Mapping Soil Phosphorus Sorption Capacity in West Virginia

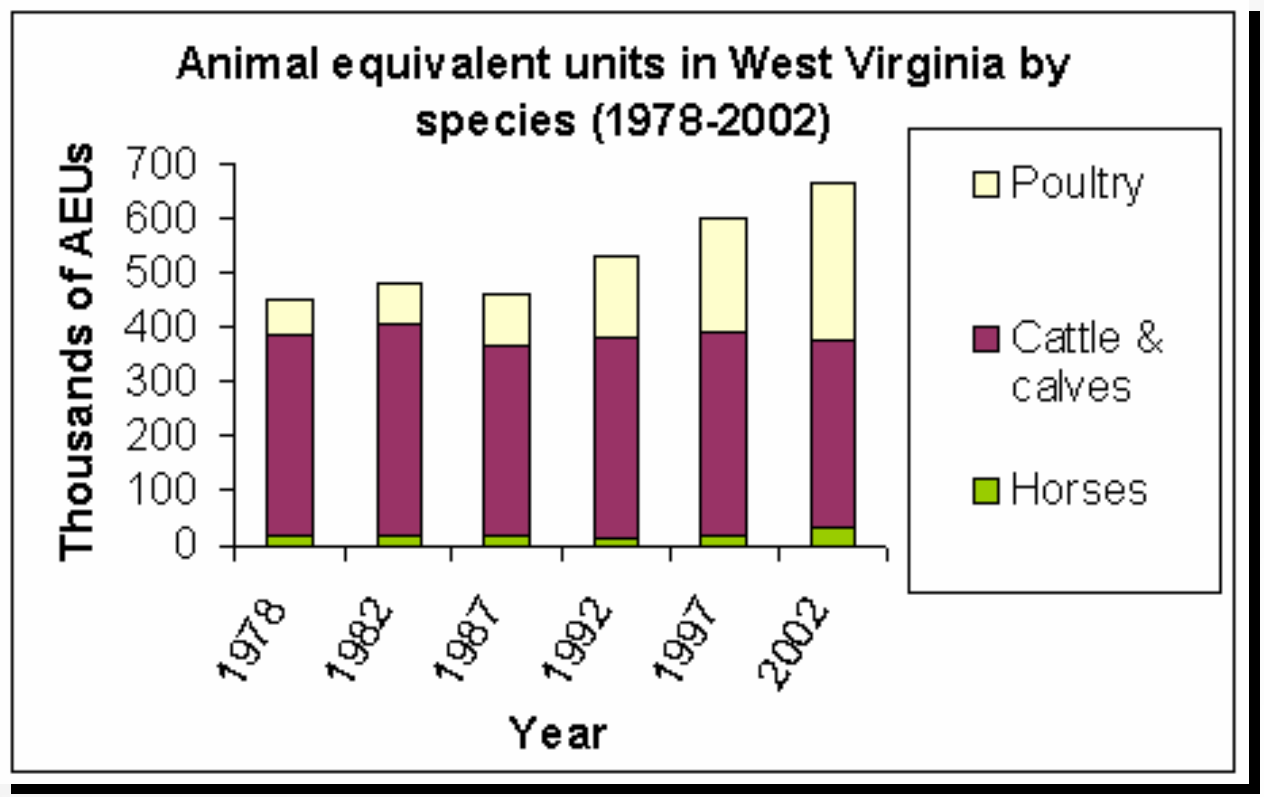
Jim Thompson, Sharon Waltman, John Sencindiver, DK Bhumbla, and Steve Carpenter

West Virginia University

NRCS Natural Resources Conservation Service

Justification

- Number of animal equivalent units has significantly increased in West Virginia



Source: Mid-Atlantic Regional Water Quality Program

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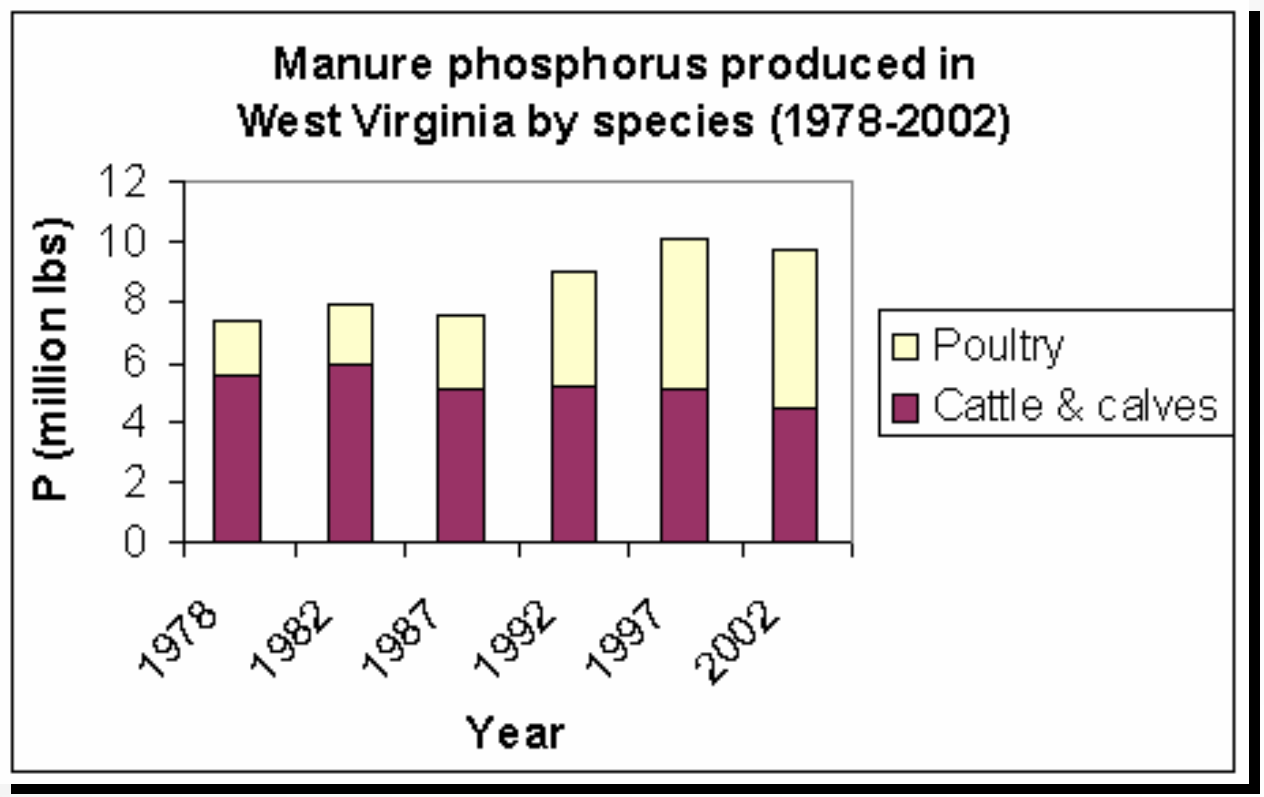
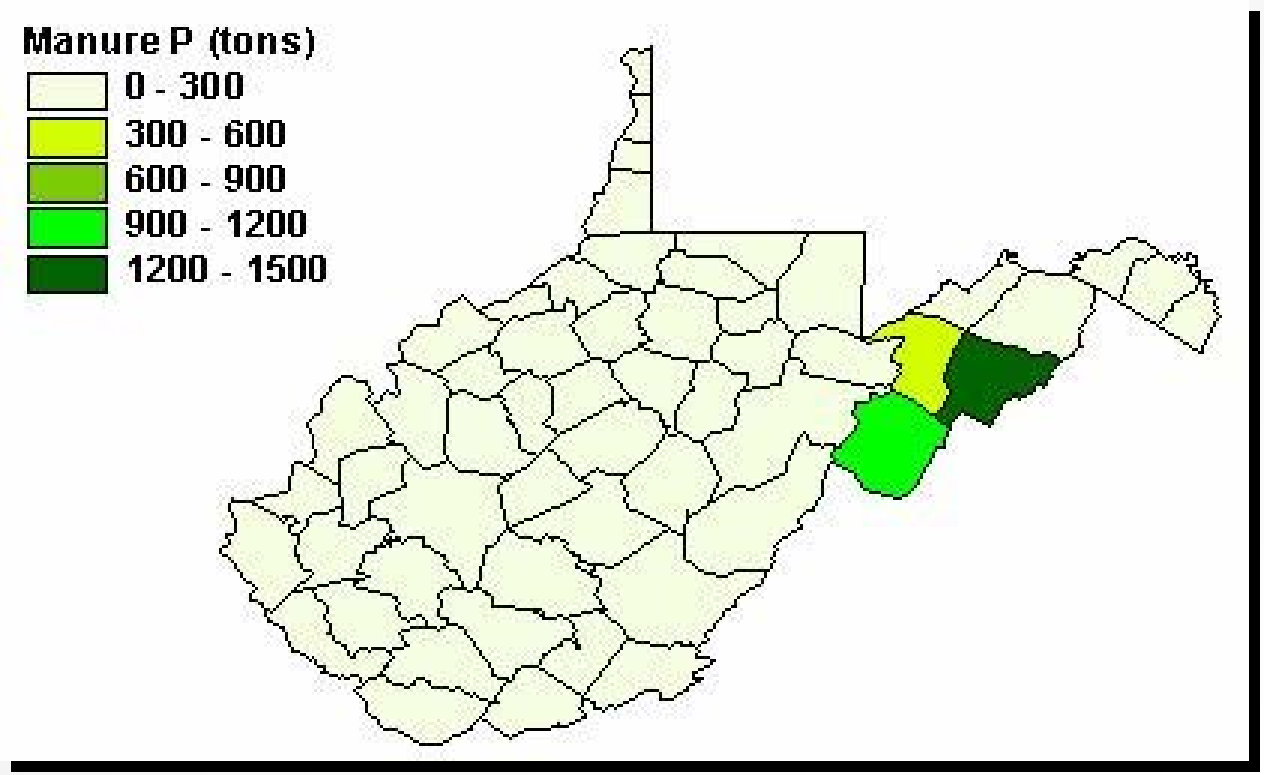


Source: Mid-Atlantic Regional Water Quality Program

Justification

- Amount of manure P produced has increased the most in West Virginia's Eastern Panhandle



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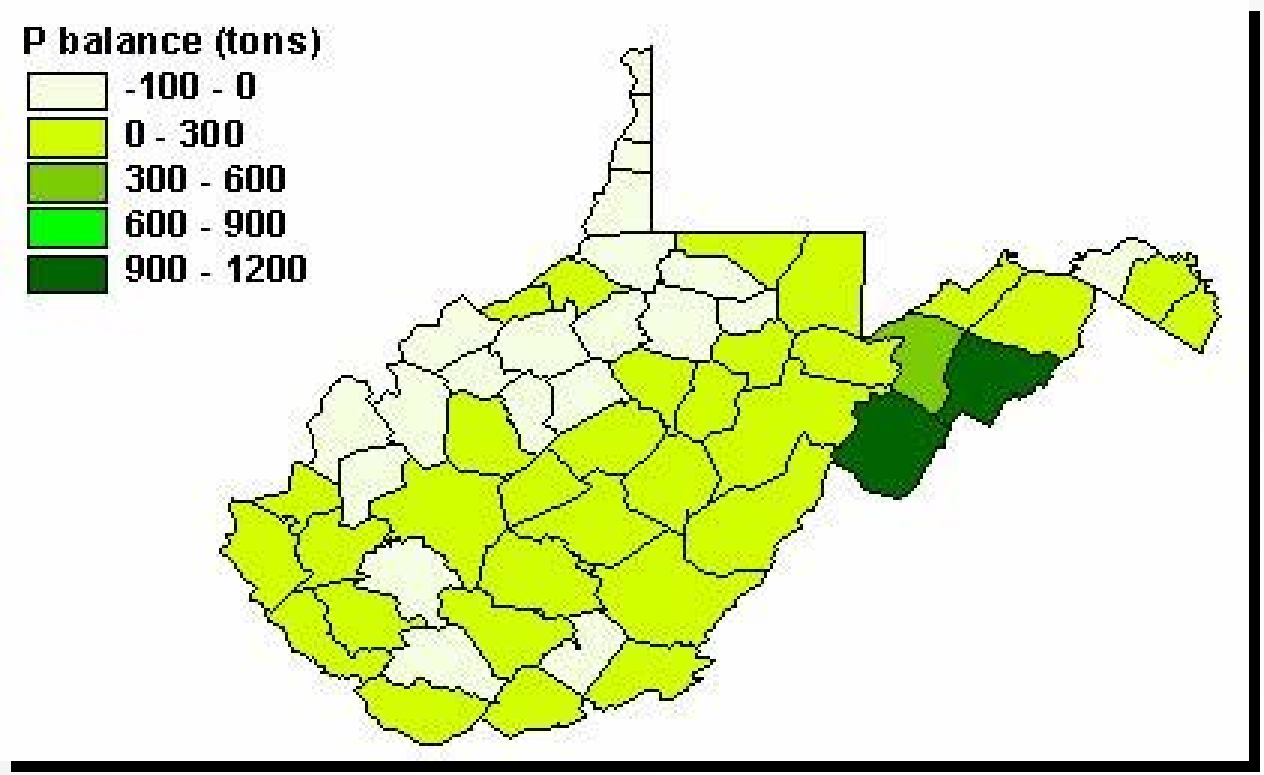
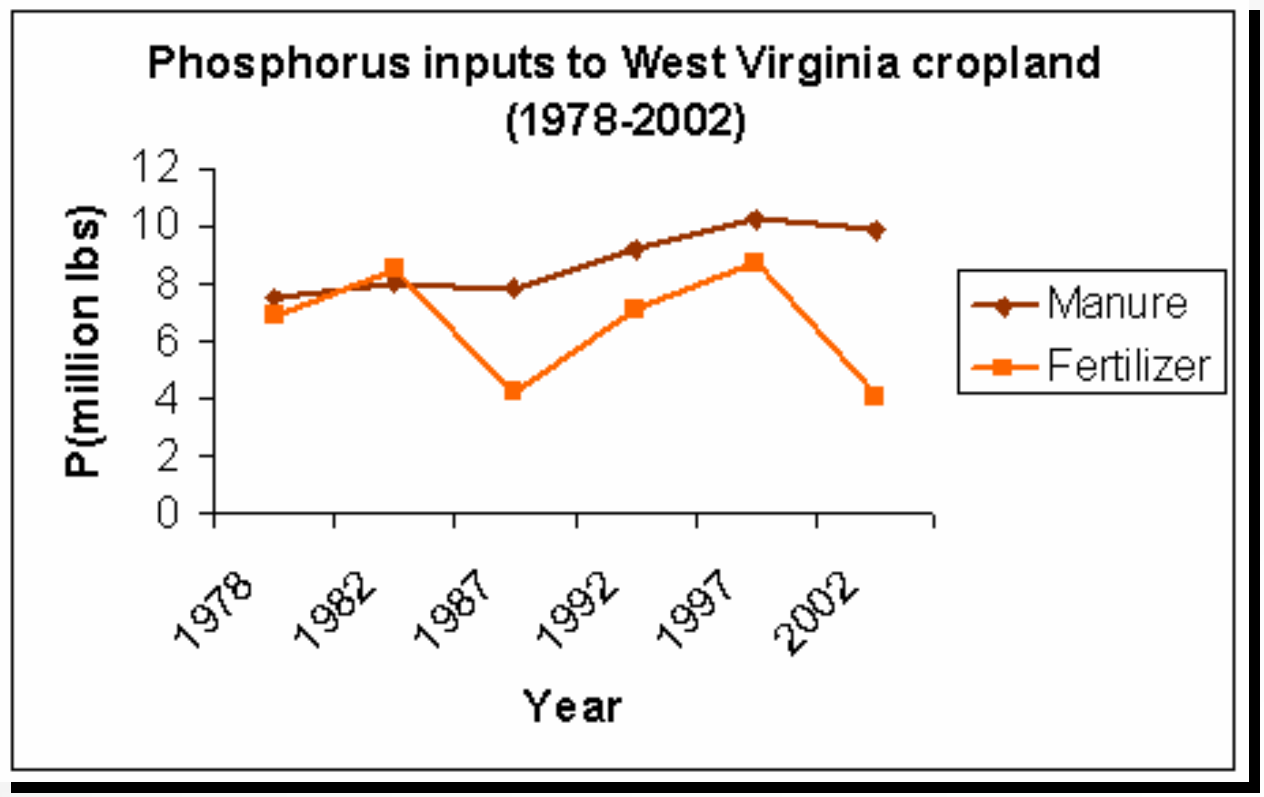


Source: Mid-Atlantic Regional Water Quality Program

Justification

- Manure now supplies more P to West Virginia crops than does inorganic fertilizer



Source: Mid-Atlantic Regional Water Quality Program

Justification

- Increases in manure production and land application have the potential to greatly influence surface water quality

- Applied P can accumulate in the soil
  - Much is retained
  - Also subject to losses by runoff, erosion, and leaching

Previous Studies

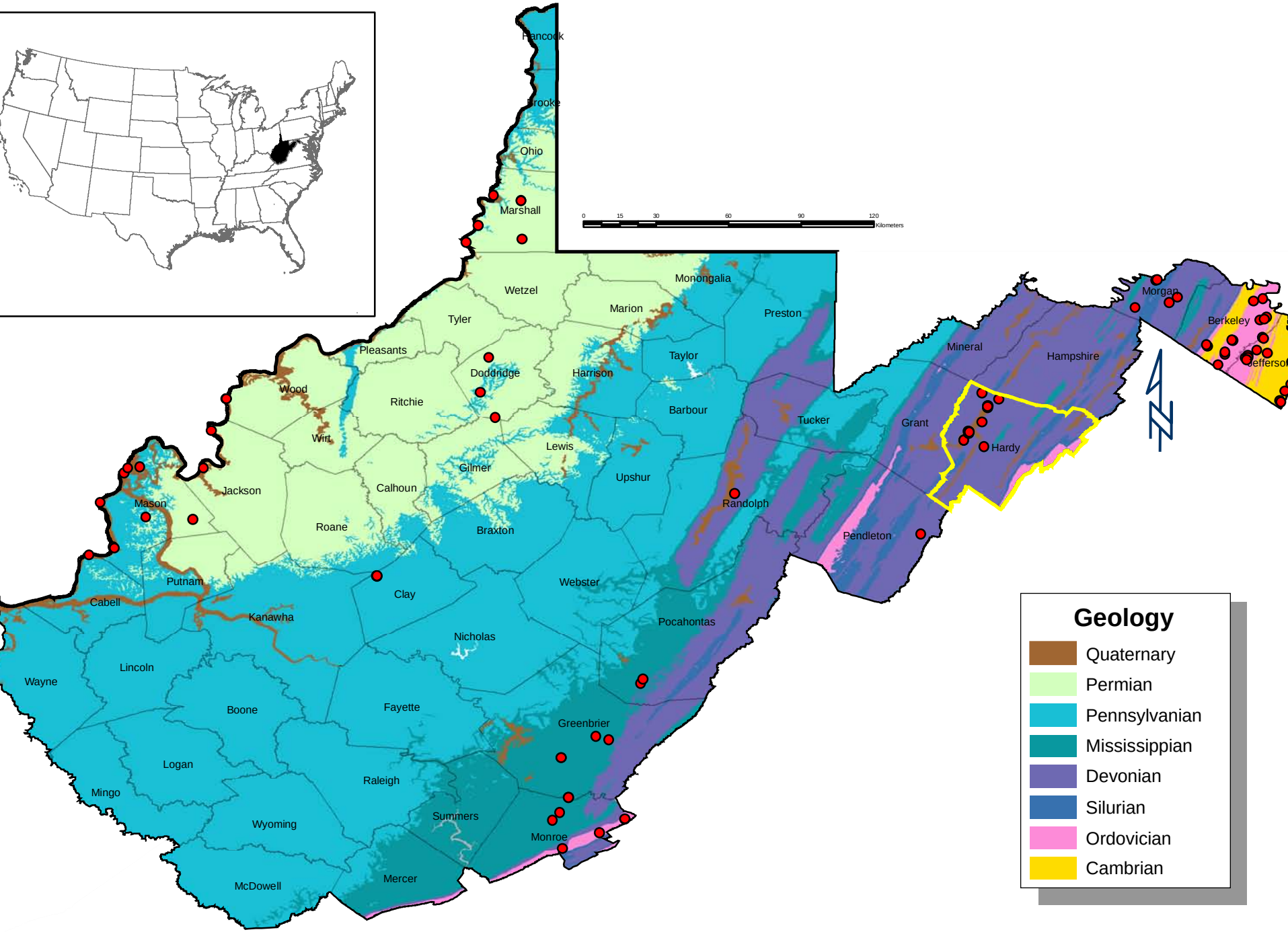
- Focused on soil types of local or regional importance
  - geographic extent or economic value
- In West Virginia, pedons throughout the agriculturally important regions of the state sampled and characterized relative to their P sorption capacity
- P sorption capacity (PSC) determined for 85 pedons from 31 soil series
  - Including 57 pedons from 17 benchmark soils

Objective

- Proper evaluation of landscape-scale P cycling and watershed-based P management requires an ability to extrapolate intensive field and laboratory data (i.e., point data) to broader landscapes (i.e., map units).
- Our objective was to use previously collected data on West Virginia soils to develop county-wide and state-wide maps of P sorption capacity.

Soil PSC Data

- 85 pedons were described, sampled, and characterized
  - Extractable Fe, Al, and Mn
  - Extractable acidity and pH
  - Exchangeable Ca
  - Carbon content
  - Texture and bulk density
- From multiple land uses
  - cropland (14%)
  - forest land (42%)
  - pasture/hayland (44%)


Hancock
Brooke
Ohio
Marshall
Wetzel
Monongalia
Marion
Preston
Tyler
Pleasants
Taylor
Doddridge
Harrison
Wood
Ritchie
Barbour
Tucker
Wirt
Lewis
Gilmer
Upshur
Jackson
Calhoun
Mason
Randolph
Roane
Braxton
Pendleton
Putnam
Clay
Webster
Cabell
Kanawha
Pocahontas
Nicholas
Lincoln
Wayne
Boone
Fayette
Greenbrier
Logan
Raleigh
Mingo
Summers
Wyoming
Monroe
Mercer
McDowell
Morgan
Berkeley
Mineral
Hampshire
Grant
Hardy
0 15 30 60 90 120
Kilometers
Geology
Quaternary
Permian
Pennsylvanian
Mississippian
Devonian
Silurian
Ordovician
Cambrian

Soil PSC Data

- PSC (mg P/kg soil) for each genetic horizon was determined
  - Incubate 0.5 g soil for 18 hours with 30 mL of 0.01M $CaCl_2$ solution containing a series of P concentrations (Sekhon, 2002)

- Principle component regression used to develop pedotransfer functions that relate P adsorption capacity to physical and chemical characterization data
  - r^2 values range from 0.50 to 0.94

Soil PSC Data

- PSC (kg P/m^2 soil) of each horizon was calculated using
  - PSC of each sample
  - bulk density (BD)
  - horizon thickness (T)
  - rock fragment correction factor (RFCF)
    - 1 – percent rock fragments
  - unit conversion factor (UCF):

$$PSC_{(kg/m^2)} = PSC_{(mg/kg\ soil)} \times BD \times T \times RFCF \times UCF$$

Soil PSC Data

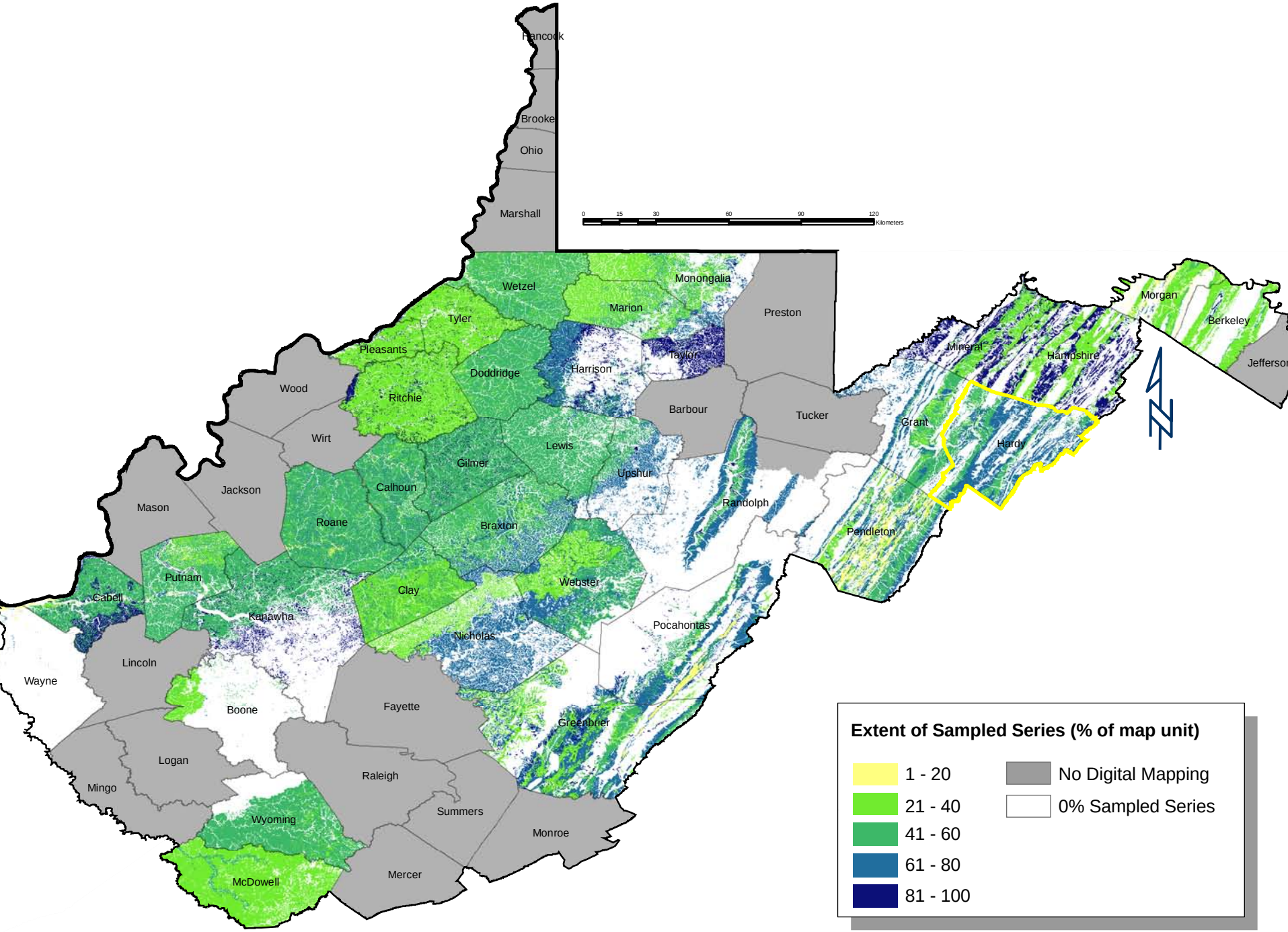
- PSC for a given pedon was determined for the upper 20 cm
  - Sum of PSC values for all or part of any horizon within the upper 20 cm of the soil

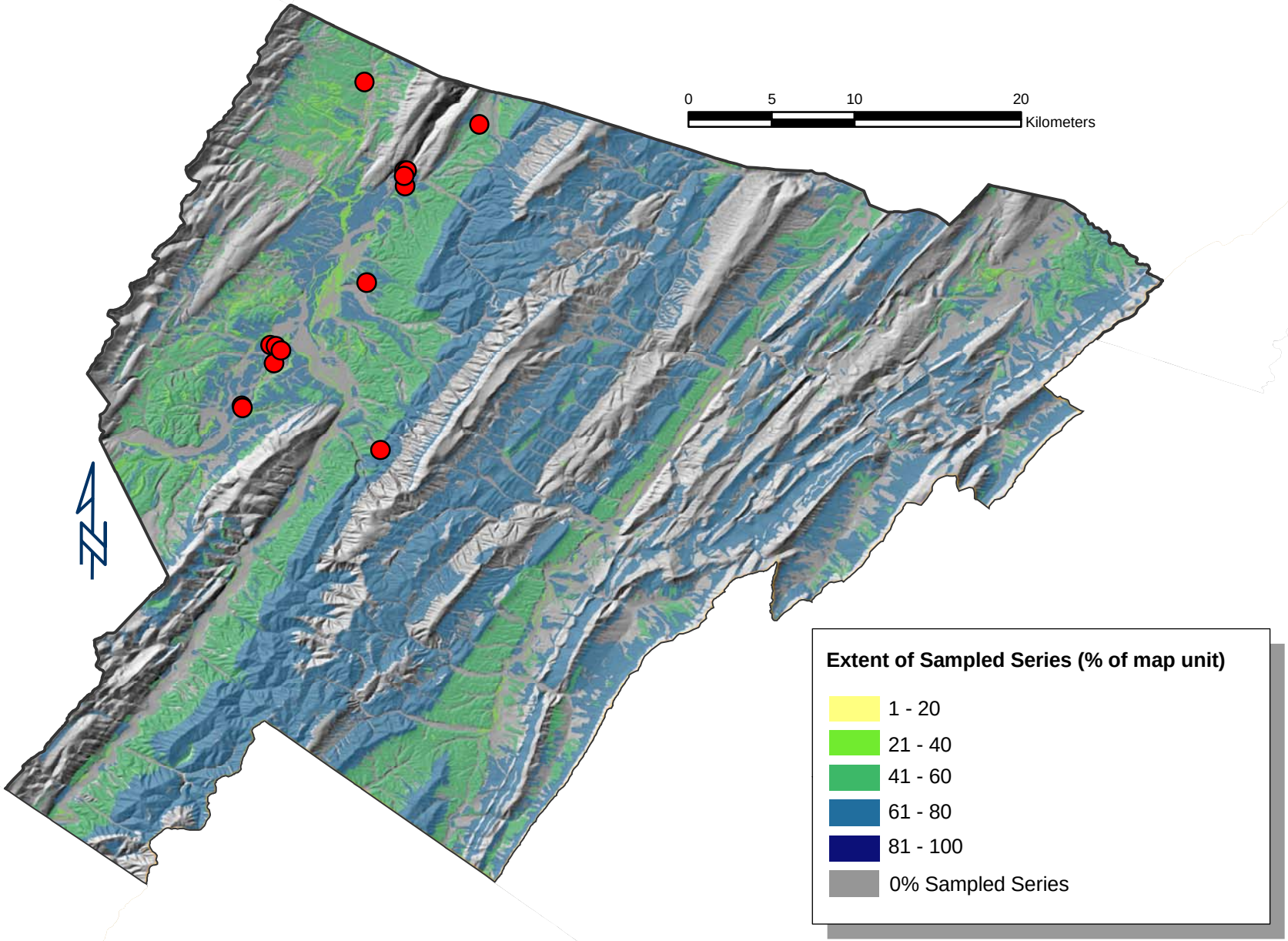
Soil PSC Data

- Carbo (n = 4) 17.0 kg P/m^2
  - Very-fine, mixed, active, mesic Typic Hapludalfs
- Huntington (n = 7) 16.4 kg P/m^2
  - Fine-silty, mixed, active, mesic Fluventic Hapludolls
- Lindside (n = 4) 14.0 kg P/m^2
  - Fine-silty, mixed, active, mesic Fluvaquentic Eutrudepts
- Berks (n = 7) 12.5 kg P/m^2
  - Loamy-skeletal, mixed, active, mesic Typic Dystrudepts
- Monongahela (n = 7) 11.7 kg P/m^2
  - Fine-loamy, mixed, semiactive, mesic Typic Fragiudults
- Hagerstown (n = 6) 10.6 kg P/m^2
  - Fine, mixed, semiactive, mesic Typic Hapludalfs
- Gilpin (n = 3) 8.8 kg P/m^2
  - Fine-loamy, mixed, active, mesic Typic Hapludults
- Frederick (n = 4) 5.4 kg P/m^2
  - Fine, mixed, semiactive, mesic Typic Paleudults

PSC Mapping

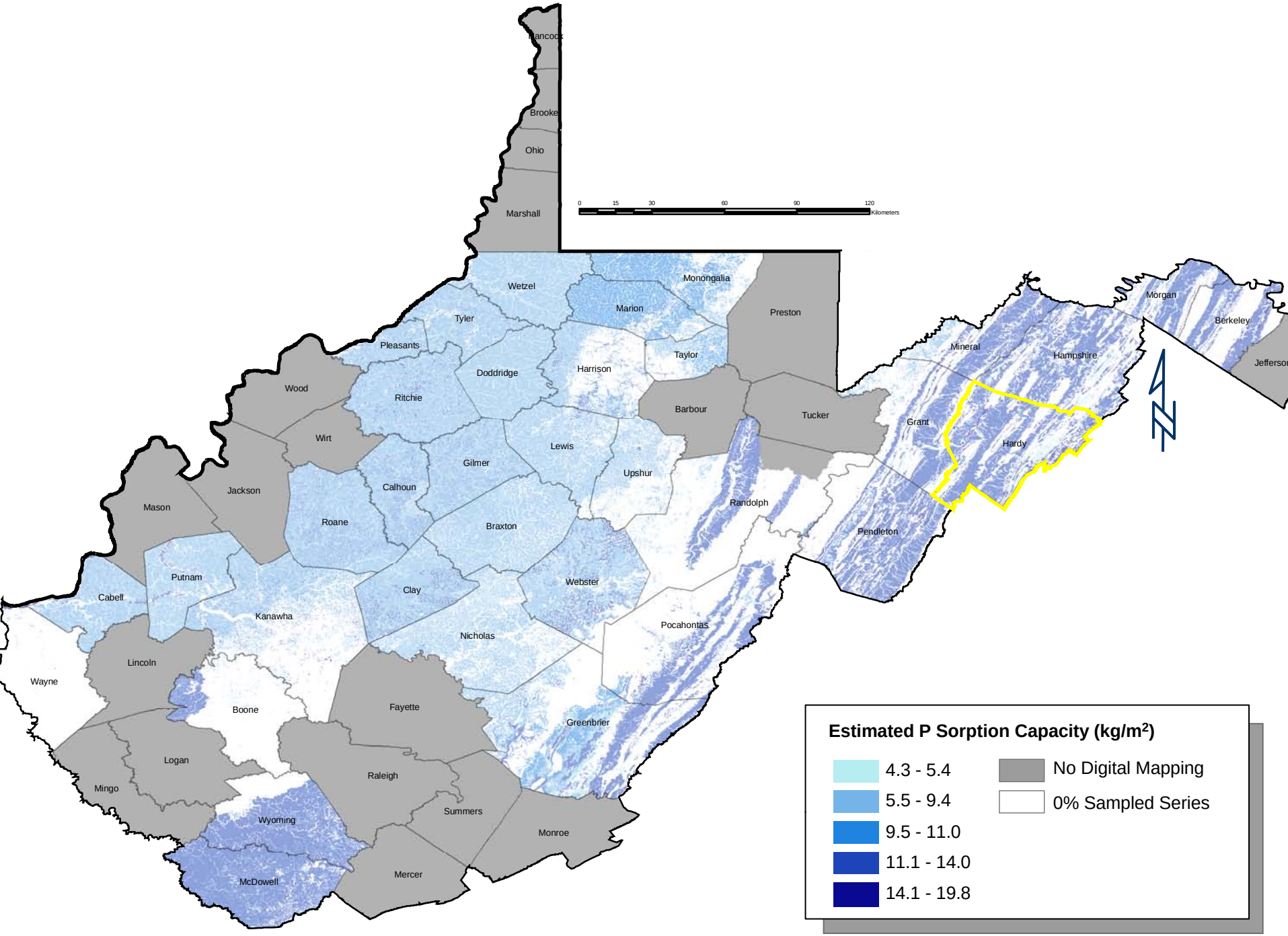
- SSURGO data were used to map the extent of sampled soil series
  - SSURGO data available for 35 of 55 West Virginia counties
  - Map shows the percent of each map unit that is represented by one or more of the 31 sampled soil series


Hancock
Brooke
Ohio
Marshall
0 15 30 60 90 120
Kilometers
Wetzel
Monongalia
Marion
Preston
Tyler
Pleasants
Taylor
Harrison
Doddridge
Wood
Ritchie
Barbour
Tucker
Wirt
Lewis
Gilmer
Upshur
Jackson
Calhoun
Mason
Randolph
Roane
Braxton
Putnam
Clay
Webster
Cabell
Kanawha
Nicholas
Pocahontas
Lincoln
Wayne
Boone
Fayette
Greenbrier
Logan
Raleigh
Mingo
Summers
Wyoming
Monroe
Mercer
McDowell
Morgan
Berkeley
Mineral
Hampshire
Jefferson
Grant
Hardy
Pendleton
N
Extent of Sampled Series (% of map unit)
1 - 20
21 - 40
41 - 60
61 - 80
81 - 100
No Digital Mapping
0% Sampled Series


0
5
10
20
Kilometers
N
Extent of Sampled Series (% of map unit)
1 - 20
21 - 40
41 - 60
61 - 80
81 - 100
0% Sampled Series

PSC Mapping

- SSURGO data used to map estimated PSC
  - The PSC value of the dominant soil map unit component series was assigned to each map unit
  - Map units with no sampled components are given a null value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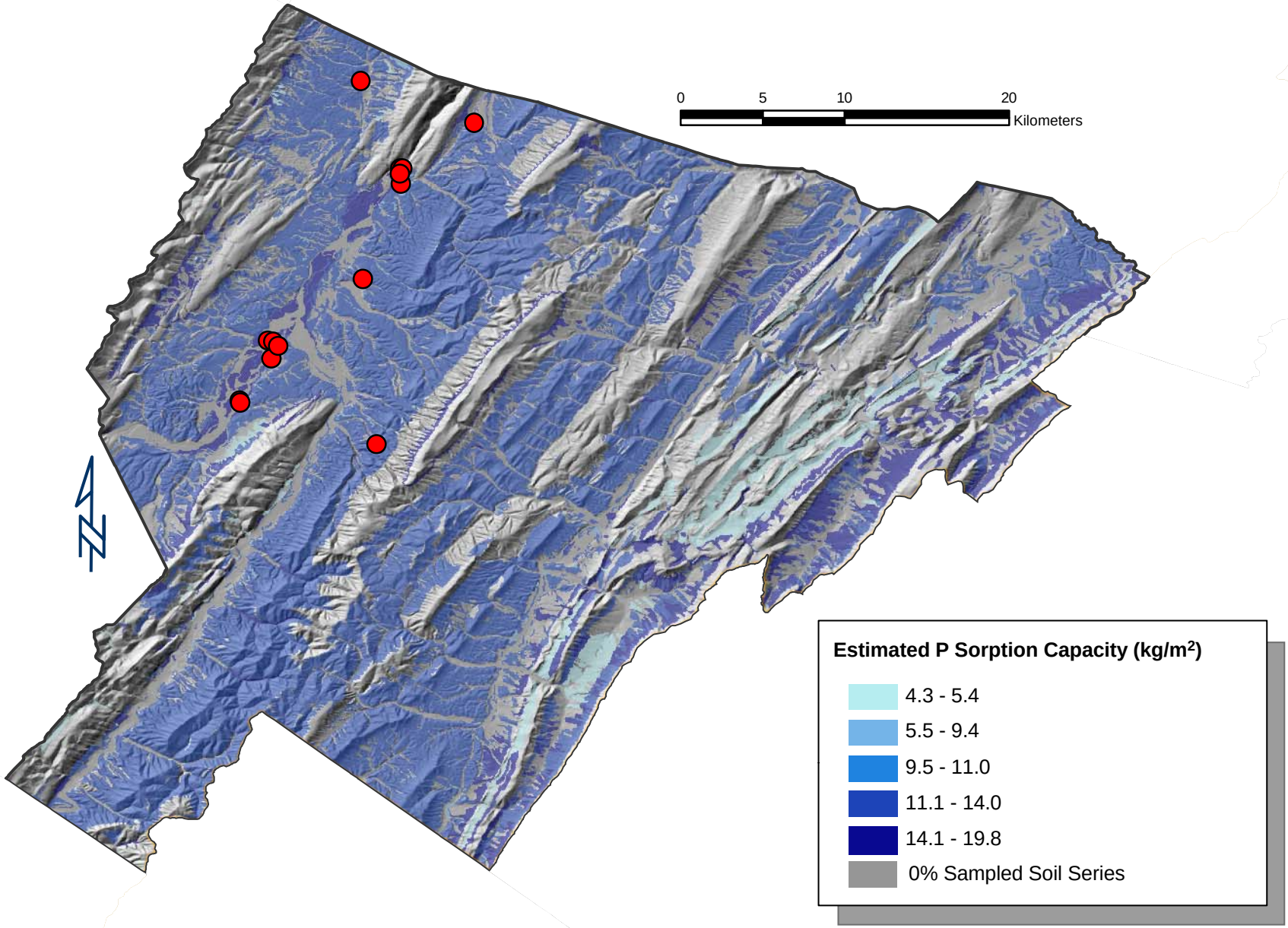
Hampshire
Morgan
Berkeley
Jefferson
Grant
Hardy
Pendleton
Estimated P Sorption Capacity (kg/m2)
4.3 - 5.4
5.5 - 9.4
9.5 - 11.0
11.1 - 14.0
14.1 - 19.8
No Digital Mapping
0% Sampled Series


0
5
10
20
Kilometers
N
Estimated P Sorption Capacity (kg/m2)
4.3 - 5.4
5.5 - 9.4
9.5 - 11.0
11.1 - 14.0
14.1 - 19.8
0% Sampled Soil Series

Future Considerations

- Use land use information
  - Map PSC as conditioned by land use
- Link measured PSC data to SSURGO map units at higher taxonomic levels
  - To increase the areal extent of mapped data
- Examine spatial trends in mapped PSC data
- Collect PSC data for additional soil series
- Incorporate PSC data from sampled soils outside of West Virginia