Analyzing Subsoil Quality:

A Survey of Root and Nutrient Distributions in Winter Canola and Winter Wheat

Jacqueline Huettenmoser & Mayra Núñez

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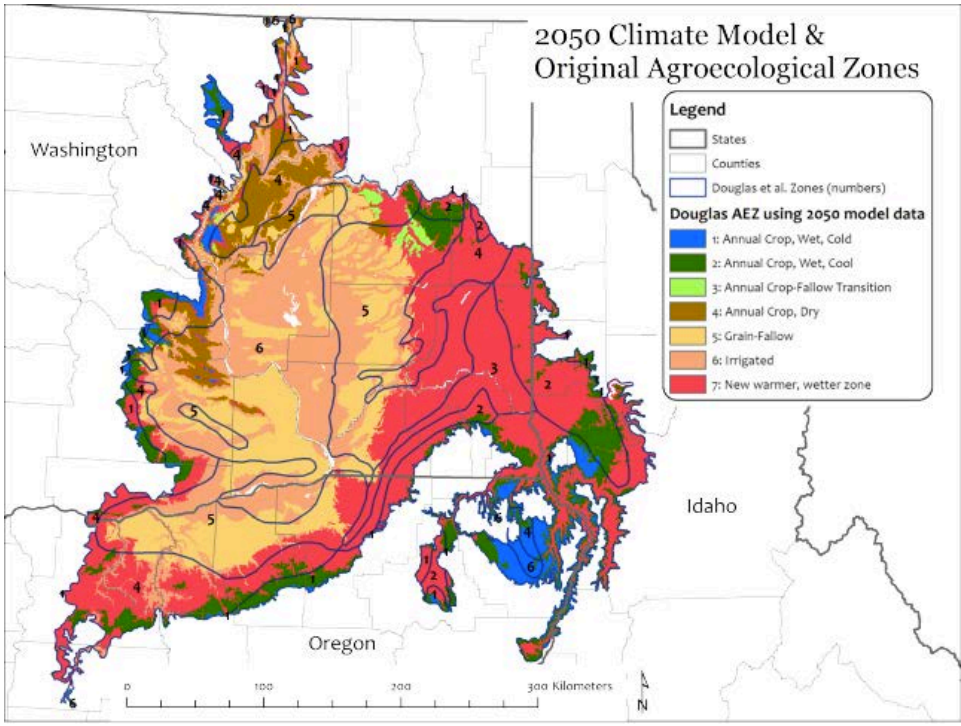
USDA

REACCH Regional Approaches to Climate Change – PACIFIC NORTHWEST AGRICULTURE

Justification

- Threat of climate change
  - Less precipitation increases reliance on subsoil
  - Drier soils, reduces soil carbon and nitrogen
- Assess the availability and accessibility of subsoil resources
  - Limited tests
  - Limited knowledge on roots accessibility
  - Impact of precipitation, compaction, and management

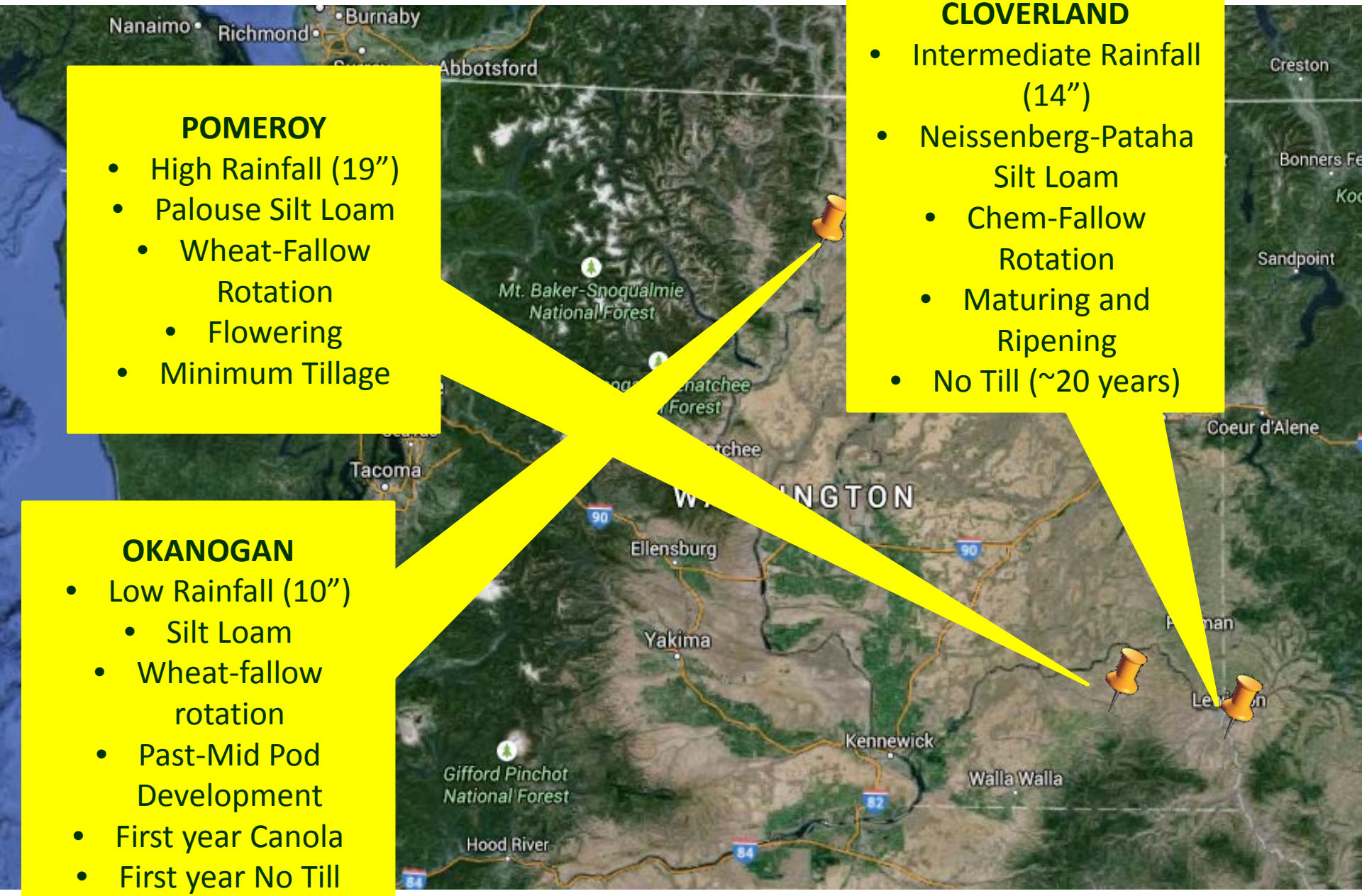


Field Methods

Assessing Winter Canola in Different Rainfall Zones

Mayra Núñez

- Soil compaction is a problem
  - Restricts root growth
  - Production costs and yield
- Precipitation effect on compaction



POMEROY

- High Rainfall (19”)
- Palouse Silt Loam
- Wheat-Fallow Rotation
- Flowering
- Minimum Tillage

CLOVERLAND

- Intermediate Rainfall (14”)
- Neissenberg-Pataha Silt Loam
- Chem-Fallow Rotation
- Maturing and Ripening
- No Till (~20 years)

OKANOGAN

- Low Rainfall (10”)
- Silt Loam
- Wheat-fallow rotation
- Past-Mid Pod Development
- First year Canola
- First year No Till

Objective

Determine if canola roots are able to reach the subsoil and access subsoil resources in the low, intermediate, and high rainfall zones

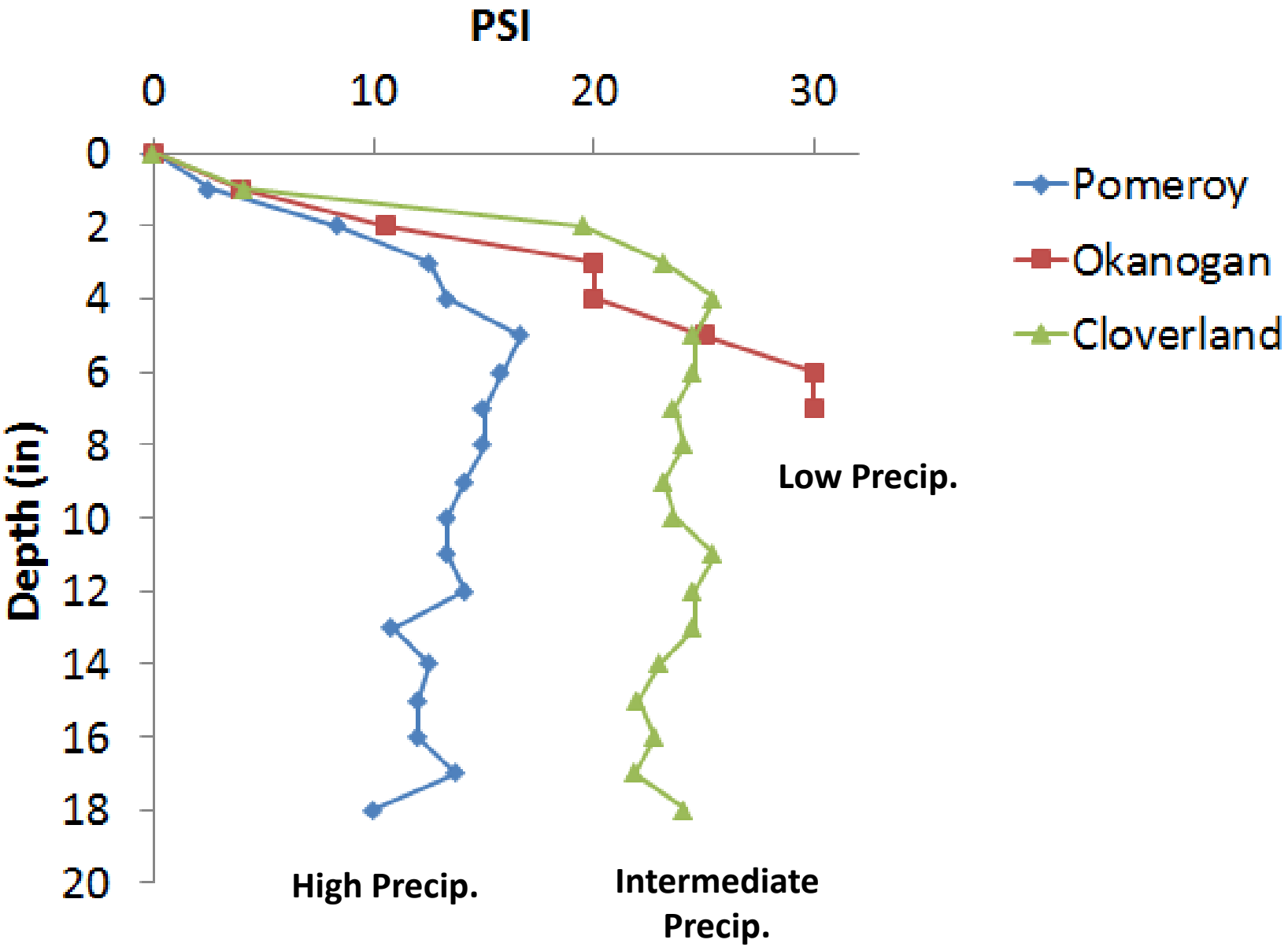
Limitations

- One snapshot of the whole picture
- Different times, different moisture contents
- Sampled closed to harvest

Research Questions

1. **Does the extent of compaction differ between the different rainfall zones?**
2. To what extent is root density affected by the compaction layers?
3. What are the available resources in the subsoil?

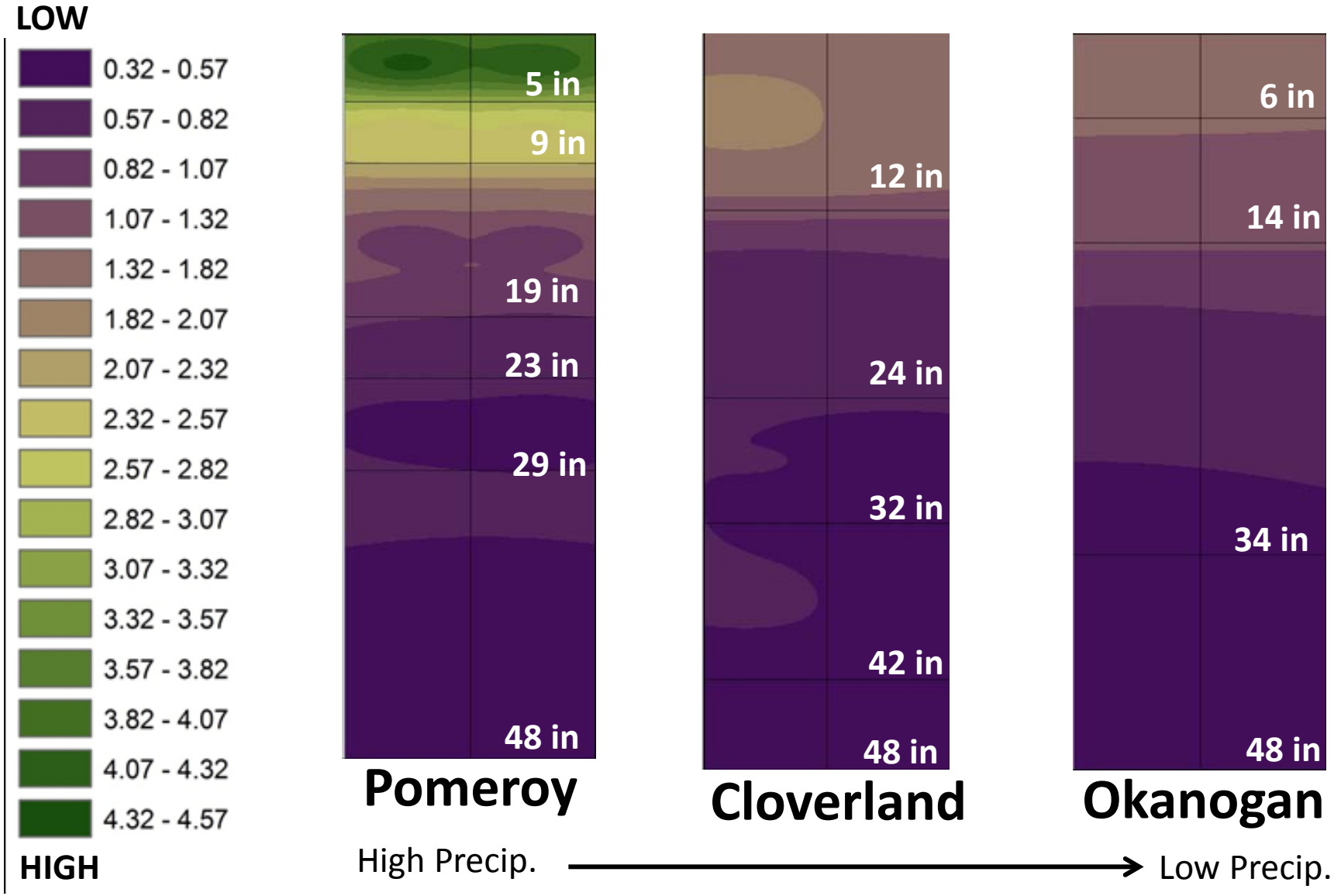
Field Penetrometer Measurements of Three Sites



Site	Distinguishing physical characteristics of first visual pan relative to layer above and below
Okanogan	Higher bulk density*, Higher resistance strength***, Higher silt concentration*
Cloverland	Higher silt concentration***
Pomeroy	Less gravimetric soil water**, Lower silt concentration**

*, **, *** indicate significance at p-value <0.05, <0.01, and <0.001, respectively

Interpolated Organic Matter (%) Across Three Sites



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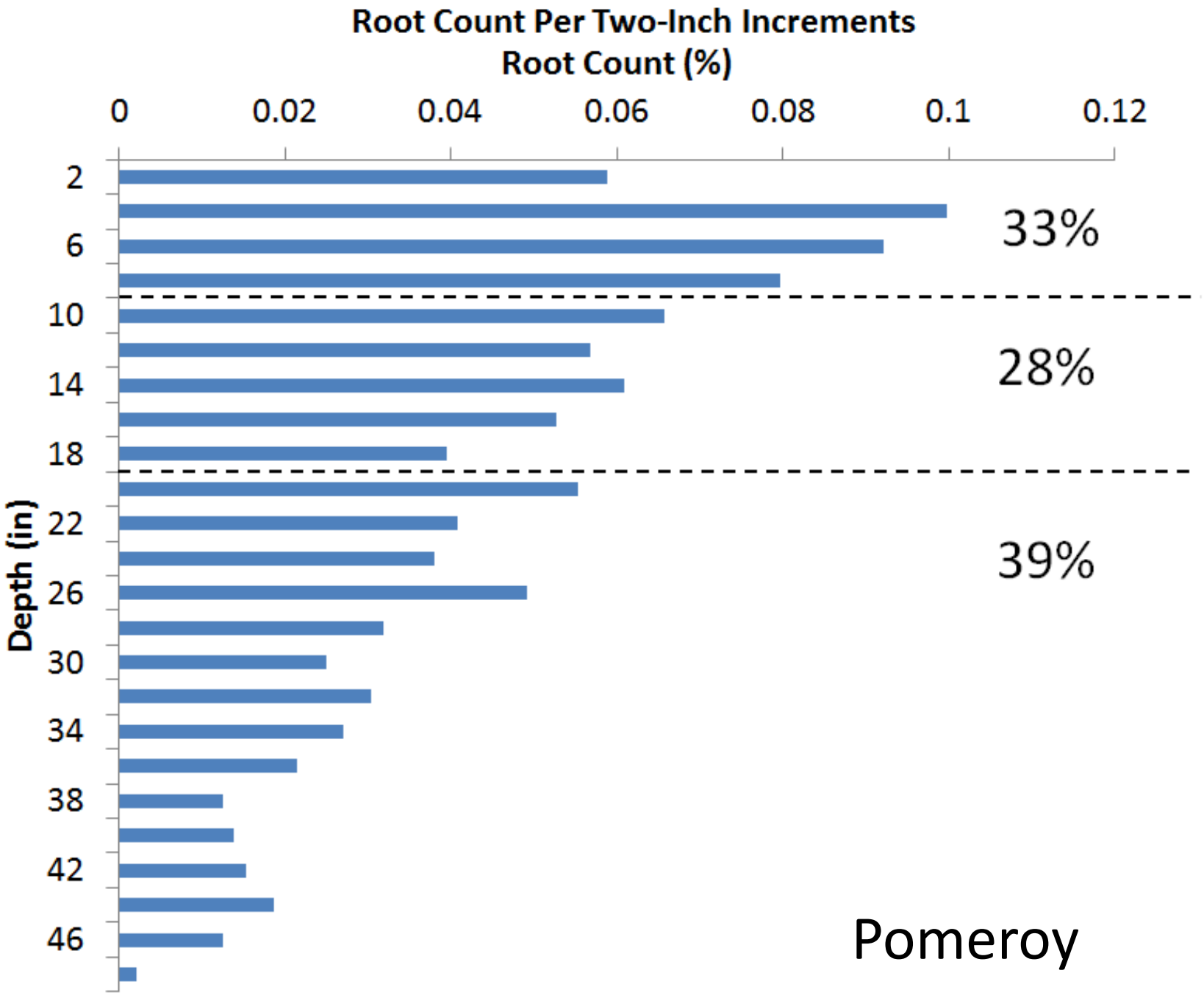
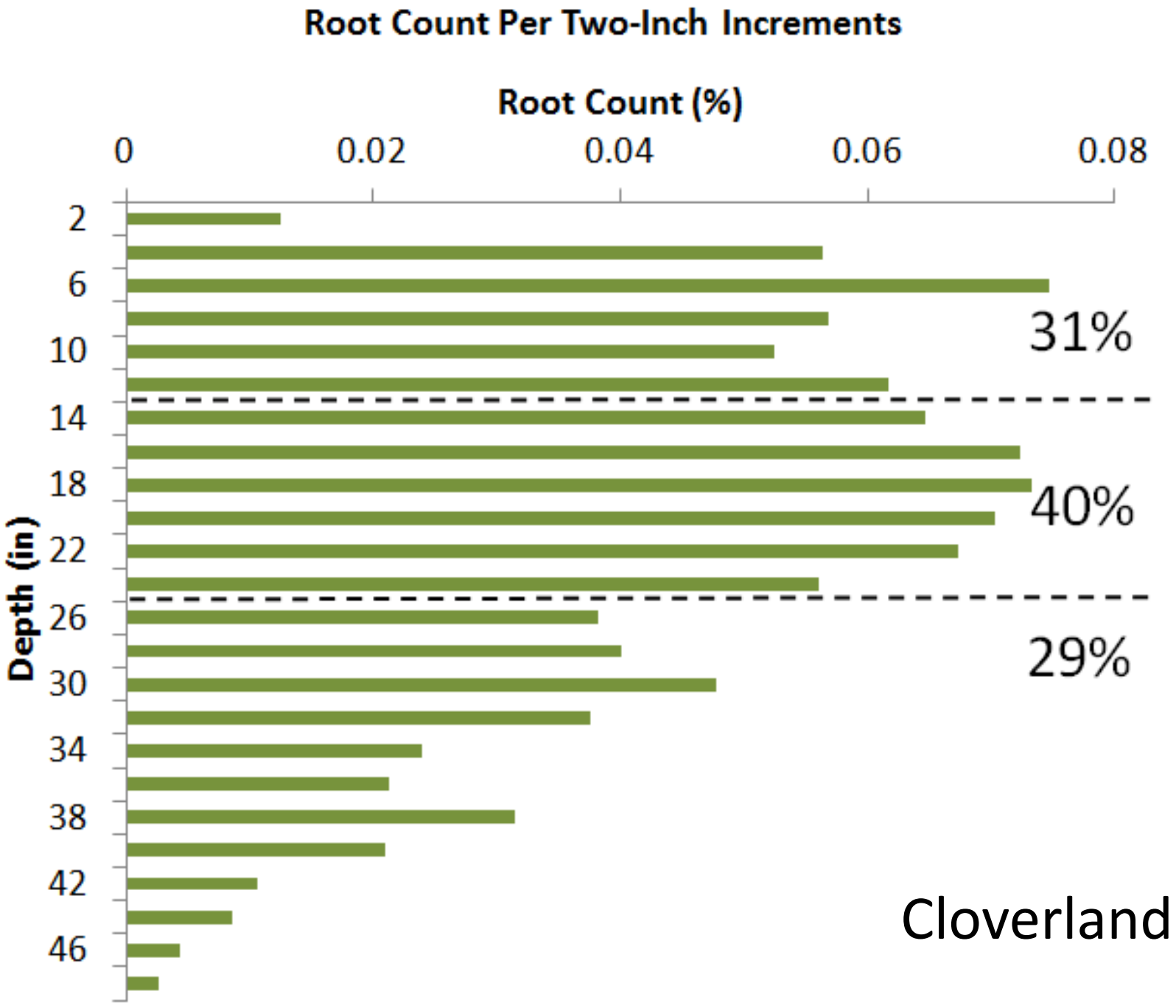
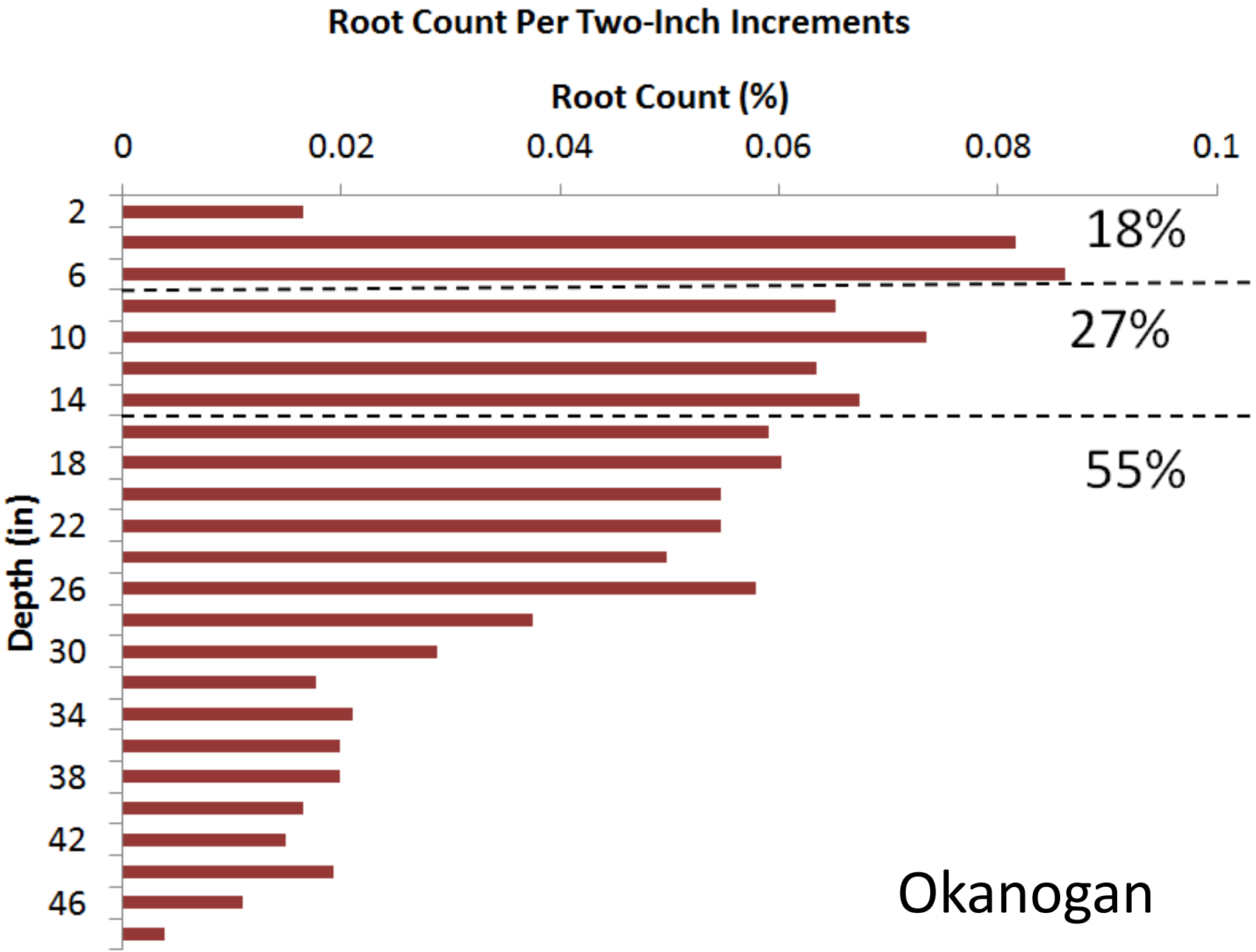

Root Count Per Two-Inch Increments
Root Count (%)
0
0.02
0.04
0.06
0.08
0.1
0.12
Depth (in)
2
6
10
14
18
22
26
30
34
38
42
46
33%
28%
39%
Pomeroy


Root Count Per Two-Inch Increments
Root Count (%)
0
0.02
0.04
0.06
0.08
Depth (in)
2
6
10
14
18
22
26
30
34
38
42
46
31%
40%
29%
Cloverland


Root Count Per Two-Inch Increments
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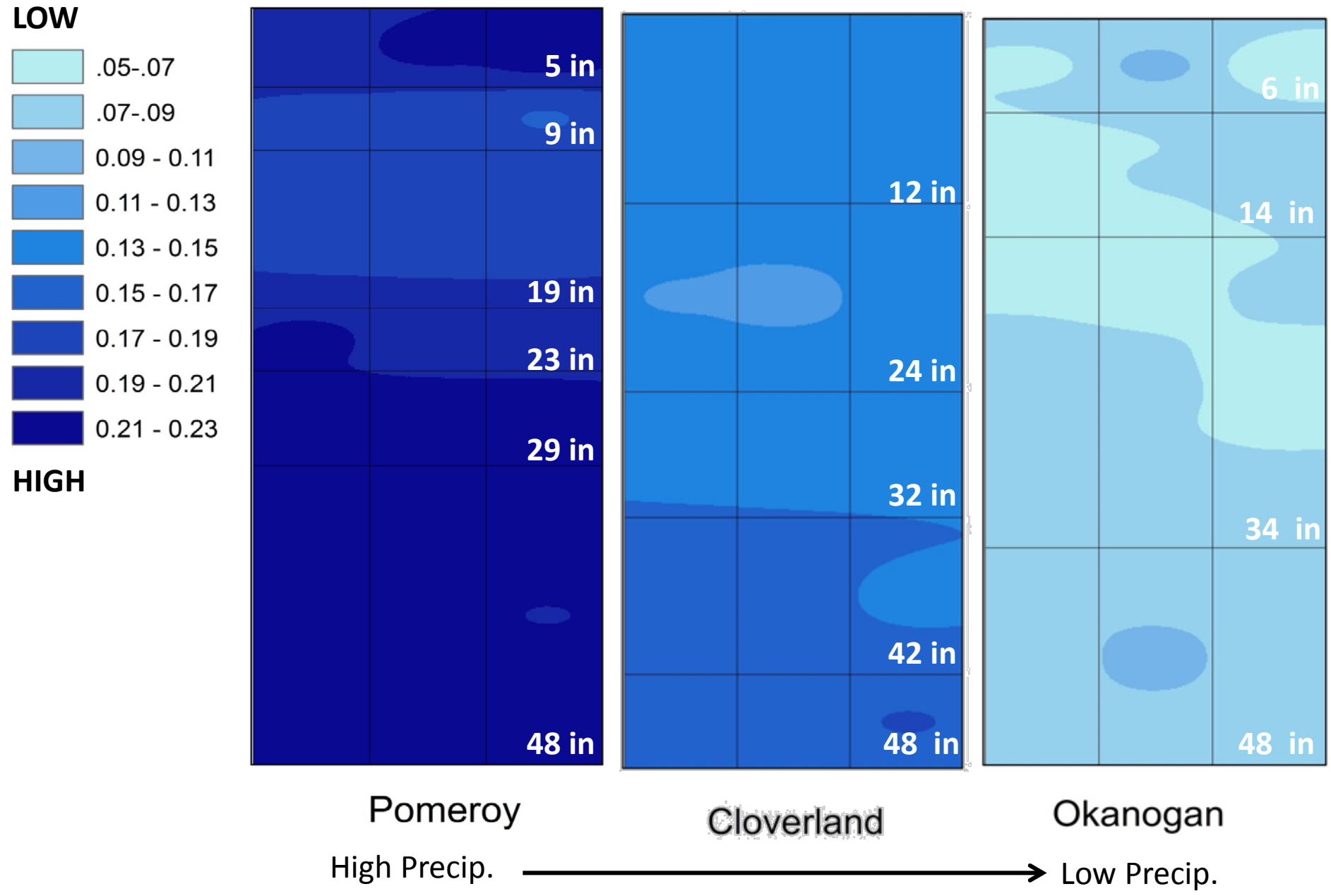
0
0.02
0.04
0.06
0.08
0.1
Depth (in)
2
6
10
14
18
22
26
30
34
38
42
46
18%
27%
55%
Okanogan

“J-hooking” in Okanogan

Research Questions

1. Does the extent of compaction differ between the different rainfall zones?
2. To what extent is root density affected by the compaction layers?
3. **What are the available resources in the subsoil?**

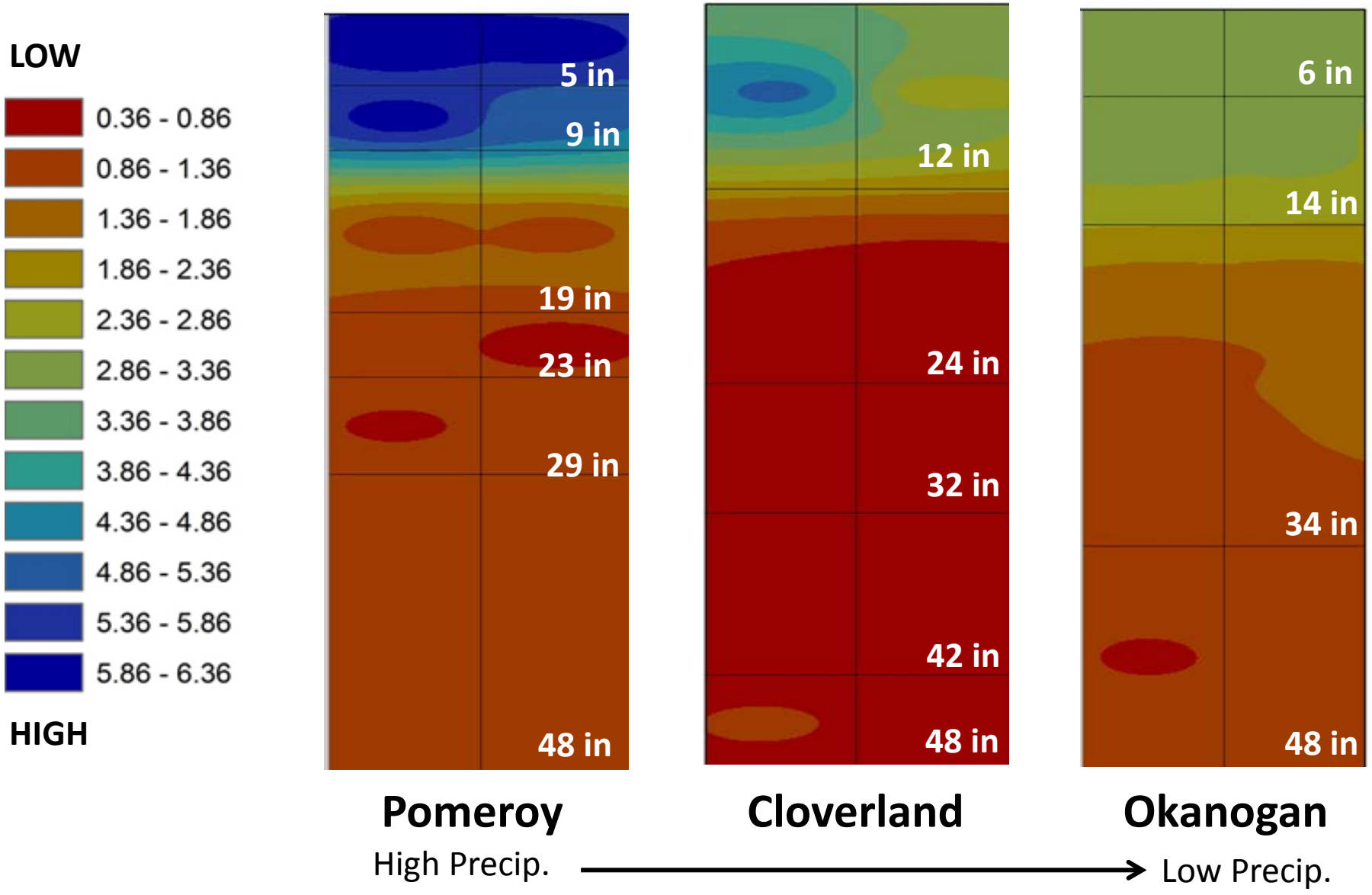
Interpolated Average Gravimetric Water Across Three Sites



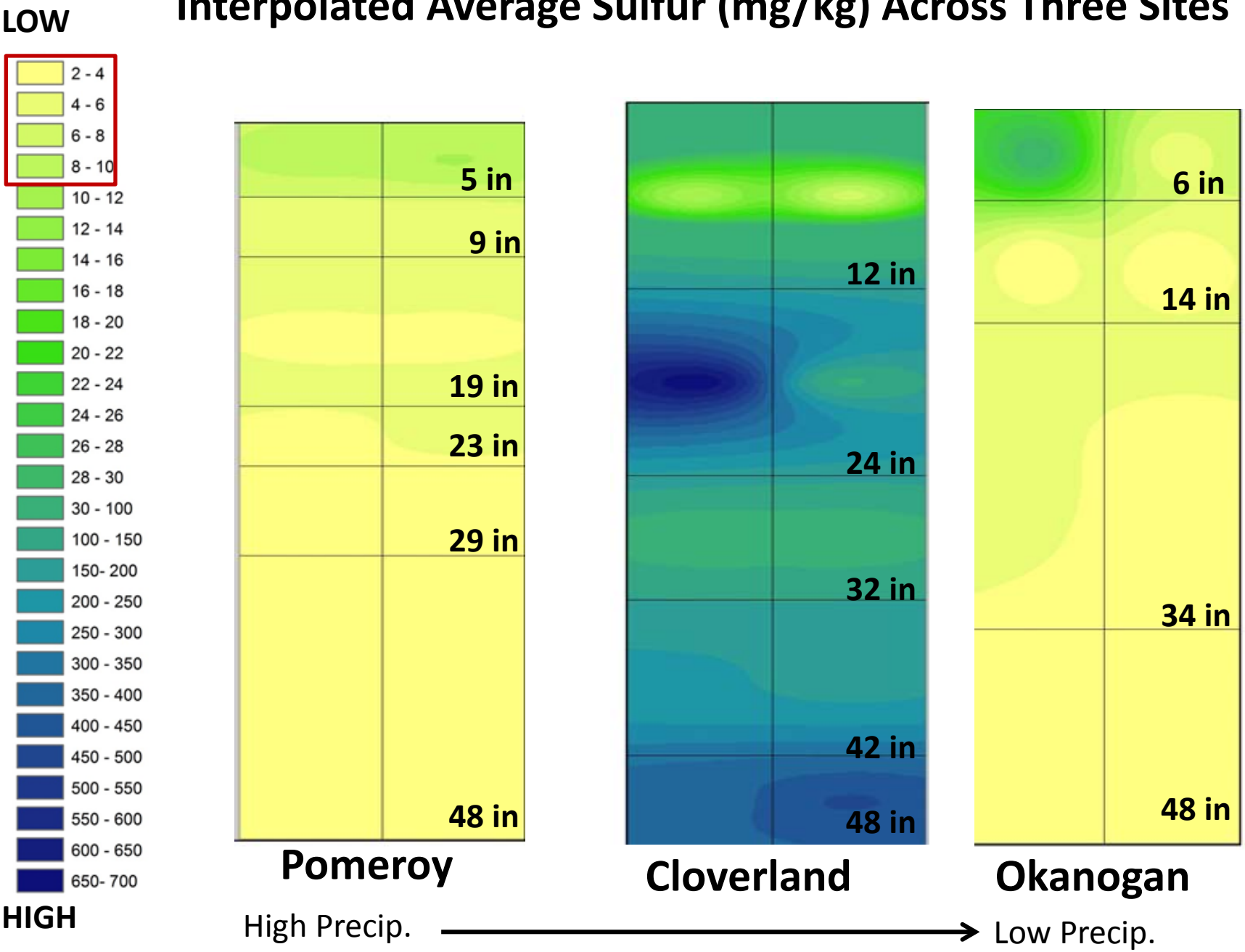
Sufficient Nutrient Levels for Winter Canola

Nutrient	Sufficient Levels	Source
Inorganic Nitrogen	Dependent on potential yield	Mahler & Guy (2005)
Sulfur	> 10 mg/kg	Mahler & Guy (2005)
Boron	> 0.5 mg/kg	Mahler & Guy (2005)
Phosphorus	> 12 mg/kg	Mahler & Guy (2005)
Zinc	> 0.6 mg/kg	Mahler & Guy (2005)

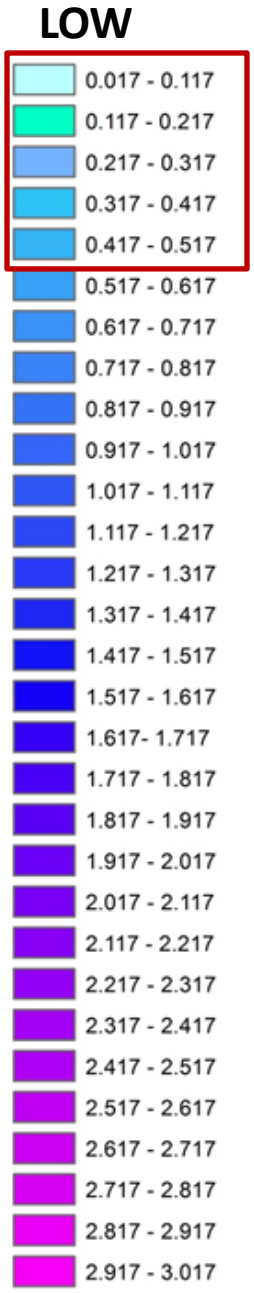
Interpolated Average Inorganic Nitrogen (mg/kg) Across Three Sites

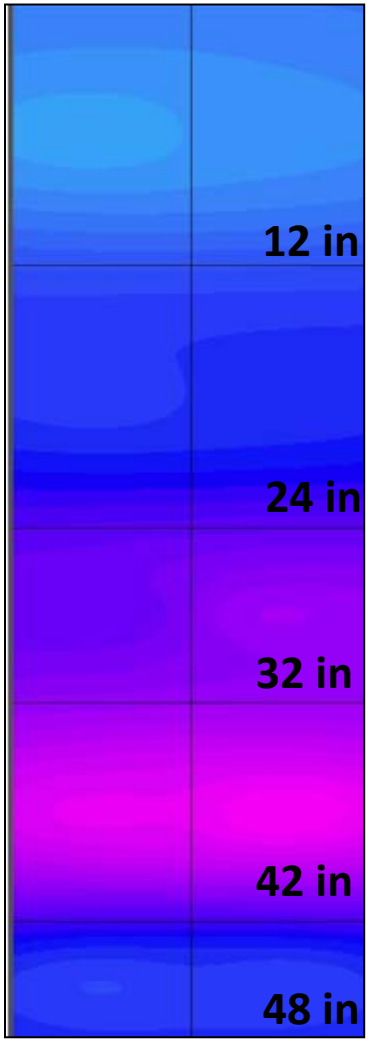


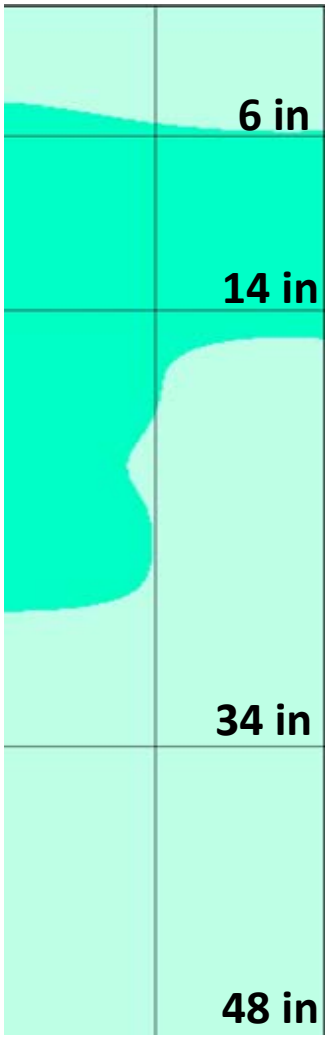
Interpolated Average Sulfur (mg/kg) Across Three Sites



Interpolated Average Boron (mg/kg) Across Three Sites



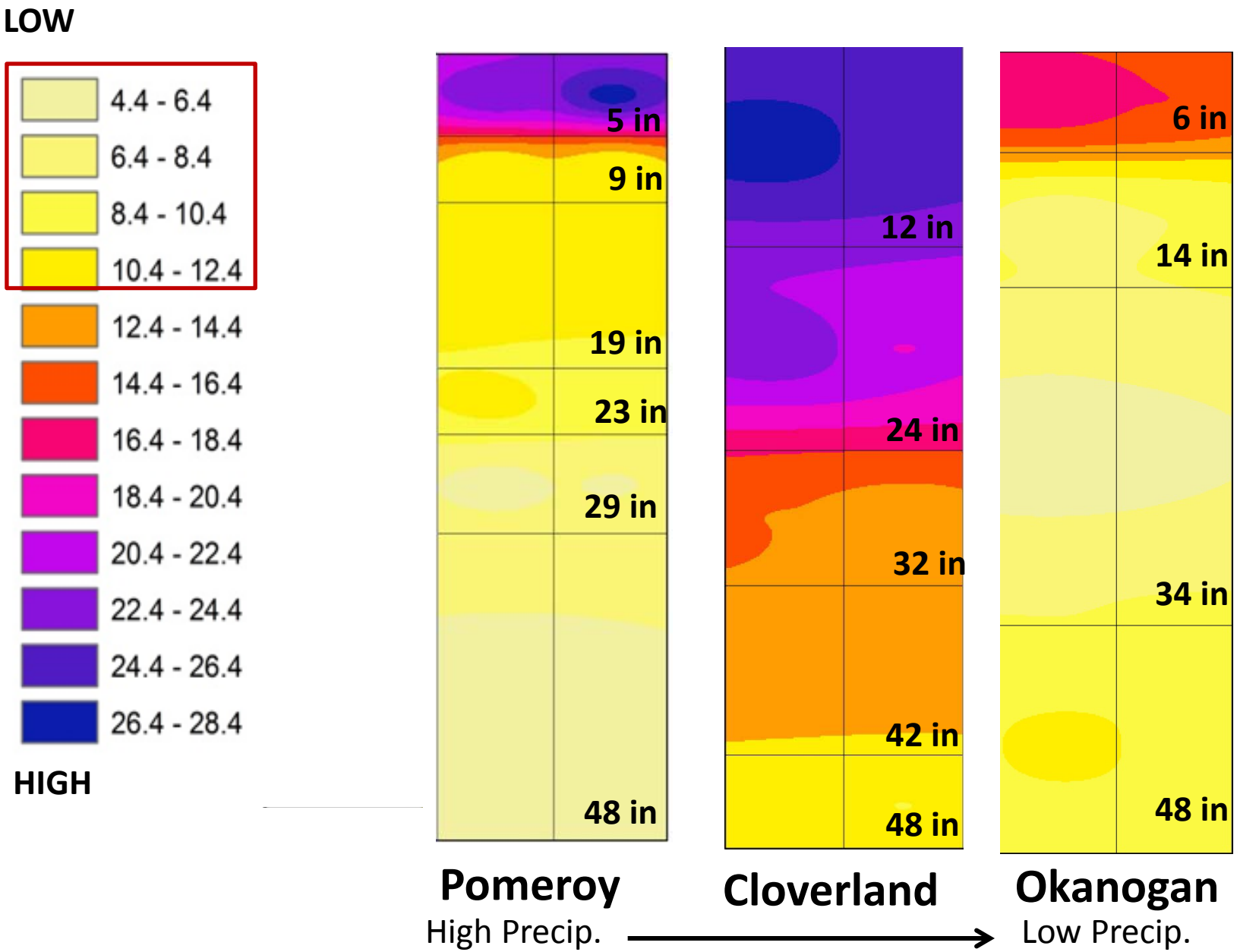




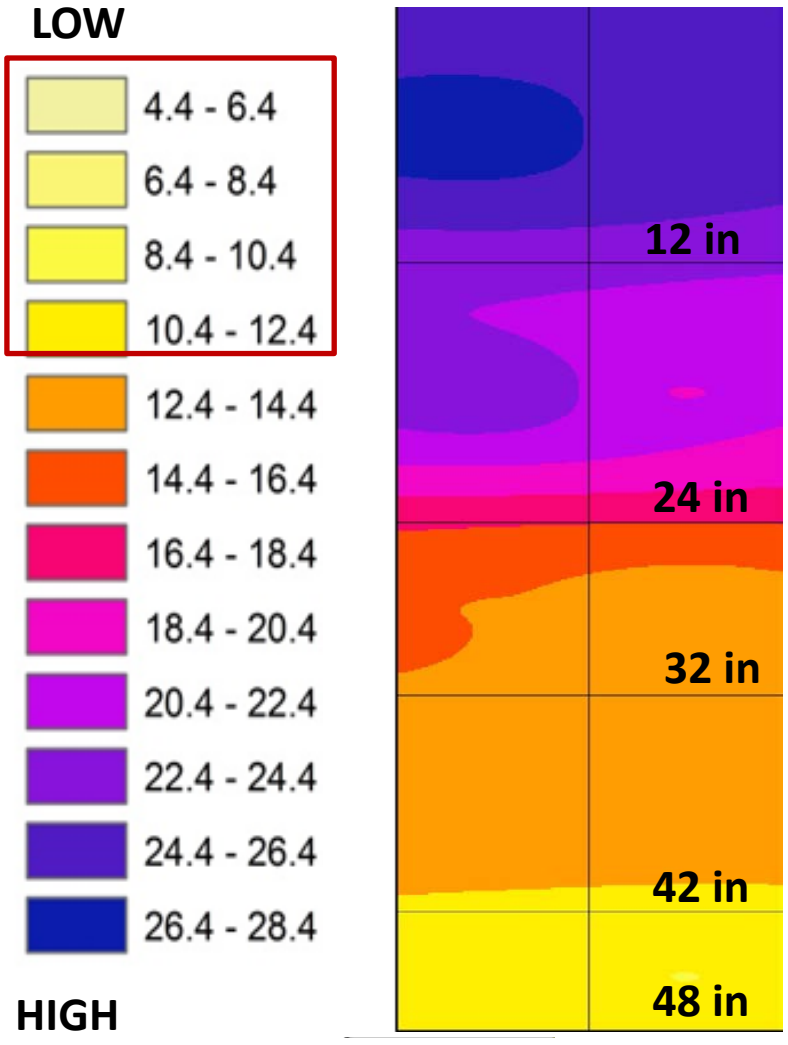
Pomeroy **Cloverland** **Okanogan**

High Precip. → Low Precip.

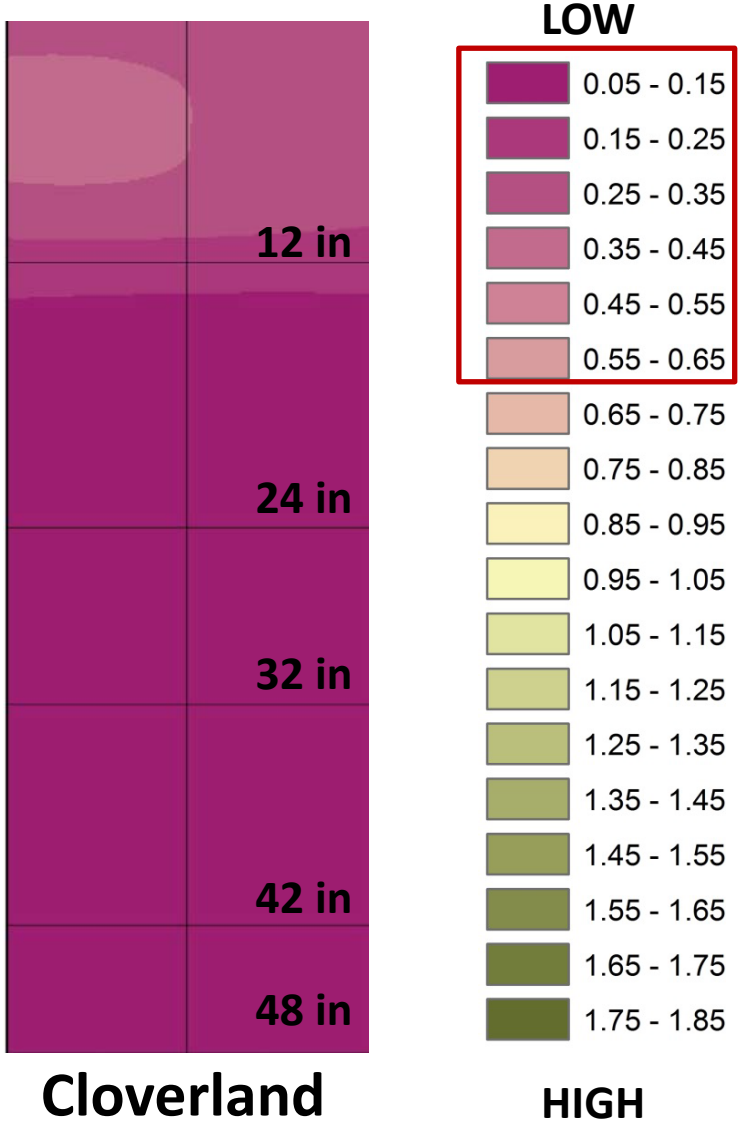
Interpolated Average Phosphorus (mg/kg) Across Three Sites



Phosphorus (mg/kg)



Zinc (mg/kg)



Results

- The site with low precipitation had a more severe compacted layer when compared to the other sites
- Data demonstrated that compaction did not inhibit root growth
- Roots are able to get to the subsoil
- Subsoil generally deficient in nutrients

Conclusions

- Planting canola might be a strategy to alleviate compaction
- Although roots are able to access the subsoil, there the resources they can access are limited
- Growers should reconsider fertilizer requirements when transitioning from wheat to canola and when treating deficiencies
- If subsoil quality does not improve, crop growth and yield can be negatively affected in the changing climate

Comparing Winter Wheat Management Practices

Jacqueline Huettenmoser

Justification

- Soil is non-renewable
- No-till identified as a solution
  - Reduce erosion losses
  - Regains soil quality?

Objective

Assess how management affects subsoil quality and quantify the degree of root accessibility to the available resources.

The Plots

- Native
  - Flowering
- No till since the late 1970s
  - Corn in previous year
- Conventional
  - Fallow in previous year

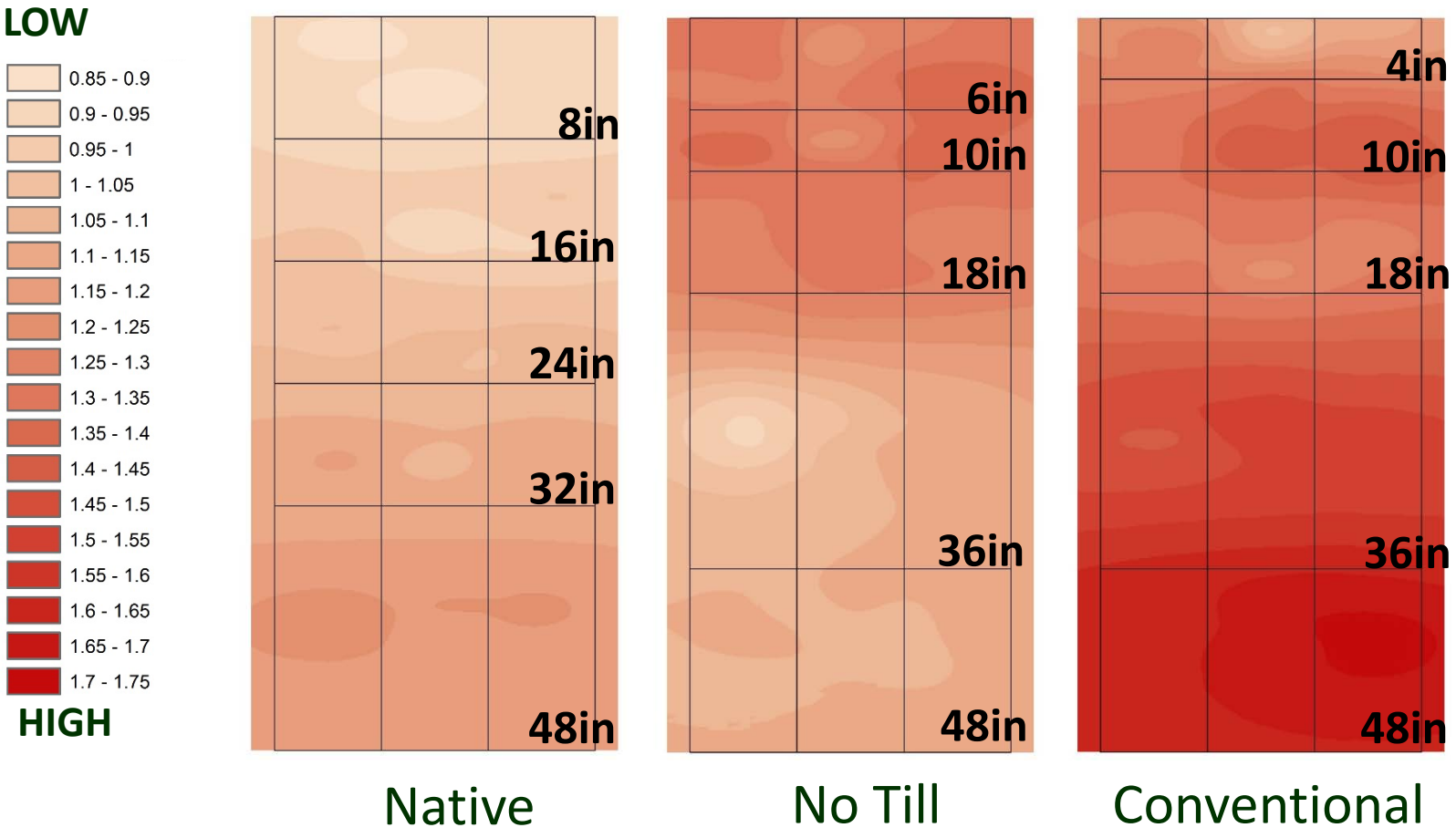
http://pnwsteep.wsu.edu/dscases/ext_pubs/pnw0515.pdf

Research Questions

- **Is compaction affecting resource-use efficiency in any plot?**
- Are subsoil resources sufficient enough to satisfy the plants needs?
- Are the roots utilizing the resources efficiently?

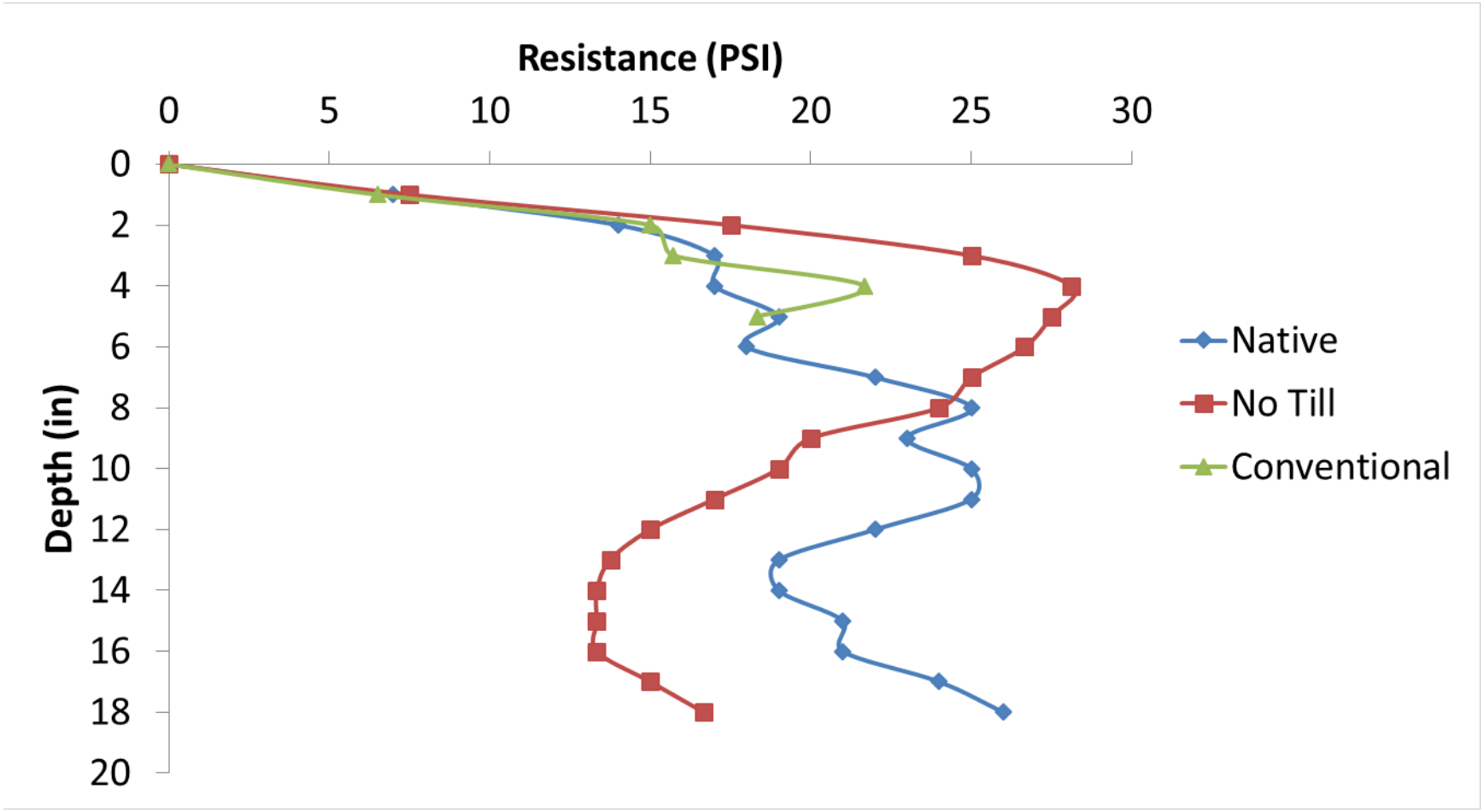
Is compaction affecting root access to subsoil?

Interpolated Bulk Density (g/cm^3) Across Sites



Is compaction affecting resource-use efficiency in any plot?

Field Penetrometer Measurements



Is compaction affecting resource-use efficiency in any plot?

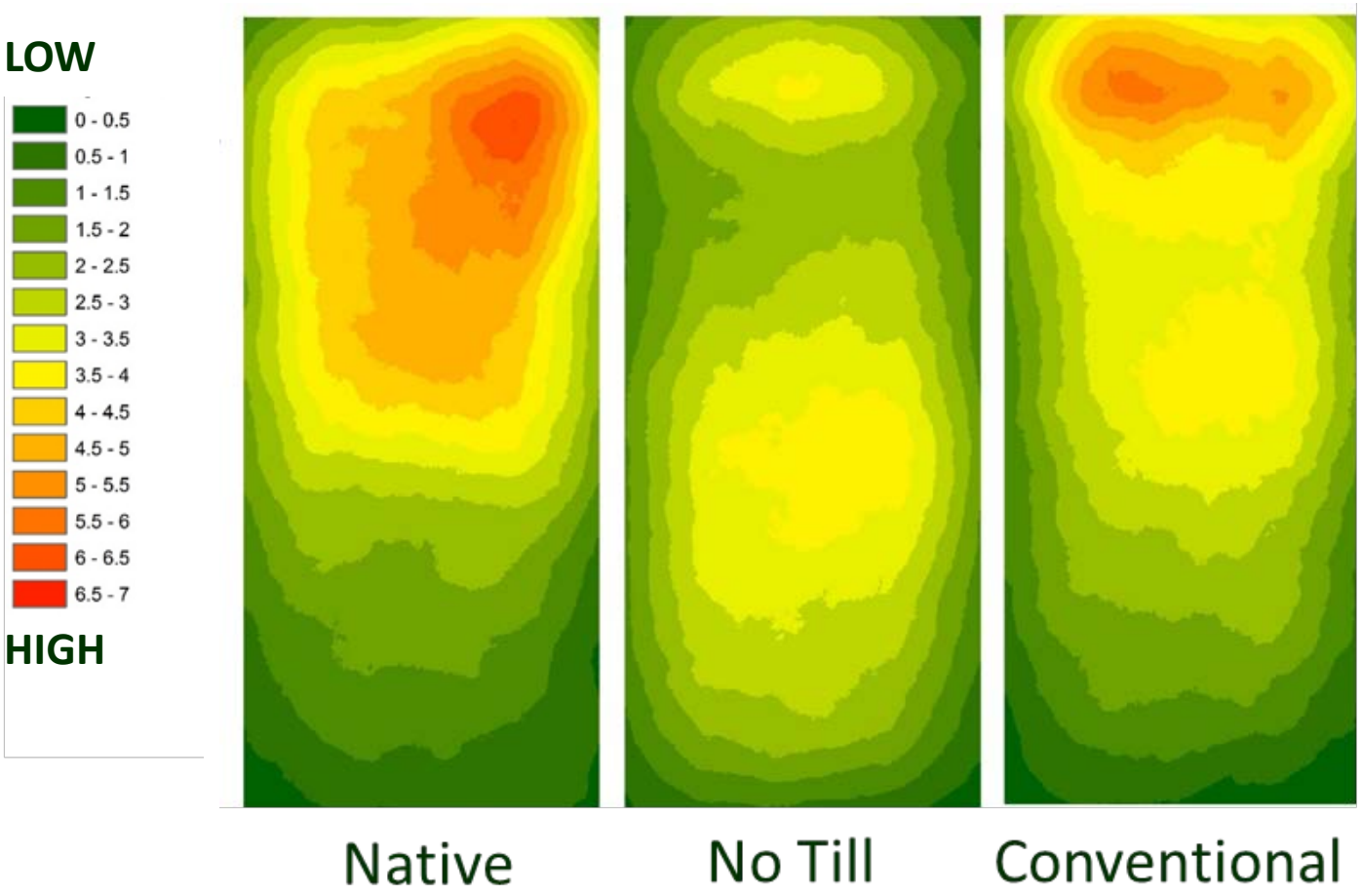
Physical Characteristics of Pan Layer

Site	Significant physical characteristics relative to layer above and below
Native	Higher silt concentration*
No-till	Higher bulk density***
Conventional	Higher bulk density***, Higher silt concentration ***

*, **, *** indicate significance at p-value <0.05, <0.01, and <0.001, respectively

Is compaction affecting root access to subsoil?

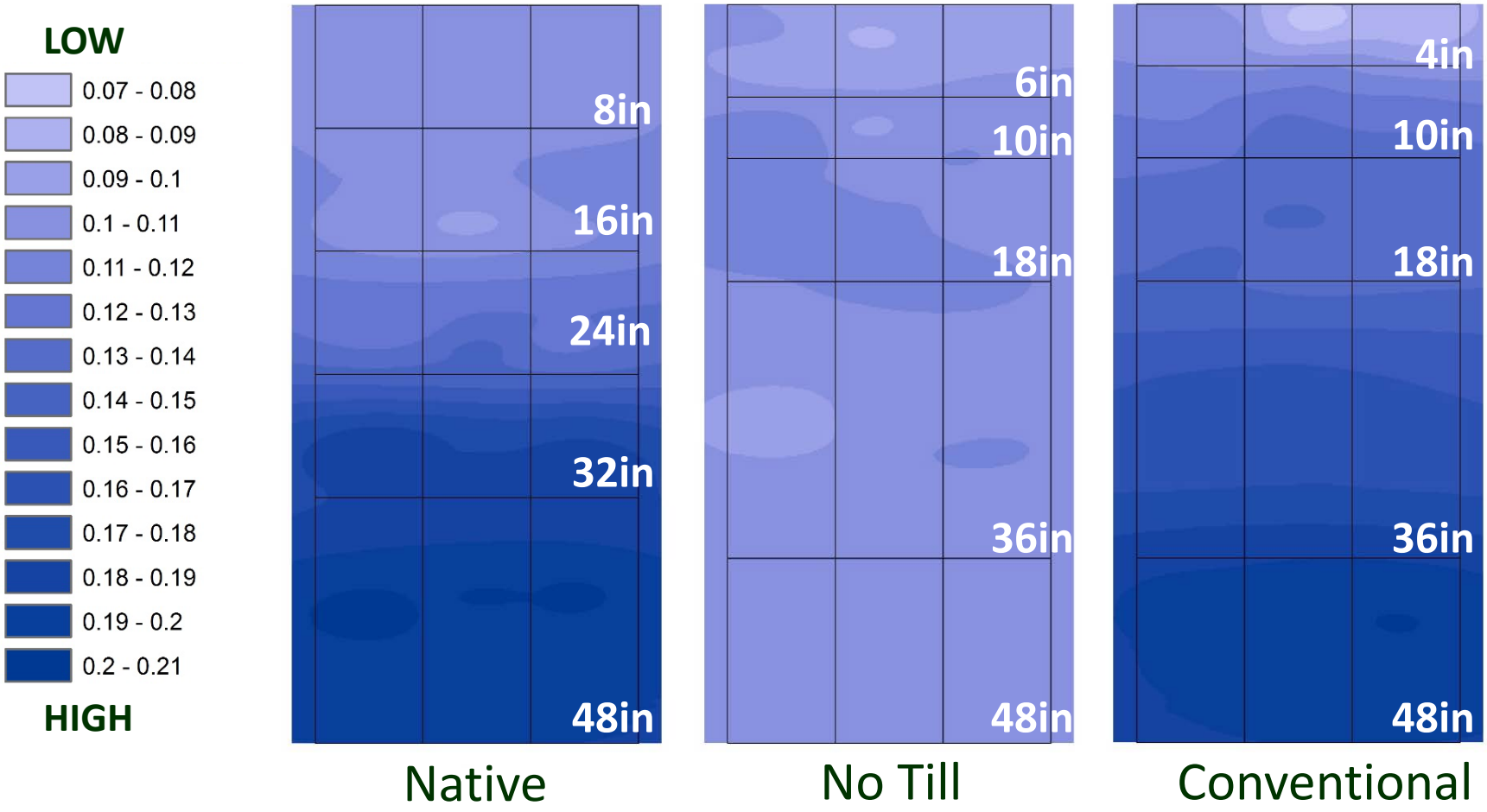
Interpolated Root Density (count/in^2) Across Sites



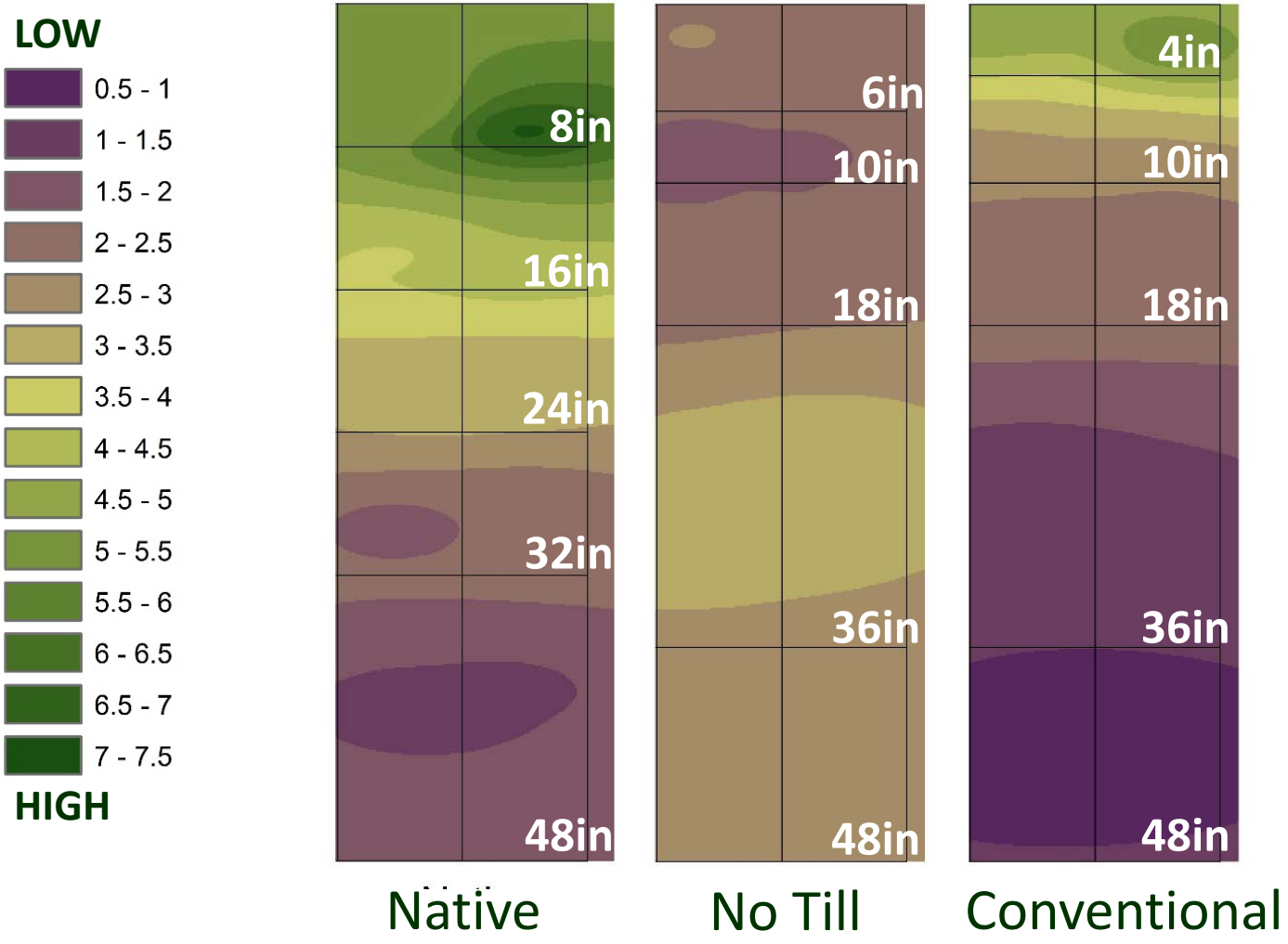
Research Questions

- Is compaction affecting root access to subsoil?
- **Are subsoil resources sufficient enough to satisfy the plants needs?**
- **Are the roots utilizing the resources efficiently?**

Interpolated Volumetric Water Across Sites

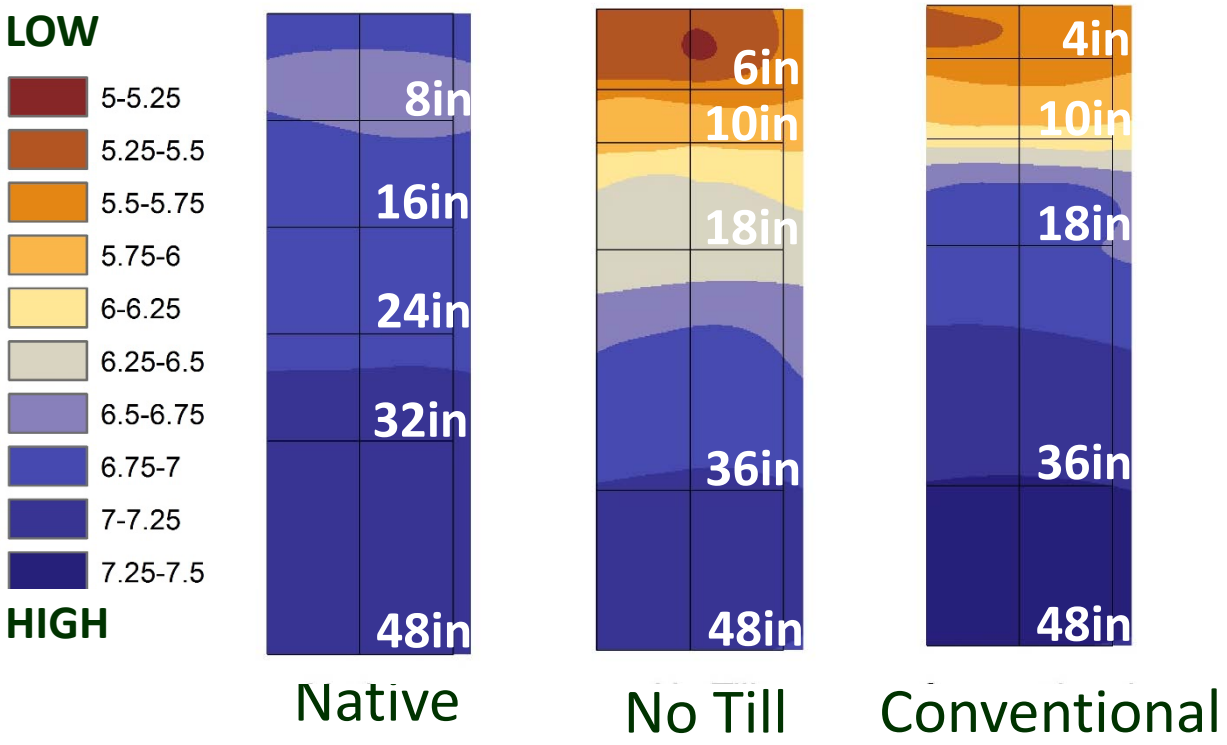


Interpolated Soil Organic Matter (%) Across Sites

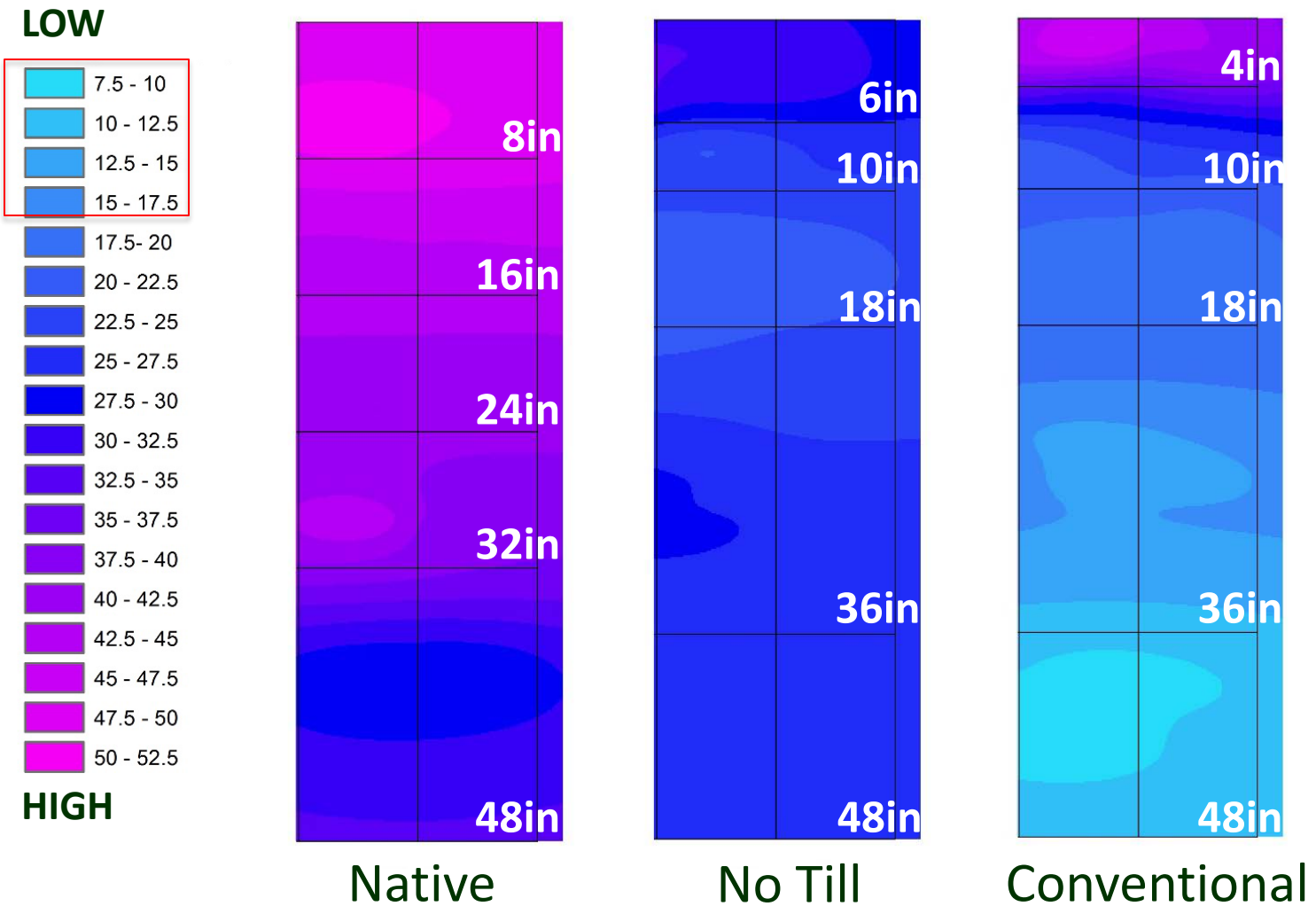


Fence Post in 90 year Conventional, 40 year No Till Subsoil

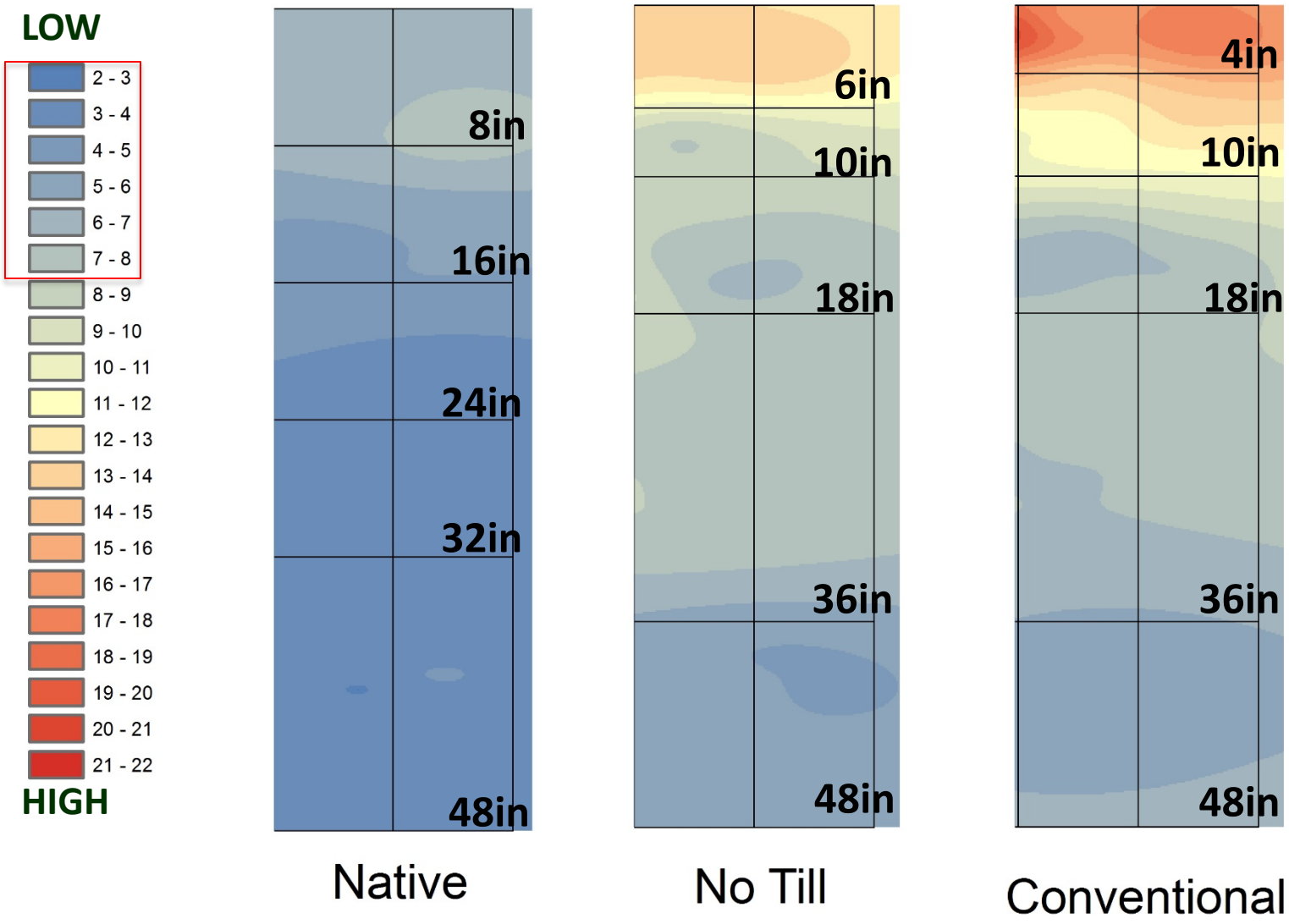
Interpolated pH Across Sites



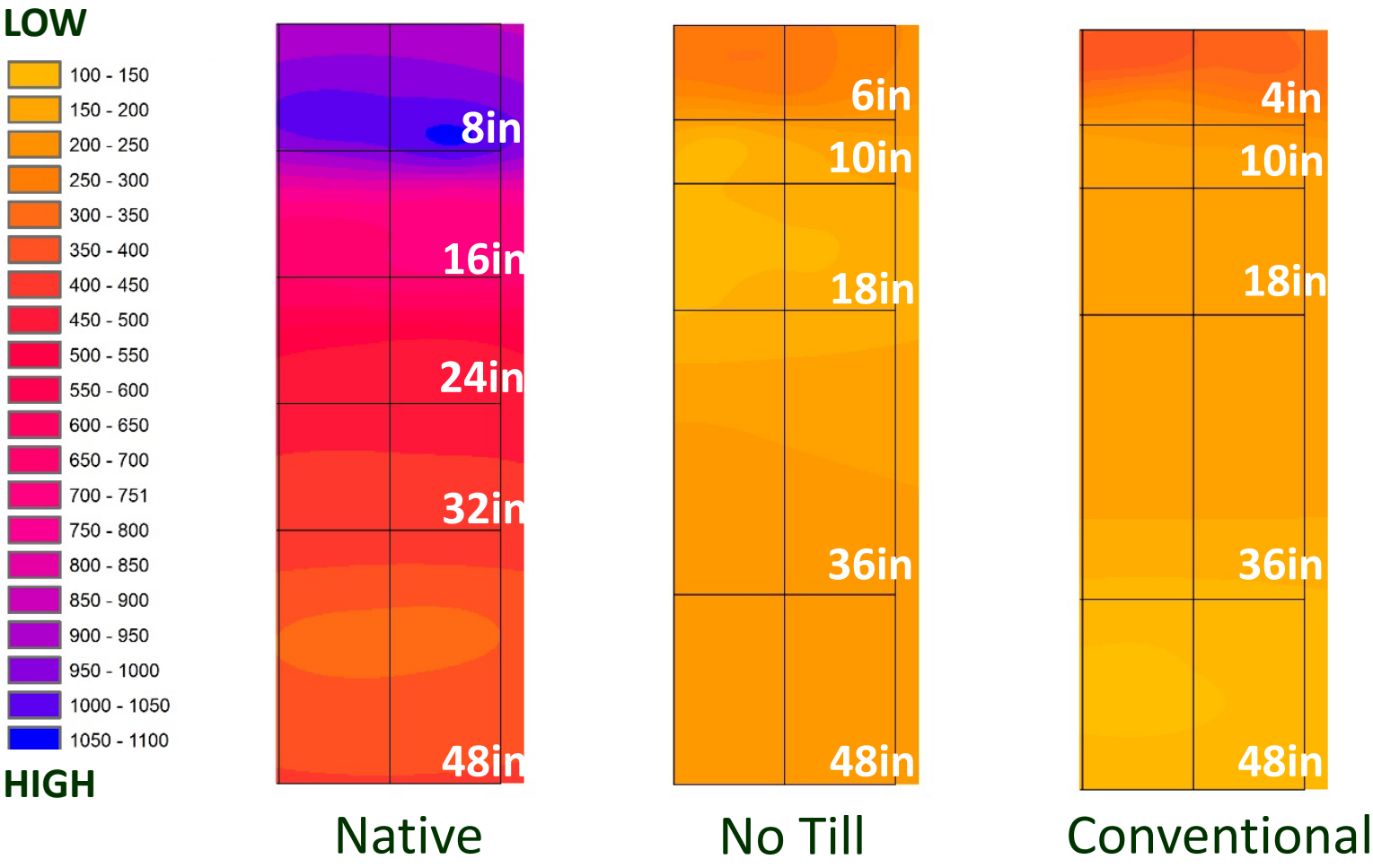
Interpolated Phosphorus (mg/kg) Across Sites



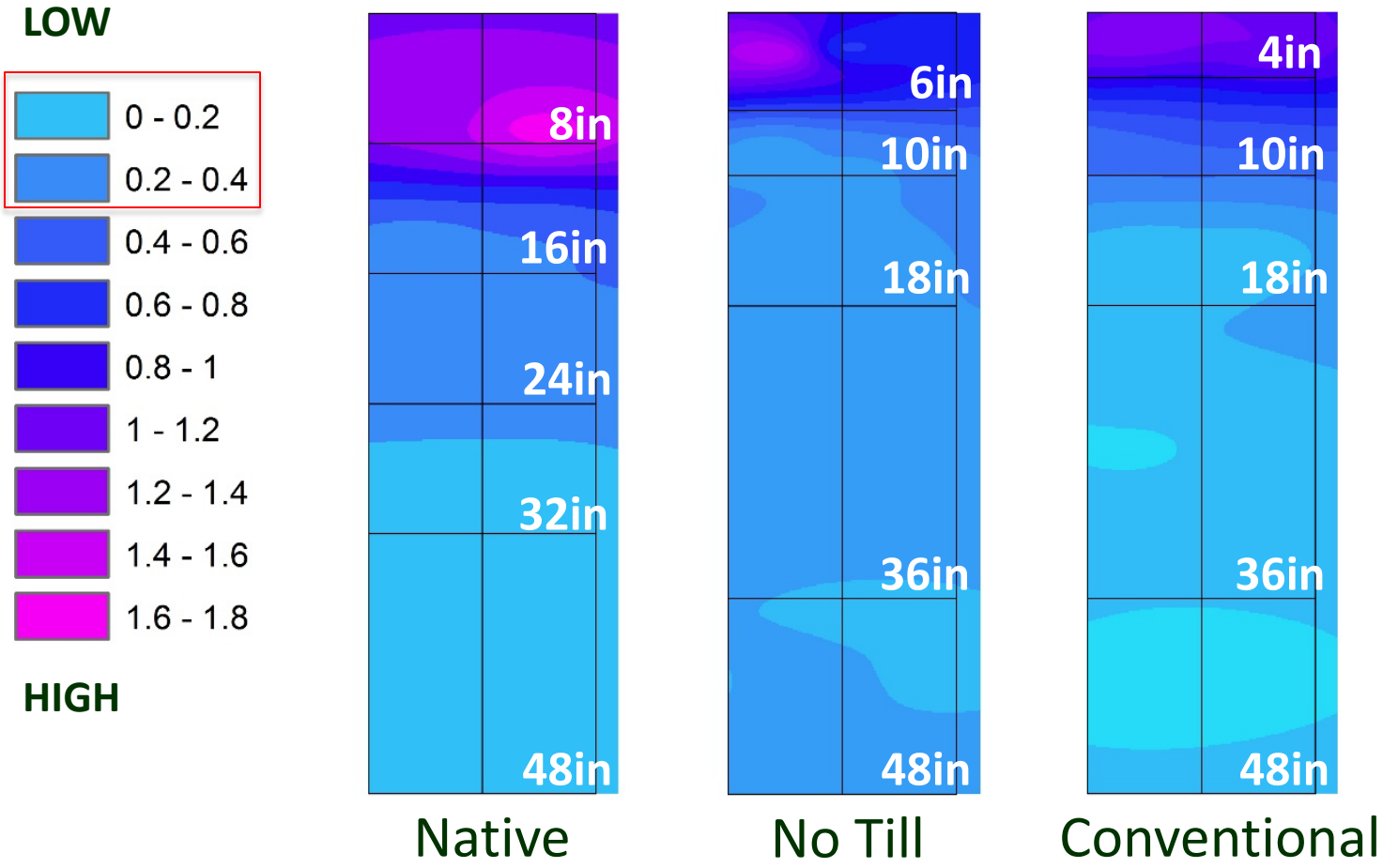
Interpolated Sulfur (mg/kg) Across Sites



Interpolated Potassium (mg/kg) Across Sites



Interpolated Zinc (mg/kg) Across Sites



Results

- Compaction is not inhibiting root access to subsoil resources across sites
- Observed compaction was deeper and less thick in no-till
- Significantly less organic matter in the no-till topsoil
- Acidification in no-till topsoil relates to banded ammonium fertilization
- Phosphorus is cycled in native system and removed in ag systems, but better phosphorus availability is maintained in no-till

Conclusions

- Transitioning to no-till management reduces compaction
- No till management prevents erosion and degradation, but is only part of the solution
- Further research is needed

Overall Messages

- Both canola and wheat roots were reaching the bottom of the fourth foot and probably beyond
- High subsoil nutrients were in the native site due to more nutrient cycling in place and less nutrient exporting with grain harvest
- Some subsoil nutrients were at adequate levels (e.g. P) of long term no till sites at Cloverland and Aeschliman's
- Surface soil acidification observed in all agricultural soils, pH units lower than the native soil condition

Outcomes & Impacts

- Long-Term Experiments
- Extension and Publications
  - Increase knowledge of growers
  - Better understanding of subsoil quality
- Stakeholders
  - Growers, advisors and manufacturers







Special thanks to:

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USDA
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John Aeschliman
Mark Greene
Ed Townsend
Beau Blachly