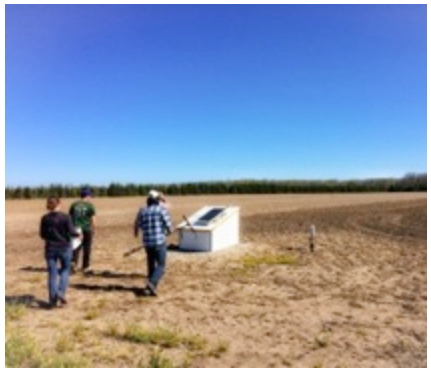
GLOBAL WATER FUTURES
SOLUTIONS TO WATER THREATS IN AN ERA OF GLOBAL CHANGE

AGRICULTURAL WATER FUTURES

Dominant glacial landforms in the lower Great Lakes region exhibit different soil chemistry and potential risk of phosphorus loss

J. Plach, M. Macrae, M. Williams, B. Lee, and K. King



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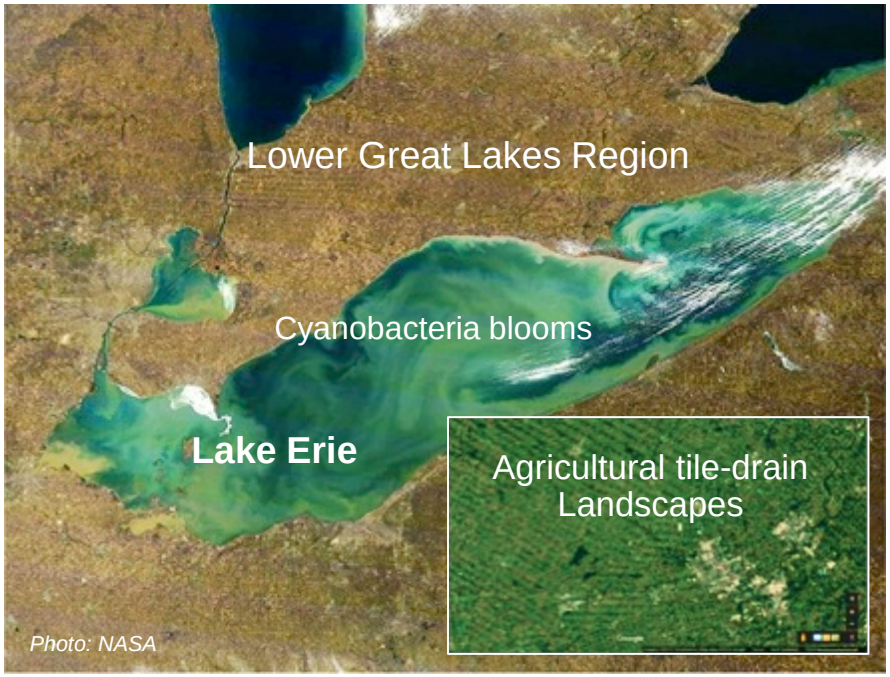
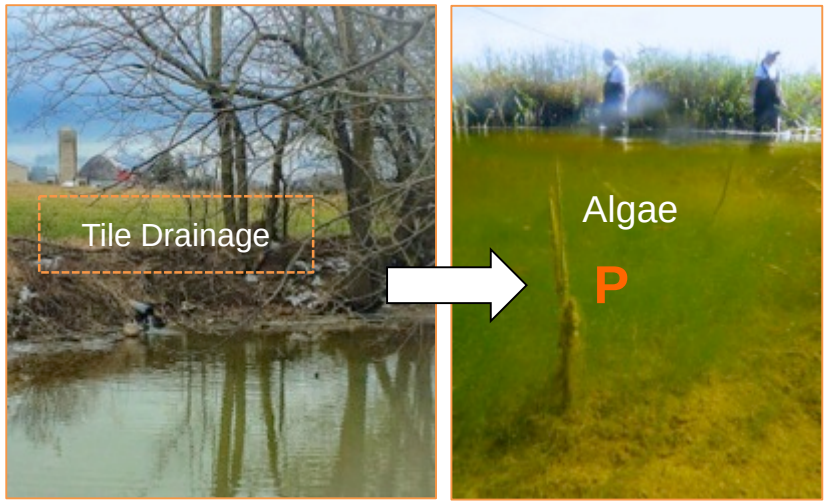
Water Quality in the Great Lakes Region

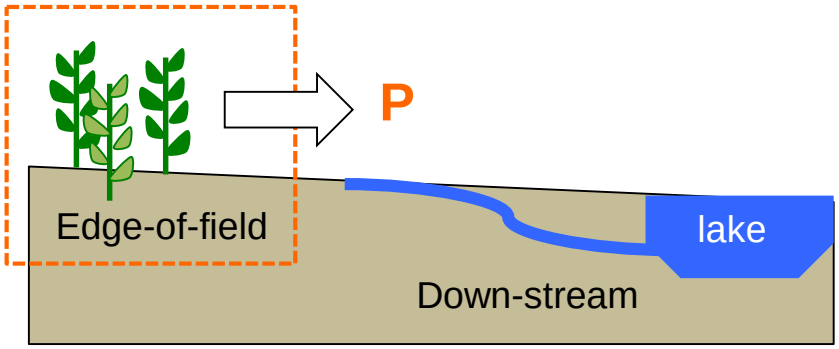




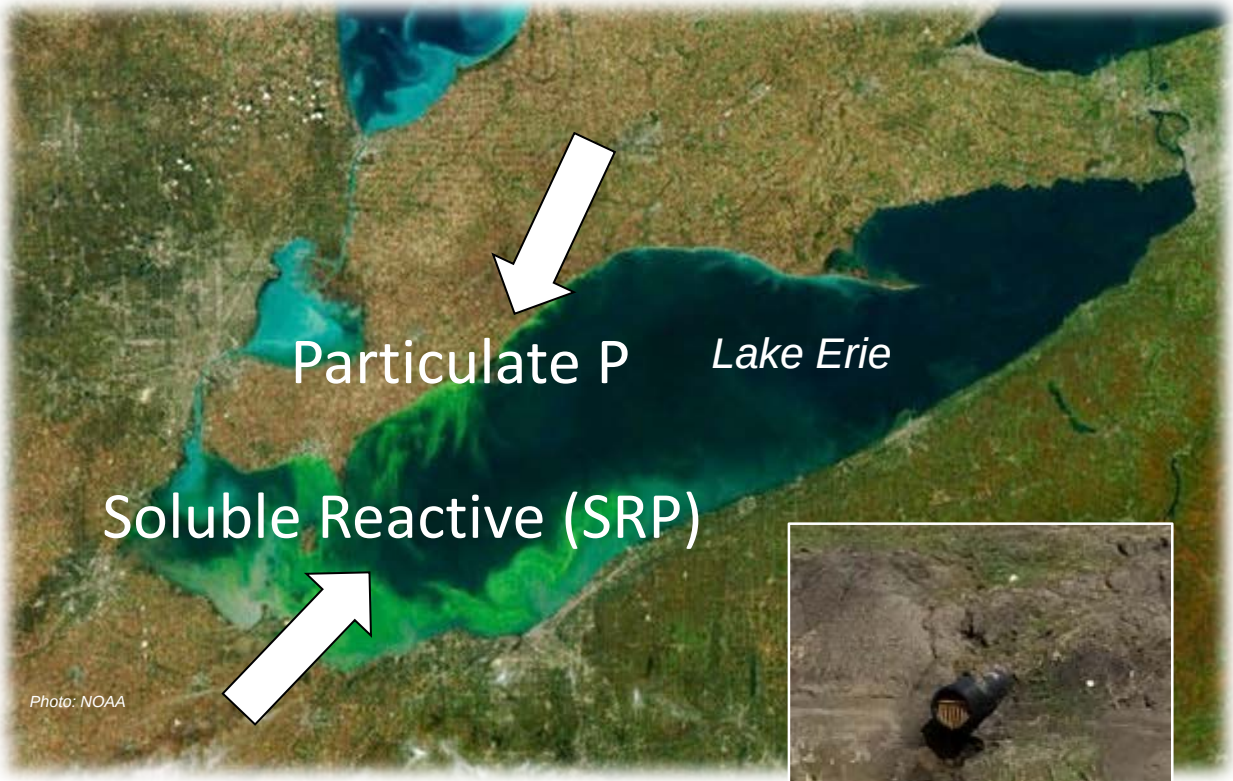
Phosphorus (P) losses – economic & environmental concern → crop productivity & water-quality

Eutrophication - harmful algae blooms & hypoxia; P -limiting nutrient

Management – evaluate processes controlling soil P mobility → **predict risk** of P losses & design best management practices (BMPs)



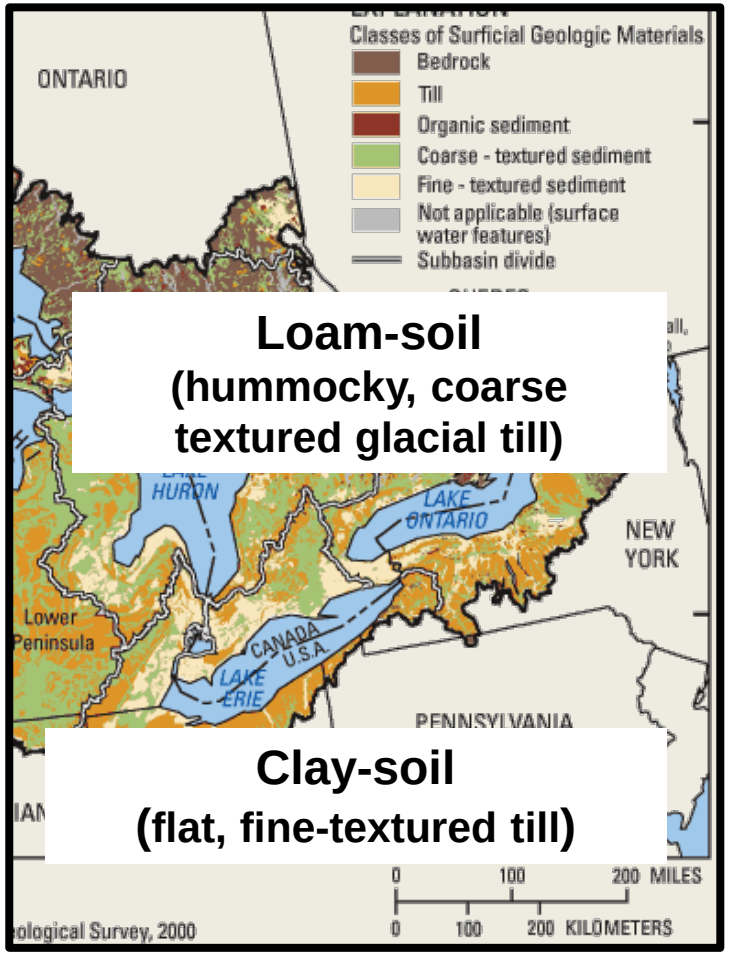
Tile drain P losses in the Great Lakes Region



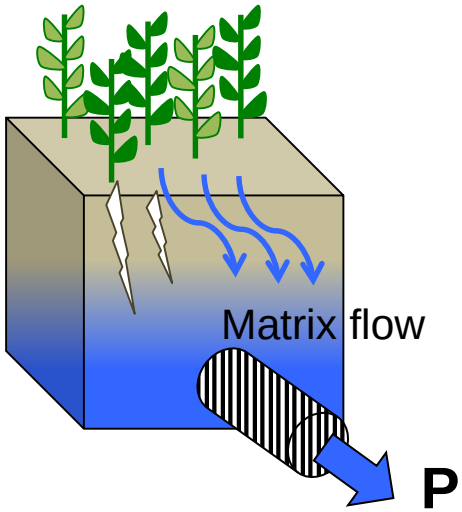
→ **Why regional differences?**

1. Management (e.g., P application)? 2. Landscape variability in soil type?

Soil types in the Great Lakes Region



Source: https://pubs.usgs.gov/sir/2005/5284/images/Figure1.gif

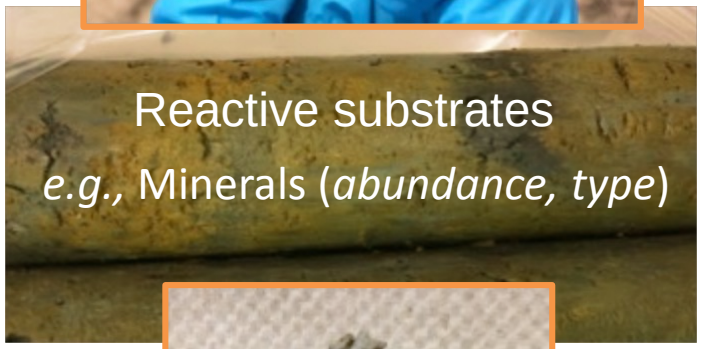


Tile Drainage

Soil Type→ 1. **Water flow paths** 2. **Soil P retention**

Risk of P loss from soils

1. **Storage of soil inorganic-P (P_i)**
2. **Mobility potential of soil P_i**



Solubilize P under changing soil conditions:

- **Grain size** (soil texture),
- **Composition** (organic, carbonates, oxides), **pH**
- **Hydrology** (*e.g.,* matrix, macropore, soil erosion)

P mobility & fate, availability to crops & runoff

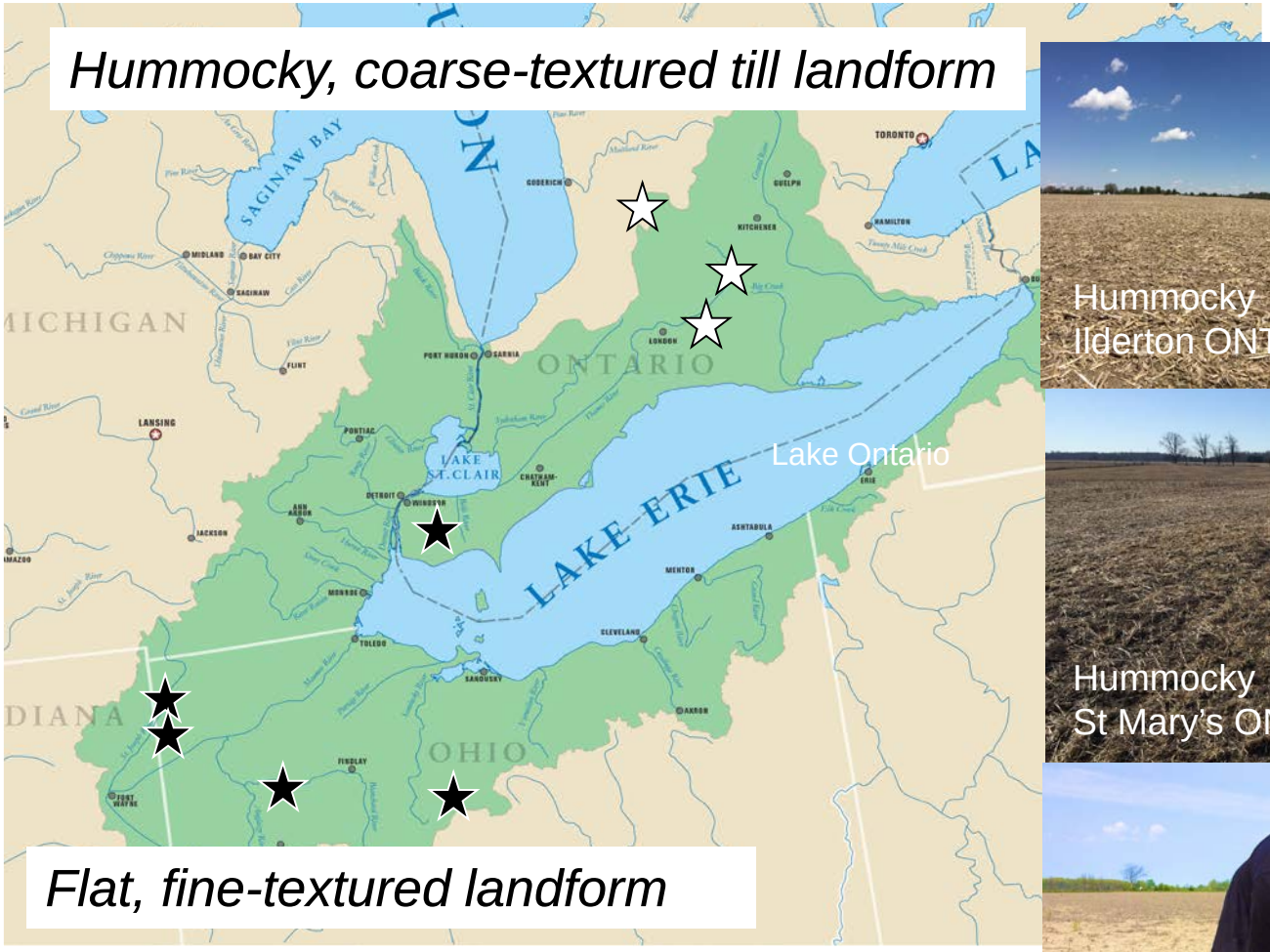
Project Objectives


Are there natural differences in **landscape sensitivity** to P losses?

1. **Storage of P**
2. **How “tightly” is P held in different soil types?**

Comparing agricultural croplands in lower Great Lakes region of Ontario, Canada & USA

Study Sites

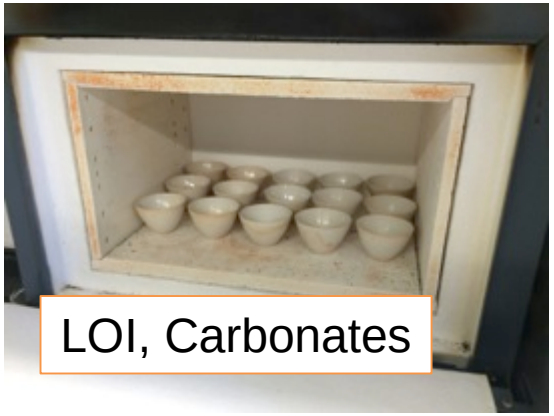


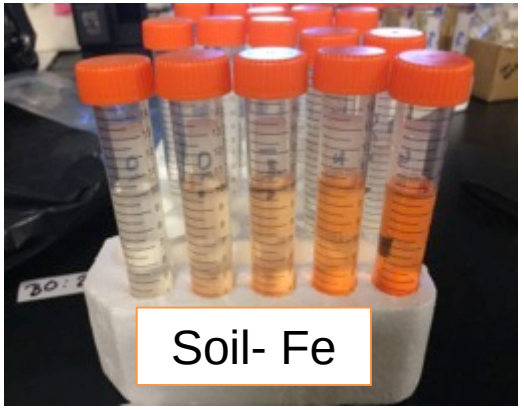
- **8 Fields**
- **Similar management, C-S-W rotation**
- **up to 36 inches (tile depth)**

Soil Analysis

Key Parameters

- Composition, pH
- Texture (sand%, silt%, clay%)
- Soil test, STP (Olsen, Bray, Mehlich)
- Soil P_i fractionation

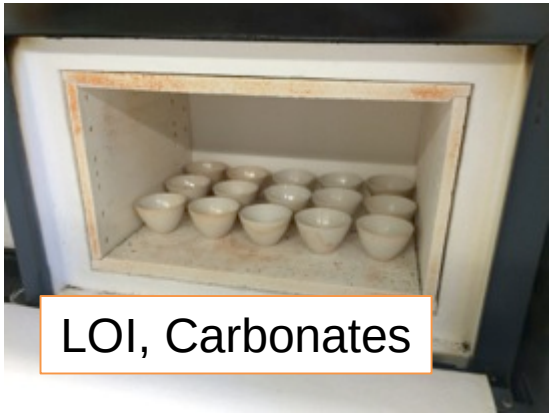


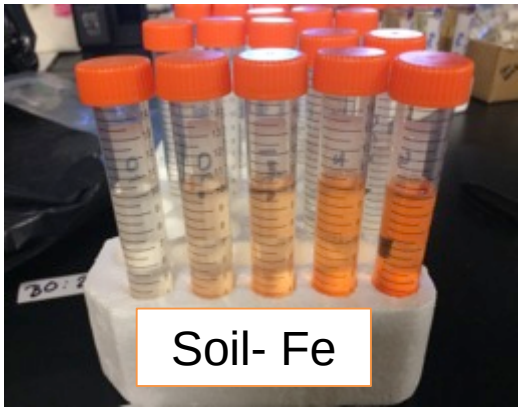


Soil Analysis

- **Loosely-bound**
- **Reducible-bound**
- **Calcium-bound**
- **Residual-bound**

Total Soil-P_i





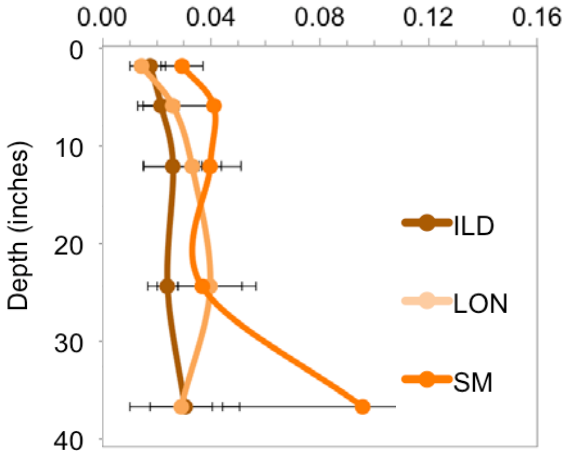
Soil Texture

Hummocky, coarse-textured landform

COLE

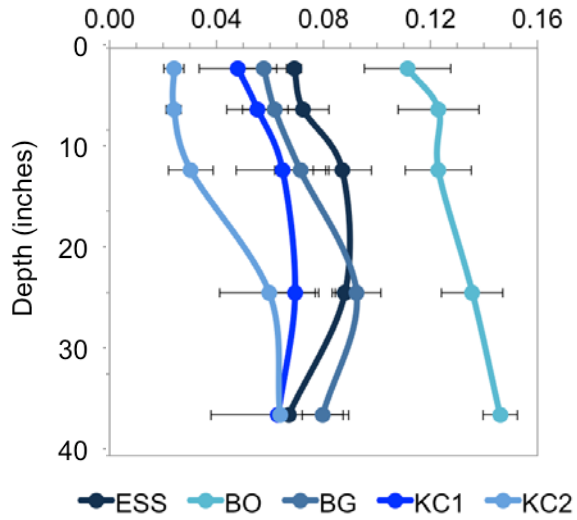
- loam
- low shrink-swell

→ matrix flow



- clay
- high shrink-swell

→ preferential flow



Flat, fine-textured landform

Higher shrink-swell

Soil inorganic P (P_i) pools

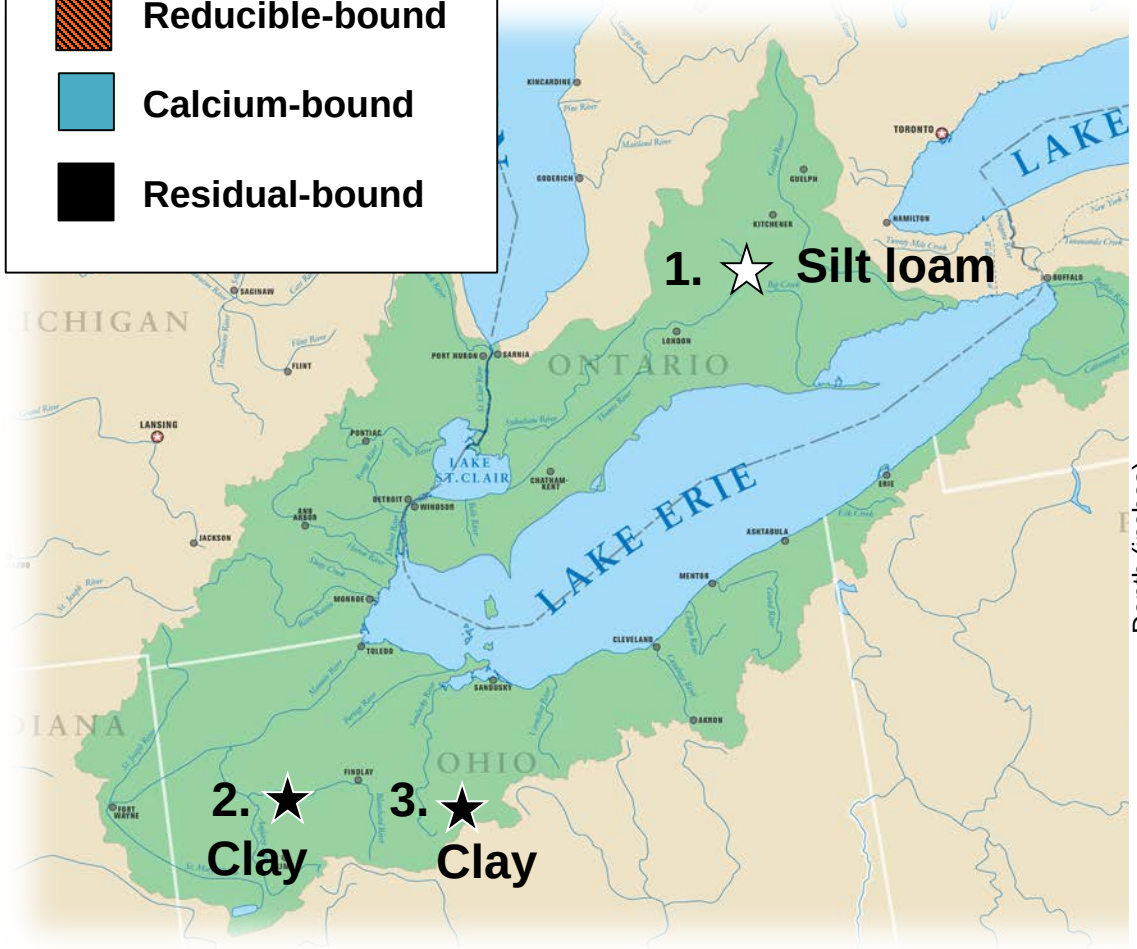
Loosely-bound

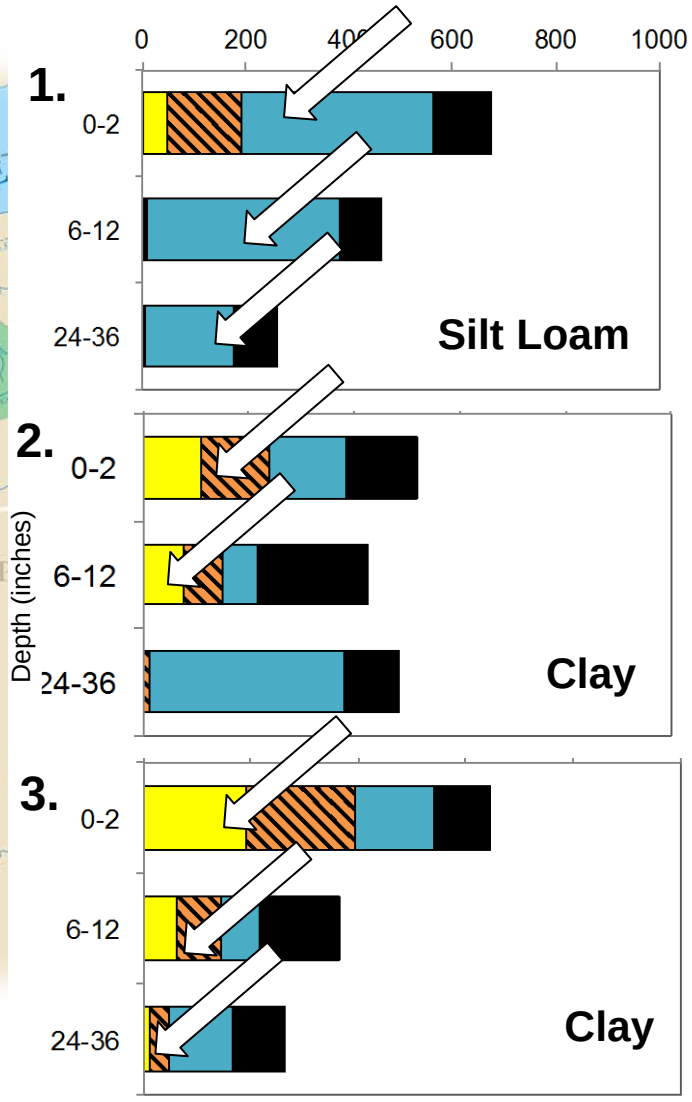
Reducible-bound

Calcium-bound

Residual-bound

Hummocky, coarse-textured landform



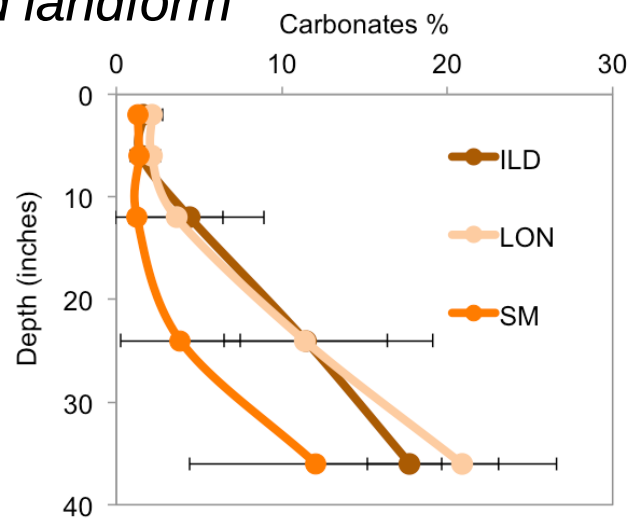


Flat, fine-textured landform

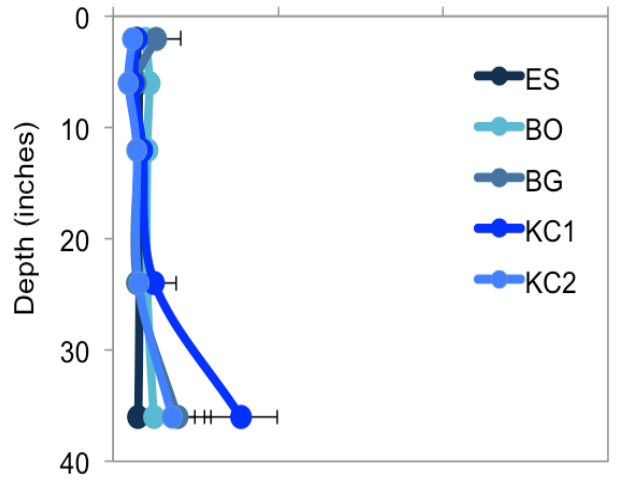
Soil Composition

Hummocky, coarse-textured landform

- Calcareous
- alkaline



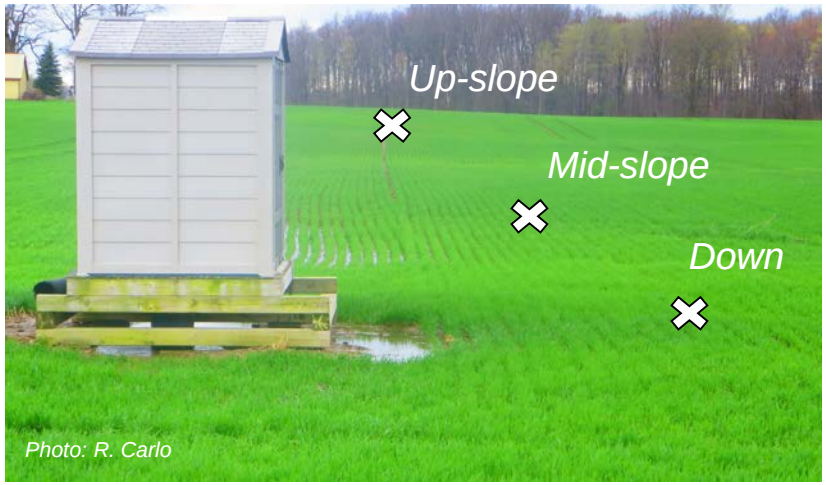
- low-carbonate
- slightly acidic

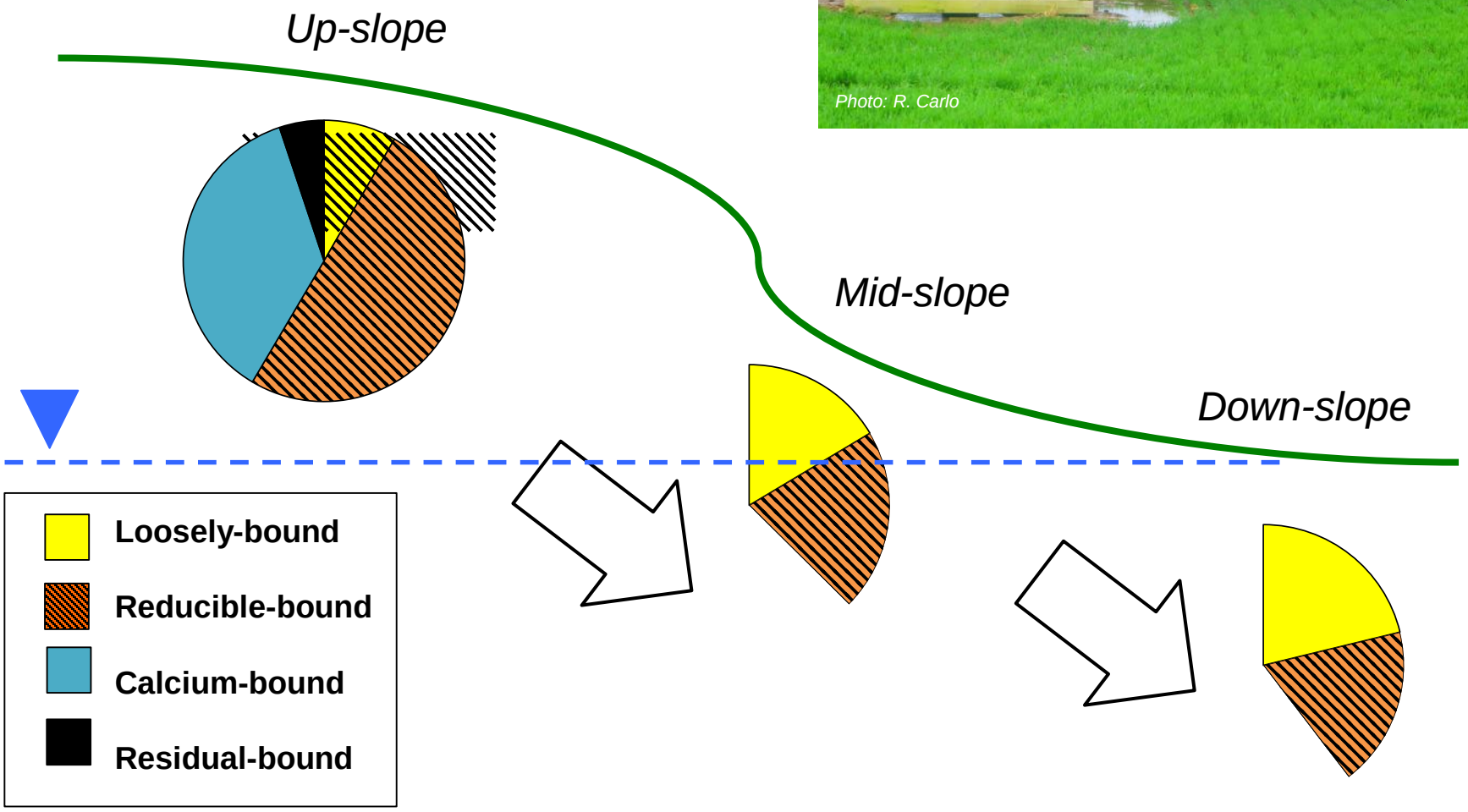


Flat, fine-textured landform

Ca-P_i – Slope Patterns

Ontario- Silt Loam





Ca-P_i – Slope Patterns

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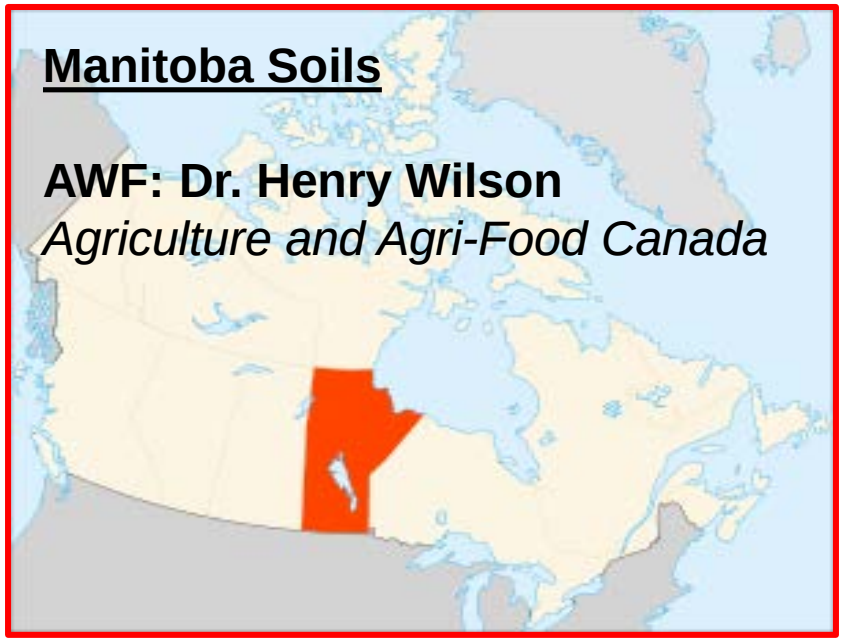

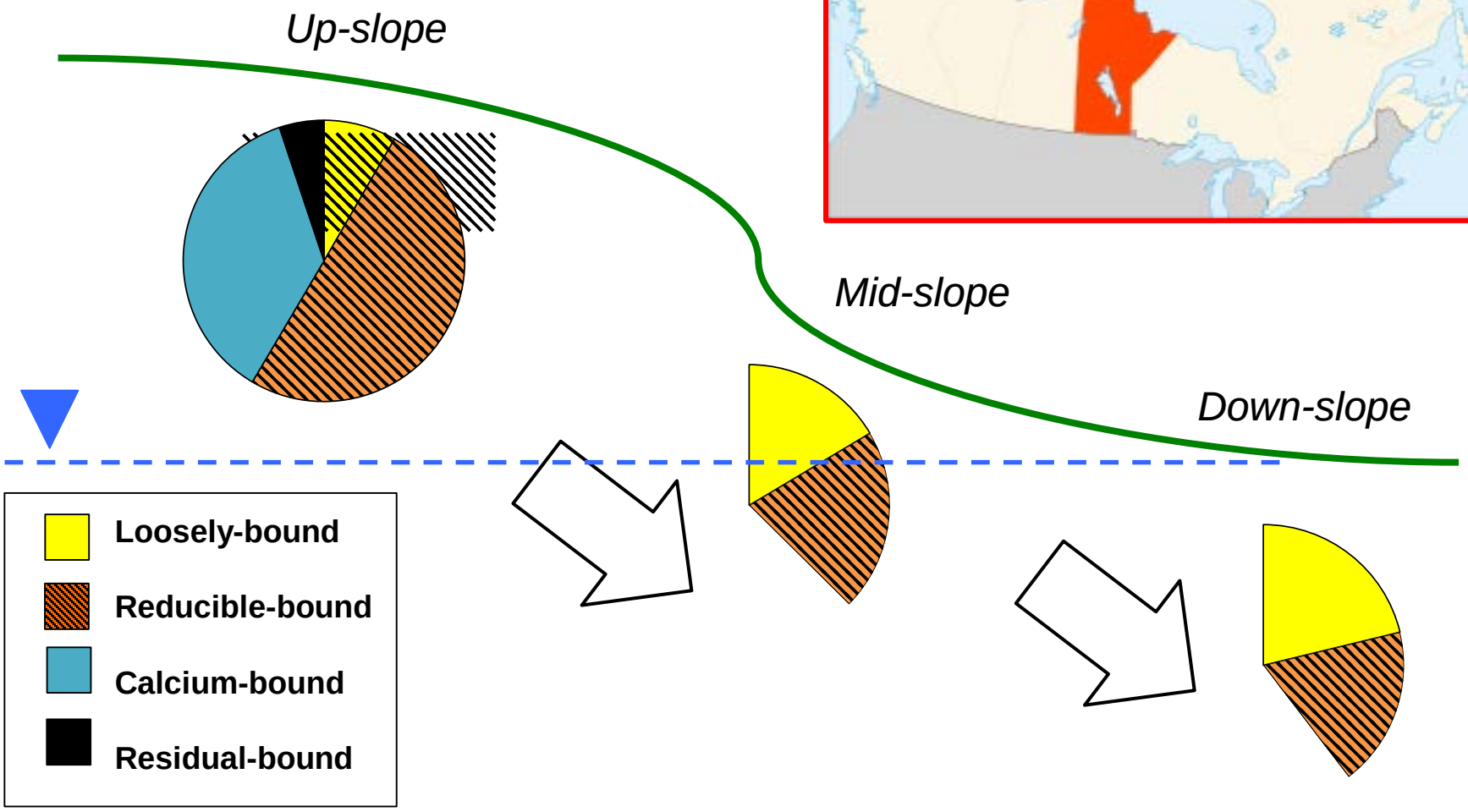

Summary and Implications

1. Clear difference in water quality between landscapes

2. No difference total soil P_i, BUT different soil P speciation

3. **Mid-western Ontario, P bound more "tightly" Ca-P**

→ Higher natural buffer capacity (carbonate, alkaline)

→ Potential for matrix flow in subsurface

→ Tile P loss- landscape driven? Design region-specific management

THANK YOU!

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QUESTIONS?

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