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## Purpose & Research Questions

**Case 1:** Determine whether locally produced biochar made in small-batch kilns, utilizing invasive plant biomass, can be as effective as commercial grade biochar. Can these biochars have the same impact in the amelioration of urban & roadside soil as their commercially produced counterparts?

**Case 2:** Determine how much impact biochar had to road-side, salt affected soil adjacent to a highway exit ramp. Did adding biochar improve the biotic & abiotic soil properties of the highway embankment after 5 years?

## Abstract - Case 1

### Utilizing Invasive Species to Improve Urban Soils



Small-batch kiln produced biochar from invasive species, gathered from local feedstock, showed improved soil hydrology & economic potential

## Sites, Methods & Analysis

- Case 1:** Howard Community College (HCC)
  - Columbia, MD
  - Sandy loam



### Invasive Species

- Privet \*
- Ligustrum sinense
- White Ash \*
- Fraxinus americana
- Emerald ash borer infested
- Paulownia
- Paulownia tomentosa
- Autumn Olive
- Elaeagnus umbellata

- ROGUE BIOCHAR™**
- Commercial biochar
- Installation - July 2022
- 30 cm depth x 1 m<sup>2</sup>
- 4% biochar by mass
- Seasonal field measurements
- \* Used in field study

Both field sites used the same equipment to obtain field data:

- MPD & DCP, see above
- Dynamax SM150
  - Soil moisture %
- FieldScout TDR150
  - Electrical Conductivity
  - Volumetric Water Content

Modified Phillip-Dunne (MPD) Infiltrrometer  
By Upstream Technologies

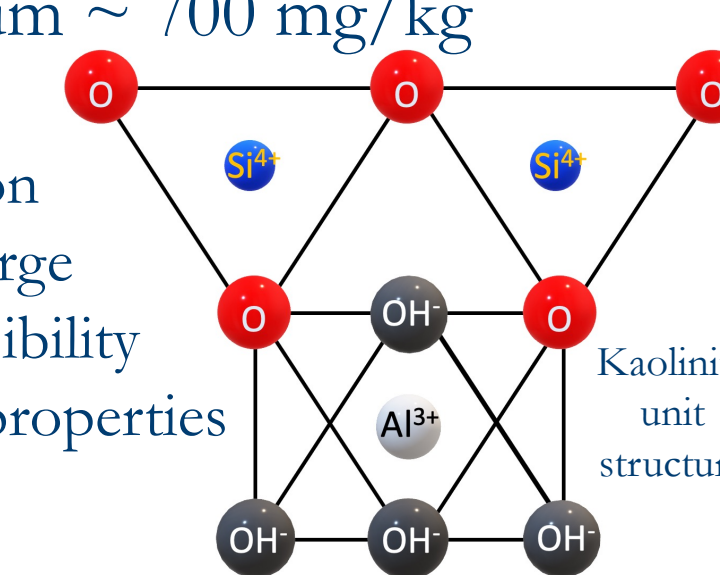
- Infiltration
- Saturated Hydraulic Conductivity ( $K_{sat}$ )

K-100A Dynamic Cone Penetrometer (DCP)  
By Kessler Soils Engineering

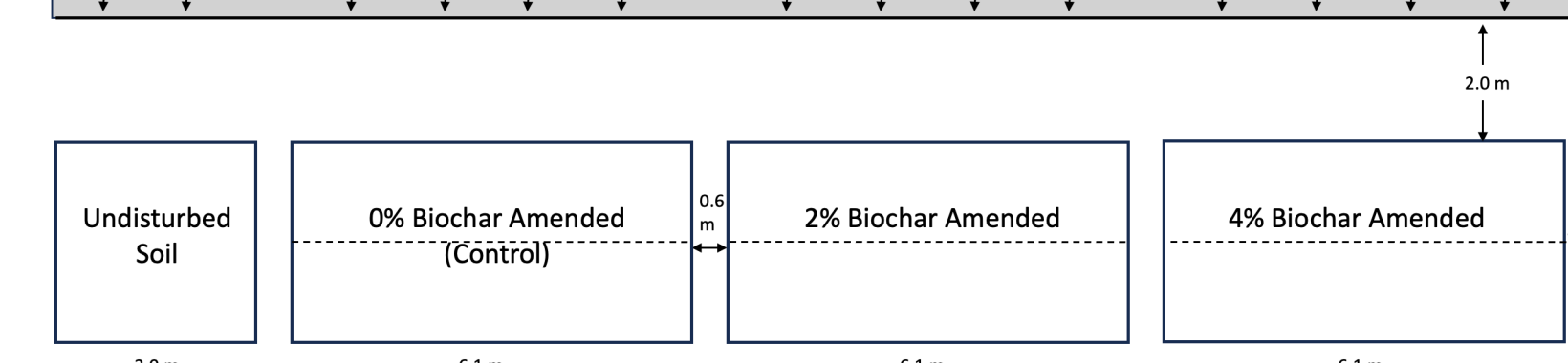
- Resistance of soil

- Case 2:** I95-South Exit Ramp 109B

- Elkton, MD @ DE border
- Sandy loam, w/ sodium ~ 700 mg/kg
- Kaolinite
  - ~ 75% of clay fraction
  - Weak (-) surface charge
  - [Na<sup>+</sup>] affects dispersibility & cementation properties



Interstate 95 - South Exit Ramp 109B



## Conclusions

### Small-batch Kiln

**Invasive**

- Effective for general use
- Labor intensive feedstock gathering

Soil Hydrology & Soil Compaction

### Commercial

**Rogue™**

- Effective for general use
- Mechanized production w/ economies of scale

after 1+ years in soil

Cost to produce 1 yd<sup>3</sup>

Beginning 1 year after I95-South installation, **biochar had little to no impact** in improving overall soil health of embankment



**Salt accumulation combining with clay composition** of the native soil is the likely cause of failure



## Abstract - Case 2

### Soil Mineralogy Impacts Biochar Effectiveness

**Impervious Soil**

- ~ 10% Kaolinite clay (w/w)
- Road salt accumulation ~ 17.0 SAR
- Minimal sub-surface organic matter

**Till in Biochar**

- July 2020 - seasonal monitoring
- 2% & 4% (w/w) application
- 30 cm depth x 36 m<sup>2</sup>

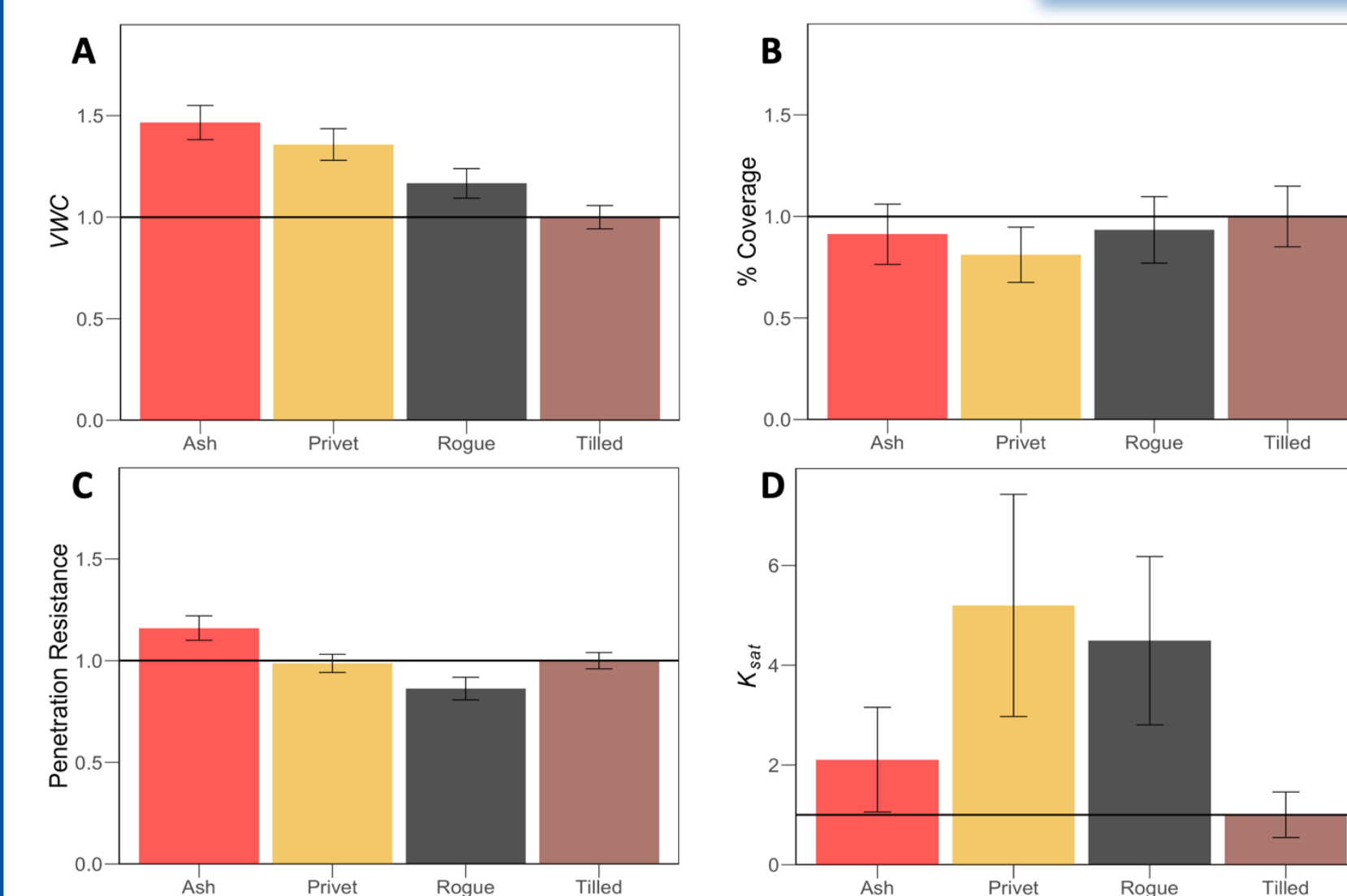
**Water-logged Soil w/ Biochar**

- Short-term soil improvement
- Soil returned to degraded condition after 1 year
- Elevated Electrical Conductivity & VWC

Biochar application yielded no improvement to soil structure or soil health over the course of 5 year monitoring program

## Results

### Case 1



### Response Factor ( $R_f$ )

Allows for a relative quantification of the treatment's effectiveness

$$R_{fVWC} = \frac{VWC_{treatment}}{VWC_{control}} > 1.0$$
$$R_{f\%Cov} = \frac{\% Coverage_{treatment}}{\% Coverage_{control}} > 1.0$$
$$R_{fPR} = \frac{PR_{treatment}}{PR_{control}} < 1.0$$
$$R_{fK_{sat}} = \frac{K_{sat,treatment}}{K_{sat,control}} > 1.0$$

Biochar addition more effective than 0% biochar or "Tilled" treatment

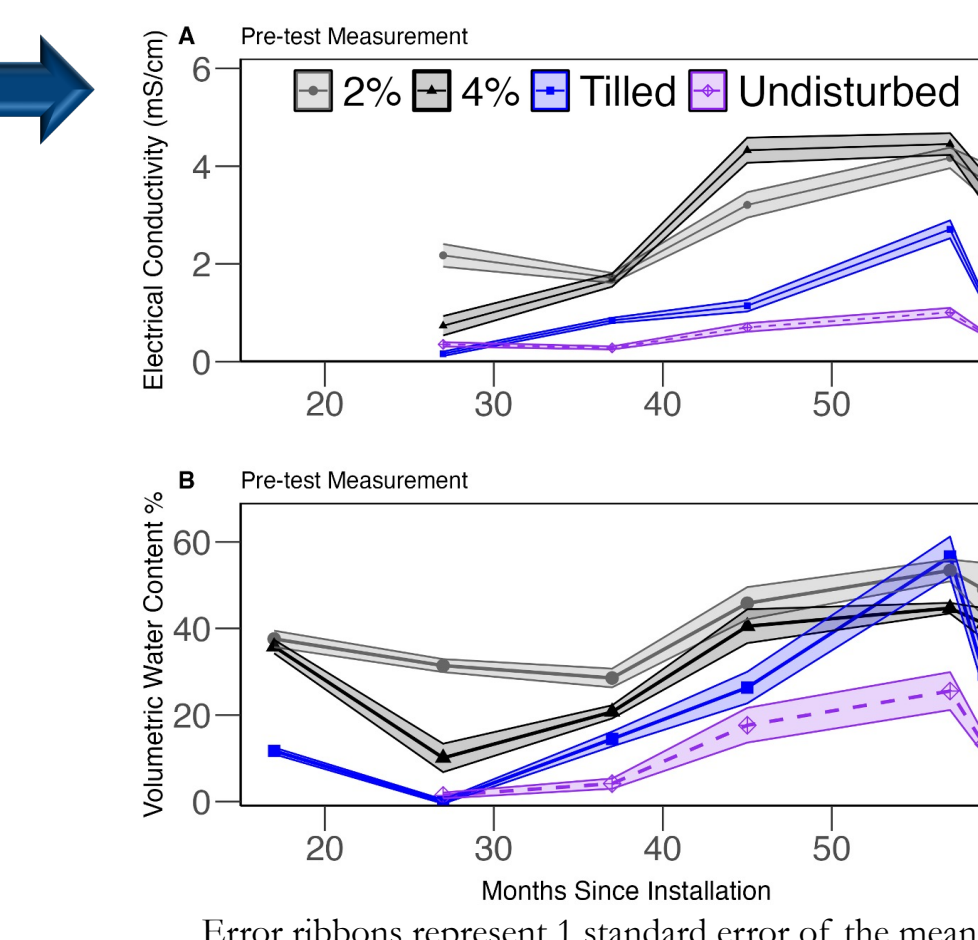
### Howard Community College

- Biochar additions showed improvement to soil hydrologic functionality
- Commercial biochar had best results for soil penetration resistance, indicating less compaction
- No difference in turfgrass coverage among treatments

### I95-S Exit Ramp 109B at MD 279

- Electrical conductivity 1.5 to 5 times higher in biochar plots
- Biochar treatment showed increased water holding capacity
- Infiltration below detectable rate of MPD, 1 year after biochar installation
- Biochar treated areas showed no improvement in vegetation

### Case 2



## Directions for Future Research

- Mediated electrochemical analysis to determine the redox properties from invasive feedstocks
- Electrostatic interactions of biochar with clay minerals & salts to study aggregation potential
- Erosion rates of biochar to understand longevity of applications

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