Projected Climate Change Impacts to Floodplain Forests in the Twin Cities Metro

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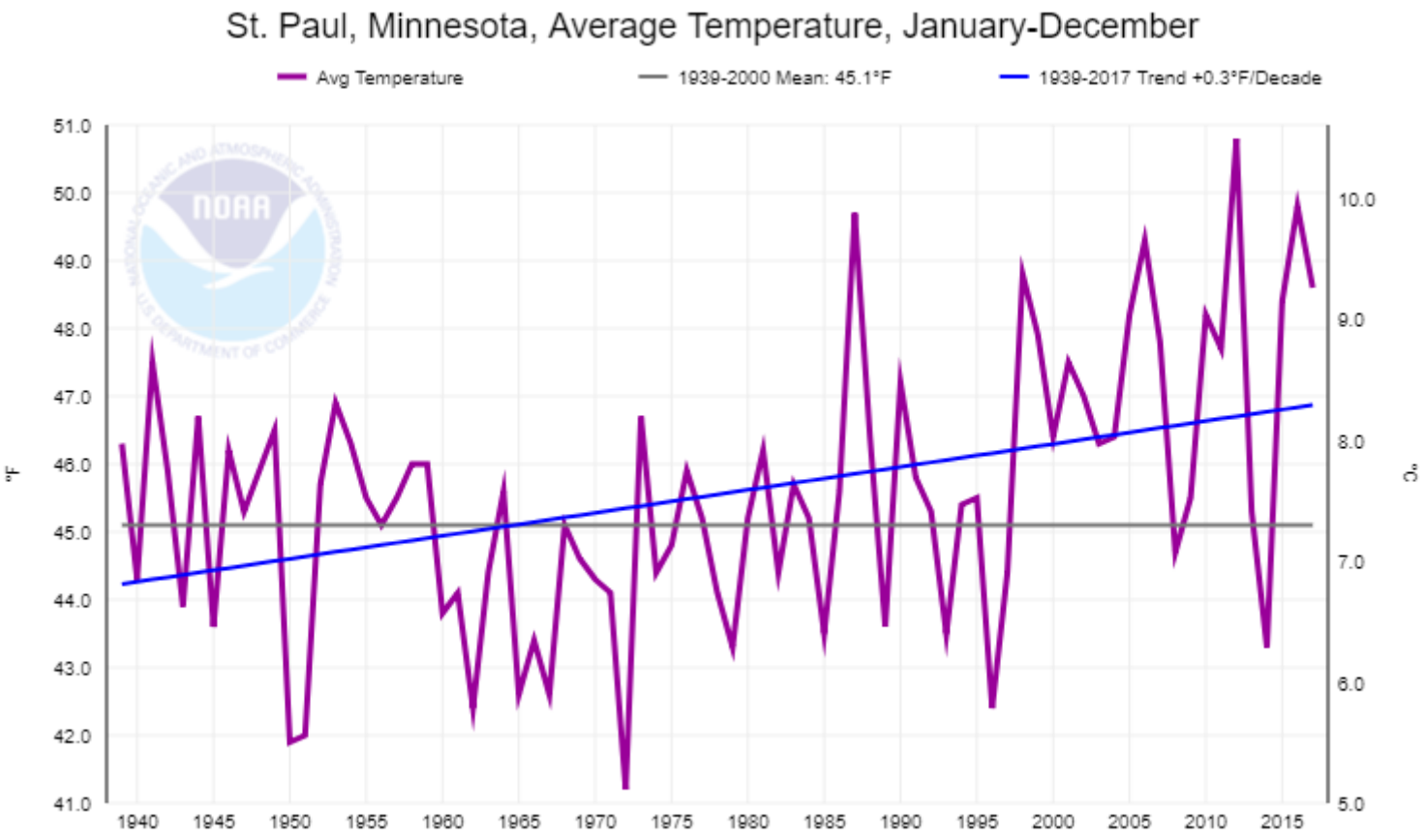
Northern Institute of Applied Climate Science
US Forest Service

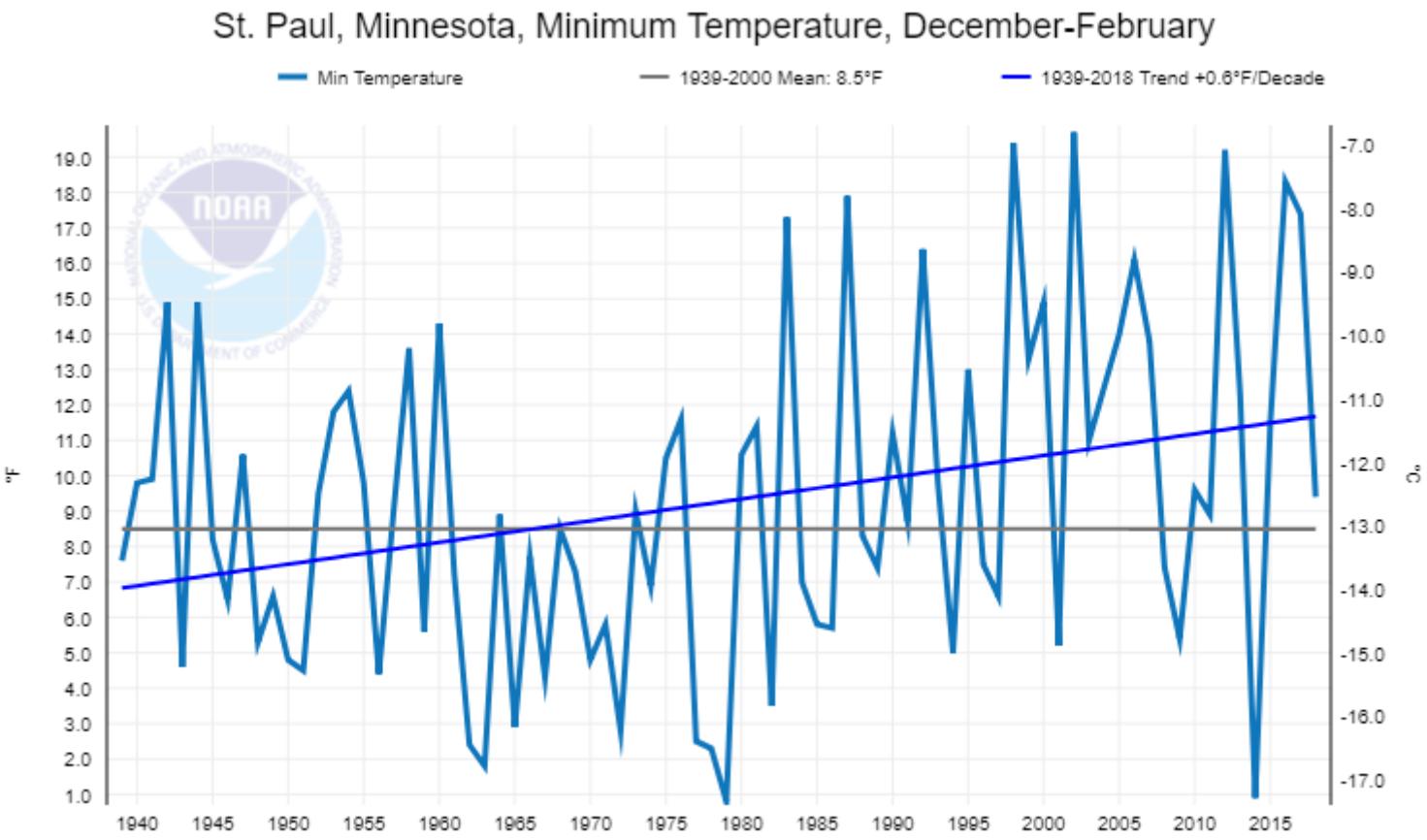
Current Trends

Temperatures are rising



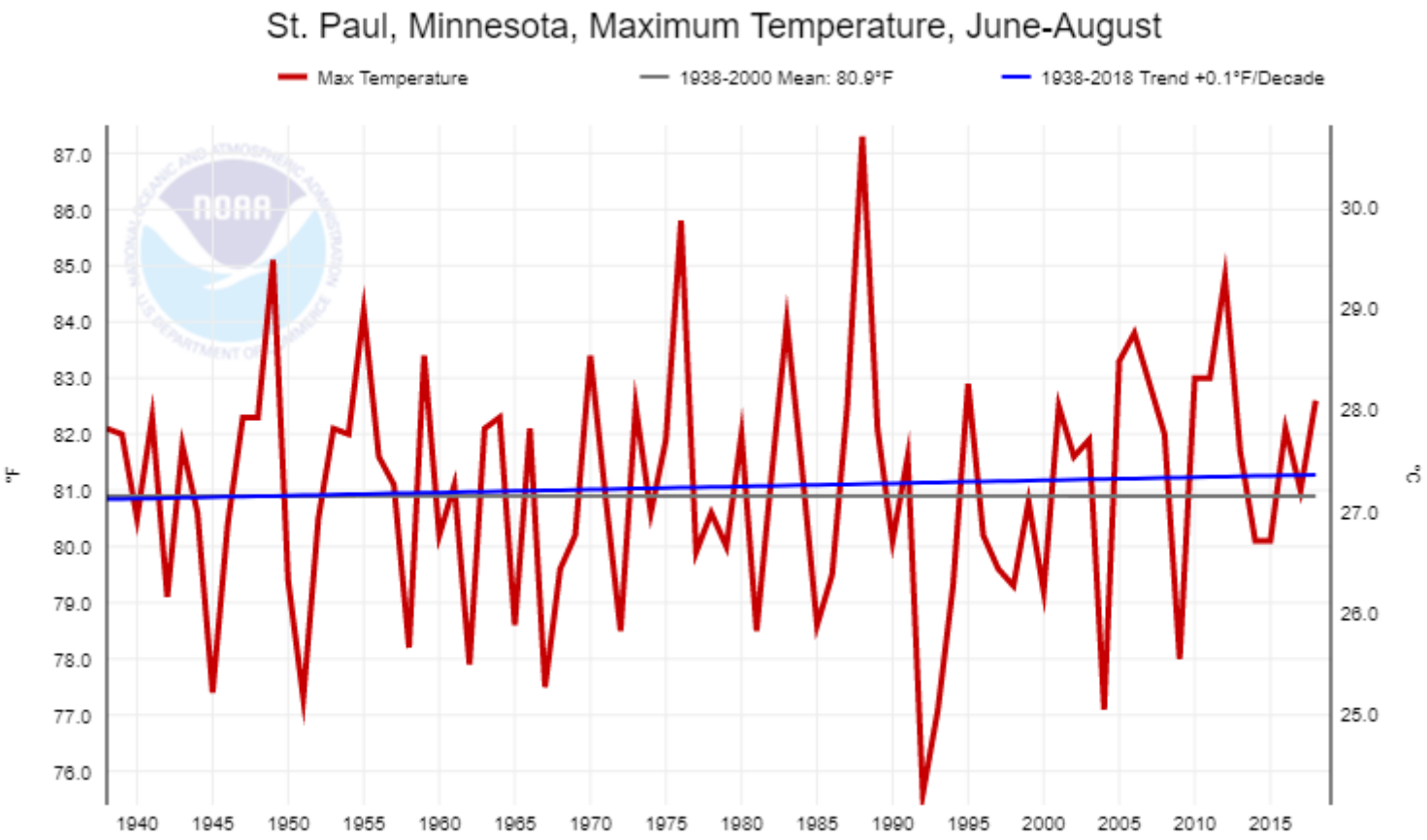
Source: https://www.ncdc.noaa.gov/cag/global/time-series

Winter lows are increasing most



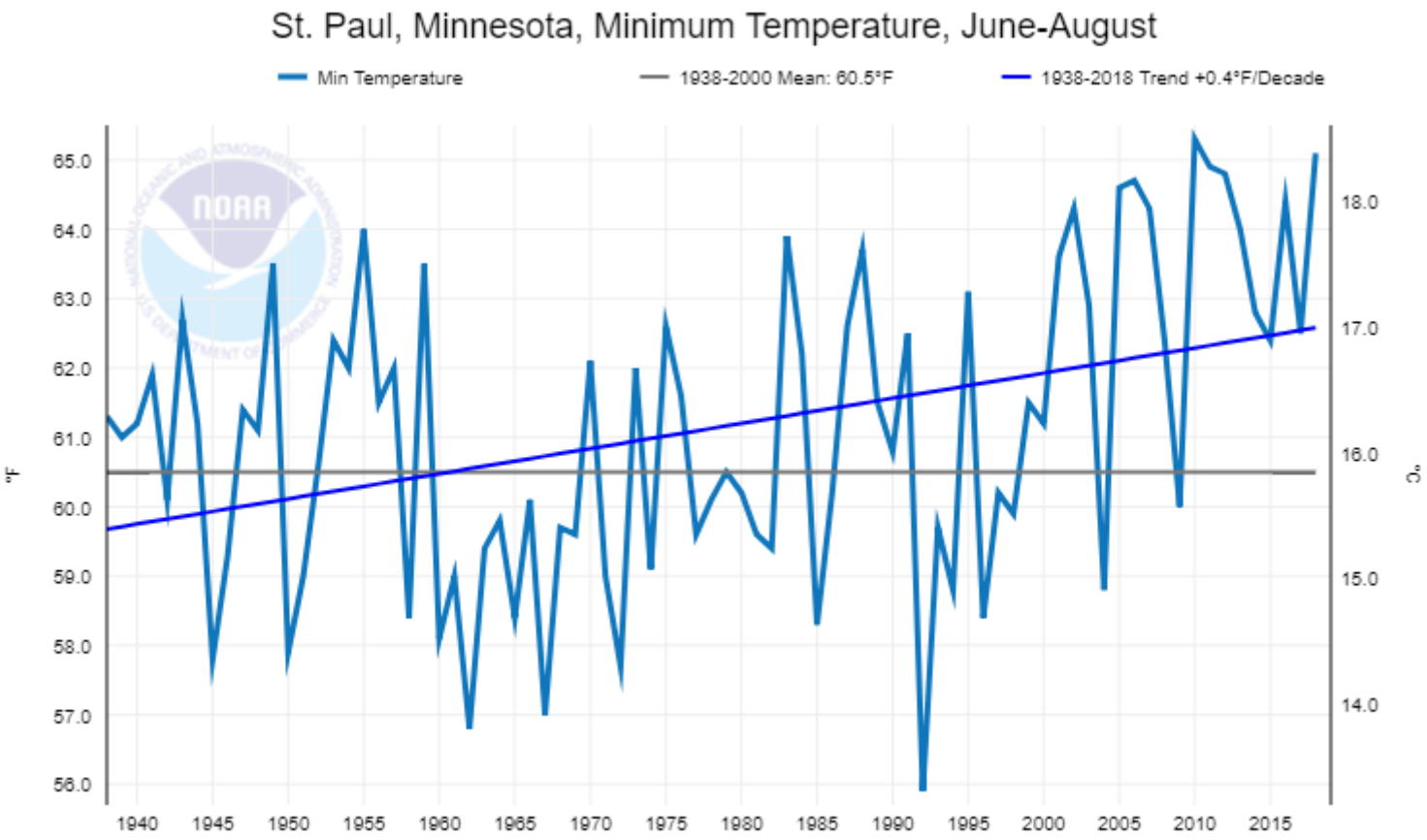
Source: https://www.ncdc.noaa.gov/cag/global/time-series

Summer highs are not changing much



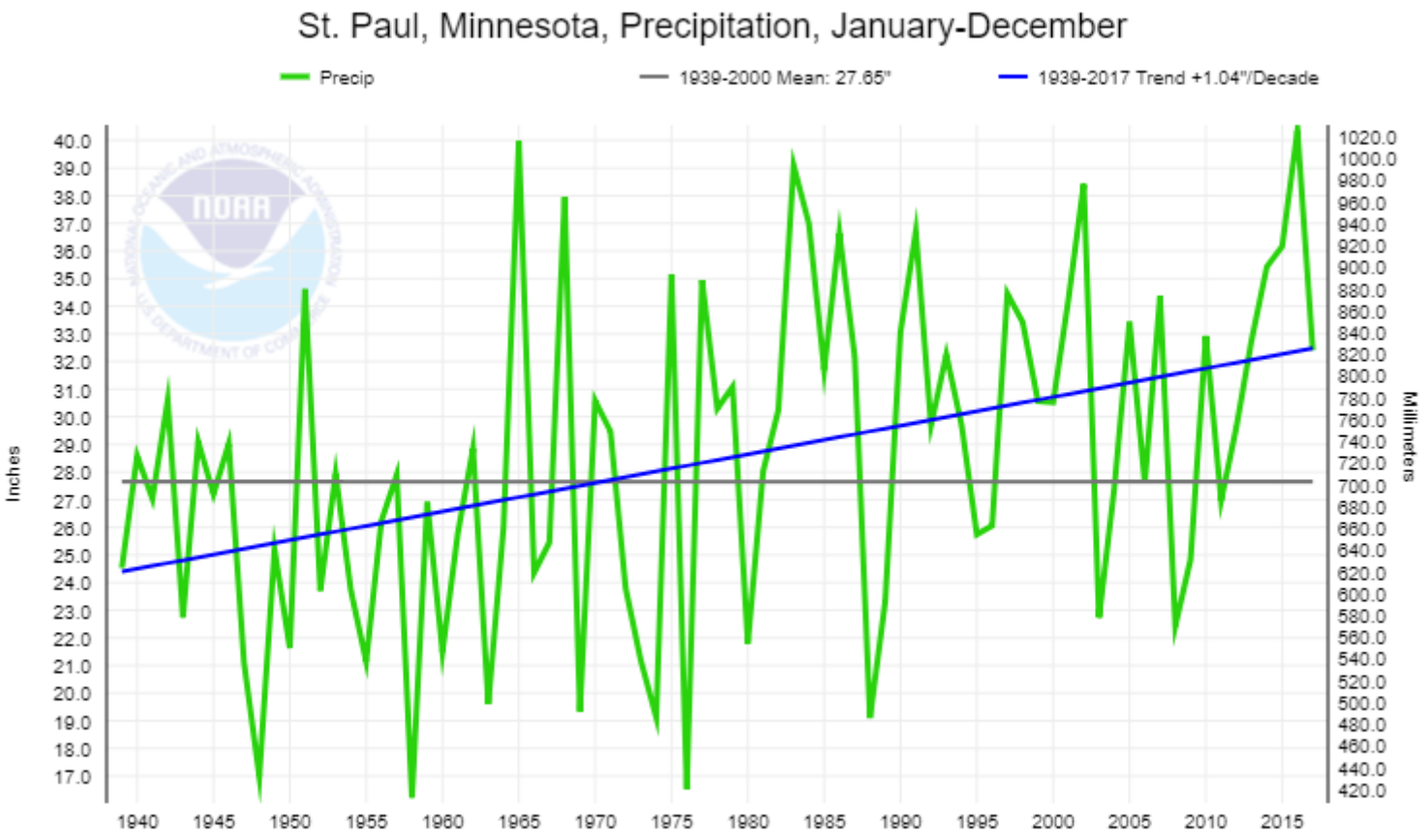
Source: https://www.ncdc.noaa.gov/cag/global/time-series

Summer lows are increasing



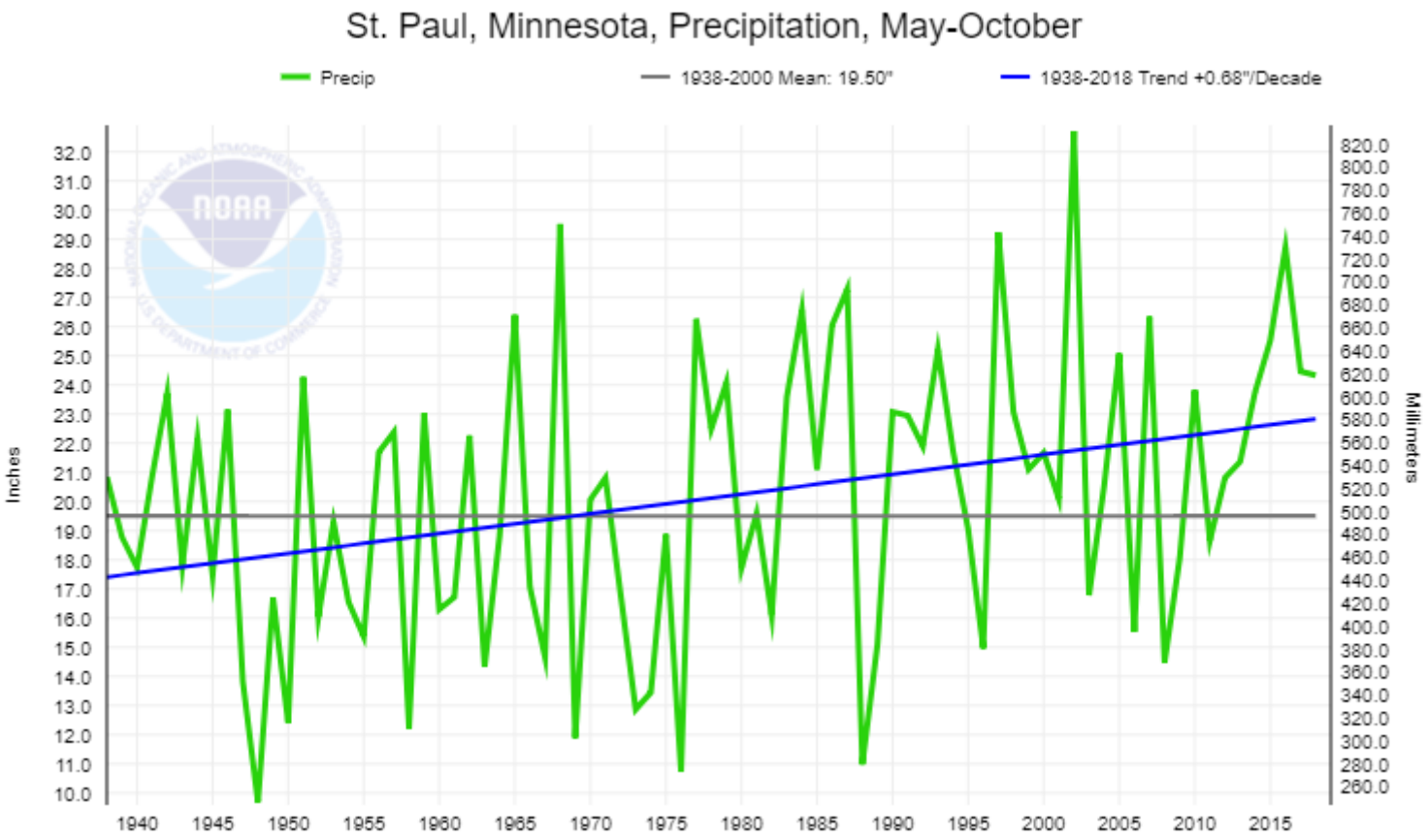
Source: https://www.ncdc.noaa.gov/cag/global/time-series

It’s getting wetter!



Source: https://www.ncdc.noaa.gov/cag/global/time-series

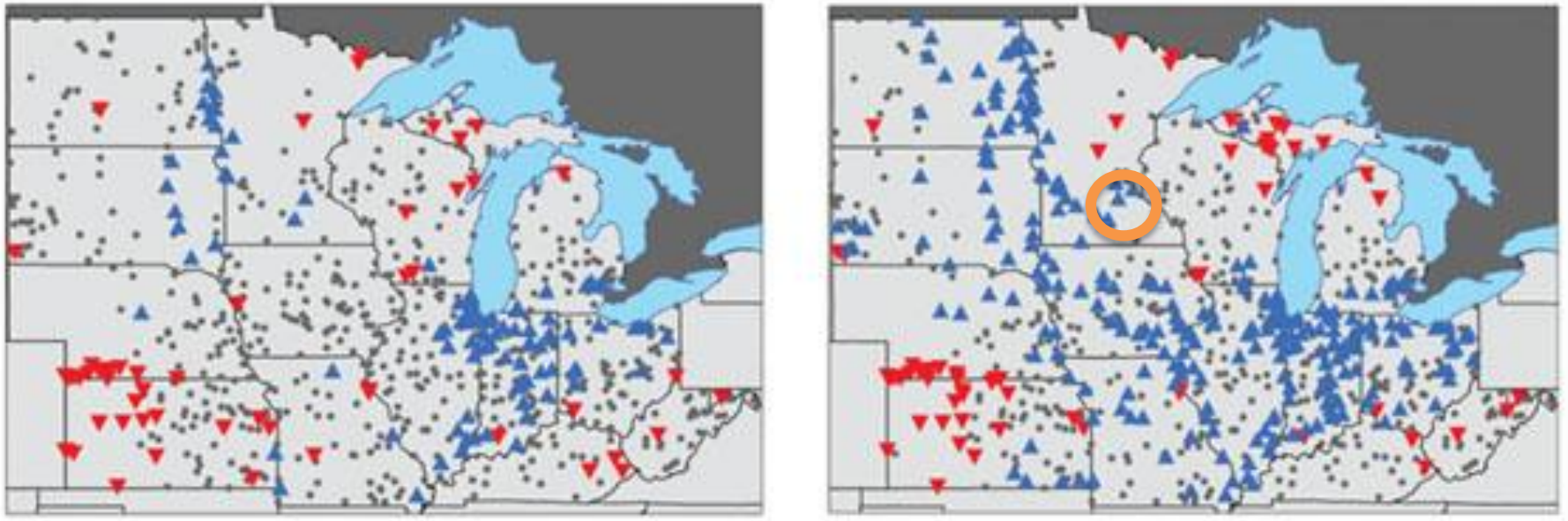
…Including During the Growing Season



Source: https://www.ncdc.noaa.gov/cag/global/time-series

Floods are more frequent

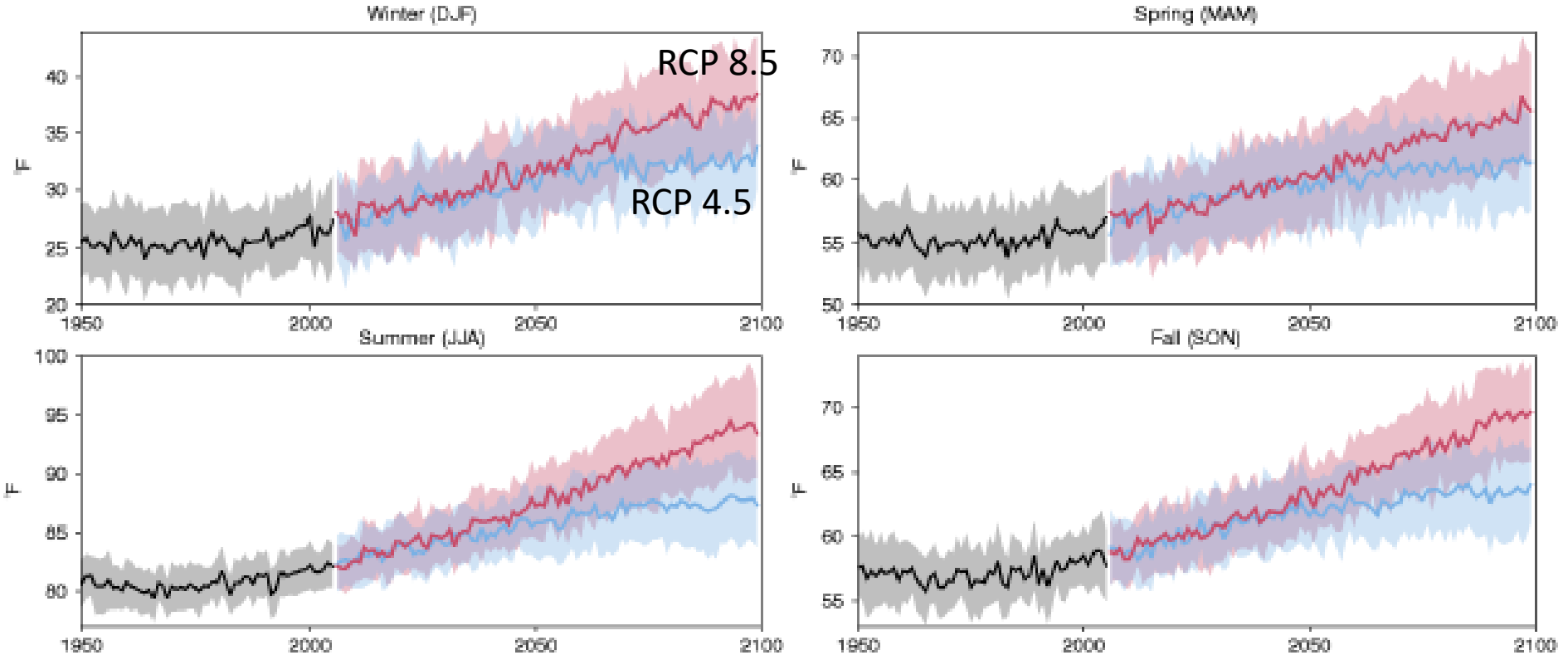
Flood magnitude and frequency in the central U.S., 1962-2011



Changes in flood magnitude (left) and frequency (right). Blue indicates increasing frequency and red shows decreasing frequency. Credit: *Nature Climate Change*, 2015.

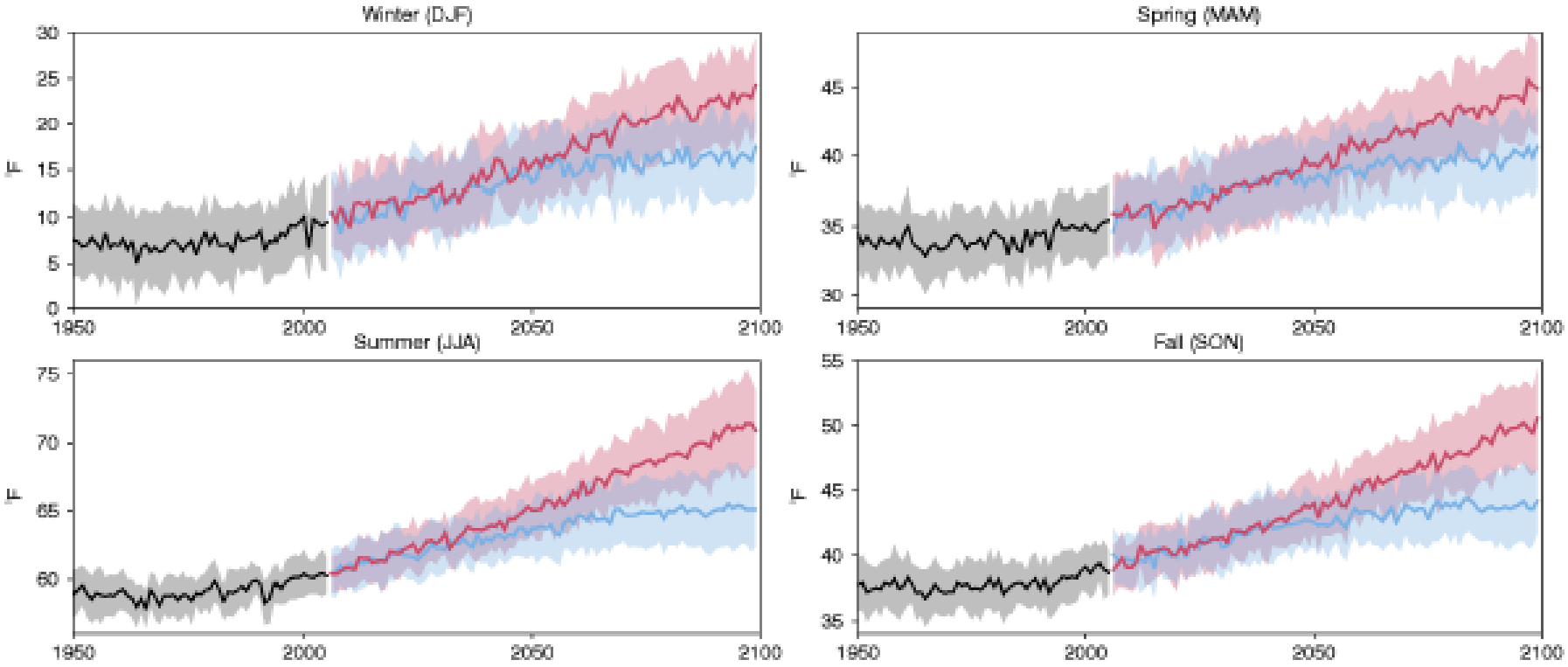
Looking Forward

Daily Maximum Temperatures Expected to Increase Across All Seasons



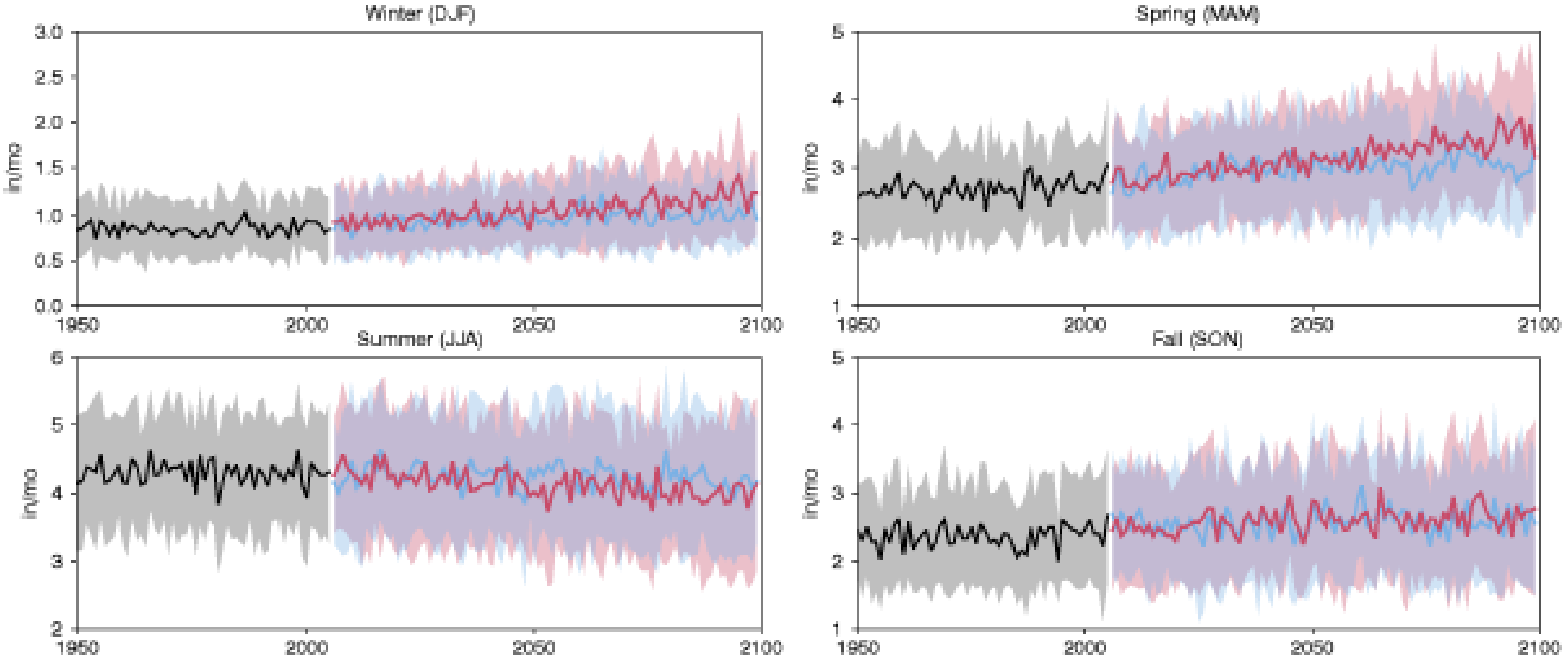
Source: https://www2.usgs.gov/climate_landuse/CLU_rd/nccv/viewer.asp

Minimum Temperatures will increase across all seasons



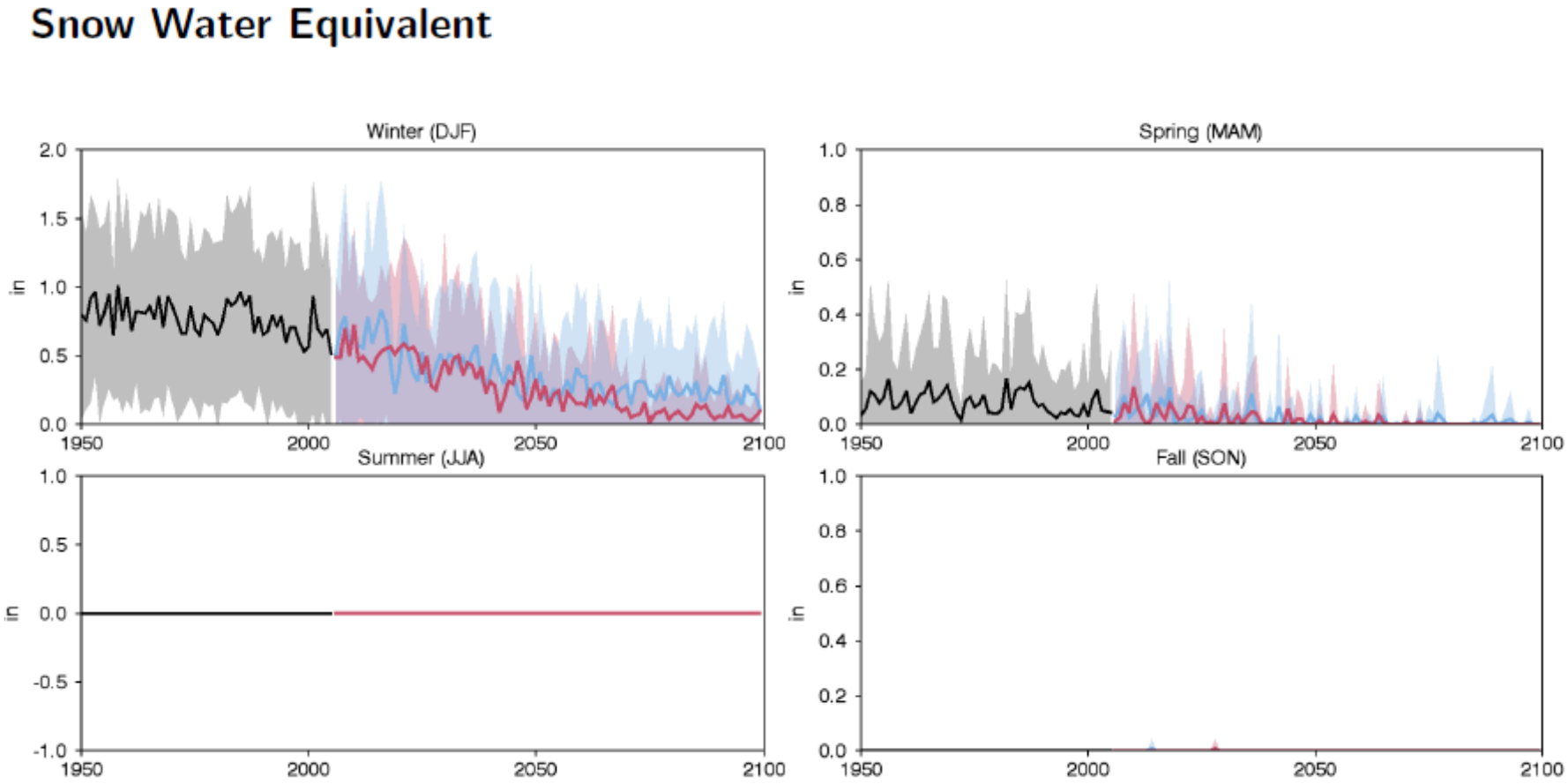
Source: https://www2.usgs.gov/climate_landuse/CLU_rd/nccv/viewer.asp

Uncertainty in Precipitation Projections



Source: https://www2.usgs.gov/climate_landuse/CLU_rd/nccv/viewer.asp

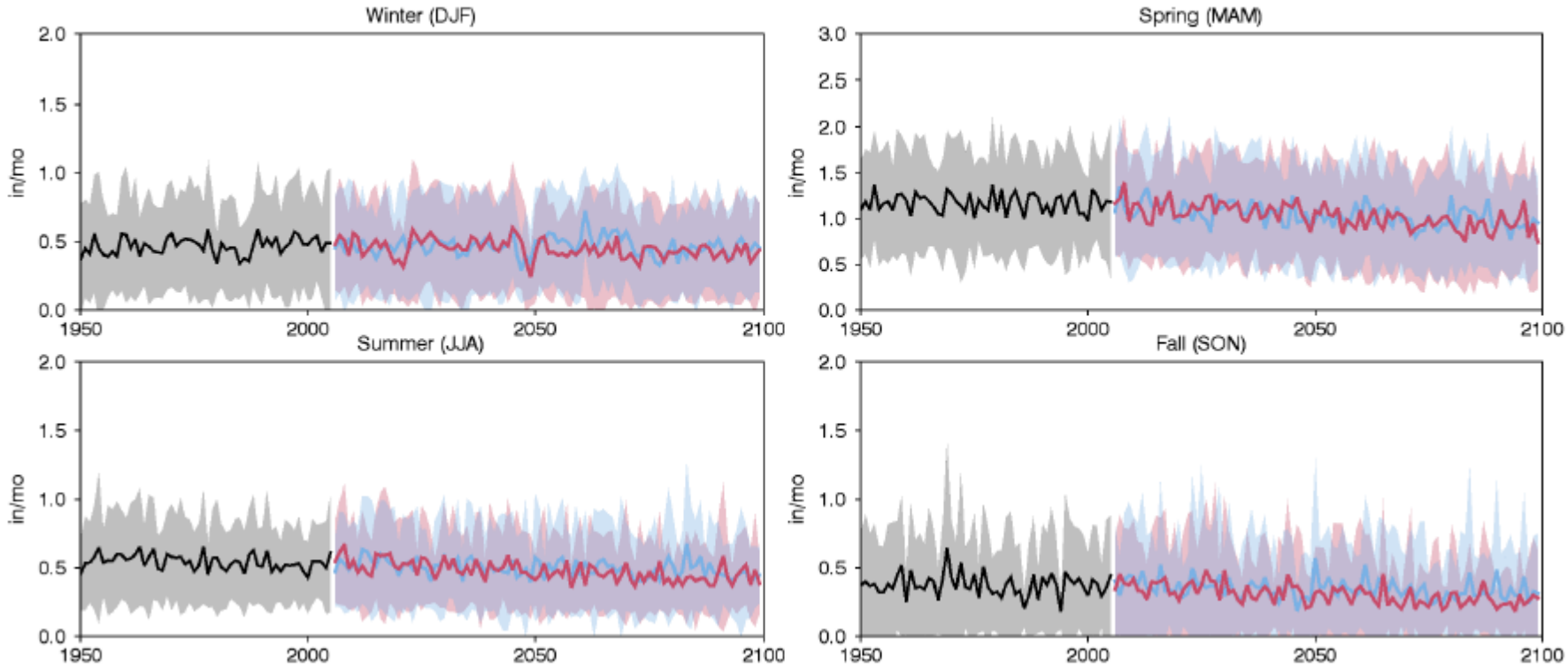
Less precipitation will fall as snow



Source: https://www2.usgs.gov/climate_landuse/CLU_rd/nccv/viewer.asp

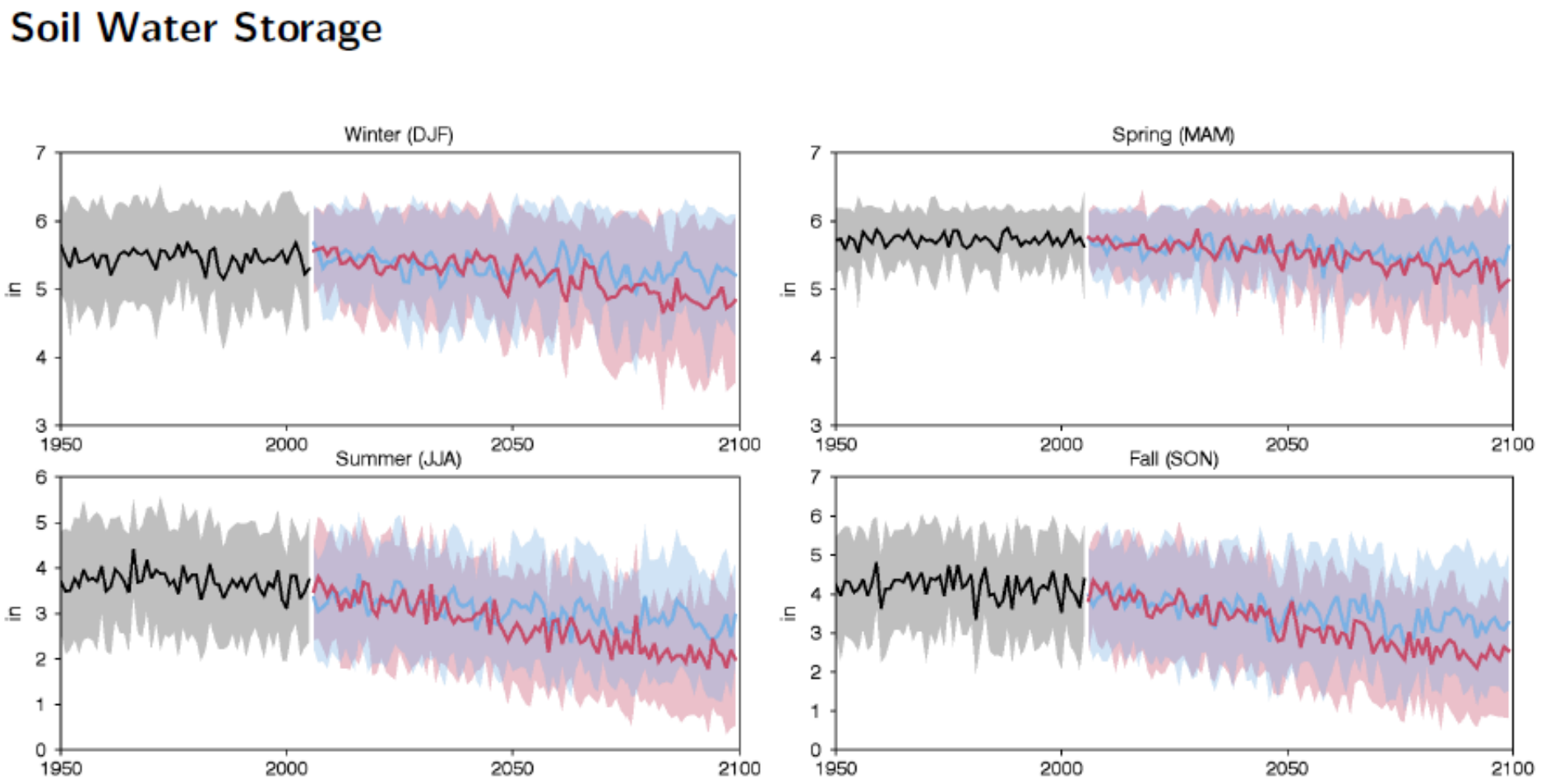
No clear trends in runoff

5 Runoff



Source: https://www2.usgs.gov/climate_landuse/CLU_rd/nccv/viewer.asp

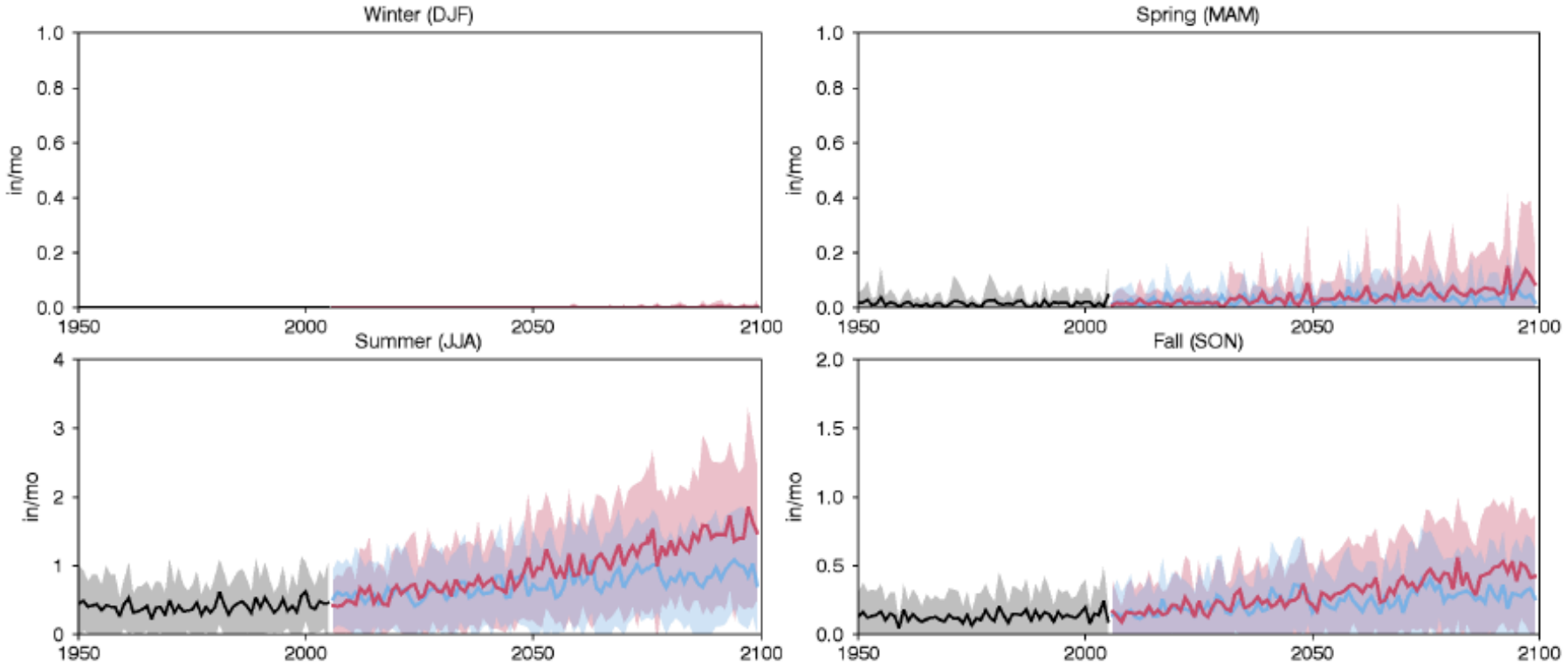
Reduced soil water storage (especially in summer)



Source: https://www2.usgs.gov/climate_landuse/CLU_rd/nccv/viewer.asp

More evaporative deficit in summer/fall

7 Evaporative Deficit



Source: https://www2.usgs.gov/climate_landuse/CLU_rd/nccv/viewer.asp

Future Climate Analogs?

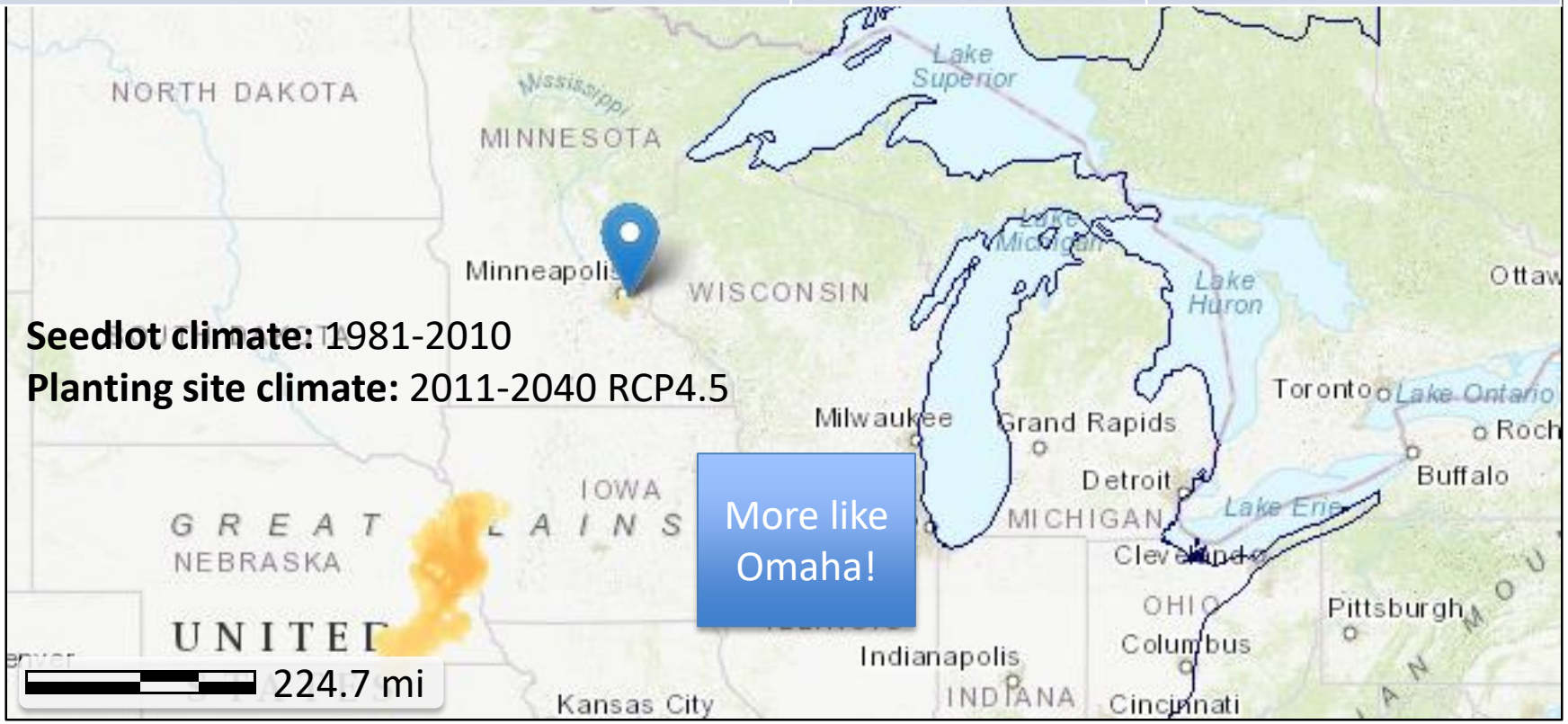
Seedlot Selection Tool

- Web-based mapping application
- Defines the center of the climatic space to be mapped, and then maps all areas that fall within a specified climatic distance
- Within the mapped area, the degree of climatic similarity is shown using different colors.
- By choosing a future climate, the SST can be used to examine how assisted migration might be used to respond to climate change.

52.32° N

104.48° W

Variable	Center	Transfer limit (+/-)
EMT: Extreme minimum temperature over 30 years	-34.5 °C	5.00 °C (modified)
FFP: Frost-free period	171 days	14 days (modified)
MAP: Mean annual precipitation	779.0 mm	50.0 mm (modified)



N

76.14° W

39.23° N

Low — High

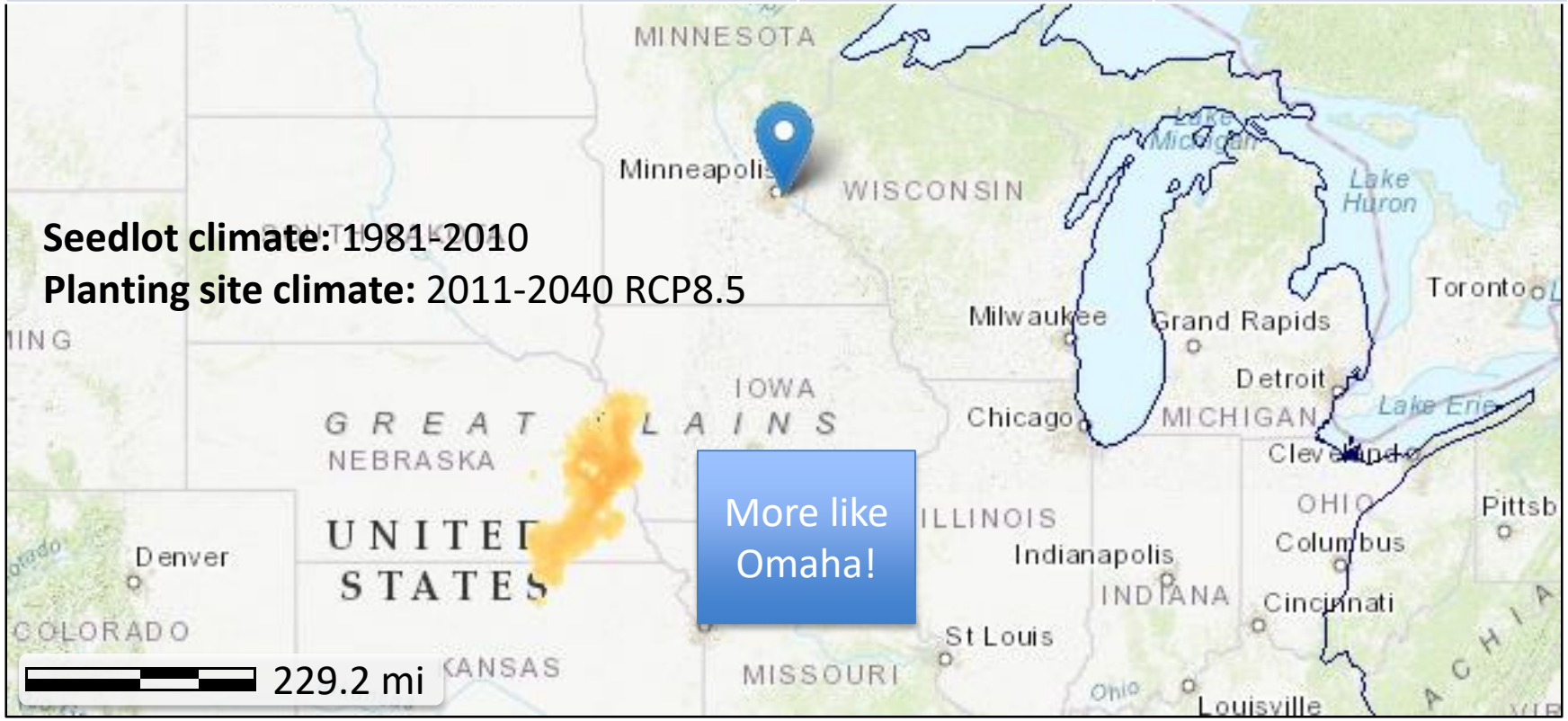
Match

Generated 12/14/2018 by the Seedlot Selection Tool

51.21° N

107.29° W

Variable	Center	Transfer limit (+/-)
EMT: Extreme minimum temperature over 30 years	-34.2 °C	5.00 °C (modified)
FFP: Frost-free period	172 days	14 days (modified)
MAP: Mean annual precipitation	774.0 mm	50.0 mm (modified)



Generated 12/14/2018 by the Seedlot Selection Tool

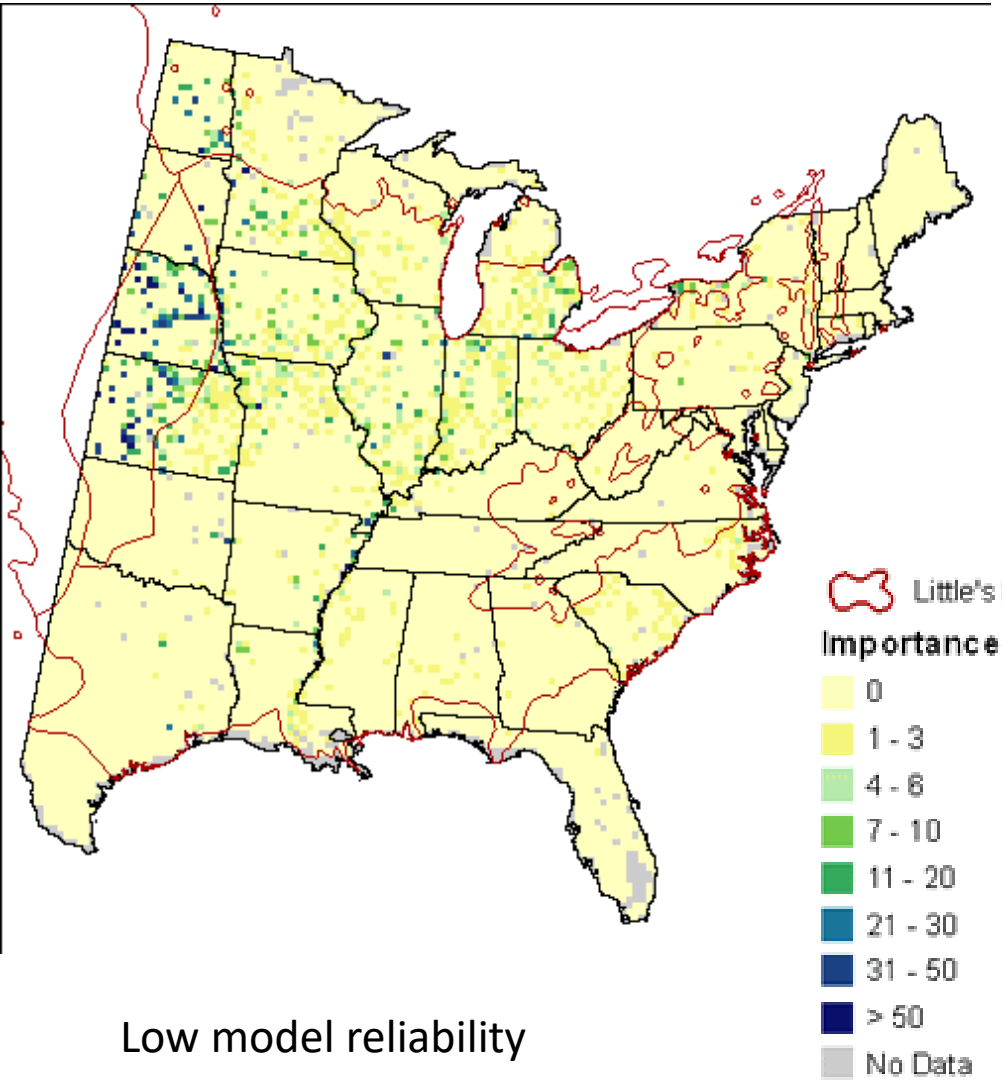
Climate Change Tree Atlas

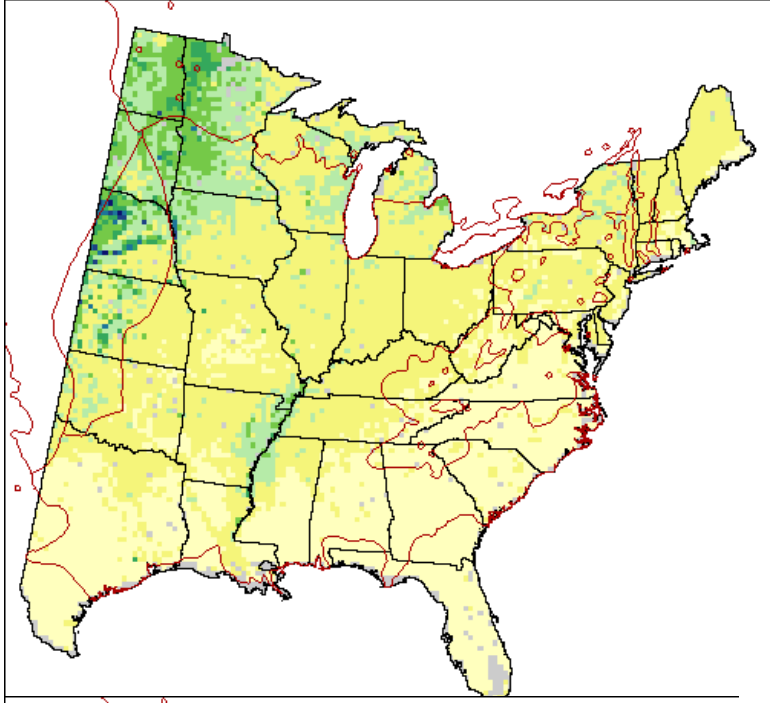
http://www.fs.fed.us/nrs/atlas/

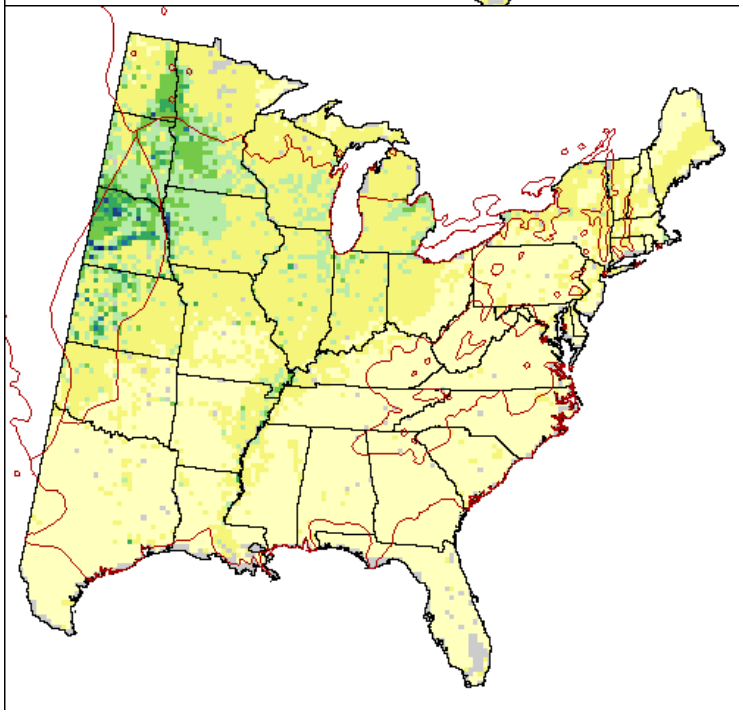
Losing Habitat

- Cottonwood?
- Northern white cedar
- Black willow?
- Silver Maple?
- Boxelder?

Cottonwood

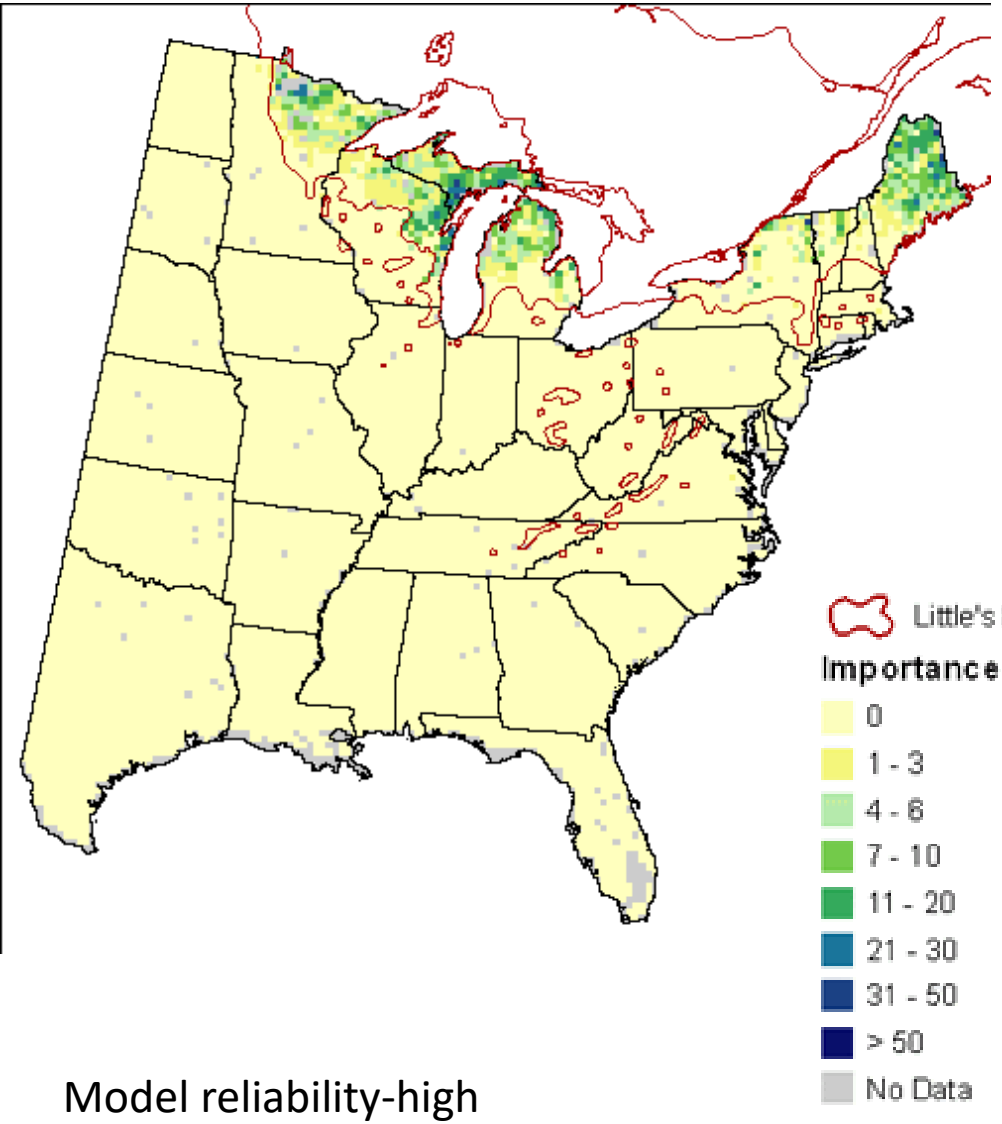


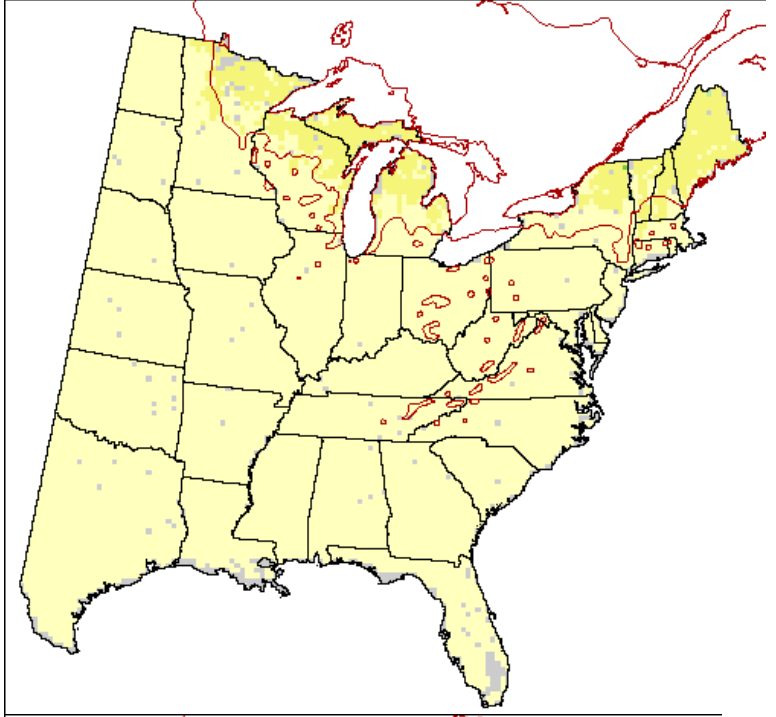


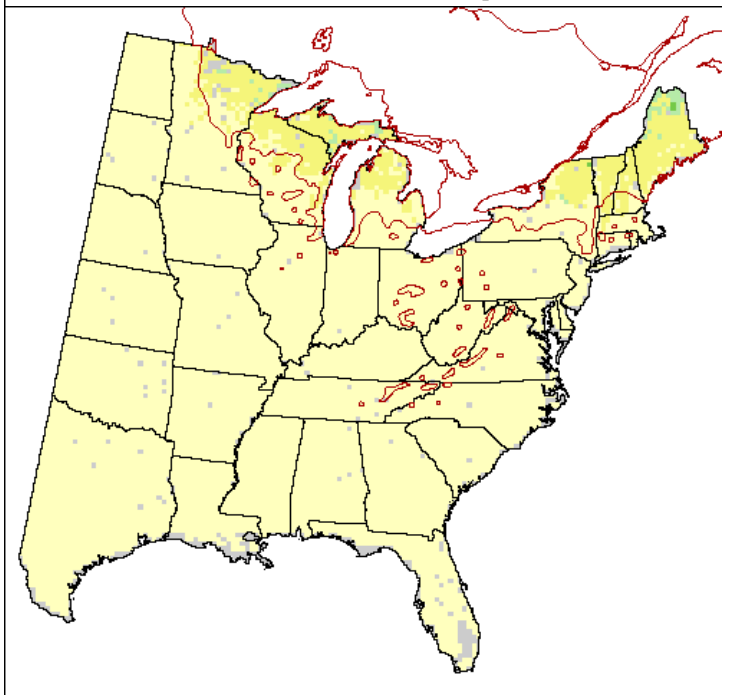


Low model reliability

Northern White Cedar

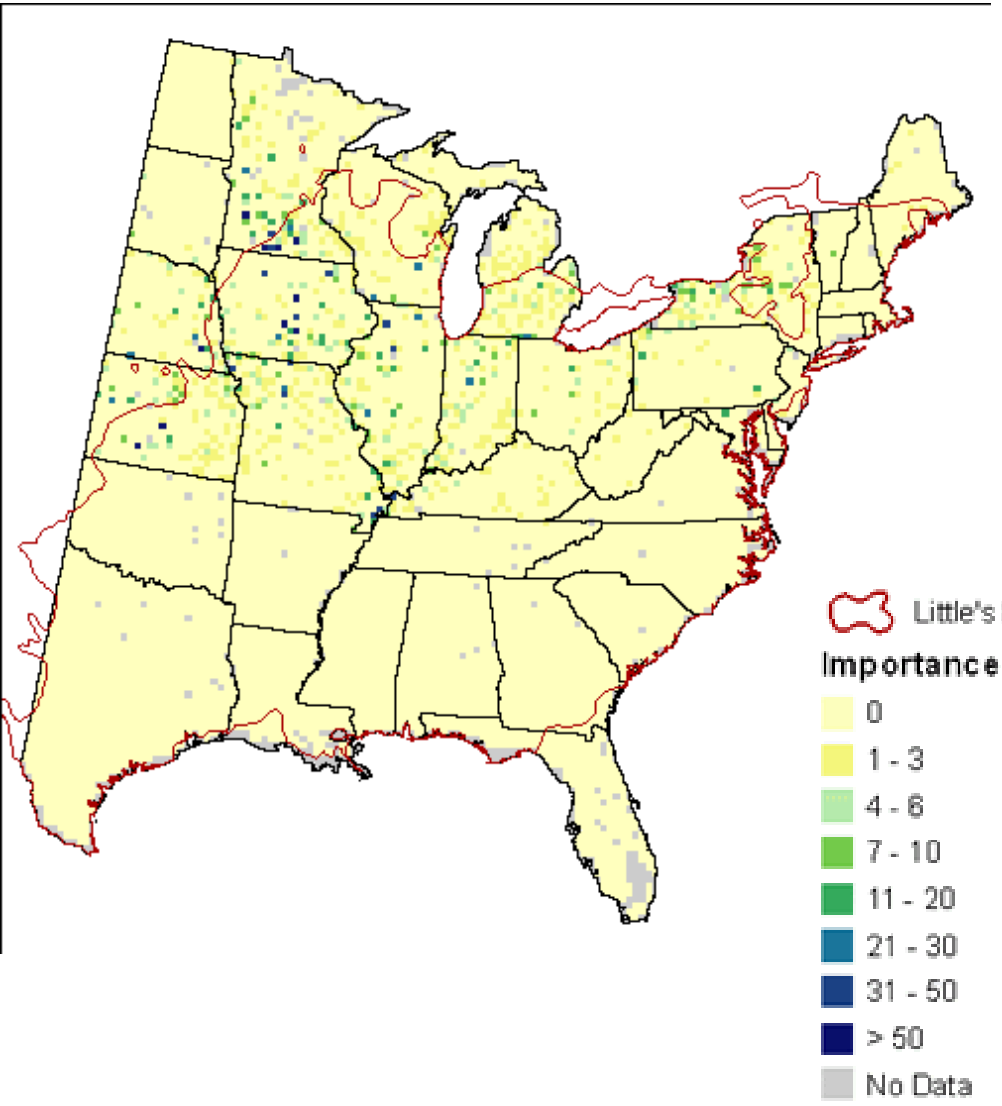


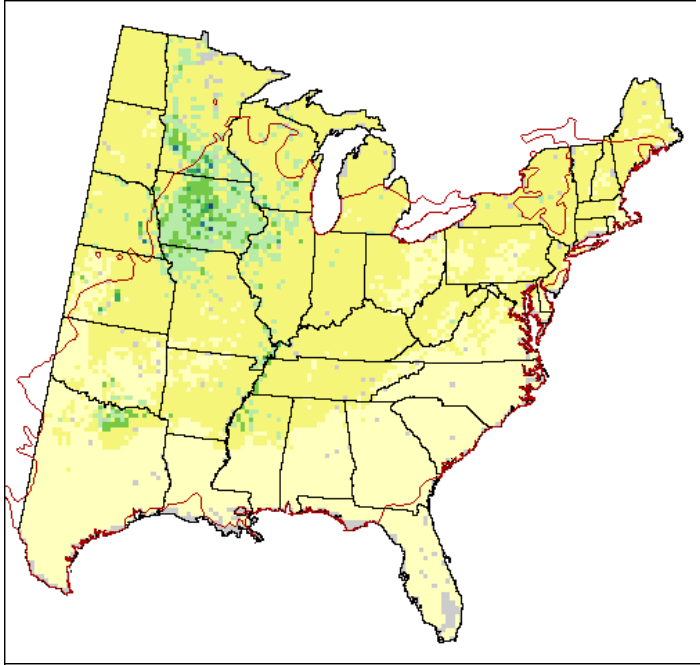


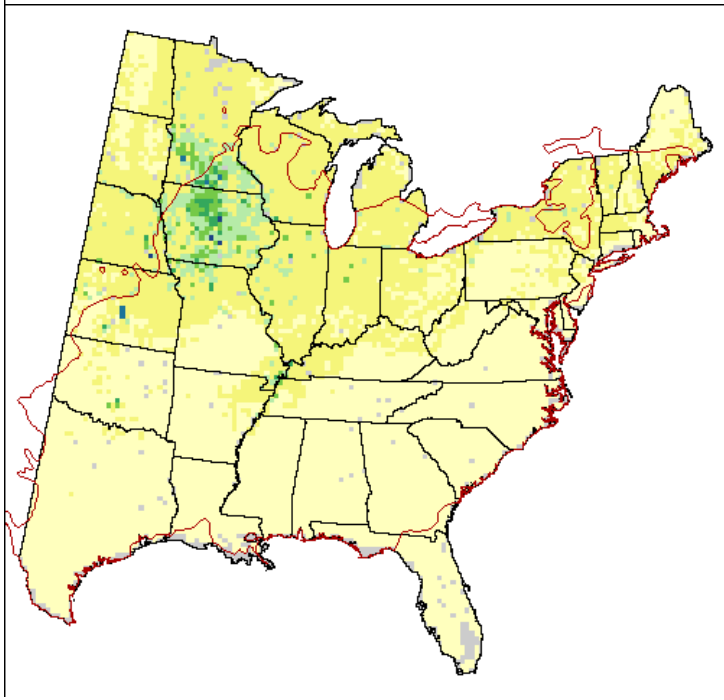


Model reliability-high

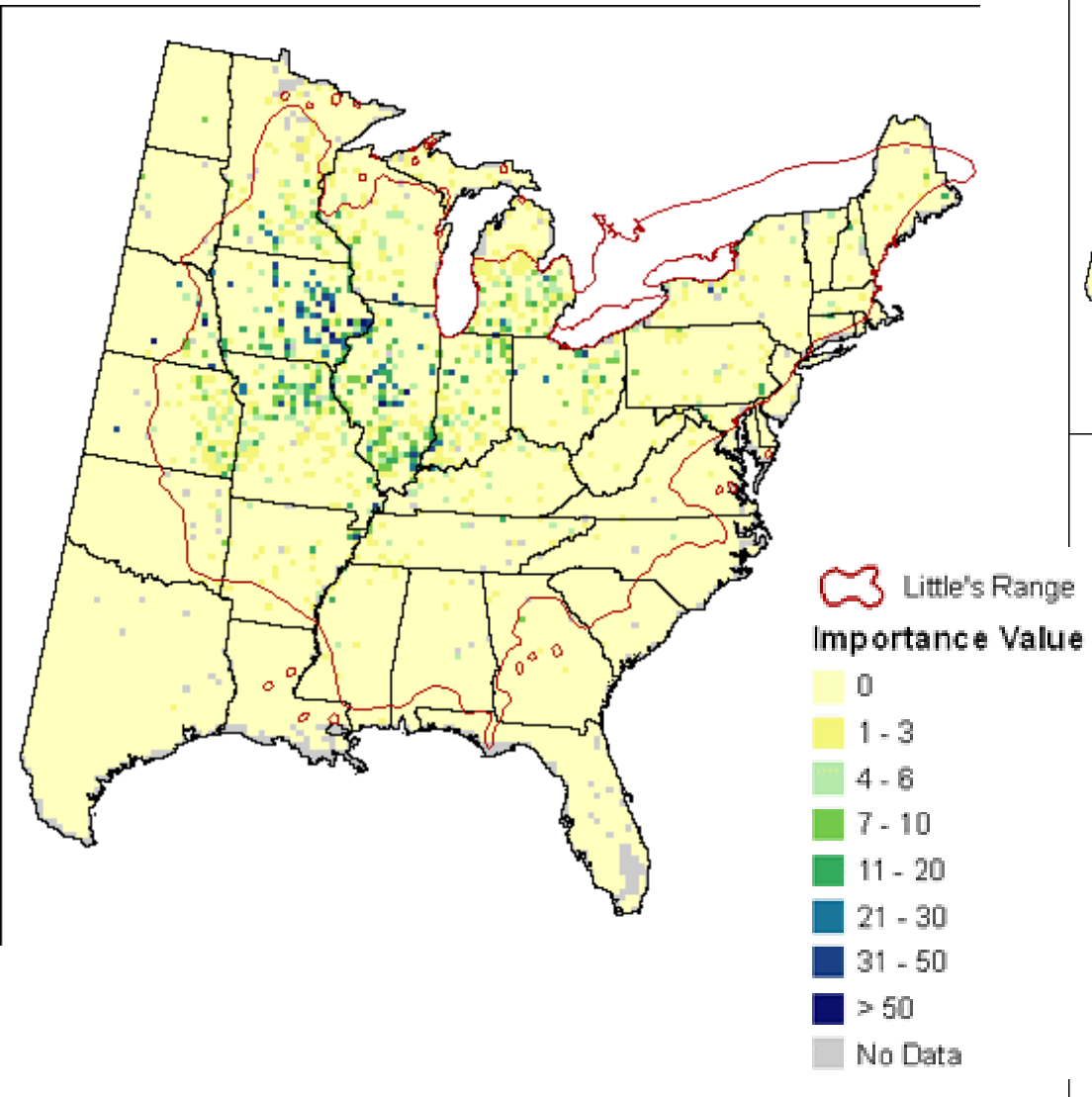
Black Willow

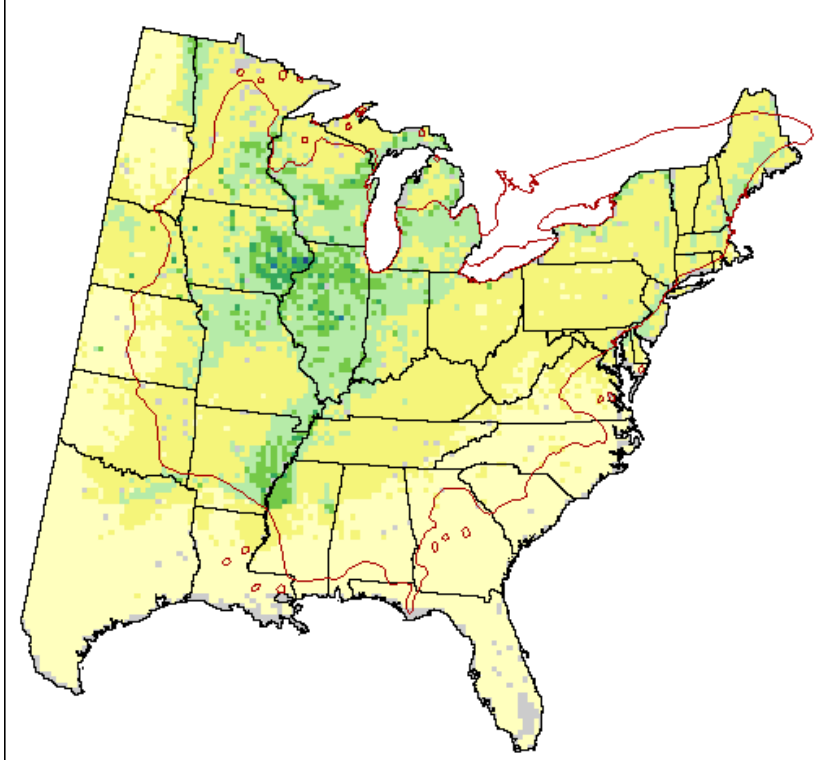


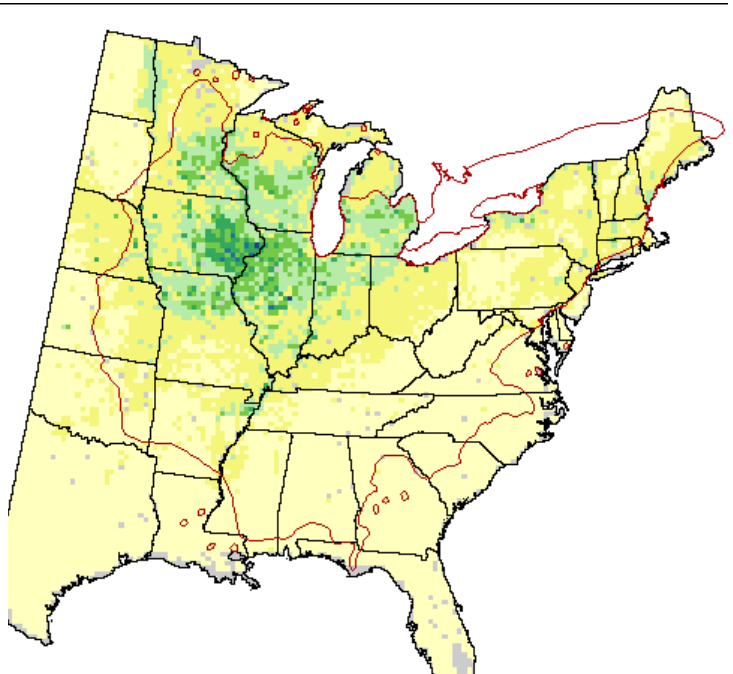




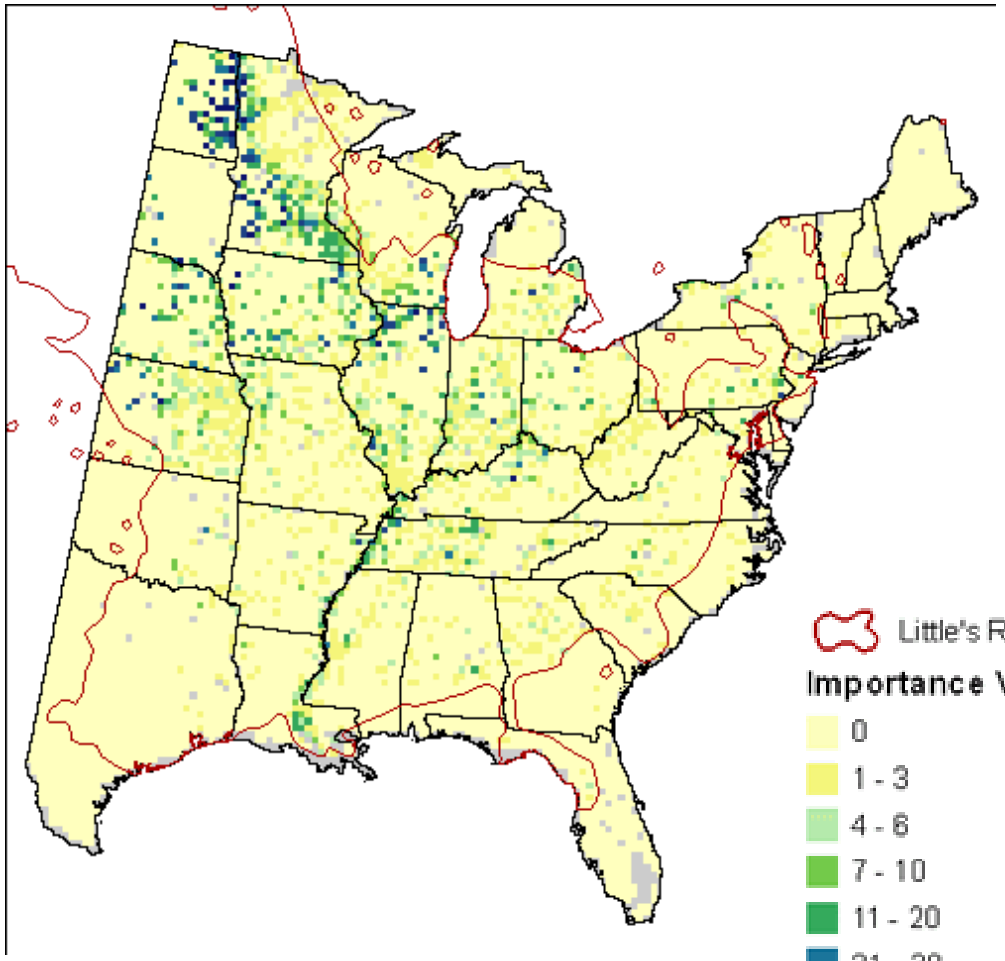
Silver Maple

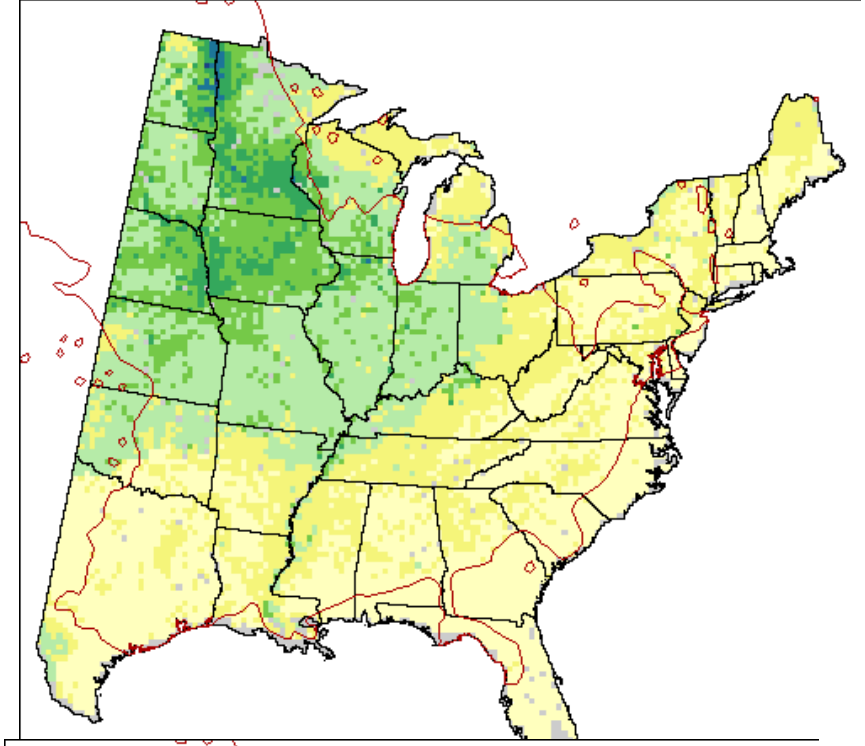


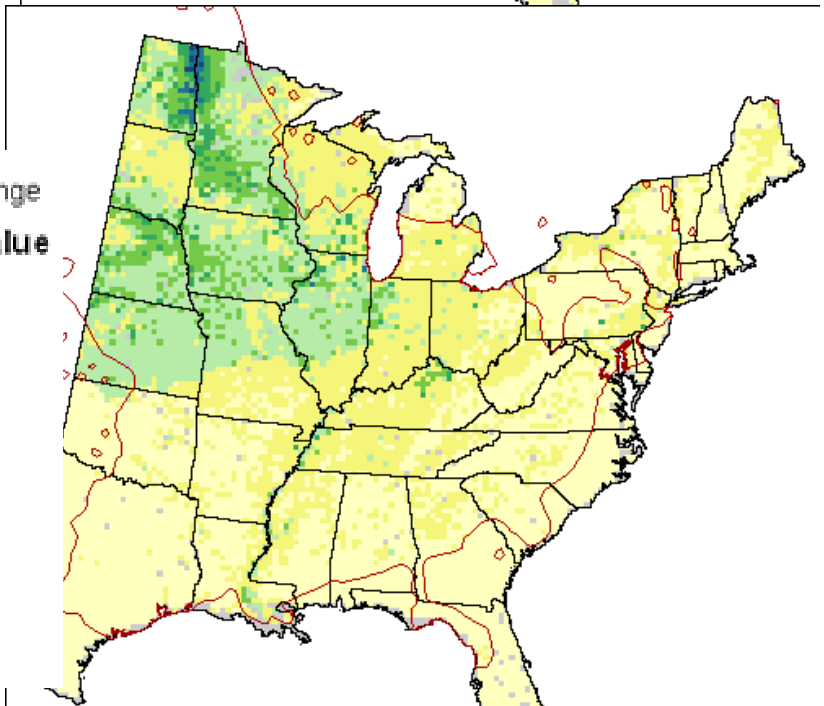




Boxelder







Little's Range

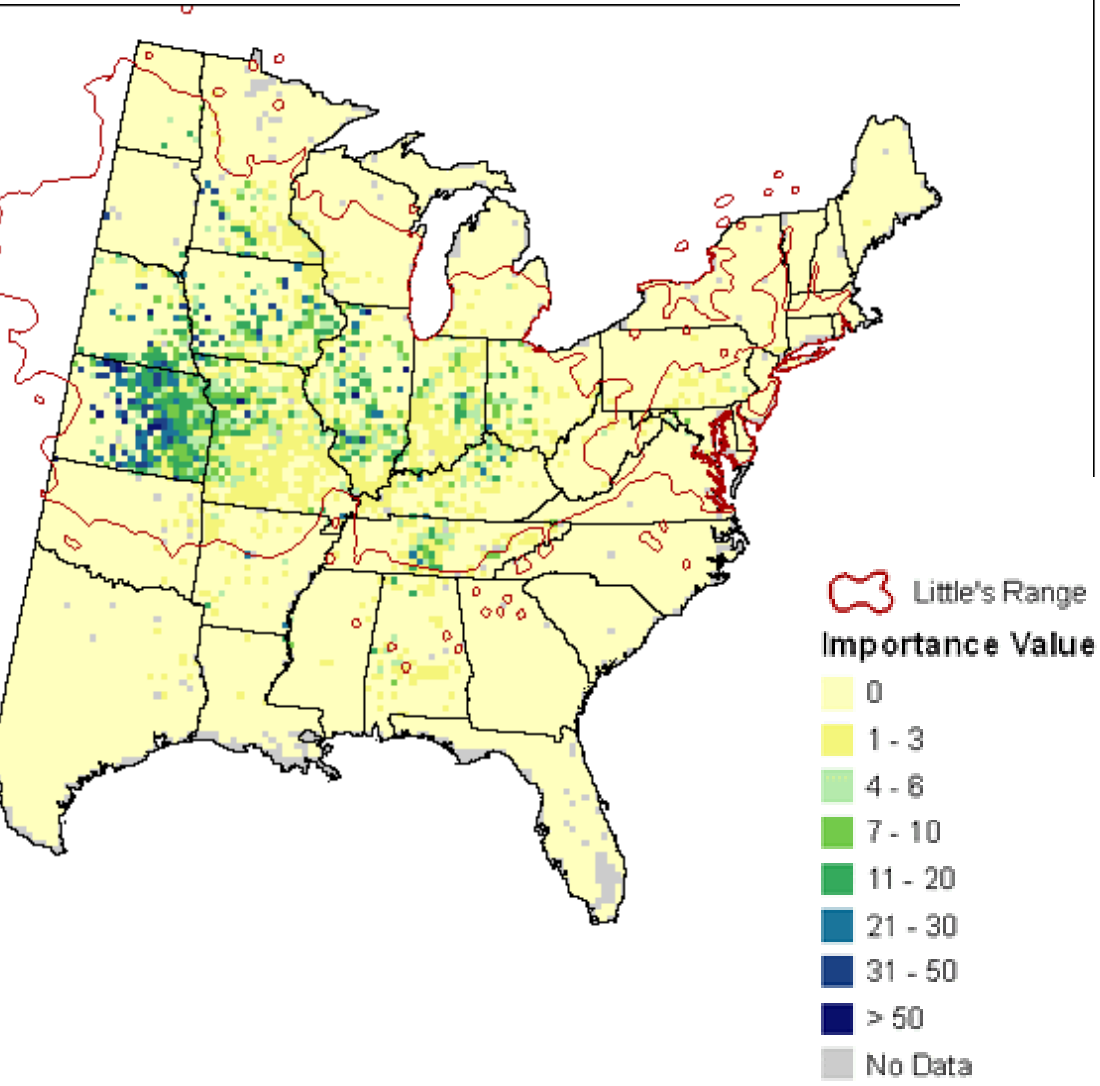
Importance Value

- 0
- 1 - 3
- 4 - 6
- 7 - 10
- 11 - 20
- 21 - 30
- 31 - 50
- > 50
- No Data

Retaining/Gaining Suitable Habitat

- Hackberry
- Bur Oak
- American elm
- Red mulberry

Hackberry


Little's Range
Importance Value
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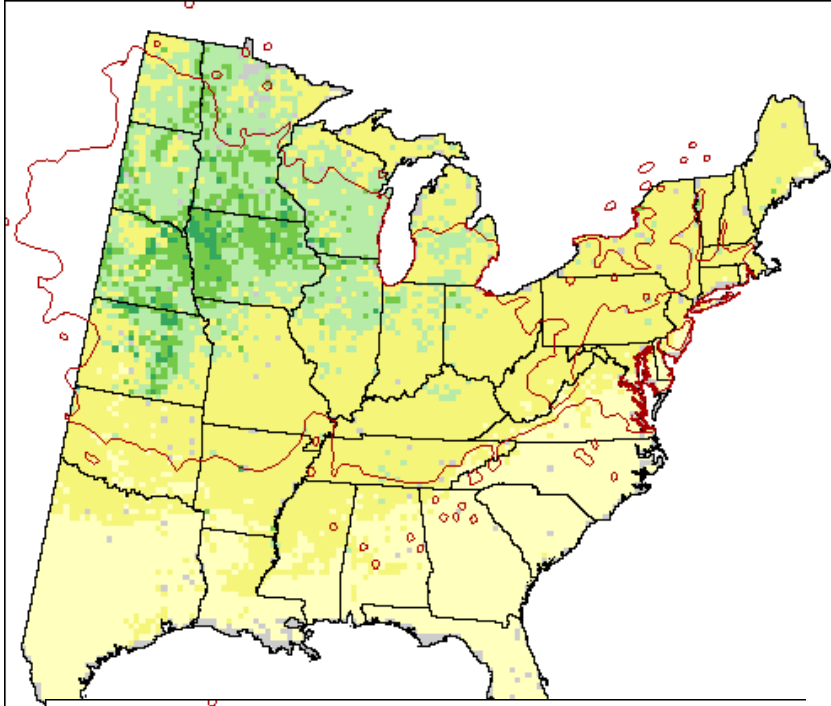
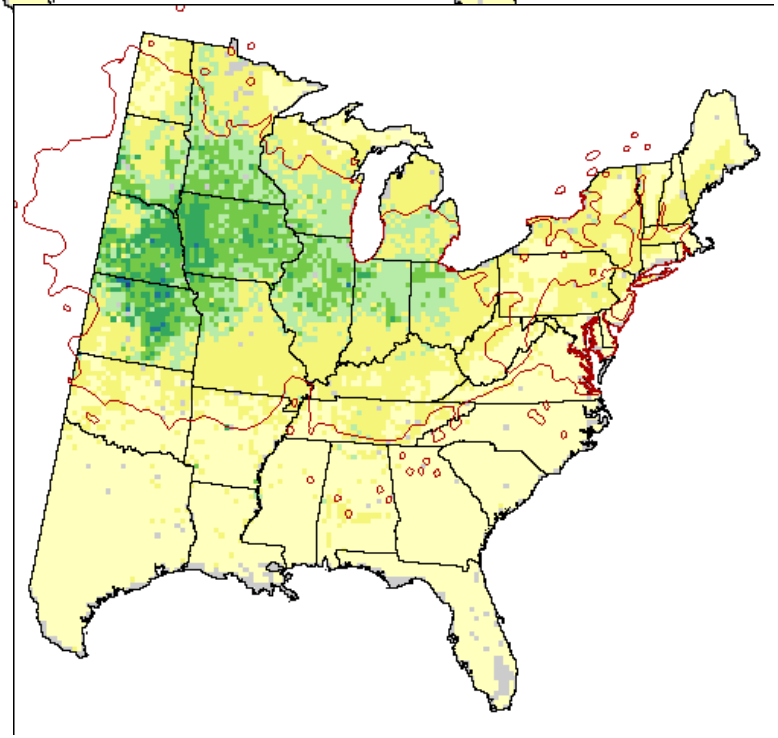
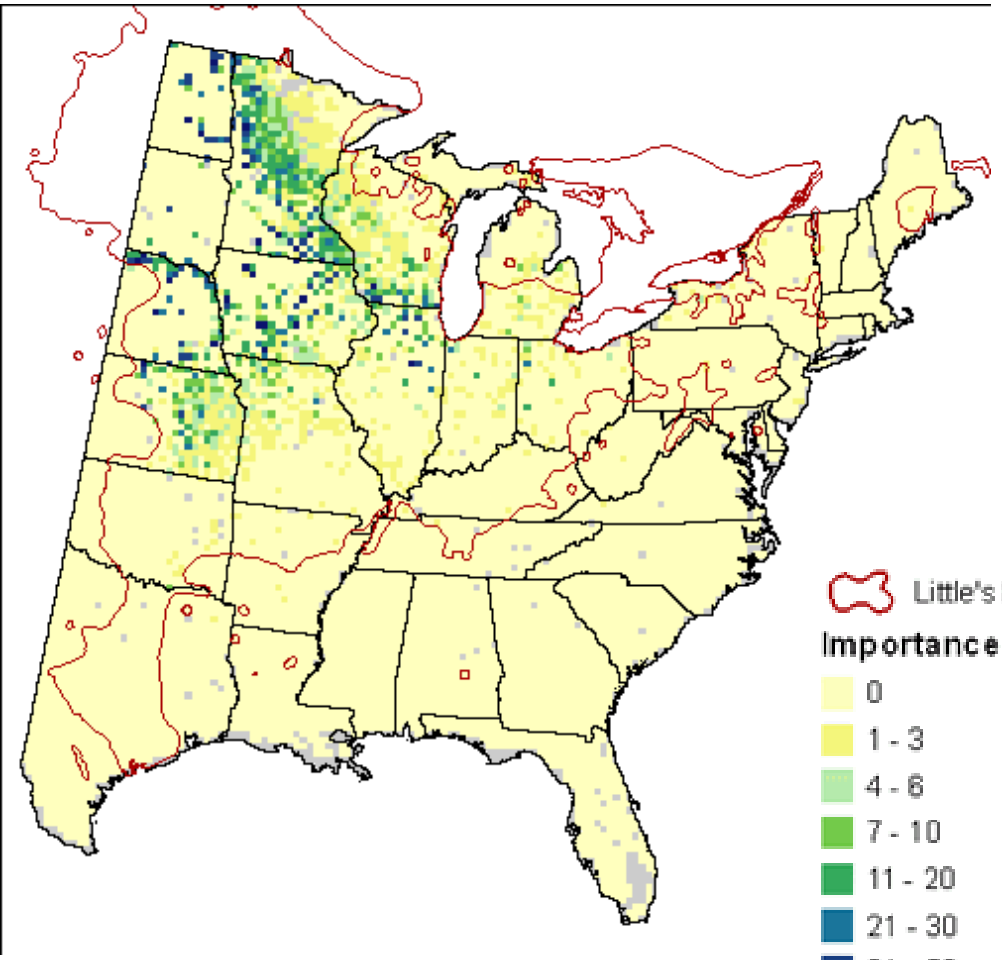
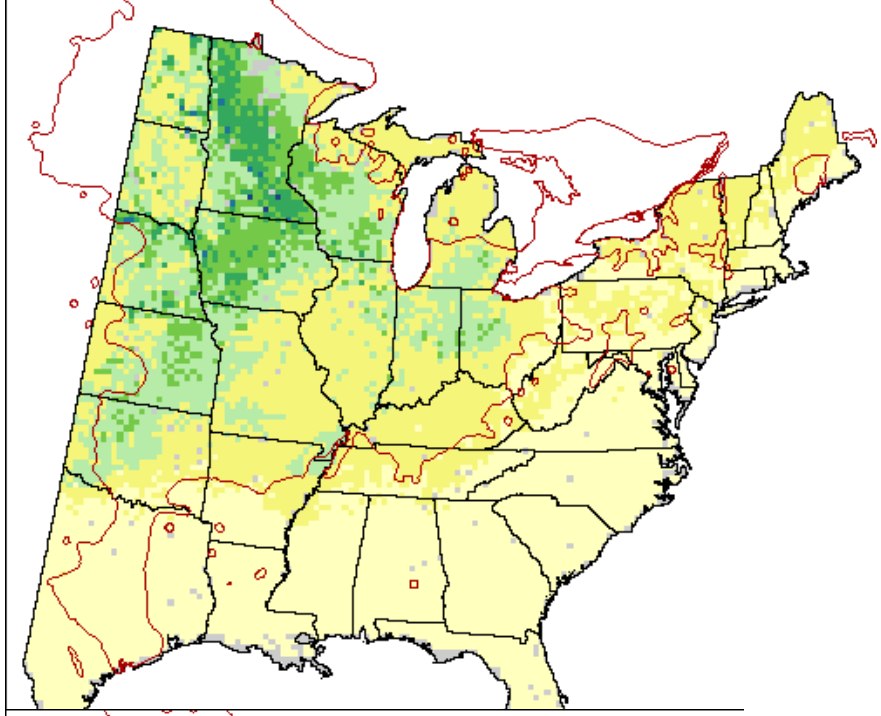
No Data

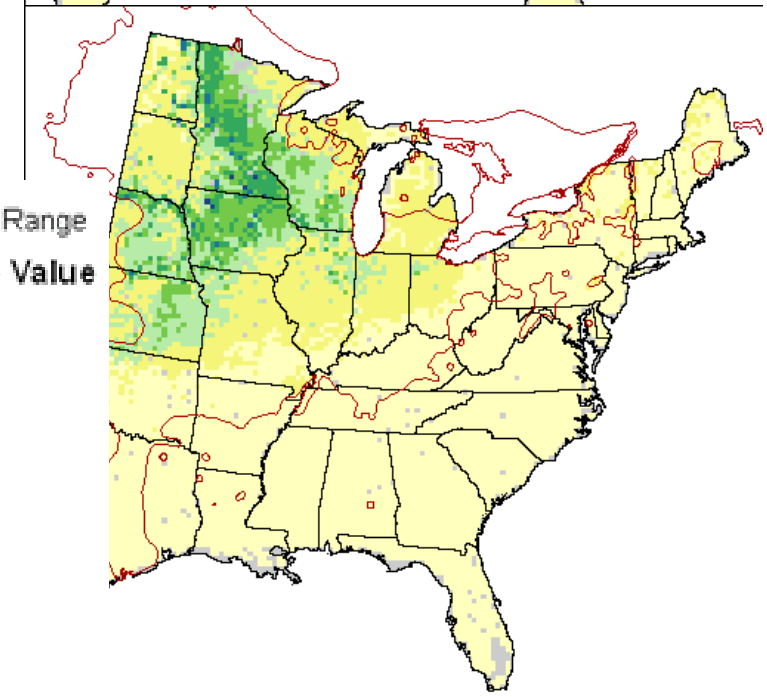




Bur Oak





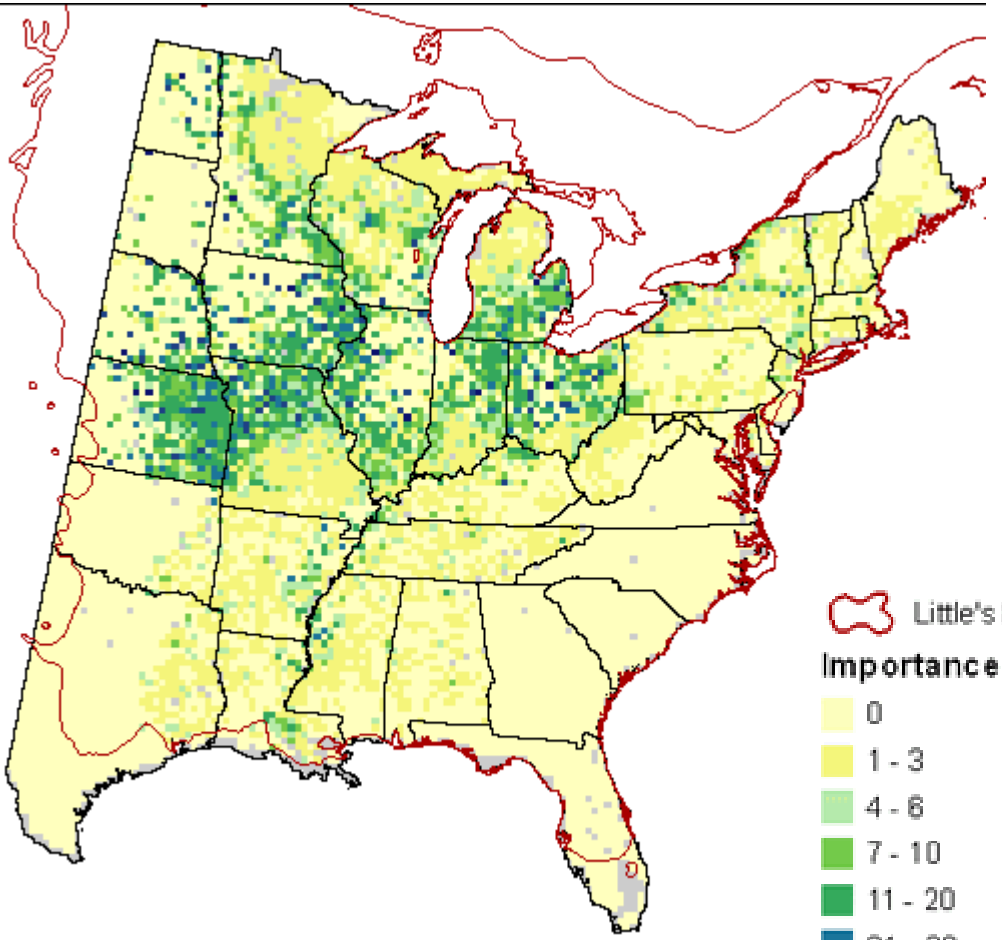


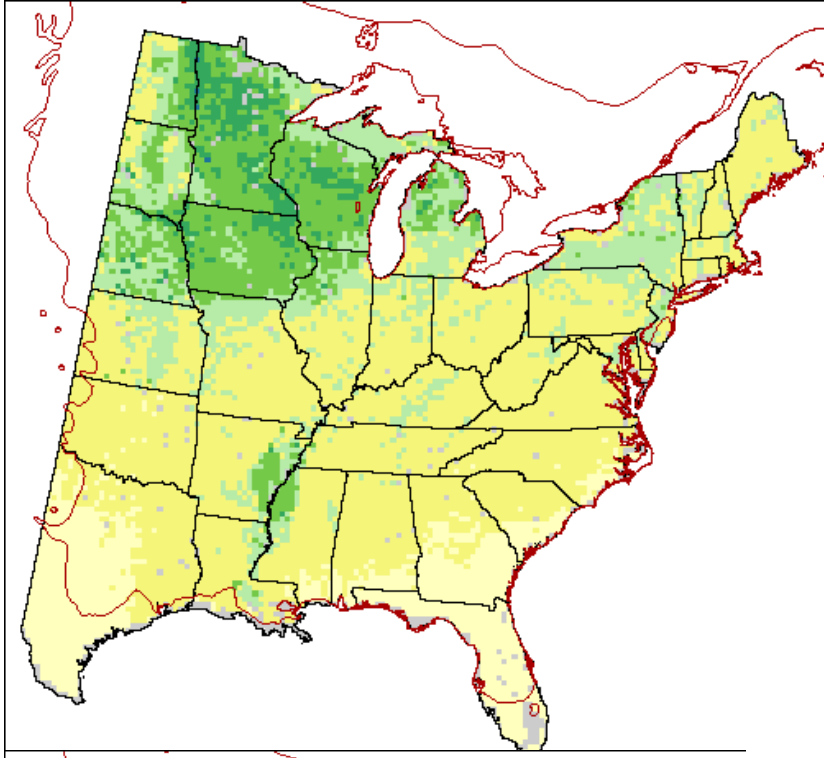
Little's Range

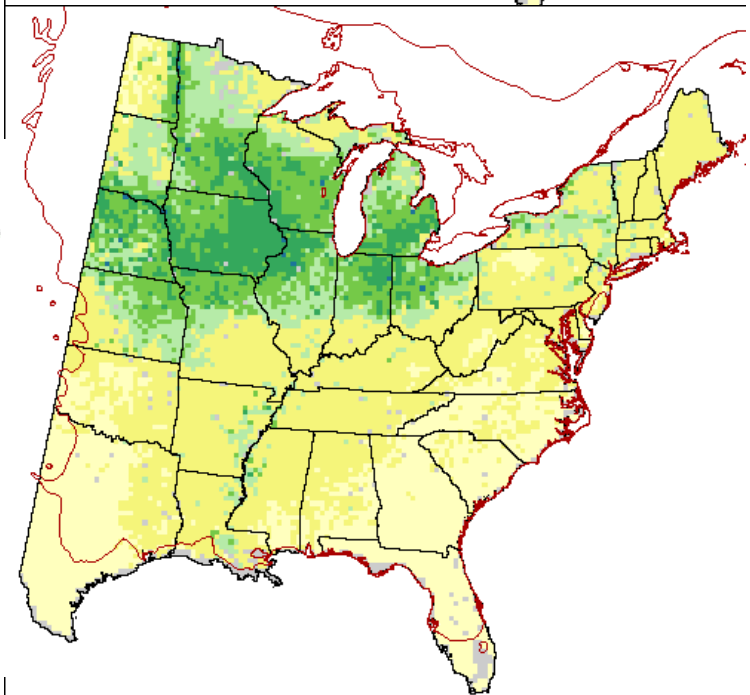
Importance Value

- 0
- 1 - 3
- 4 - 6
- 7 - 10
- 11 - 20
- 21 - 30
- 31 - 50
- > 50
- No Data

American Elm







Little's Range

Importance Value

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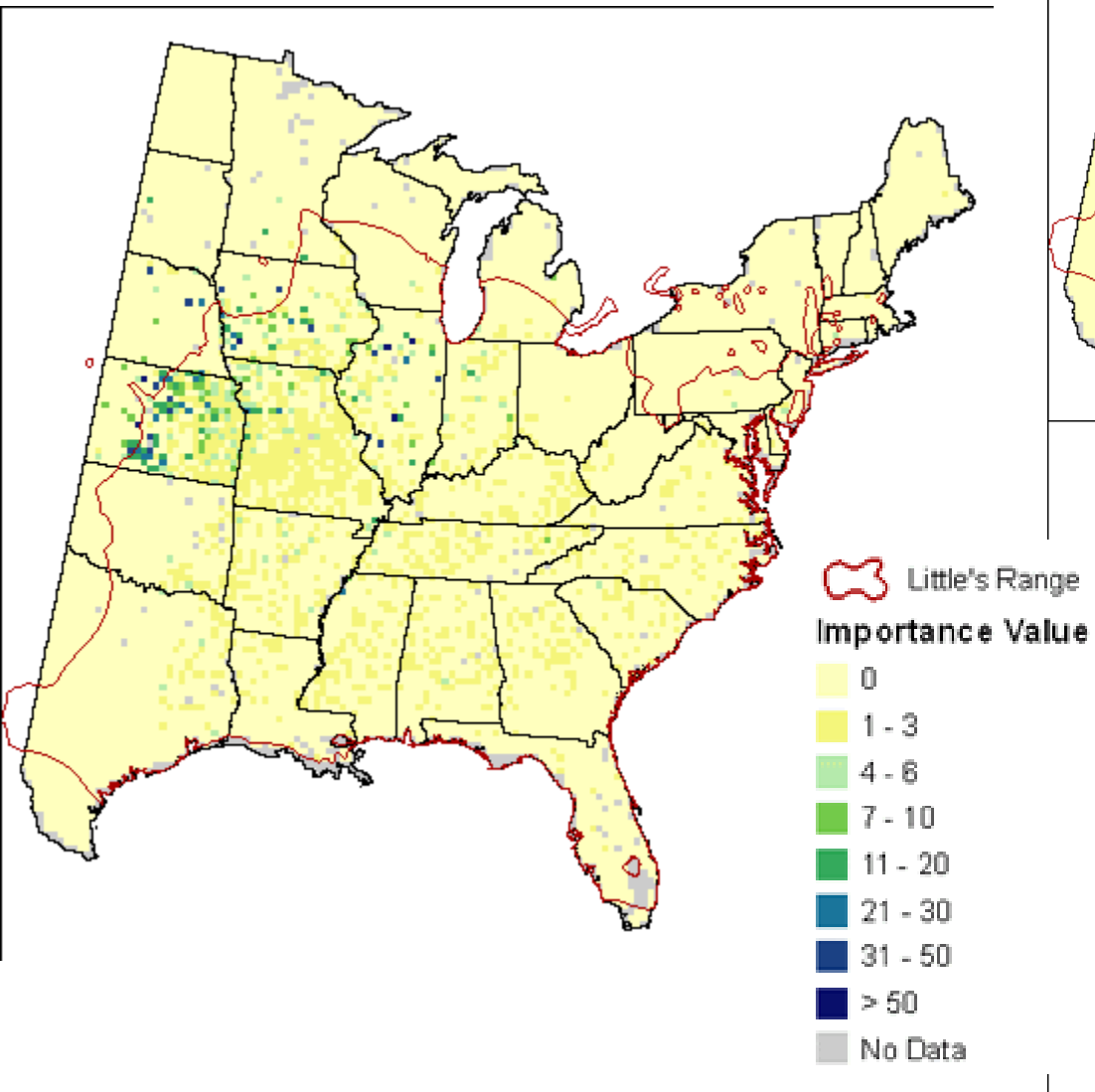
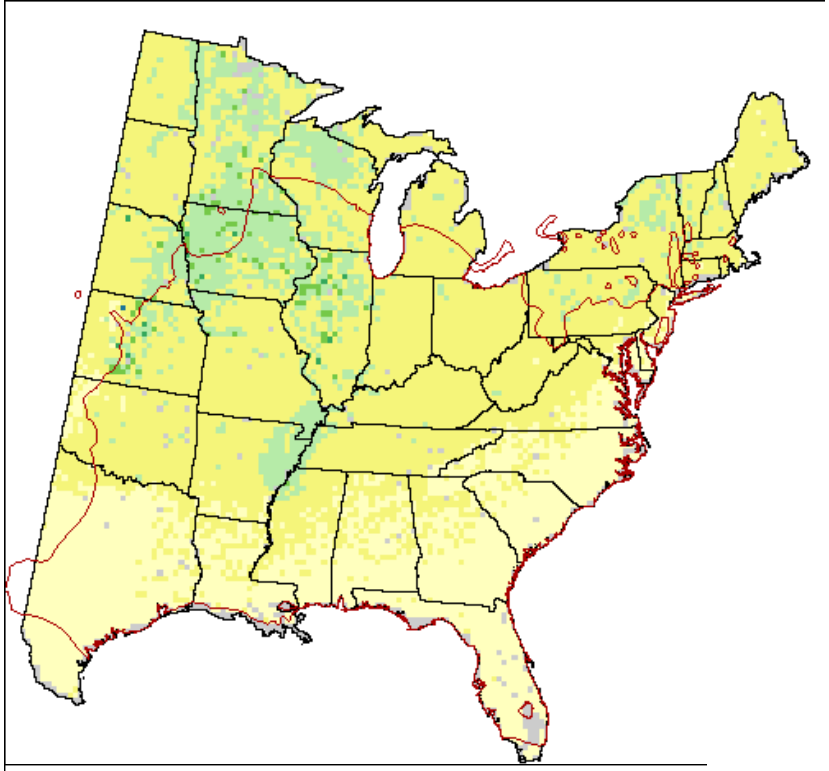
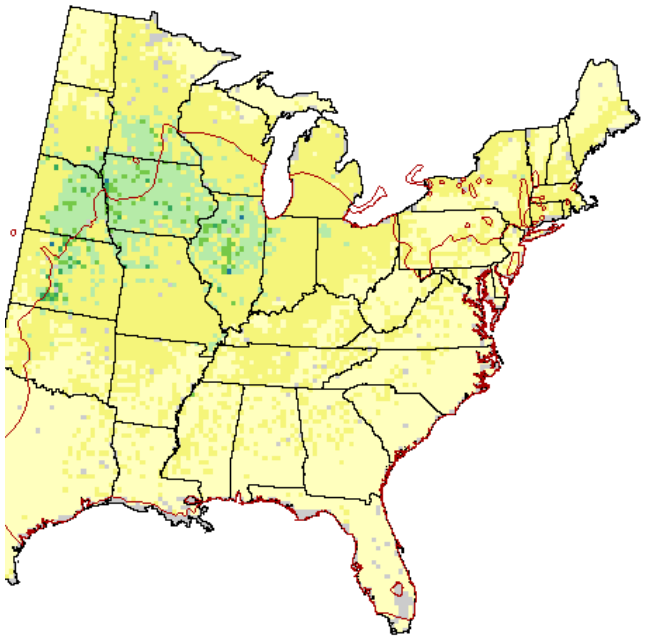
- 21 - 30
- 31 - 50
- > 50
- No Data

Red Mulberry



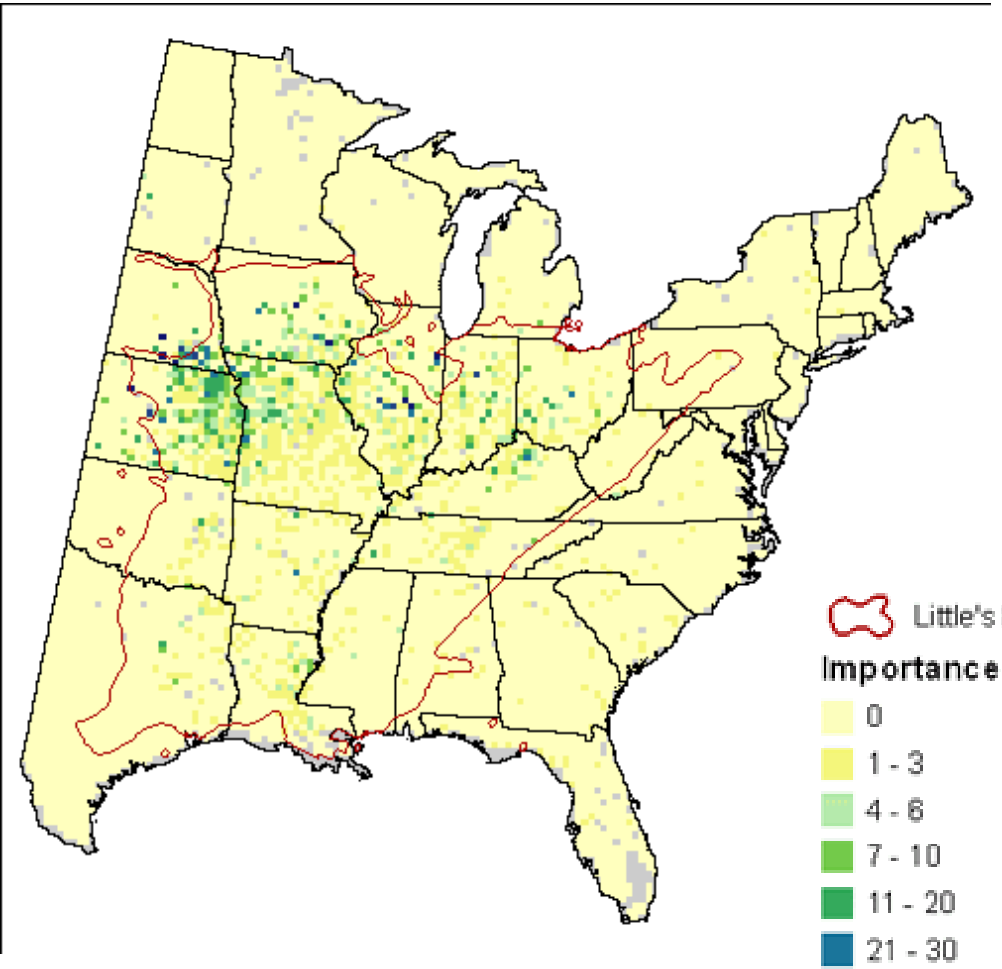


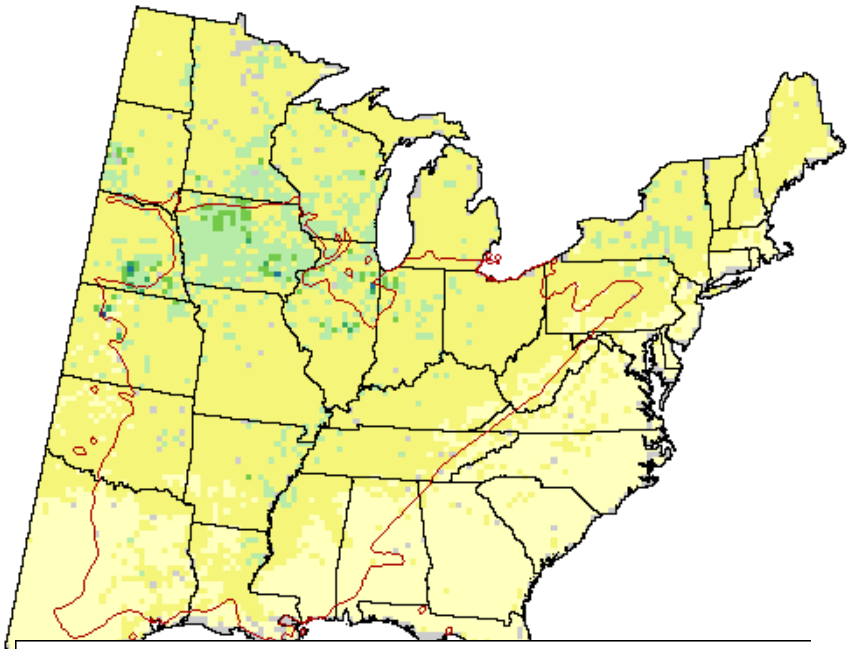


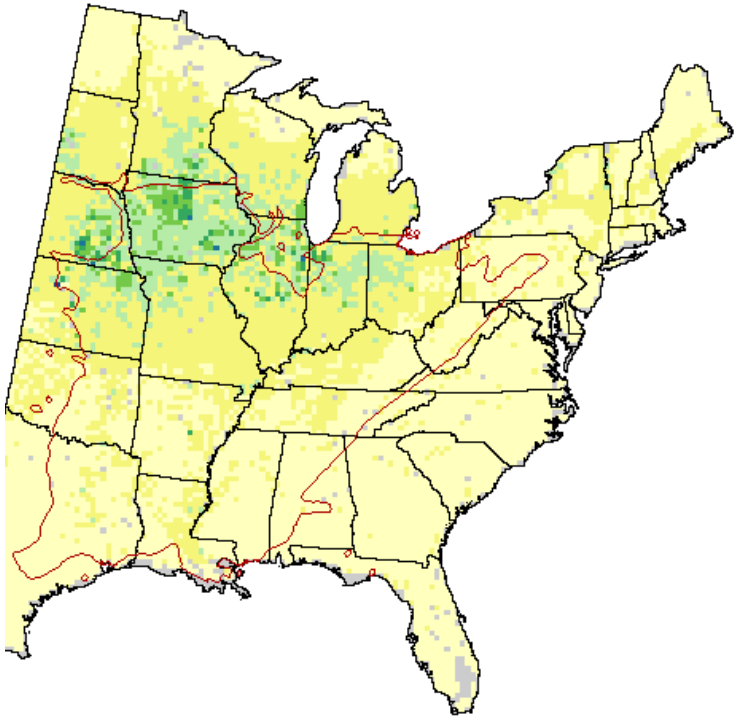
New Habitat

- Honeylocust
- Red Maple
- Sycamore
- Swamp white oak

Honeylocust







Little's Range

Importance Value

- 0
- 1 - 3
- 4 - 6
- 7 - 10
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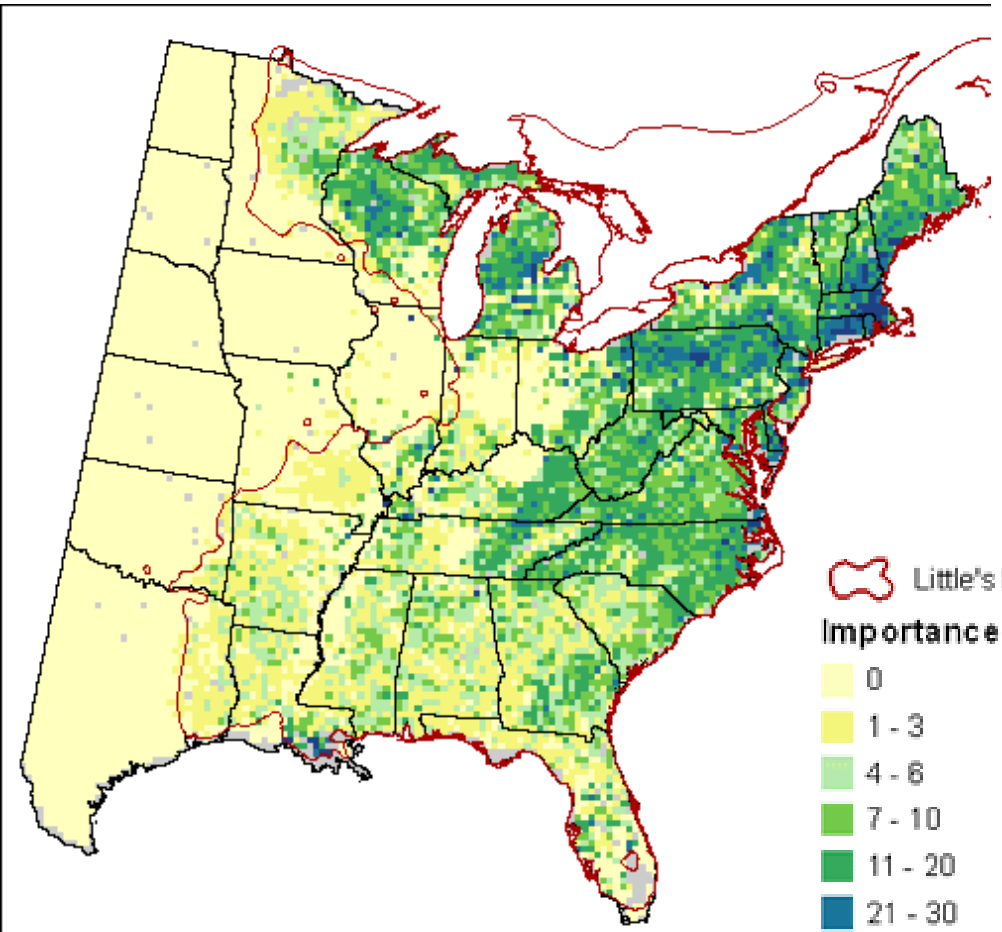
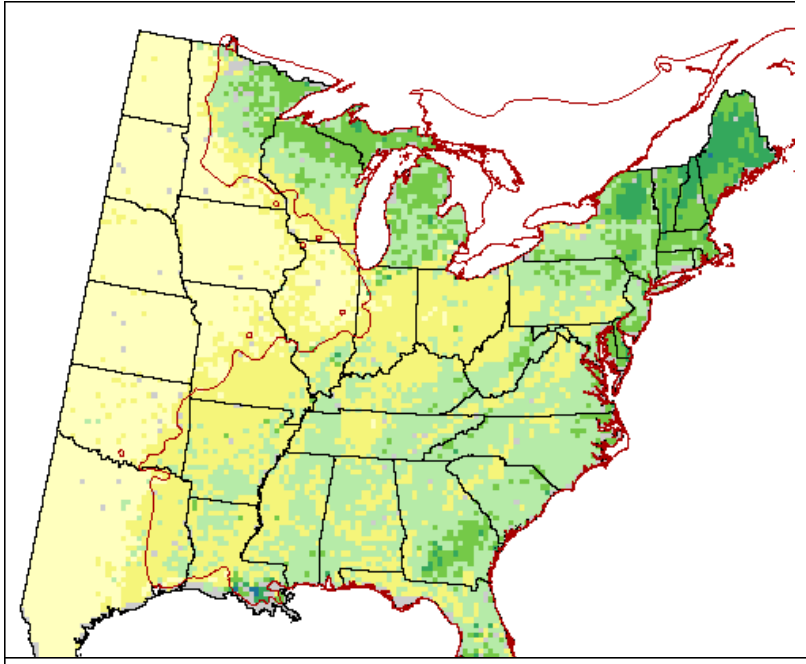
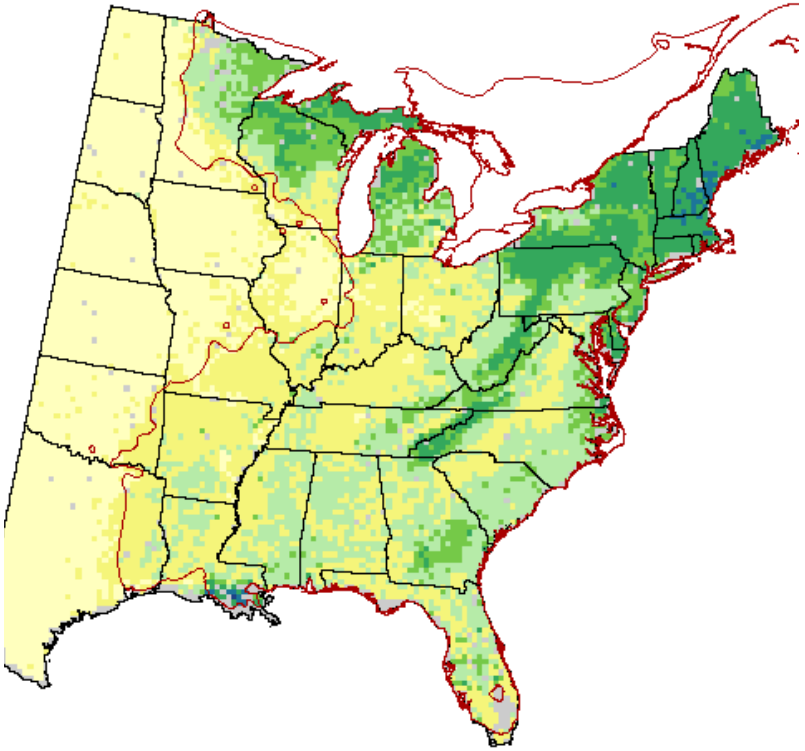
- 21 - 30
- 31 - 50
- > 50
- No Data

Low model reliability

Red Maple







Little's Range

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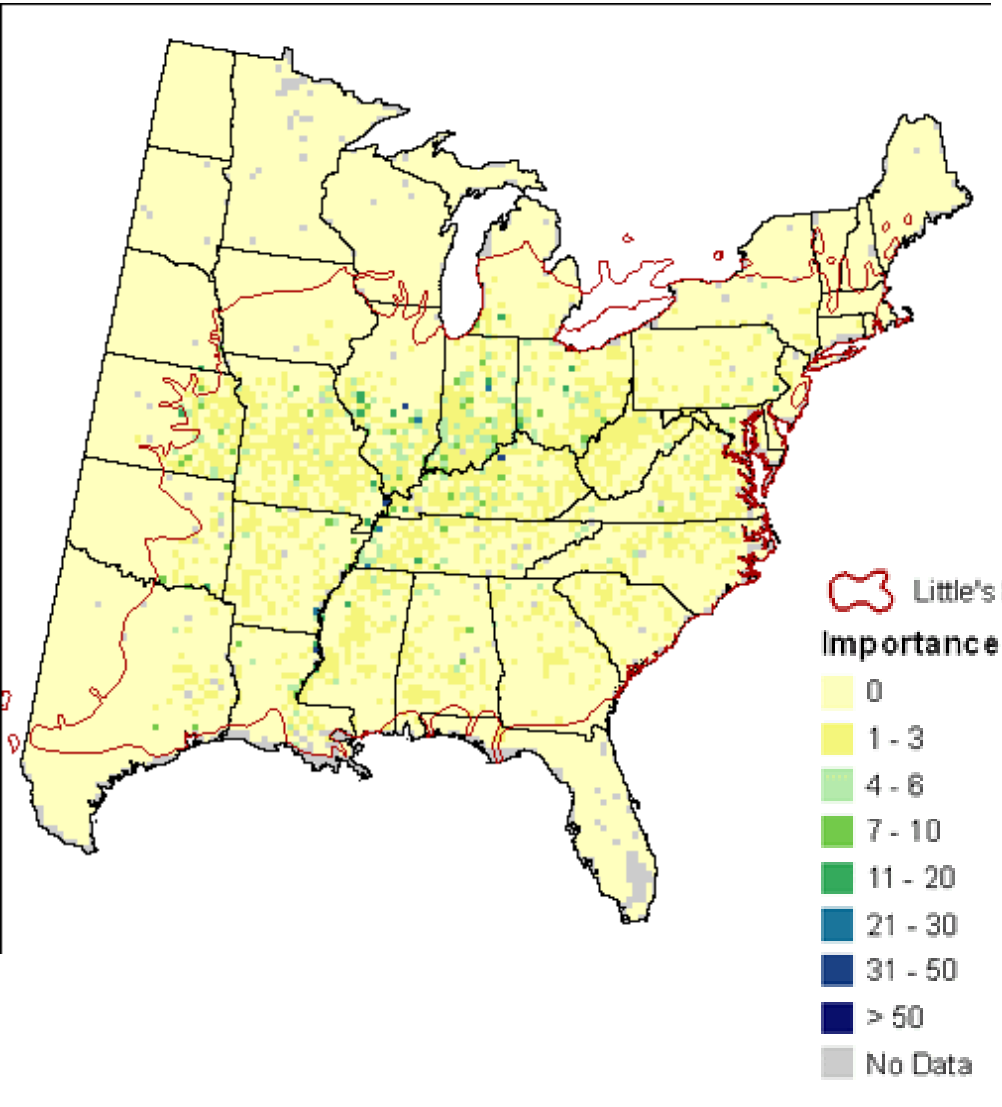
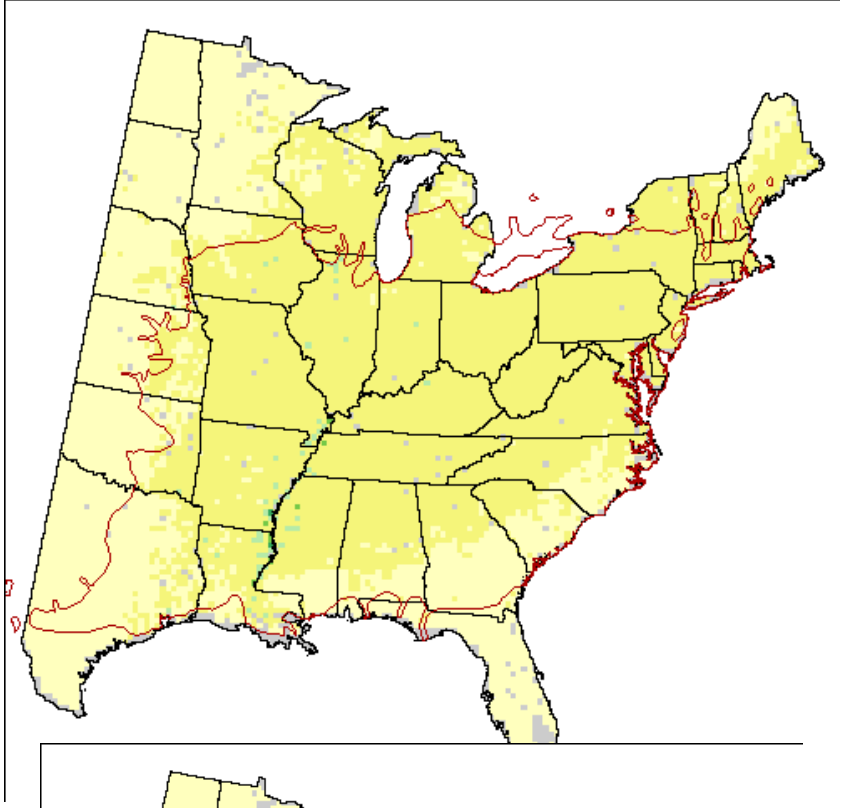
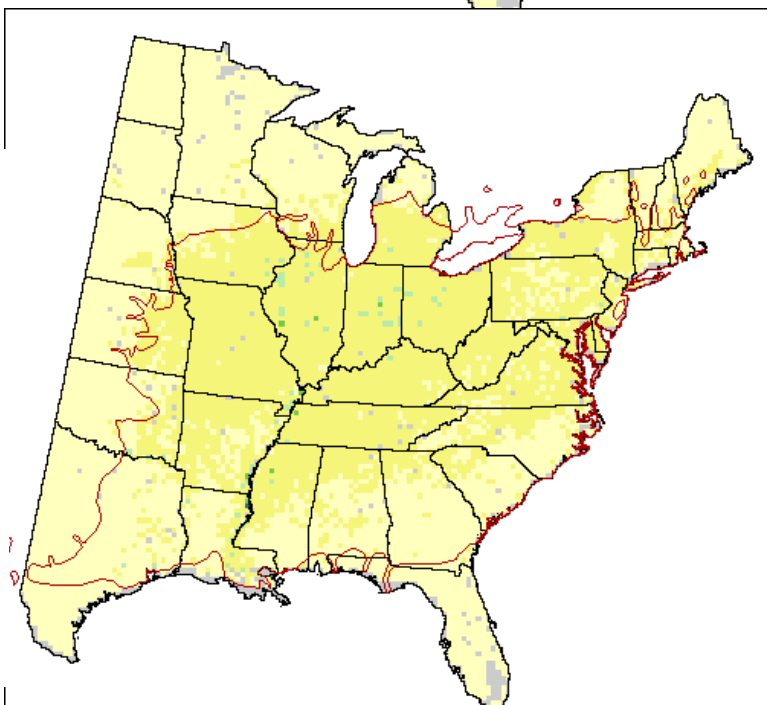
- 21 - 30
- 31 - 50
- > 50
- No Data

American Sycamore







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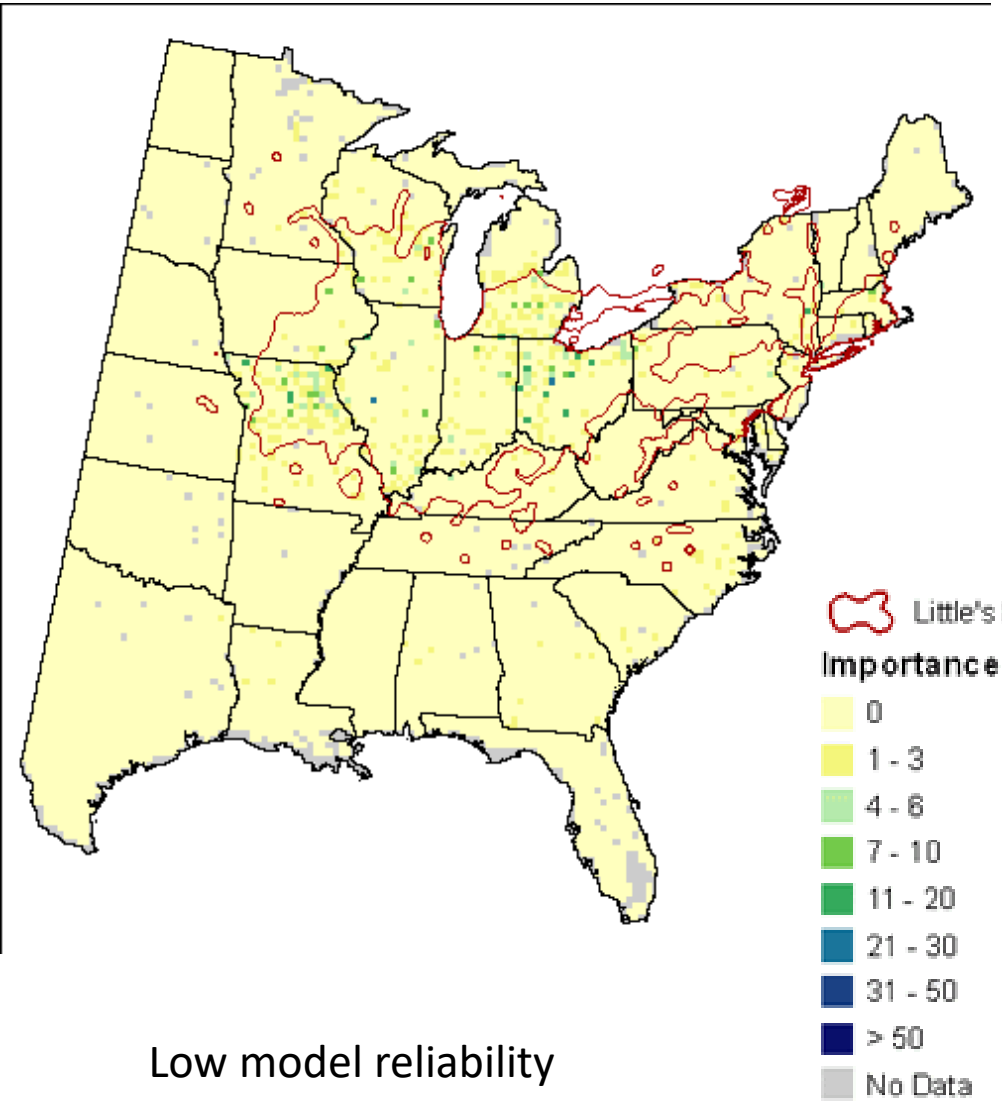
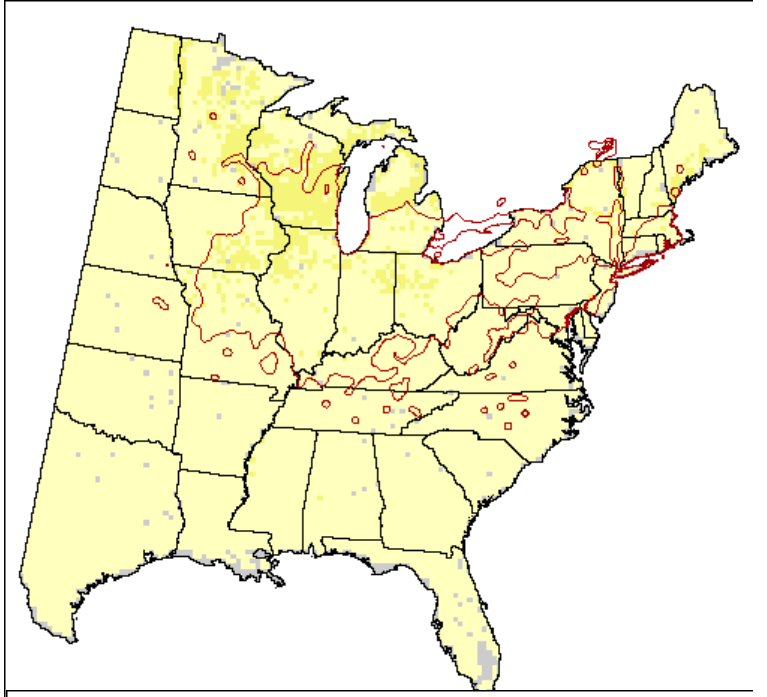
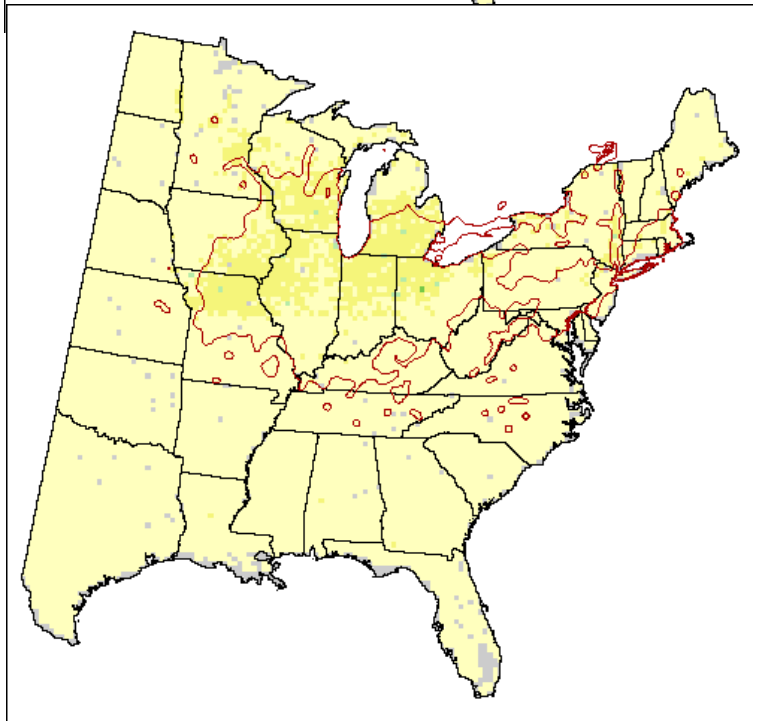
- No Data

Swamp White Oak





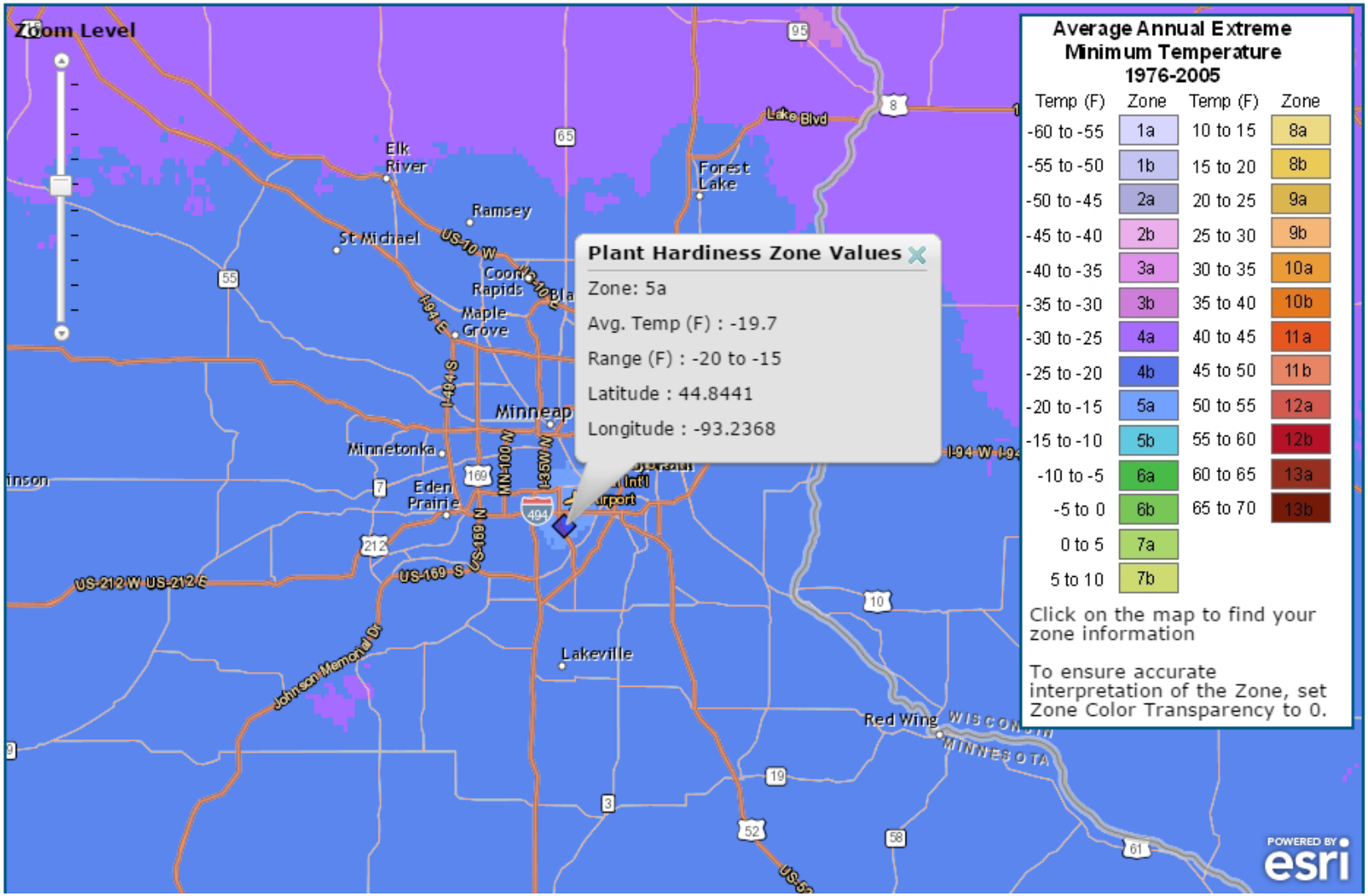


Low model reliability

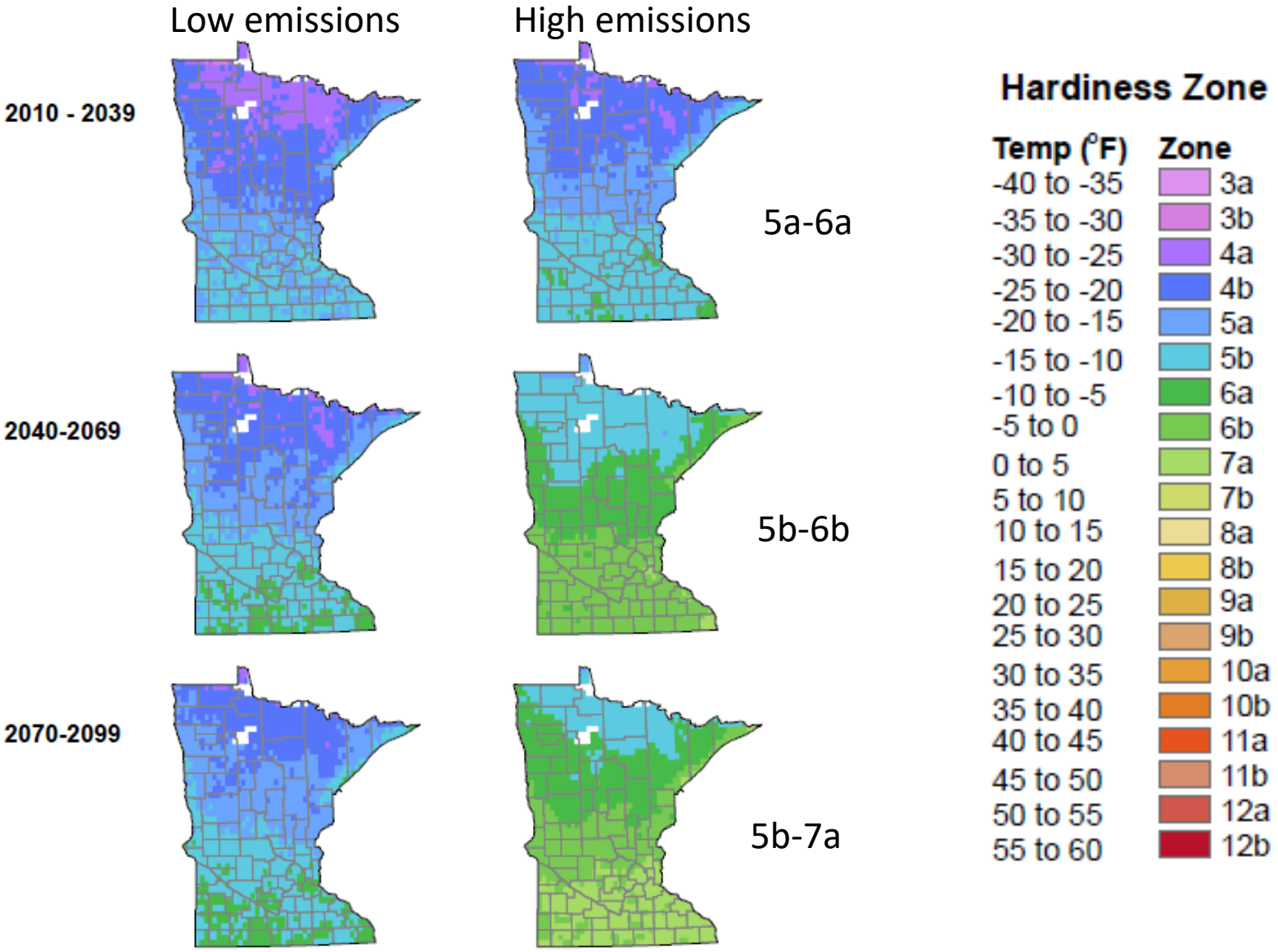
Floodplain species not modeled or out of range

	Hardiness Zone
Bald cypress	4-9
Southern Pin Oak	4-8
River Birch	4-9
Shellbark Hickory	5-8
Sweetgum	5-9
Swap Chestnut Oak	5-9
Cherrybark Oak	6-9
Pecan	6-9

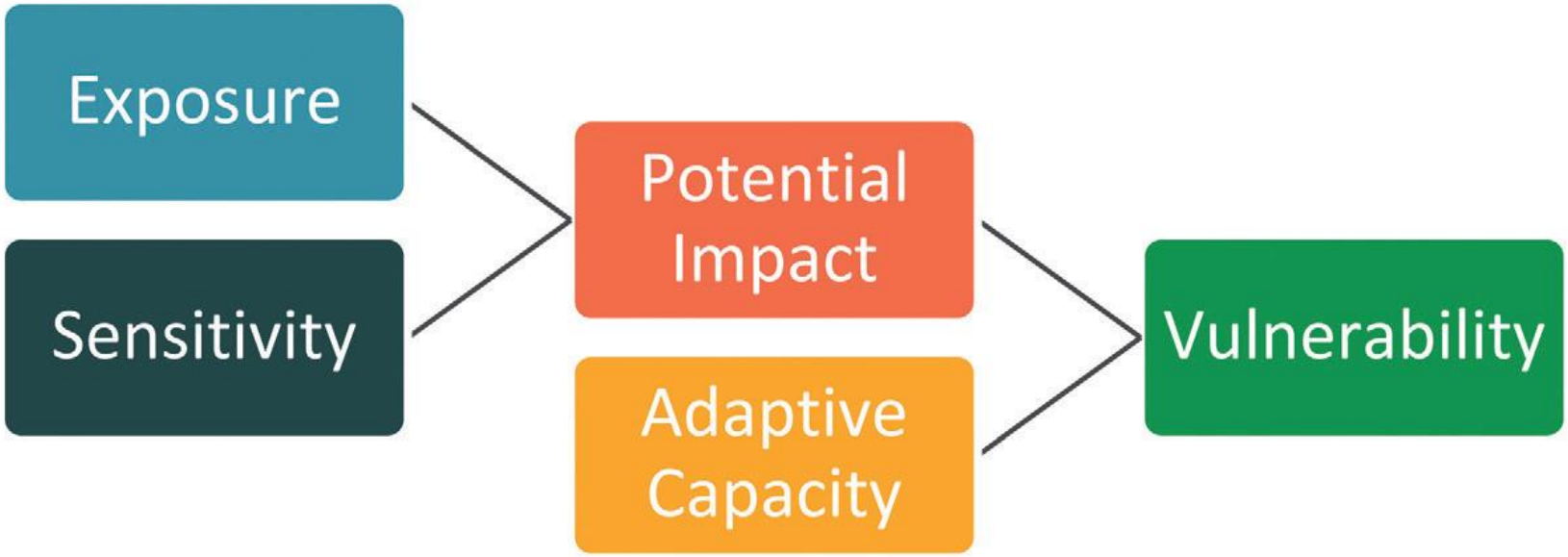
Current USDA Hardiness Zones



Hardiness Zone Projections

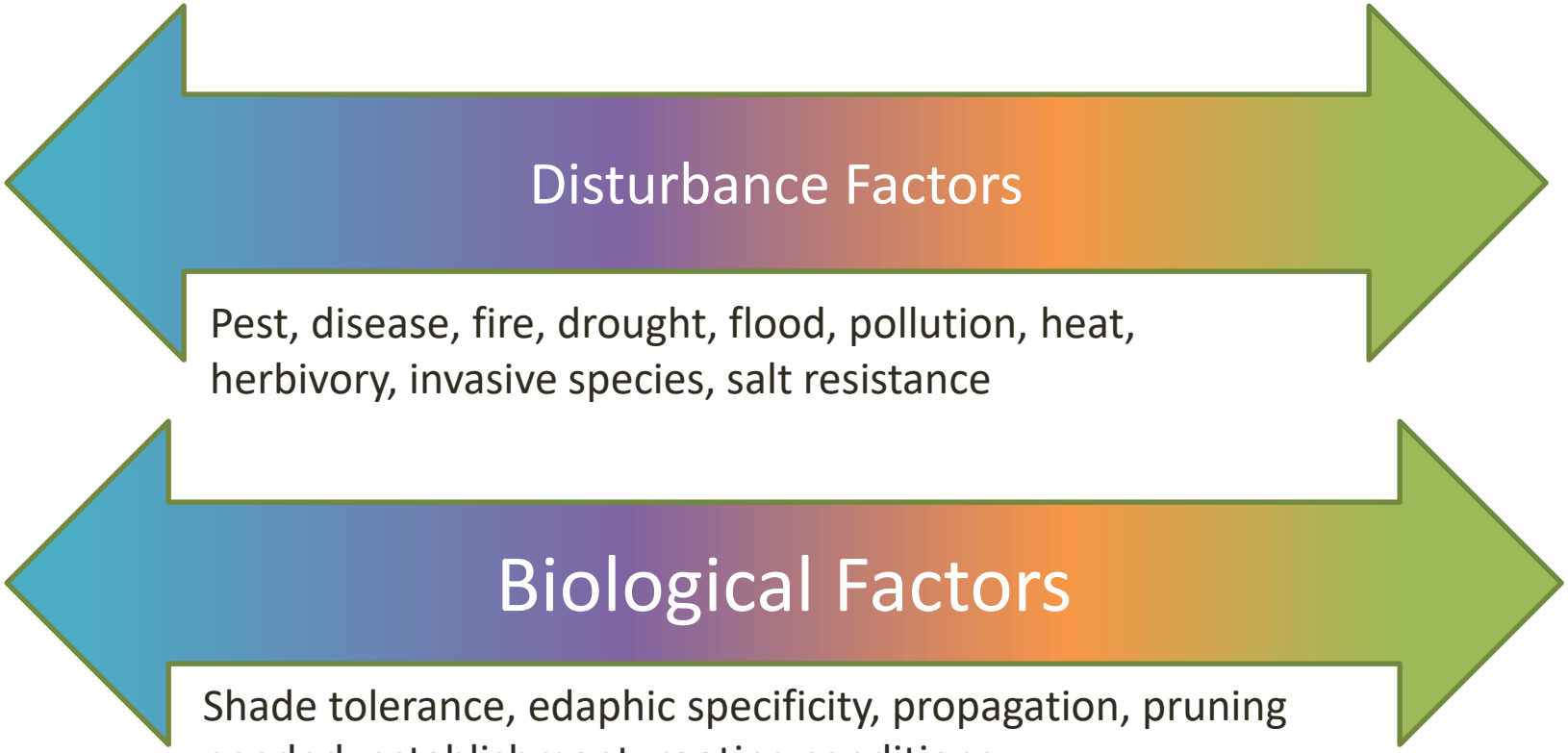


Vulnerability

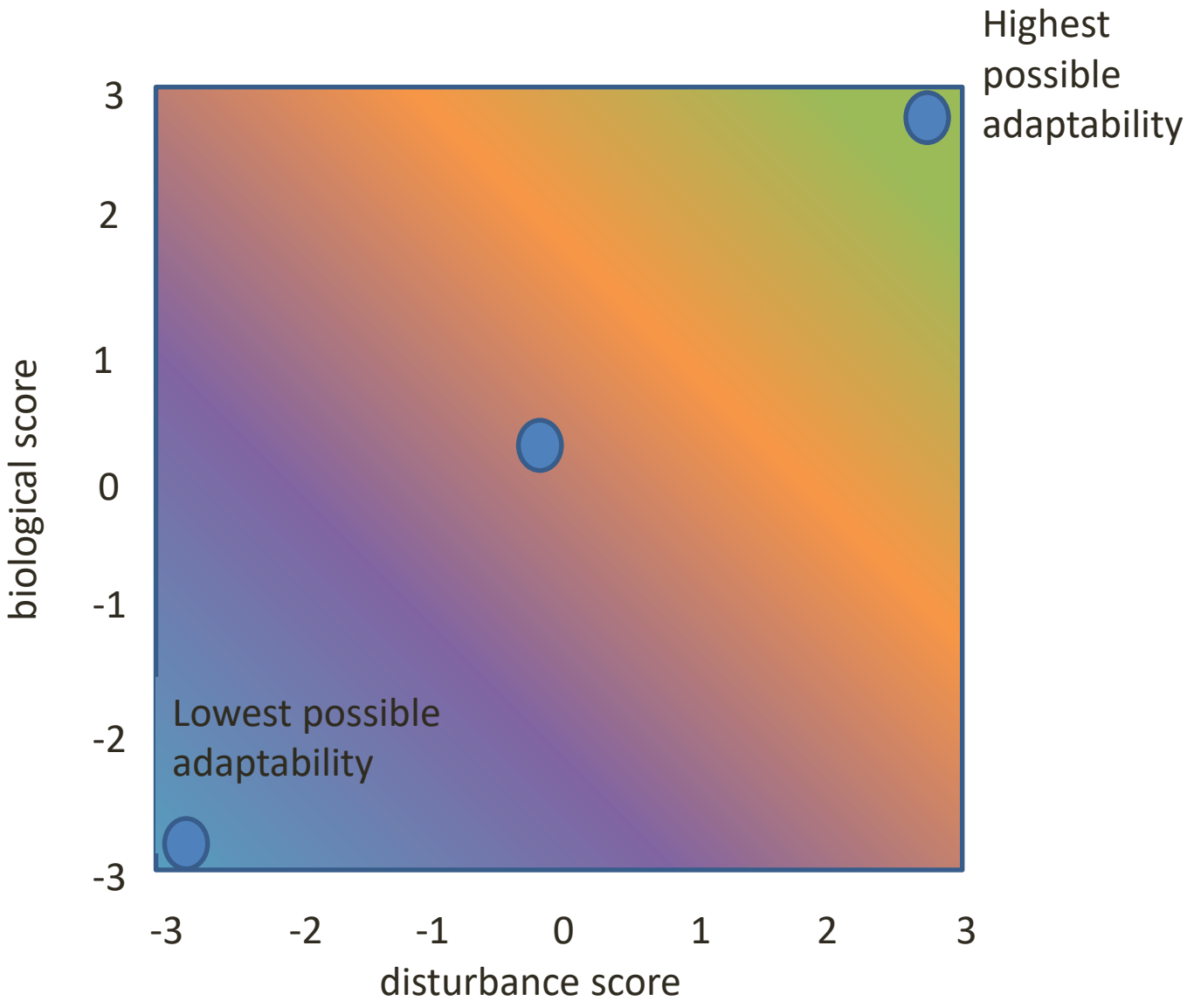


Adaptability

Matthews et al. 2011



Adaptive Capacity Score



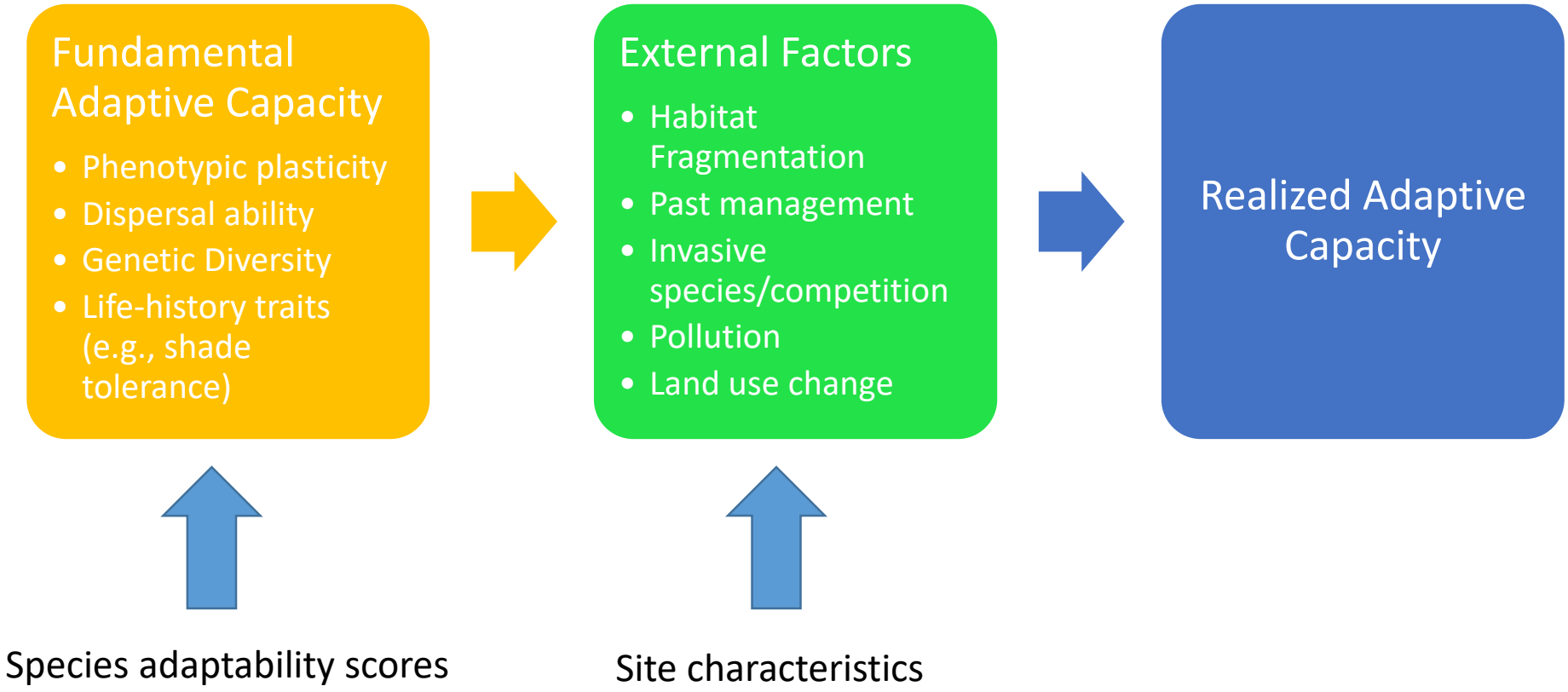
Species with High Adaptive Capacity

- boxelder
- bur oak
- hackberry
- honeylocust
- red mulberry
- silver maple
- swamp white oak
- sycamore

Species with Lower Adaptive Capacity

- black willow
- American elm
- eastern cottonwood
- green ash
- northern white-cedar
- peachleaf willow
- river birch

Fundamental vs. Realized Adaptive Capacity



From Beever et al. 2015

Key Vulnerability Factors: Floodplain Forests (from Handler et al. 2014)

Impacts:

- more variability in flood regimes
- more flooding may expand the width of the floodplain
- earlier and larger spring flood pulses
- lower summer flows
- flashier hydrological systems
- increase in erosion during heavy precipitation events

Adaptive Capacity:

- low species diversity
- dispersal-mainly downstream/south?
- dams currently in place to control flood dynamics

Key Points

- The Twin Cities are getting warmer (especially at night) and wetter (with more heavy rain events and flooding)
- Temperatures will increase even more in the future, and we may experience more drought stress in the summer.
- The climate may be more similar Omaha, Nebraska and we may shift up to a zone 5 or 6!
- Tree species that are more vulnerable:
  - Northern white cedar, black willow, ashes, non-DED resistant elms, cottonwood.
- Tree species that are less vulnerable:
  - Bur oak, honeylocust, swamp white oak, hackberry, silver maple