Monitoring Water Quality in Alaskan National Parks: Development of RIVPACS Empirical Models for Assessing Ecological Condition and Detecting Change in a Heterogeneous Landscape

Trey Simmons
Central Alaska Network

Jeff Ostermiller
Ostermiller Consulting

CAKN
Central Alaska Network

National Goals for I&M Program

1. **Determine the status and trends in selected indicators** of the condition of park ecosystems to allow managers to make better-informed decisions and to work more effectively with other agencies and individuals for the benefit of park resources.
2. **Provide early warning of abnormal conditions of selected resources** to help develop effective mitigation measures and reduce costs of management.
3. **Provide data to better understand the dynamic nature and condition of park ecosystems** and to provide reference points for comparisons with other, altered environments.
4. **Provide data to meet certain legal and Congressional mandates** related to natural resource protection and visitor enjoyment (e.g. the Clean Water Act).
5. **Provide a means of measuring progress towards performance goals.**

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Central Alaska Network Stream Monitoring Program Objectives

1. Determine decadal-scale trends in chemical and biological measures of water quality.
2. Determine decadal-scale trends in the composition and spatial distribution of aquatic macroinvertebrates and diatoms.
3. Develop cost-effective and tractable methods to monitor changes in the distribution of anadromous and resident fish species.
4. Determine decadal-scale trends in annual and seasonal flow patterns in selected streams and rivers.
5. Develop bioassessment tools for park managers to assess water quality in selected rivers and streams.

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Water quality issues in the Central Alaska Network

Climate change

- Increased air temperature
- Increased fire frequency and intensity
- Degradation of permafrost
- Receding glaciers
- Changing ppt/water balance
- Landcover changes

Airborne contaminants

- Mercury
- Pesticides

Resource extraction

- Legacy mining impacts
- Active mining claims
- Logging

Infrastructure development

- Extensive inholdings

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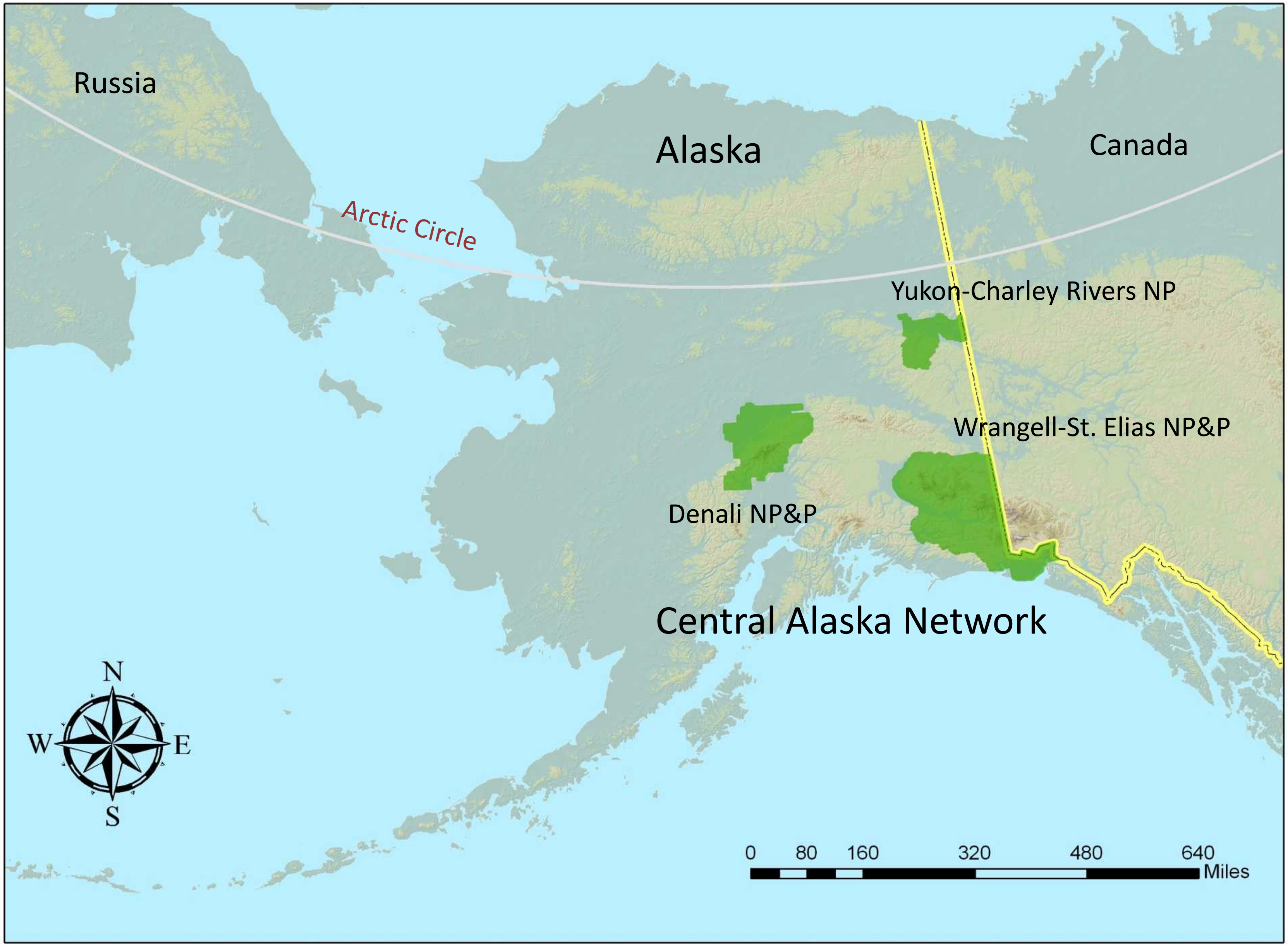
NPS Inventory and Monitoring Program



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Overview of the Central Alaska Network

Almost 90,000 km^2 (about the same size as Indiana)
26% of all National Park Service land
33% of all stream length in the National Park system (45,000 km)
80% as large as all parklands in the lower 48 states combined
Spans 13 ecoregions over 425,000 km^2 (size of California)
Elevation range from sea level to 6200 meters

Total of 3 dirt roads (~190 miles)
No currently active stream gages
Baseline/historical physical, biological and chemical data are sparse
Hydrography data (NHD) are outdated and inaccurate
Staff = 1, budget = $50,000/year

In other words, it's a big challenge!
Collaboration and cooperation will be critical

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Overview of RIVPACS (O/E) bioassessment

1. Collect biological, environmental data from large # of unimpaired (reference) sites
2. Define biological groups (cluster analysis)
3. Use environmental data to construct discriminant model (LDA, random forests)
4. Use discriminant model to calculate probabilities of group membership
5. Use probabilities of group membership, distribution of taxa to calculate expected taxa composition at each site (E)
6. Compare # of expected taxa actually observed (O) to expected (E)
7. Use distribution of reference site O/E scores to evaluate model and define thresholds of impairment

RIVPACS model for the Central Alaska Network

- 80 reference sites, 150 unique taxa
- Mean taxa richness = 19
- Eliminate low-richness/abundance outliers (glacial rivers, intermittent streams)
- 68 sites used to build model, mean taxa richness = 21
- Eliminate rare taxa for clustering (60% of taxa found at < 10% of sites)
- Identified 6 biologically significant groups
- Use only GIS-derived environmental predictors

Random forests discriminant model

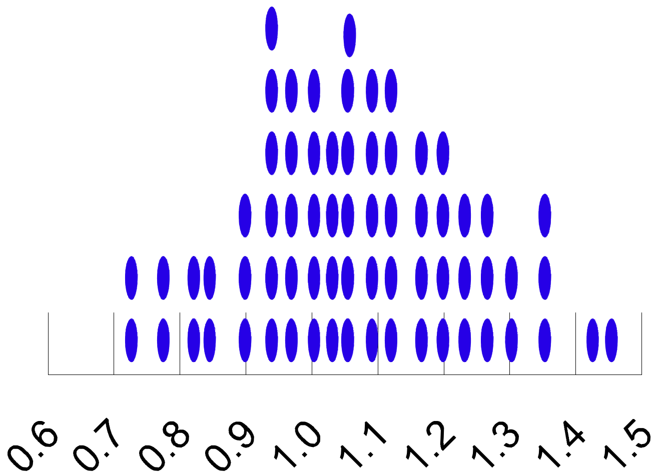
Globally important predictors

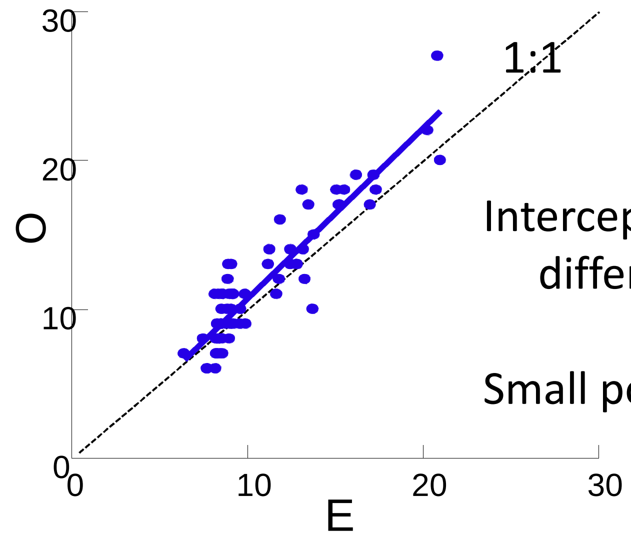
Watershed Area
Watershed Perimeter
Annual Max. Temperature
July Max. Temperature
Annual Min. Temperature
CV Slope
Minimum Elevation
Percent Evergreen Forest
Percent Lakes
Percent Wetlands

Distribution of reference site O/E scores

Mean O/E= 1.04

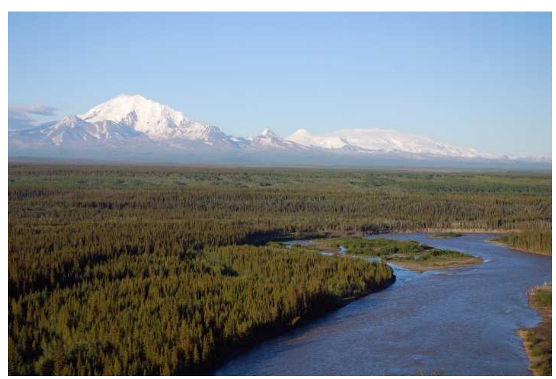
SD = 0.17 (SD of null model = 0.23)





Intercept not significantly different from zero (p=0.32)

Small positive bias (slope = 1.15)



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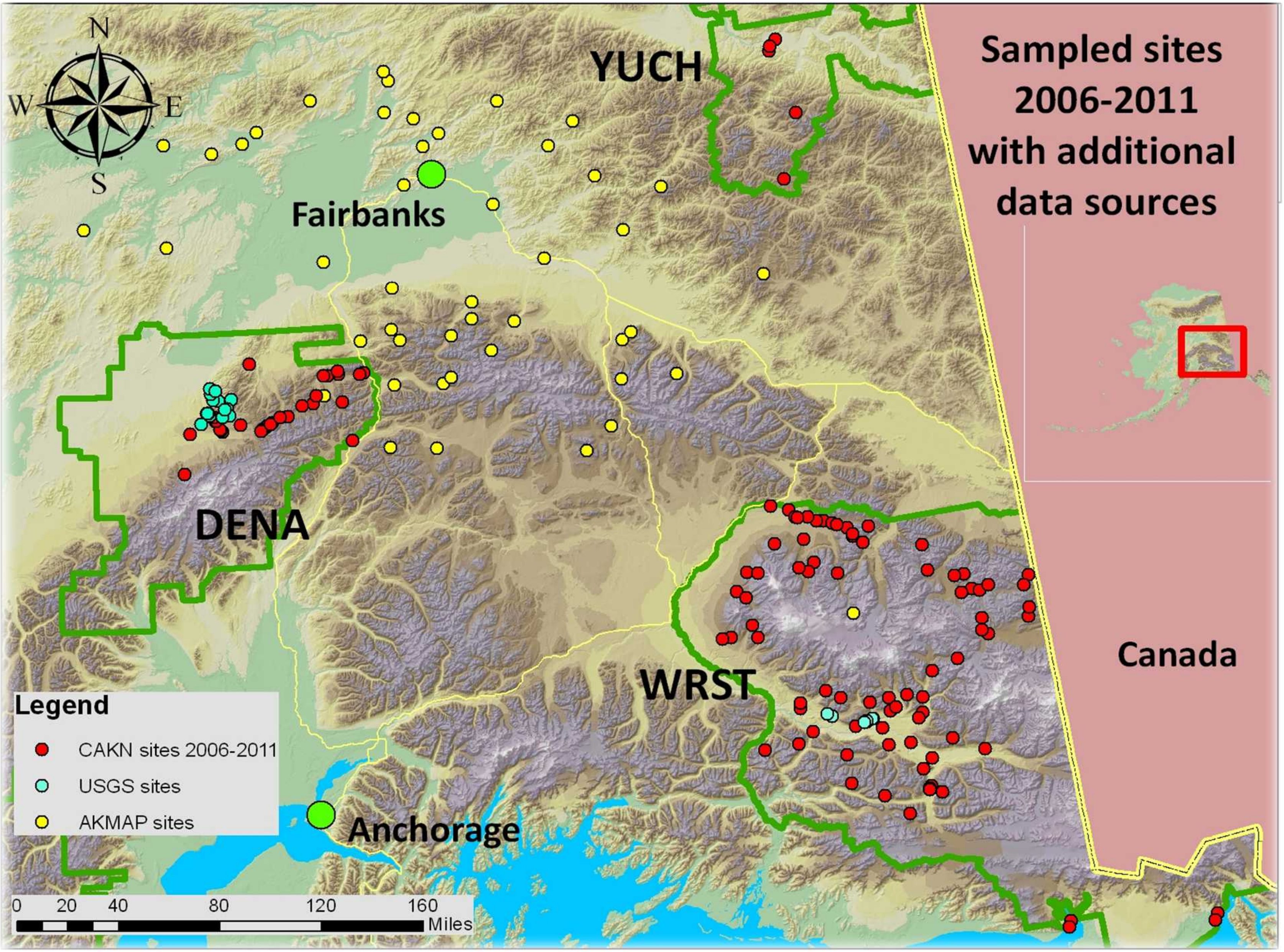
NPS Inventory and Monitoring Program



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Next Steps

Use data from reference sites that are sampled annually to
- estimate variance
- estimate power to detect change in O/E

Include diatom data – separate and combined models

Use models to detect climate change effects?
- Calibrate model using data from limited time period (e.g., 2004-2010)
  – define as baseline condition
- Apply model to sites that are sampled infrequently (GRTS sites)
  - most of these will be reference-quality sites
  - allows change detection at sites sampled for the first time
  - allows estimates of average change over the landscape

Foster collaboration/cooperation with other agencies
- ADEC, USFWS, USGS

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Thanks !

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