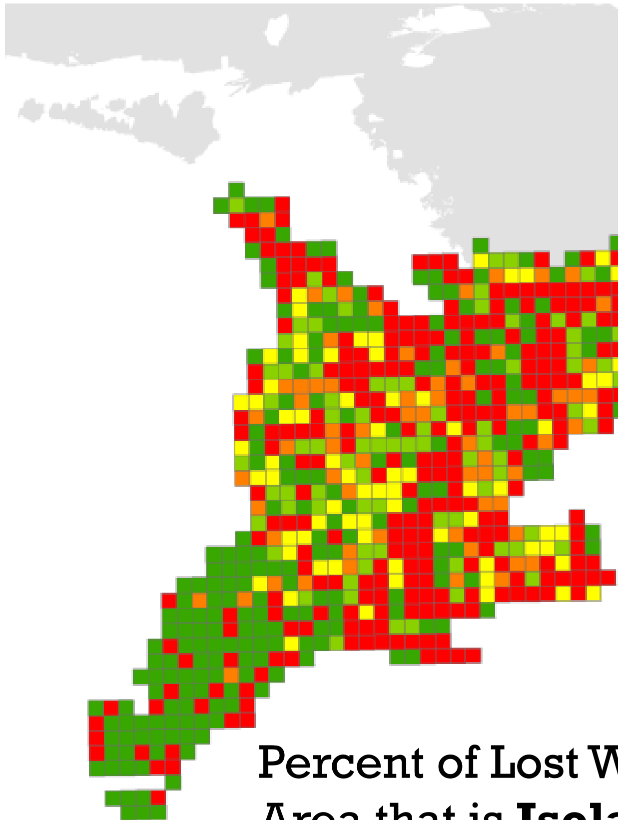


Our focus was on small (0.1 to 2.0 ha)

Power Law Statistics (connected)	
Percent number lost	**79%**
Percent area lost	**9%**

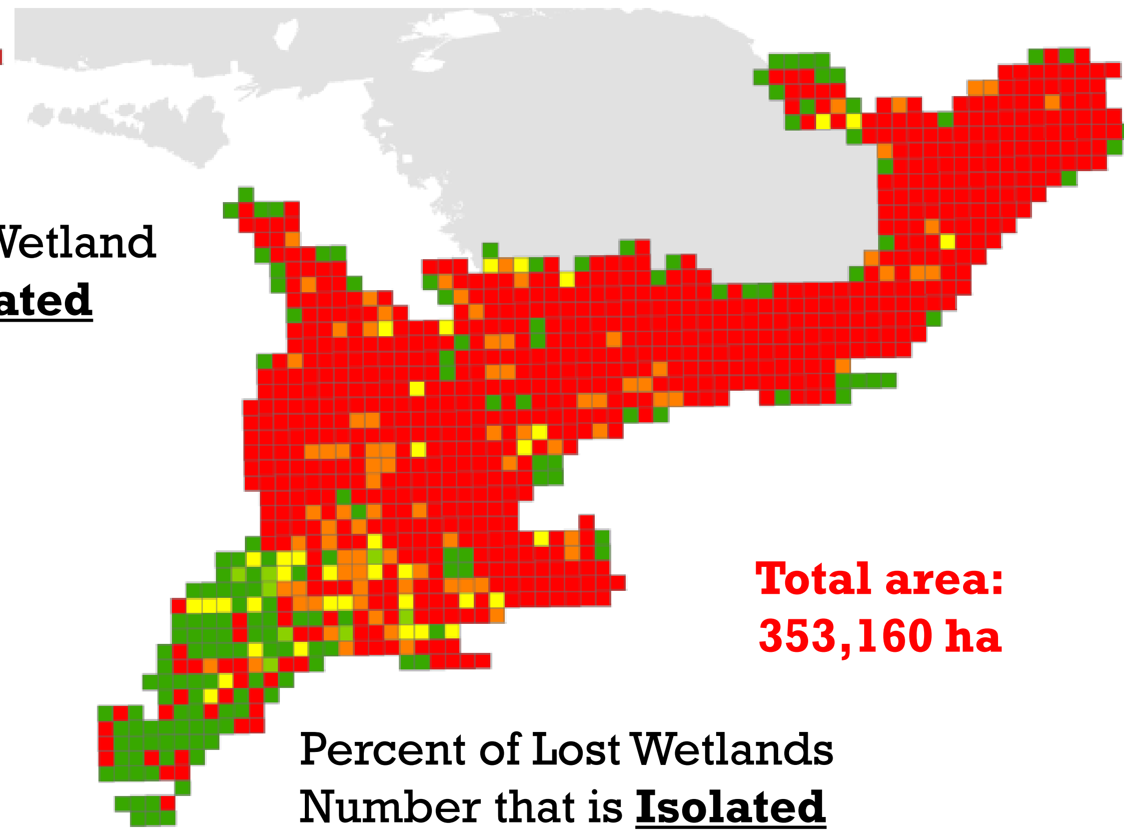
Power Law Statistics (isolated)	
Percent number lost	**94%**
Percent area lost	**53%**

Isolated mineral wetlands have the greatest restoration potential in southern Ontario



Percent of Lost Wetland Area that is **Isolated**

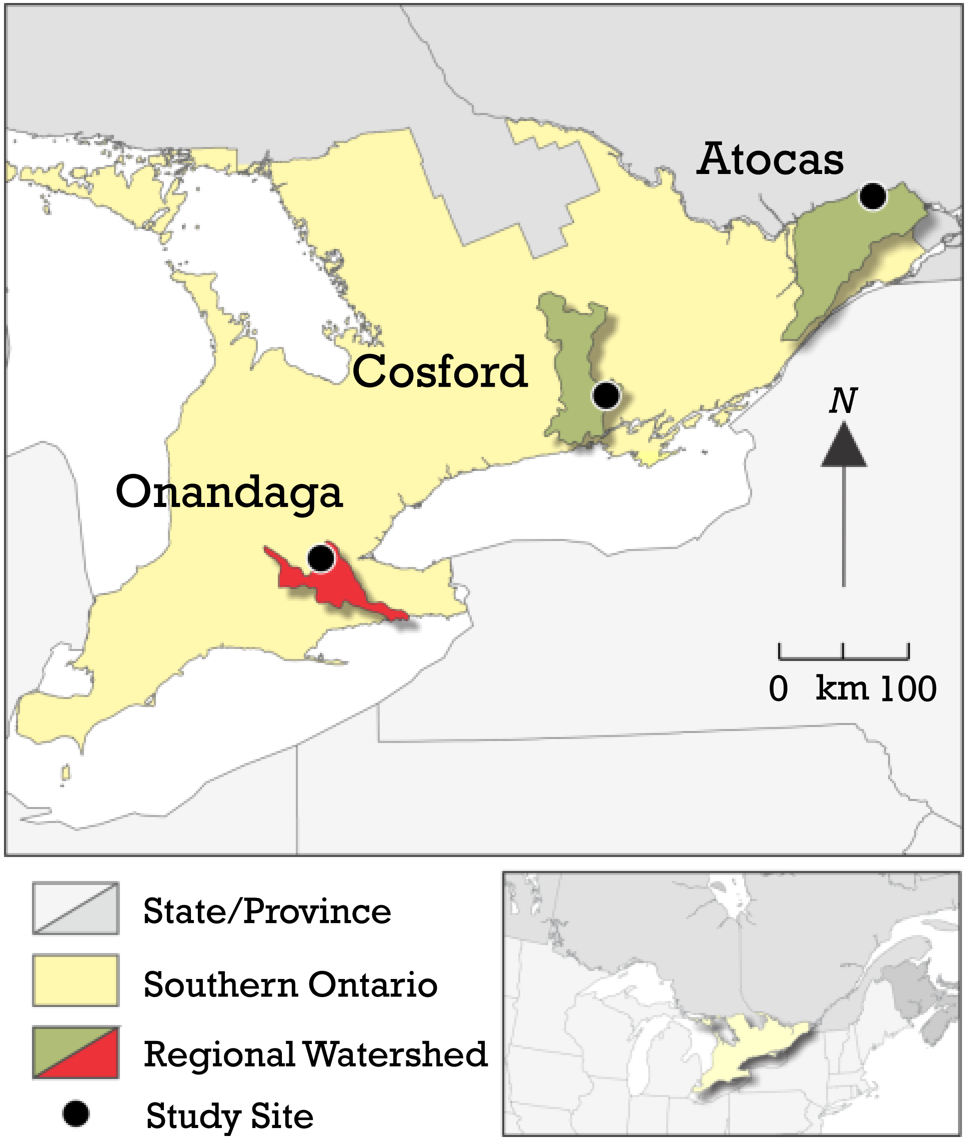
- < 20
- 20 to 40
- 40 to 60
- 60 to 80
- 80 to 100



Total area: 353,160 ha

Percent of Lost Wetlands Number that is **Isolated**

field estimation of nutrient retention rates



three DUC project sites identified along this geographic gradient as potential sites from where wetlands could be sampled

field estimation of nutrient retention rates

sampled three marsh wetlands for each of the following: drained, 10, 20, 35 years since restoration, intact

field estimation of nutrient retention rates

sediment samples taken along a transect at four positions:
P1 - center of wetland (open-water);
P2 - emergent vegetation zone;
P3 – wet meadow zone (i.e., high water mark); and
P4 – upland where flooding rarely occurs.

field estimation of nutrient retention rates

three replicate samples taken using:

- a WaterMark Universal Corer for sediments
- an AMS Extendible Corer for soils

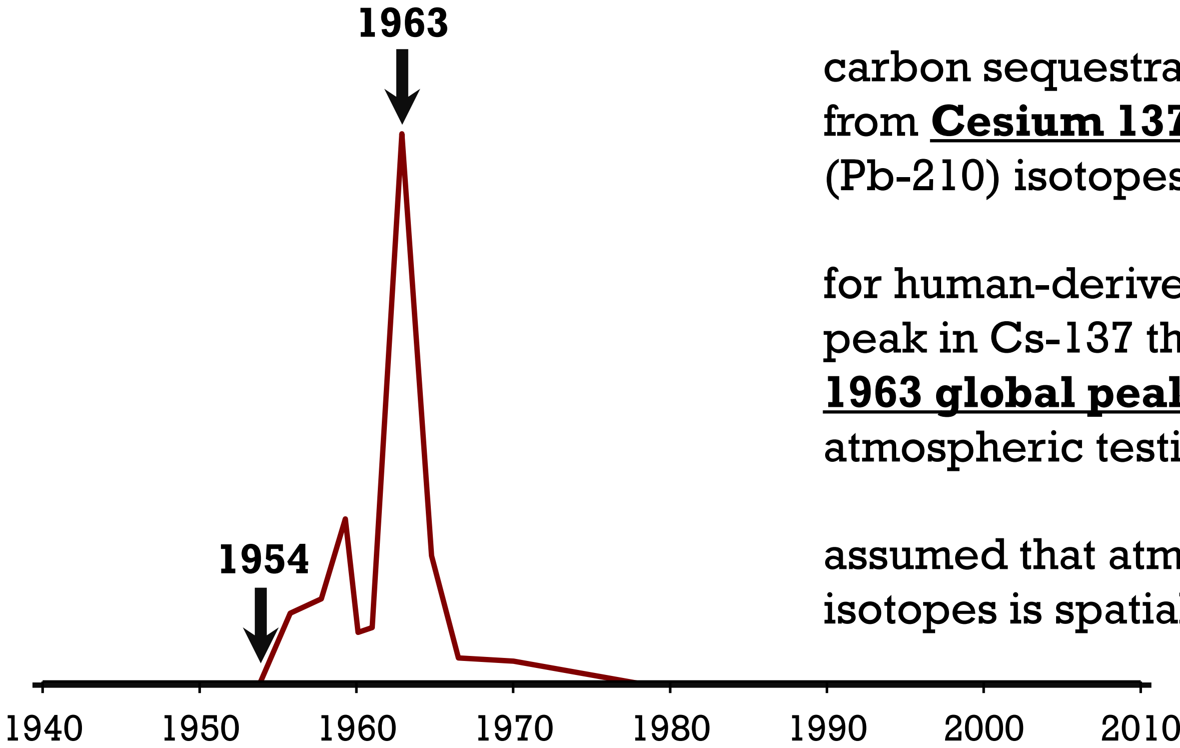
to a **maximum 30 cm of depth**.

each replicate core cut into **1 cm intervals** and composited in the field.

sedimentation rates and **organic C, N, P pools** determined for each 1 cm interval composited sample.

step 1: sedimentation rate

Atmospheric Deposition of ^{137}Cs

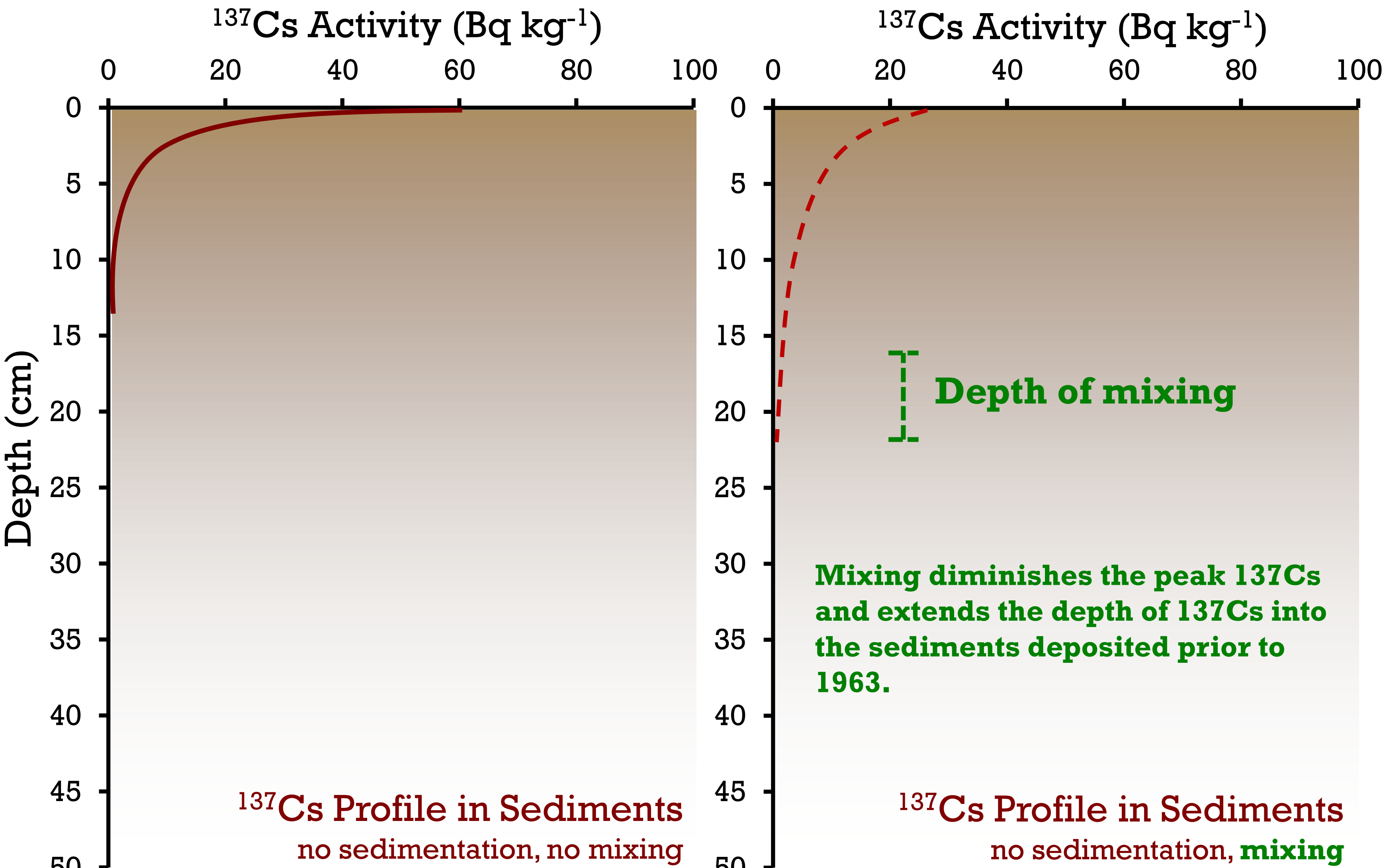


carbon sequestration rates estimated from **Cesium 137 (Cs-137)** and Lead 210 (Pb-210) isotopes.

for human-derived Cs-137, there is a peak in Cs-137 that corresponds to the **1963 global peak emission** due to atmospheric testing of nuclear weapons.

assumed that atmospheric deposition of isotopes is spatially uniform.

step 1: sedimentation rate



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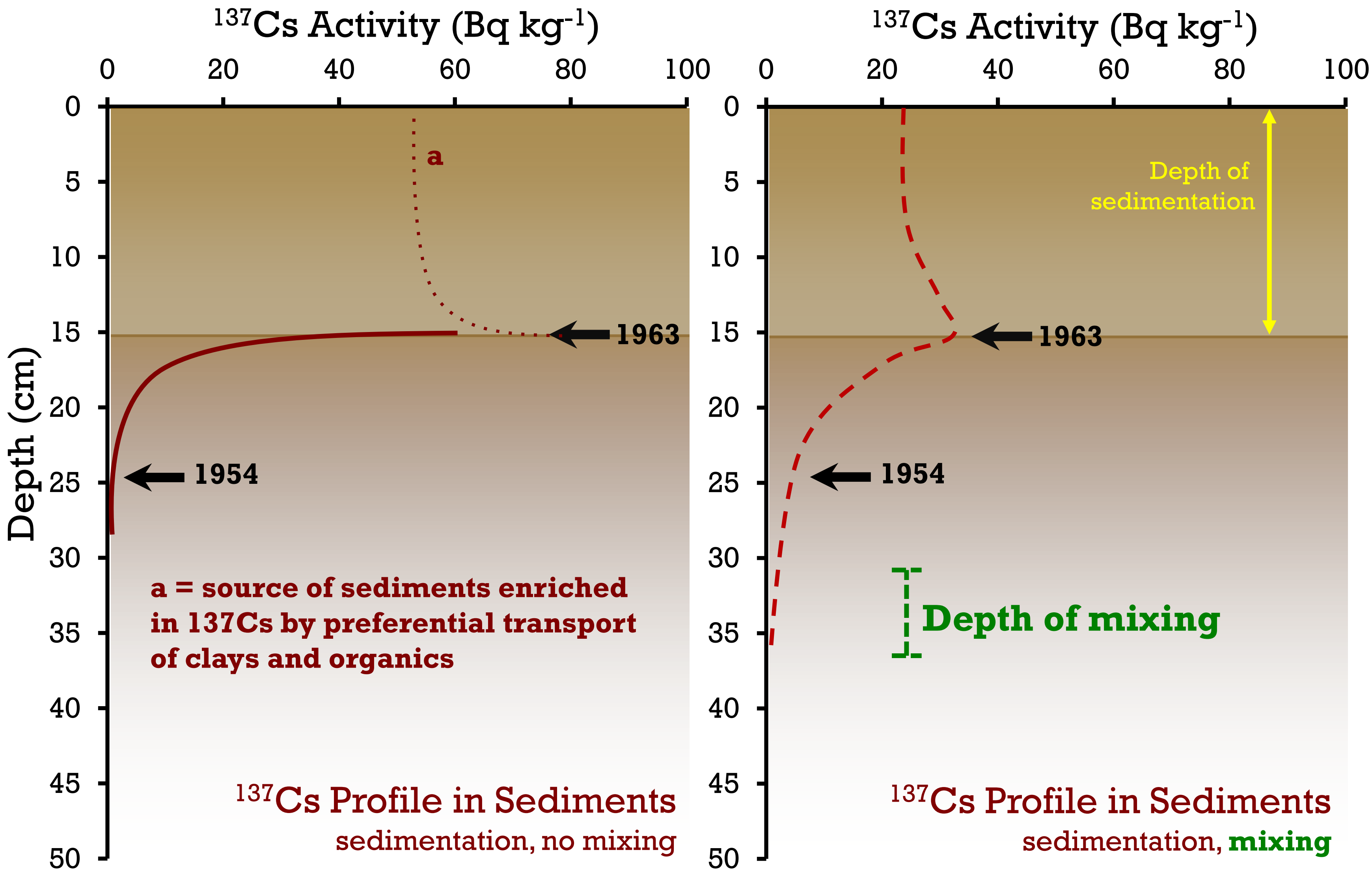
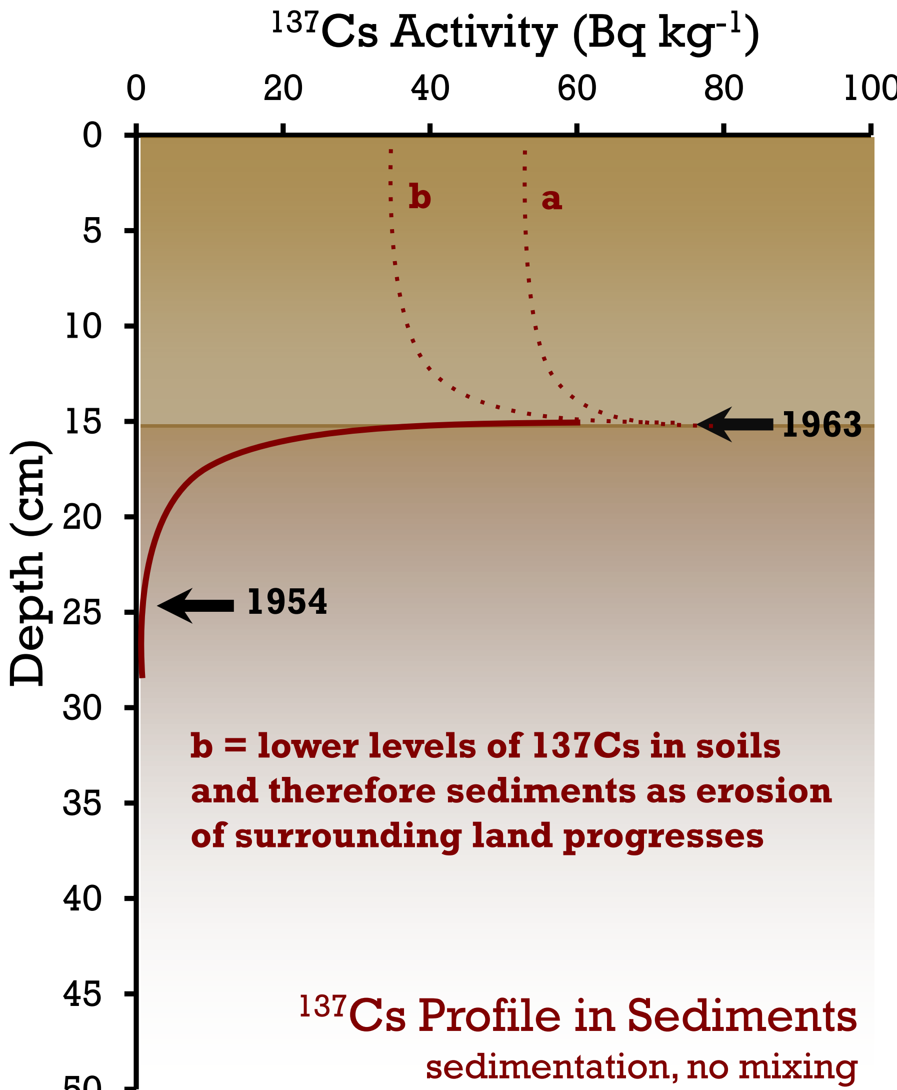
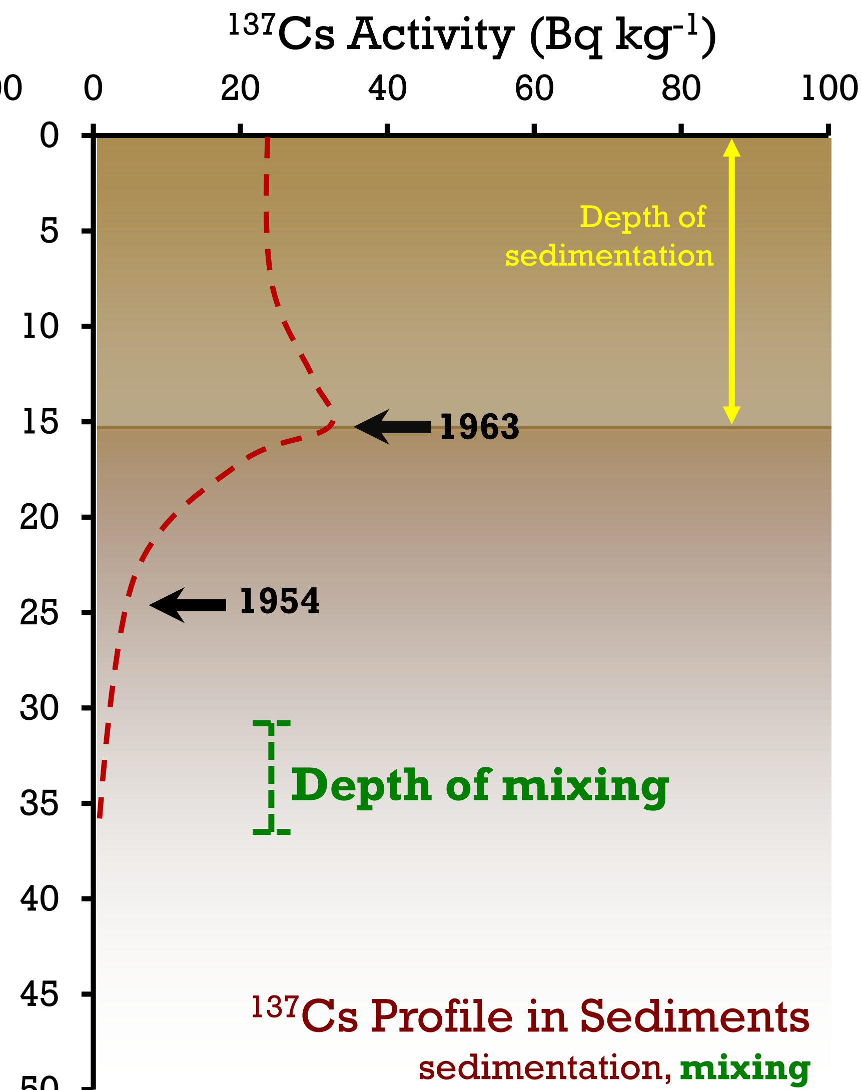


step 1: sedimentation rate





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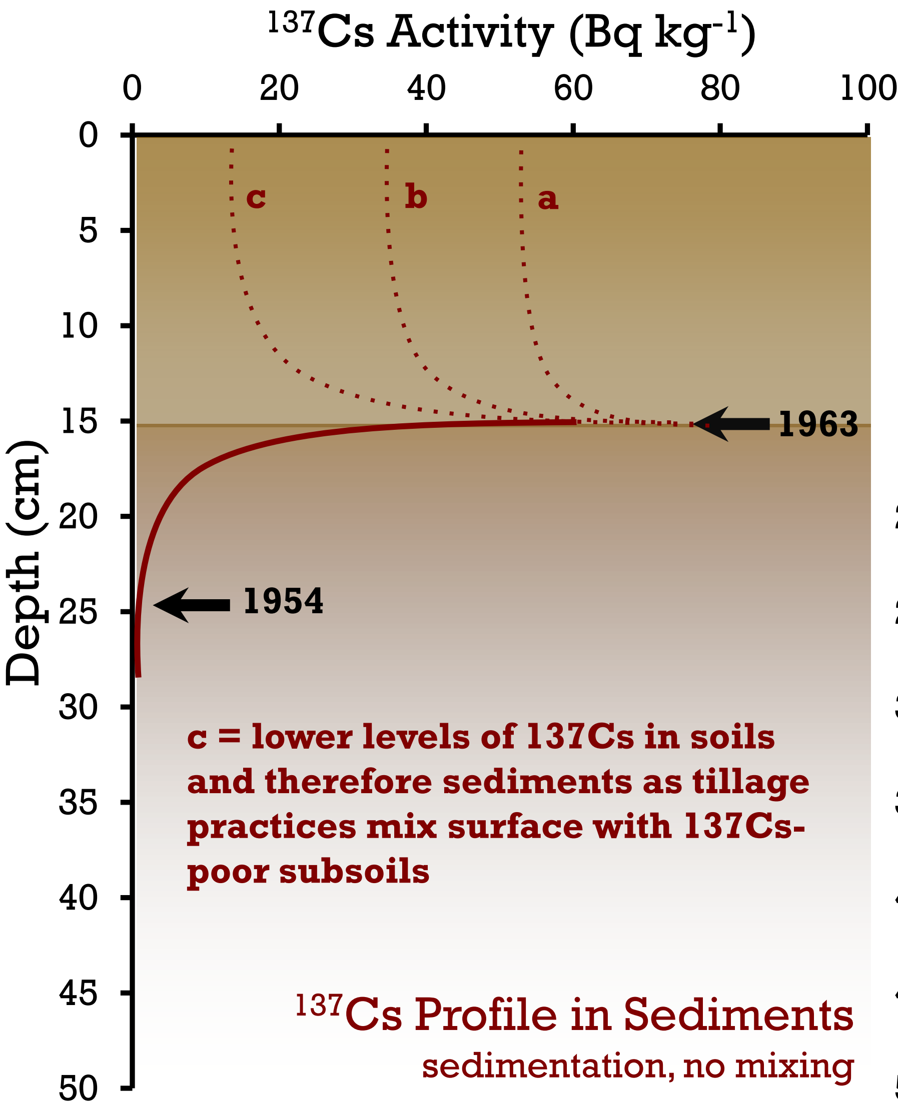
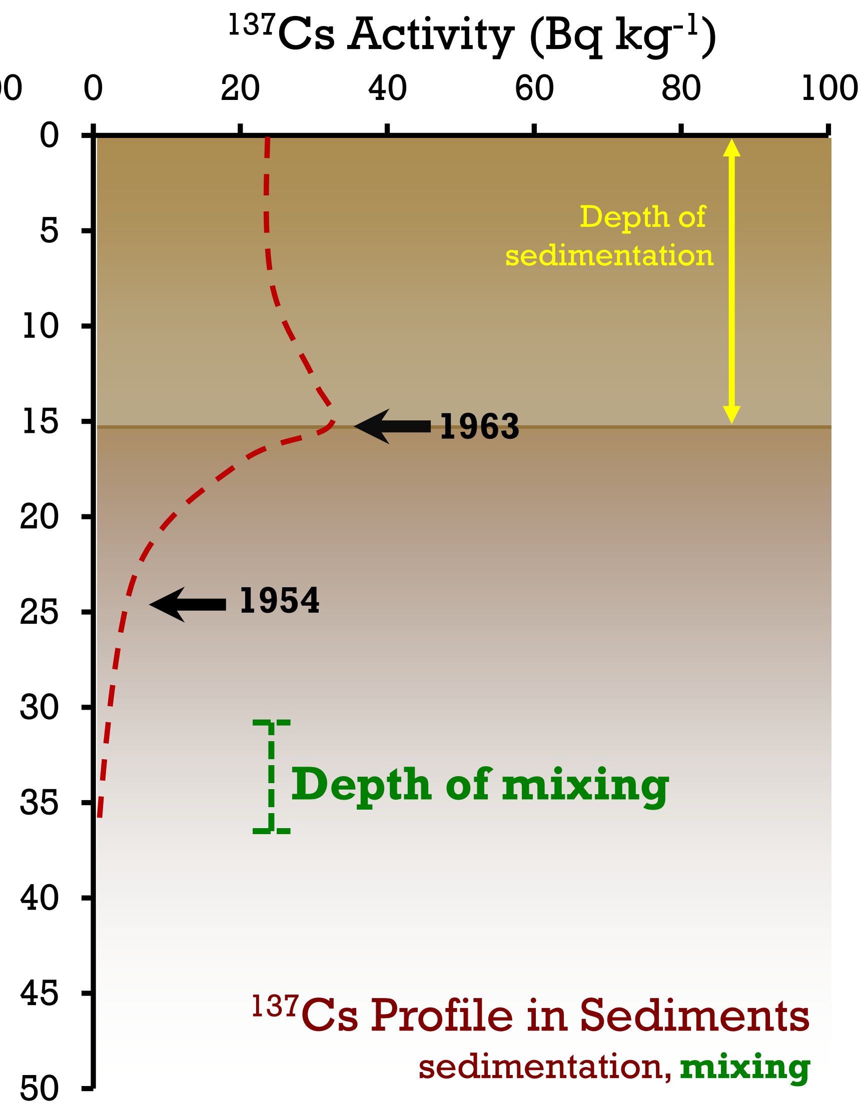
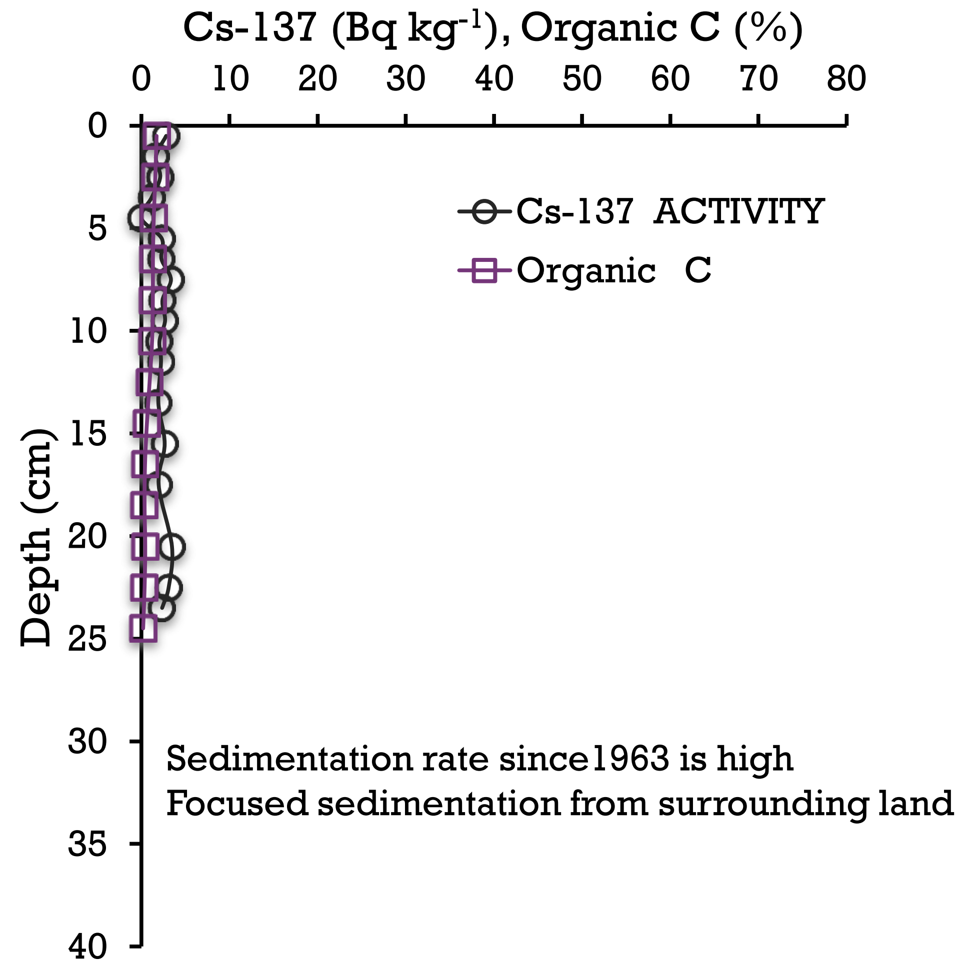




step 2: C sequestration

drained wetland

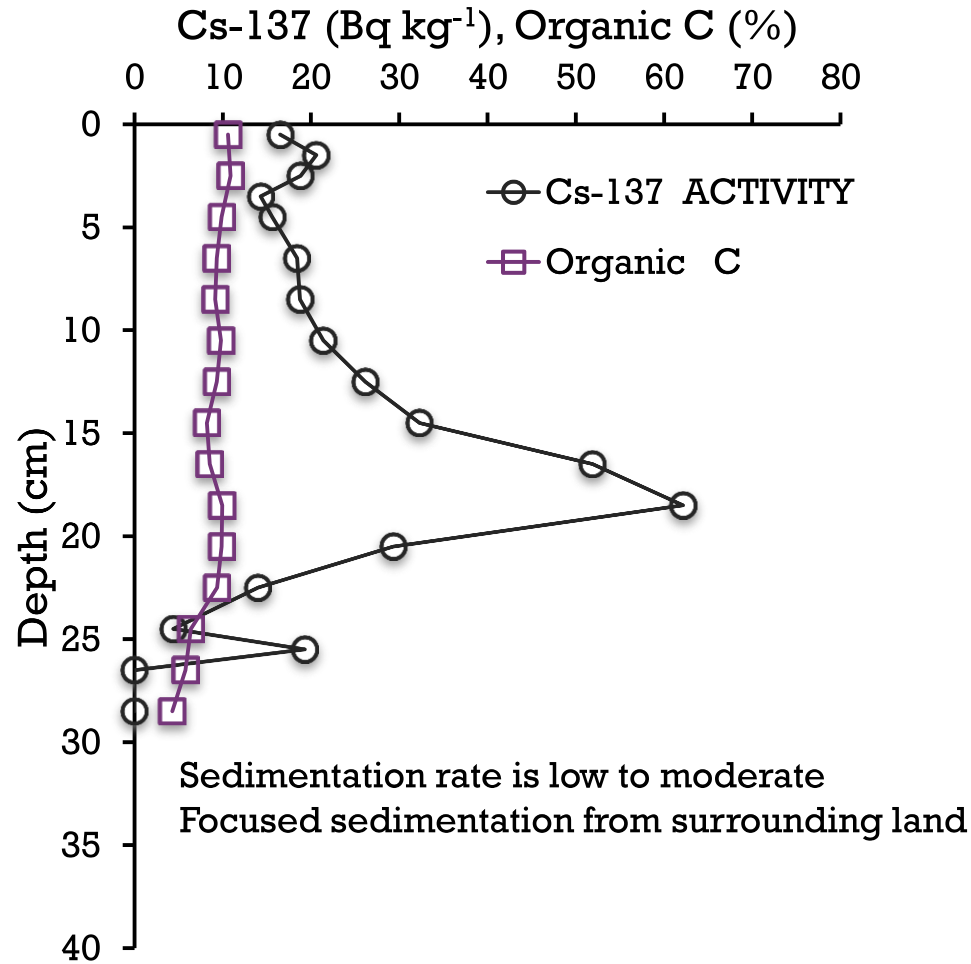


Total carbon accumulation: **5.1 kg m^{-2}**

Carbon accumulation rate: **101 g m^{-2} yr^{-1}**

10 Years After Restoration

step 2: C sequestration
10 years

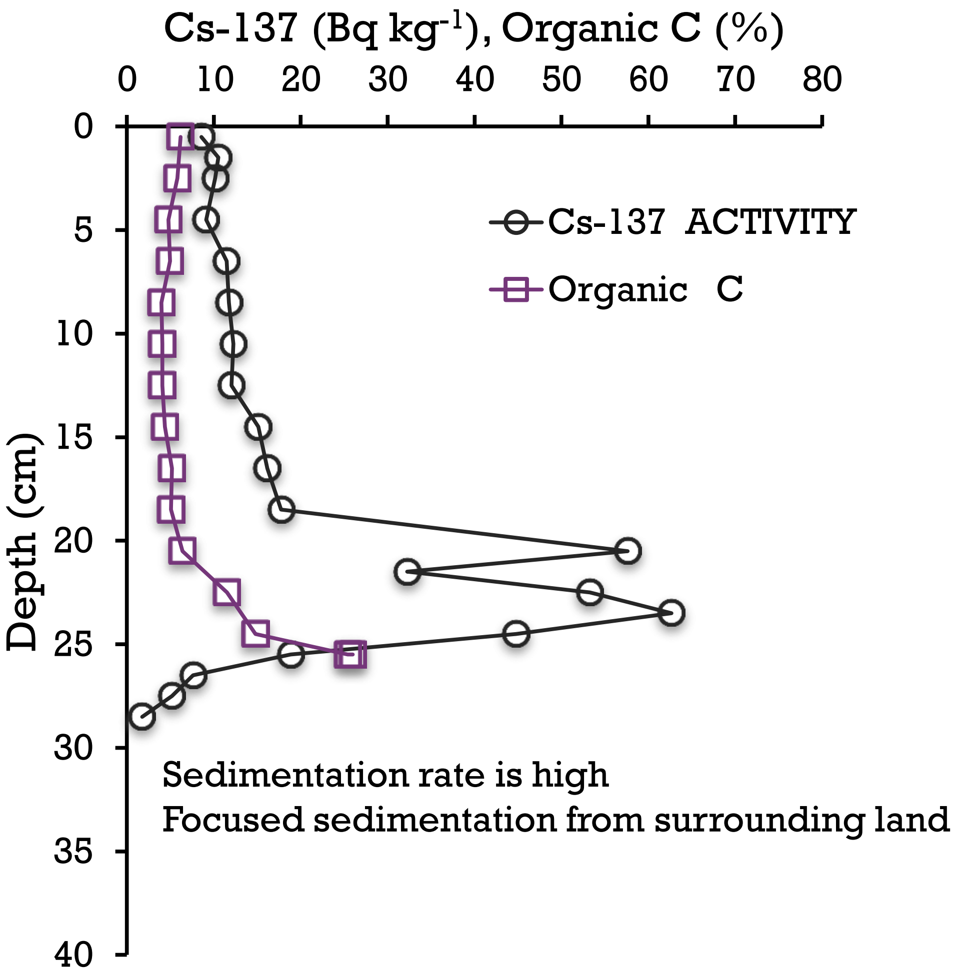


Total carbon accumulation: **7.1 kg m^{-2}**

Carbon accumulation rate: **142 g m^{-2} yr^{-1}**

step 2: C sequestration

20 years



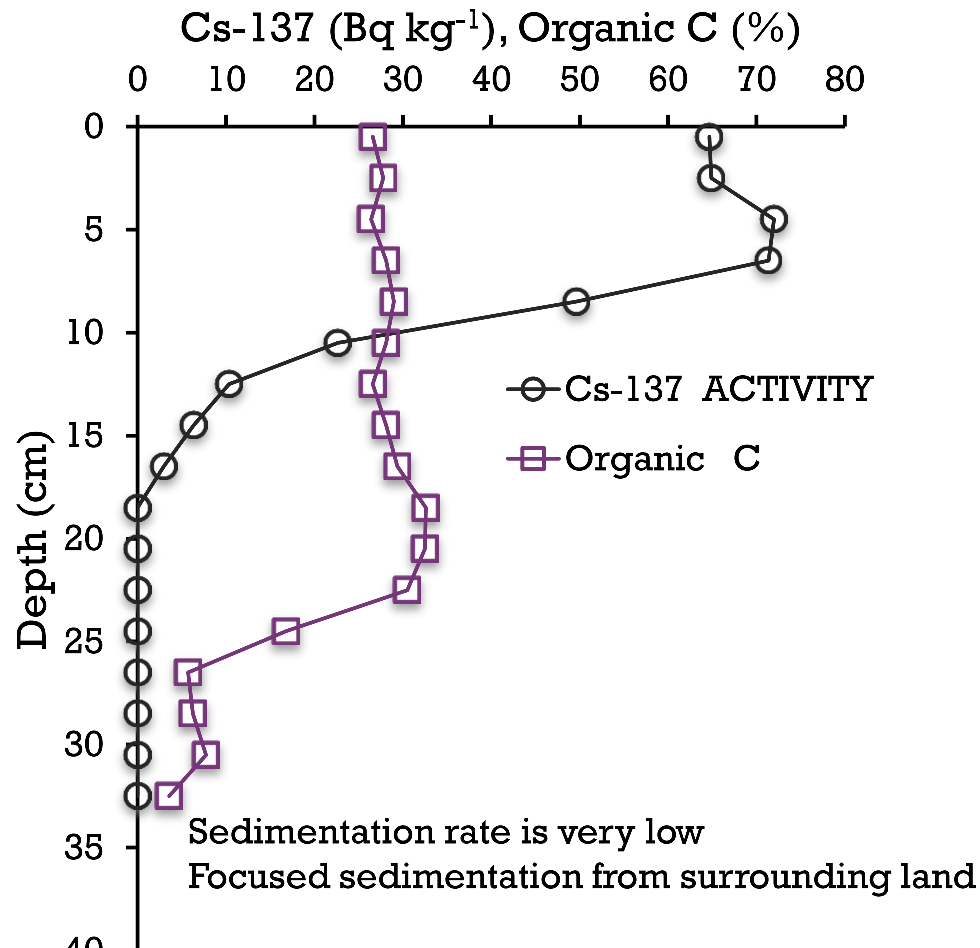
Total carbon accumulation: **18.4 kg m^{-2}**

Carbon accumulation rate: **369 g m^{-2} yr^{-1}**

35 Years After Restoration

step 2: C sequestration

35 years

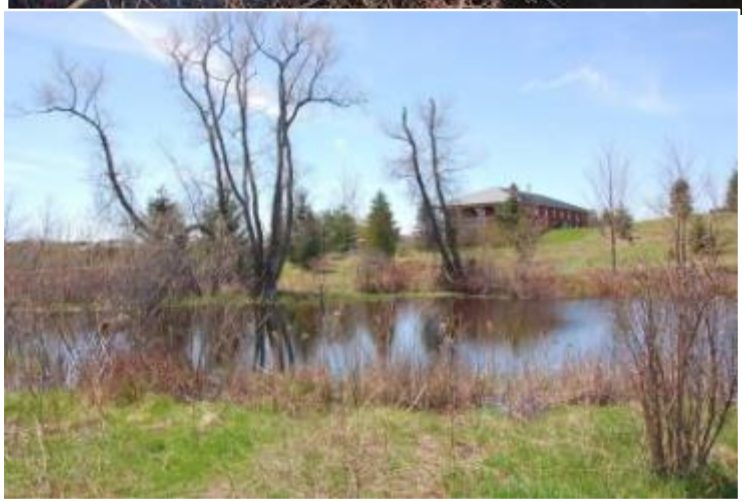


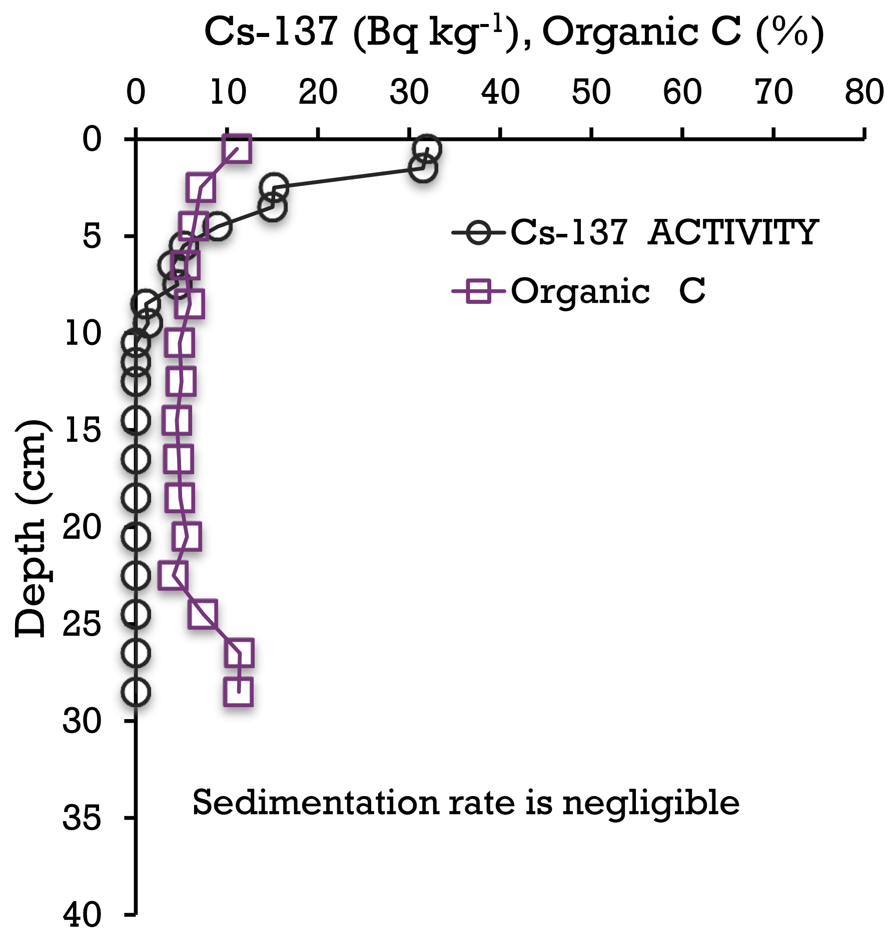
Total carbon accumulation: **2.2 kg m^{-2}**

Carbon accumulation rate: **44 g m^{-2} yr^{-1}**

50+ Years After Restoration

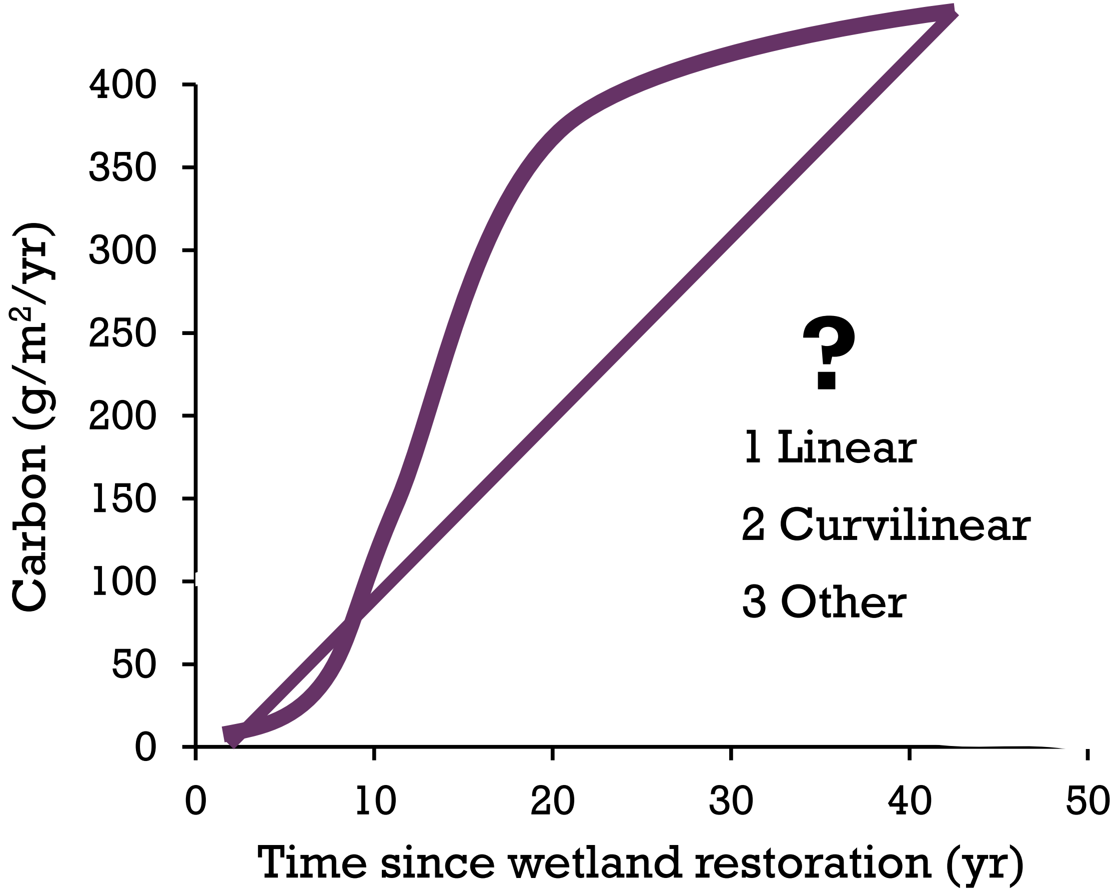
intact



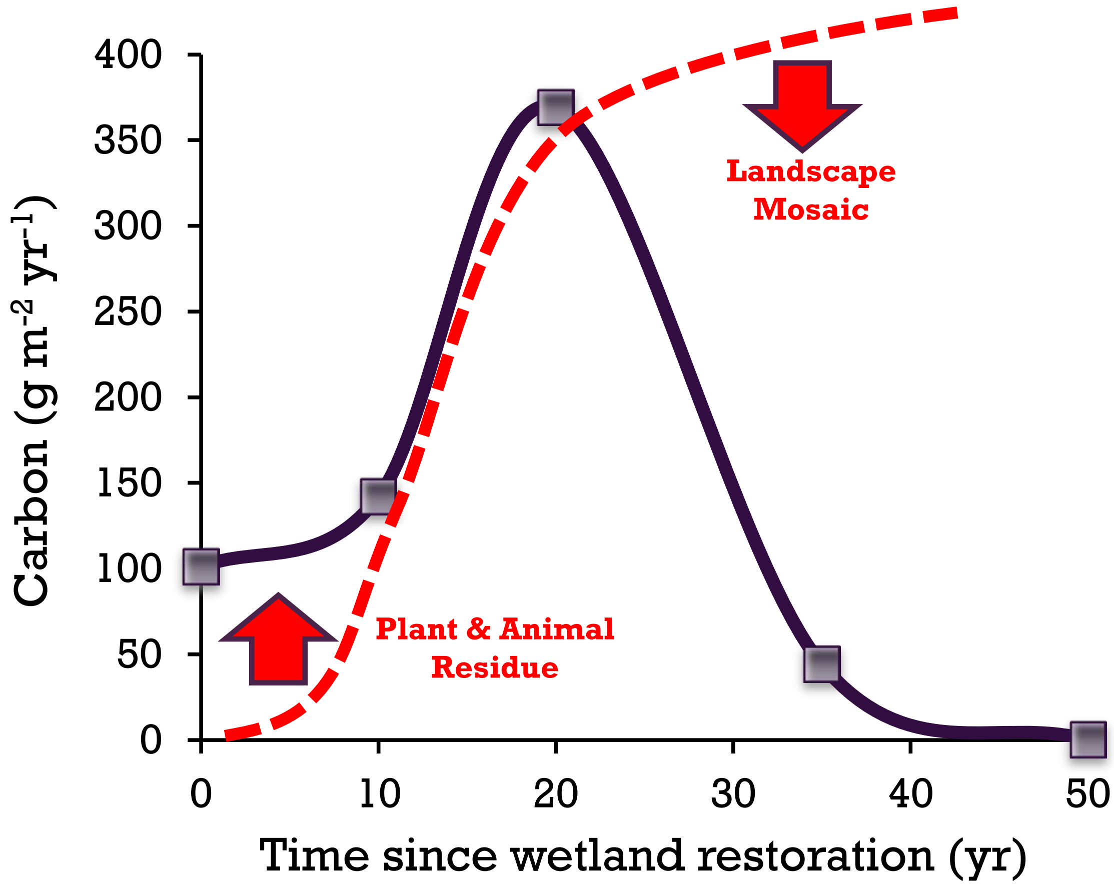


Total carbon accumulation: **negligible**
Carbon accumulation rate: **0 g m^{-2} yr^{-1}**

step 2: carbon sequestration rate

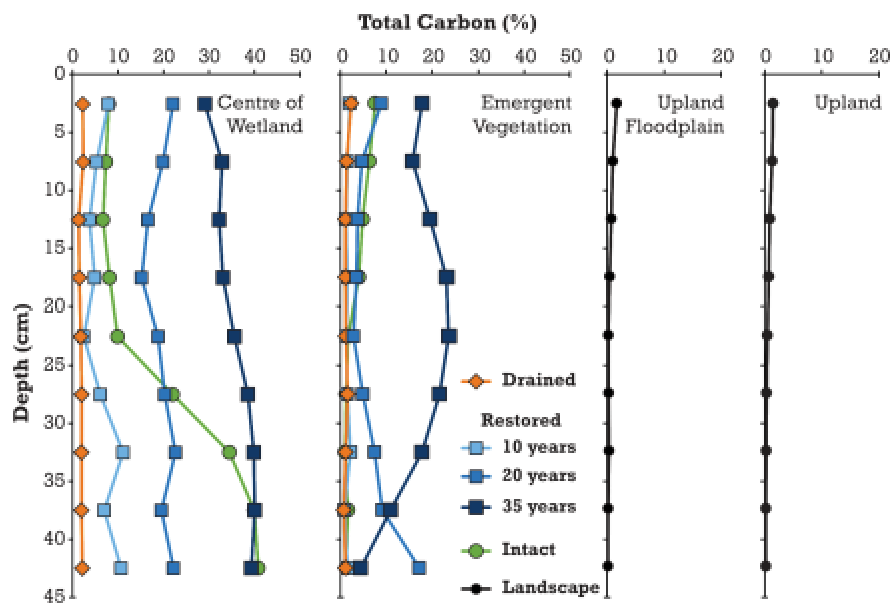


step 2: carbon sequestration rates

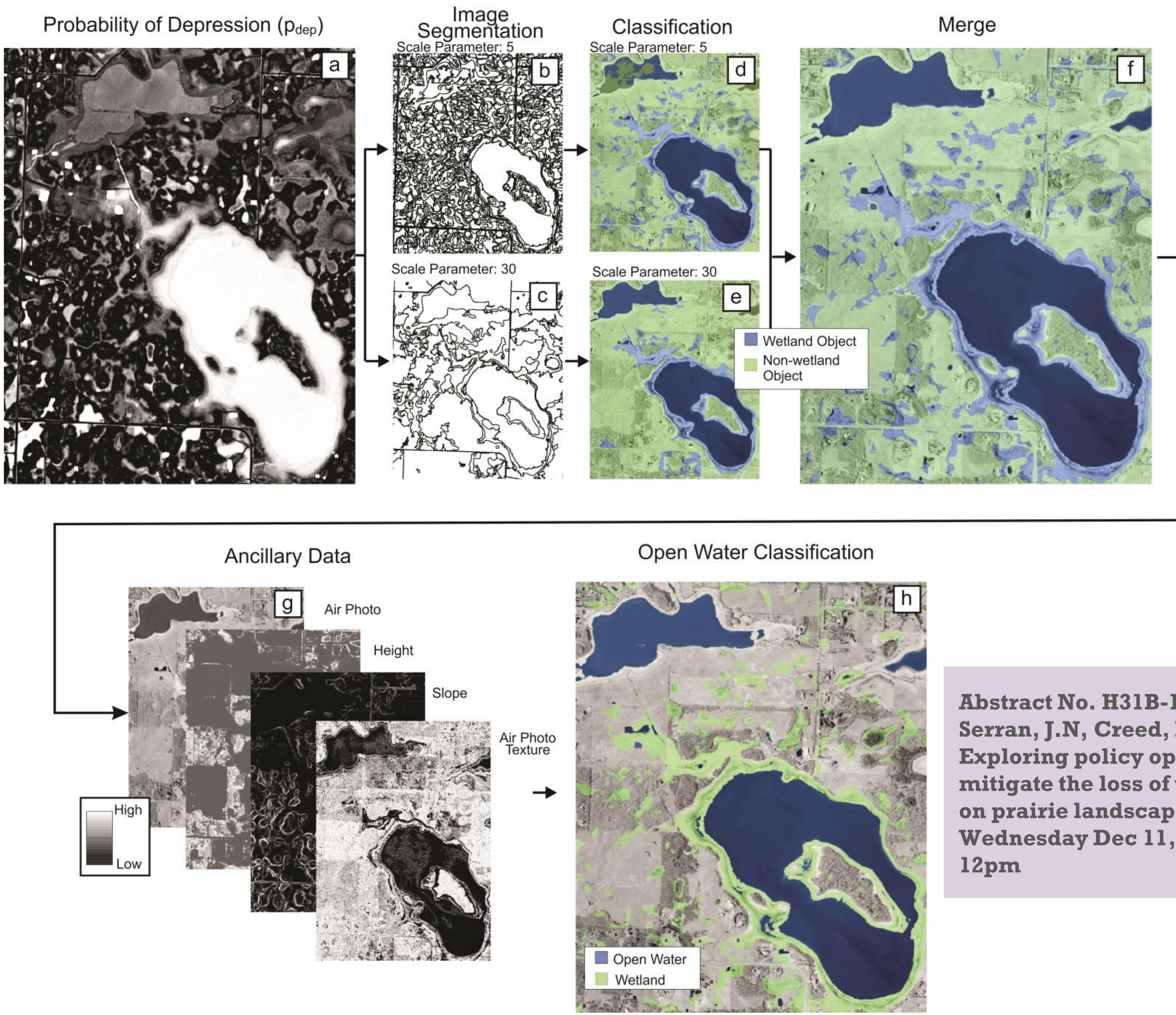


Basin Scale

step 3: carbon pools within wetland basin



step 3: carbon pools within wetland basin



Abstract No. H31B-1173
Serran, J.N, Creed, I.F.,
Exploring policy options to mitigate the loss of wetlands on prairie landscapes.
Wednesday Dec 11, 8am - 12pm

diversification of farmer’s markets

policy options to encourage farmer uptake

- Fixed payments
- Tax rebates/incentives
- Reverse auctions
- Extension/education

diversification of farmer's markets

Restored wetland (ha)	Low carbon storage (52.1 Mg CO_2 eq/yr)	High carbon storage (135.5 Mg CO_2 eq/yr)	Economic Value ($30/yr) of carbon storage based on different estimates	
			Market estimate $/Mg CO_2 eq	
			Low	**High**
1	52	135	$1,562	$4,059
10	521	1,353	$15,620	$40,590
100	5,207	13,530	$156,200	$405,900
1,000	52,067	135,300	$1,562,000	$4,059,000
10,000	520,667	1,353,000	$15,620,000	$40,590,000
353,160	18,387,875	47,782,578	$551,636,264	$1,433,477,333

**Note: 353,160 denotes total value of isolated wetland loss*

next steps for operationalizing

- Include "bundles" of ecosystem services
- Model cumulative effects of the restored wetlands on provision of ecosystem services on regional watersheds
- Model future scenarios of land development under global change

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