Multi-Element Fingerprinting of Wetland Soils Yields Insight into Wetland Quality and Functioning

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METHODS FLOW CHART

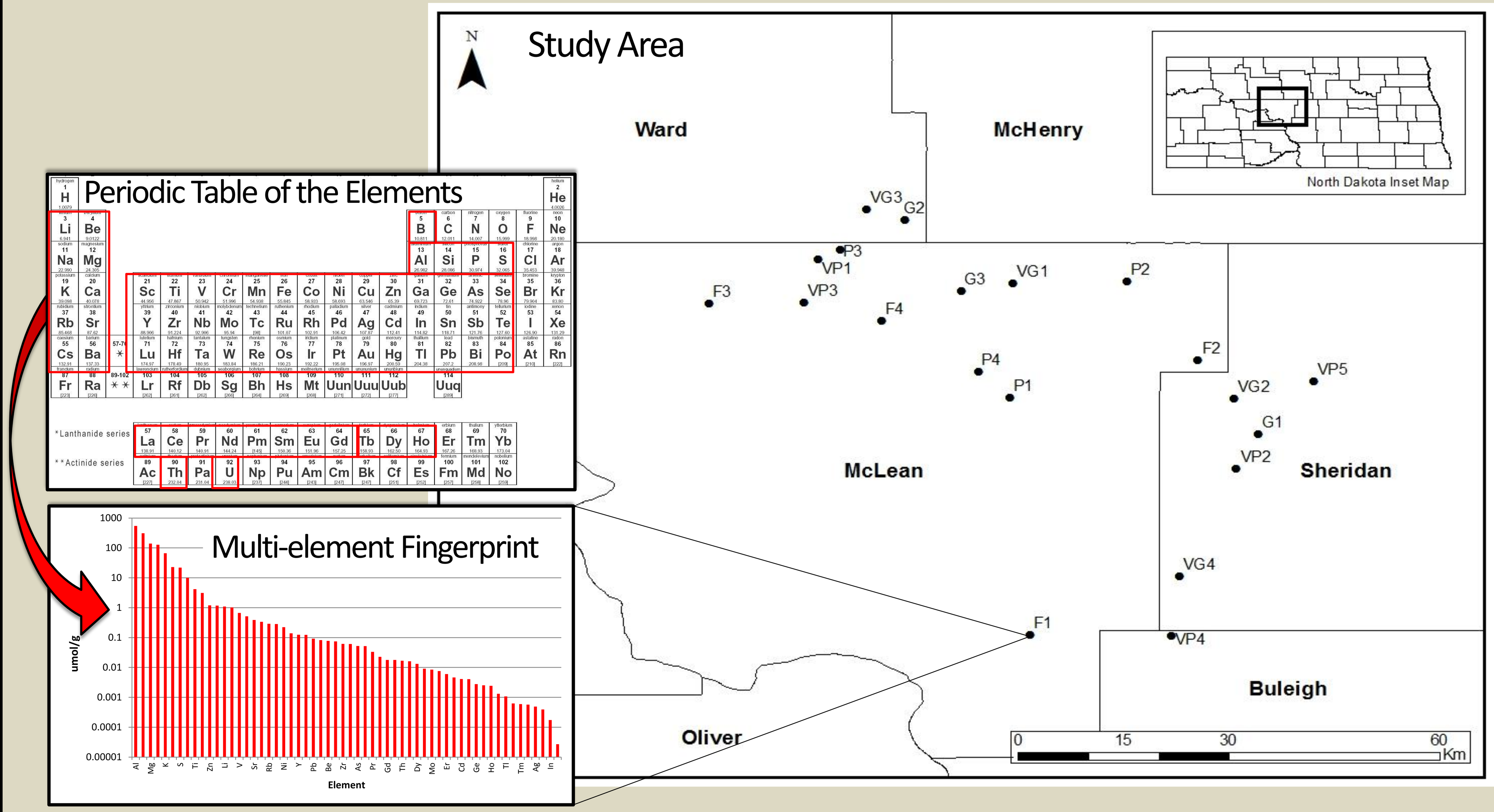


Figure 1. The soil composition of over 60 elements (multi-element fingerprint via ICP-MS) was assessed for 20 wetlands which had their plant communities previously assessed by the Index of Plant Community Integrity (IPCI), a tool which places plant communities in one of five conditions: very good, good, fair, poor, or very poor.

Analysis of Variance (ANOVA)

The ANOVA (P-value≤0.05) statistical test enabled us to detect elements whose concentrations could discern among IPCI condition. This showed that **38 elements differed significantly** among wetland condition. These data can then be used to **assess** wetland **condition** using **decision tree** or **element ratio**.

a

b

BACKGROUND

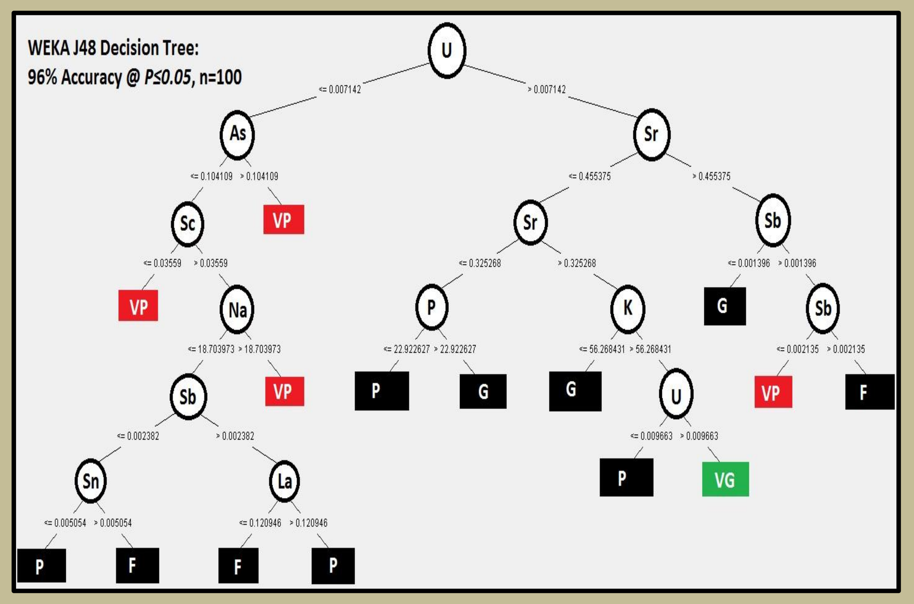
Wetlands of the Prairie Pothole Region of North Dakota are an integral component to the ND ecological landscape and their ecosystem services include nutrient cycling, aquifer recharge, flood water abatement, and waterfowl production. Wetlands have been affected by anthropogenic activities and as a result their ecological communities have been degraded. Assessment of these resources are essential for scientific inquiry and effective natural resources management.

Wetland assessment typically includes the composition of vegetative communities, upland land use, and, to a lesser extent, a limited set of chemical characteristics used to define if a habitat is suitable for sustaining wildlife. We used multi-element fingerprinting to study the relationship between the quality of 20 wetland plant communities as defined by the Index of Plant Community Integrity (IPCI) and wetland soil element chemistry of seasonal wetlands within the Prairie Pothole Region of North Dakota. The IPCI assesses vegetative communities using various diversity metrics to classify a wetland as displaying very poor, poor, fair, good, and very good plant community condition (Figure 1). We used the results to develop a tool which utilizes the relationships between and among element concentrations to classify IPCI measurements.

WEKA Decision Tree

To identify element relationships which define wetland condition, 38 elements from the ANOVA were plug-and-chugged into Weka 3.2, a program used to construct decision trees.

Right: An output decision tree showing ten elements that can be used to characterize condition. Concentration thresholds define decision-making and IPCI condition placement.



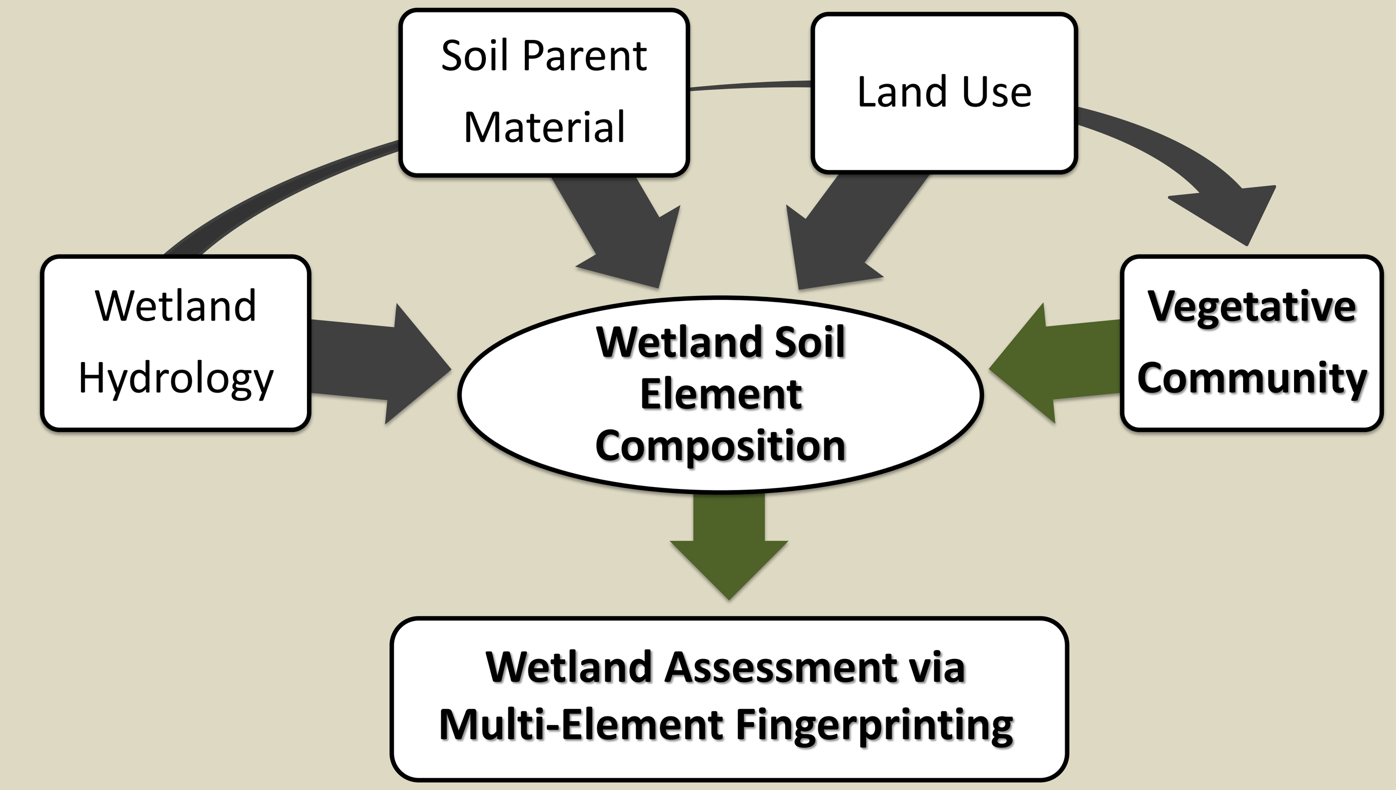


Figure 2. Factors which dictate wetland vegetative communities and soil element composition are used to develop a novel assessment.

BACKGROUND CONT. & CONCLUSIONS

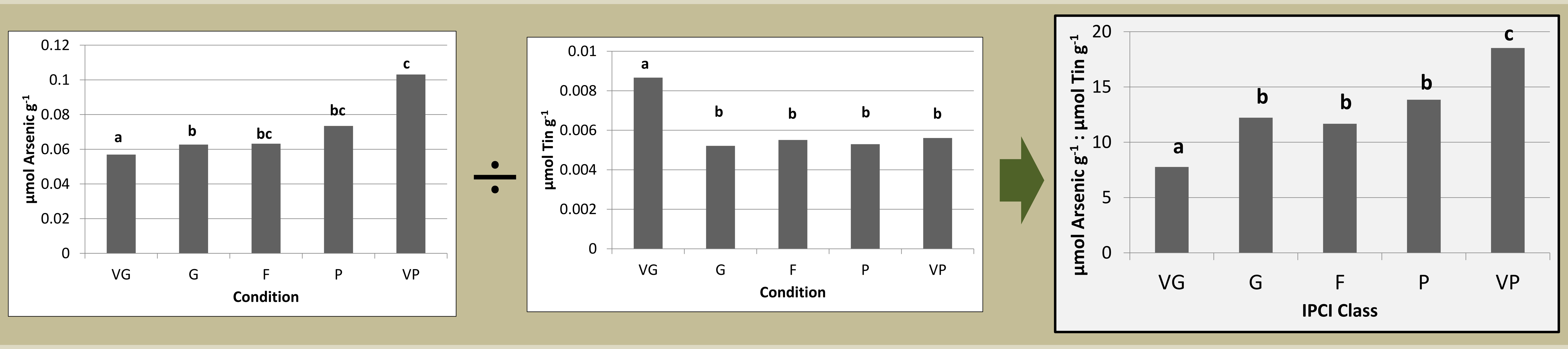
The element composition of a wetland soil is governed by its hydrological status, parent material, land use, and vegetative communities. Wetland hydrology is dynamic and can act to enrich or deplete the concentrations of water soluble elements. The parent material can be composed of differing amounts of clay and sand, with the main constituent of each being aluminum, iron, potassium and silicon. Land use such as agriculture can enrich elements such as zinc, sulfur, cadmium, and phosphorous through the continued use of phosphate fertilizer. Finally, it is well known that plants can enrich iron, manganese, and zinc near their root zones due to their effect on soil redox chemistry and these effects vary from species to species (Kissoon et al. 2010, 2011). The sum of these processes dictate element composition of wetland soils and this composition can be defined by ICP-MS, a tool which analyzes the concentrations of more than 60 elements to produce a multi-element fingerprint (Figure 2).

The results of this study have shown that the concentration of 38 elements vary in a manner consistent with a vegetative disturbance gradient. Additionally, multi-element fingerprinting can be interpreted by using multiple methods to yield new insight to wetland quality and functioning. Research is underway to test proposed methods.

Identify Trends: Element Ratios

Tukey's multiple comparisons allowed us to identify statistically valid trends which are viable when discerning among condition. This enables us to identify opposing relationships and these relationships can be used to develop a simple yet effective assessment tool.

Right: Arsenic (p=0) is higher in very poor soils relative to very good-assessed wetland soils; conversely Tin (p=0) is low in very poor soils relative to very good soils. The ratio of these elements shows that this method can be used to identify wetlands whose conditions are very good and very poor, but not for good, fair, or poor conditions.



ACKNOWLEDGEMENTS

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