

Hydrochemical Regions Within the Glacial Aquifer Based on Statistical and Spatial Analysis of Ground-Water Chemistry and Related Environmental Characteristics

Timeline

Task	FY 04	FY 04	FY 04	FY 04	FY 05	FY 05	FY 05	FY 05	FY 06	FY 06	FY 06	FY 06	FY 07	FY 07	FY 07	FY 07
Delineation of hydrochemical regions within the glacial aquifer system based on chemical type of ground water and related environmental characteristics	O-D, 200 3	J-M, 200 4	A-J, 200 4	J-S, 200 4	O-D, 200 4	J-M, 200 5	A-J, 200 5	J-S, 200 5	O-D, 200 5	J-M, 200 6	A-J, 200 6	J-S, 200 6	O-D, 200 6	J-M, 200 7	A-J, 200 7	J-S, 200 7
Last Updated: 07/22/2004																
Prelim annotated report outline (specifies purpose and scope of report)			X													
Data compilation			X													
Data analysis and interpretation			X	X	X	X	X	X	X							
Final annotated report outline							X	X								
Report writing									X	X	X	X				
First draft									X	X						
Colleague review										X	X					
Director's approval												X	X			
Other task																
Other task																
Publication													X	X		

Questions to Answer

- Is there a difference in ground-water quality across the glacial aquifer?
- Can any differences be quantified to delineate hydrogeologic regions of similar water quality?
- Can the hydrogeologic regions be used to estimate water quality in unsampled areas?

Constituent Focus

Constituent	Number of Samples
Calcium	1665
Chloride	1662
DO	1640
Fluoride	1558
Magnesium	1666
Nitrate and nitrite	1616
Potassium	1667
Sodium	1666
Sulfate	1657
Carbonate	1456
Bicarbonate	1455

Local Differences

Analysis of Variance shows there is a statistically significant difference in the mean of the focus constituents for at least one of the different Study Units ($\alpha = 0.05$)

	F Value	Pr(F)
Calcium	38.96	0.000
Chloride	8.42	0.004
DO	37.96	0.000
Fluoride	55.24	0.000
Magnesium	191.66	0.000
NO ₂ NO ₃	1.92	0.167
Potassium	15.30	0.000
Sodium	14.80	0.000
Sulfate	5.29	0.022
Bicarbonate	15.40	0.000
Carbonate	3.67	0.056

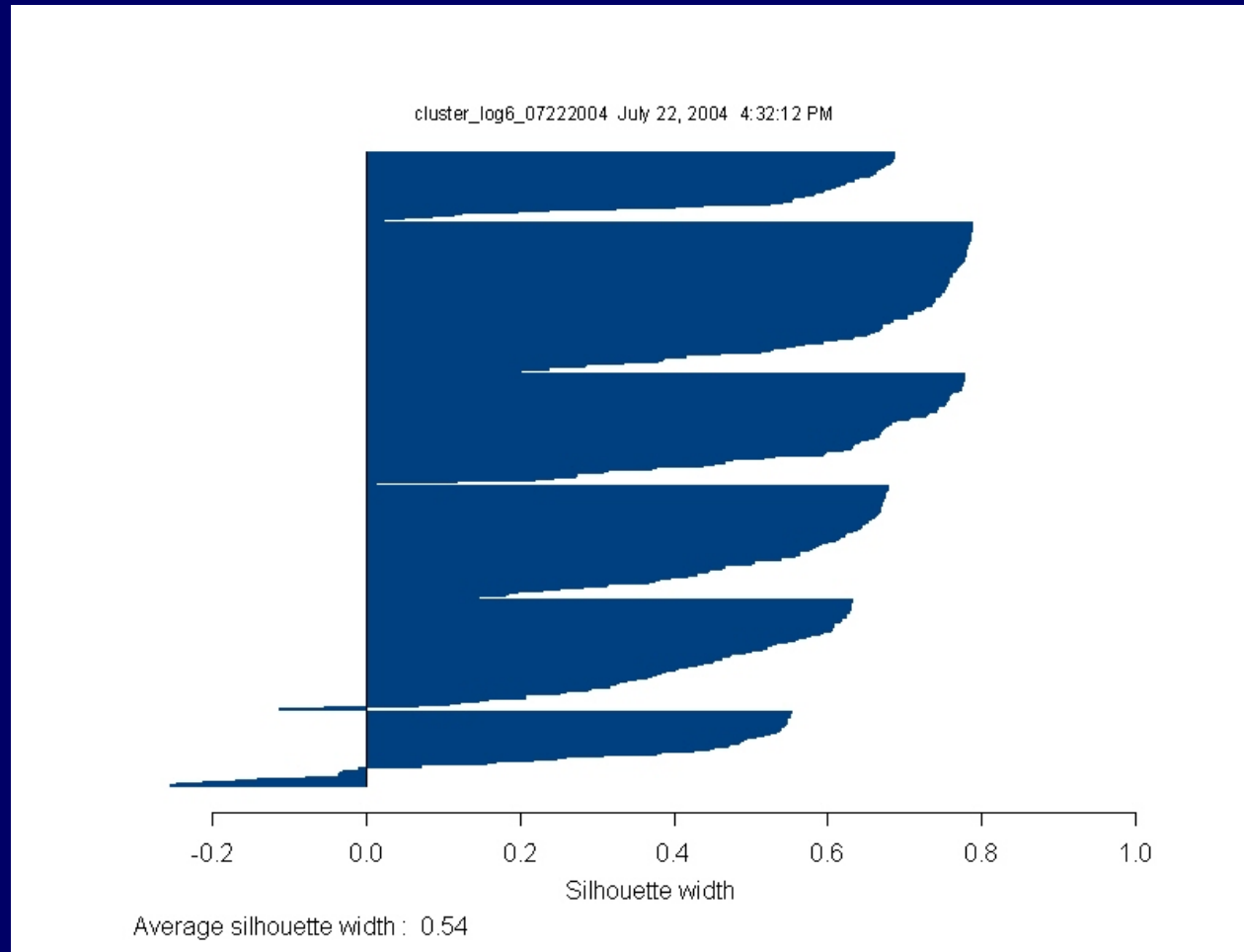
Regional Differences

Analysis of Variance shows there is a statistically significant difference in the mean of the focus constituents for each of the different Glacial Stratification Regions (east, central, west, far west)

- East/Central and East/West are different for all but carbonate and bicarbonate
- East and Far West different for all but potassium, sulfate, carbonate and bicarbonate
- Central and West different for all but calcium, DO, sodium, and bicarbonate
- Central and Far West different for all but fluoride and bicarbonate
- West and Far West different for all but magnesium, bicarbonate and carbonate

Cluster Analysis of Focus Constituents

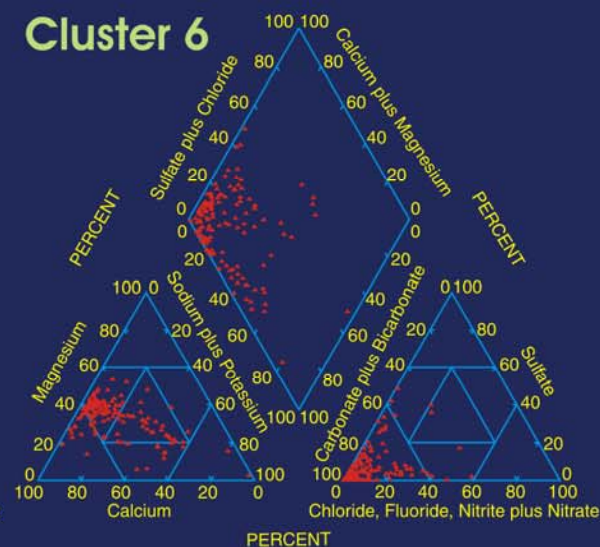
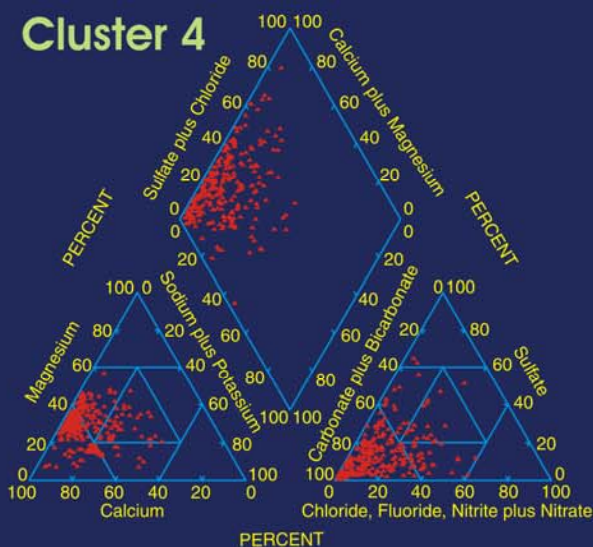
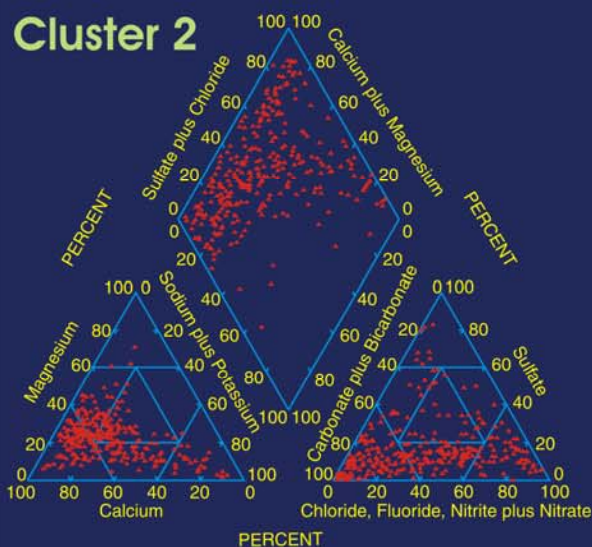
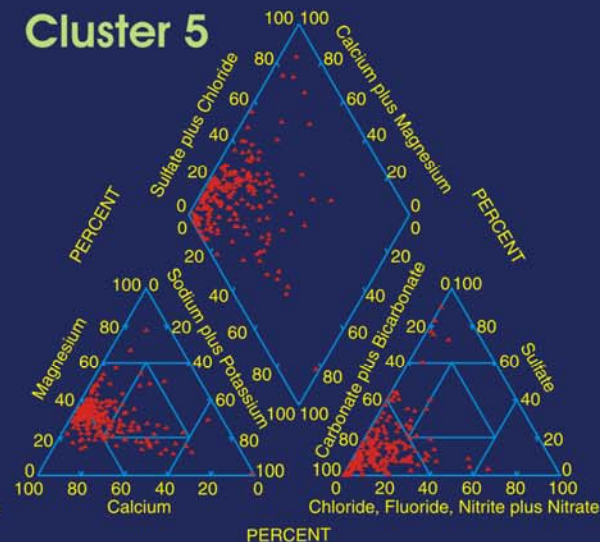
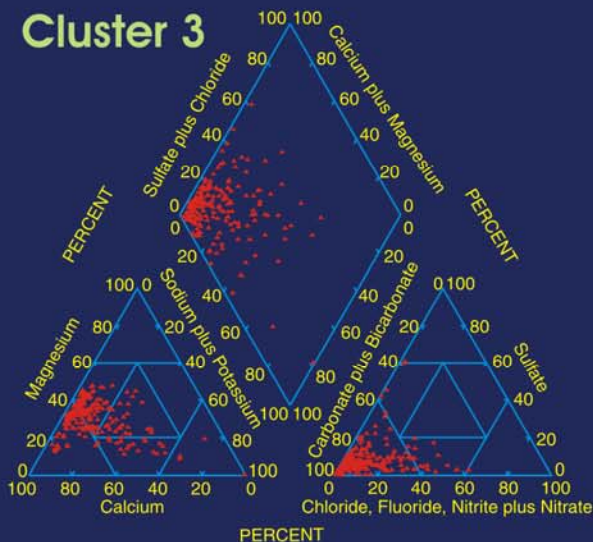
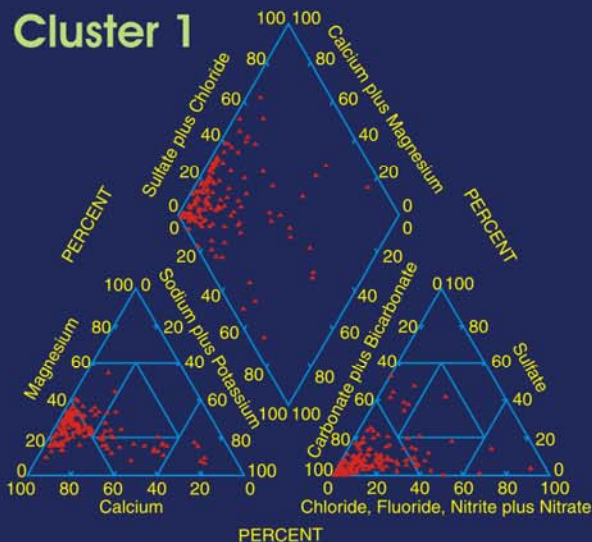
- 6 well-formed clusters
- Calcium and Chloride explain 52% of the variability



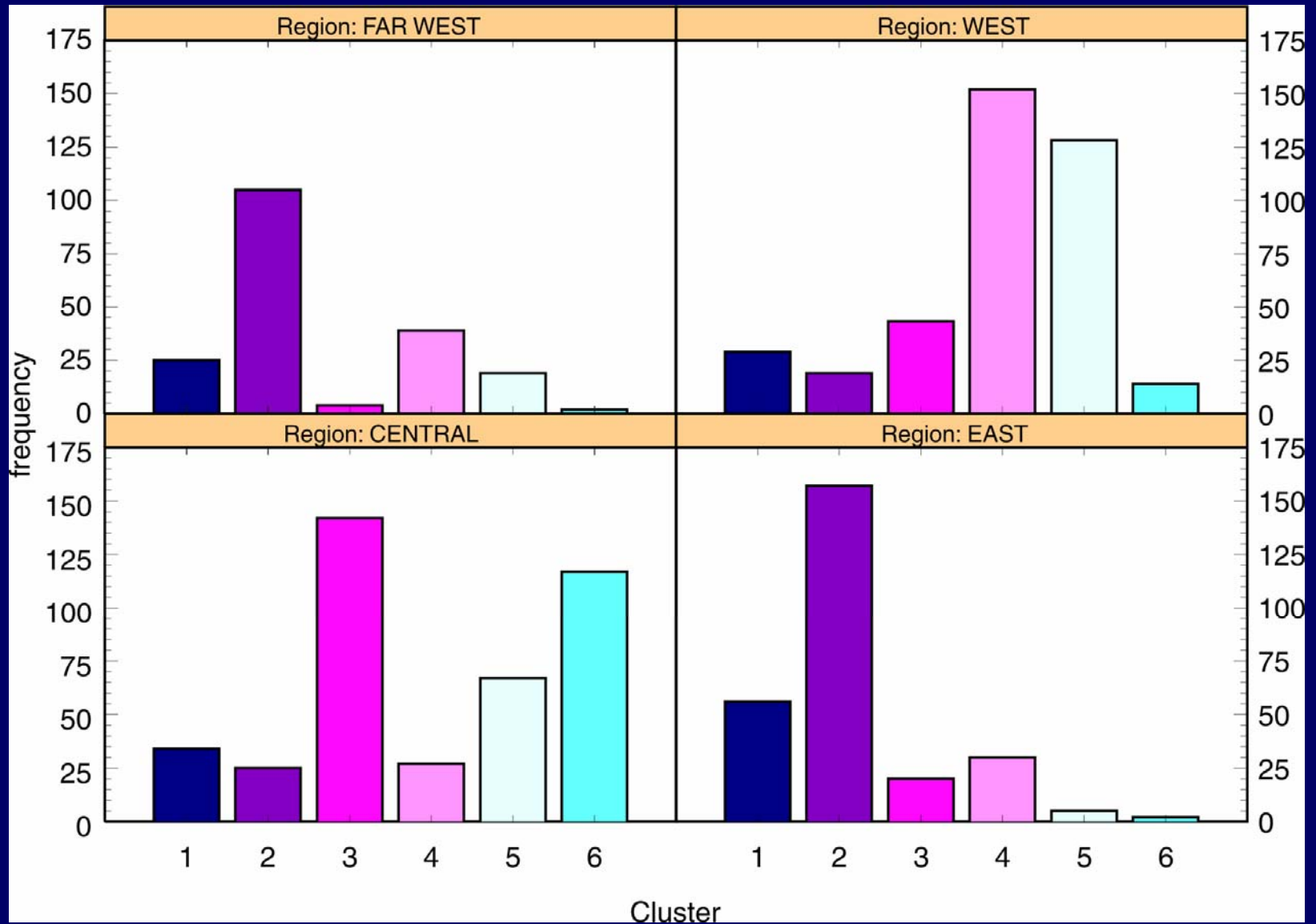
ANOVA Shows Significant Differences in Clusters ($\alpha=0.05$)

Compare Clusters	1	1	1	1	1	2	2	2	2	3	3	3	4	4	5
	2	3	4	5	6	3	4	5	6	4	5	6	5	6	6
Calcium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.04
Chloride	0.02	0.04	0	0	0.02	0.12	0	0	0.61	0	0	0.20	0	0	0
DO	0	0	0	0	0	0	0.36	0	0	0	0	0.15	0	0	0
Fluoride	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NO ₂ NO ₃	0	0.18	0	0.03	0	0	0	0	0	0	0	0.41	0	0	0
Potassium	0	0.33	0	0	0.28	0	0.25	0	0.21	0	0	0.33	0	0.09	0
Sodium	0.67	0	0.02	0	0	0	0.14	0	0	0	0	0	0	0	0
Sulfate	0	0	0.02	0	0	0.71	0	0	0	0	0	0	0	0	0
Carbonate	0	0.19	0	0	0	0	0	0	0	0	0	0	0.01	0	0
Bicarbonate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

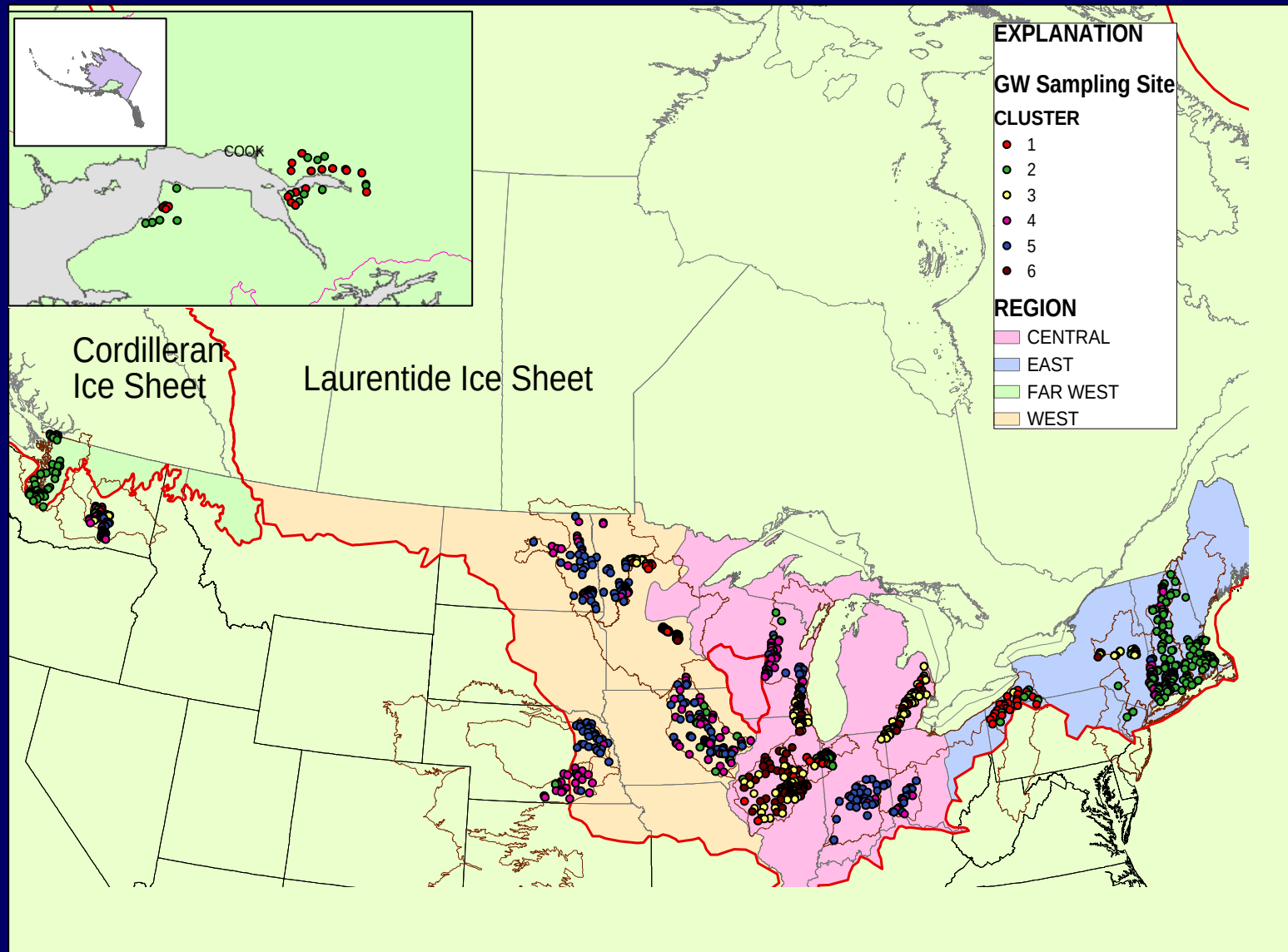
Water Quality of Clusters



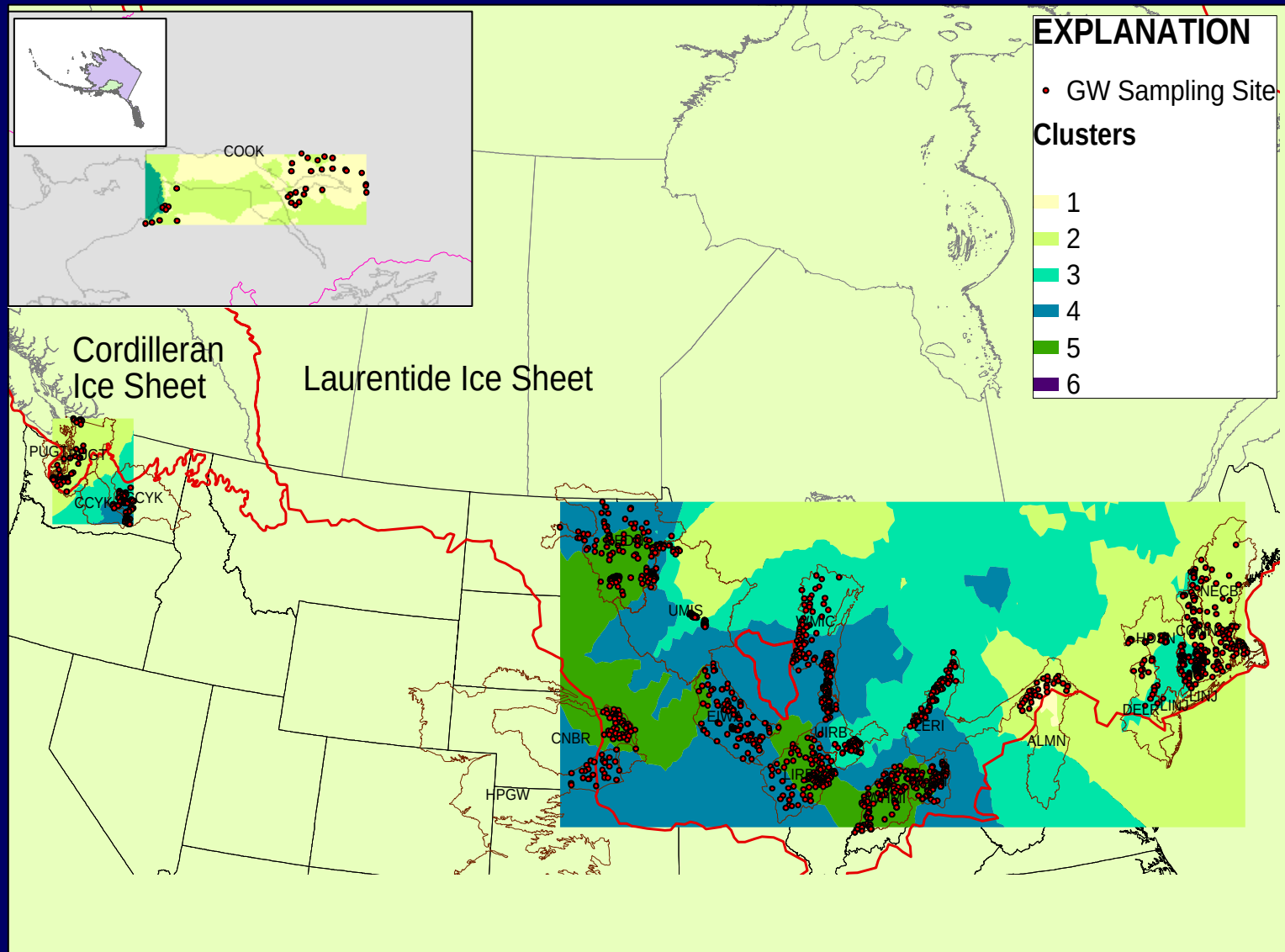
Cluster Frequency by Region



Spatial Distribution of Clusters – Points Only



Spatial Distribution of Clusters – Kriged



Where to go from here?

- 1) Examine relations between hydrochemical regions and environmental and/or geologic factors: texture of surficial deposits, surficial and bedrock geology, depth to water or depth of well, location, hydrologic landscape units (Wolock), soil properties (STATSGO), climate
- 2) Verify regions using additional QW data: retrieve data from NWIS, use PLUTO and RASS sediment and soils chemical data
- 3) Try to extrapolate findings