

**Soil Organic C, SON and SOP of
Sandy Soils As Affected by Intensive
Loblolly Pine Management in SE U.S.**

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Importance of Southern Pine Ecosystems for SOC Storage

- ❑ More than 12 and 5.3 million ha in loblolly and slash pine respectively (Neary et al 1990).
- ❑ 5.8 million hectares of Spodosols in the southeastern U.S.
- ❑ 70 Mg C y⁻¹ accumulated in secondary forests of SE U.S. (Richter et al. 1995).



Storage and Protection Mechanisms of SOC

- **Total Storage – Increase in total SOC**
- **Long-term storage – Increase in protected SOC**

- **Protection mechanisms**
 - **Chemical: Sorption onto clay**
 - **Physical: Macro and micro-aggregates**
 - **Bio-chemical: Chemical recalcitrance**

Sandy Soils of the Southeast and SOC Storage

□ Chemical protection

- Low clay; 2-5%

□ Physical protection

- Macroaggregation is weak
- Microaggregation is unknown

Sandy Soils of the Southeast and SOC Storage

□ Biochemical protection

➤ Litter-fall of pine is acidic and high in polyphenols

□ High accumulation of forest floor C (Johnson and Todd, 1992) and slow accumulation of soil C (Schlesinger 1990, 1991)

Carbon Accumulation in Pine Ecosystem

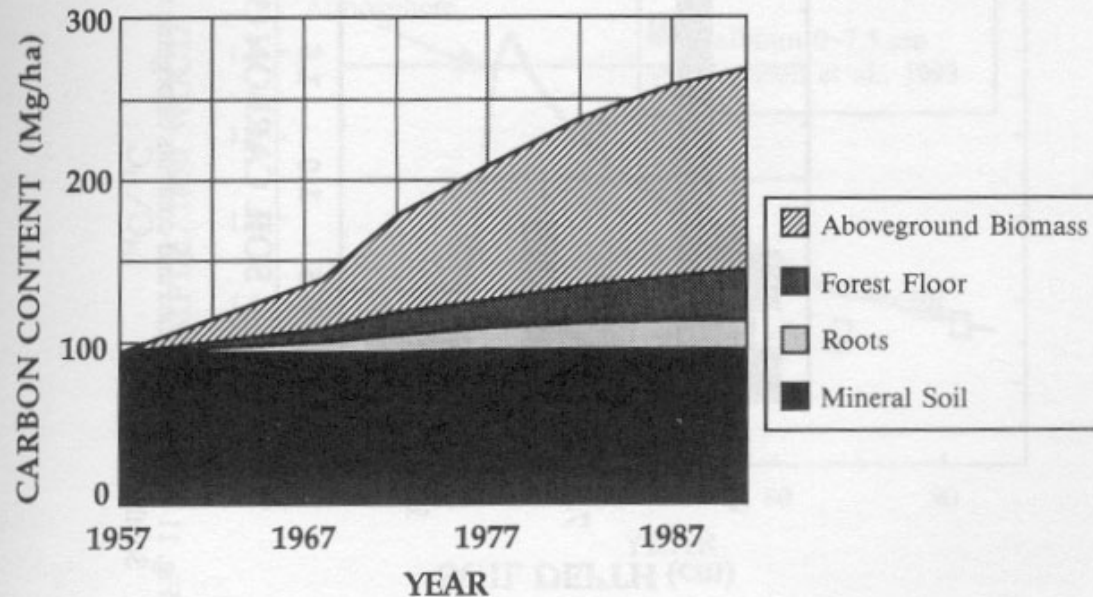


Fig. 11-2. Accumulation of C over 28 yr in a loblolly pine ecosystem in the Calhoun Experimental Forest, South Carolina.

(Richter et al. 1995)

Intensive Management

- Site preparation and bedding**
- Application of complete fertilizer**
- Sustained weed control**

Effects of Intensive Management

- Increase in litter input
- Decrease in weed biomass
- Decrease in root mortality and fine root biomass?

Effects of Intensive Management

- Increase in mineralization potential
 - Fertilization decreased litter polyphenols by 17% (Polglase et al 1992)
 - Weed control increased polyphenol content of foliage by 48%

Effects of Intensive Management

- **Changes in SOC of -30 % to +100% have been reported**

(Laiho et al 2003, Johnson and Curtis 2001, Shan et al 2001, Harding and Jokela 1994)

- **Initial investigations have shown a 9% to 69% increase in the 0-5 and 5-10 cm depths in the >2mm fraction**

SOM Fractionation

□ Size fractionation

- Sand size OM (Macro OM)
- Silt and clay size OM

□ Density fractionation

- Light fraction
- heavy fraction

Active Fractions

- ❑ Higher contents of C and N
- ❑ Lower protection
- ❑ Higher mineralization rates
(Romkens 1999, Gregorich et al. 1994)
- ❑ Important for nutrient supply
- ❑ e.g Light fraction, Macro OM

Passive Fractions

- ❑ **Higher recalcitrance**
- ❑ **Longer turnover periods**
- ❑ **Important for long term storage of carbon in the ecosystem**
- ❑ **e.g. Heavy fraction and silt size fraction**

Importance of Organic N and P

- ❑ **Forested Spodosols are generally deficient in both N and P**
- ❑ **The bioavailability of N and P in surface soils is controlled by mineralization**
- ❑ **Intensive management can alter mineralization by influencing the distribution of N and P in different fractions (Polglase et al. 1992; Grierson et al. 1997)**

Objectives

- ❑ **Adapt methods for characterization of SOC, SON and SOP in sandy soils using size-density fractionation and mineralization**
- ❑ **Investigate the SOC, SON and SOP changes due to intensive management**
 - **Low vs. high intensity fertilization and weed control**
 - **Genotype influences**
 - **Planting density**

Hypotheses

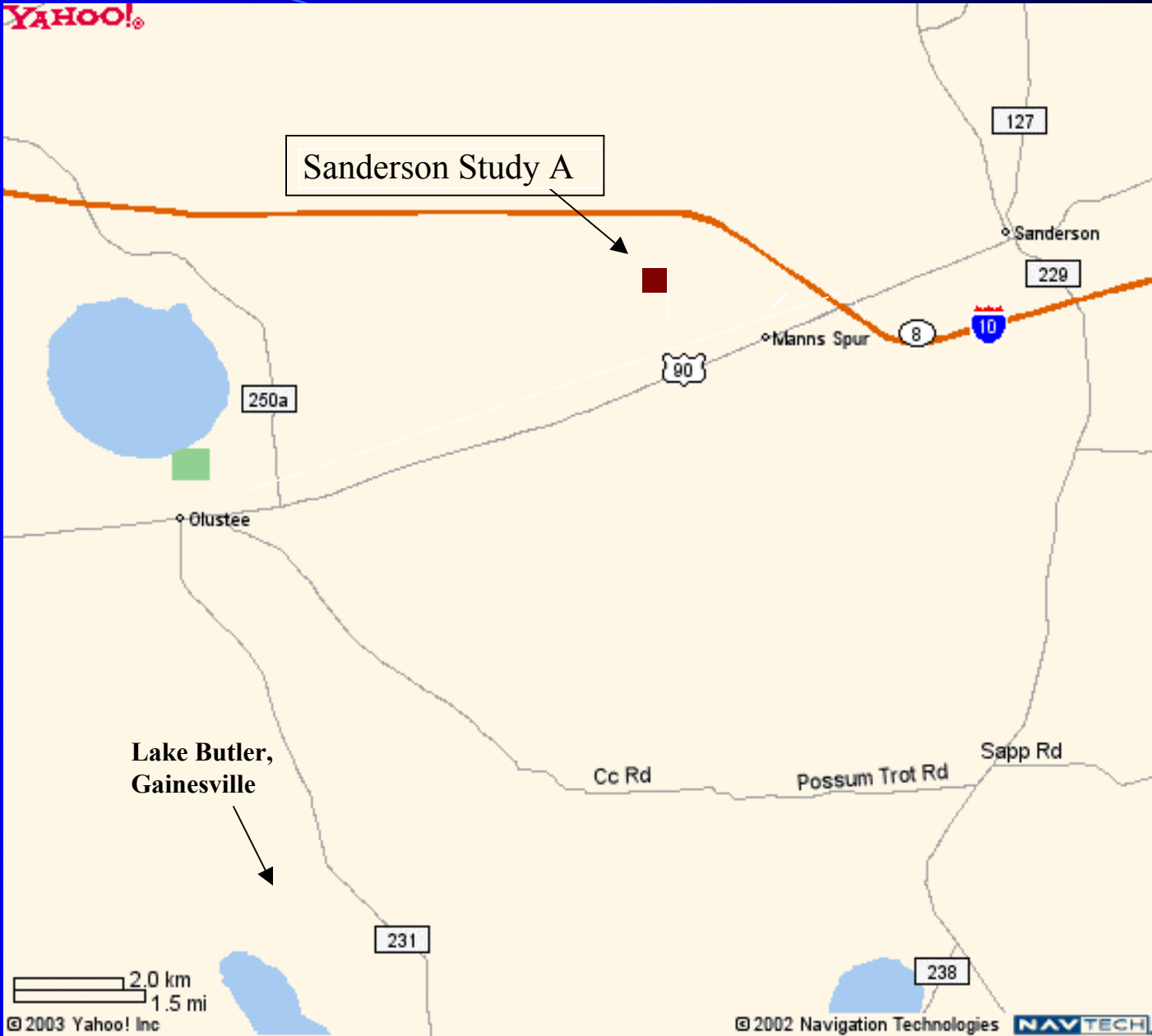
- **Carbon size-density characteristics**
 - **H1:** The light density fraction of all size classes is the active fraction, with higher N, P concentrations and greater mineralizability
 - **H2:** The > 150 micron light fraction is most active

Hypotheses II

- Carbon changes with management intensity
 - **H3:** High intensity management results in higher proportion of active SOC (whole soil basis)
 - **H4:** The passive fractions are not affected by management intensity
 - **H5:** The genotype 756 produces more litterfall of better quality
 - **H6:** The soil under 756 contains higher C, N and P concentrations, hence more active SOC

Experimental Site

- ❑ **A loblolly pine study owned by International Paper Company and managed by the Forest Biology Research Cooperative; a part of SFRC.**
- ❑ **The variables are management intensity, planting density and genotypes.**



Methods

- ❑ **Size-Density Fractionation**
 - **Sieving, sonication and density separation (Meijboom et al, 1995; Cambardella and Elliot, 1993)**
- ❑ **Chemical Characterization**
 - **C, N, P**
 - **Polyphenols**
- ❑ **Mineralization potential of fractions**
 - **Lab incubation (Zibilske 1994)**
 - **Permanganate oxidation (Blair et al, 1995)**



Interpretation

□ Physically protected SOC

- Size fractionation; sonication

□ Chemically protected SOC

- Size and Density fractionation

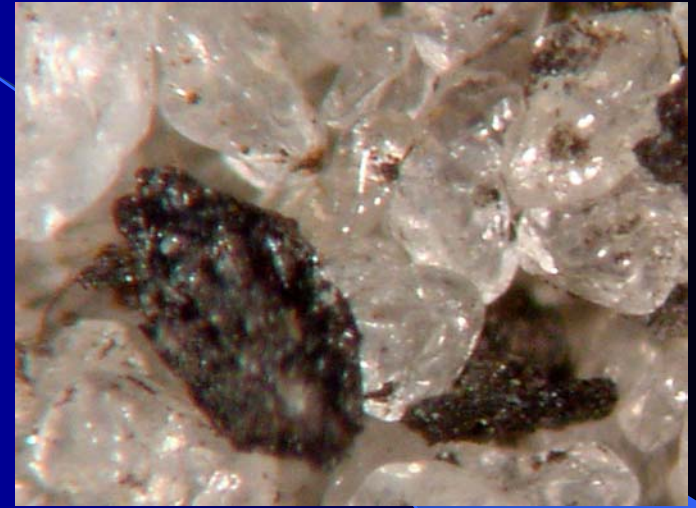
□ Biochemically protected SOC

- Size-density fractionation; polyphenol content, mineralization potential

Methods Evaluation



Dry Sieving



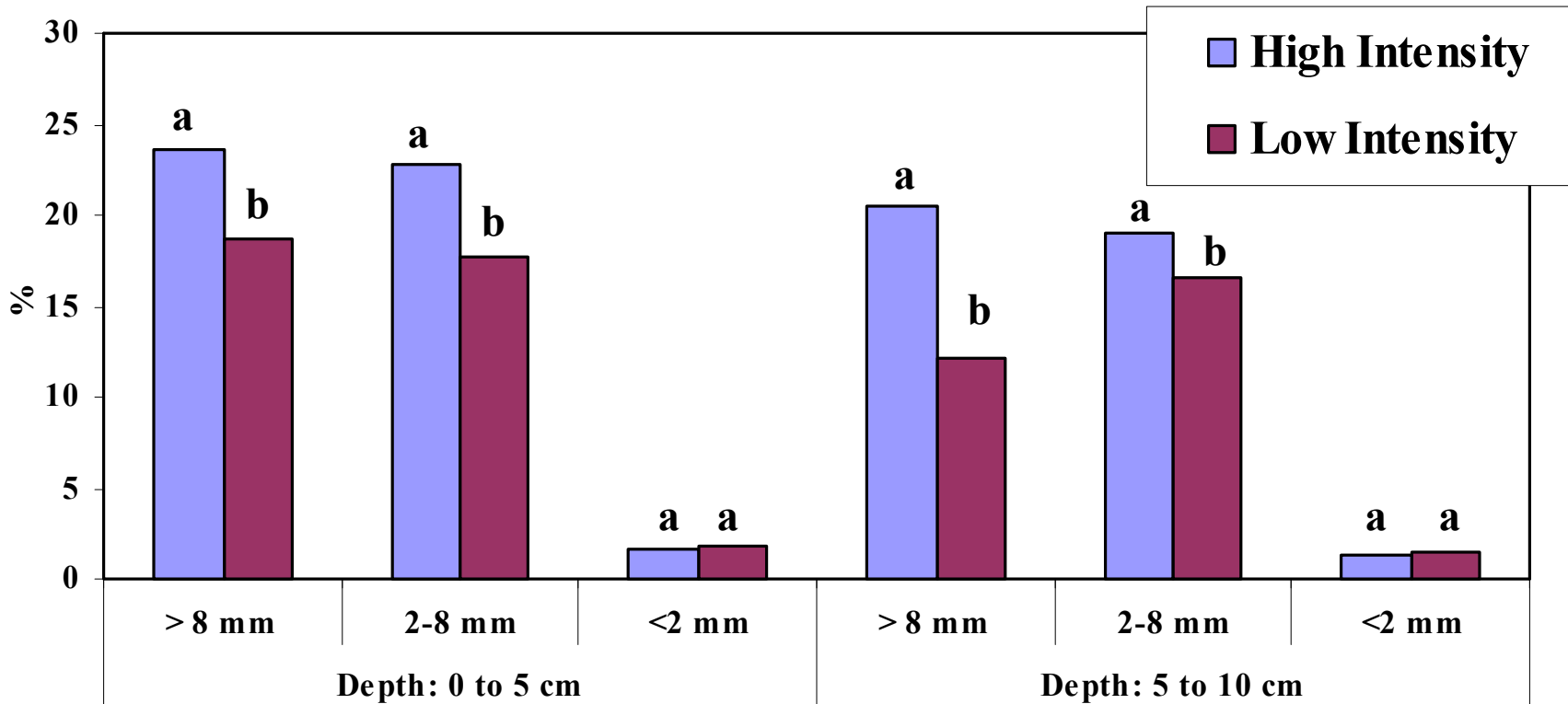
Wet Sieving



Sonication

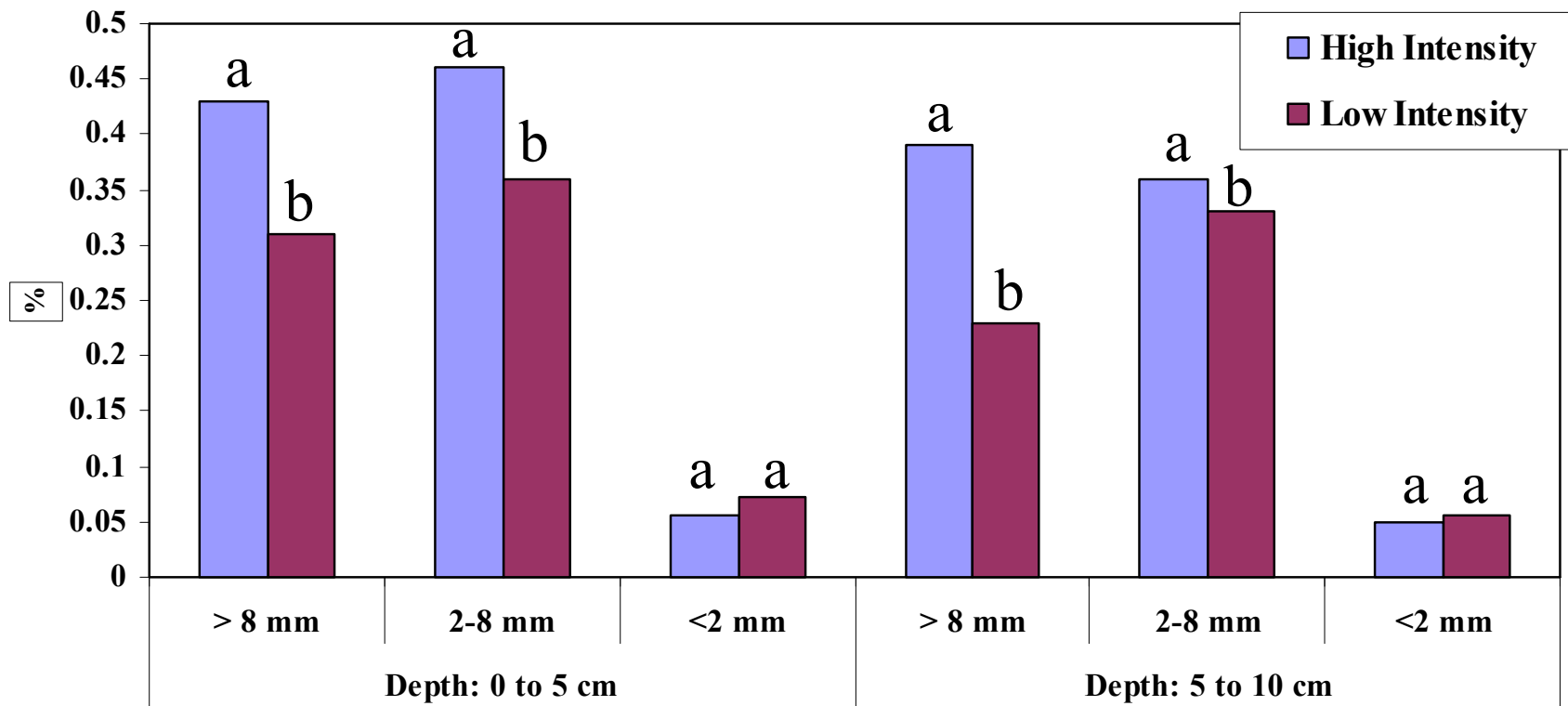
Effect of Management Intensity I

Changes in Total C Due to Management Intensity



Effect of Management Intensity II

Changes in Total N Due to Management Intensity



To Summarize..

- **Profile of SOM with associated N and P**
- **Effect of management on SOM quality in terms of**
 - **Nutrient supply**
 - **Long term C storage**

Thank you!