

US EPA ARCHIVE DOCUMENT

Considerations for a Climate Change Monitoring Network in Rivers and Streams

Britta Bierwagen

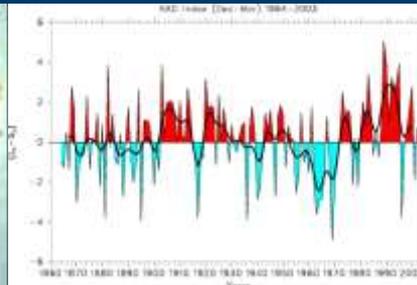
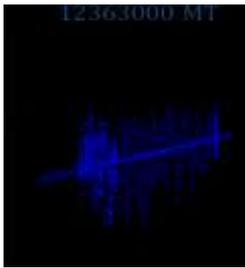
Global Change Research Program, National Center for Environmental Assessment, ORD, USEPA



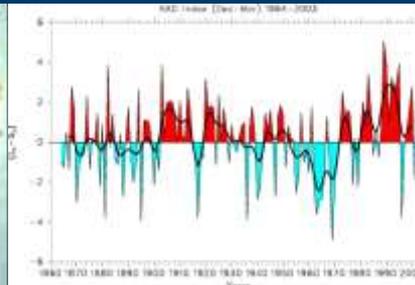
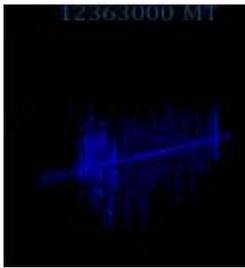
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What We've Considered So Far

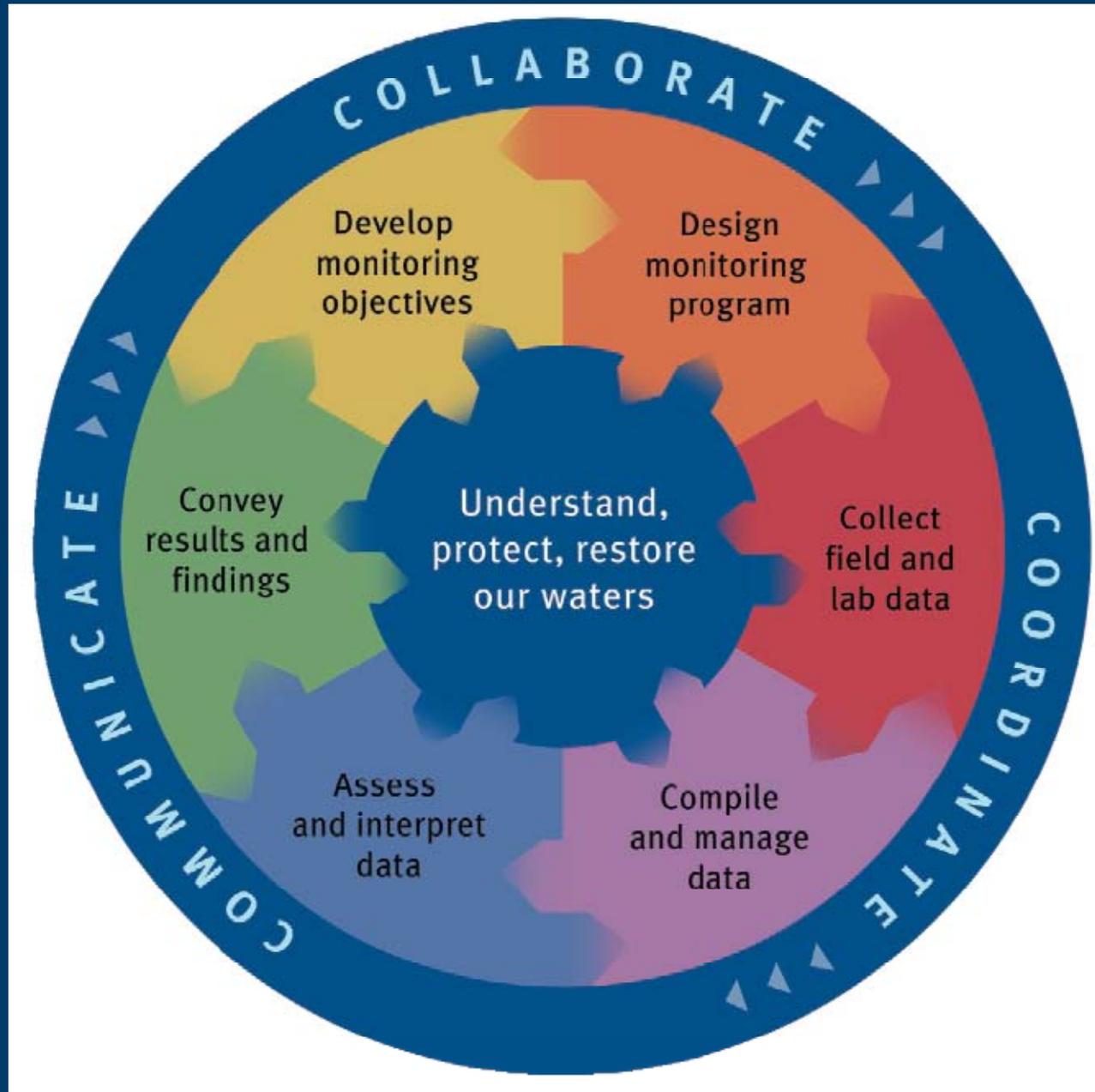
- Scales and geographies of potential monitoring region
- Vulnerabilities and confounding factors
 - Site selection criteria
 - Approaching thresholds
- Sensitivity of indicators, metrics
 - Candidates to detect climate-related changes



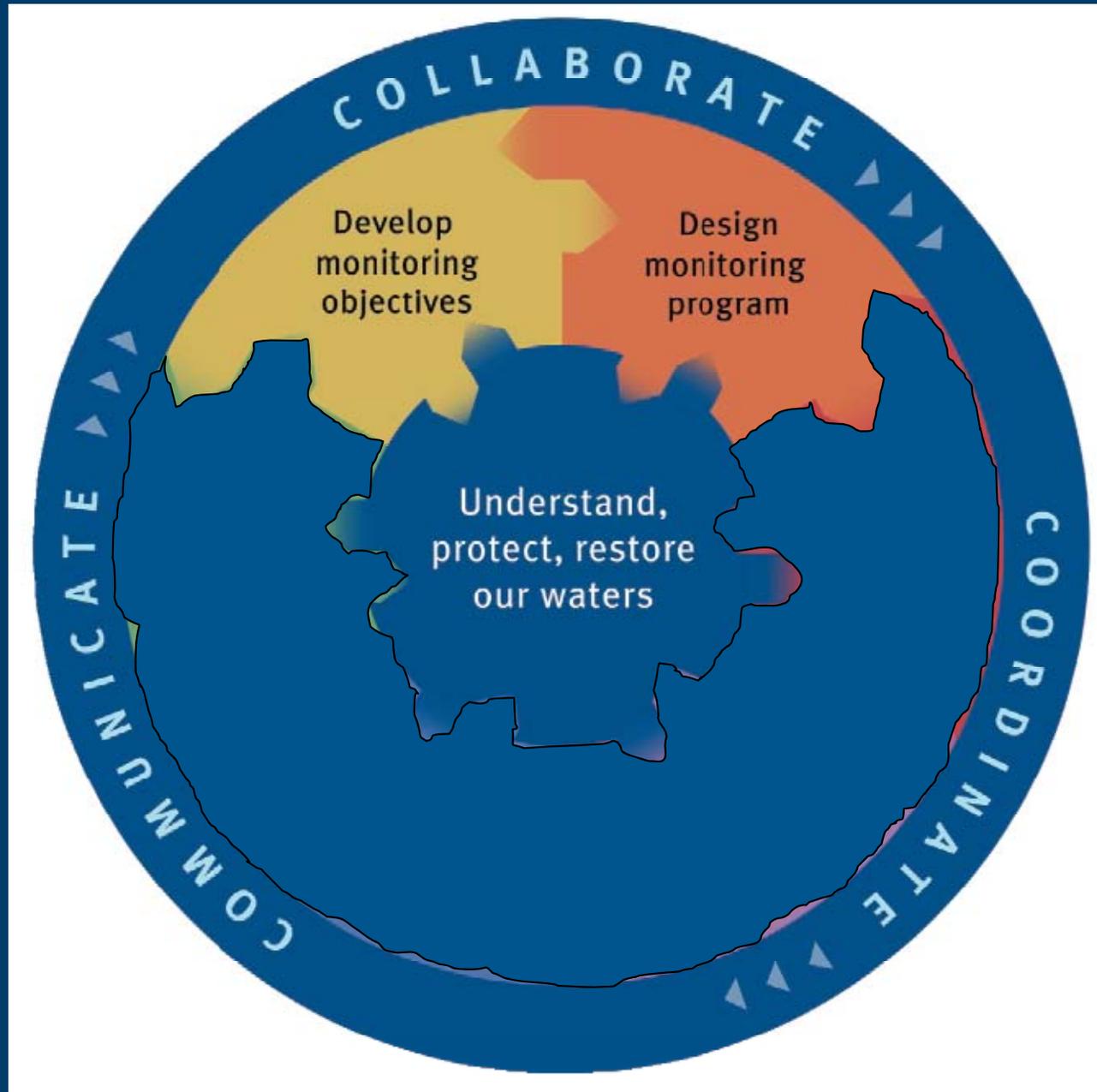
- States and tribes perform bioassessment-related sampling
- National Aquatic Resource Surveys
- USGS, USFS, NPS, other EPA networks
- Other efforts that may be relevant



Lots of Steps in Monitoring



Focus for Workshop



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 - risks, exposure, thresholds)
- How to determine sampling frequency (power analysis)





- 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

- **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



Natural structural, functional, and taxonomic integrity is preserved.

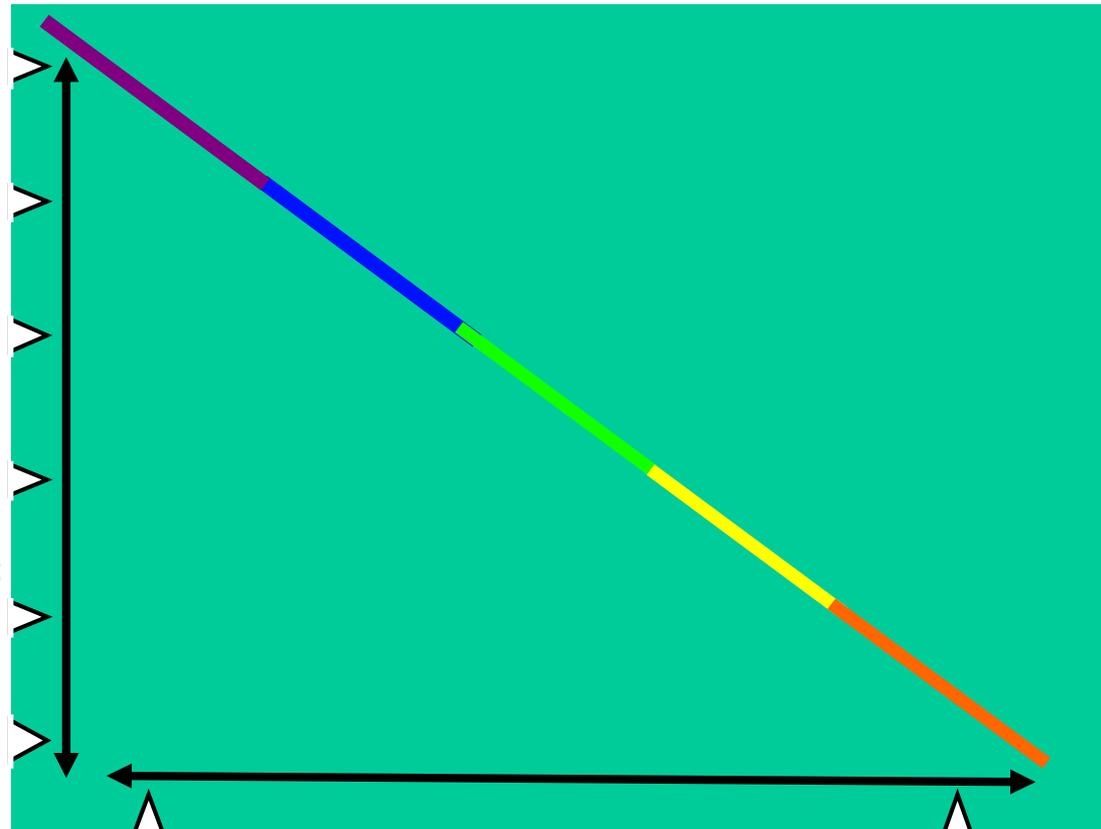
Structure & function similar to natural community with some additional taxa & biomass; ecosystem level functions are fully maintained.

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.

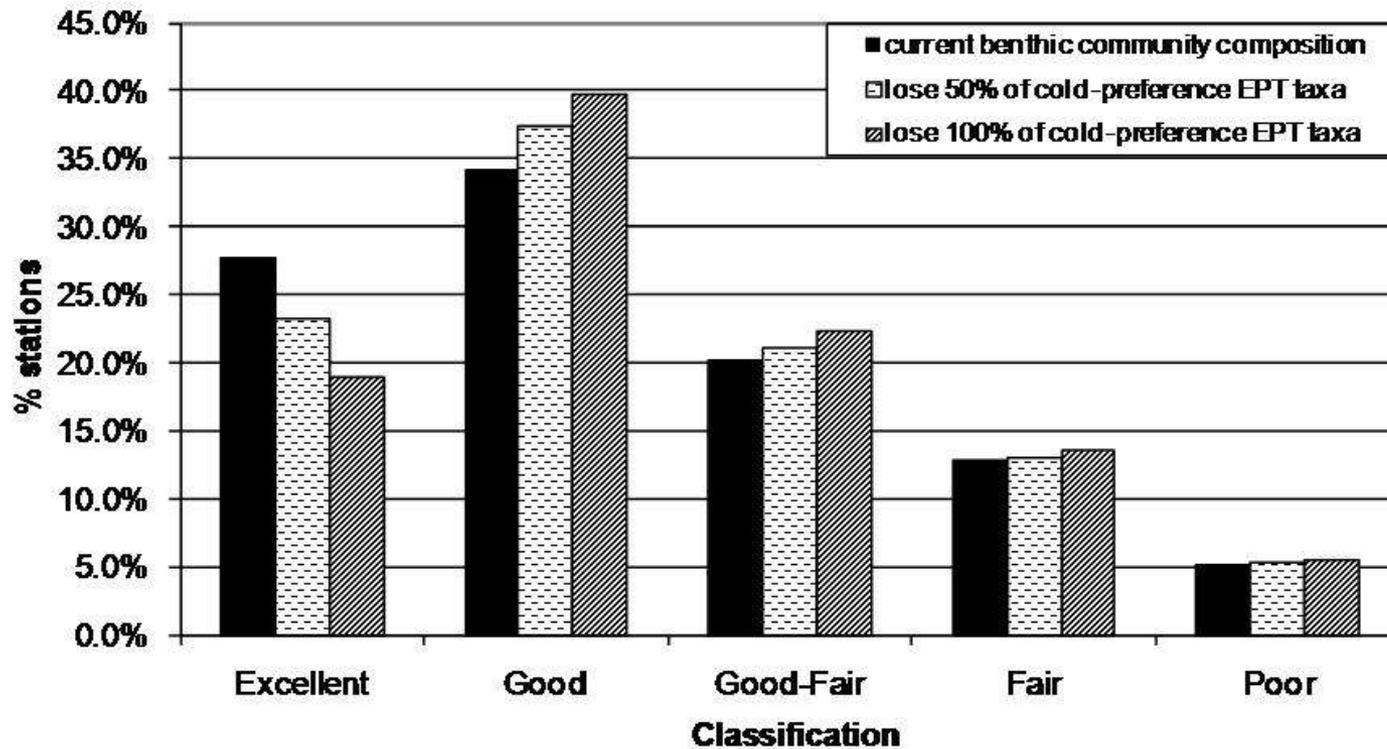


Watershed, habitat, flow regime and water chemistry as naturally occurs

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

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

North Carolina Blue Ridge Mountain ecoregion stations



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?





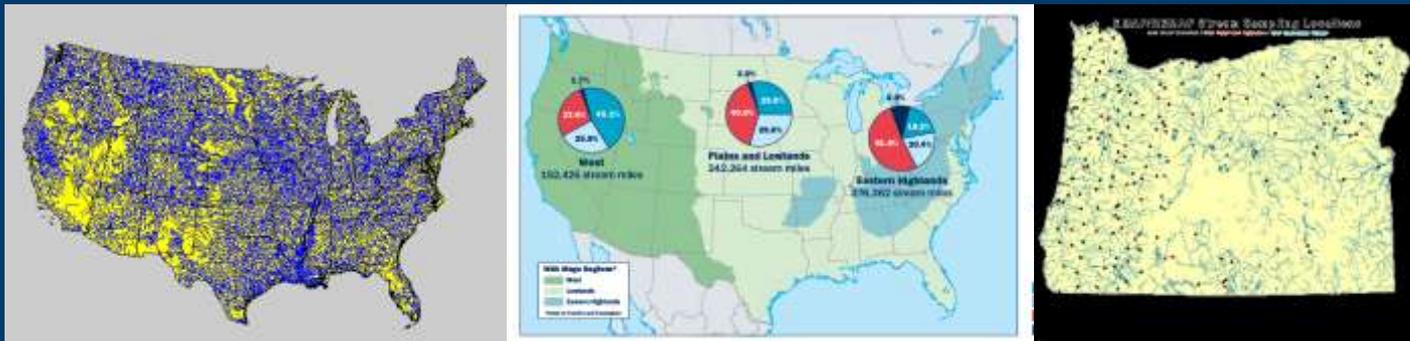
- Biotic data
- Abiotic/environmental data
 - climate
 - hydrology (temperature, flow)
 - chemistry (pH, DO, nutrients, conductivity)
 - substrate & habitat condition
- Sampling sites
 - site selection criteria
- Sampling design
 - site density & distribution
 - frequency
 - seasonality

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

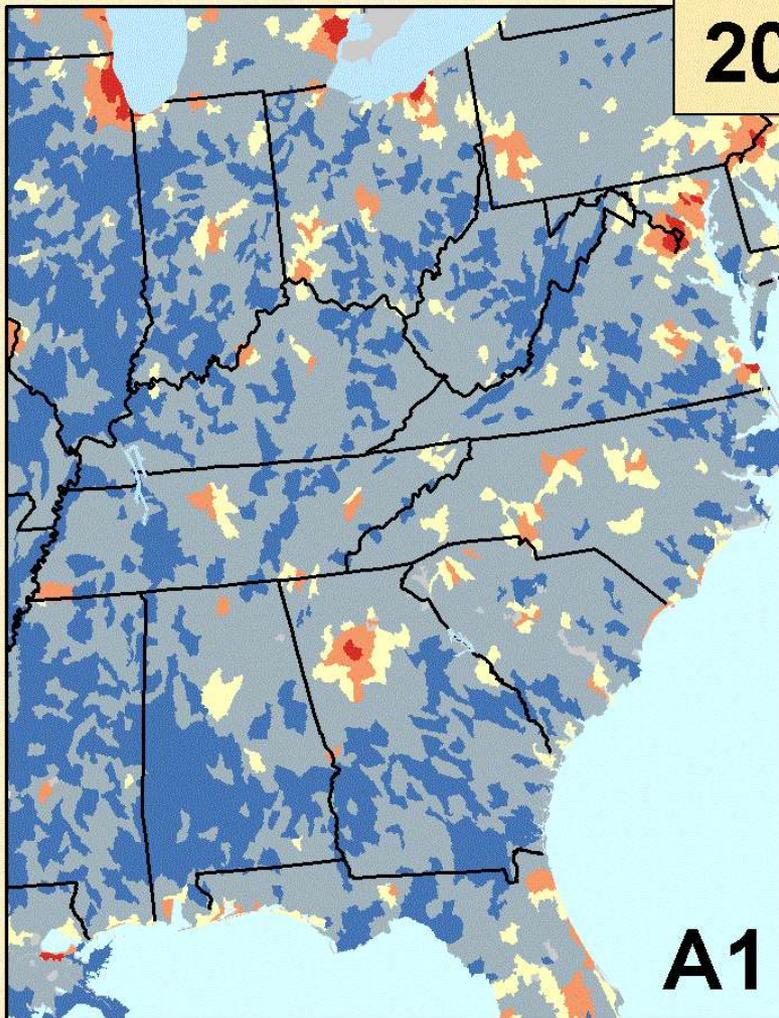
Recommendation

- 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

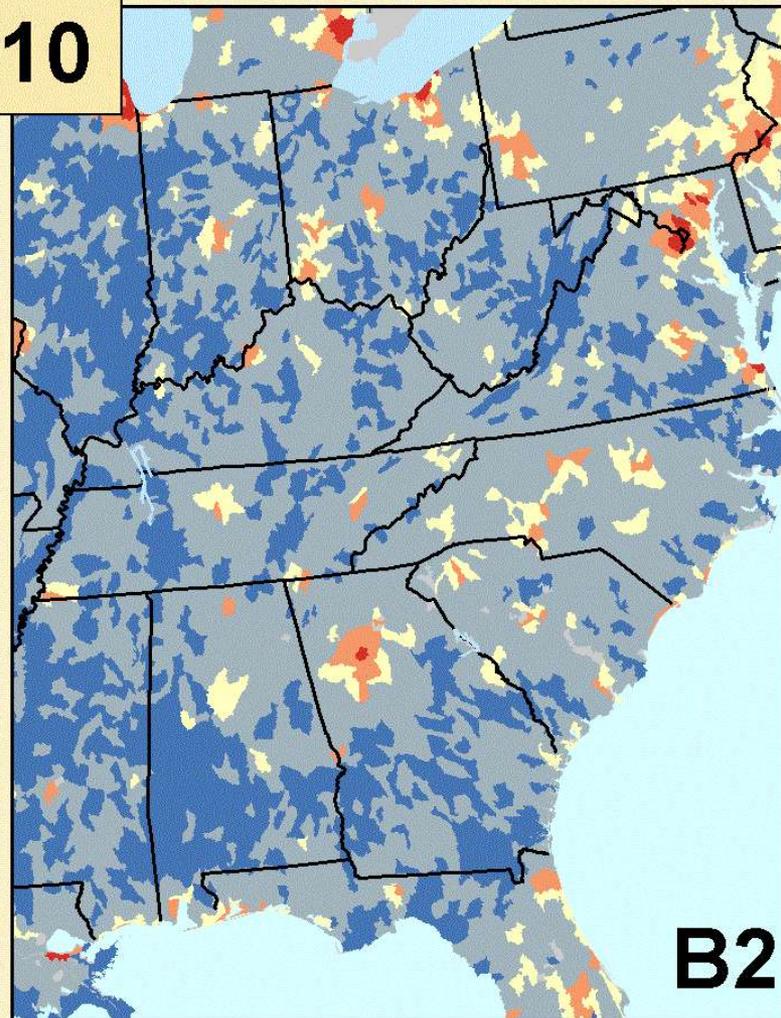
- Represent full spectrum of conditions
 - Minimally disturbed sites
 - Gradients of condition and vulnerabilities
- Use land cover, land use, vulnerabilities to define strata to select samples
- Draw random samples
 - balanced, probabilistic design



2010



A1



B2



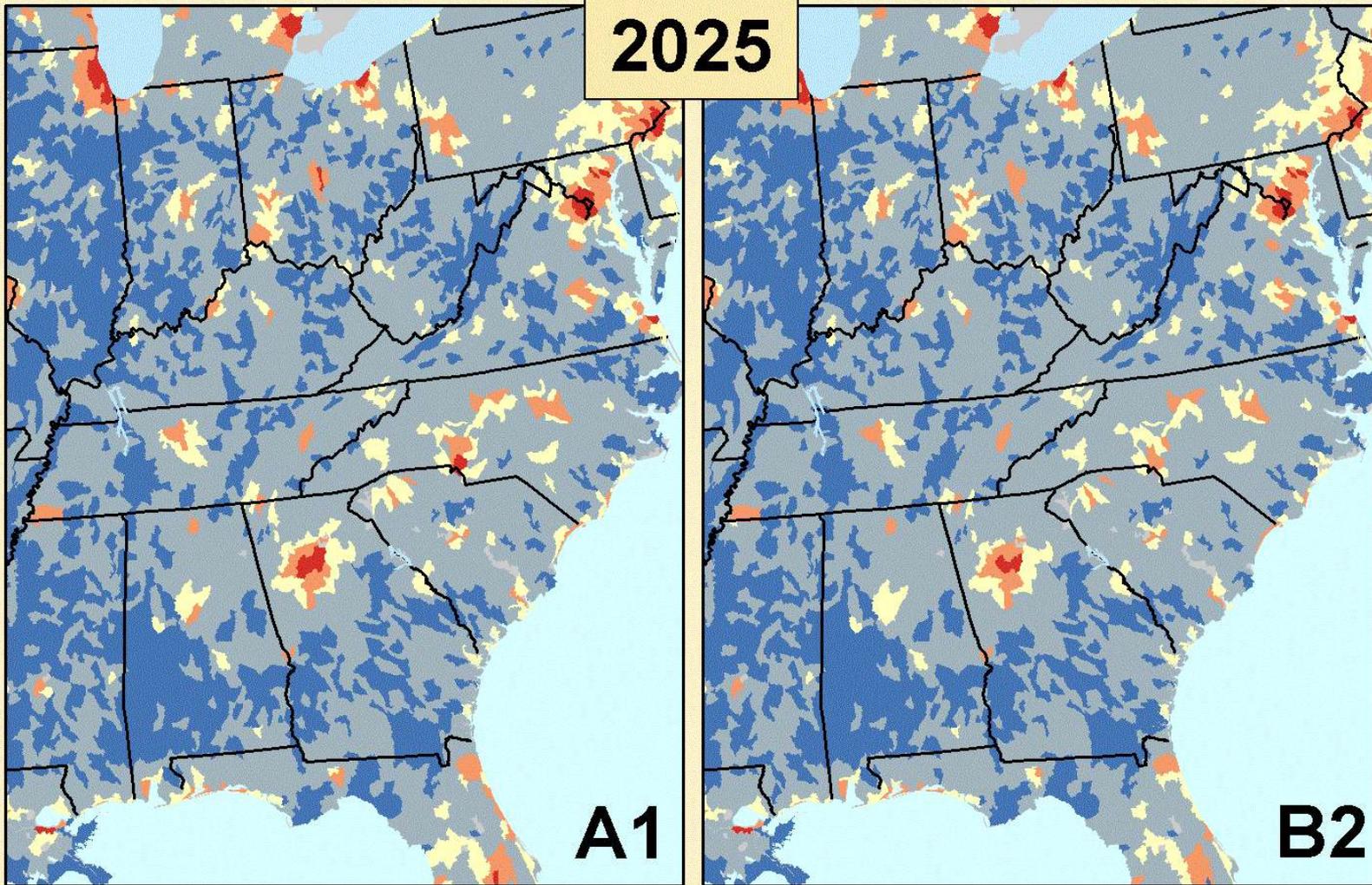
Integrated Climate and Land-Use Scenarios (ICLUS); version 1.3



Albers Projection
Central Meridian: -96
1st Std Parallel: 20
2nd Std Parallel: 80
Latitude of Origin: -40



2025



A1

B2



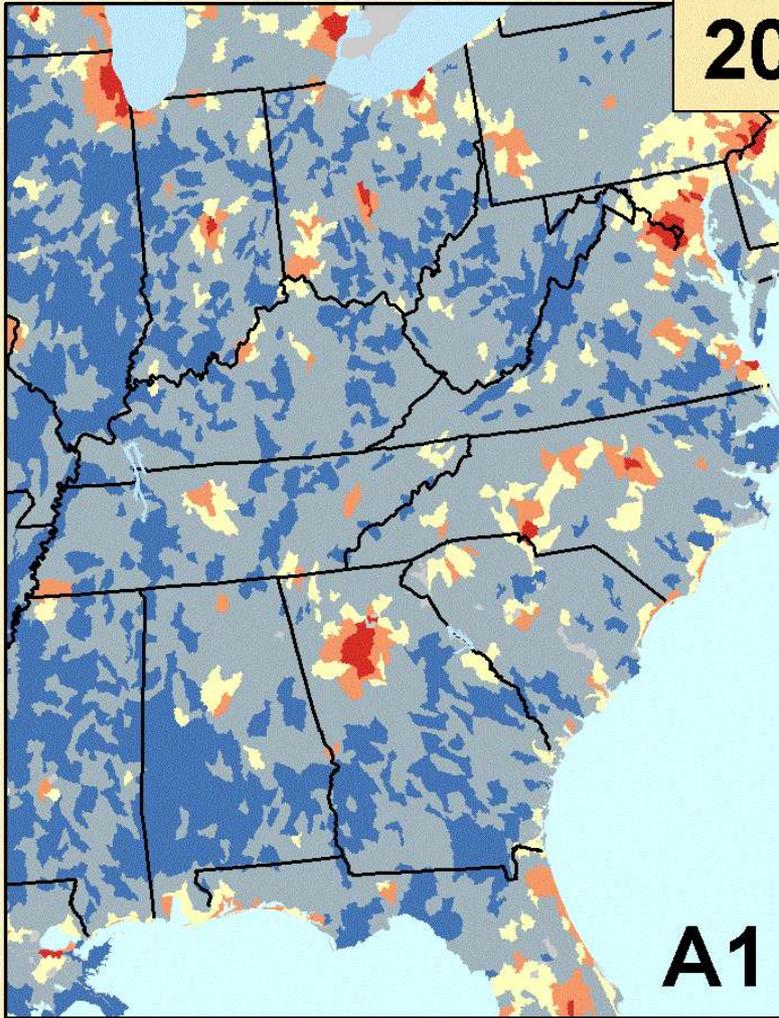
Integrated Climate and Land-Use Scenarios (ICLUS); version 1.3



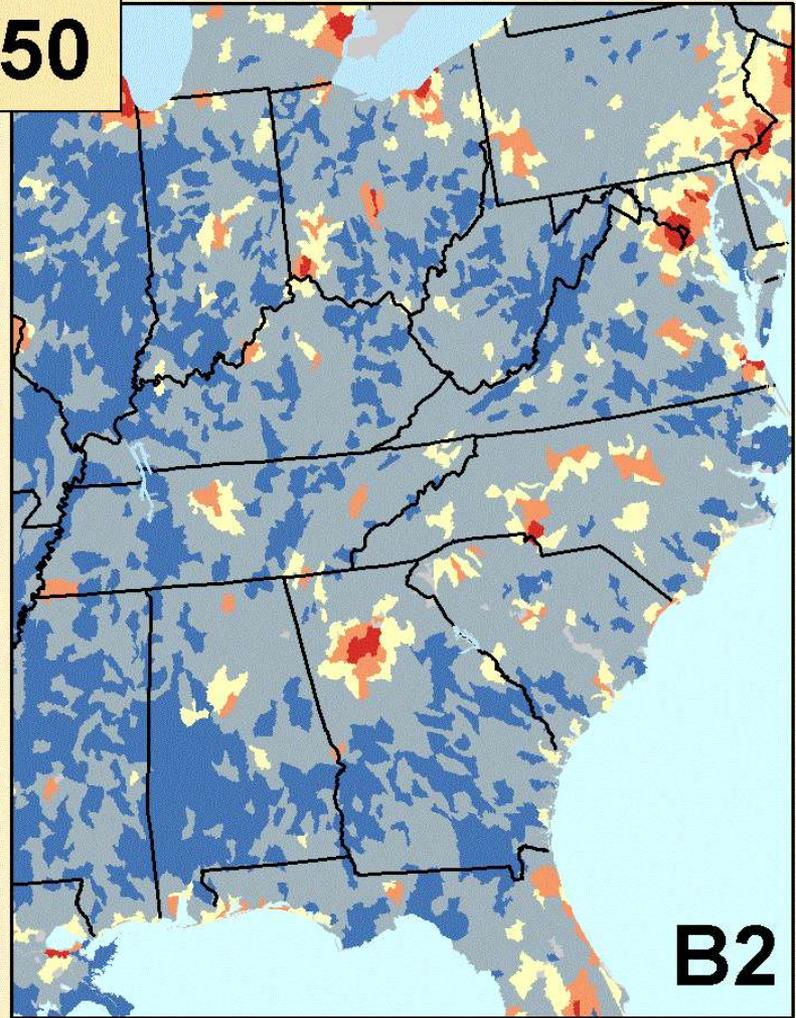
Albers Projection
Central Meridian: -96
1st Std Parallel: 20
2nd Std Parallel: 60
Latitude of Origin: -40



2050



A1



B2



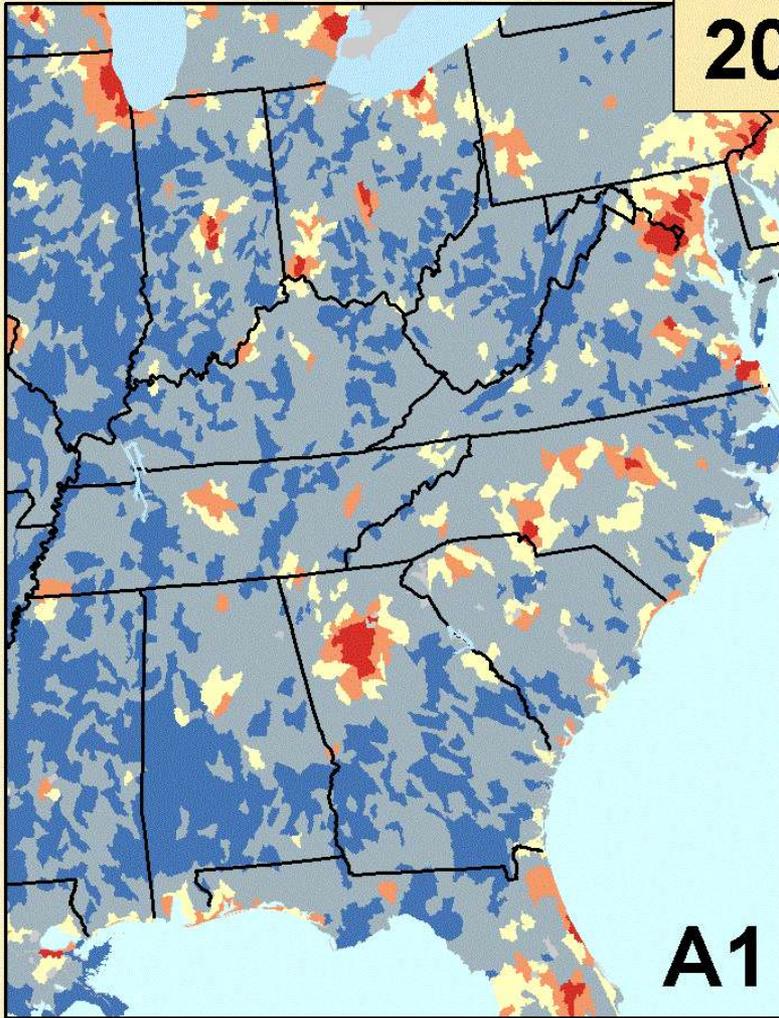
Integrated Climate and Land-Use Scenarios (ICLUS); version 1.3



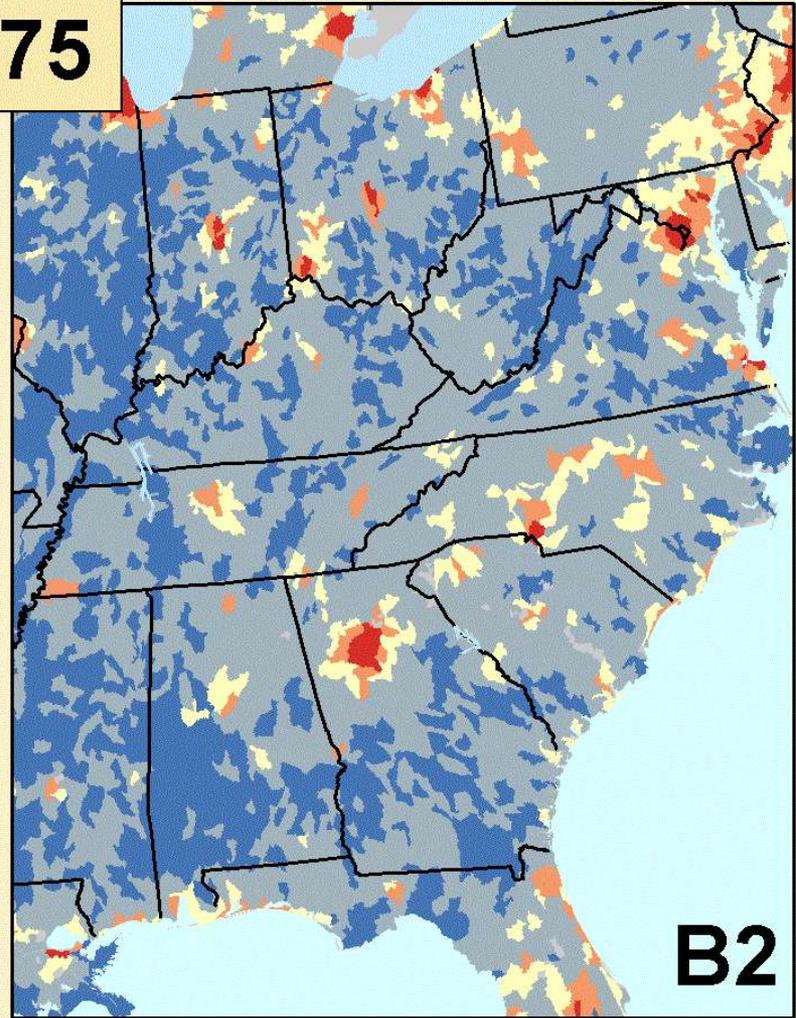
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Central Meridian: -96
1st Std Parallel: 20
2nd Std Parallel: 80
Latitude of Origin: -40



2075



A1



B2



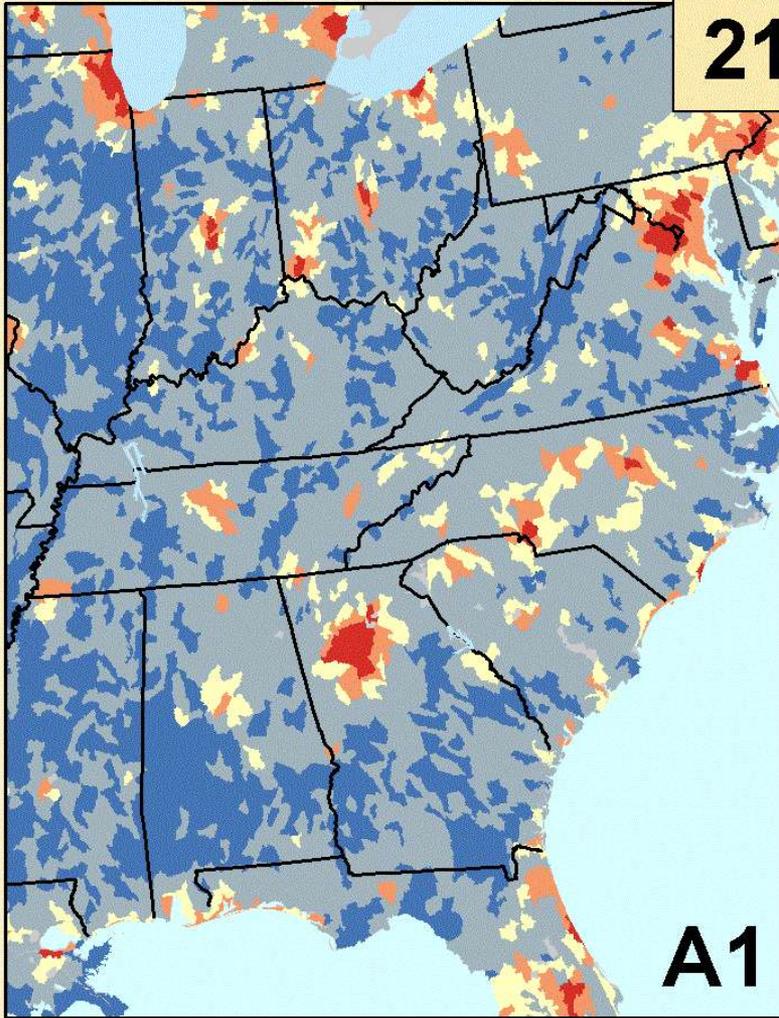
Integrated Climate and Land-Use Scenarios (ICLUS); version 1.3



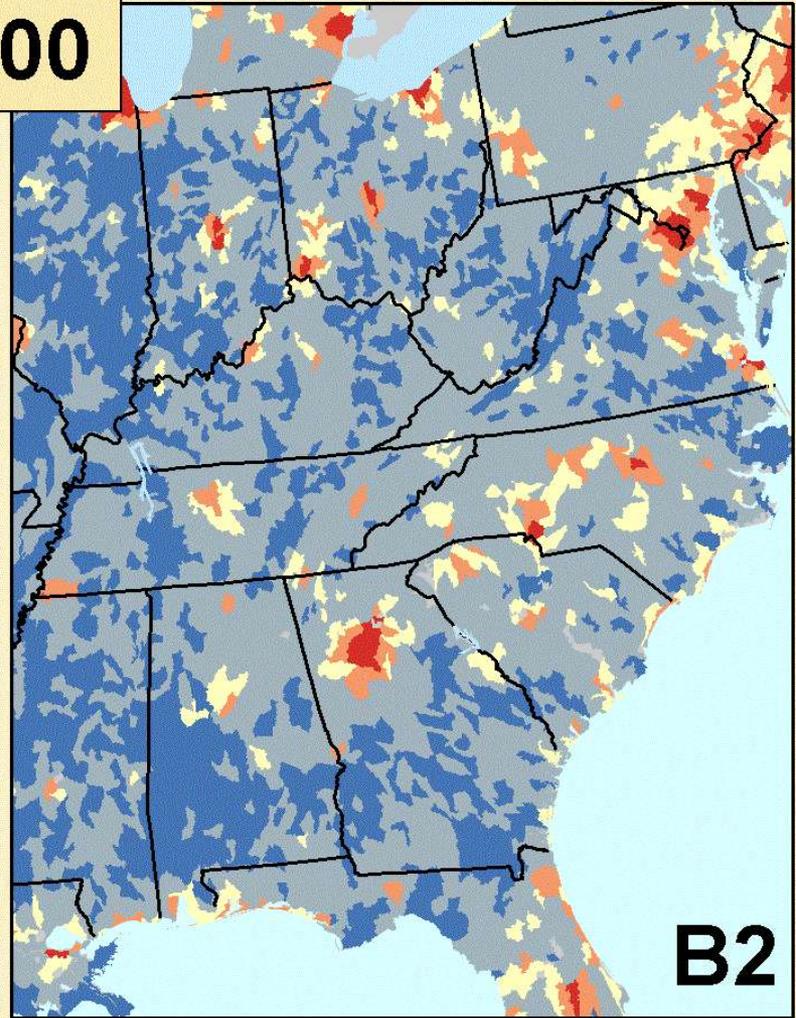
Albers Projection
Central Meridian: -96
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2nd Std Parallel: 80
Latitude of Origin: 40



2100



A1



B2



Integrated Climate and Land-Use Scenarios (ICLUS); version 1.3



Albers Projection
Central Meridian: -96
1st Std Parallel: 20
2nd Std Parallel: 60
Latitude of Origin: 40



- **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
- **Restore streams to improve current conditions**
 - push threshold further out in time



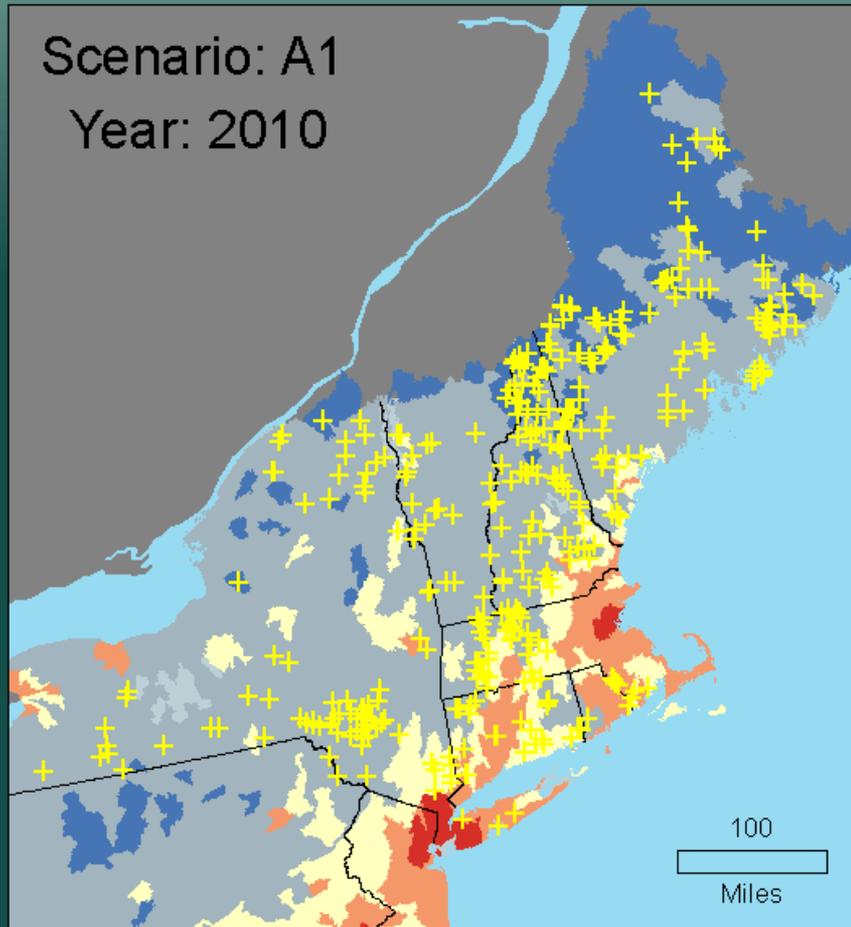
- Many reference sites already protected from potential development

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

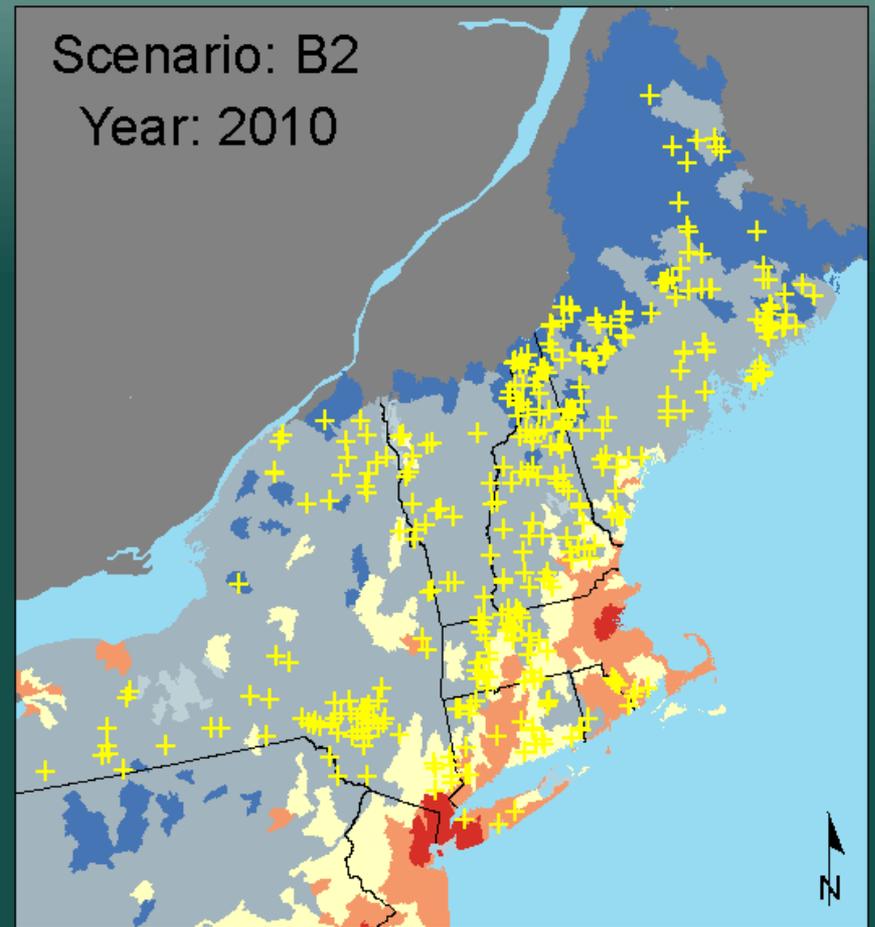
0	Damaged	> 25%	0
7	Impacted	>10 - 25%	7
51	Stressed	>5 - 10%	51
265	L. Stressed	1 - 5%	265
83	Unstressed	< 1%	83

Integrated Climate
and Land-Use Scenarios
(version 1.3)

Scenario: A1
Year: 2010



Scenario: B2
Year: 2010

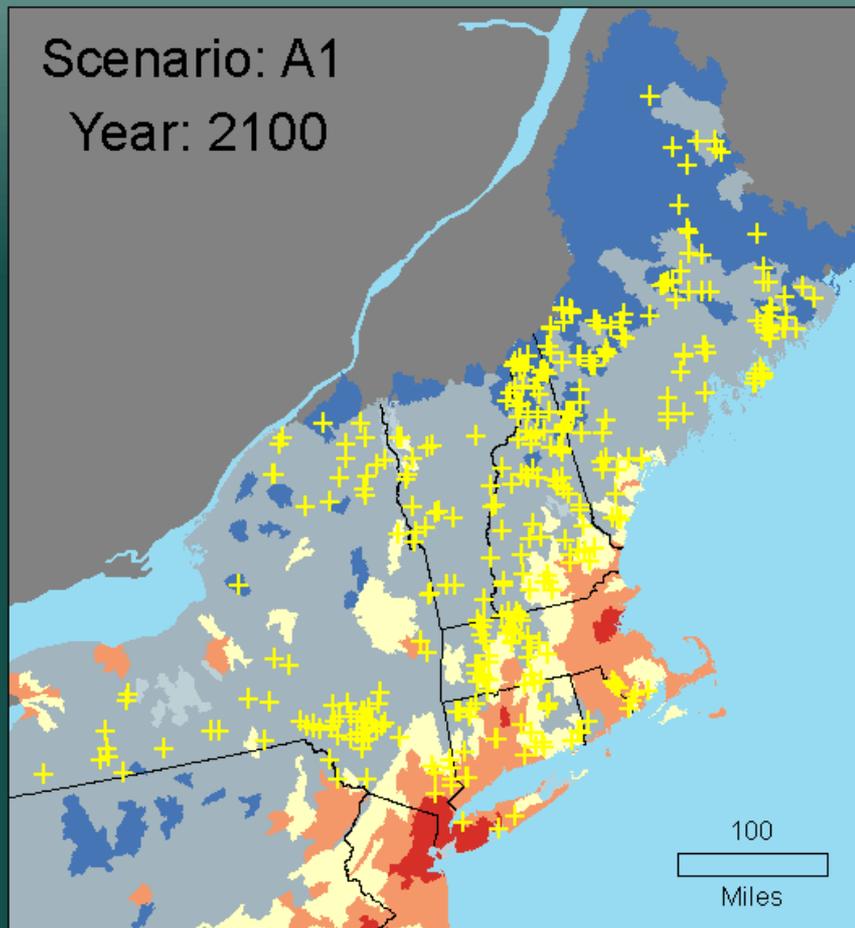


Number of Reference Sites
By Watershed Condition
(HUC-10)

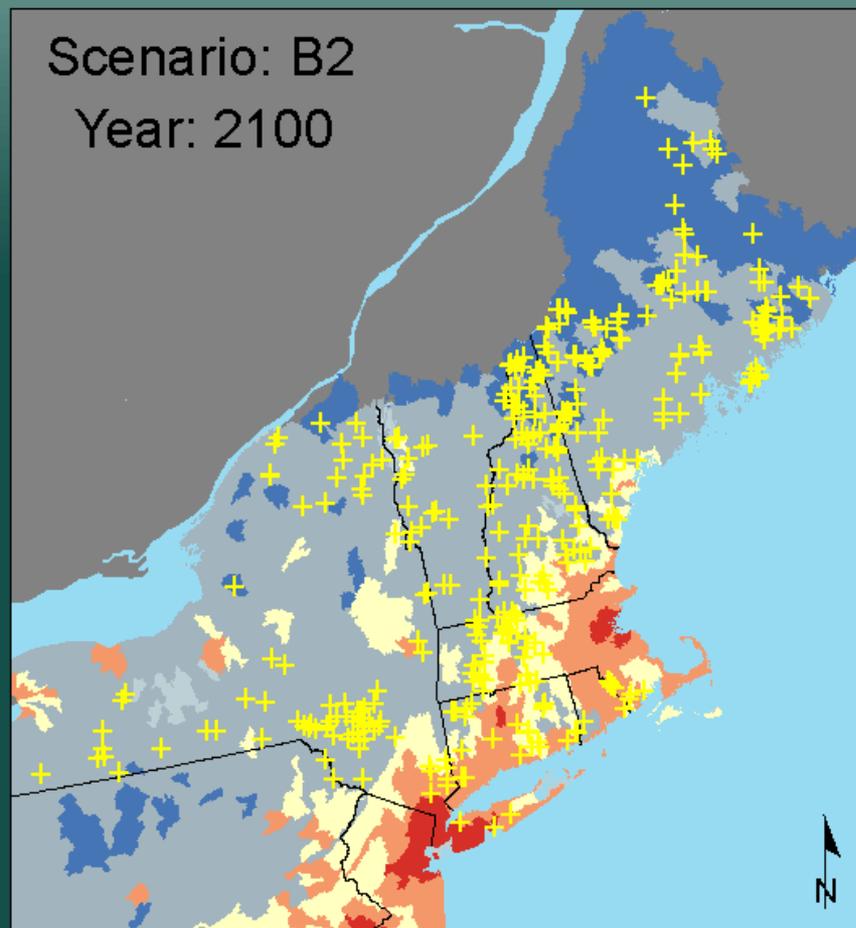
1	Damaged	> 25%	1
14	Impacted	>10 - 25%	14
50	Stressed	>5 - 10%	57
258	L. Stressed	1 - 5%	251
83	Unstressed	< 1%	83

Integrated Climate
and Land-Use Scenarios
(version 1.3)

Scenario: A1
Year: 2100



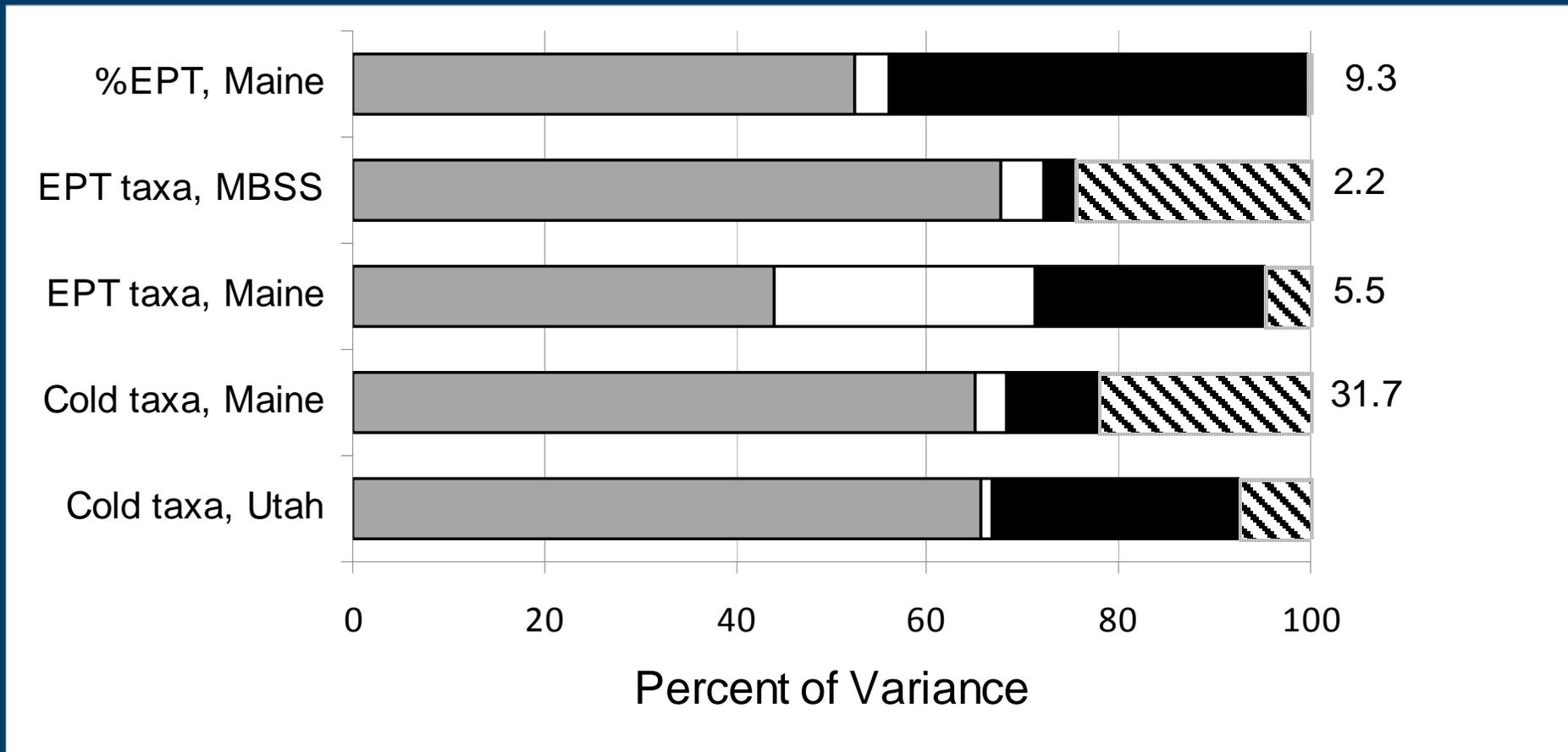
Scenario: B2
Year: 2100



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

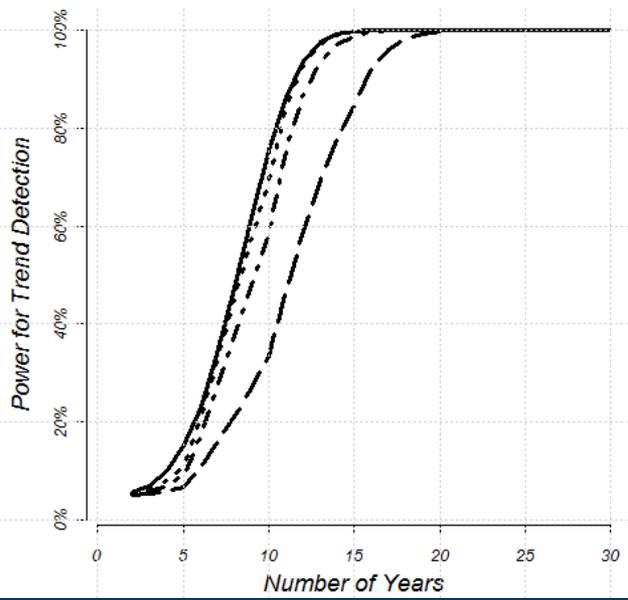
Temperature rate (° C/yr)	0.047	0.054	0.022
Loss cold-preference taxa/yr	1.59	1.48	0.72
Variance of cold-preference taxa	NA	9.3	2.2
Loss EPT taxa/yr	2.66	3.47	NS
Variance EPT taxa	NA	NA	15.5
Decrease relative abundance EPT taxa/yr	NS	NS	14.65
Variance EPT relative abundance	NA	NA	559

Components of Variance

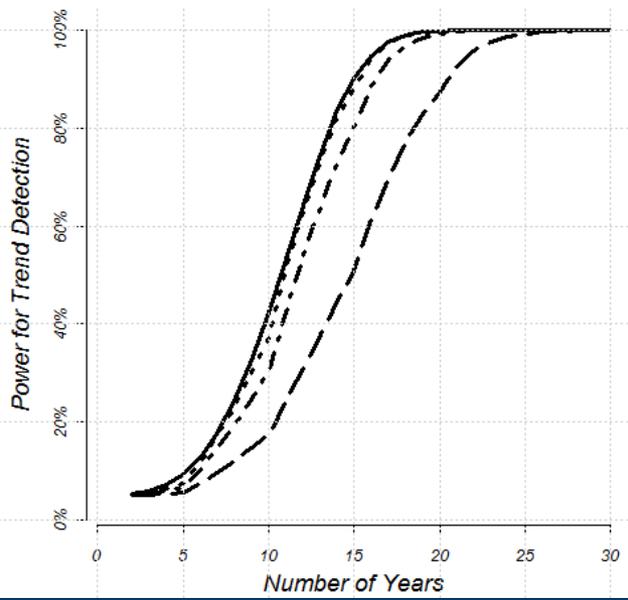


Laurentian Hills & Plains	3%	2%	1%	0.5%
Coldwater taxa loss/° C	14	18	29	>30
EPT taxa loss/° C	18	24	>30	>30
Percent EPT taxa loss/° C	10	13	21	>30

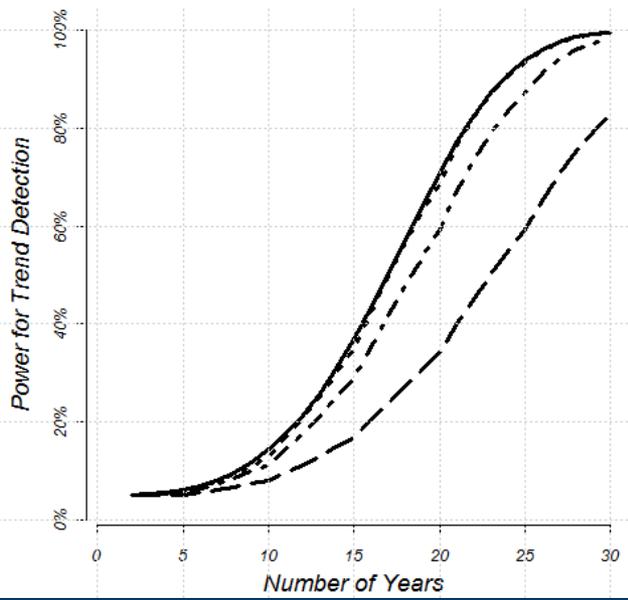
Using rotating panel of 30 sampling sites



3% trend

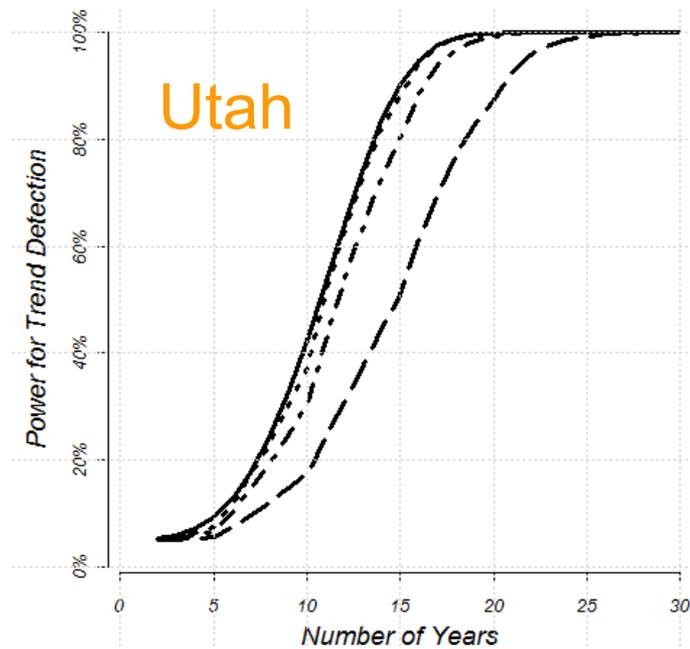
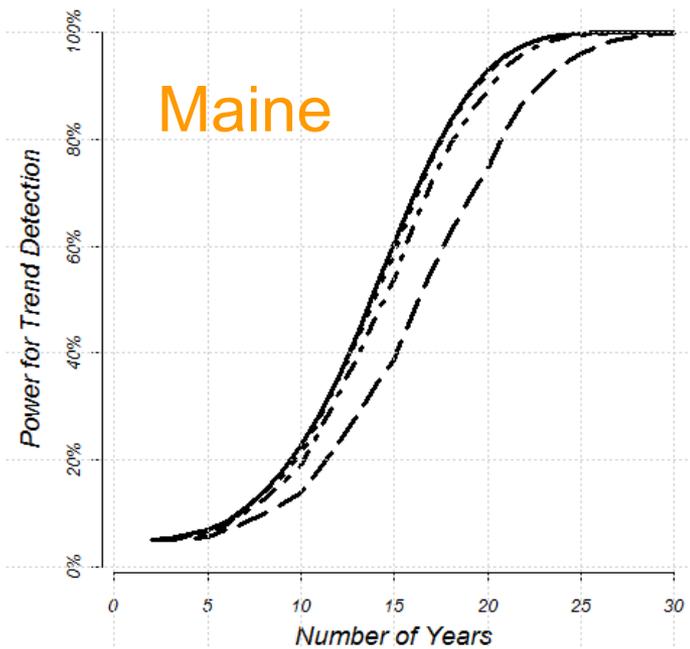


2% trend

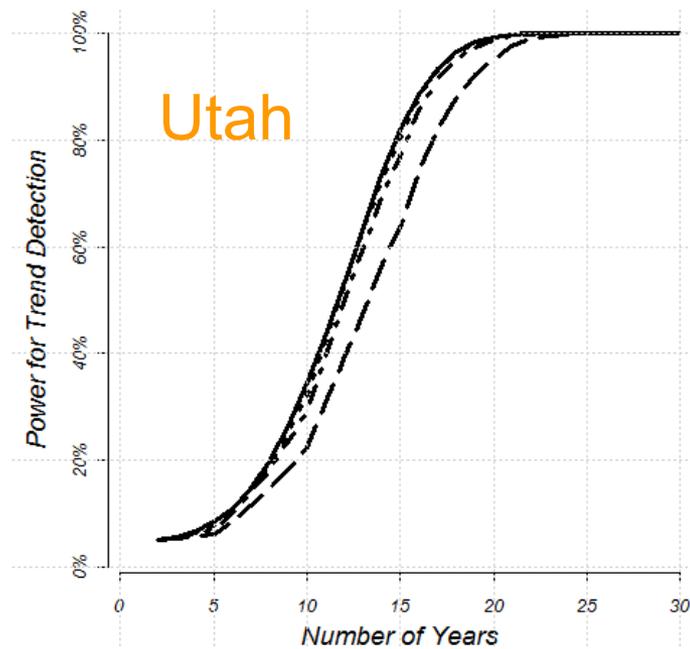
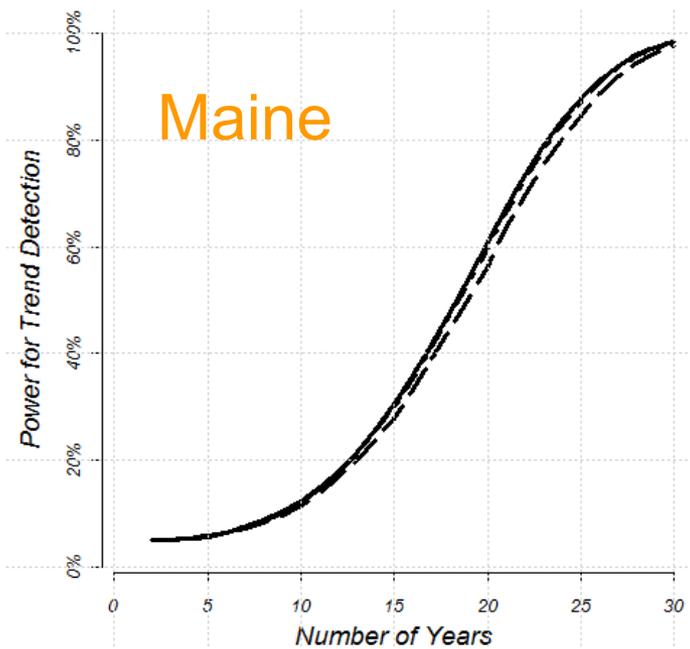


1% trend

Cold
Taxa



EPT
Taxa





- 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

- How can we build on current monitoring designs?
 - maximize ability to detect small, long-term changes
 - coordinate with existing efforts
- 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?

