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# Quantifying soil carbon sequestration rates, a critical ecosystem service, from measures of wetland condition in freshwater wetlands of Ohio

Sally Wilson[1] and Siobhan Fennessy[2]

*1. Undergraduate at Kenyon College 2. Professor of Biology, Kenyon College*

## Introduction

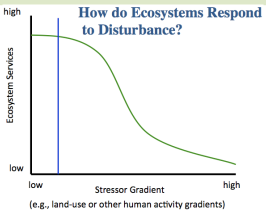



**Figure 1.** Hypothetical relationship between ecosystem service provisioning and stressor gradient.

Wetlands provide ecosystem services that increase our quality of life, including: the preservation and support of biodiversity, flood abatement, and nutrient transformation and sinks.

Wetland soils are a major reservoir of organic matter and an important carbon sink.
Carbon accumulation supports anaerobic pathways of microbial metabolism and contributes to long-term wetland stability through organic matter accumulation and mineral sediment deposit.

Carbon storage capacity varies as a function of wetland type and condition.

**Question**

How is the ability to provide carbon storage (quantified using carbon accretion rates) affected by anthropogenic disturbance?

**Hypothesis**

We expected carbon accretion rates to be greater at depressional vs. riverine sites due to hydrology and greater at high condition vs. low condition sites due to anthropogenic stressors. We predict carbon accretion rates will decrease as the stressor gradient increases (Figure 1).

10 experimental wetland sites were selected along a gradient of disturbance (Table 1).
Disturbances: 1. Land use adjacent to the site and/or 2. Hydrologic alterations through drainage.

Accumulation of carbon (accretion) can be calculated using $^{137}$Cs vertical accretion rate and bulk density of soil core samples.

## Methods

| Site name | County (OH) | HGM type | Relative ecological condition |
|---|---|---|---|
| Ballfield | Knox | Depressional | High |
| Batnest | Knox | Depressional | Low |
| Hellbender | Knox | Riverine | Moderate |
| Kokosing | Knox | Riverine | Moderate |
| Bee rescue | Knox | Depressional | High |
| Blackout | Cuyahoga | Depressional | Low |
| Lizard tail | Cuyahoga | Riverine | Moderate-high |
| Secret marsh | Cuyahoga | Depressional | High |
| Skunk forest | Cuyahoga | Riverine | High |
| Vernal pool | Cuyahoga | Riverine | Moderate-low |

**Table 1.** Experimental wetland sites (n=10) selected along a gradient of disturbance. High condition sites=least disturbed. Low condition sites = most disturbed.

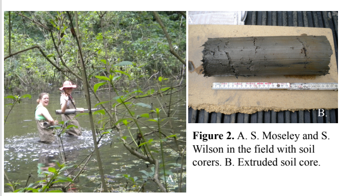


**Figure 2.** A. S. Moseley and S. Wilson in the field with soil corers. B. Extruded soil core.

**Soil Sampling and Analysis**
Soil cores 8.5 cm diameter by up to 60 cm deep were sectioned in the field into 2cm increments (Figure 3).

Increments were air dried at 70°C and weighed for **bulk density**

Bulk density = dry weight / volume of solids and pore spaces

Bulk density provides a measure of soil porosity. **Porosity** determines root penetration, water movement, and gas movement.

Ground and sieved samples were analyzed for $^{137}$Cs to determine vertical accretion.

Cesium-137 maxima had well-defined peaks that represent the location of the soil surface in 1964, the year of peak deposition of atmospheric $^{137}$Cs from aboveground weapons testing.

Accretion rate (mm/yr) = depth (mm) of Cs-137 peak in soil / time (years) since 1964.

Accumulation of C can be estimated from $^{137}$Cs vertical accretion rate and carbon concentration.

## Results

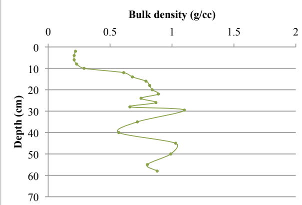
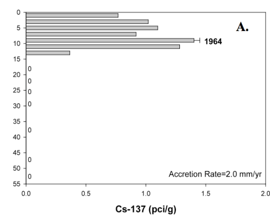



**Figure 3.** Bulk density analysis of 2cm increments from a 58cm soil core taken from Ballfield, a high-condition depressional site, in Knox County, Ohio. Sampled in June, 2010.



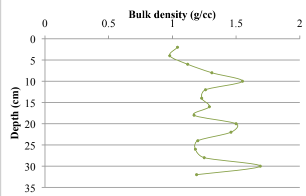
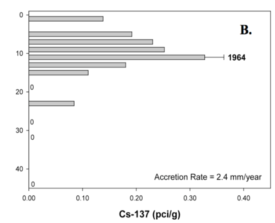




**Figure 4.** Bulk density analysis of 2cm increments from a 32cm soil core taken from Hellbender, a moderate-condition riverine site, in Knox County, Ohio. Sampled in June, 2010.



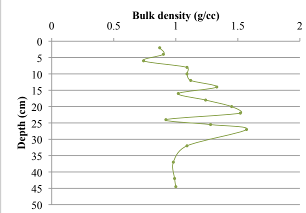




**Figure 5.** Bulk density analysis of 2cm increments from a 44.5cm soil core taken from Kokosing, a moderate-condition riverine site, in Knox County, Ohio. Sampled in June, 2010.

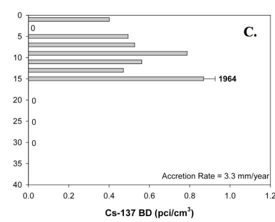



**Figure 7.** Representative $^{137}$Cs profiles with depth for A. Ballfield B. Hellbender and C. Kokosing experimental sites. Zeroes denote where $^{137}$Cs was no longer detected. Cesium-axis values differ between graphs.

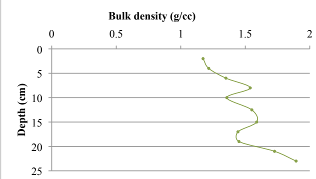



**Figure 6.** Bulk density analysis of 2cm increments from a 23cm soil core taken from Batnest, a low condition depressional site, in Knox County, Ohio. Sampled in June, 2011.

| Site name | Ecological condition | HGM type | Accretion rate (mm/yr) |
|---|---|---|---|
| Lizard tail | Moderate-high | Riverine | 1.5 |
| Skunk forest | High | Riverine | 1.5 |
| Kokosing | Moderate | Riverine | 3.3 |

**Table 2.** Comparison of soil accretion rate among riverine sites of varying ecological condition. The soil accretion rate at Kokosing was more than double the rate of accretion at Lizard tail and Skunk forest, two other riverine sites of higher condition.

## Discussion

**Figure 8.** Photograph of Batnest, a low-condition depressional wetland in Knox County, Ohio.

**Bulk density**
Of the local sites, the soil core taken at Batnest had the greatest bulk densities (Figure 6).

Typical mineral soils have bulk densities that range from 1.0 to 1.6 g $cm^{-3}$.

A bulk density greater than 1.6 g $cm^{-3}$ may indicate compaction, which means the soil has low total porosity. Low porosity tends to inhibit gas movement and storage.

As a result, the rate of carbon accretion may be lower at Batnest due to compaction.
Potential source of compaction: agricultural machinery (Figure 8).

**Soil accretion**
Of the local sites, Kokosing had the greatest soil accretion rate (Figure 7).

Compared to other riverine sites, the soil accretion rate at Kokosing is higher (Table 2).

Due to hydrologic alterations, Kokosing is beginning to functioning like a depressional wetland site with regard to soil accumulation.

## Future work

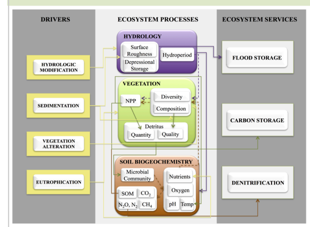



**Figure 9.** A conceptual model of ecosystem service production.

Nutrient analysis of organic C and N using a CHN analyzer and total P using colorometric analysis.

Quantify C, N, and P accumulation using $^{137}$Cs vertical accretion rate and bulk density.

Model estimated amount of carbon storage provided, taking into account the interactions in Figure 9.

This model has application for restoration, management and policy.

## References

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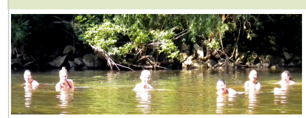
## Acknowledgements



2011 summer research group in the Kokosing River.

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