

PYRENE SORPTION TO AND EXTRACTION FROM CORN STOVER CHAR

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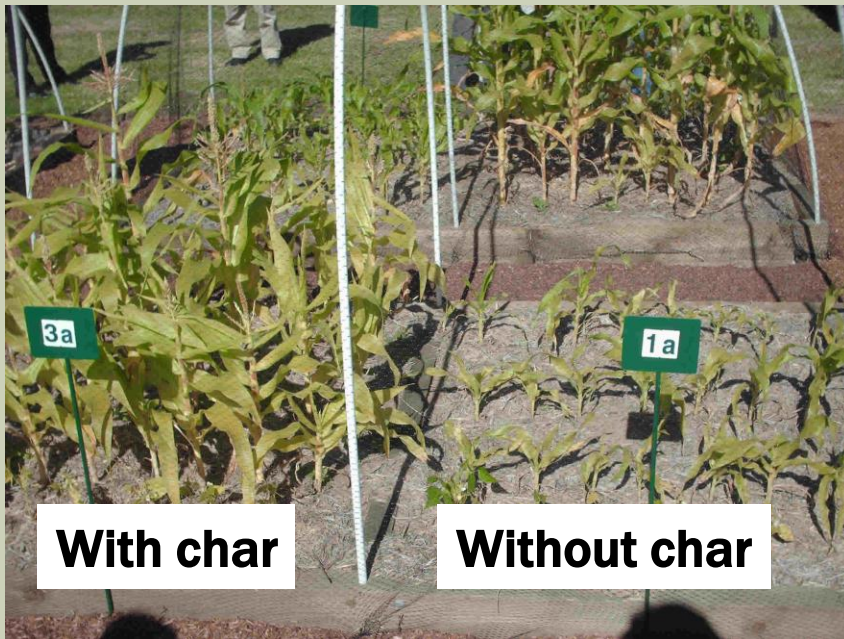
ILLINOIS SUSTAINABLE
TECHNOLOGY CENTER
PRAIRIE RESEARCH INSTITUTE



ILLINOIS

BIOCHAR: VALUABLE COMMODITY?

Soil Amendment



TERRESTRIAL CARBON SEQUESTRATION

Analysis of Terrestrial Carbon Sequestration at Three Contaminated Sites Remediated and Revitalized with Soil Amendments

United States Environmental Protection Agency | Solid Waste and Emergency Response | EPA-542-R-10-003 | February 2011

Sharon Steel Site
Famell, PA
Former steel mill/
slag disposal site

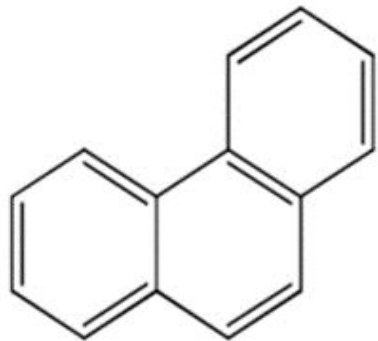
Stafford Site
Stafford, VA
Airport with exposed
acidic soils

Leadville Site
Leadville, CO
Former mining site

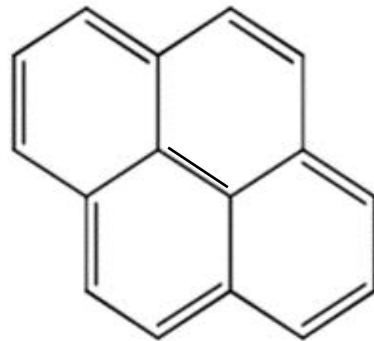
Version 1, www.clu-in.org/ecotools

BIOCHAR: HAZARDOUS WASTE?

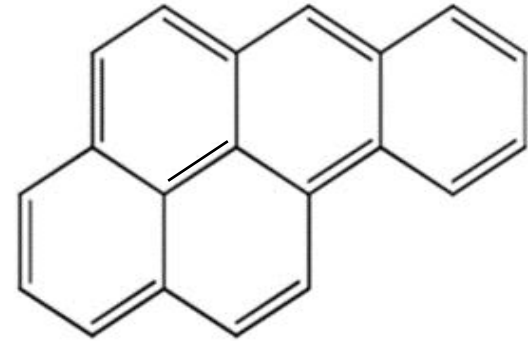
- Contain polycyclic aromatic hydrocarbons (PAHs)
- Carcinogens



Phenanthrene



Pyrene



Benzo[a]pyrene

BIOCHAR PREPARATION

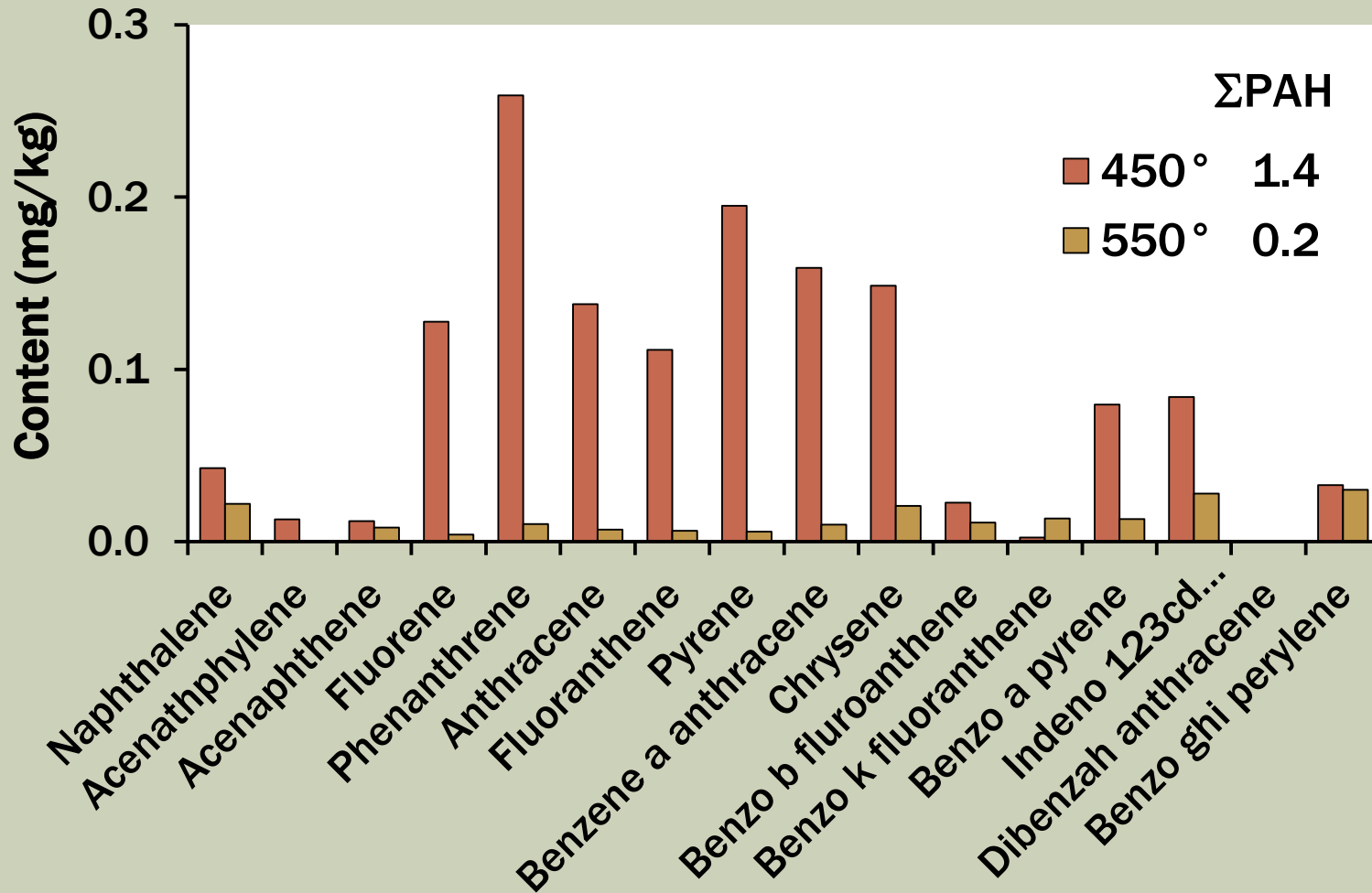
- **Corn stover**
 - 450°
 - 550°
 - 750°
- **N₂ atmosphere**



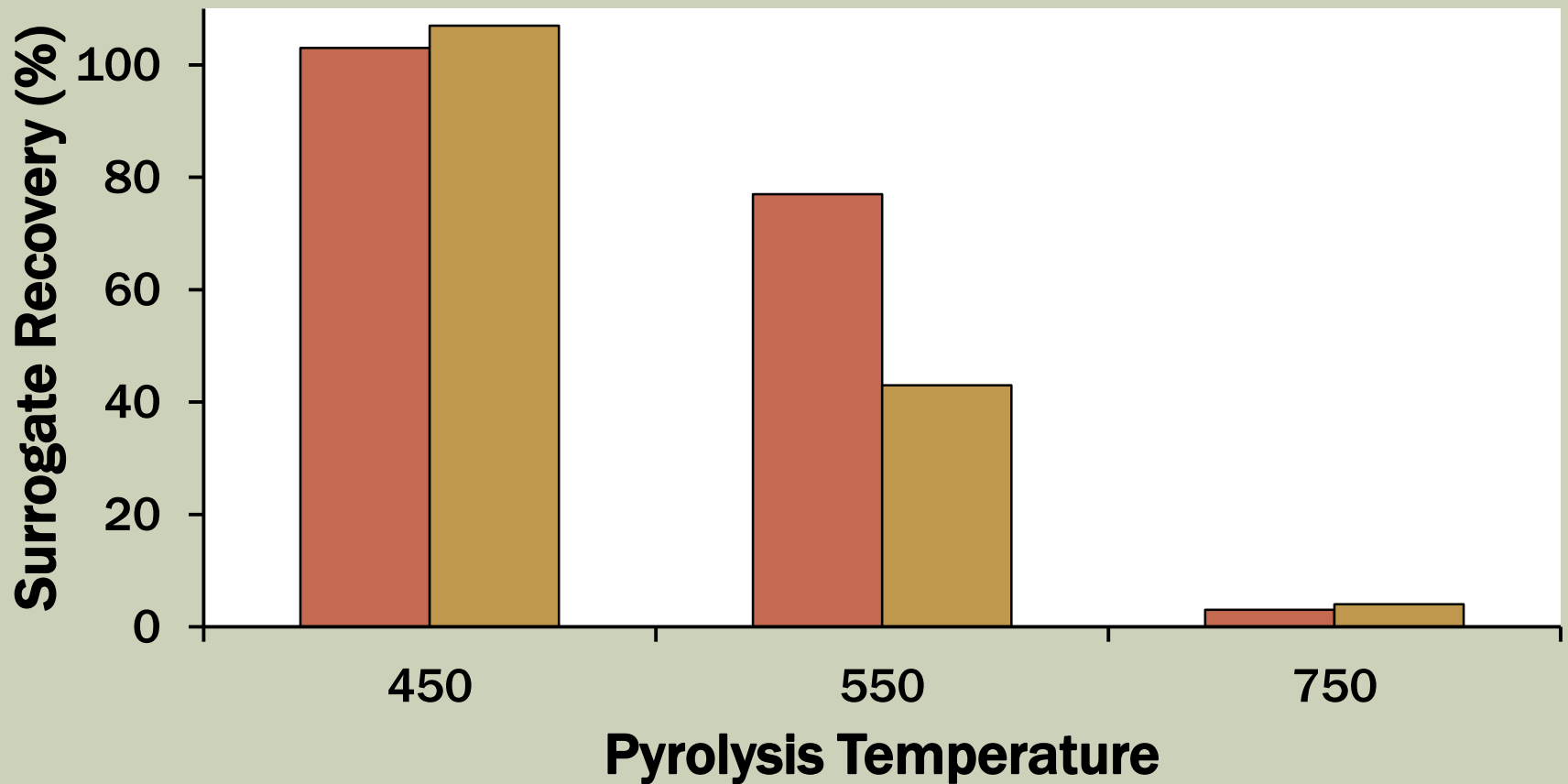
CHAR CHARACTERIZATION

- Surface area, etc.
- Total PAH content
- Adsorption of PAHs
- Mild extraction (bioavailability)

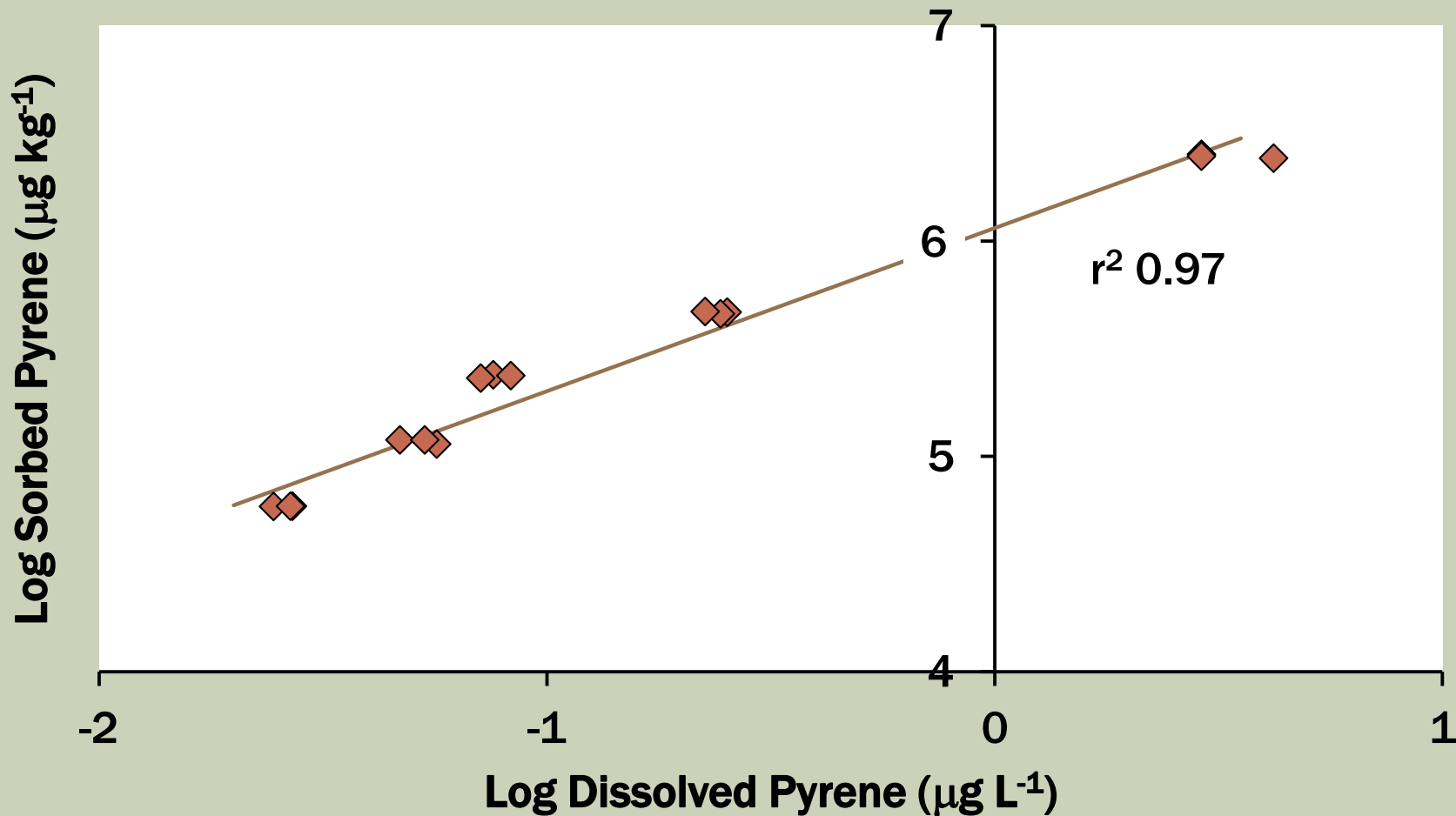
USEPA-16 PAH CONTENT OF CORN STOVER CHAR



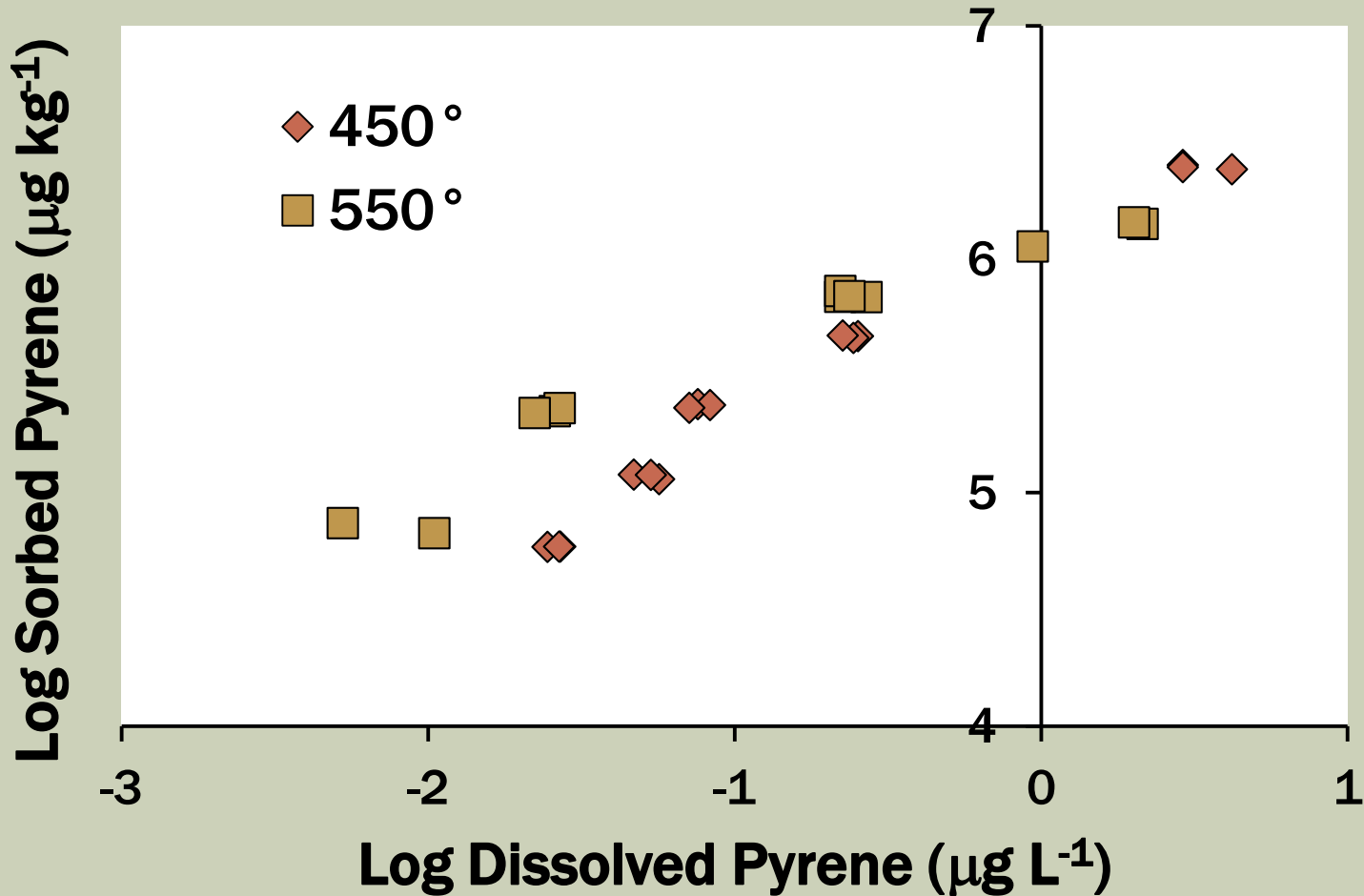
SURROGATE RECOVERY



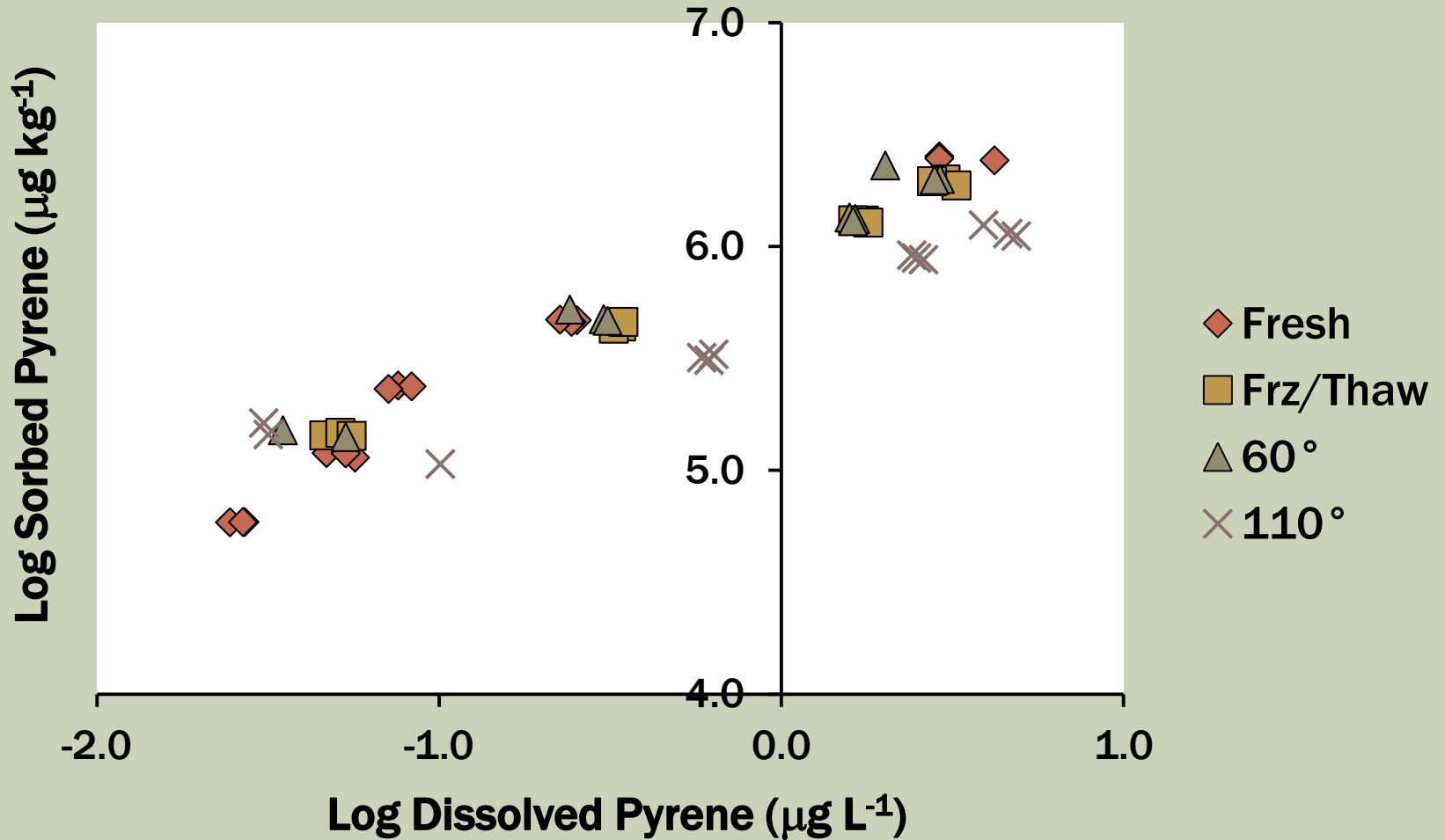
PYRENE SORPTION ISOTHERM 450 ° CHAR



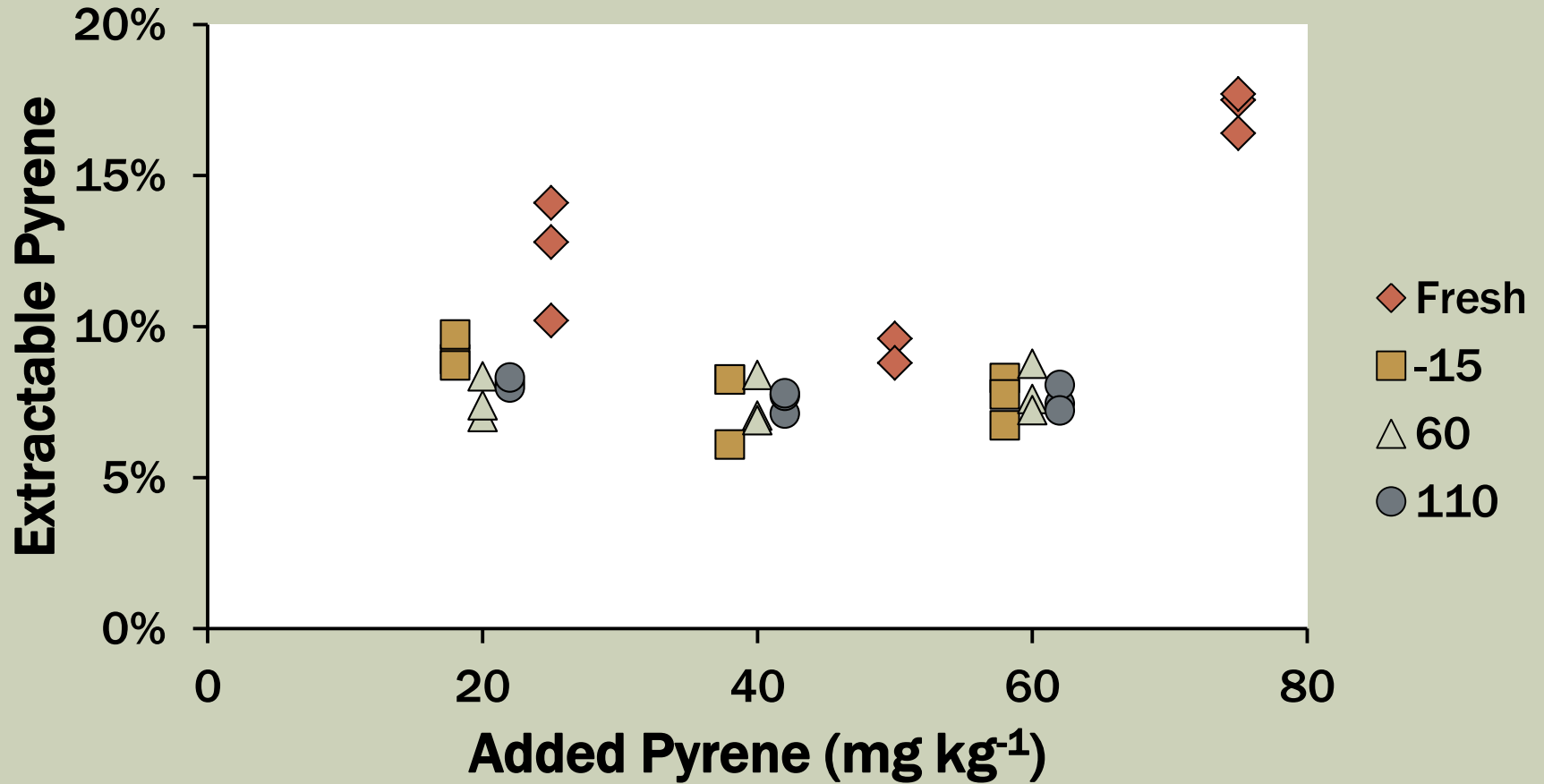
SORPTION ISOTHERMS 450 AND 550 °












PYRENE SORPTION, AGED 450 ° CHAR



MILD EXTRACTIONS, 450 ° CHAR



WORK PLAN, FRESH CHAR

| | 450° | 550° | 750° |
|------------------|--|---|---|
| Total PAHs |  |  |  |
| Sorption |  |  |  |
| Extraction, HPCD |  |  |  |















Done



In progress

WORK PLAN, AGED CHAR

| | 450° | 550° | 750° |
|------------------|---|--|--|
| Char aging |  |  |  |
| Total PAHs |  |  |  |
| Sorption |  |  |  |
| Extraction, HPCD |  |  |  |

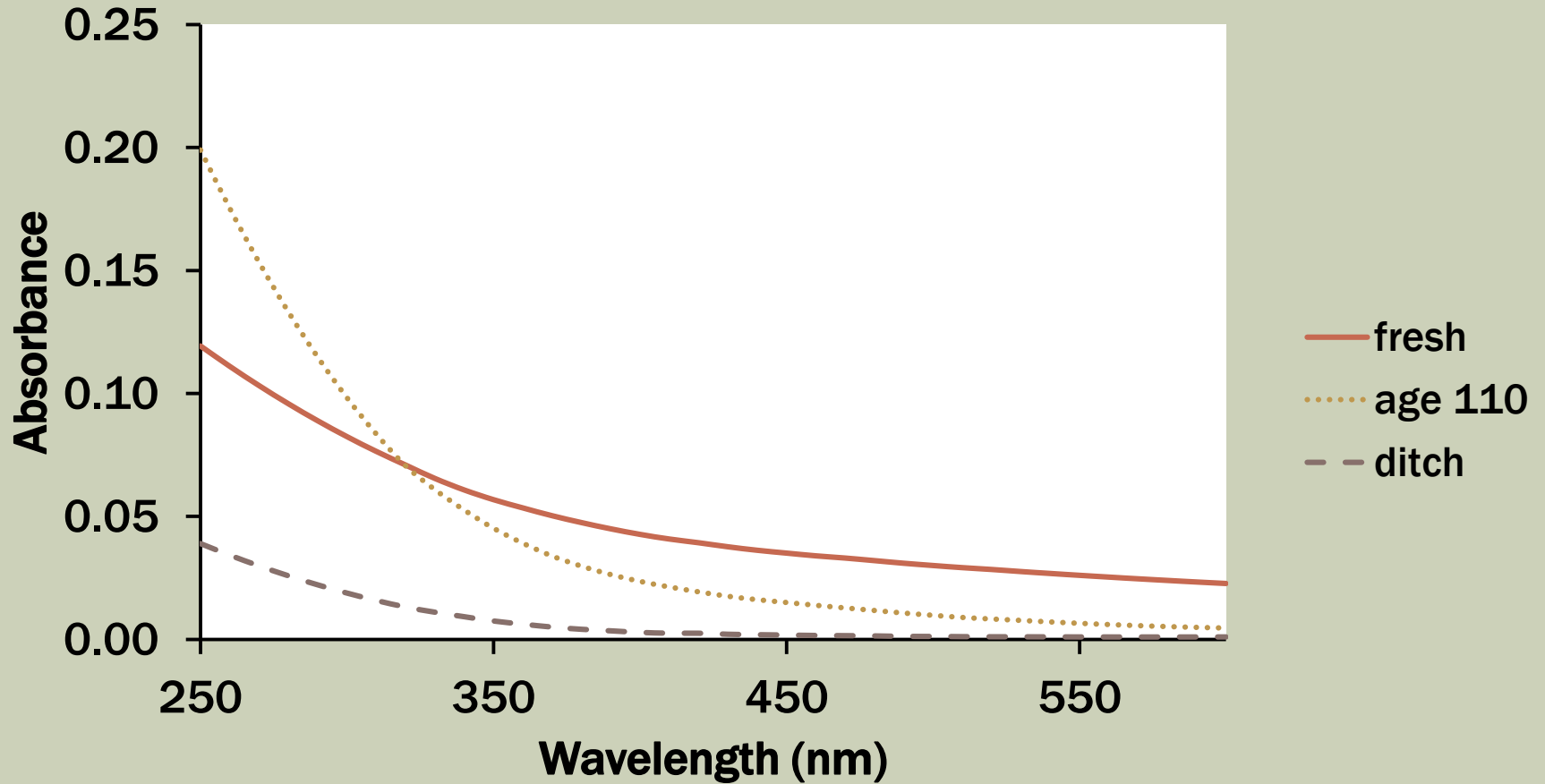


Done



Planned

UV SPECTRA 450 ° CHAR LEACHATES



ACKNOWLEDGEMENTS

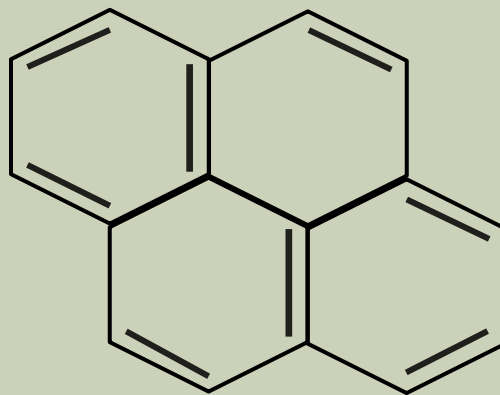
- B. K. Sharma, Wei Zheng for biochar pyrolysis
- Illinois Sustainable Technology Center for project support



EXTRA SLIDES

SORPTION EXPERIMENTS

- Pyrene probe compound
 - <0.3% methanol, no co-solvent effects
 - Add in stages, never exceed solubility



SORPTION EXPERIMENTS

- **Polyoxomethylene (POM, aka Delrin®)**
competing phase
- **Pyrene determined by synchronous**
fluorescence

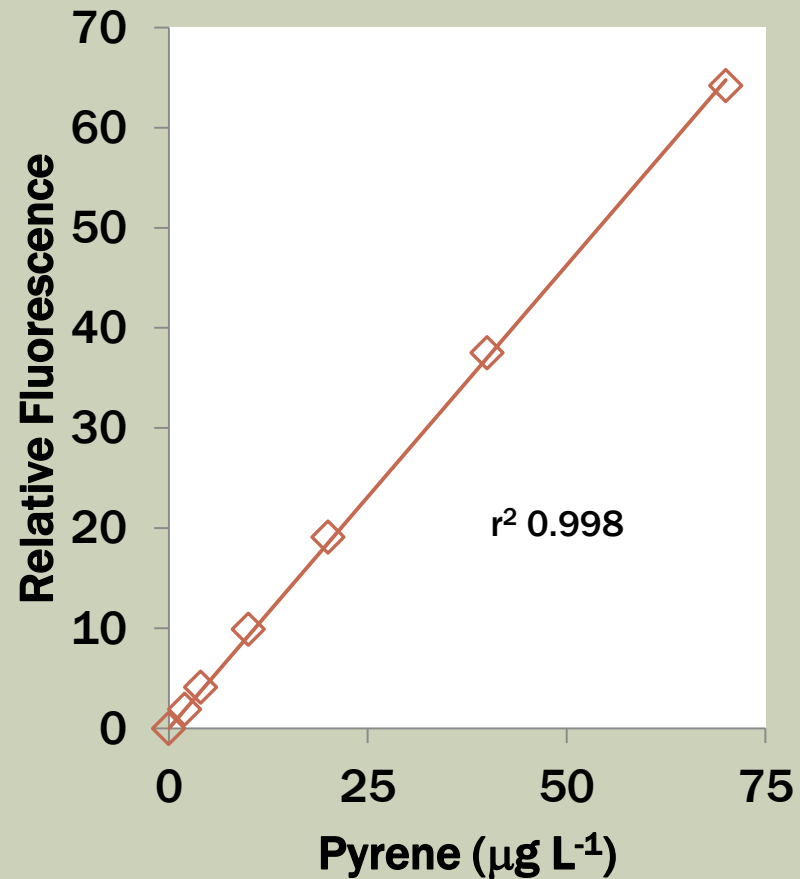
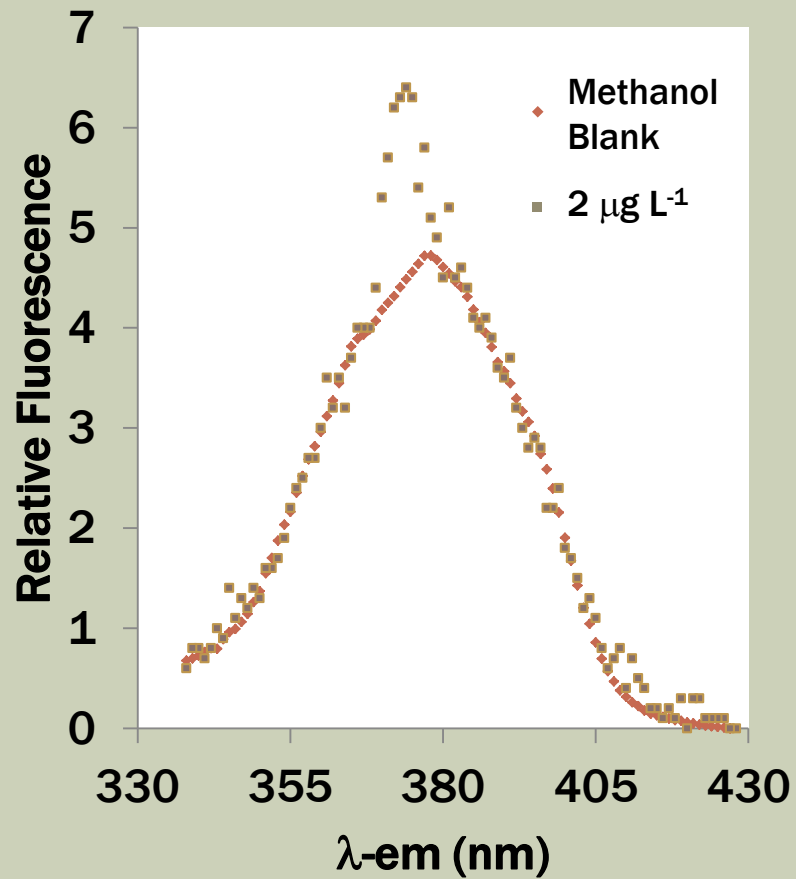
ARTIFICIAL AGING

- Hale et al. (2011)
- Moistened char to 40% of field capacity
- Incubate 1 month
 - Freeze/Thaw
 - 60 °C
 - 110 °C
 - Add H₂O as needed

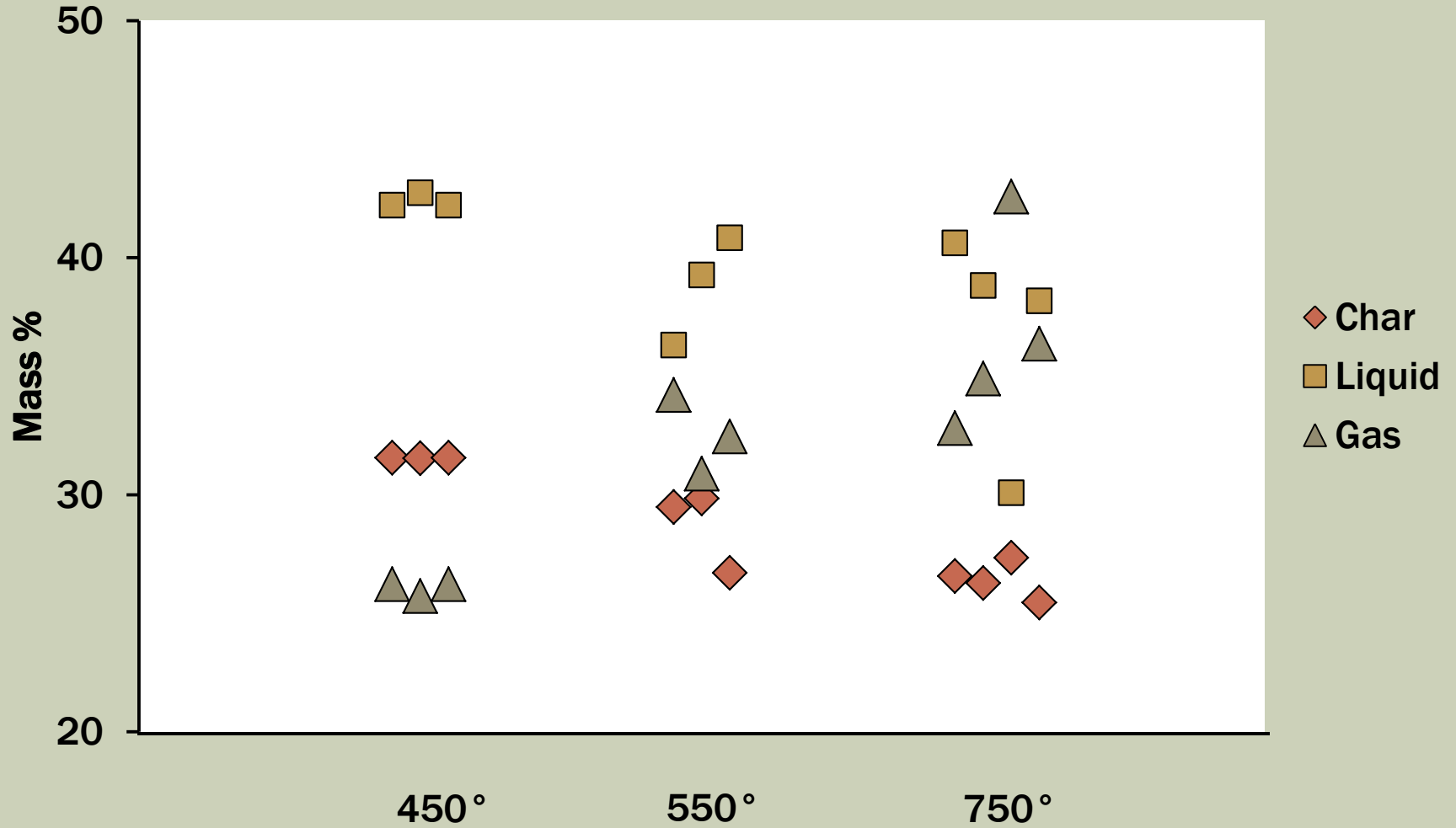
MILD EXTRACTIONS

- Extractant: 2-hydroxypropyl- β -cyclodextrin
- HPCD-extractable PAHs correlate well with
 - Bioavailability
 - Biodegradation
- Poor correlation with total PAH content

SYNCHRONOUS FLUORESCENCE

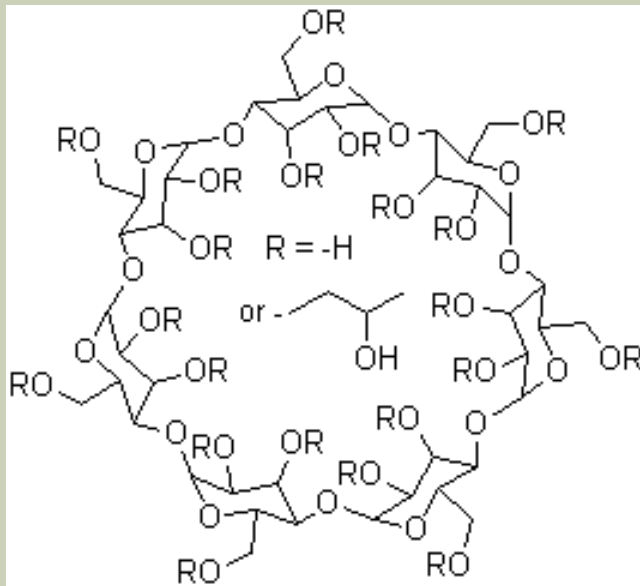


YIELDS



HPCD EXTRACTANT

HPCD



2-hydroxypropyl-β-cyclodextrin



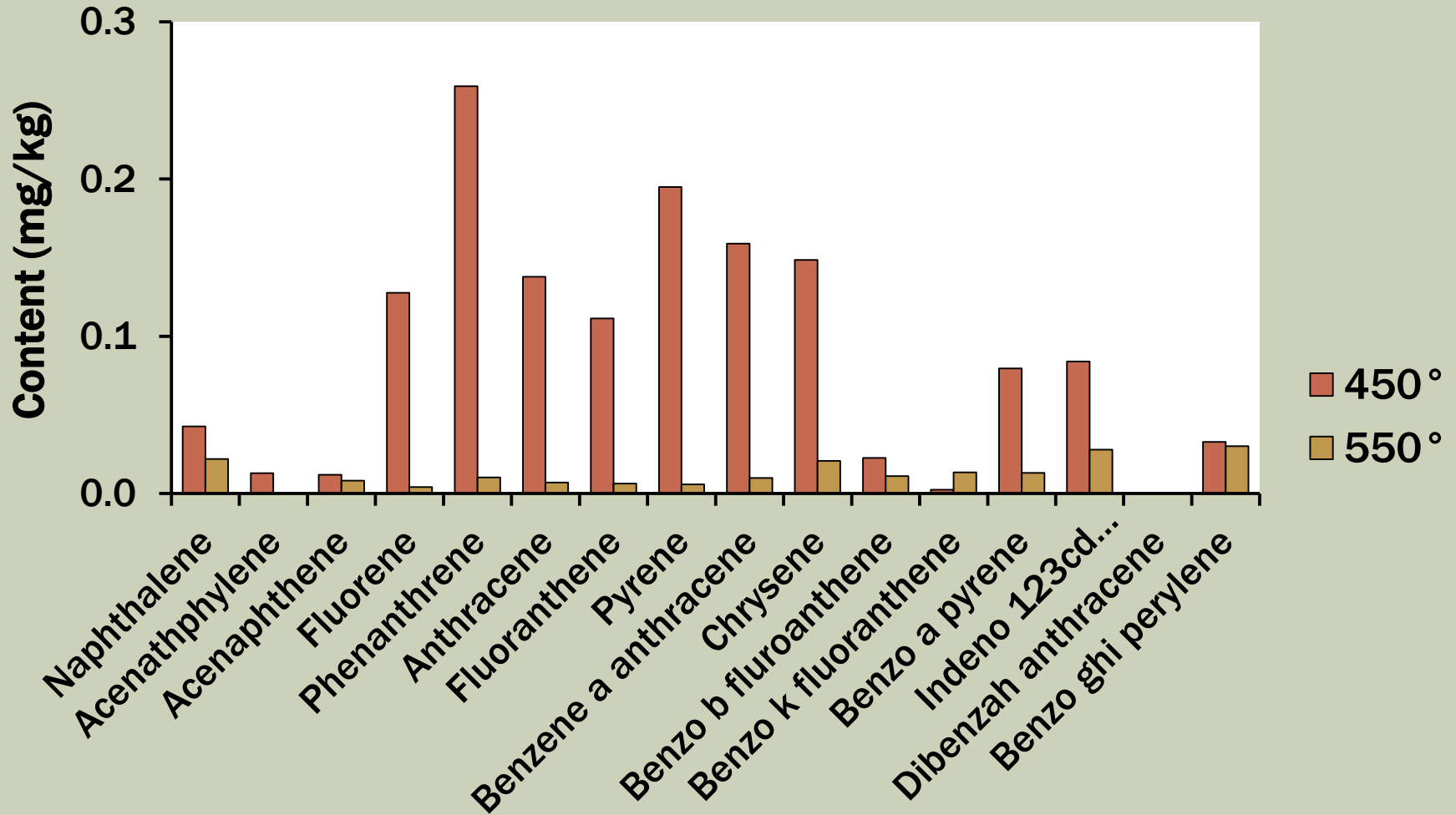
HYPOTHESES

- Biochar binds PAHs very strongly.
 - Black carbon content
- Only a small fraction of biochar PAH content is readily available.

OBJECTIVES

- Characterize PAH sorption
- Perform mild extractions
 - → bioavailability
- Perform artificial aging
 - sorption
 - mild extraction

USEPA-16 PAH CONTENT OF CORN STOVER CHAR



TOTAL PAH CONTENTS OF CORN STOVER CHARS

- 450° 1.4 mg kg⁻¹
- 550° 0.2 mg kg⁻¹

MILD EXTRACTIONS & BIOAVAILABILITY

- Lab/greenhouse
- Field



SOIL/SEDIMENT REMEDIATION

In-situ Sorbent Amendments: A New Direction in Contaminated Sediment Management[†]

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University of Maryland Baltimore County, Baltimore, Maryland 21250, United States

Richard G. Luthy

Stanford University, Stanford, California, United States

Gerard Cornelissen

Norwegian Geotechnical Institute, Oslo, Norway, University of Life Sciences, Ås, Norway, Stockholm University, Stockholm, Sweden

David Werner

Newcastle University, Newcastle upon Tyne, United Kingdom

Charles A. Menzie

Exponent, Alexandria, Virginia, United States



Ghosh et al. (2011)

Environmental Science & Technology

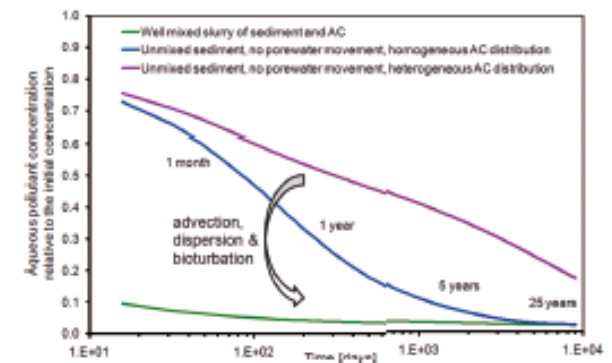


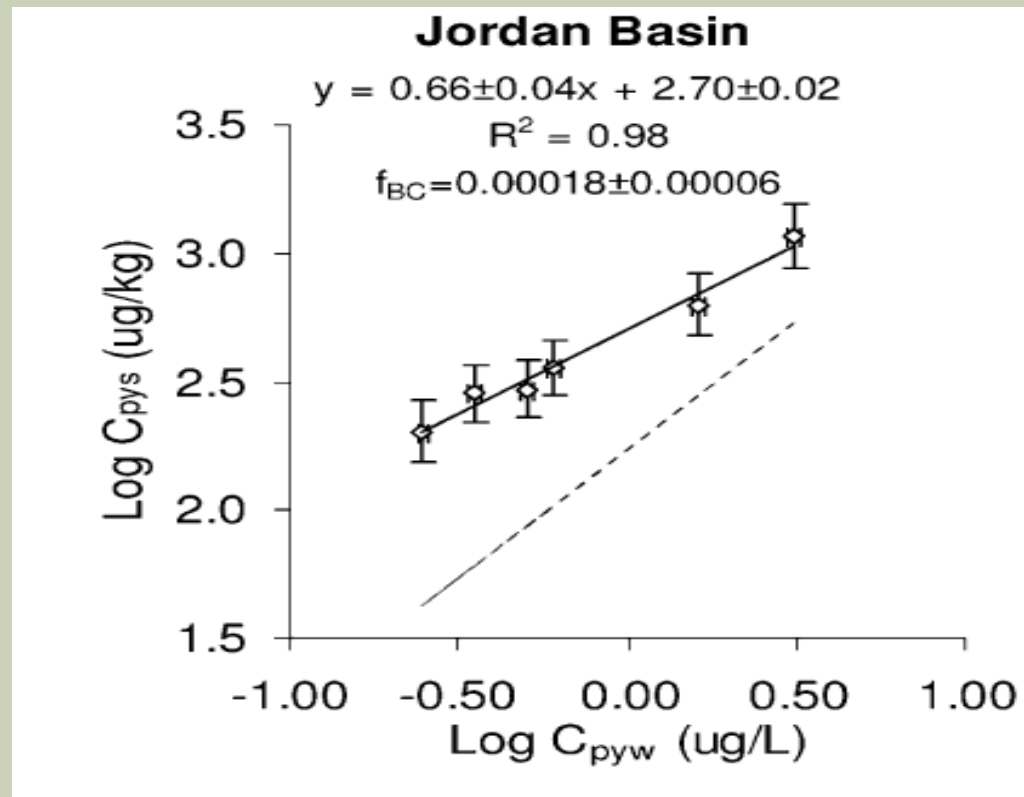
Figure 3. Simulated decrease in the average aqueous PCB 101 concentration for Hunters Point sediment amended with 3.4% by weight activated carbon with a mean particle size of 150 μm . The simulation of the heterogeneous distribution assumes 1 cm spherical volumes of activated carbon free sediment surrounded by activated carbon rich sediment.

sorbent amendments can be applied during and immediately after a dredging process to minimize aqueous contaminant release from resuspended sediments and residuals, or as an amendment to sand caps to enhance sorption capacity.

POTENTIAL USE OF BIOCHARS AND CARBON SEQUESTRATION

Charcoals, especially anthropogenic ones created under high-temperature conditions ("biochar"), are known to persist for thousands of years in soils and sediments, indicating carbon

ESTIMATE/VERIFY SOIL BIOCHAR CONTENT



Flores-Cervantes et al. (2009)