Considerations for a Climate Change Monitoring Network in Rivers and Streams

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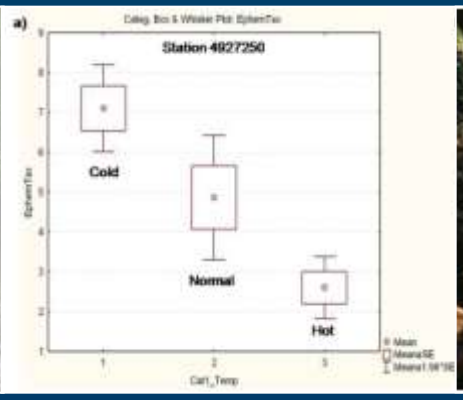

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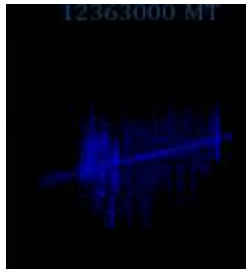
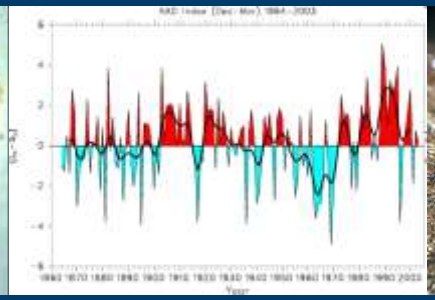
What We've Considered So Far

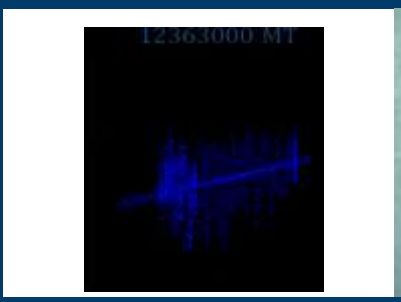
- Maps defining potential monitoring region
- Vulnerabilities and confounding factors
  - Site selection criteria
- Sensitivity of indicators, metrics
  - Candidates to detect climate-related changes

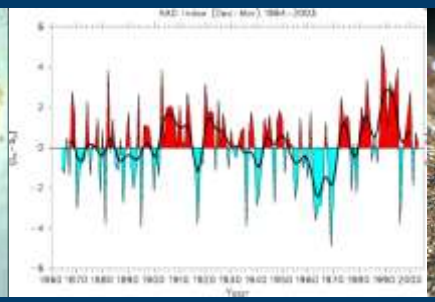


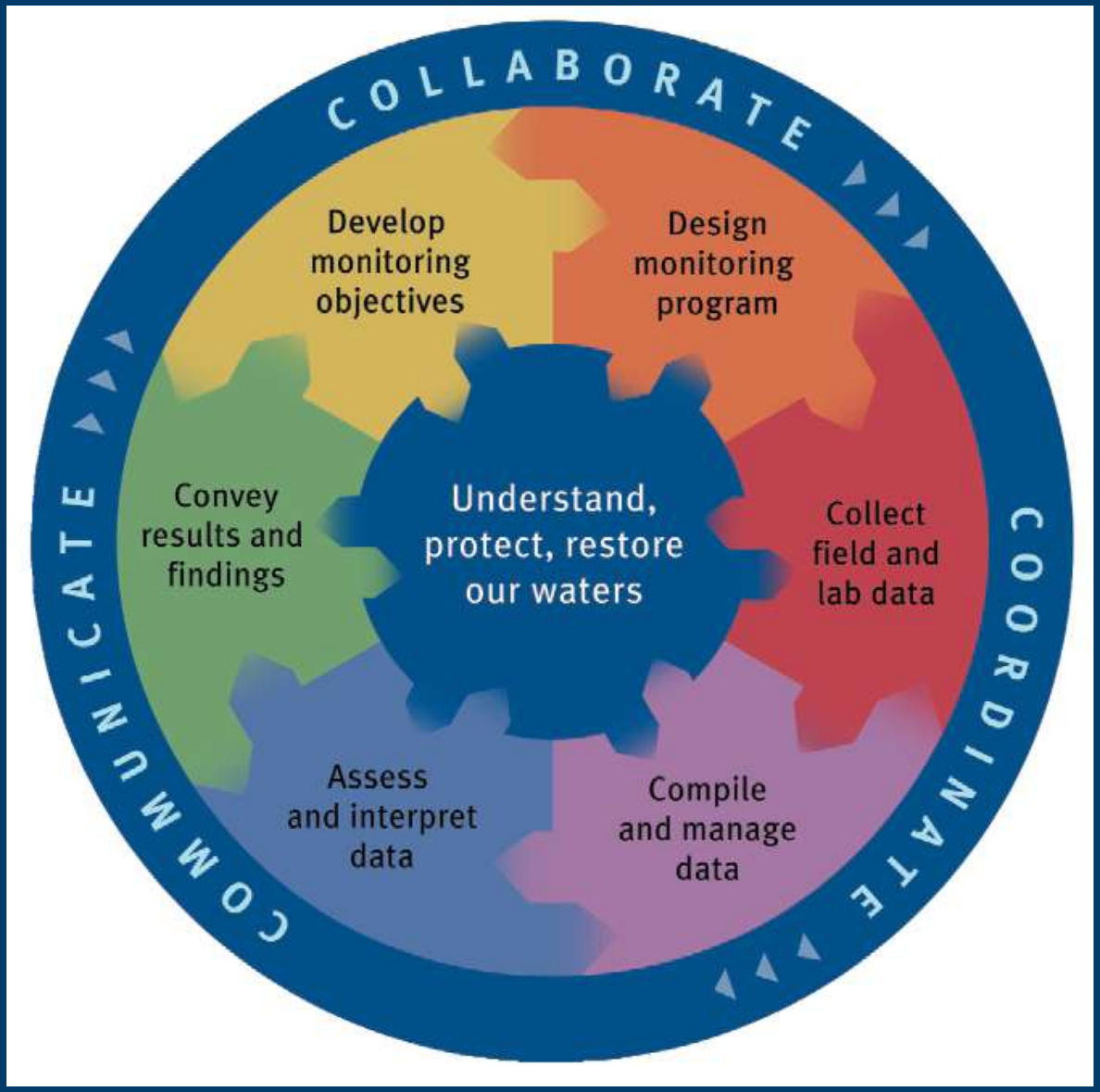
What We Have as Networks

- States perform bioassessment-related sampling
- National Aquatic Resource Surveys
- USGS, USFS, NPS, other EPA networks
- Other efforts that may be relevant



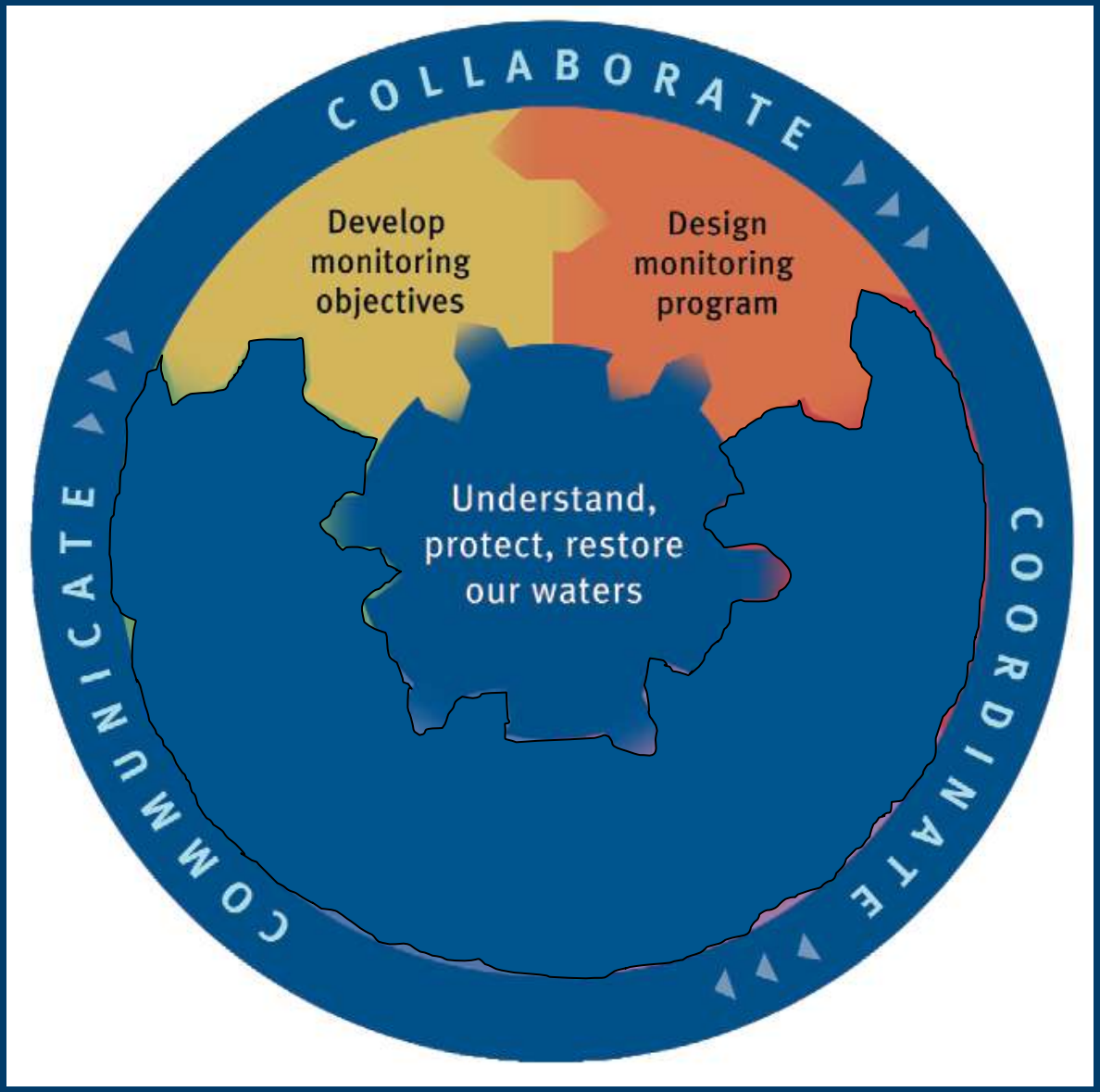


Lots of Steps in Monitoring



Peters & Ward, 2003. Water Resources Impact

Focus for Workshop



Peters & Ward, 2003. Water Resources Impact

Focus for Objectives & Design

Monitoring Objectives

- Which goal(s) to choose

Monitoring Design Elements

- What indicators may work (traits, community metrics)
- What to consider when selecting sites (land use changes, vulnerabilities)
- How to determine sampling frequency (power analysis)




Current Monitoring Goals

- Variety of monitoring networks & goals
  - system condition
  - causes of impairment
  - trends
  - compliance with regulatory programs

Goals need to be met despite climate change effects

- need monitoring to detect effects and distinguish from other sources of impairment

Goals of a Climate Change Effects Monitoring Network

- Detect changes comprehensively
  - Detect changes
  - Attribute effects to climate change
  - Inform management
  - Test hypotheses

- Detect changes early
  - Describe magnitude and extent of impacts
  - Focus on vulnerability of sites
  - Track trends at “canary” sites
  - Limits applicability for management outside of sites

Up to What Condition Can You Detect Climate Changes?

Levels of Biological Condition

Natural structural, functional, and taxonomic integrity is preserved.

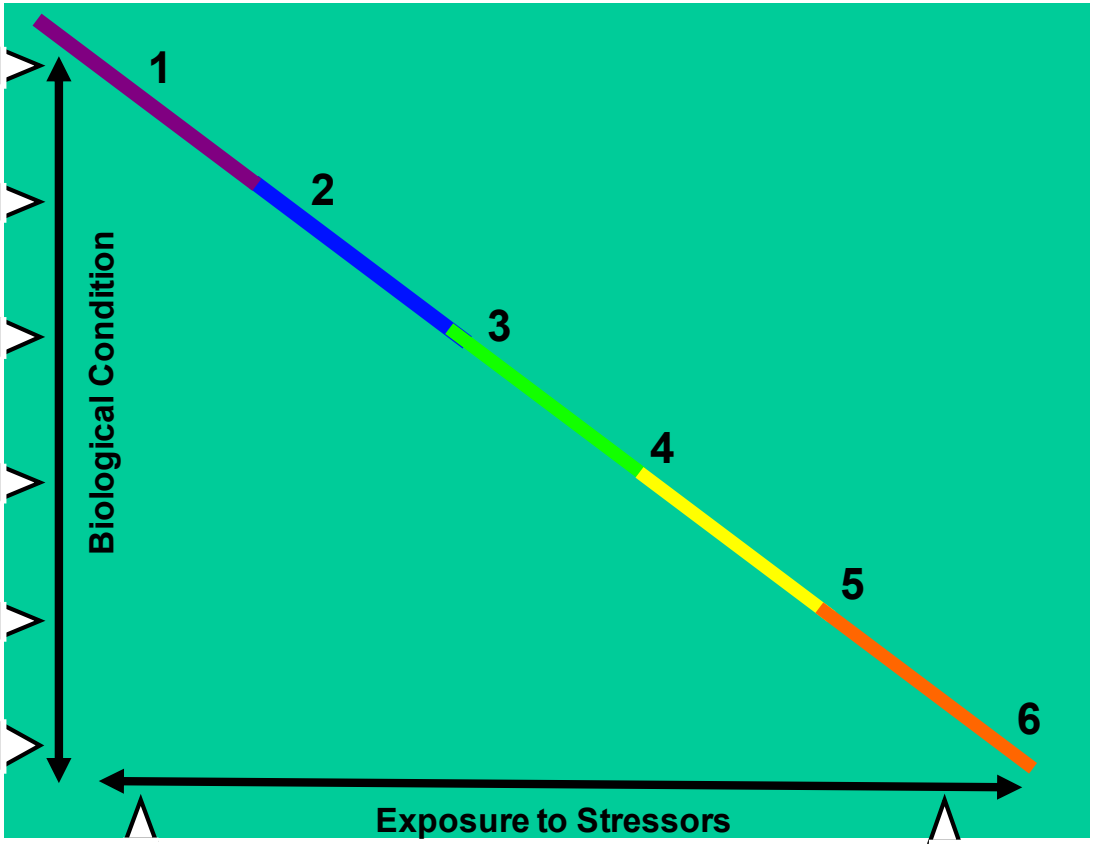
Structure & function similar to natural community with some additional taxa & biomass; ecosystem level functions are fully maintained.

Evident changes in structure due to loss of some highly sensitive taxa; shifts in relative abundance; ecosystem level functions fully maintained.

Moderate changes in structure due to replacement of some sensitive ubiquitous taxa by more tolerant taxa; ecosystem functions largely maintained.

Sensitive taxa markedly diminished; conspicuously unbalanced distribution of major taxonomic groups; ecosystem function shows reduced complexity & redundancy.

Extreme changes in structure and ecosystem function; wholesale changes in taxonomic composition; extreme alterations from normal densities.

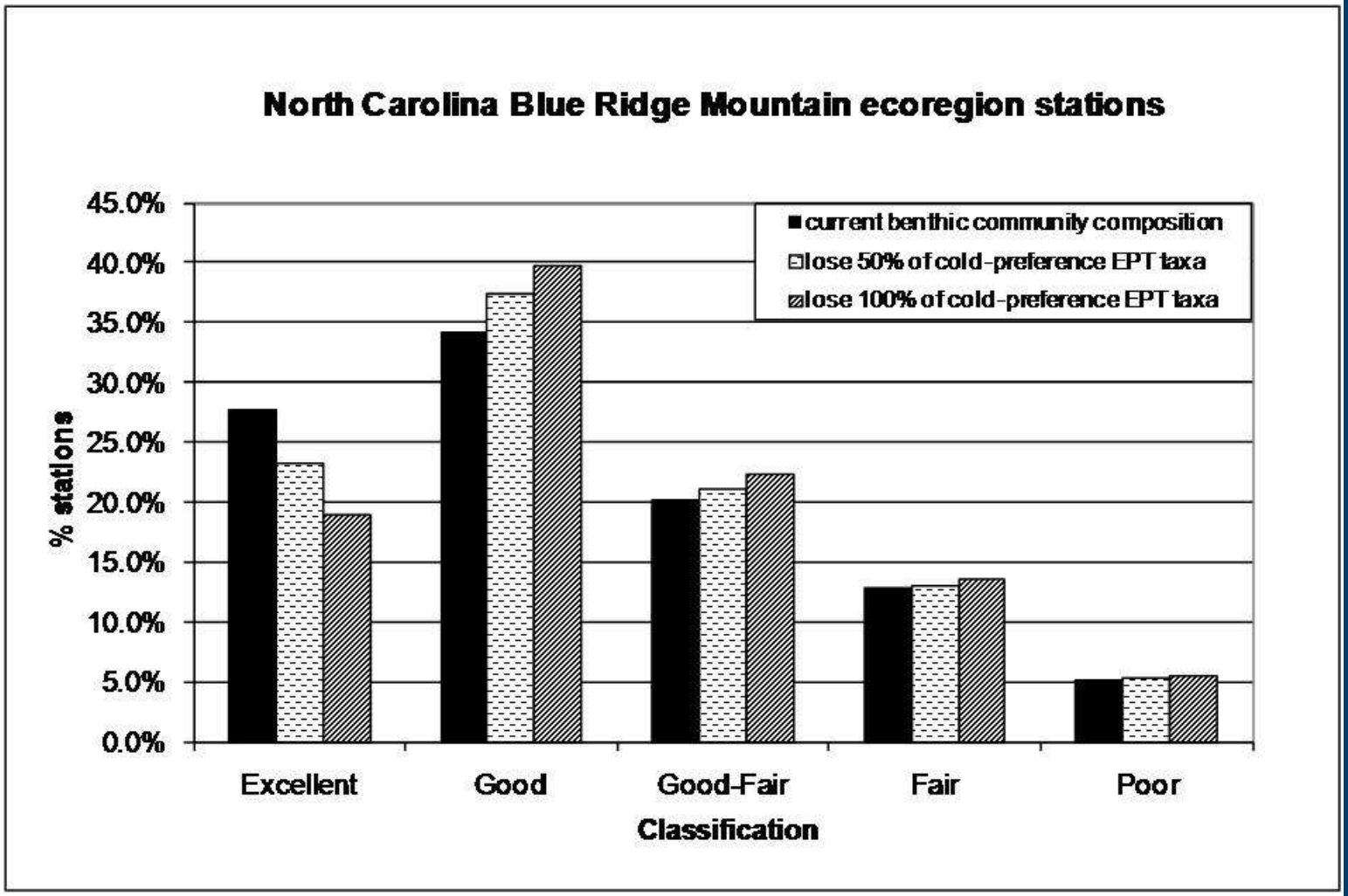


Watershed, habitat, flow regime and water chemistry as naturally occurs

Chemistry, habitat, and/or flow regime severely altered from natural conditions

Schematic of biological condition gradient, showing six levels of condition.

Assessment finding: Reference station status degrades over time



Goals Determine Geography

Comprehensive monitoring network

- Statewide monitoring sites?
- Include all ecoregions?
- Sample across conditions or down to certain level?

"Canary" monitoring network

- Regional monitoring sites
  - Level II or level III ecoregions?

Elements of a Monitoring Program

- Biotic data
- Abiotic/environmental data
  - climate
  - hydrology (temperature, flow)
  - chemistry (pH, DO, nutrients, conductivity)
  - substrate & habitat condition
- Sampling sites
  - site selection criteria
- Sampling design
  - site density & distribution
  - frequency
  - seasonality

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Possible Climate-Sensitive Indicators

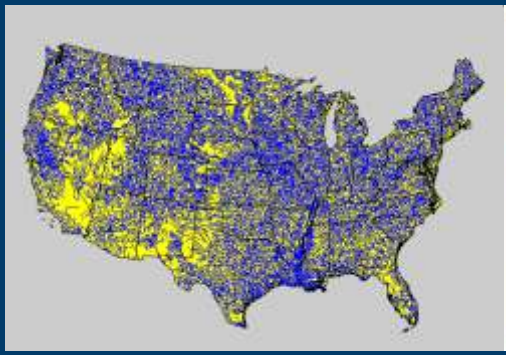
- Cold water preference taxa more widely responsive to changes in water temperature
  - long-term data limited
  - most show non-significant relationships

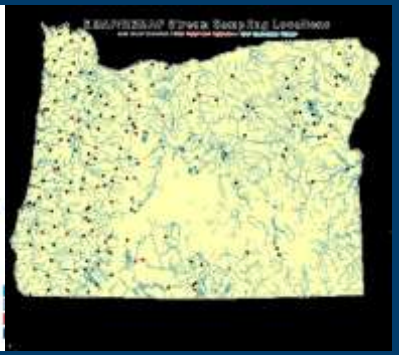
Recommendation

- Create targeted climate change-related metrics
  - cold water preference taxa richness & abundance
  - cold water preference EPT richness
  - ratio of cold water- to warm water-preference EPT richness

Sampling Site Selection

- Represent full spectrum of conditions
  - Minimally disturbed sites
  - Gradients of condition and vulnerabilities
- Use land cover, land use, vulnerabilities to define strata to select samples
- Draw random samples
  - balanced, probabilistic design

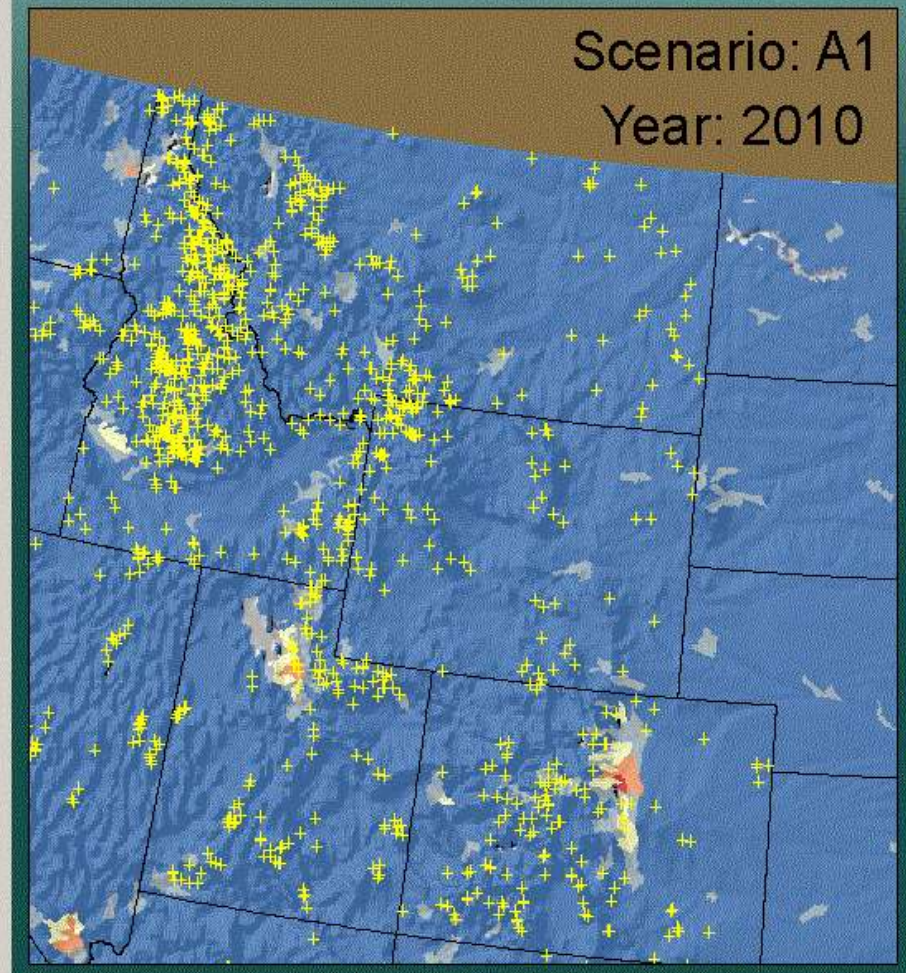


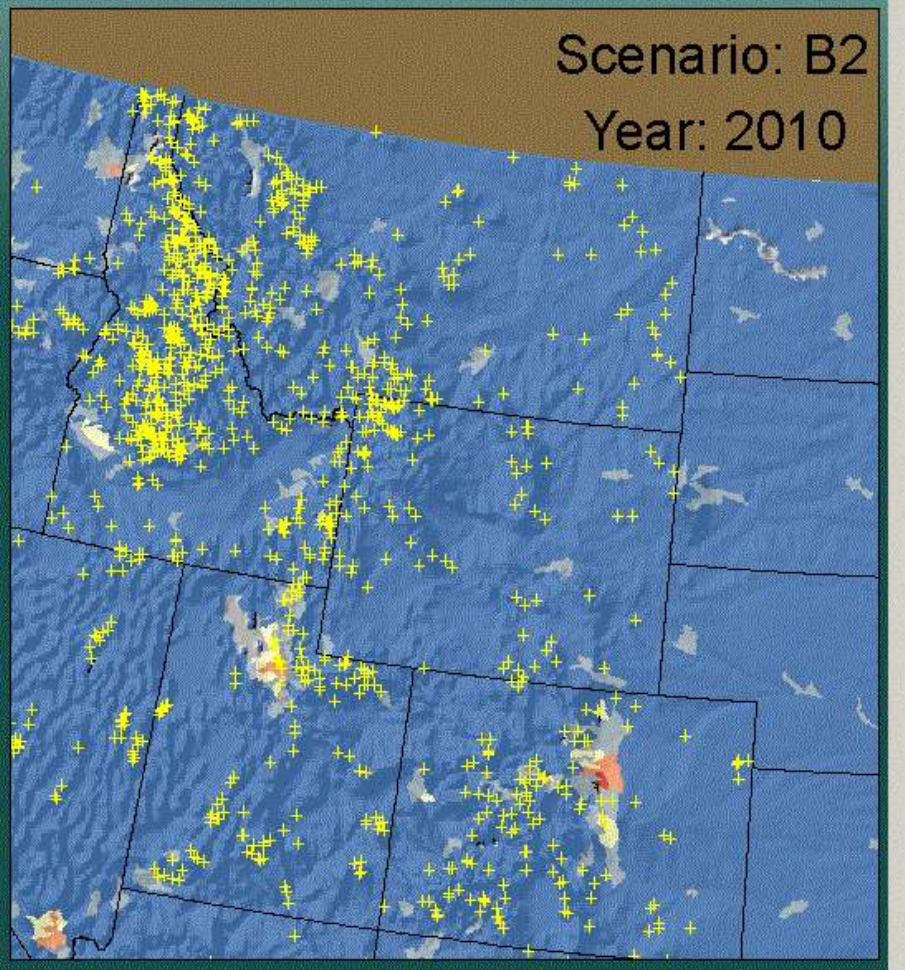


Number of Reference Sites By Watershed Condition (HUC-10)

0	Damaged	0
9	Impacted	9
23	Stressed	21
177	L. Stressed	173
2,140	Unstressed	2,146

Integrated Climate and Land-Use Scenarios (version 1.3)

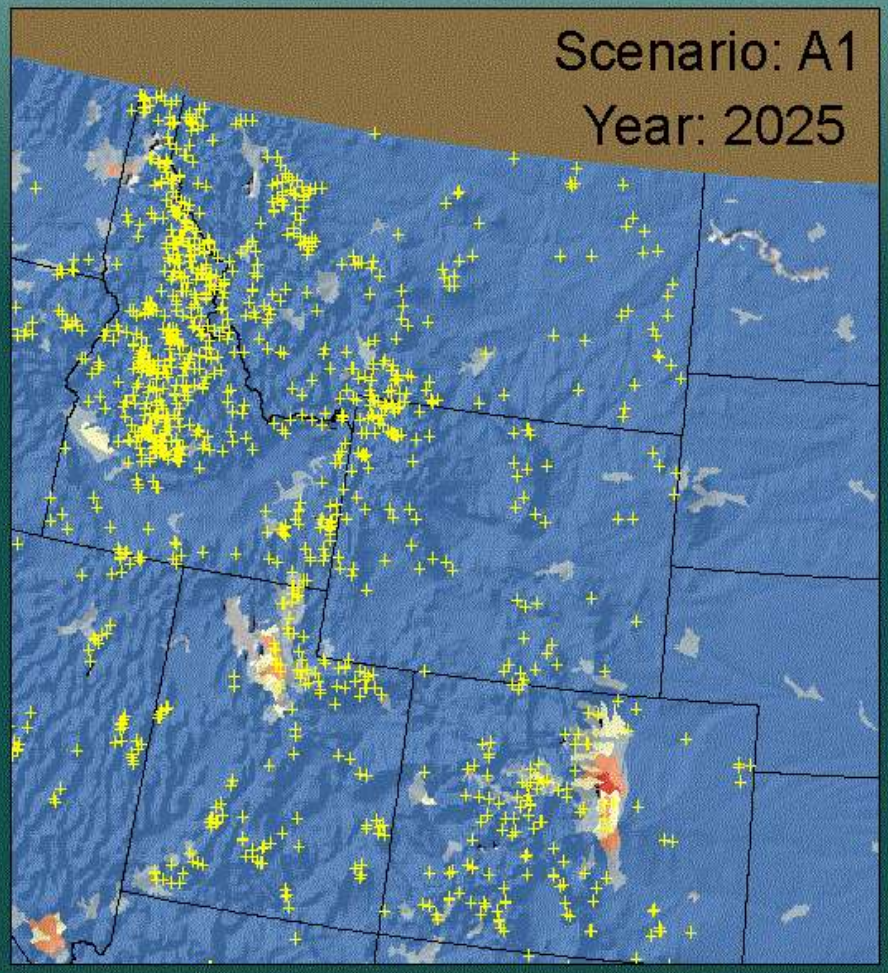


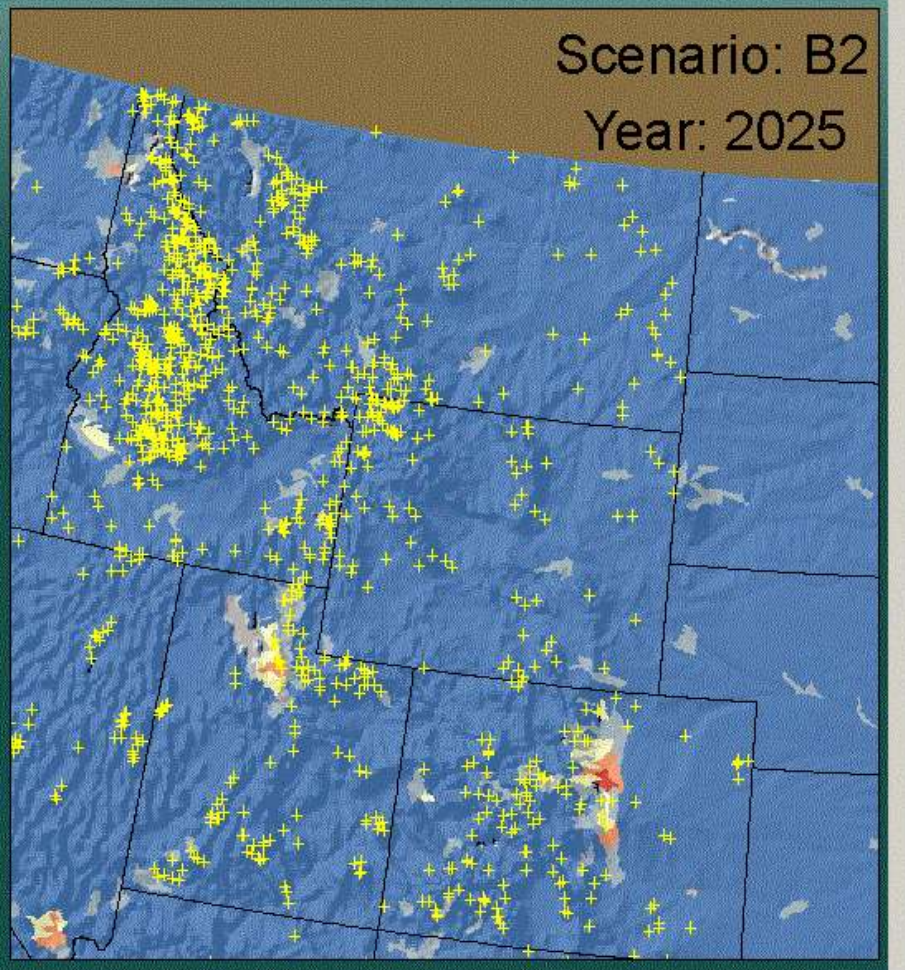


Number of Reference Sites By Watershed Condition (HUC-10)

0	Damaged	0
15	Impacted	12
24	Stressed	20
226	L. Stressed	199
2,084	Unstressed	2,118

Integrated Climate and Land-Use Scenarios (version 1.3)

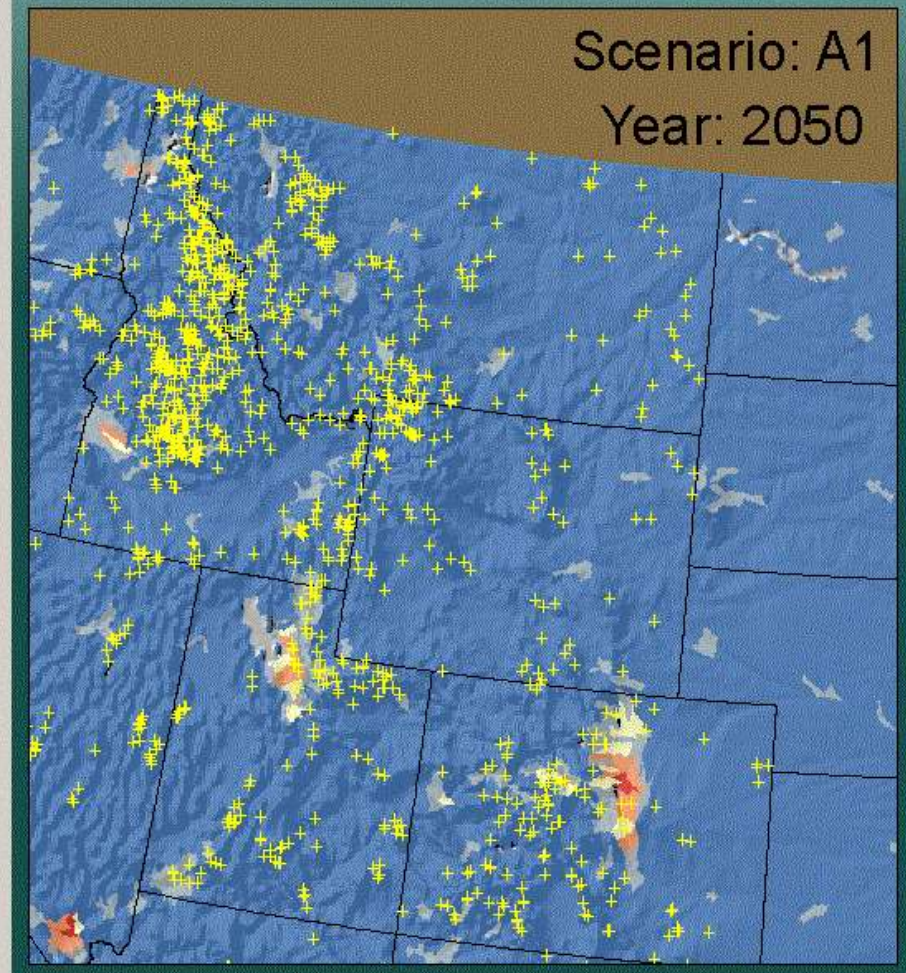


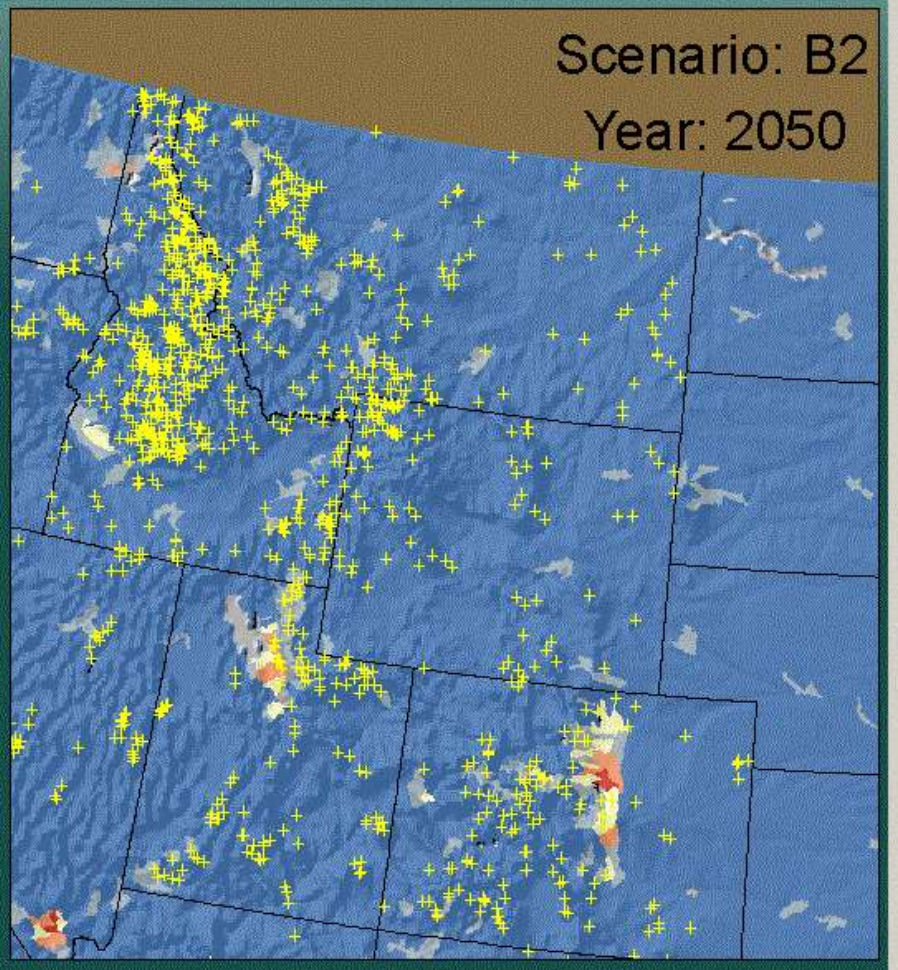


Number of Reference Sites By Watershed Condition (HUC-10)

0	Damaged	0
19	Impacted	15
37	Stressed	32
240	L. Stressed	209
2,053	Unstressed	2,093

Integrated Climate and Land-Use Scenarios (version 1.3)

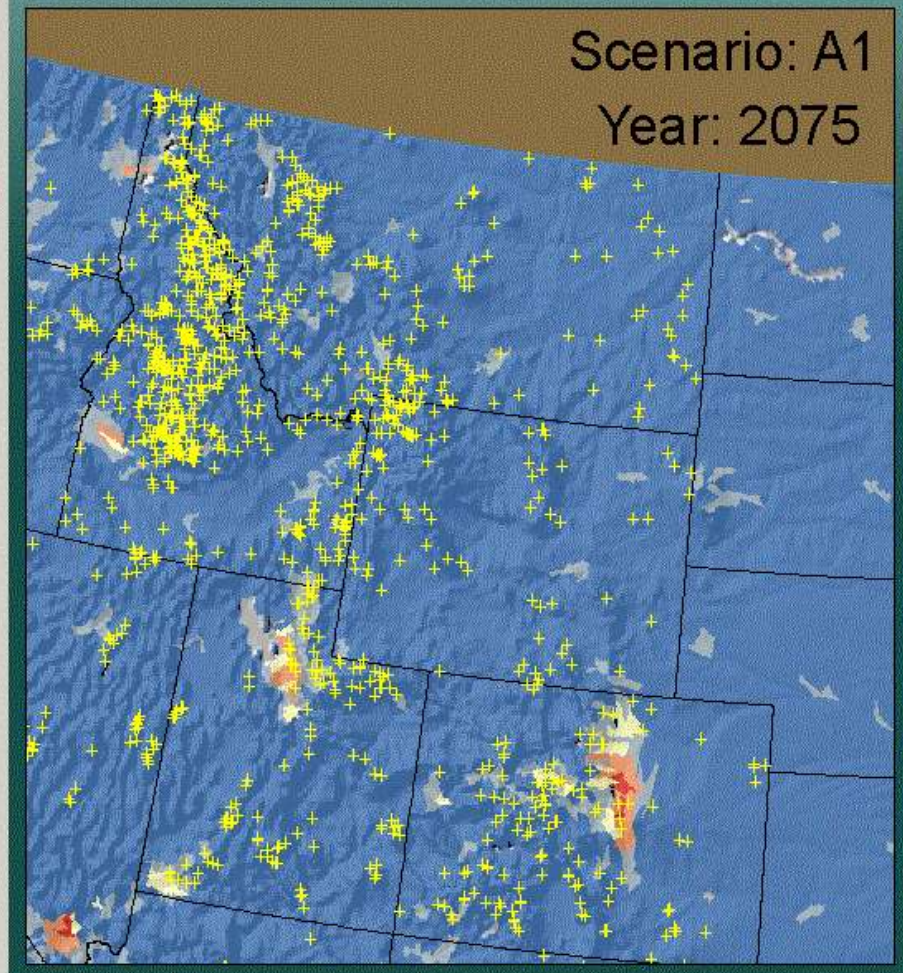


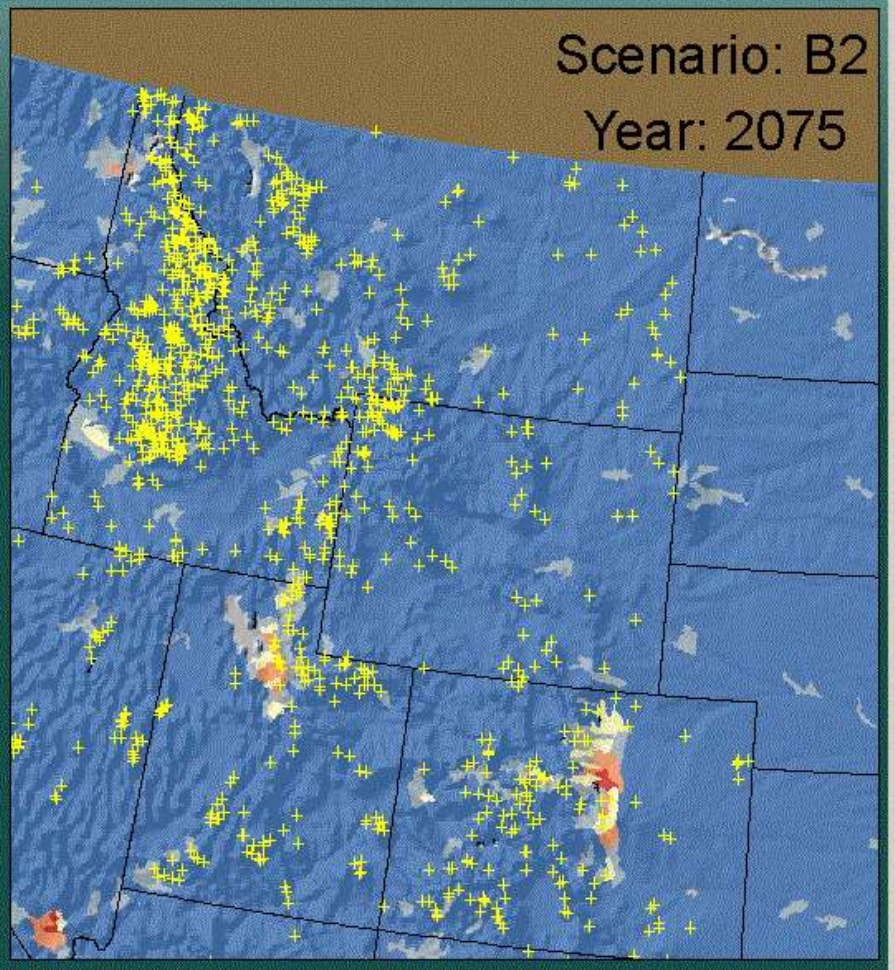


Number of Reference Sites By Watershed Condition (HUC-10)

0	Damaged	0
24	Impacted	16
36	Stressed	37
237	L. Stressed	220
2,052	Unstressed	2,076

Integrated Climate and Land-Use Scenarios (version 1.3)

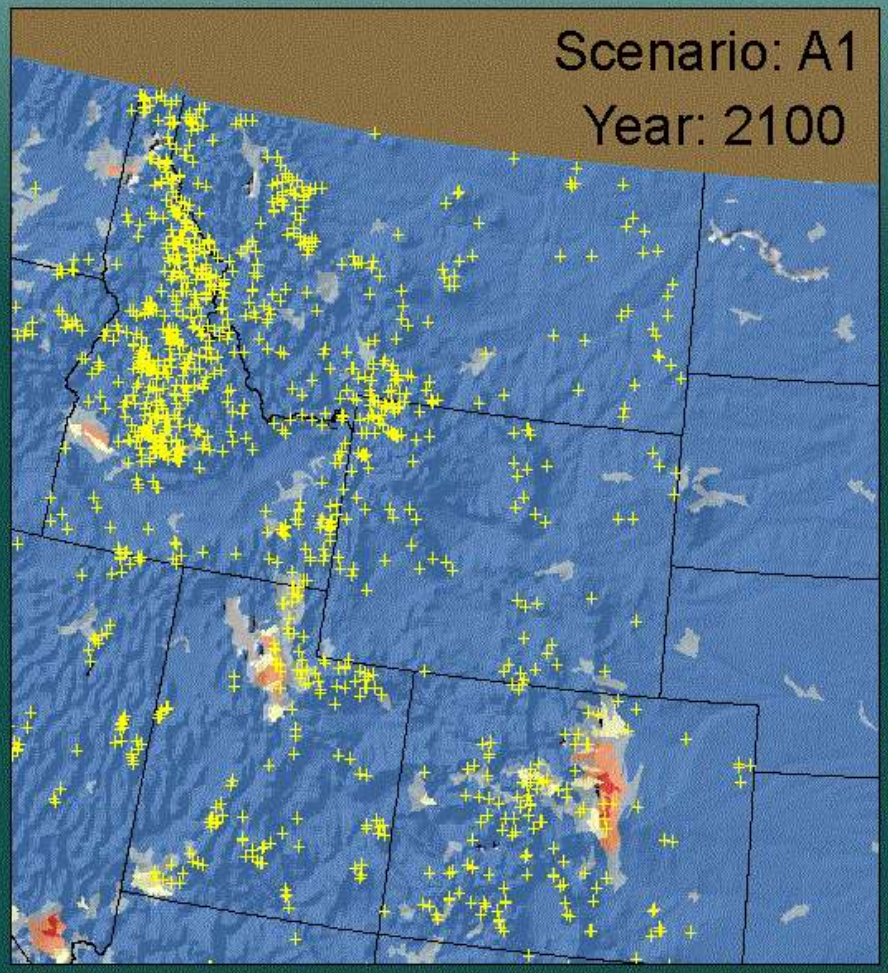


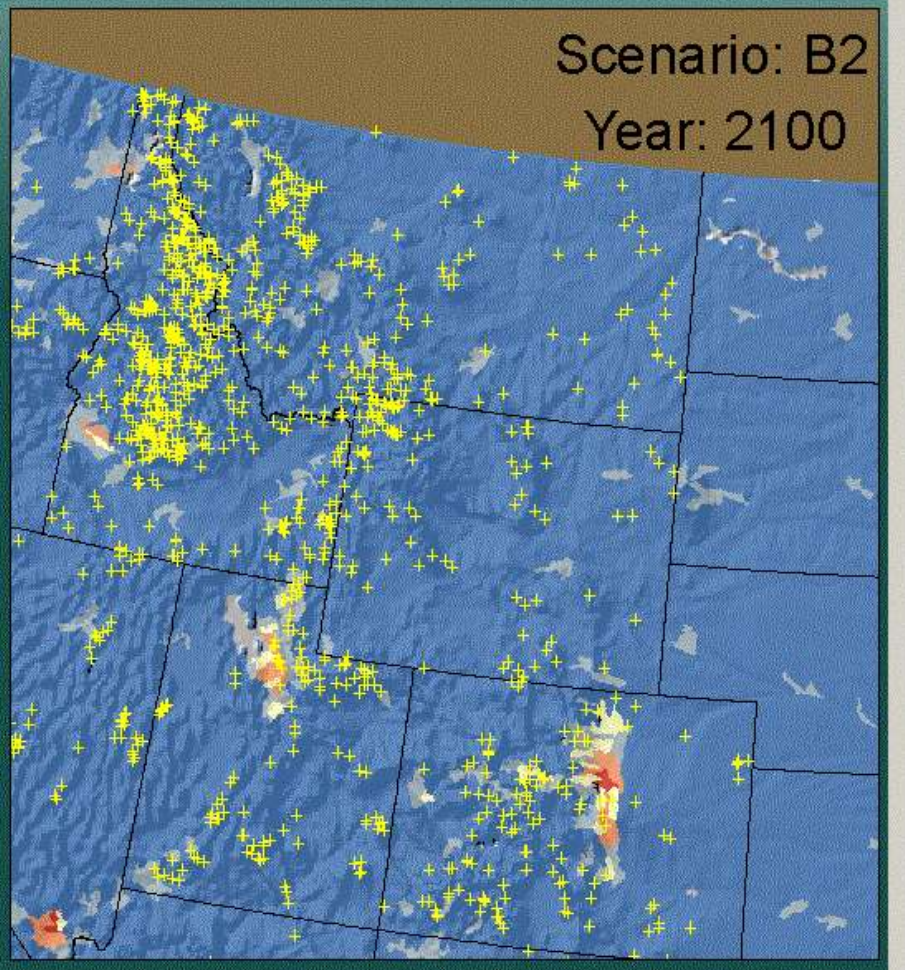


Number of Reference Sites By Watershed Condition (HUC-10)

0	Damaged	0
24	Impacted	25
36	Stressed	39
242	L. Stressed	229
2,047	Unstressed	2,056

Integrated Climate and Land-Use Scenarios (version 1.3)





Recommendations for Reference Sites

- Select reference sites using consistent criteria across country (regions) for monitoring network
  - potentially select sites to monitor along entire condition gradient
- Protect reference sites from degradation due to conventional stressors
  - land development
  - land cover change

Summary of Surveys

Region	No. Sites	No. Visits	Years Surveyed
Colorado Plateau (Utah)	18	70	1982-83, 1985-96, 2000-05
Wasatch & Uinta Mts (Utah)	38	105	1985-2005
Laurentian Hills & Plains (Maine)	106	239	1974, 1981, 1983-2006

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Trends in Loss Rates

	Colorado Plateau	Wasatch & Uinta Mts	Laurentian Hills & Plains
Temperature rate (° C/yr)	0.047	0.054	0.022
Loss cold-preference taxa/yr	1.59	1.48	0.72
Variance of cold-preference taxa	NA	9.3	2.2
Loss EPT taxa/yr	2.66	3.47	NS
Variance EPT taxa	NA	NA	15.5
Decrease relative abundance EPT taxa/yr	NS	NS	14.65
Variance EPT relative abundance	NA	NA	559

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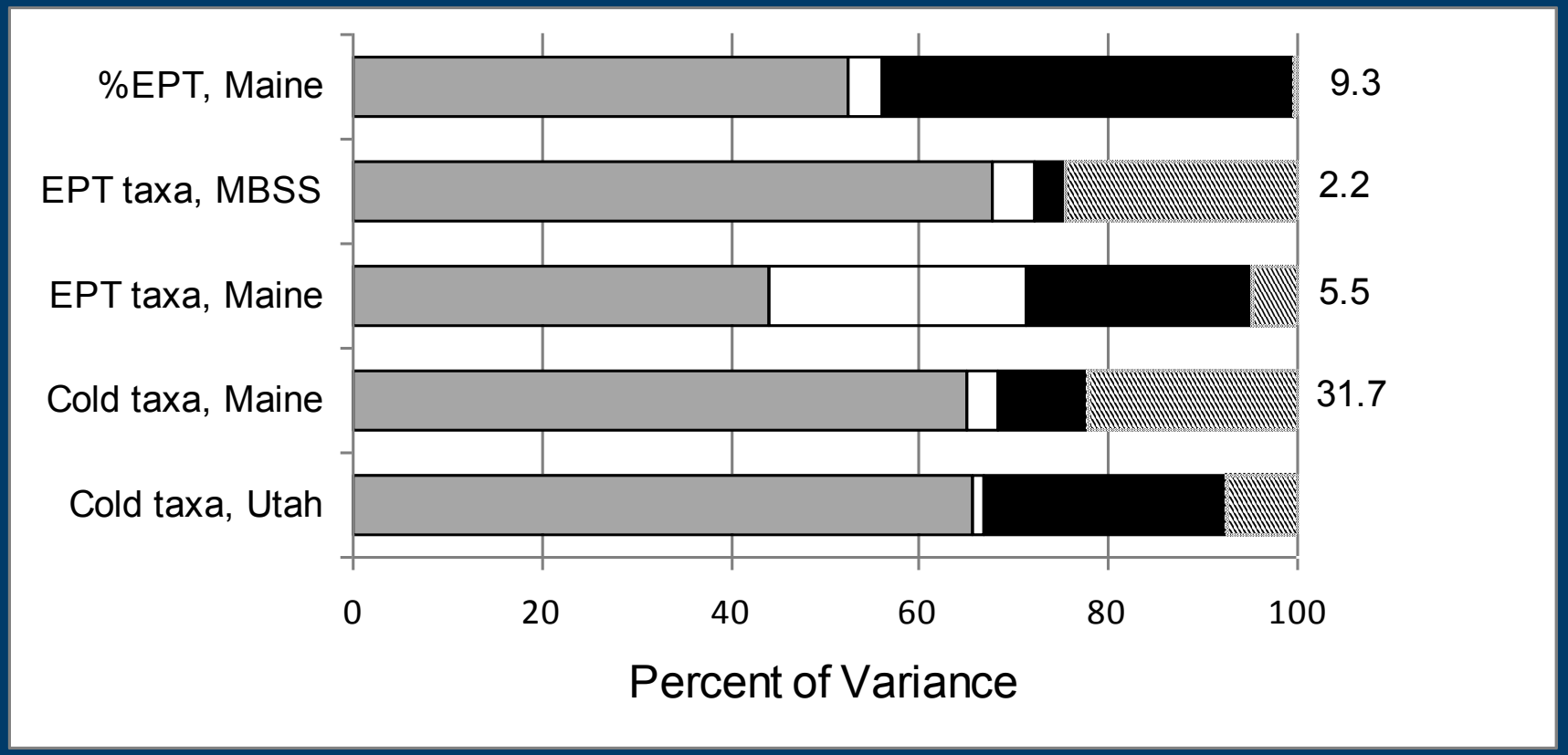

Time to Detect Trend

Laurentian Hills & Plains	Trend (years) 3%	2%	1%	0.5%
Coldwater taxa loss/° C	14	18	29	>30
EPT taxa loss/° C	18	24	>30	>30
Percent EPT taxa loss/° C	10	13	21	>30

Using rotating panel of 30 sampling sites

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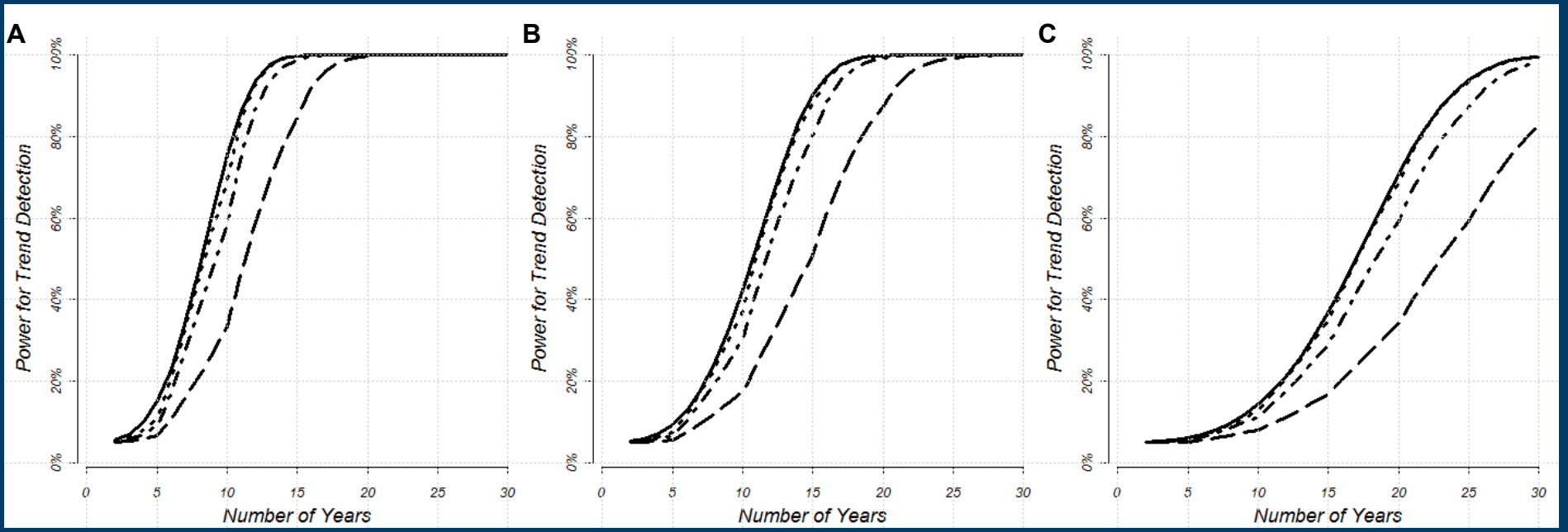

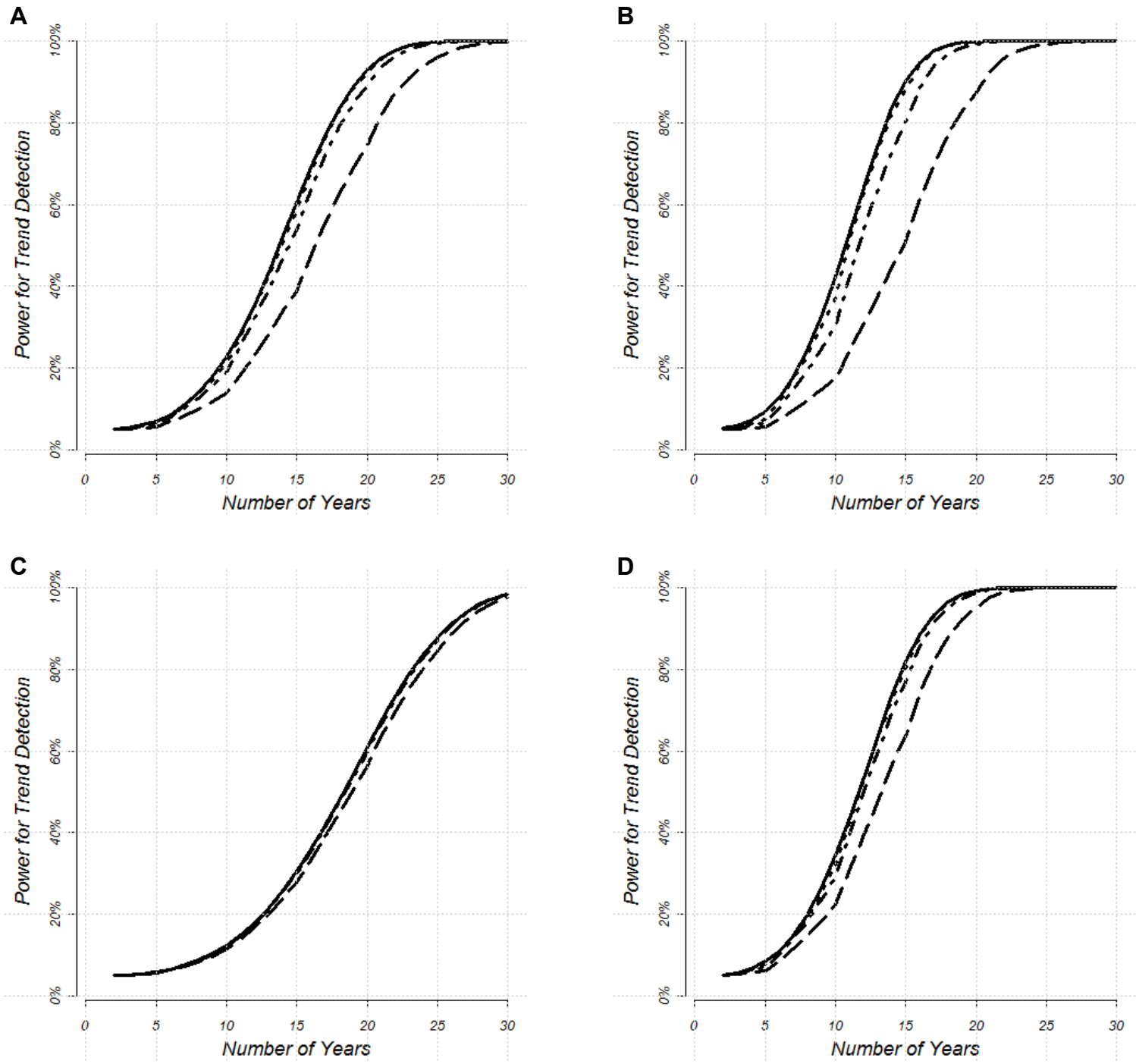
A
B
C
D
Power for Trend Detection
0%
20%
40%
60%
80%
100%
0
5
10
15
20
25
30
Number of Years

Reasons to Create Comprehensive Network

- Have evidence that climate change is occurring
  - Impacts expected in aquatic ecosystems

- Do need to understand how to deal with impacts
- Do need to continue to detect impairment
- Do need to establish baseline from which to detect changes

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Modifying Sampling Designs

- How can we build on current monitoring designs?
  - maximize ability to detect small, long-term changes
- How is ability to detect changes influenced by sampling design
- Can we use current information to select suitable reference sites in ecoregions?
  - How frequently are these monitored?
  - How frequently could these be monitored?

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Thank you!