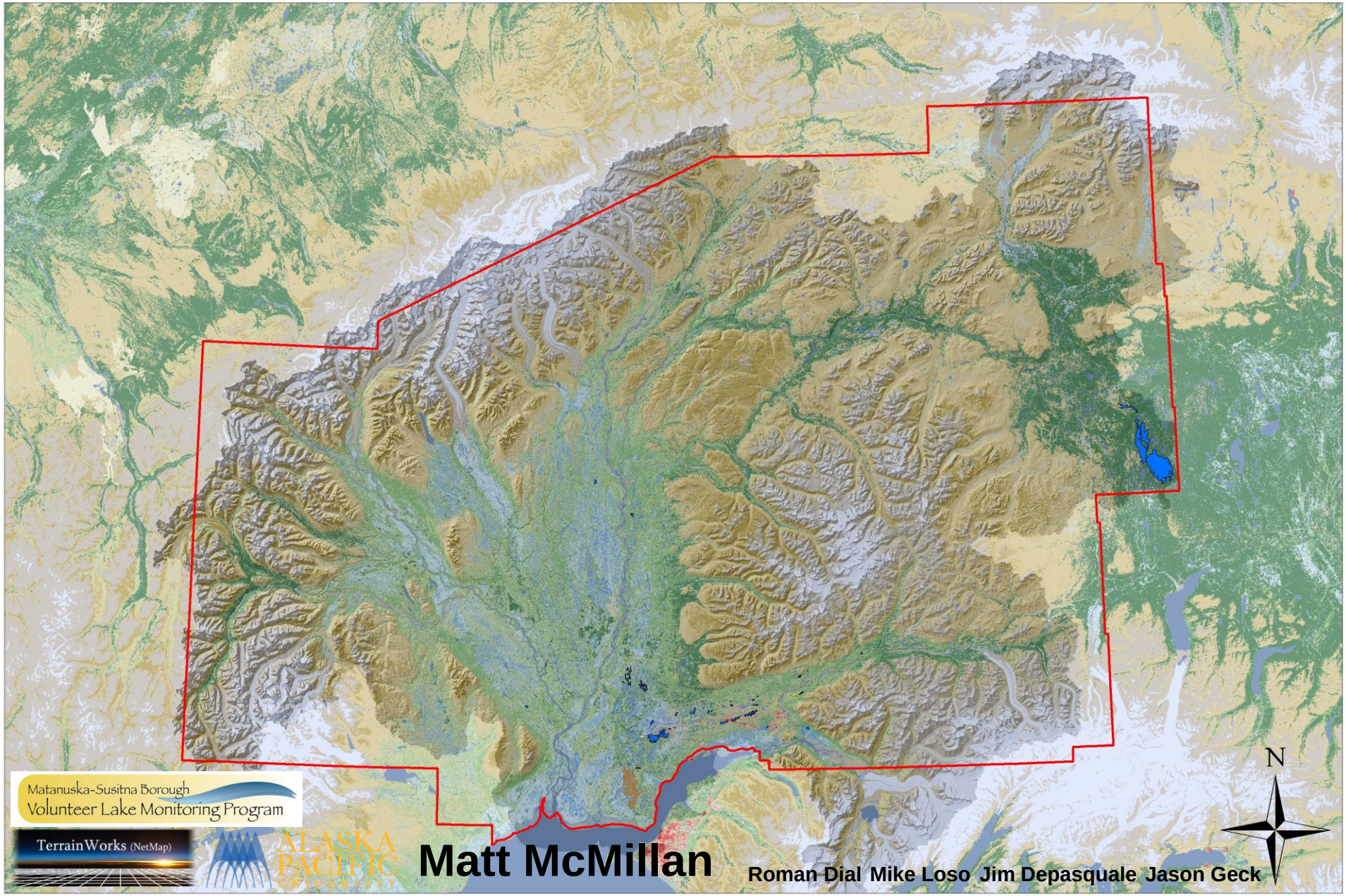
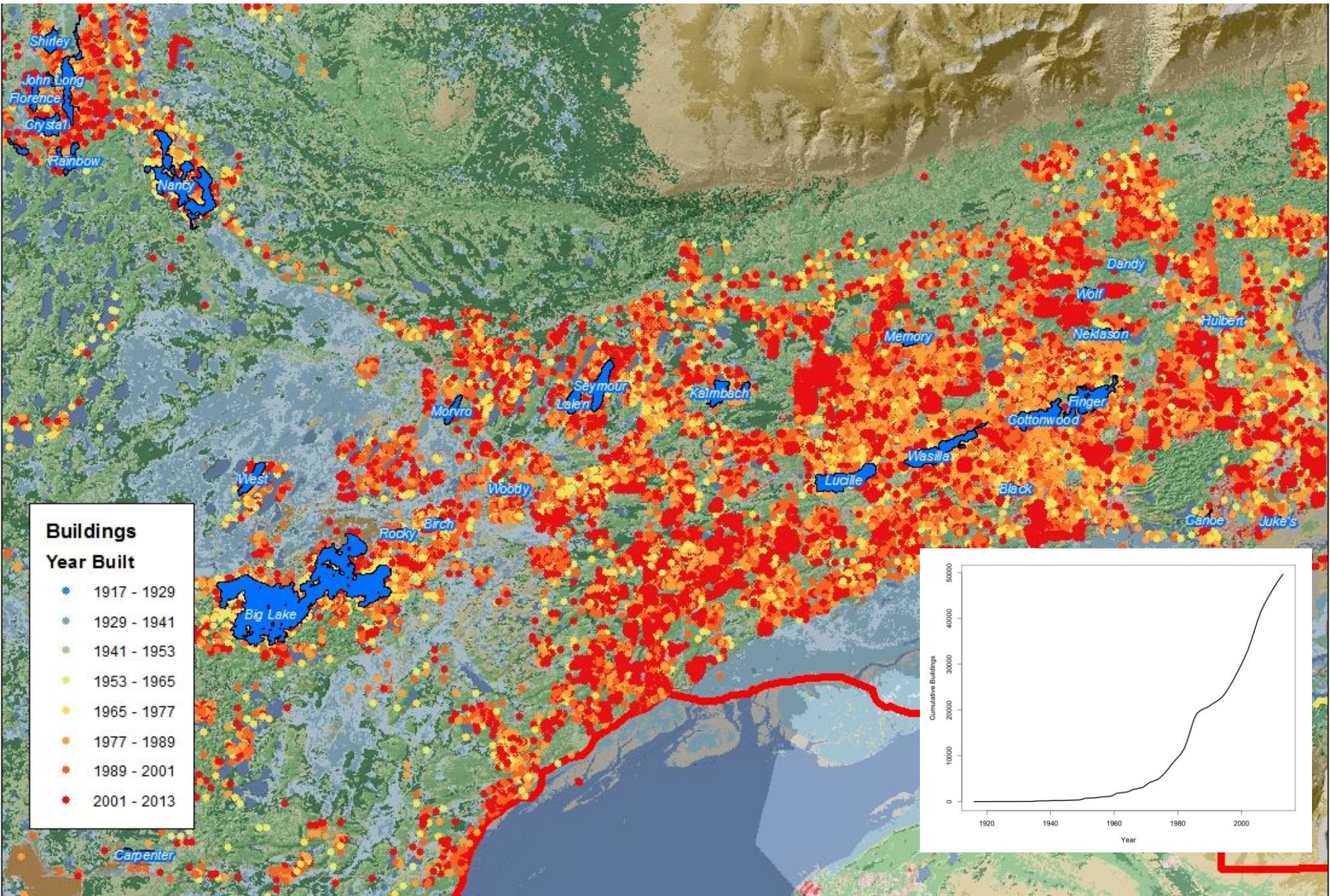
Geospatial and temporal analysis of land cover, climate, and lake water quality in the Matanuska-Susitna Valley, Alaska



Matt McMillan

Roman Dial Mike Loso Jim Depasquale Jason Geck

Buildings Built



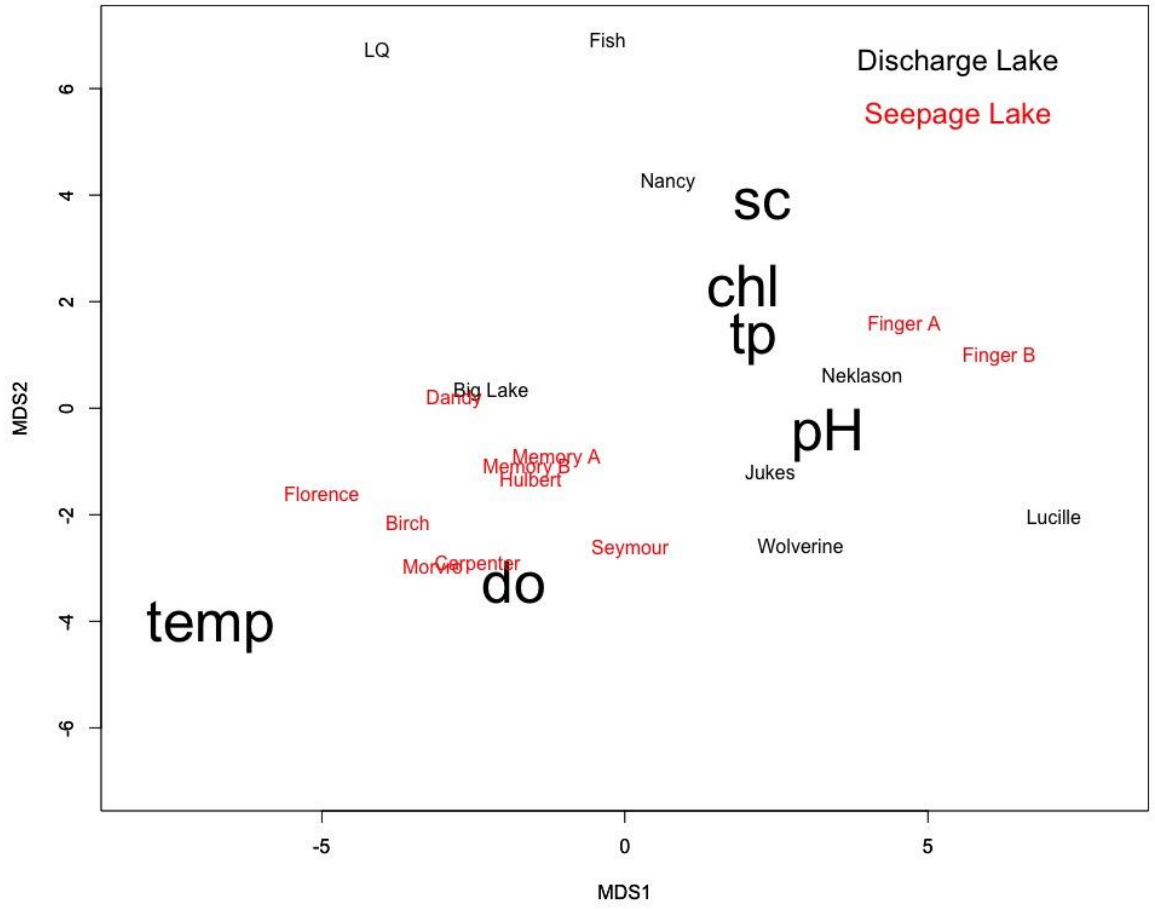
Matanuska-Susitna Borough
Volunteer Lake Monitoring Program

- **Chlorophyll-a (µg L^{-1})**
- **Total Phosphorus (µg L^{-1})**
- **Temperature (°C)**
- **pH (standard units)**
- **Dissolved Oxygen (mg L^{-1})**
- **Specific Conductivity (µS cm^{-1})**

	uS/cm
DISTILLED WATER	0.5 - 3
MELTED SNOW	2 - 42
TAP WATER	50 - 800
POTABLE WATER IN THE US	30 - 1500
FRESHWATER STREAMS	100 - 2000
INDUSTRIAL WASTEWATER	10000
SEAWATER	55000

Comparing Lakes and Water Quality

Subset of 17 lakes – 6 median water quality parameters



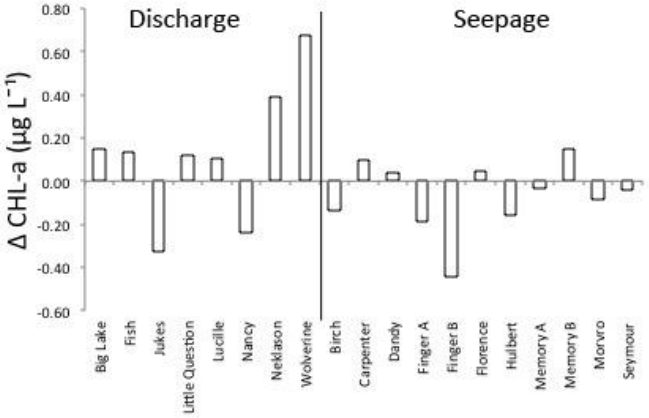
sc – Specific Conductivity
chl – Chlorophyll-a
tp – Total Phosphorus
pH – pH
do – Dissolved Oxygen
temp – Temperature

Non-metric Multidimensional Scaling

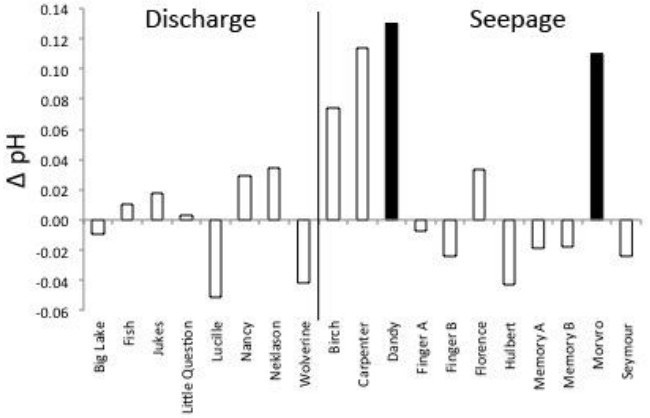
- **Lakes closer together are more similar**
- **Lakes that are farther apart are more dissimilar**

Average Annual Trends

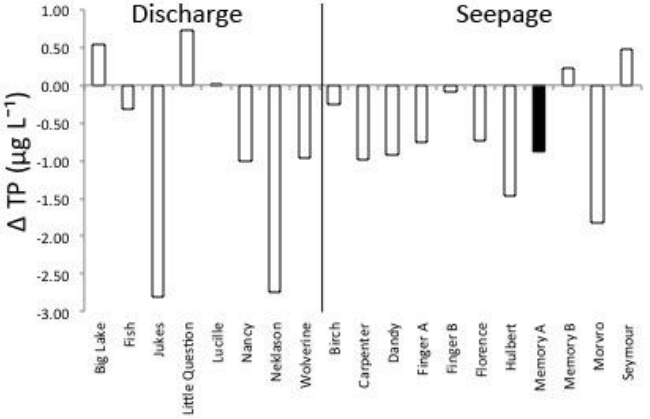
Chlorophyll-a



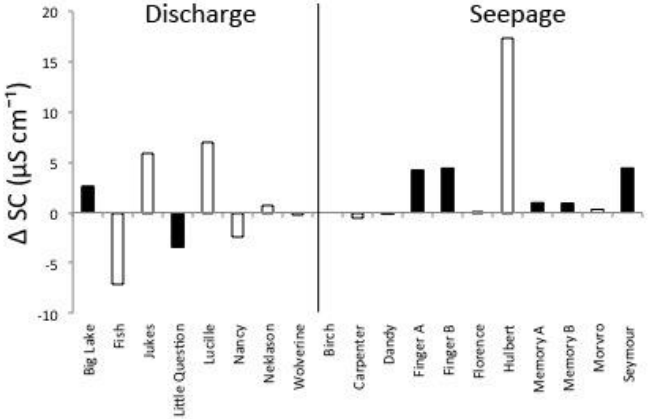
pH



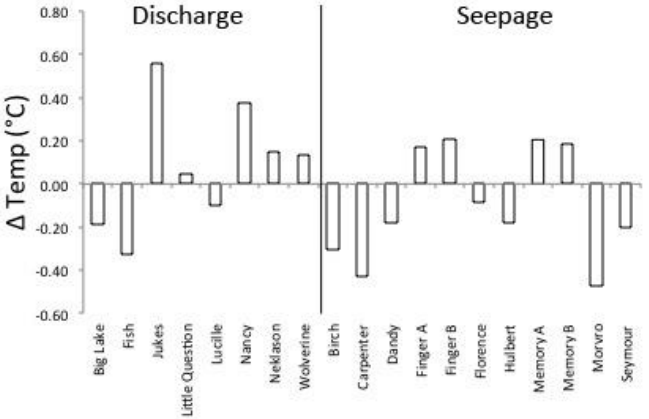
Total Phosphorus



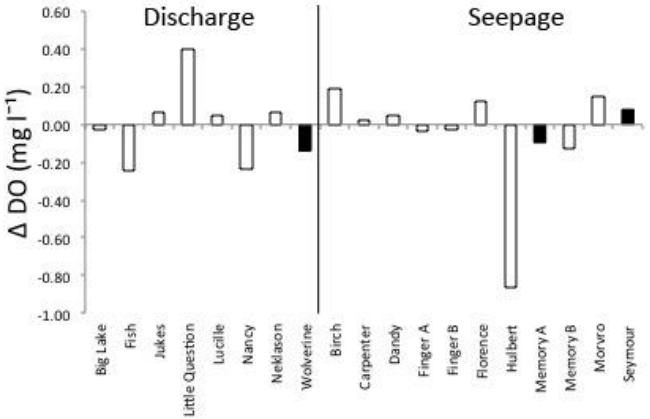
Specific Conductivity



Temperature



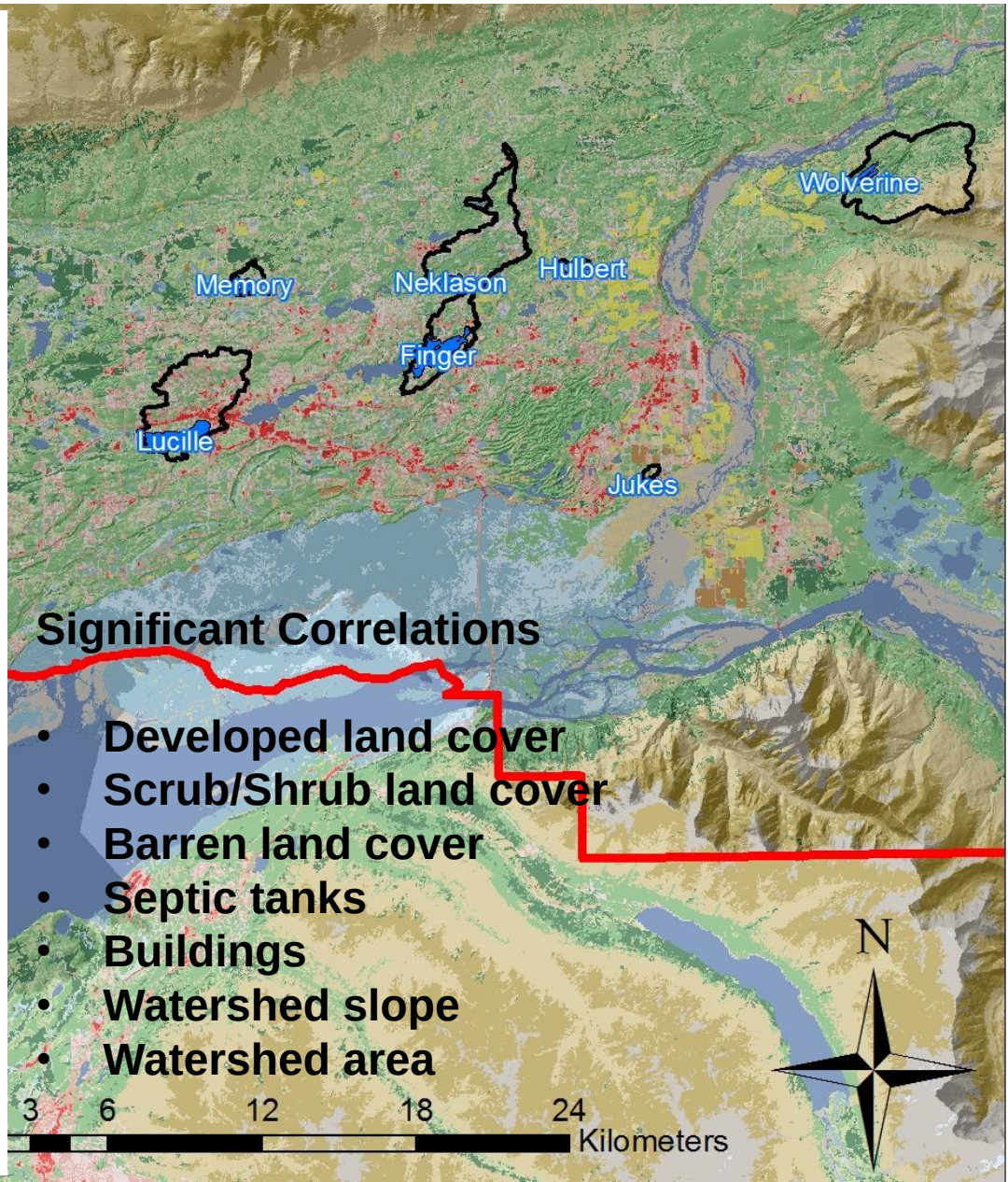
Dissolved Oxygen



Specific Conductivity-Landscape Relationships

Environmental variables evaluated for correlation with in-lake specific conductivity:

- Land cover
- wetland type/wetland area
- watershed area
- watershed:lake ratio
- 100-m buffer area
- buffer:lake ratio
- mean annual air temperature
- total annual precipitation
- septic tanks
- buildings
- road density
- perimeter
- maximum depth
- shoreline irregularity
- surface area

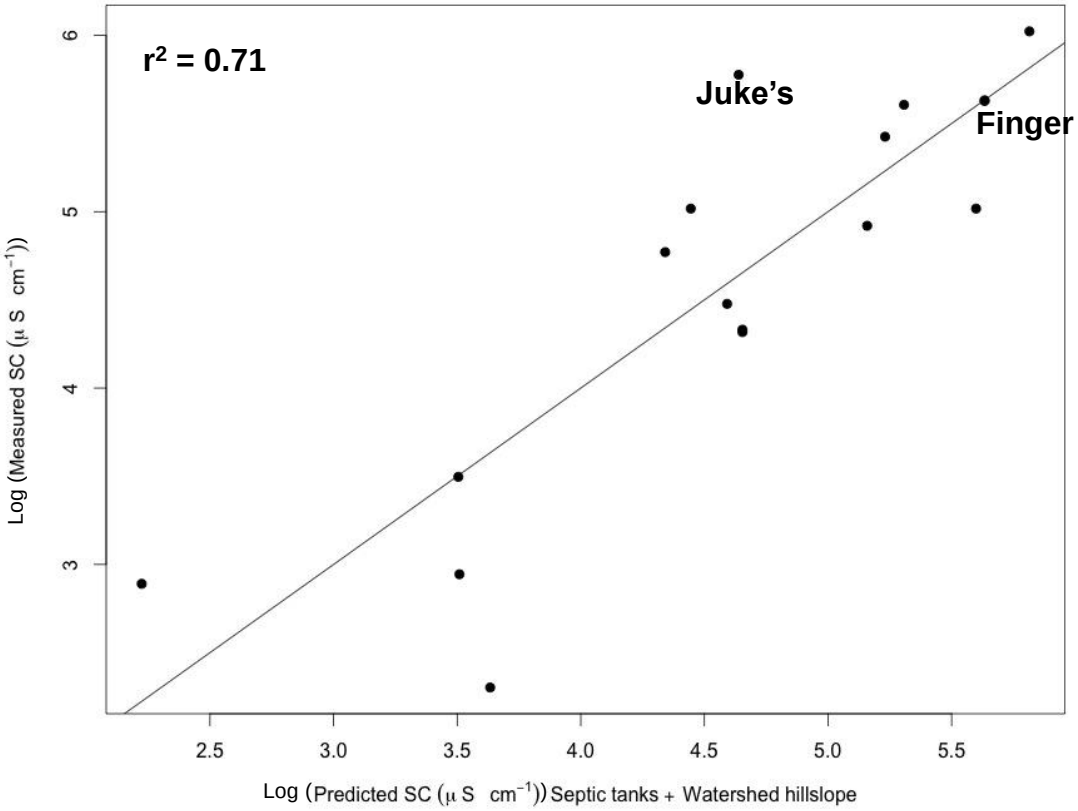


Modeling Specific Conductivity-Landscape Relationships

Multiple regression evaluated with ΔAIC

Independent variables	p-value	r^2	AIC	Δ AIC
Watershed septics + Watershed slope	<0.001	0.7	35.89	1.7
Buffer Development + Watershed slope	<0.001	0.67	37.59	1.18
Watershed buildings + Watershed slope	<0.001	0.65	38.77	0.12
Watershed Development + Watershed slope	<0.001	0.66	38.89	4.2
Buffer Development + Buffer slope	0.001	0.55	43.09	1.58
Buffer Buildings + Watershed slope	0.002	0.5	44.67	1.27
Buffer Buildings + Buffer slope	0.004	0.47	45.94	2.78
Watershed slope	0.008	0.35	48.72	0.69
Buffer slope	0.01	0.32	49.41	-

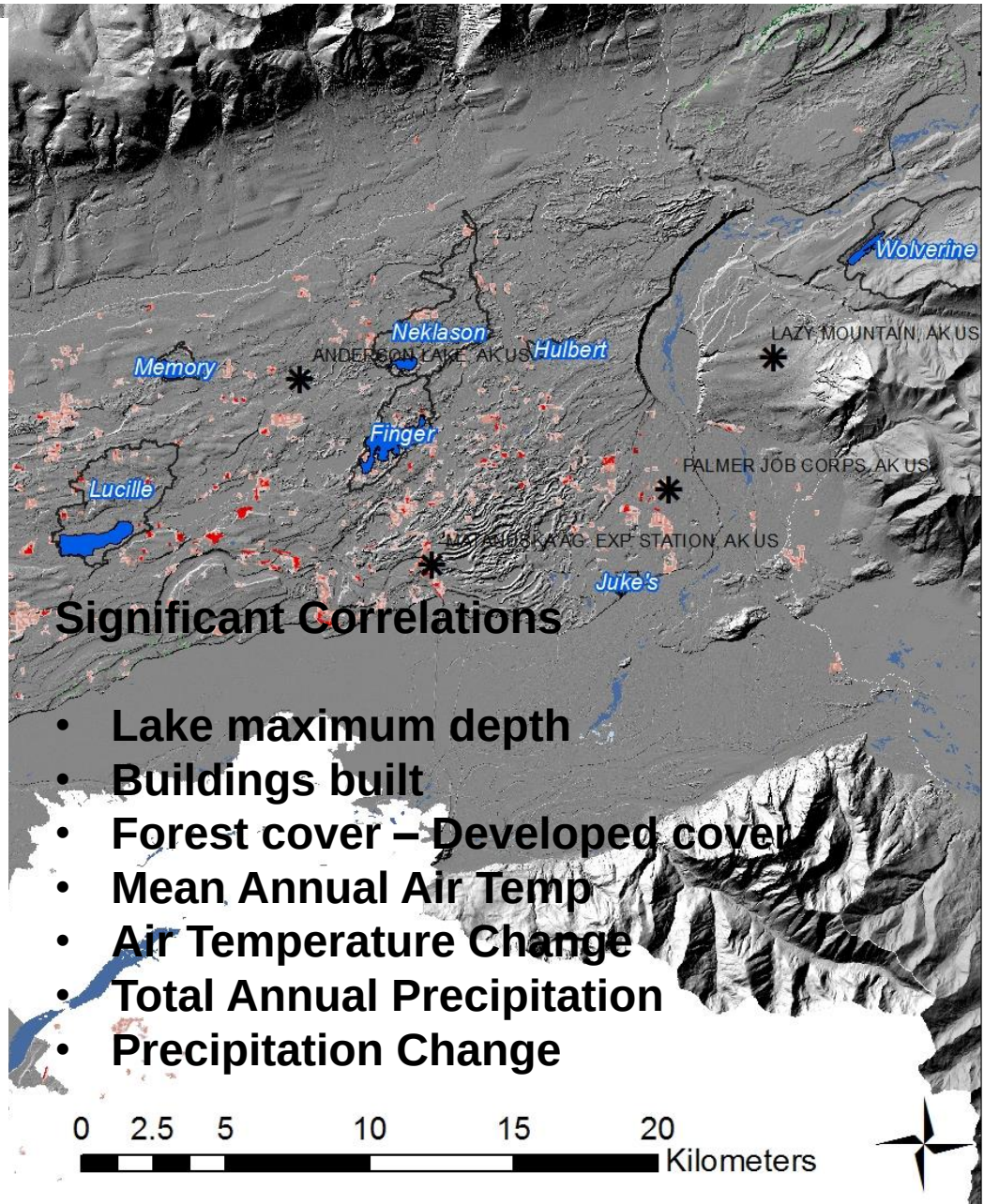
Specific conductivity = Watershed slope + Septic tanks



Specific Conductivity Trends

Environmental variables evaluated for correlation with in-lake specific conductivity trends:

- Land cover change 2001-2011,
- Change in average mean air temperature from normal 2001-2011
- change in average total precipitation from normal 2001-2011
- watershed area
- 100-m buffer area
- Buildings built
- road density
- Perimeter
- maximum depth
- shoreline irregularity
- surface area

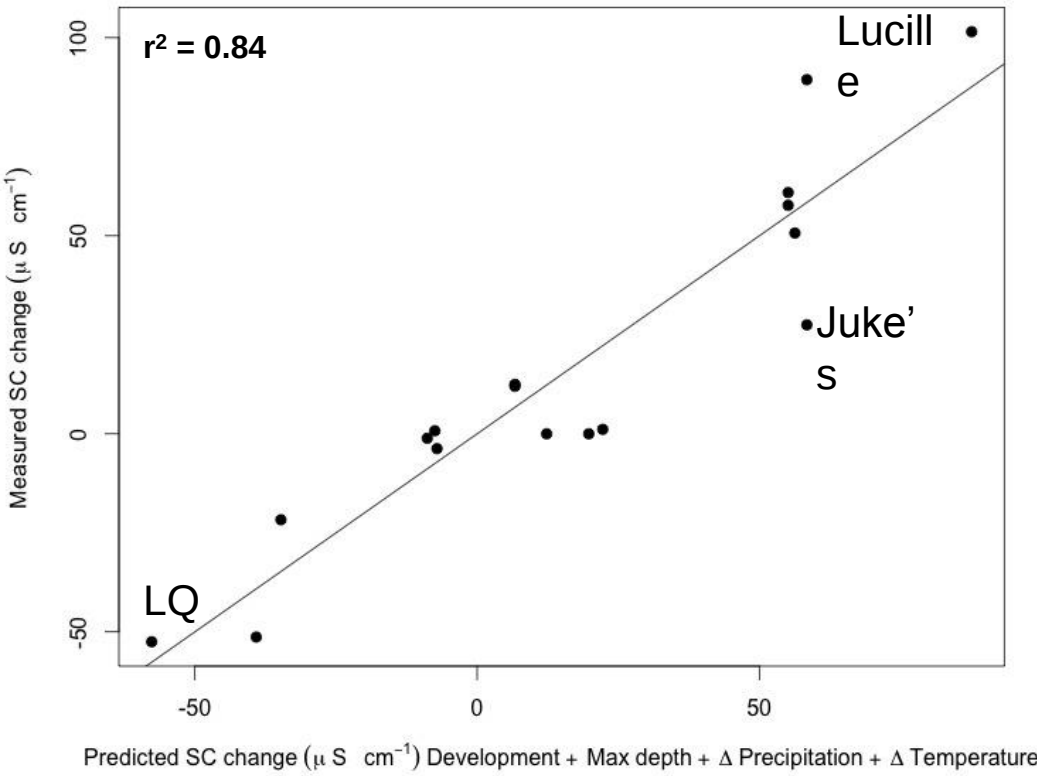


Modeling Specific Conductivity Trends

Multiple regression evaluated with ΔAIC

Independent variables	p-value	r^2	AIC	Δ AIC
WSB development + max depth + Δ temperature + Δ precipitation	<0.001	0.84	151.6	5.19
Buffer buildings built + max depth + Δ temperature	0.002	0.63	156.69	0.1
WSB development + max depth + Δ precipitation	<0.001	0.77	156.79	1.18
WSB buildings built + max depth + Δ temperature	<0.001	0.75	157.97	2.05
WSB development + max depth + Δ temperature	<0.001	0.72	160.02	4.3
WSB development + max depth	<0.001	0.63	164.32	4.81
WSB buildings built + max depth	0.003	0.51	169.13	3.51
Buffer development + max depth	0.01	0.39	172.64	1.28
WSB development	0.01	0.31	173.92	2.75
+ Δ temperature	0.04	0.19	176.67	-

SC trend = Development - Max depth + Δ Temp + Δ Precip



Take Home

- **Lake water quality depends on hydrology - Discharge, Seepage**
- **Overall very few statistically significant trends**
- **Most of the trends were increases in Specific Conductivity**
- **Specific conductivity depends on:**
- **the steepness of the watershed**
- **development within the watershed.**
- **Trends in Specific Conductivity depended on:**
- **New development**
- **Increased Precipitation**
- **Increased Temperatures**
- **Lake depth**

- **Important for modeling the effects on water quality in land use and climate change scenarios**

Work in progress/planned

- Stable isotopes of oxygen and hydrogen
- Particulate organic matter (POM)
- Holocene climate reconstruction using lake sediment cores from small marl (calcium carbonate) lake

Future Lake Research Needed

- Chemical analysis of dissolved ions in lakes
- Fecal coliform sampling
- Sediment coring
- Lake bathymetry
- Effects from wildfires on water quality
- Classification of land cover using high resolution imagery

Thank You

- Melanie Trost
- Laura Gooch
- Frankie Barker

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