Washington County Water Consortium

February 5, 2025
2 to 3:15 pm
Remote meeting – Zoom
(If you are not on the Consortium listserv, please email
Adriana.Atcheson@co.washington.mn.us for the Zoom link and access code)

Agenda

2:00 – 2:05 **Welcome**
Introductions, Announcements

2:05 – 2:30 **Twin-Cities Metropolitan Area Urban Soil Survey**

Topic: The University of Minnesota Department of Soil/Water/Climate is engaging in a collaborative project with the USDA-NRCS (Natural Resources Conservation Service) to generate an updated soil map of the Twin-Cities Metropolitan Area. Western portions of Washington County are included in the survey. This valuable soil data generates more accurate maps, which are useful for everything from urban agriculture and gardening to building development.

Presenter: Adam Devlin, Soil Scientist, NRCS MN State Office

2:30 – 3:00 **Trends in Soil Properties Across the Minneapolis-St. Paul Metropolitan Area – Implications for Ecosystem Services**

Topic: This presentation examines soil properties across different land use types in the Minneapolis-St. Paul metropolitan area, with a particular focus on urban food production (UFP) sites compared to other urban land uses like parks, residential areas, and natural vegetation.

Presenter: Nic Jelinski, Associate Professor, Department of Soil/Water/Climate, U of M

3:00 – 3:15 **Questions/Adjourn**

USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

Twin Cities Urban Soil Survey

Background and Outcomes for Washington County

Adam Devlin, Soil Scientist, St. Paul, MN

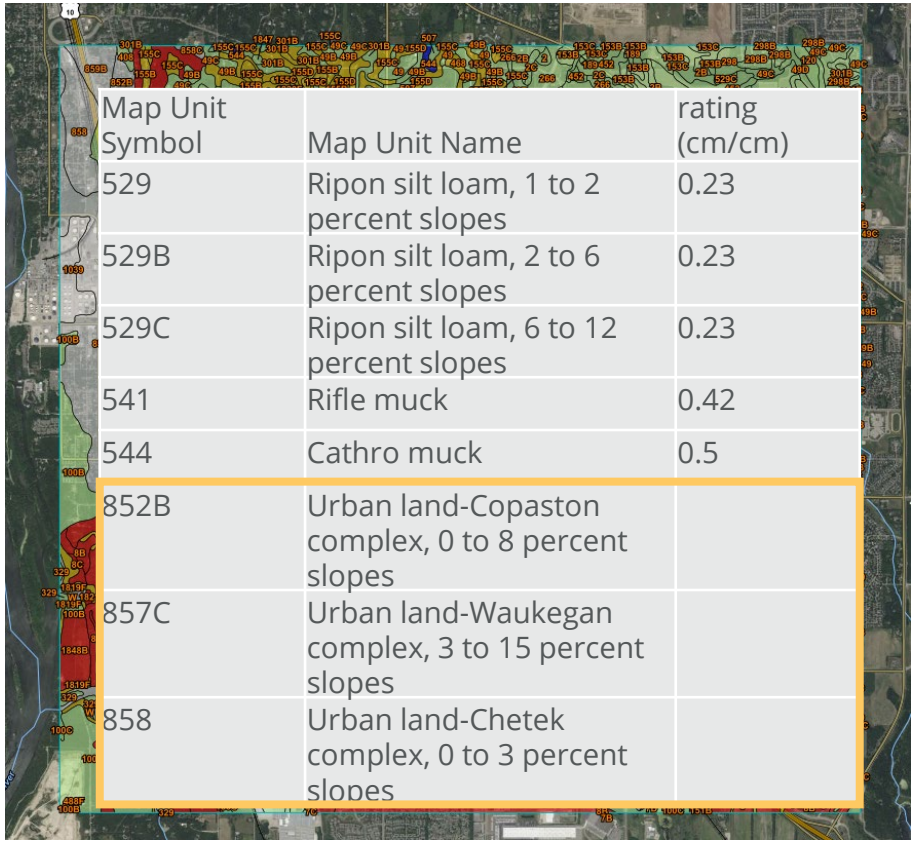
FARM PRODUCTION AND CONSERVATION
FSA | NRCS | RMA | Business Center

Terms

- **Soil Survey**: Systematic characterization and mapping of soils across a landscape to support land management decision making
- **Urban Soil:** Soil that has been disturbed or manipulated by and for human use in a population center
- **Web Soil Survey**: NRCS's online portal to access soil survey data including:
  - maps of soil types, properties, and interpretations.
  - Tables of soil property values used to generate maps

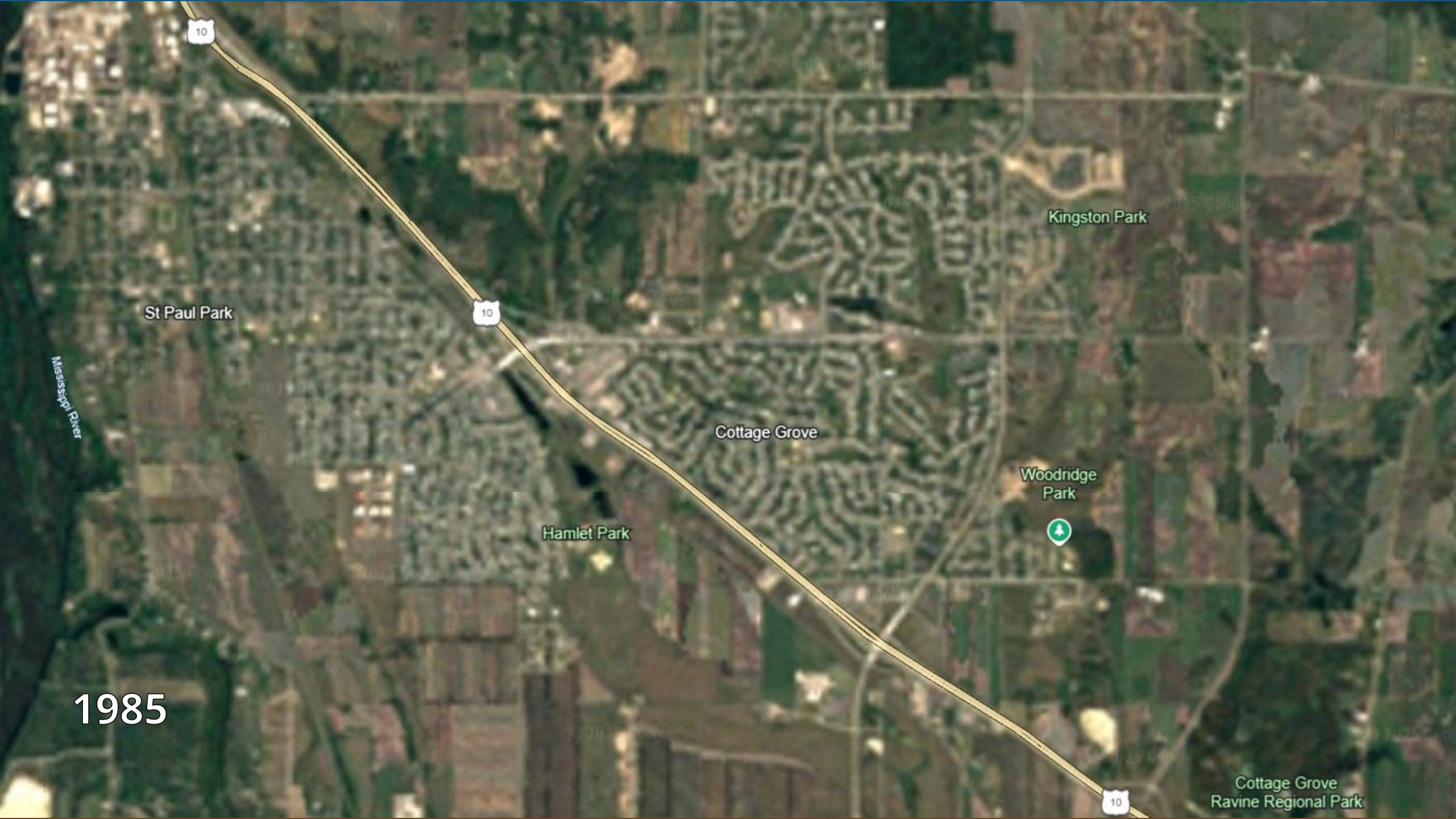
Background and Purpose

- Current soil maps of limited use, out-of-date
  - Urban farming, stormwater management, construction
  - Soil taxonomy is modernizing
- NRCS 🤝 UMN-Jelinski Lab
  1. **Update survey** for contiguous 7-county metro
  2. **Technical assistance** for geophysical tools, contaminant monitoring
  3. **Engagement and outreach**



Map Unit Symbol	Map Unit Name	rating (cm/cm)
529	Ripon silt loam, 1 to 2 percent slopes	0.23
529B	Ripon silt loam, 2 to 6 percent slopes	0.23
529C	Ripon silt loam, 6 to 12 percent slopes	0.23
541	Rifle muck	0.42
544	Cathro muck	0.5
852B	Urban land-Copaston complex, 0 to 8 percent slopes	
857C	Urban land-Waukegan complex, 3 to 15 percent slopes	
858	Urban land-Chetek complex, 0 to 3 percent slopes	

Cottage Grove WSS Rating map for "Soil Health – **Available Water Capacity**". Urban land map units return "no data", minor components with data are likely under sampled.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Hamlet Park
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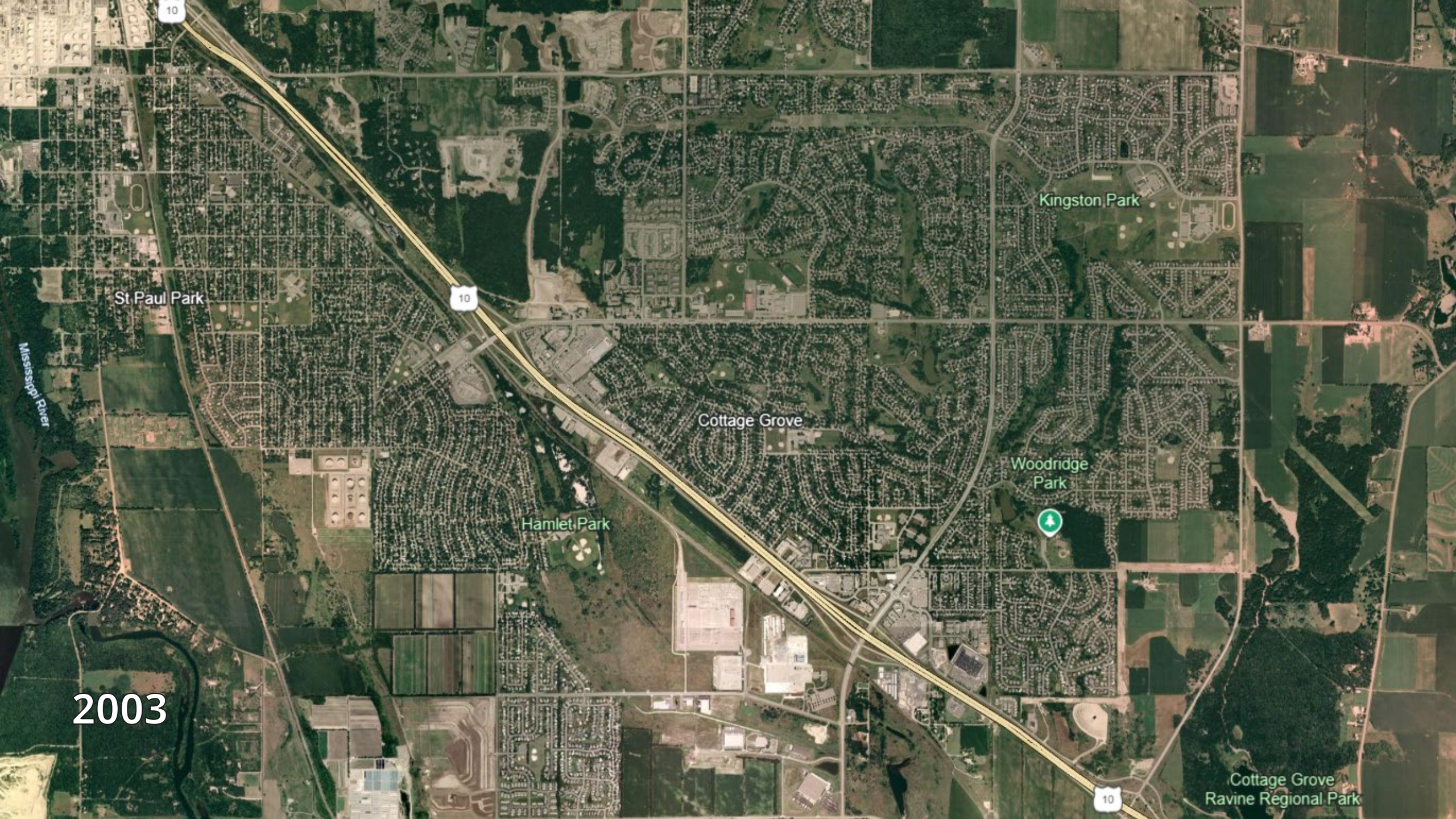
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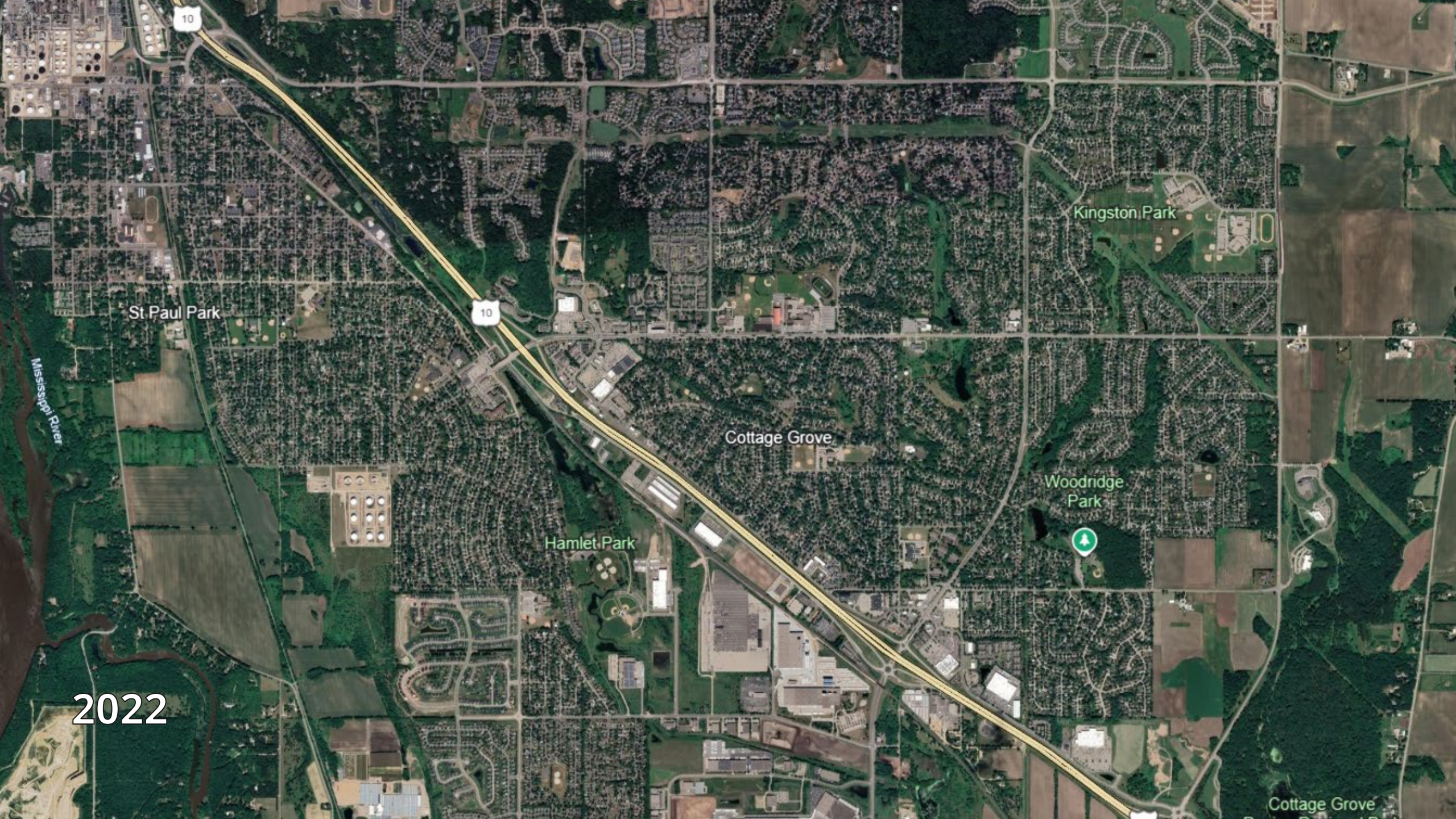
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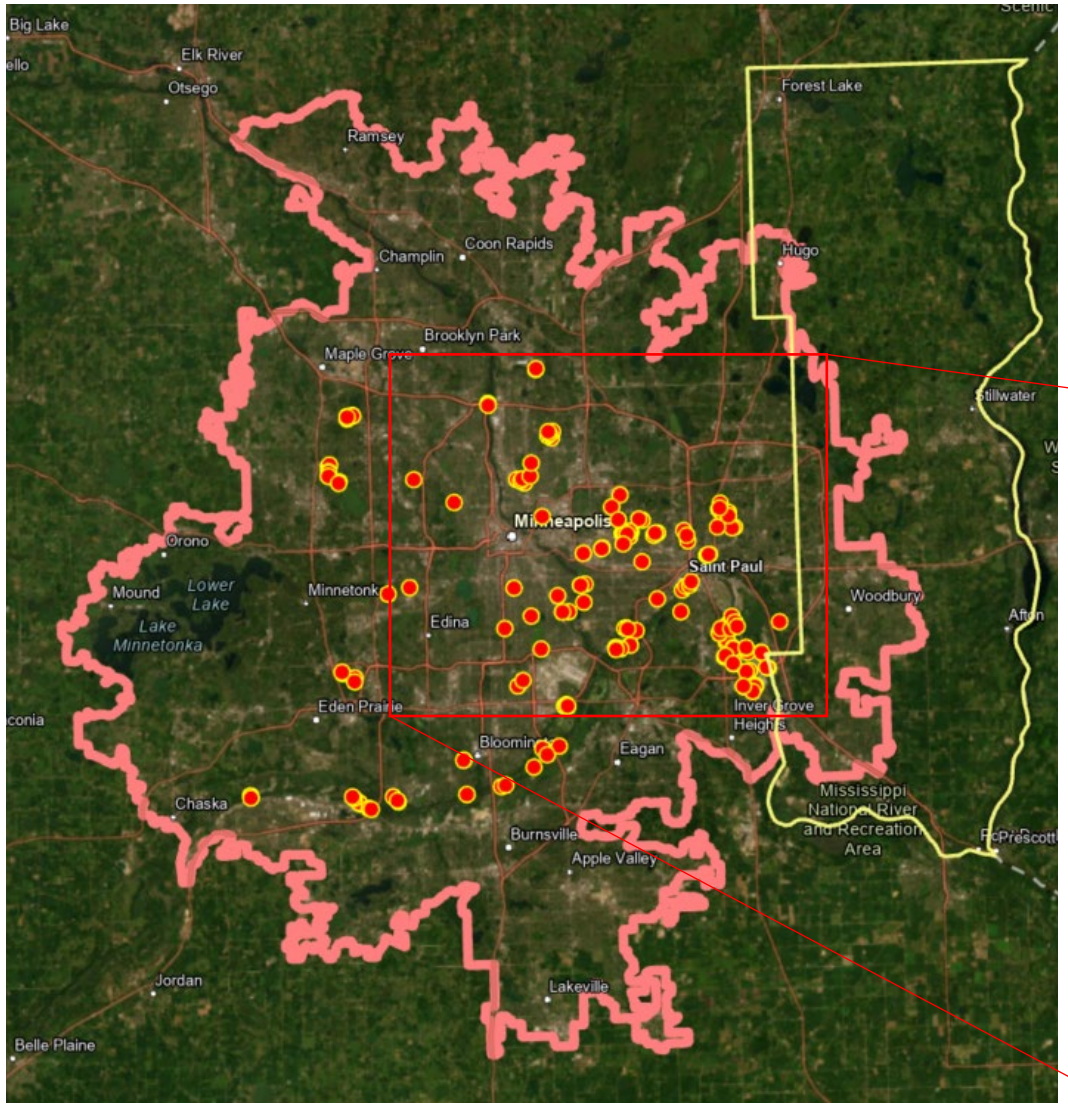
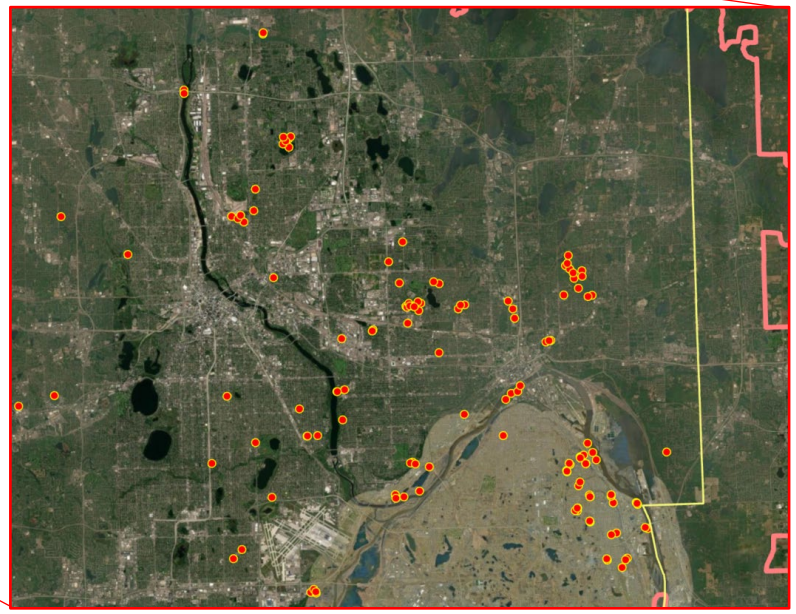


Progress so far

- >180 field descriptions
  - St. Paul and South St. Paul Parks
  - MN River NWR
  - Residences and one school



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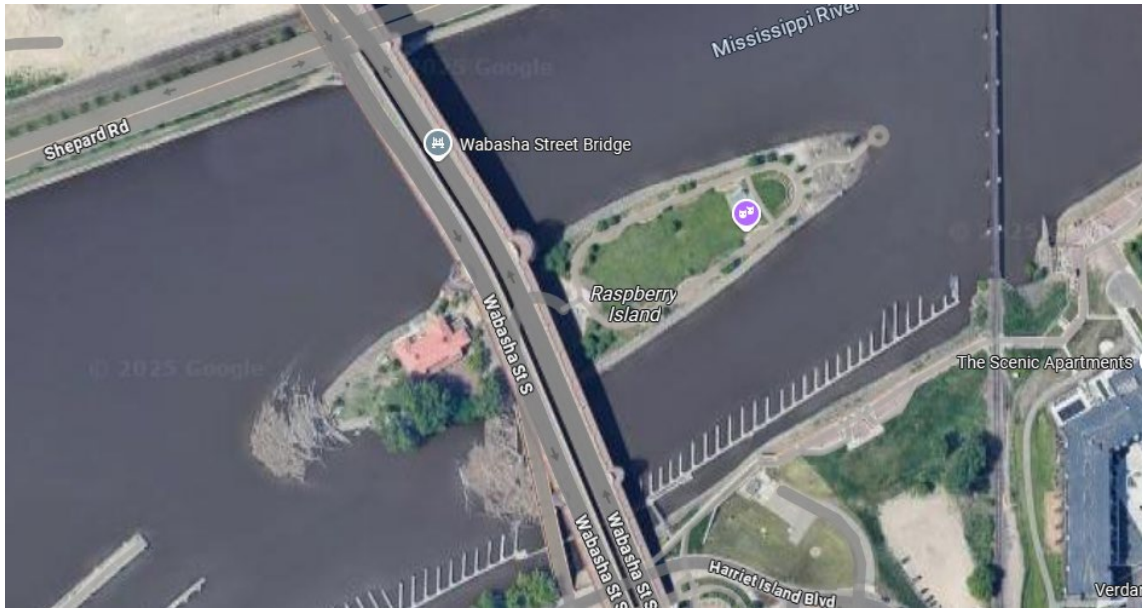


Raspberry Island, Downtown St. Paul. Historically built up for a military fort, downtown parking lot, and current day event space.

What's the story in the soil?

- **Systematic** compaction of constructional fill
  - Soil properties are not represented by urban land or native soil components as currently mapped
  - *Still*, large capacity to support ecosystem services

Phalen Park - Buried organic soil supporting trees, herbaceous veg, stormwater protection

Trout Brook NS - Former railroad bed supporting prairie restoration, wildlife habitat, recreation

Great River School – Former parking lot supporting urban teaching farm

What's the story in the soil?

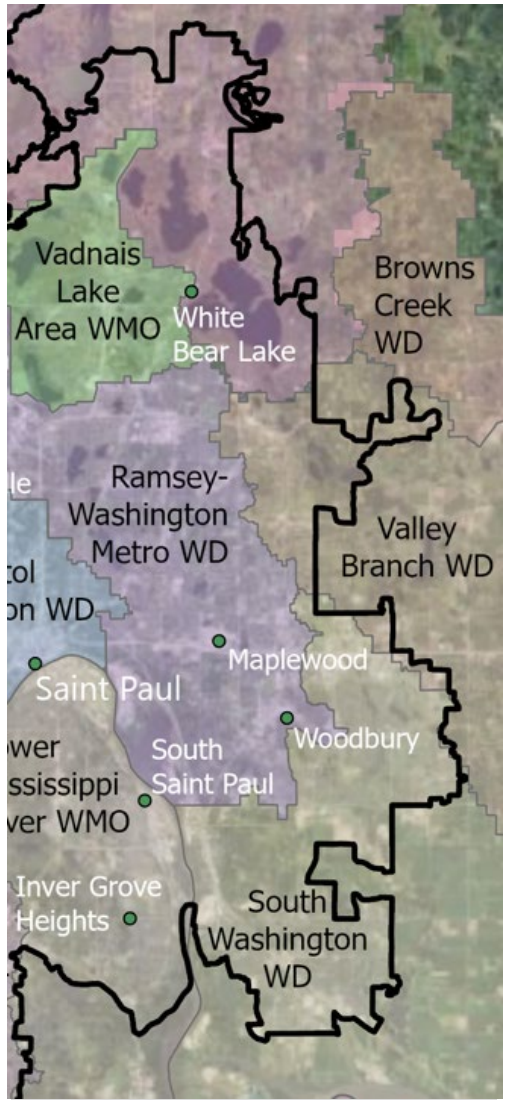
- Park soil shows St. Paul history
  - Older parks like show fewer signs of disturbance
  - Marydale, Troutbrook, and Swede Hollow exhibit clues of industrial past

Swede Hollow ca. 1910 (MN Historical Society)

Swede Hollow Park, 2024, 70 years after the last houses were razed

Where are our needs?

- Contiguous metro in Washington Co
  - No sites sampled in 2024
- Important to capture variability:
  - Residences
  - Light industrial (businesses, community centers, schools)
  - Urban farms

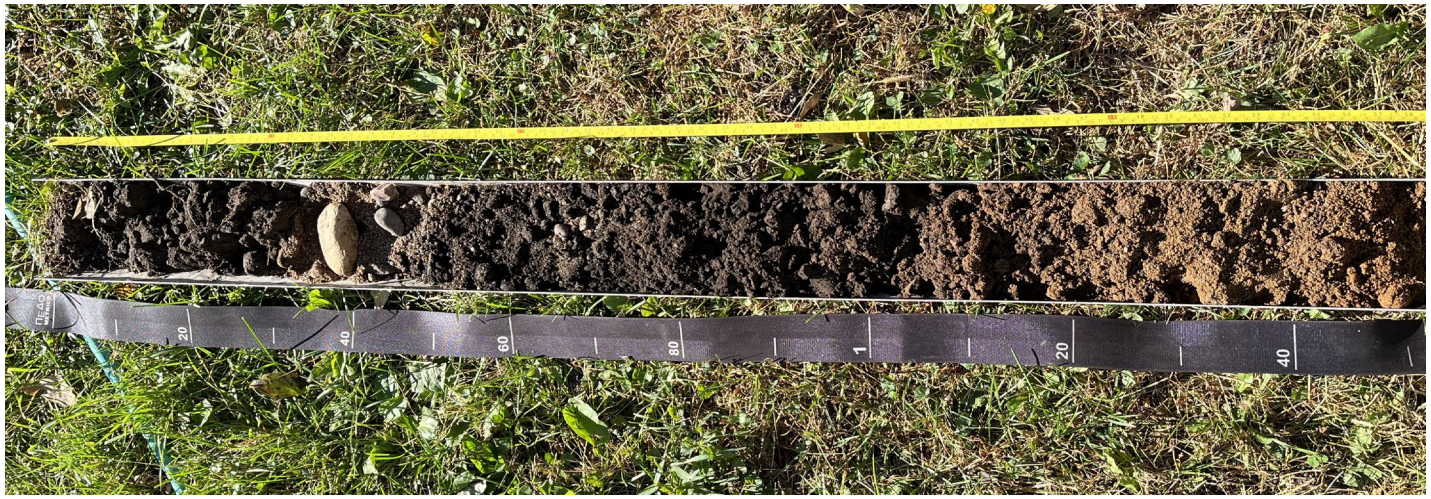


Partnership Opportunities

- Understanding Urban Soil Health
  - In-Field Soil Health Assessment to document soil health (therefore, water cycling) concerns at survey sites
  - Promote NRCS and partner programs to improve soil health for water quality
  - Produce localized guidance materials for managing land for soil health
    - Gardens, lawns, green spaces, urban farms
- Public outreach – connect soil to water quality
  - Soil health demo at community events
  - Urban soil health field days?

Technical Services Available

- Assessing soil contamination
  - Field-ready x-ray fluorescence tool for heavy metal contamination monitoring with NRCS and partner needs
- Guidance on Web Soil Survey, soil property determination
  - Tag along with the soil survey crew to gain experience!



Any soil needs or questions?

What of this info is resonating?

Where do you see more need?

Support the survey!

- Link to google sign up form w/ detailed survey procedure
- Flier with QR code could be added to newsletters, displayed in office
- For more info:

Adam Devlin, Soil Scientist, St. Paul
USDA-NRCS MN State Office
e: adam.devlin@usda.gov
p: (612) 528-3497

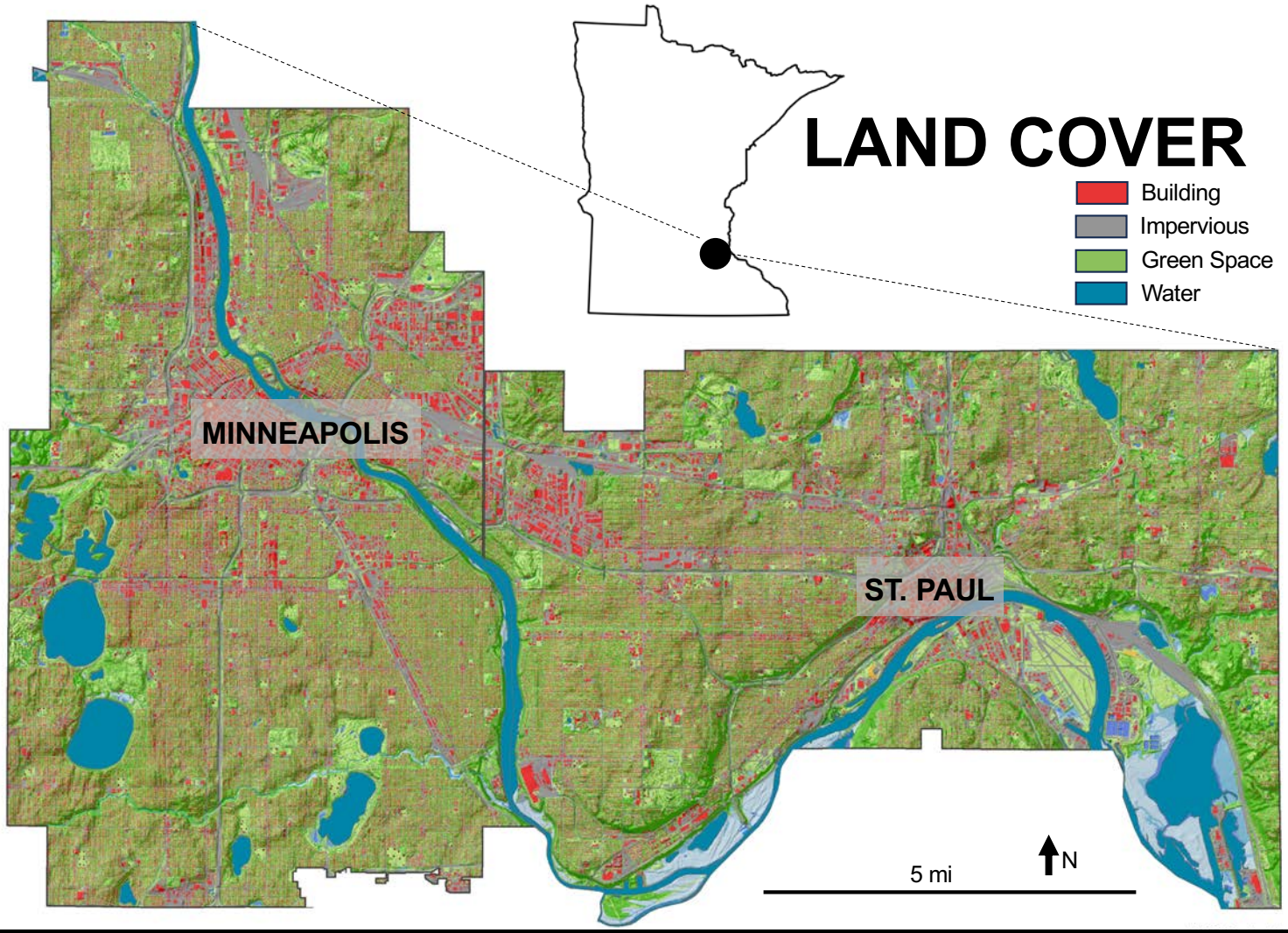
Washington County Water Consortium Meeting
February 5th, 2025
(Remote)

Trends in Soil Properties Across the Minneapolis-St. Paul Metropolitan Area - Implications for Ecosystem Services

N.A. Jelinski, N. Pearson, K.M. LaBine, T. LaShae, J.A. Nicklay

University of Minnesota Dept. of Soil, Water and Climate

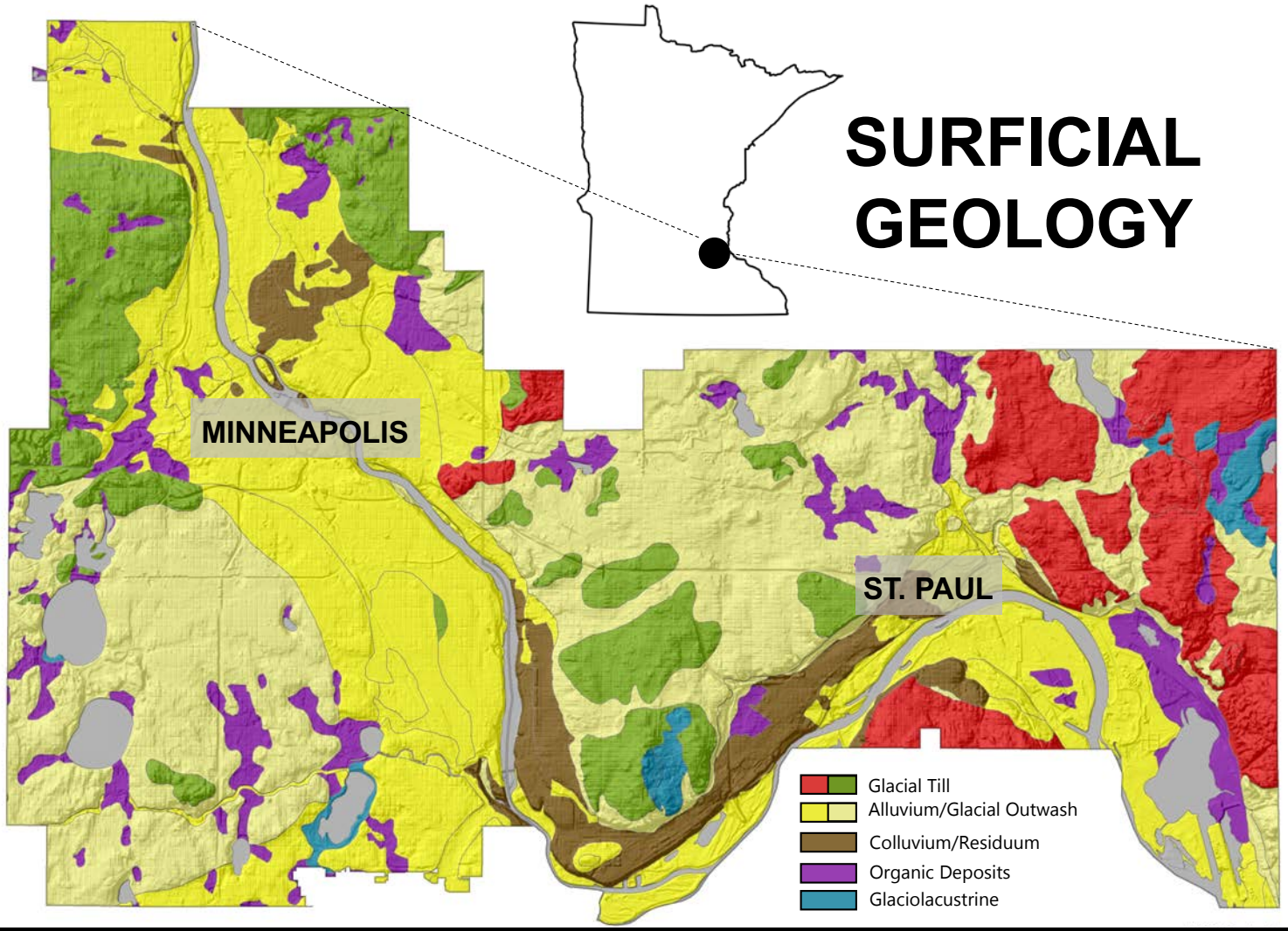
Image: N. Jelinski, Karamu Garden – Minneapolis, MN



Background: MSP Geography, Land Cover, Parent Material, and Soil Map

- Minneapolis + St. Paul population (proper): > 832,000
- Greater Metropolitan Area population: ~3,000,000 (#16)
- Minneapolis has the largest extent of concentrated, highly urbanized lands, but St. Paul has large industrial zones outside of the city center.

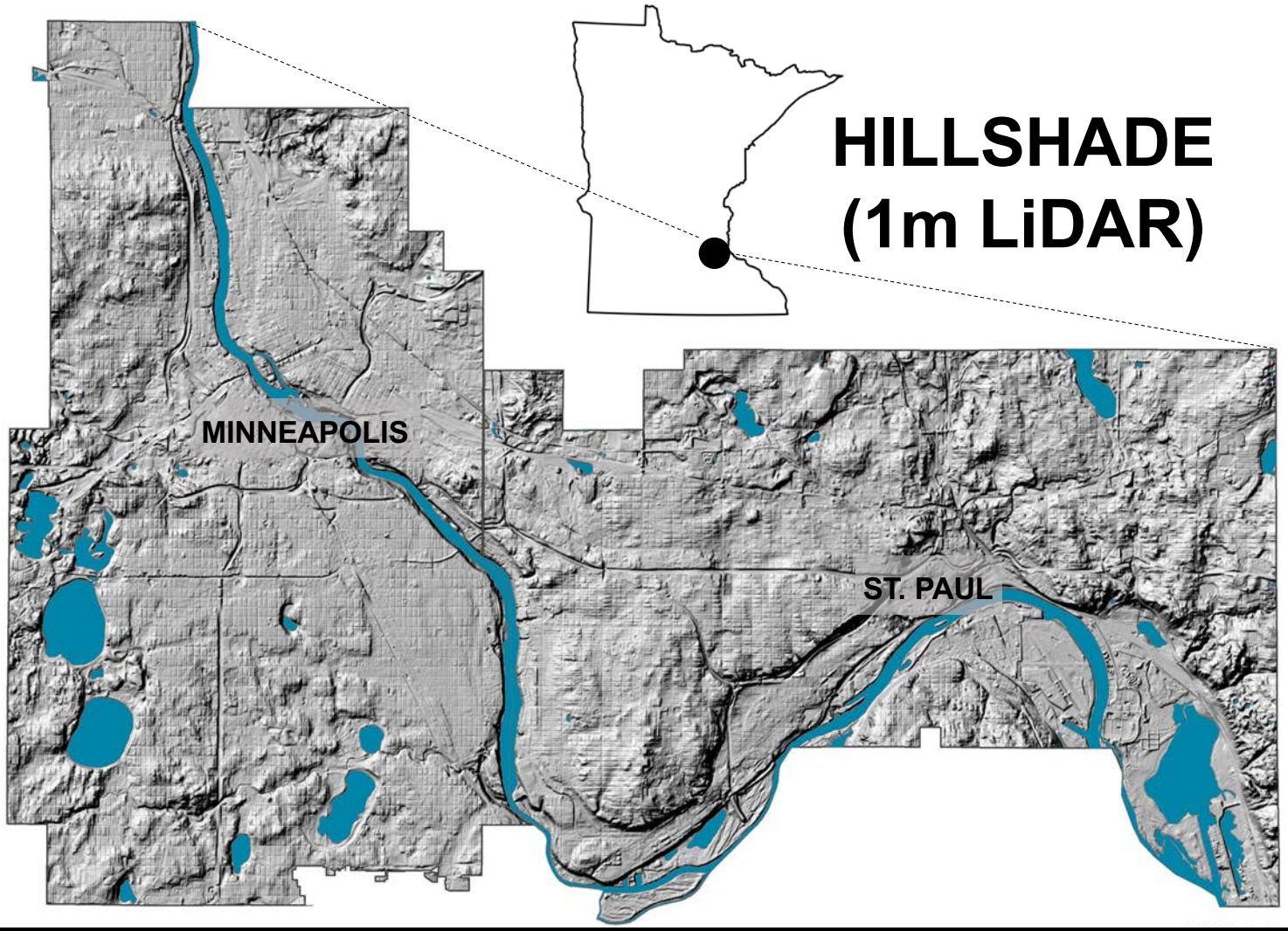
Figure: N. Jelinski, adapted from 1m LiDAR data – MN DNR (2011) and Knight (2016)



Background: MSP Geography, Land Cover, Parent Material, and Soil Map

- Parent materials are dominated by alluvium, outwash, and glacial till of two different provenances.
- Scattered colluvium, organics, and glaciolacustrine

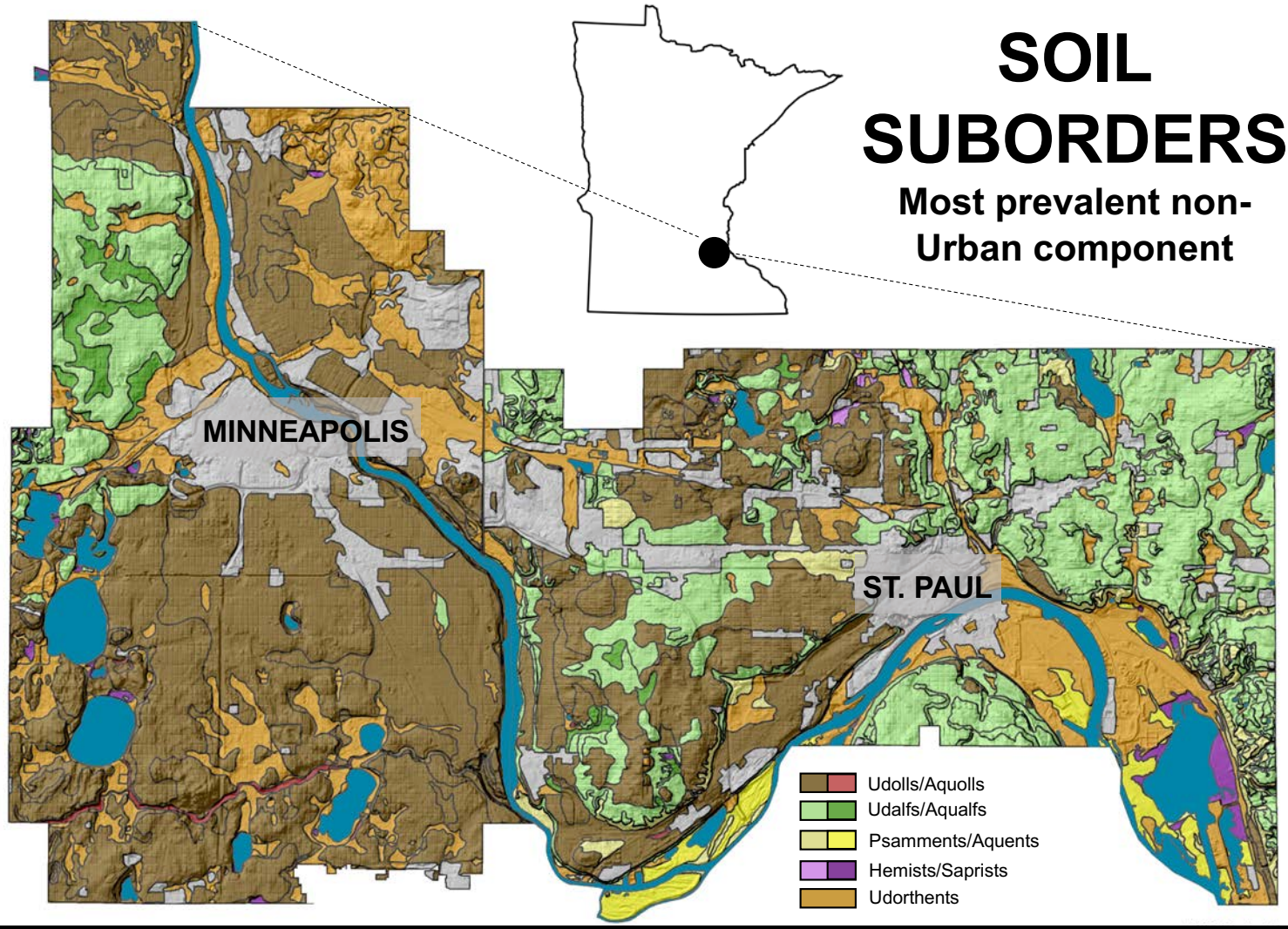
Figure: N. Jelinski, adapted from 1m LiDAR data – MN DNR (2011) and Meyer (2007)



Background: MSP Geography, Land Cover, Parent Material, and Soil Map

- Topographic variability and fluvial morphology drove development of two large cities < 10 mi apart.

Figure: N. Jelinski, adapted from 1m LiDAR data – MN DNR (2011)



Background: MSP Geography, Land Cover, Parent Material, and Soil Map

- Minor "natural" components fairly well represented, based on geomorphic studies conducted in the 60s-70s.

Figure: N. Jelinski, adapted from 1m LiDAR data – MN DNR (2011) and Web Soil Survey (2019)

How do key soil properties vary across Minneapolis-St. Paul (MSP) by land use/land cover, with special emphasis on impacts of urban food production (UFP)?

- Part of much larger project on multi-city distributed urban agriculture/food systems* and…
- …plot-based, community-engaged research on urban ag practices in MSP**
- Interest in evaluating urban agriculture as a viable green infrastructure practice in MSP. How does UFP compare to other land cover/land use categories?

*USDA/NSF INFEWS

**NCR-SARE

Image: N. Jelinski, Frogtown Park and Farm, St. Paul, MN

Methods

- Sample soils at ~100 sites across major MSP land use/land cover categories:
  - Community Gardens/Farms
  - Residential Properties
  - Parks and Green Spaces

- At each site, establish 3 sampling plots (~2m x 2m) to measure:
  - Organic carbon
  - Phosphorus (Available & Total)
  - pH
  - …to a depth of 1m

- Defined depth increments:
  - 0-10cm, 10-20cm
  - 20-40cm, 40-60cm, 60-80cm, 80-100cm

Image: N. Jelinski, Frogtown Park and Farm, St. Paul, MN

Methods

- …additionally, measure Ksat in the top depth increment (triplicate measurements in each plot).
- Sites selected based on access, permissions, and (as best as possible) spatial and categorical stratification.
- Plots within sites selected to represent range of management or land cover within sites.
  - If a food-producing area was present, this was sampled as well.

Image: N. Jelinski, Frogtown Park and Farm, St. Paul, MN

Sites (2018-2022)

- 132 sites sampled across MSP
  - 396 plots
  - 396 1m cores
  - > 1,000 Ksat measurements
  - > 2,300 soil samples

- Community Gardens/Urban Farms (n = 39)
  - Turfgrass/Lawn
  - Food-producing/Non-Food Producing
- Parks/Green Spaces (n = 33)
  - Turfgrass/Lawn
  - Natural Vegetation
- Residential (n = 60)
  - Turfgrass/Lawn
  - Food-producing/Non-food producing gardens

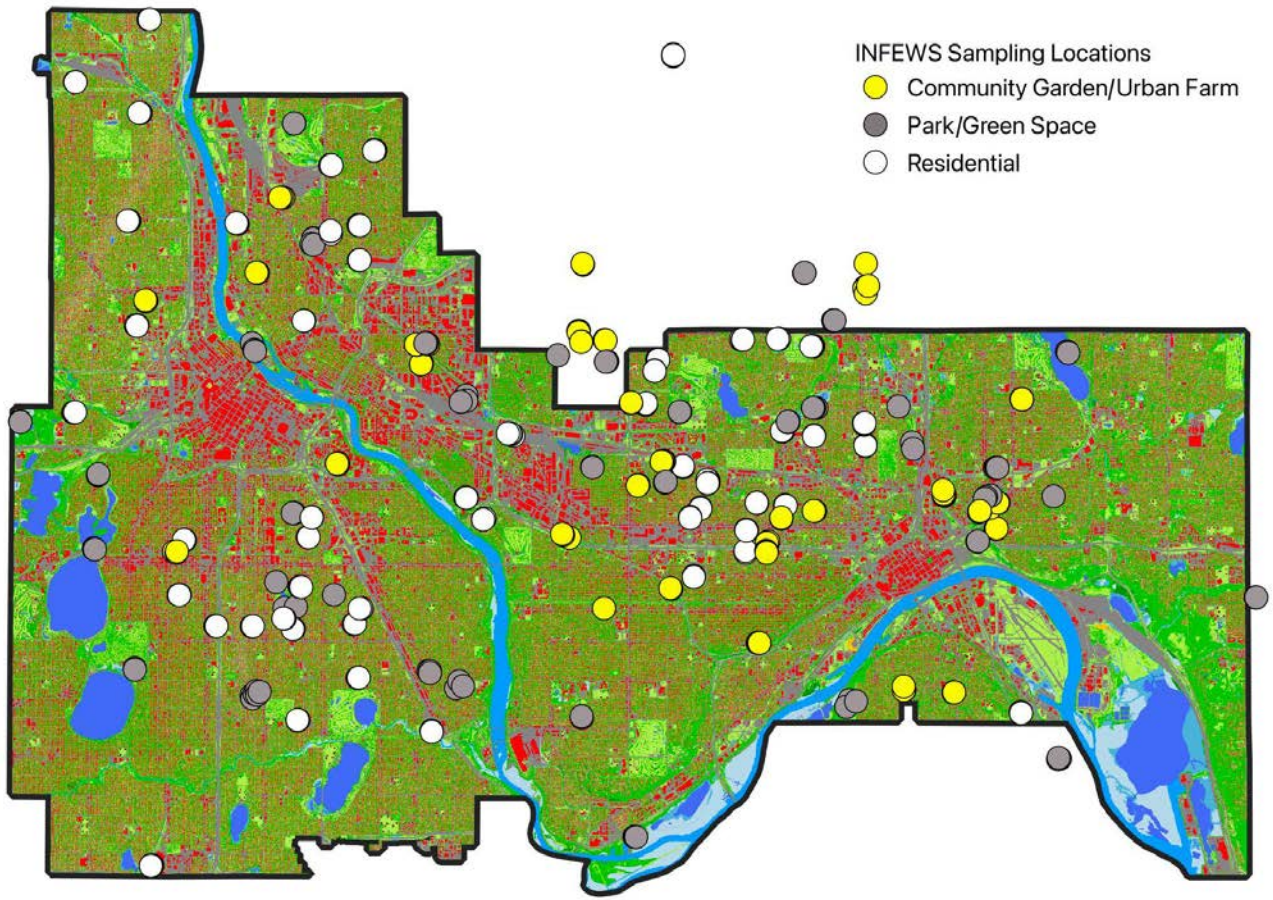


Image: N. Jelinski, Frogtown Park and Farm, St. Paul, MN

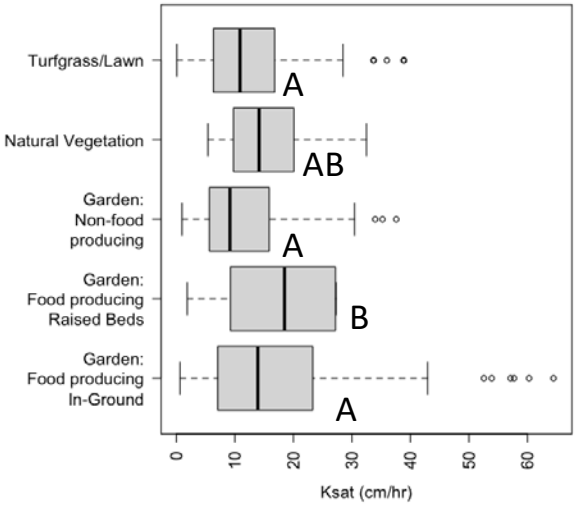
Sites (2018-2022)

- Land use categories for analysis in this presentation (5):
  - Turfgrass/Lawn
  - Natural Vegetation (unmaintained wetland, forest, prairie), regardless of native/non-native community composition and disturbance
  - Garden: Non-food producing
  - Garden: Food-producing, Raised Beds
  - Garden: Food-producing, In Ground

Image: N. Jelinski, Frogtown Park and Farm, St. Paul, MN

Surface (0-10cm) Ksat, by Land Use

- Large variability in Ksat – significantly higher in raised beds than other land use categories. Gardens (both food and non-food producing) not significantly different from turfgrass or natural vegetation.



Figures and Data: N. Jelinski, N. Pearson

Partial RUSI

Traffic

(Road Size)
0: 4 + Lanes
1: 2-4 Lanes, No Parking
2: 2-4 Lanes, Parking
3: < 2 Lanes

Infrastructure

(Distance to Nearest Building or Paved Surface)
0: < 1m
1: 1-5m
2: 5-10m
3: > 10m

Surface

(Ground Cover)
0: Bare/Impermeable
1: Patchy
2: Thick
3: Organic Mulch

Total Possible = 9

Partial RUSI

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(Road Size)
0: 4 + Lanes
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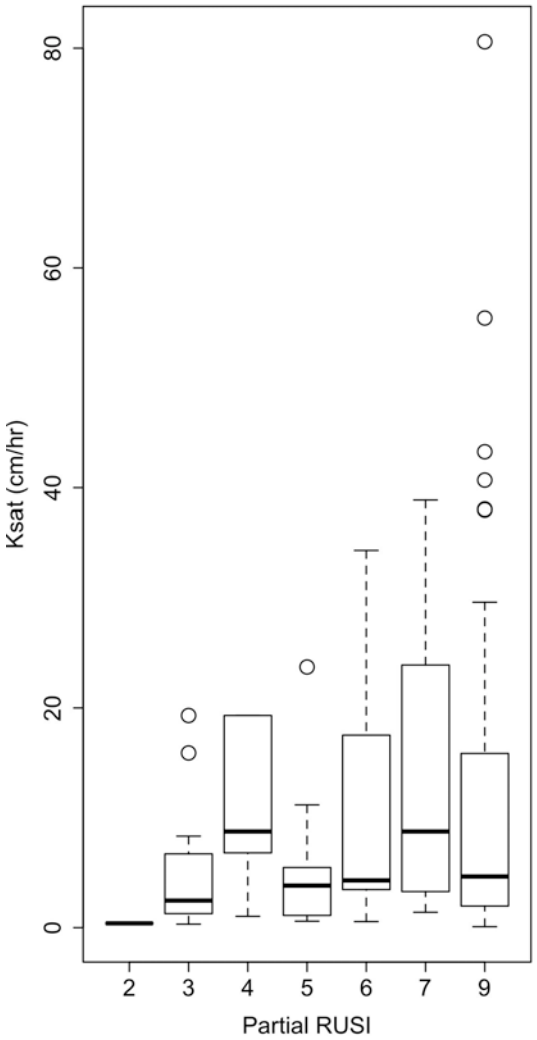

Figures and Data: N. Jelinski, K. LaBine

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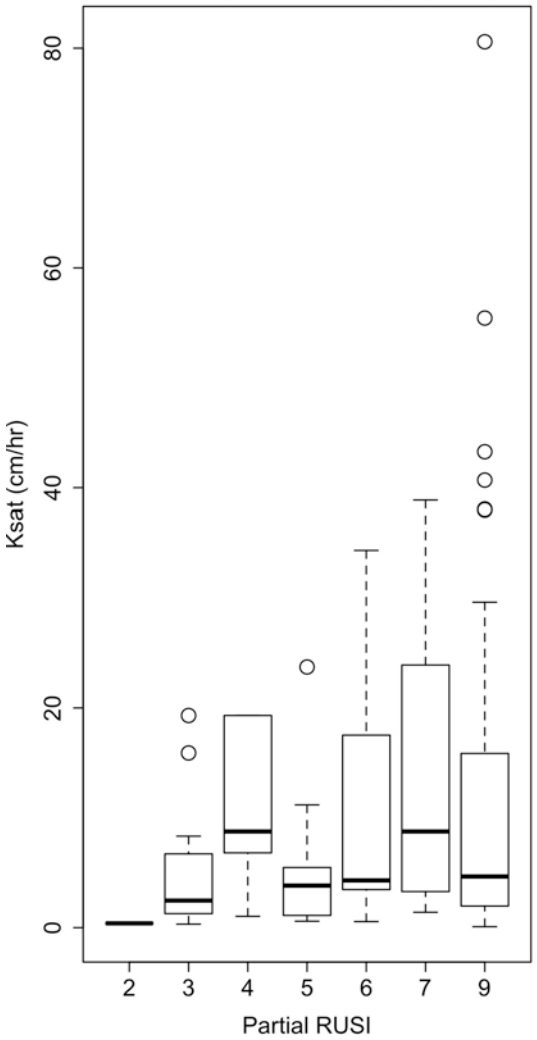
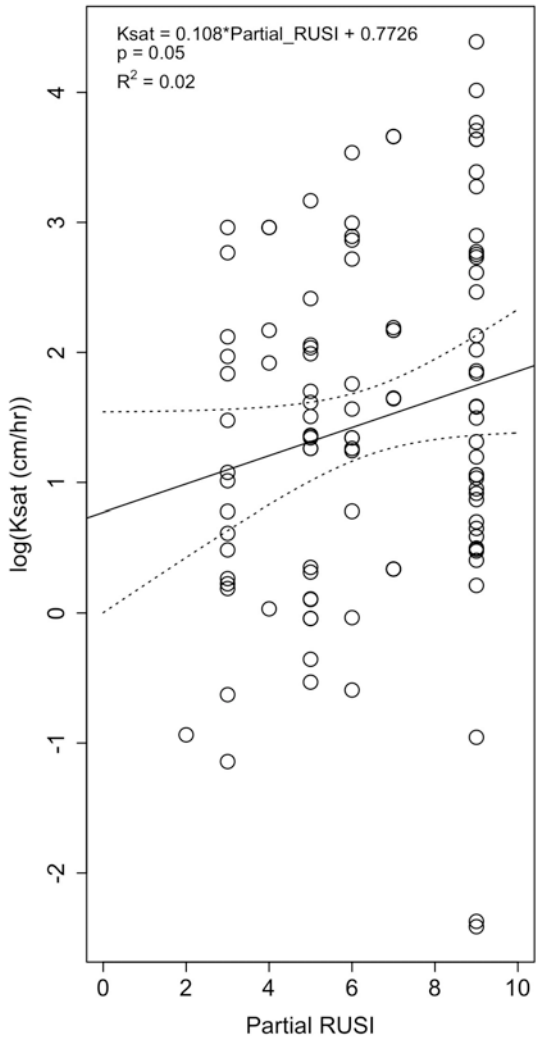




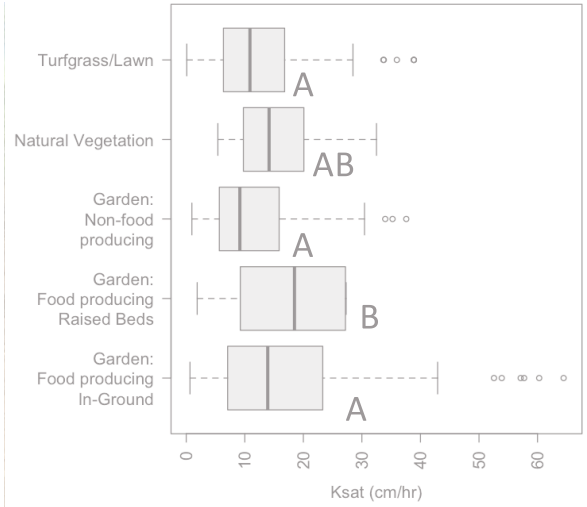
Addition of User-Defined, Adaptive Metrics

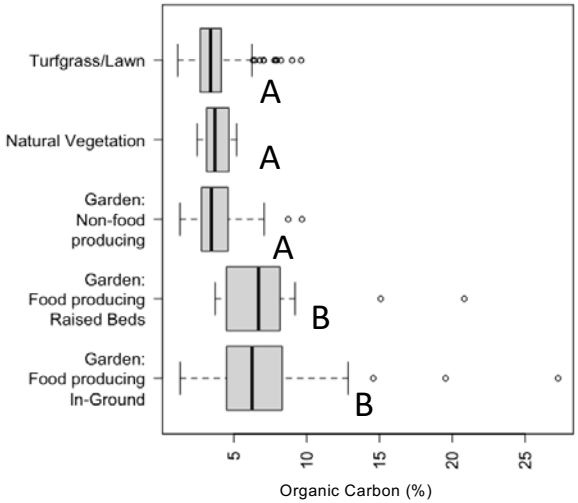
- Across 33 sites (n = 111) Ksat was only weakly correlated with a partial RUSI score (Urban only).
- Correlation improvement with more RUSI metrics?

Figures and Data: N. Jelinski, K. LaBine

Surface (0-10cm) SOC by Land Use

- Surface SOC significantly higher in food-producing areas. No significant difference between turfgrass/lawn and natural vegetation.

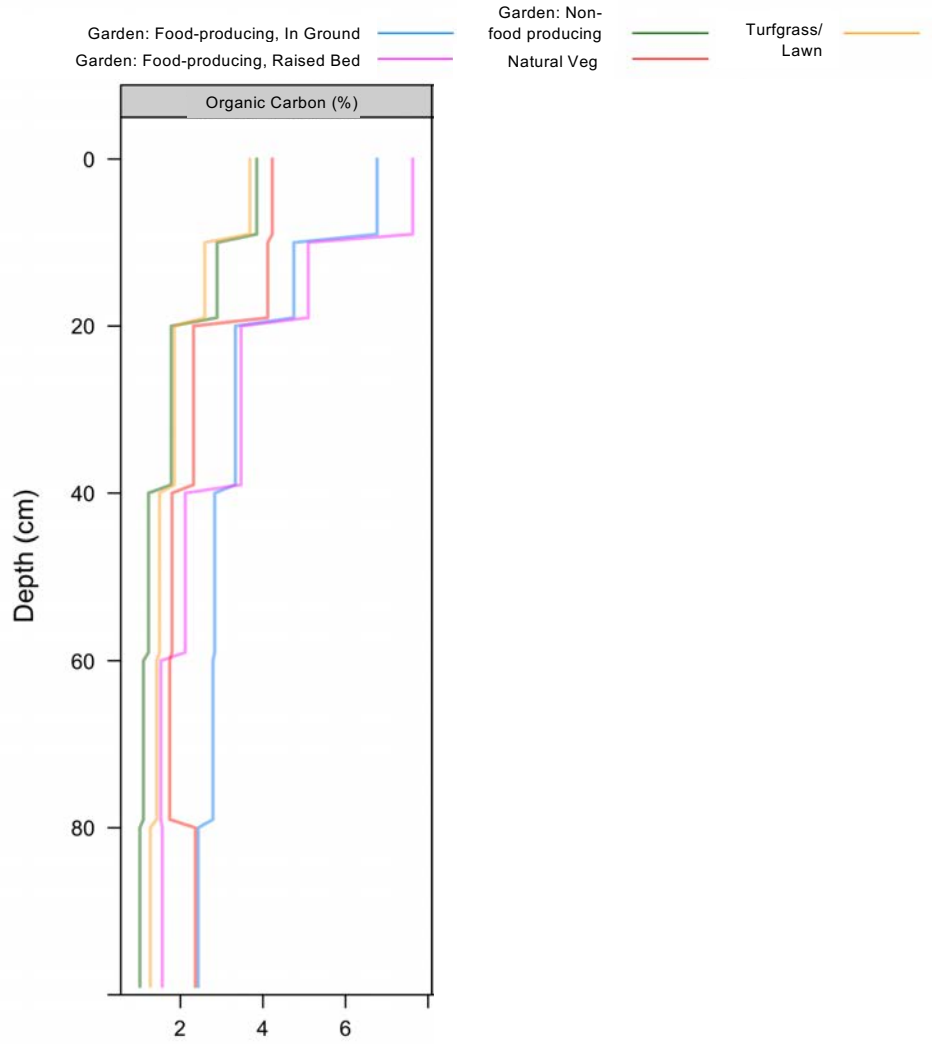




Images: (L) N. Jelinski – St. Paul, MN

Depth trends in SOC

- SOC, on average, highest in food producing areas in top 40cm.



Images: (L) N. Jelinski – St. Paul, MN

1m SOC stocks

- Highly **variable** (4 – 83 kgC m^2)
  …but…

- …1m SOC stocks, on average quite **high** 25.9 ± 14.3 kgC m^{-2}…

Image (L): N. Jelinski – St. Paul, MN

1m SOC stocks

- Highly **variable** (4 – 83 kgC m^{-2})…but…
- …1m SOC stocks, on average quite **high** 25.9 ± 14.3 kgC m^{-2}…
- …and SOC stocks, on average **significantly higher in food producing plots** (both in-ground 34 ± 16, and raised beds 32 ± 12) than non-food producing gardens (22 ± 11), and turfgrass/lawn (21 ± 12). Natural veg in between (27 ± 12 kgC m^{-2}).
- Elevated SOC associated with urbanization supported by other studies from different cities (Pouyat et al., 2002/2006 - Multicity; Mao et al., 2014 – Beijing); Scharenbroch et al., 2018 – Greater Chicago)

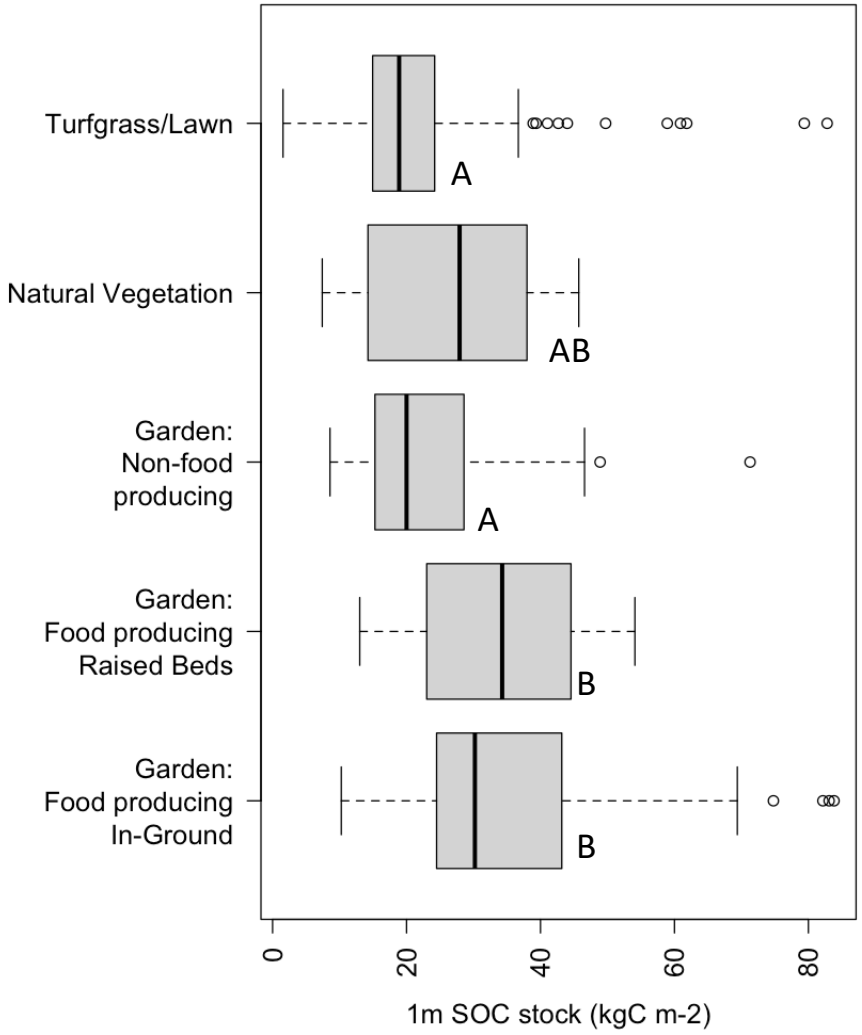


Image (L): N. Jelinski – St. Paul, MN

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- **Elevated SOC with urbanization supported by other studies from different cities (Pouyat et al., 2002/2006 - Multicity; Mao et al. 2014 – Beijing); Scharenbroch et al., 2018 – Greater Chicago)**

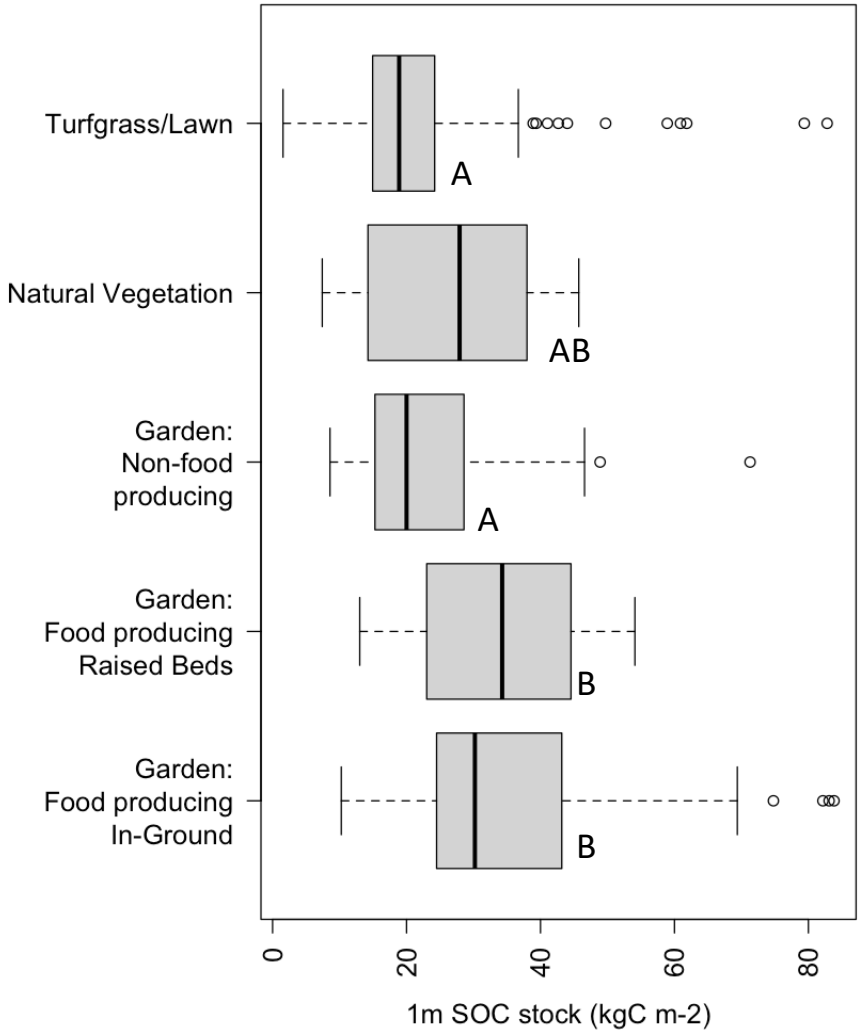
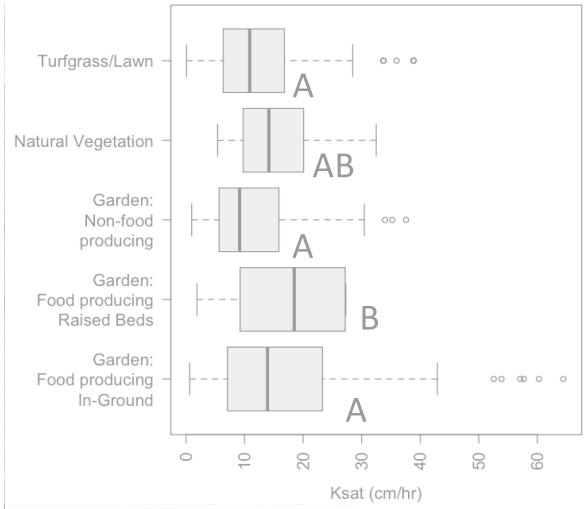
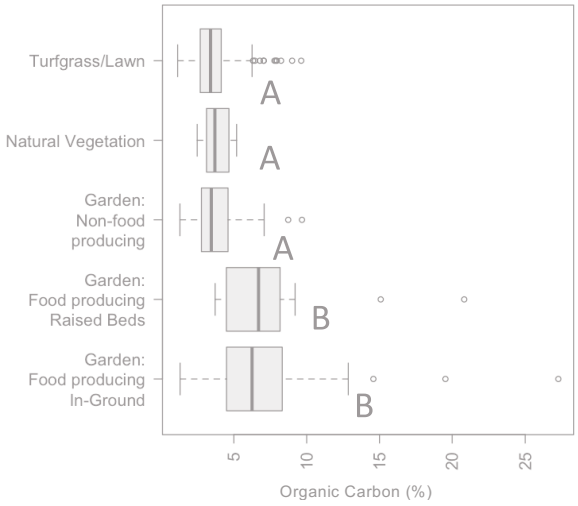


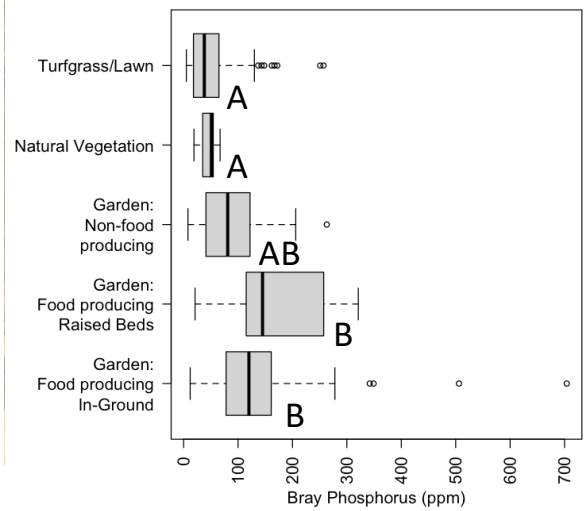
Image (L): N. Jelinski – St. Paul, MN

Surface (0-10cm) P by Land Use

- Topsoil available P (Bray P) significantly higher in food-producing areas. No significant difference between turfgrass/lawn and natural vegetation.







Images: (L) N. Jelinski – St. Paul, MN

Urban vs Non-Urban Available P

- Variable but generally higher in urbanized environments
  - Bray P in samples from Minneapolis/St. Paul and from out-state Minnesota. (>130,000 samples from 1998-2016 UMN Soil Testing Lab database).

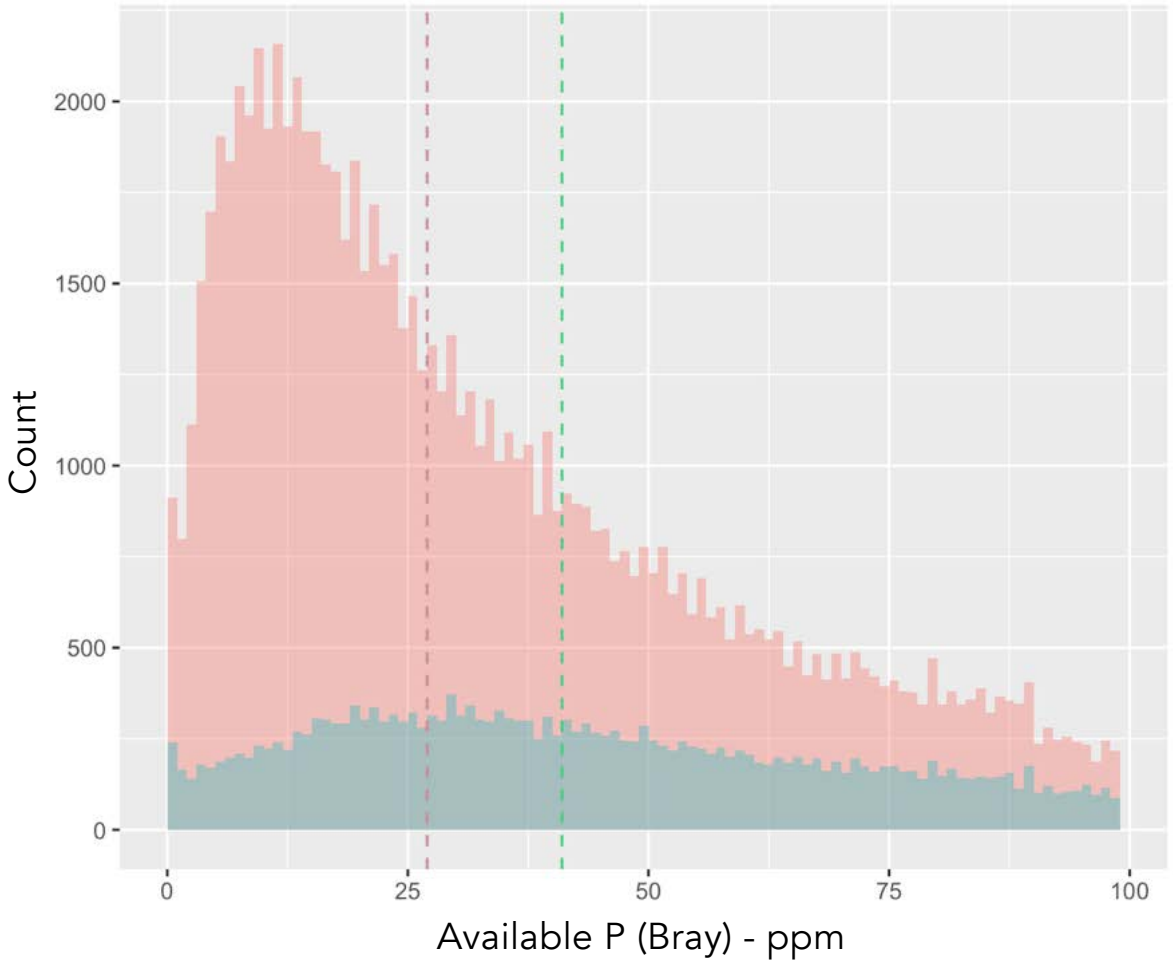


Figure: N. Jelinski; Data: UMN Soil Testing Lab Database

Urban vs Non-Urban Available P

- Variable but generally higher in urbanized environments
  - Bray P in samples from Minneapolis/St. Paul and from out-state Minnesota. (>130,000 samples from 1998-2016 UMN Soil Testing Lab database).
  - Samples in MSP higher median available P.
  - 43 ppm vs 27 ppm

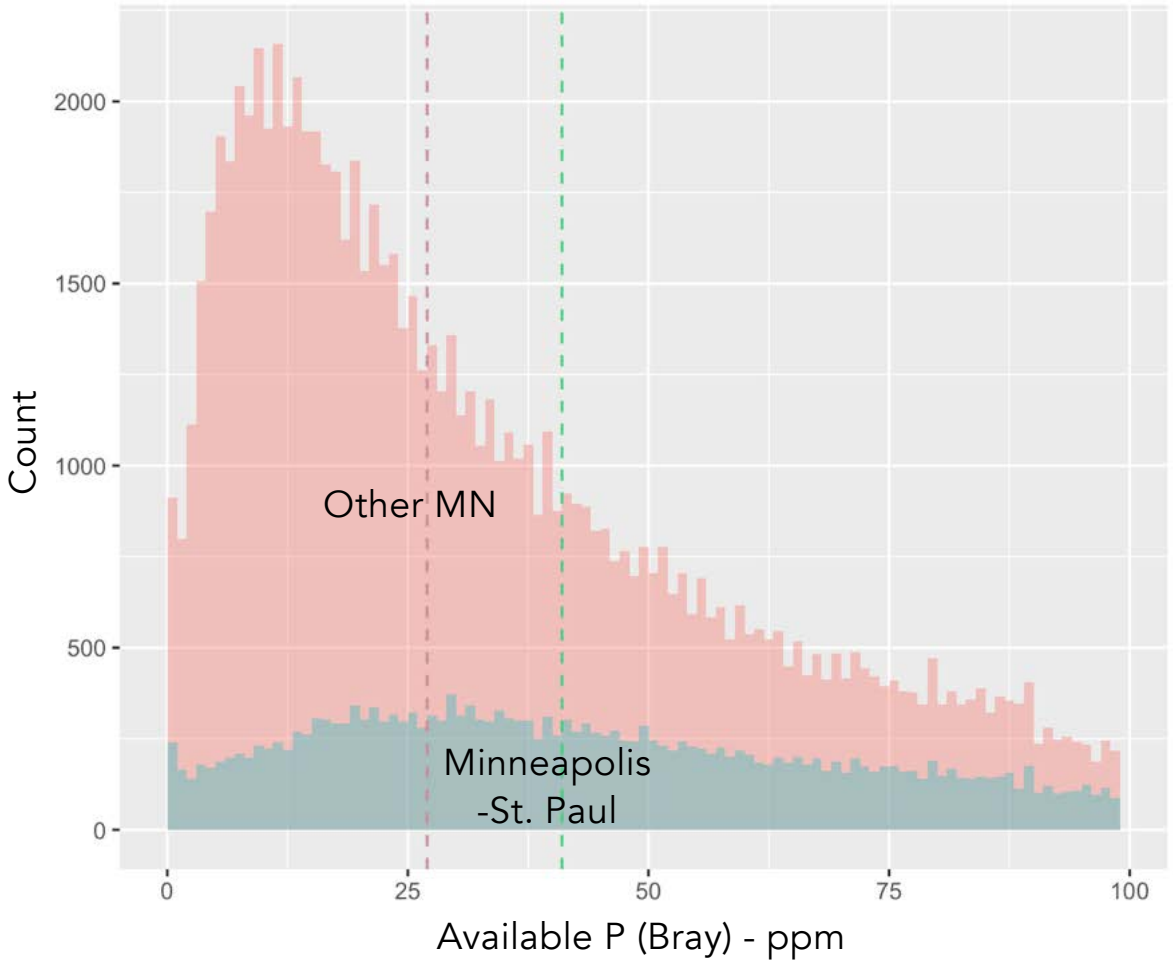


Figure: N. Jelinski; Data: UMN Soil Testing Lab Database

Urban vs Non-Urban Available P

- Variable but generally higher in urbanized environments
  - Bray P in samples from Minneapolis/St. Paul and from out-state Minnesota. (>130,000 samples from 1998-2016 UMN Soil Testing Lab database).
  - Samples in MSP higher median available P.
  - 43 ppm vs 27 ppm

- Median value of surface Bray P from our dataset: 65 ppm

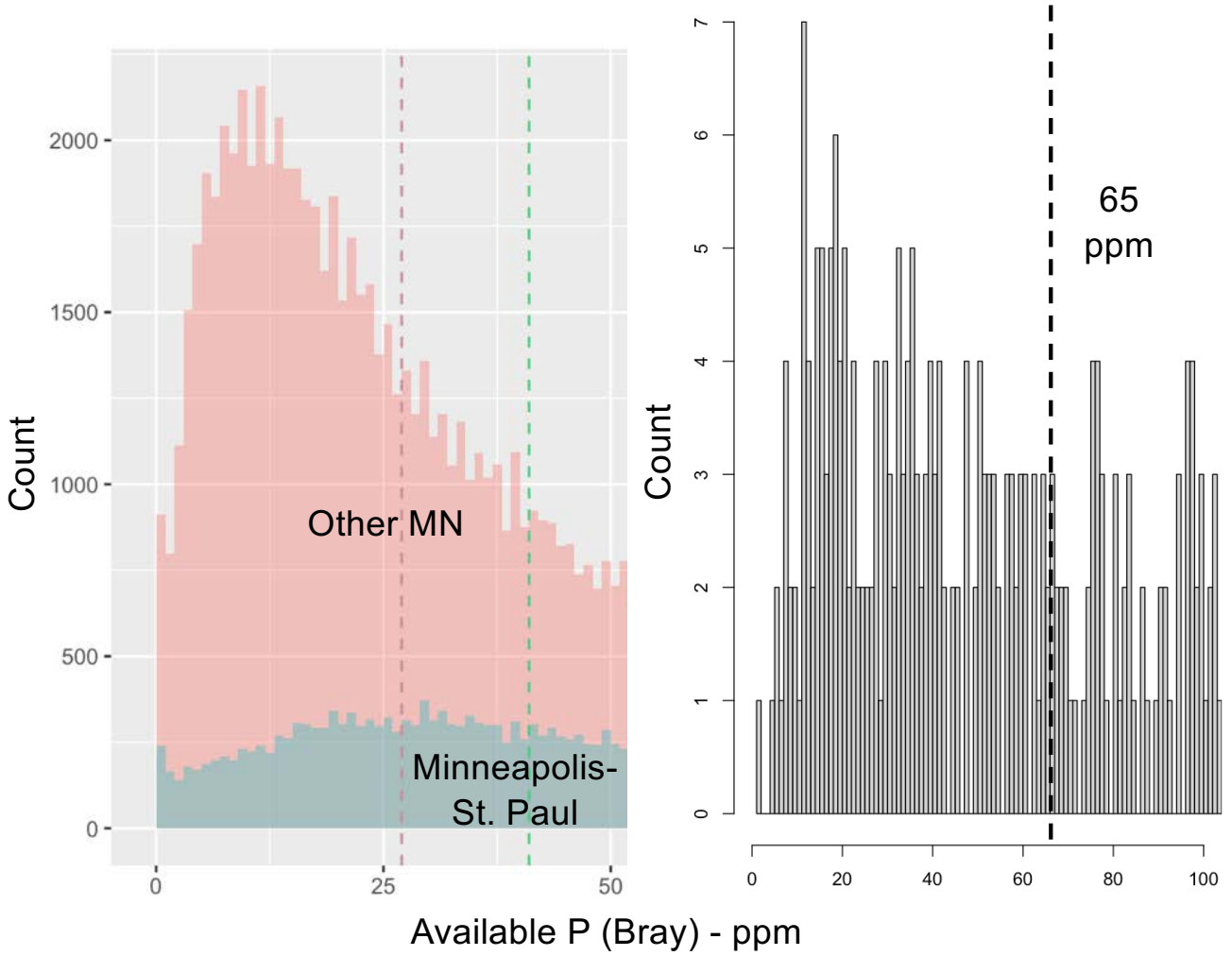
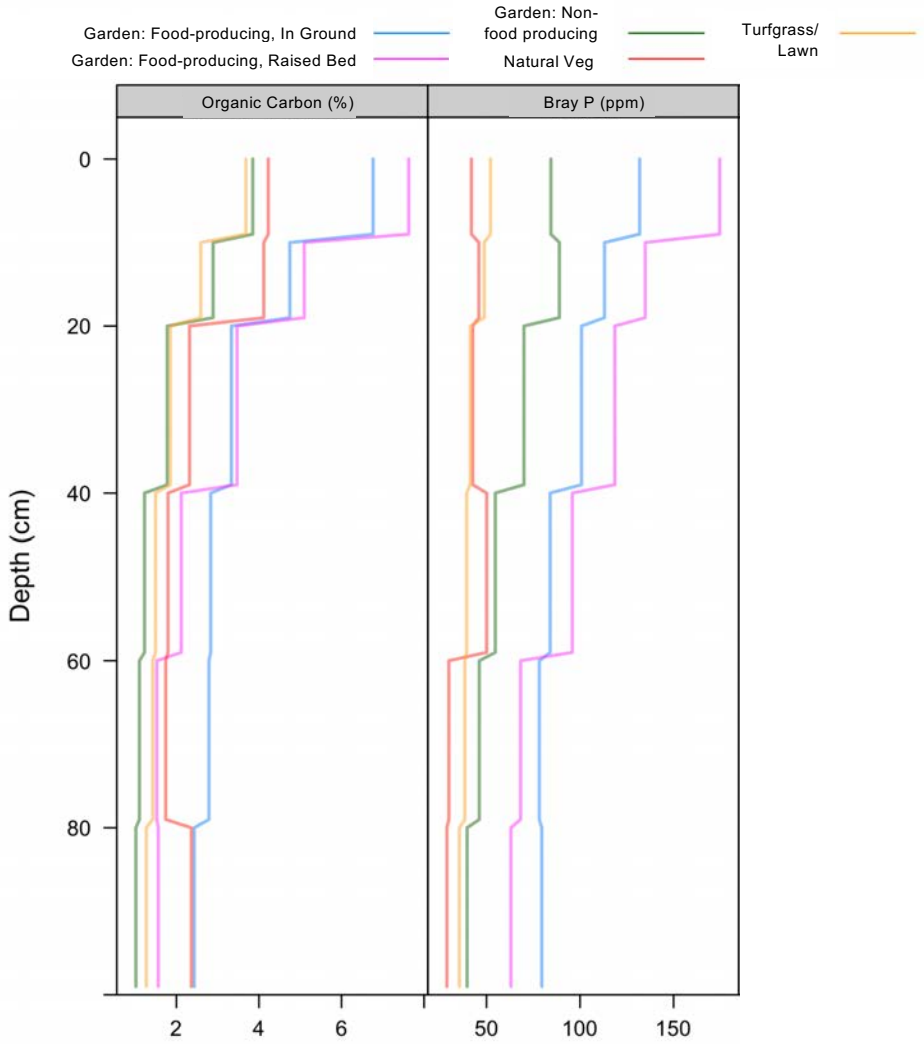


Figure: N. Jelinski; Data: UMN Soil Testing Lab Database

Depth trends in SOC, P

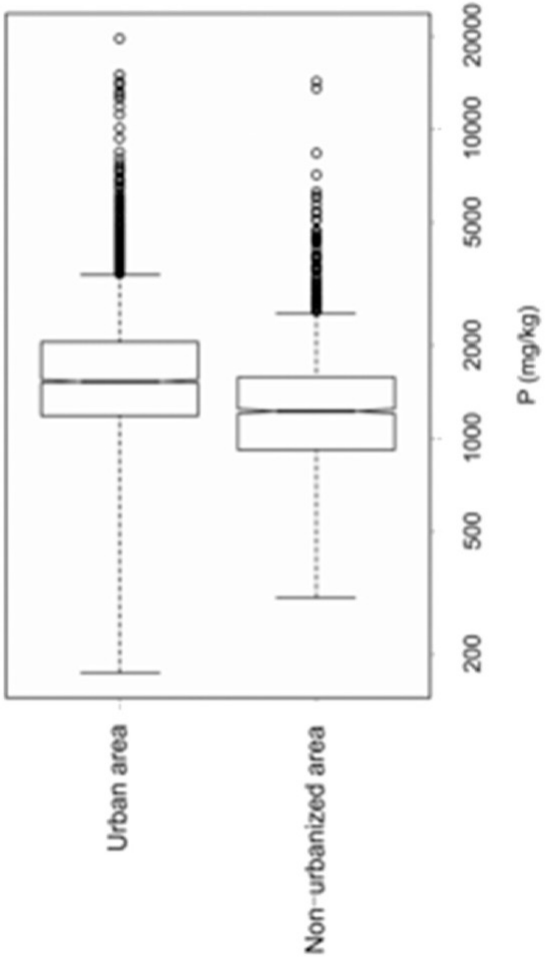
- SOC, on average, highest in food producing areas in top 40cm.
- Available P highest in food-producing areas to 80-100cm. Non-food producing gardens elevated, on average to 40cm relative to natural vegetation and turfgrass/lawn.

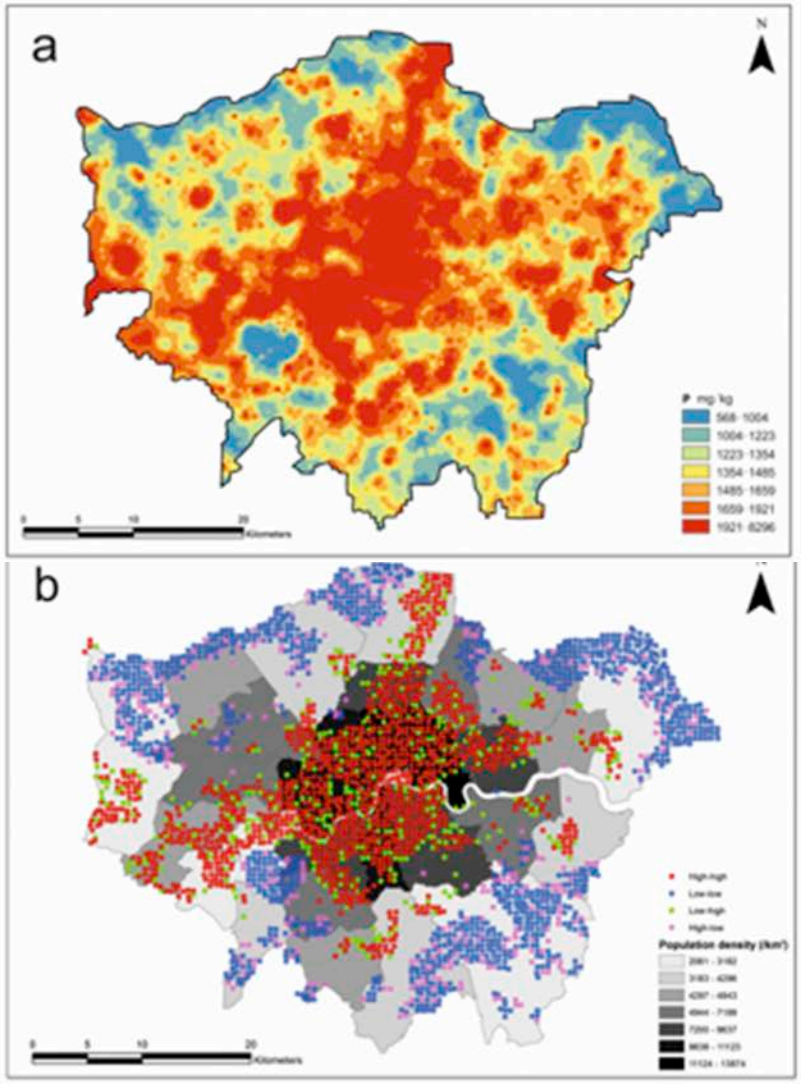


Images: (L) N. Jelinski – St. Paul, MN

Urban Soil P – Other Studies

- Variable but generally higher in urbanized environments
- Increased total P associated with urbanization (Meng et al., 2018).
- Solid, organic and pet waste streams, building materials, and fertilizers dramatically concentrated in P relative to natural systems.

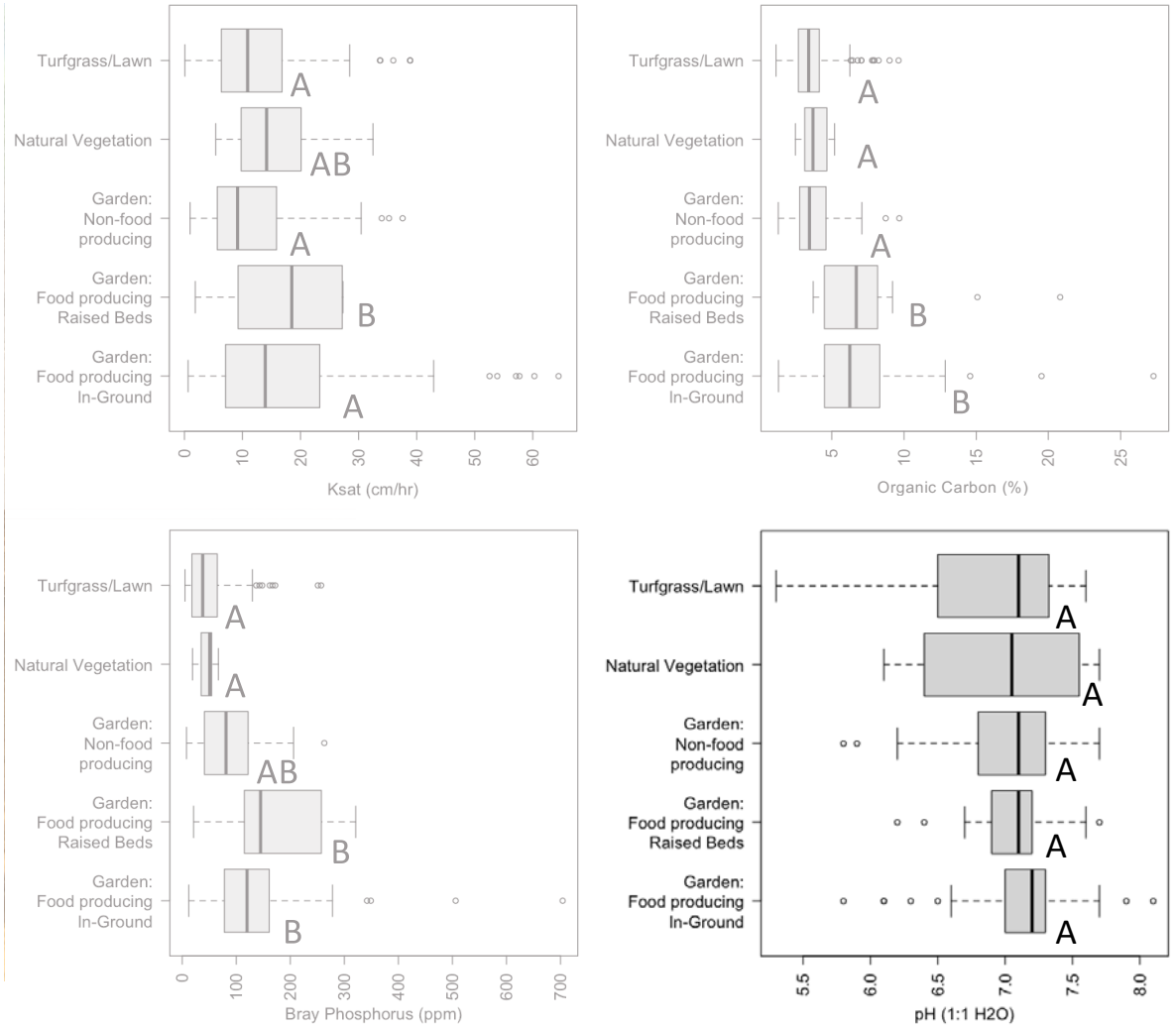




Figures: Meng et al., 2018 - London

Surface (0-10cm) pH by Land Cover

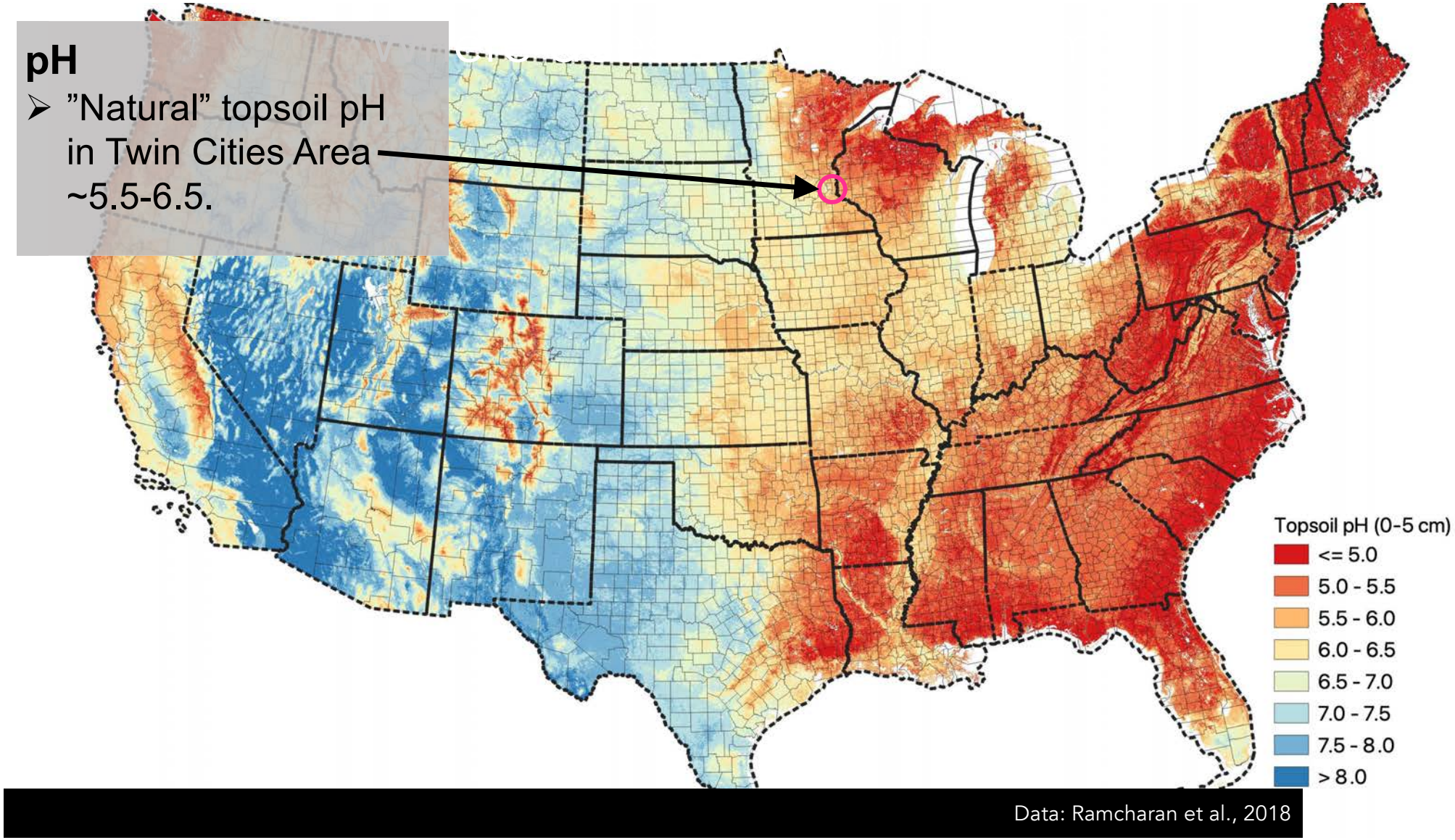
- pH not significantly different between land use categories BUT less variable under urban food production



Images: (L) N. Jelinski – St. Paul, MN

pH

- ”Natural” topsoil pH in Twin Cities Area ~5.5-6.5.



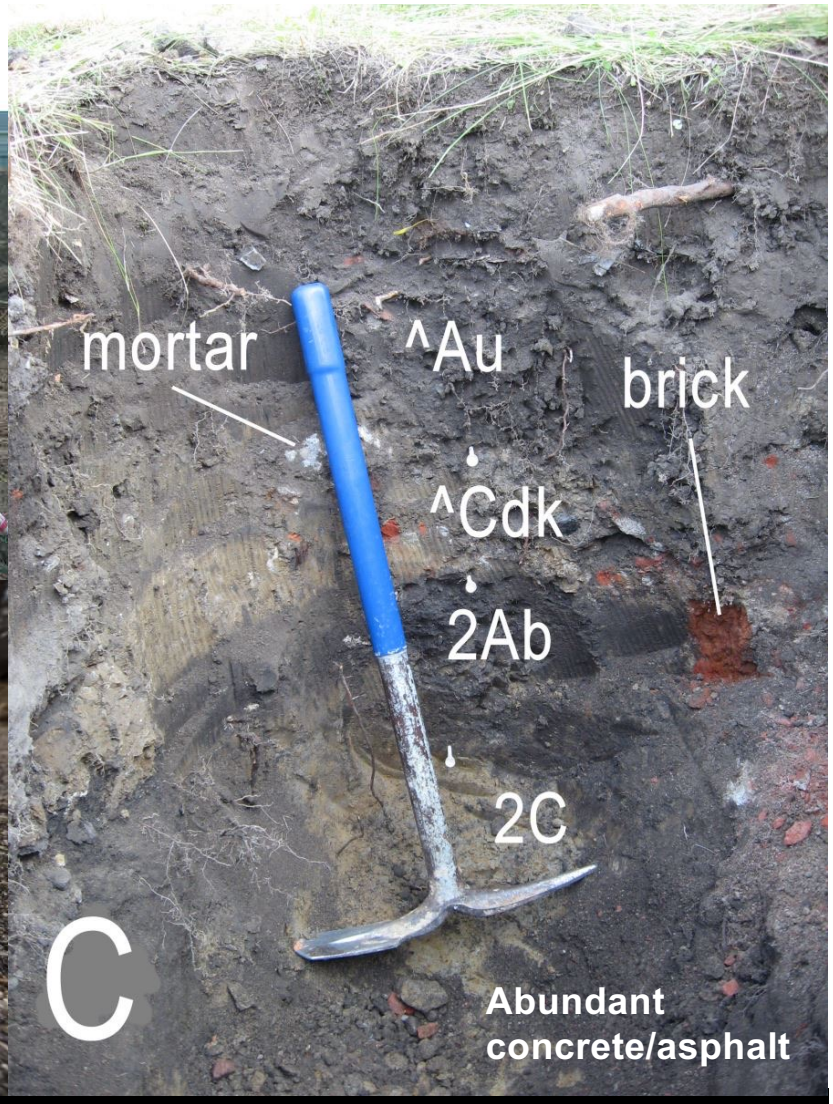
Data: Ramcharan et al., 2018

Elevated pH in urban soils

- Tends to be elevated in urban soils due to:
- Cut and fill activities; stripping of topsoil
- Salting (in northern climates)
- High artifact and debris content

Stripping and Grading of Topsoil

Na and Ca-rich salt products



Abundant concrete/asphalt

Image: (UL) M. Mamo, (BL) MPR, (R) Soil Profile in Brewster-Douglass Vacant Lots, Detroit, J. Howard, Wayne State University

Urban vs Non-Urban pH

- ”Natural” topsoil pH in Twin Cities Area ~5.5-6.5.
- UMN Soil Testing Lab Database (> 130,000 samples, 1998-2016).

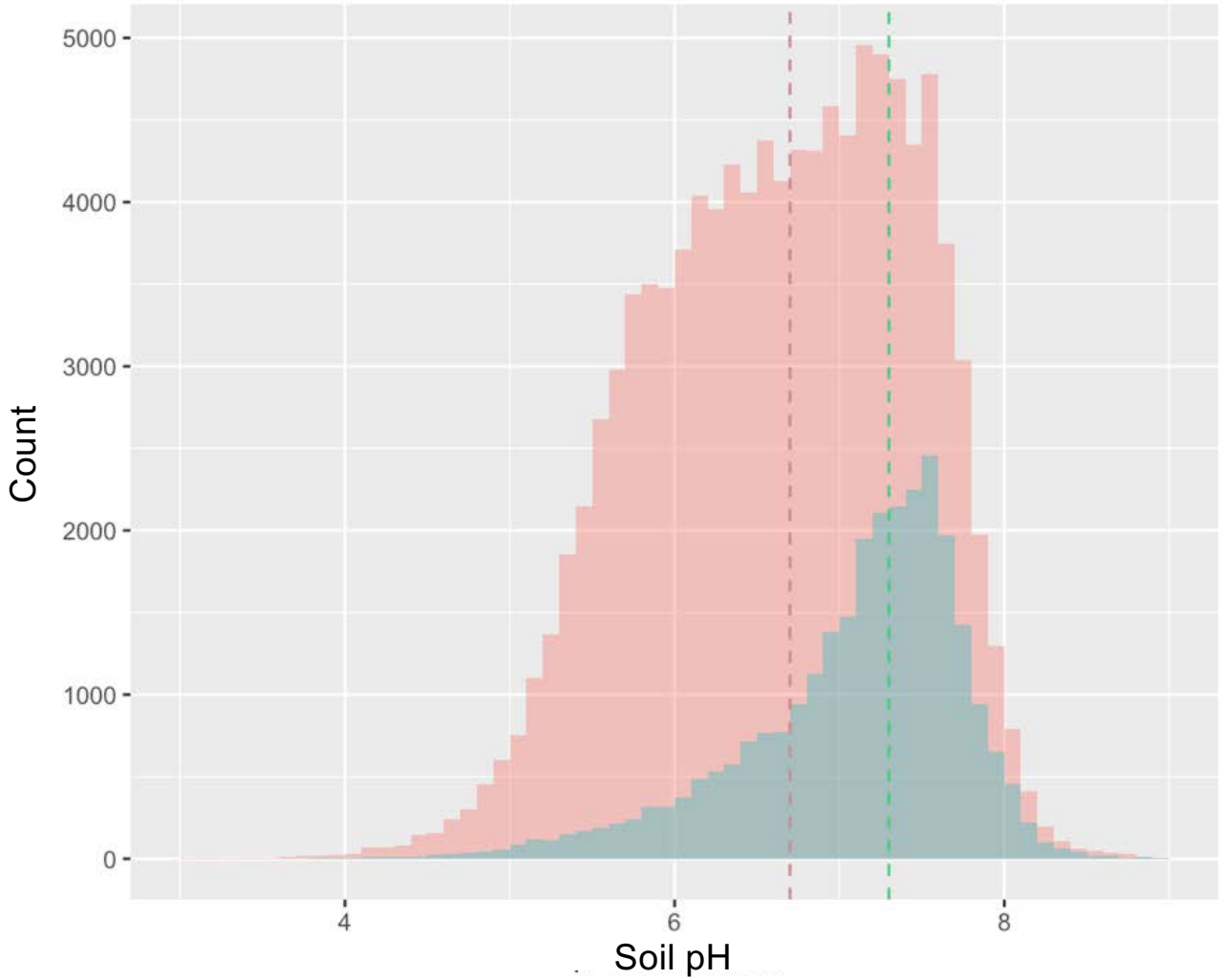


Figure: N. Jelinski; Data: UMN Soil Testing Lab Database

Urban vs Non-Urban pH

- ”Natural” topsoil pH in Twin Cities Area ~5.5-6.5.
- UMN Soil Testing Lab Database (> 130,000 samples, 1998-2016).
  - Median (MSP): 7.3
  - Median (nonMSP): 6.7

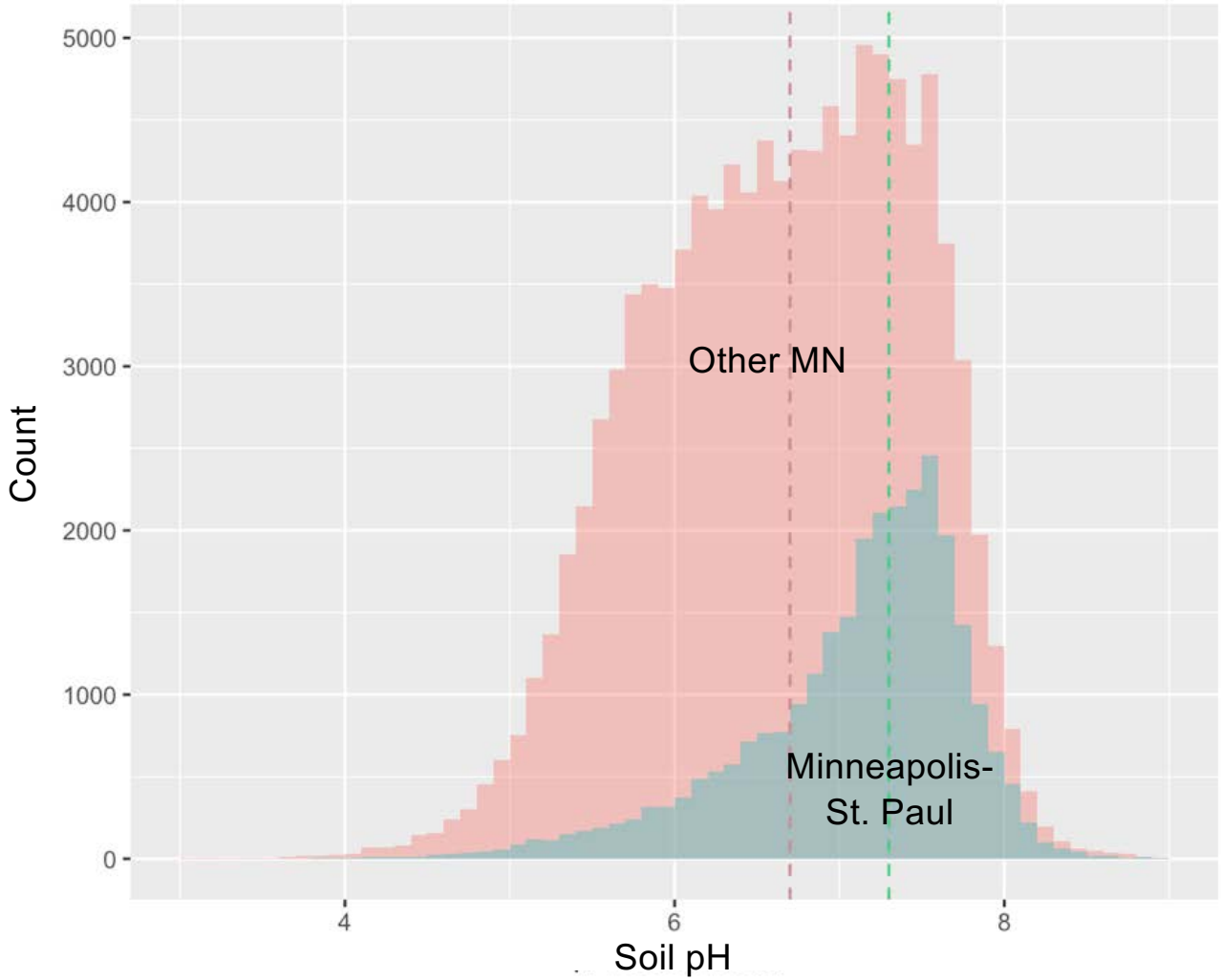


Figure: N. Jelinski; Data: UMN Soil Testing Lab Database

Urban vs Non-Urban pH

- ”Natural” topsoil pH in Twin Cities Area ~5.5-6.5.
- UMN Soil Testing Lab Database (> 130,000 samples, 1998-2016).
  - Median (MSP): 7.3
  - Median (nonMSP): 6.7
- Median value of surface pH from our dataset: 7.1

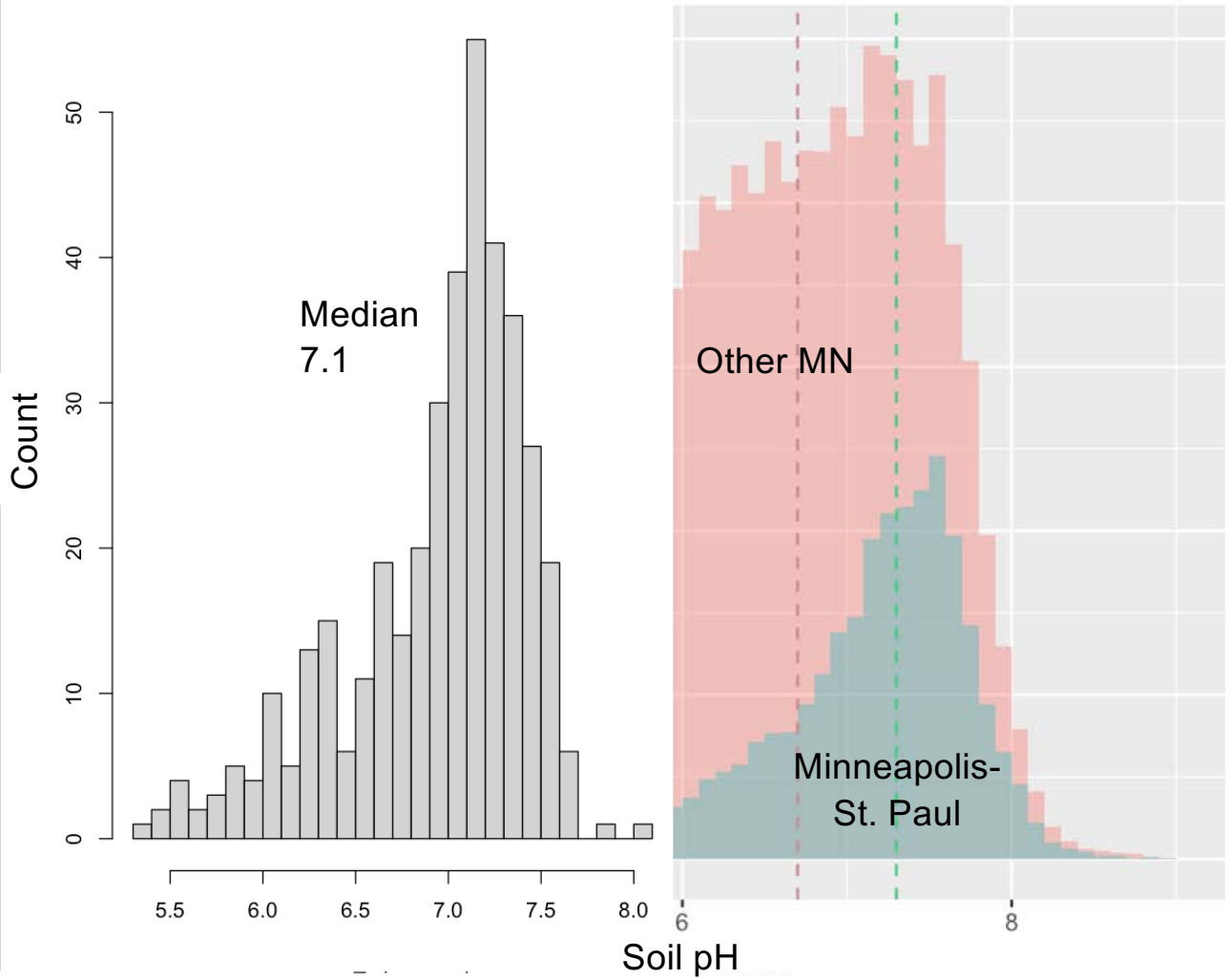
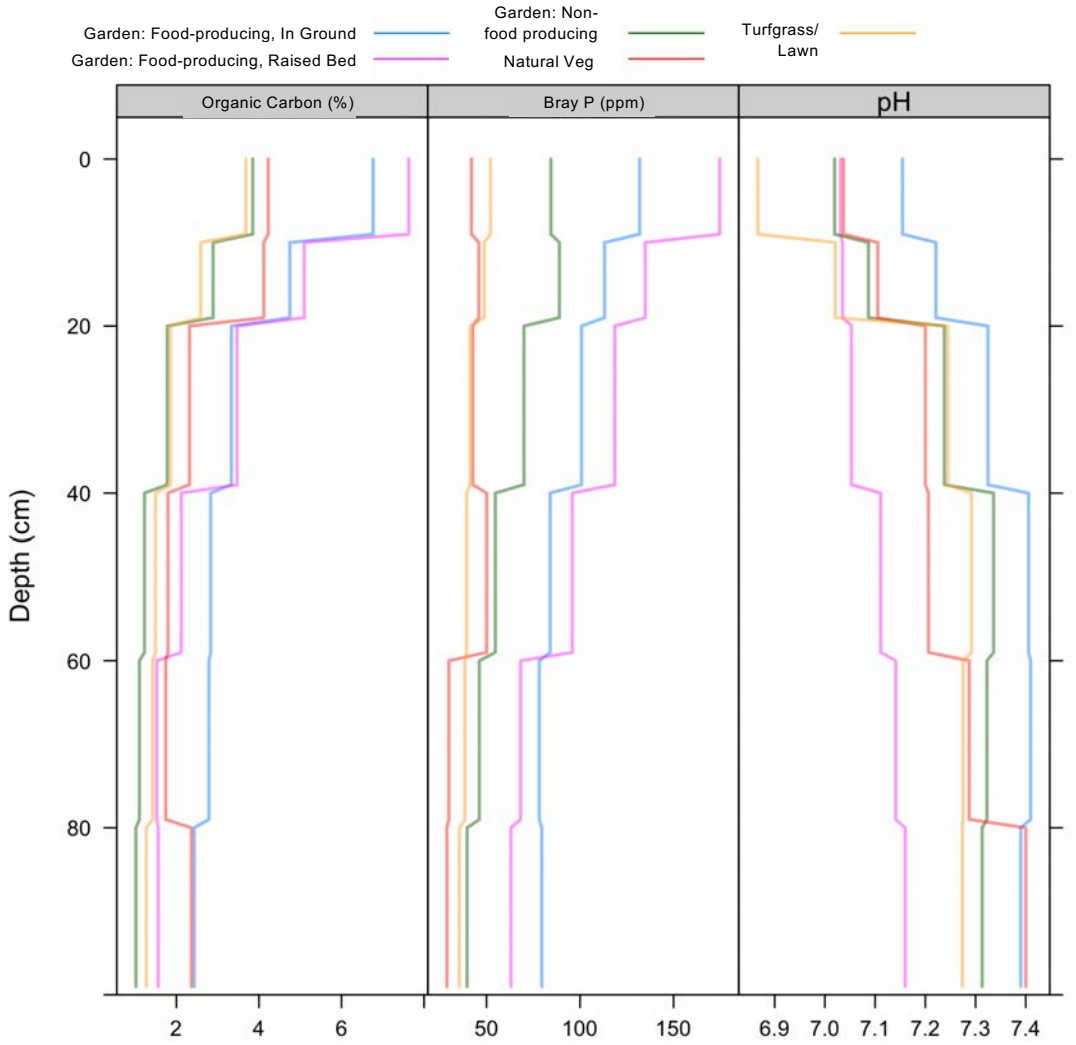


Figure: N. Jelinski; Data: UMN Soil Testing Lab Database

Depth trends in SOC, P, and pH

- SOC, on average, highest in food producing areas in top 40cm.
- Available P highest in food-producing areas to 80-100cm. Non-food producing gardens elevated, on average to 40cm relative to natural vegetation and turfgrass/lawn.
- pH exhibits similar trends across land use categories – surface increments are most different, but still similar in magnitude.



Images: (L) N. Jelinski – St. Paul, MN

Conclusions & Implications for Ecosystem Services

- **Interest in evaluating UFP as a viable green infrastructure practice in MSP. How do soil properties under UFP compare to other land cover/land use categories?**
  - UFP results in increased SOC, P, and sometimes Ksat (in the case of raised beds). Effects on SOC and P are most pronounced. UFP does not decrease Ksat relative to green spaces or turfgrass.
  - UFP results in similar but less variable topsoil pH than turfgrass and green spaces.

- **So what?**
  - UFP does not have negative impacts on important soil properties and provides a host of other services (Nicklay et al., 2020, 2022).
  - Increased SOC, P, and pH all favor contaminant (esp Pb) immobilization and decreased bio-accessibility.

Image: N. Jelinski, Frogtown Park and Farm, St. Paul, MN

Continuing Work

- Soil properties in MSP clearly influenced by land use/land cover at multiple scales, especially UFP. Beginning to examine spatial trends and attempt predictive models using creative co-variates.

- How could this information be integrated into an updated soil survey product for MSP?
  - Depends on scale, especially w/ regard to UFP plots in many residential properties may be finer-scale than gSSURGO product (10m) and not mappable. However, an opportunity to integrate this information into components based on spatial estimates (Ramaswami et al., 2022).
  - Urban land use can change dramatically - state and transition models may play an important role.
    - Opportunities to envision dynamic soil survey and interpretations? (utilizing parcel-based 4yr updates on land use spatial product for MSP?)

Image: N. Jelinski, Frogtown Park and Farm, St. Paul, MN

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Image: N. Jelinski, Frogtown Park and Farm, St. Paul, MN

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