State of Oklahoma

OWRB

WATER RESOURCES BOARD

the water agency

Implementation of OK's Statewide Statistical Survey Design for Surface Waters: Consideration, Implications and Results

Oklahoma Clean Lakes and Watersheds Association

23rd Annual Symposium, April 2014, Stillwater, OK

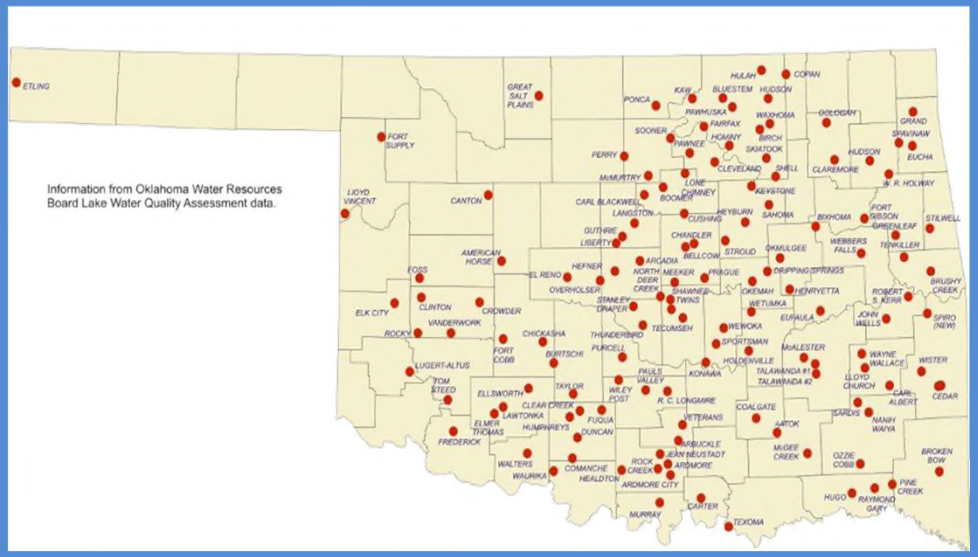
Monty Porter, Technical and Quality Manager

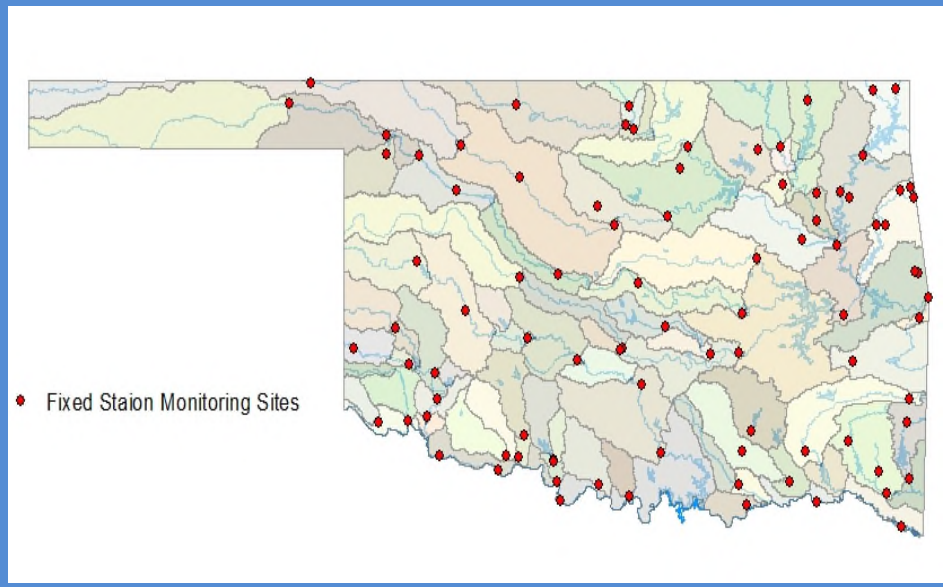
OWRB Water Quality Programs Division

- **Overview of Oklahoma's Monitoring Programs**
- **Overview of Oklahoma's Statistical Surveys**
- **Latest Report Results**

Oklahoma's Monitoring Programs

- **Traditional Water Quality Monitoring Designs**
  - **Fixed Station Trend and Assessment Program for Lakes and Rivers/Streams**
  - **Rotating Basin Program**
  - **319 Implementation Monitoring**
  - **Targeted Monitoring**





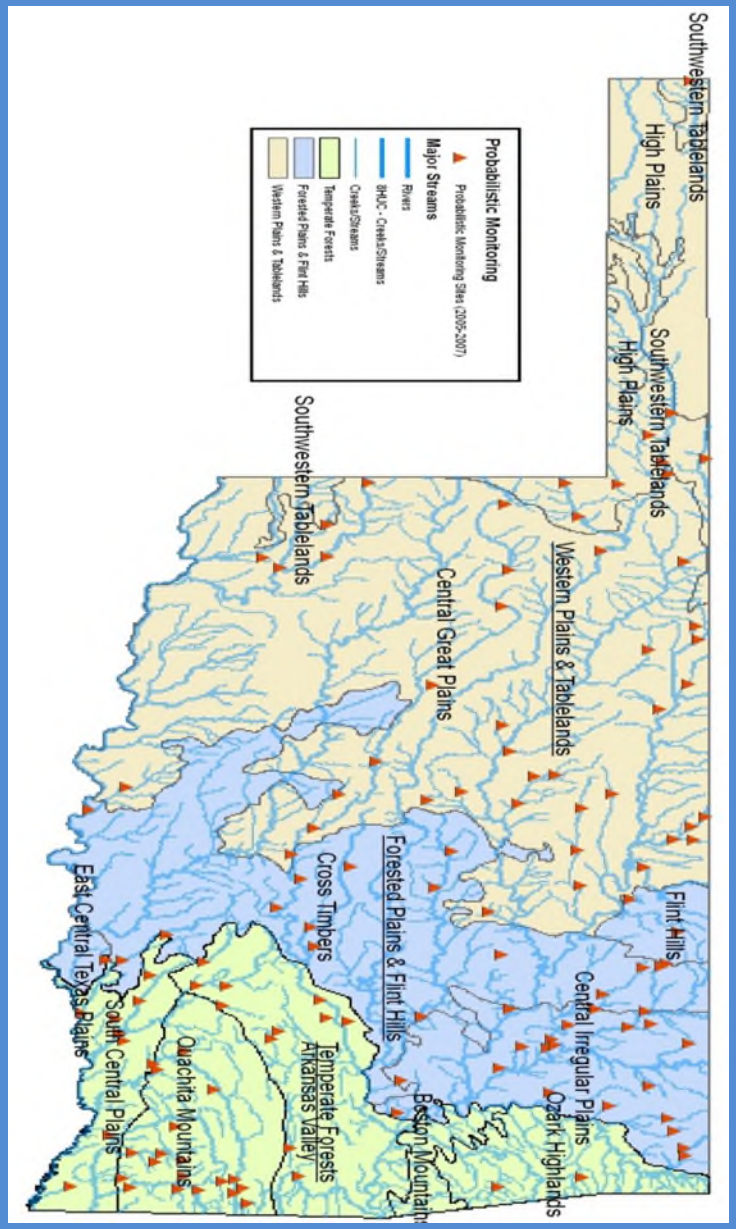
Statistical Surveys In Oklahoma

- **Lakes, Streams/Rivers**
  - **Oklahoma Conservation Commission (OCC) Planning Basin Design in Streams**
  - **Wetlands (OCC)**
- **5-year Study Windows**
  - **Overlapping between resource types**
  - **Accommodate the National Aquatic Resource Surveys (National Rivers/Streams Assessment; National Lakes Assessment)**
  - **Maximize Available Personnel**
  - **Continuous 5-year study periods (goal)**

Study Year	Streams/Rivers (n = 150)	Lakes (n ~ 160)
Year 1	SY-1/NRSA (n ~ 38)	SY-3 (n ~ 24)
Year 2	SY-2/NRSA (n ~ 38)	SY-4 (n ~ 24)
Year 3	SY-3 (n ~ 38)	SY-5 (n ~ 24)/Report Year
Year 4	SY-4 (n ~ 38)	SY-1 (n ~ 24)
Year 5	Report Year (no monitoring)	SY-2/NLA (n ~ 40-45)

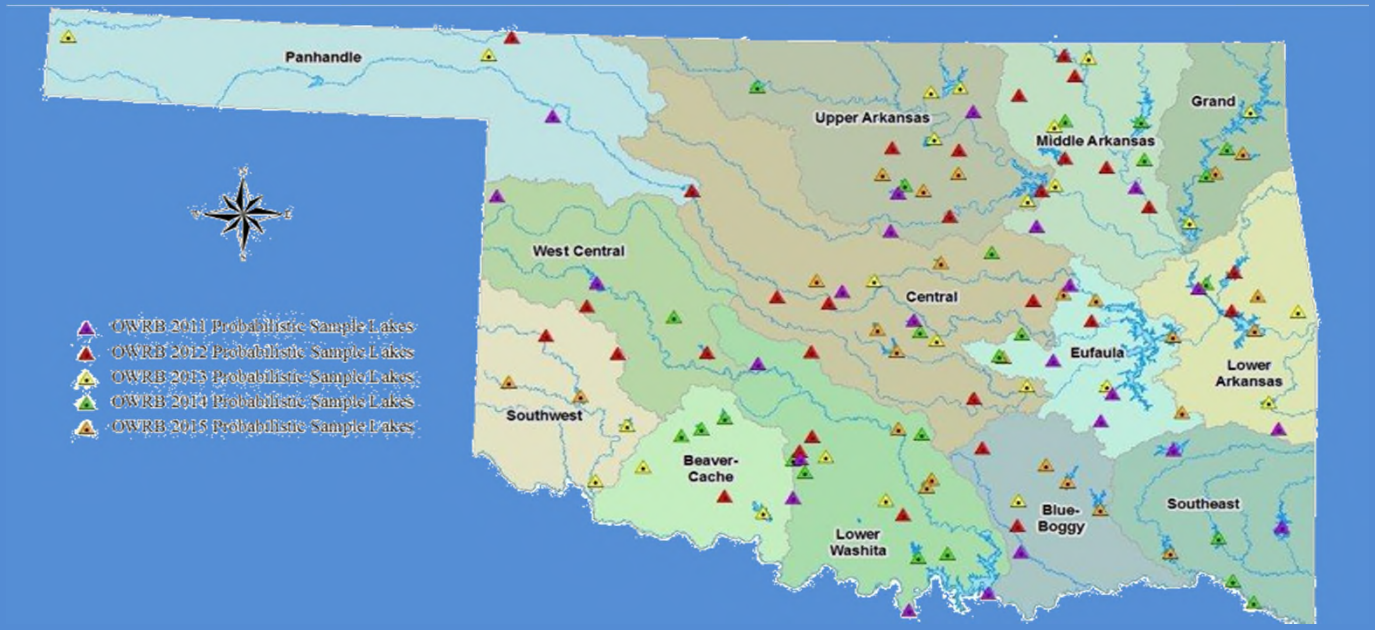
Flowing Water Statistical Surveys In Oklahoma

- National Wadeable Streams Assessment (2004)
- 1st Statewide Survey (2005-2007)
  - 128 sites across 3 aggregated ecoregions/Wadeable
- 2nd/3rd Statewide Rivers/Streams Survey (2008-2011)
  - 2008-2009 National Rivers/Streams Survey (52 sites)
  - 2010-2011 State Wide Survey (50 sites)
  - Included all Strahler order classes and use of multiple indicators
  - Large and small waterbody size categories
- 4th/5th Statewide Rivers/Streams Survey
  - 2013-2014 National Rivers/Streams Survey (51 sites)
  - Adding an additional 99 sites (2013-2016)
  - Large and small waterbody size categories
  - 3 aggregated ecoregions
  - Trend sites incorporated from previous studies
  - Development of new periphyton indicator



Lake Statistical Surveys In Oklahoma

- **2007 National Lakes Assessment (NLA)**
- **1st Statewide Lakes Survey (2011-2015)**
  - **Incorporates 2011 NLA (38 Lakes)**
  - **Includes 2 size classifications**
  - **For large multi-use lakes used to gain an additional year of sampling (68 Lakes > 500 surface acres)**
  - **For lakes < 500 surface acres monitor 10 per year**

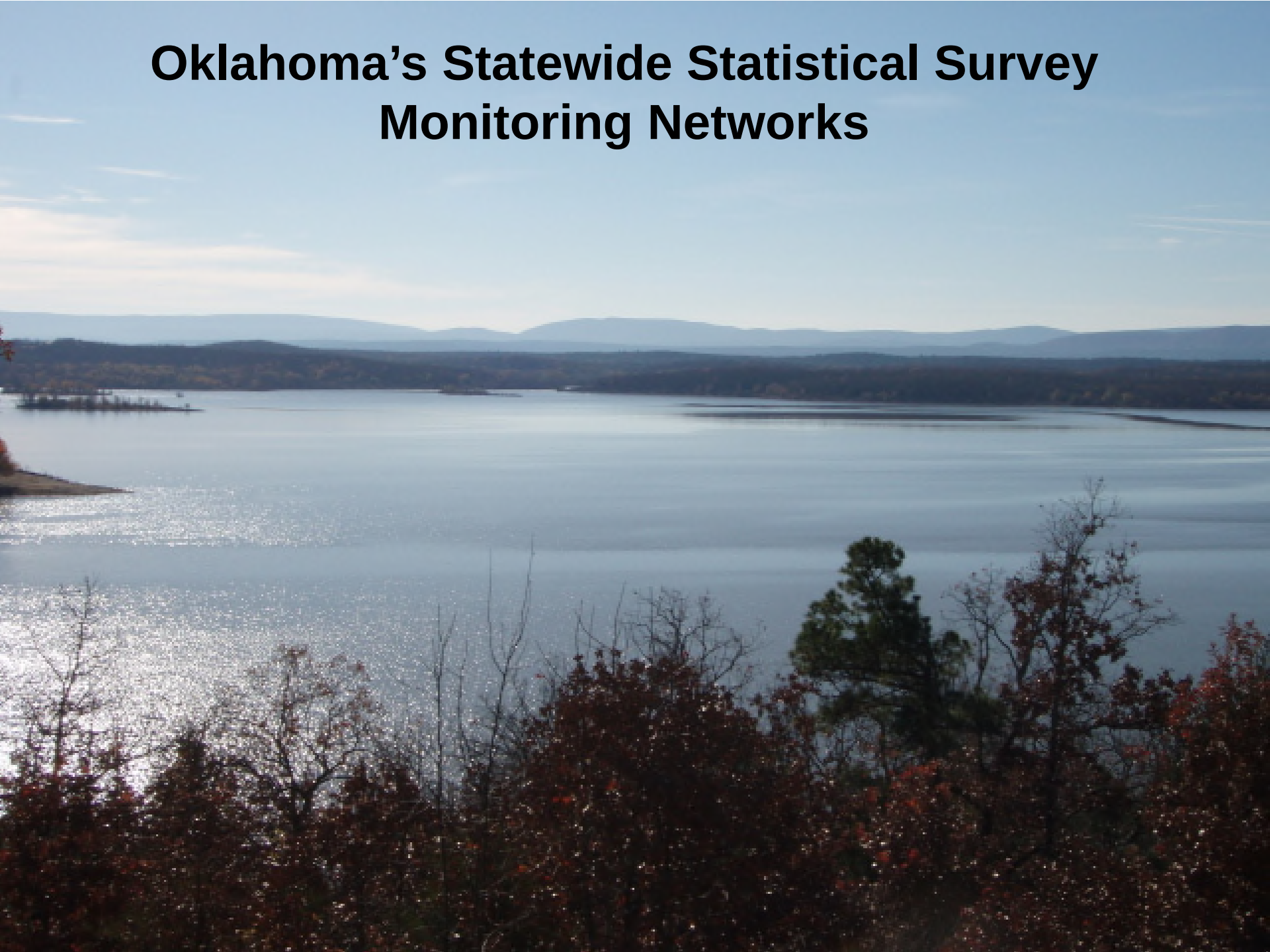


Network Design—Random vs. Fixed Stations

- Random stations provide comprehensive statewide condition estimates every 2-3 years
- Develop stronger relationships between indicators and stressors
- Excellent source of positive and negative reference condition

- Fixed stations provide excellent long-term supplemental data
- Can meet certain study objectives
- Can more easily integrate long-term chemical datasets with biological indicators

Oklahoma's Statewide Statistical Survey Monitoring Networks



Study Design

- **Multiple and Diverse Bio-indicators and Stressors**

	• **Streams/Rivers**	• **Lakes**
Bio-Indicators (condition)	Fish Community Macroinvertebrate Community Chlorophyll-a (sestonic and benthic) Periphyton (in development)	Zooplankton Phytoplankton Chlorophyll-a (sestonic)
Stressors	Total Phosphorus Total Nitrogen Conductivity Turbidity Toxics Excess Sediment Instream Cover Riparian Vegetative Cover	Total Phosphorus Total Nitrogen Conductivity Dissolved Oxygen Turbidity/Clarity Human Influence Habitat

Study Design

Streams/Rivers Target Population

- Perennial Rivers and Streams
- Greater than 50% wetted
- Sub-categories
  - Strahler Order (size)
  - Study Window
  - Aggregated Ecoregions
- Exclusions to Target Population
  - Landowner Permission Denied
  - Dry Sites
  - Impoundment (in flood pool)
  - Wetland, Oxbow, Swamp
  - Not Physically Accessible

Study Design

- **Lakes Target Population**

  - Lakes > 50 surface acres
  - Greater than 1 meter in depth
  - Sub-categories
    - > 500 sa (all), 50-500 sa
    - Study Window
    - Municipal Lakes??
  - Exclusions
    - Landowner Permission Denied
    - Dry Lake
    - Sewage Treatment pond/lagoon
    - Private Aquaculture Impoundment

Parametric Coverage

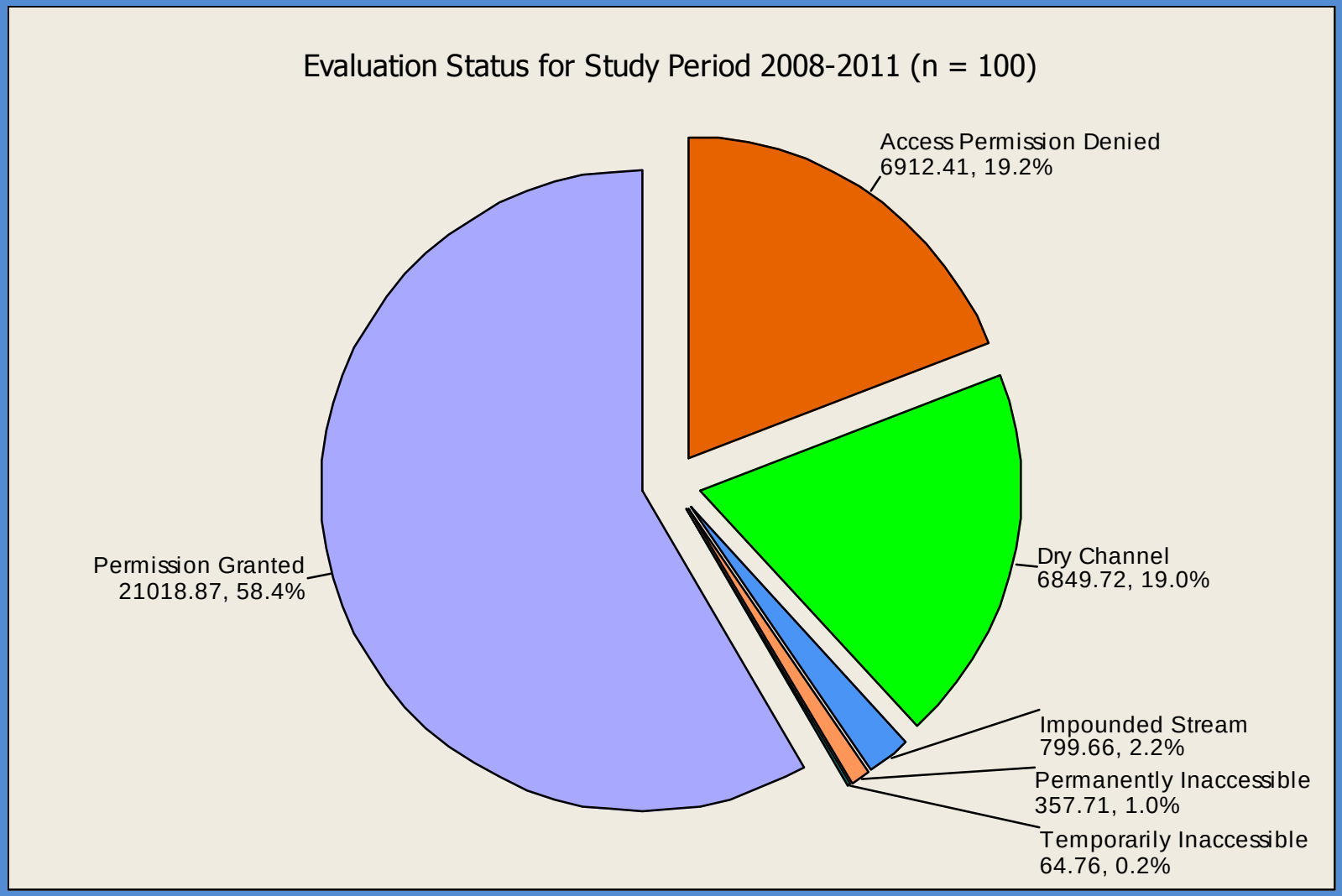
Includes a variety of physical, chemical, toxicant, habitat and biological parameters

Alkalinity	Hardness	Turbidity Secchi Disk Transparency (Lakes)	Habitat Assessment	Stream Discharge
Water Temperature (in-situ)	Specific Conductivity (in-situ)	Oxidation Reduction Potential Lakes Only (in-situ)	pH (in-situ)	Dissolved Oxygen & DO % Sat (in-situ)
Nitrogen -Ammonia -Nitrite -Nitrate -Kjeldahl	Phosphorus -Total -Ortho	Solids -Settleable -Total Dissolved -Suspended	Minerals -Chloride -Sulfate	Metals -16 metals
Fish Community Streams Only	Benthic Macroinvertebrate Community	Benthic Chlorophyll-a Periphyton Community Streams Only	Sestonic Chlorophyll-a Phytoplankton Community	Zooplankton Community ID Lakes Only

Results of 2008-2011 Statewide Streams Survey

Evaluation Status for All Perennial Stream Miles

- **36,003 stream/river miles evaluated**
- **177 sites considered**
- **Small stream miles outnumbered large river miles 3.5:1**



Fish Indicator Analysis

- **Reachwide—primary electrofish and secondary seine**
- **Use 2 local Indices and large river/boatable index from NRSA**
- **For condition, use a weight of evidence assessment**
- **For Impairment status use biocriteria unless unavailable or scored as undetermined**

BIOCRITERIA

Metric	Value	Scoring 5	Scoring 3	Scoring 1	Score
Total # of species		fig 1	fig 1	fig 1	
Shannon's Diversity based upon numbers		>2.50	2.49-1.50	<1.50	
# of sunfish species		>3	2 to 3	<2	
# of species comprising 75% of sample		>5	3 to 4	<3	
Number of intolerant species		fig 2	fig 2	fig 2	
Percentage of tolerant species		fig 3	fig 3	fig 3	
TOTAL SCORE FOR SAMPLE COMPOSITION					0
Percentage of lithophils		>36	18 to 36	<18	
Percentage of DELT anomalies		<0.1	0.1-1.3	>1.3	
Total individuals		>200	75 to 200	<75	
TOTAL SCORE FOR FISH CONDITION					0
TOTAL SCORE					0

Metrics	5	3	1
Number of species	>67%	33-67%	<33%
Number of sensitive benthic species	>67%	33-67%	<33%
Number of sunfish species	>67%	33-67%	<33%
Number of intolerant species	>67%	33-67%	<33%
Proportion tolerant individuals	<10%	10-25%	>25%
Proportion insectivorous cyprinid individuals	>45%	20-45%	<20%
Proportion individuals as lithophilic spawners	>36%	18-36%	<18%

ALT IBI CLASSIFICATION

OK FISH IBI

% Comparison to the Reference Score	Integrity Class	Characteristics
>97%	Excellent	Comparable to pristine conditions, exceptional species assemblage
80 - 87%	Good	Decreased species richness, especially intolerant species
67 - 73%	Fair	Intolerant and sensitive species rare or absent
47 - 57%	Poor	Top carnivores and many expected species absent or rare; omnivores and tolerant species dominant
26 - 37%	Very Poor	Few species and individuals present; tolerant species dominant; diseased fish frequent

Benthic Macroinvertebrate Indicator Analysis

- **Reachwide—best habitat and quantitative methods**
- **Use different indices for wadeables and boatables**
- **Must have multiple samples for assessment of wadeables**
- **For boatables used NRSA index and reference conditions**
- **For 2008-9 used NRSA classifications**

OK BENTHIC IBI

B-IBI Metrics	6	4	2	0
Taxa Richness	>80%	60-80%	40-60%	<40%
Modified HBI	>85%	70-85%	50-70%	<50%
EPT/Total	>30%	20-30%	10-20%	<10%
EPT Taxa	>90%	80-90%	70-80%	<70%
% Dominant 2 Taxa	<20%	20-30%	30-40%	>40%
Shannon-Weaver Diversity Index	>3.5	2.5-3.5	1.5-2.5	<1.5

OK Benthic IBI CLASSIFICATION

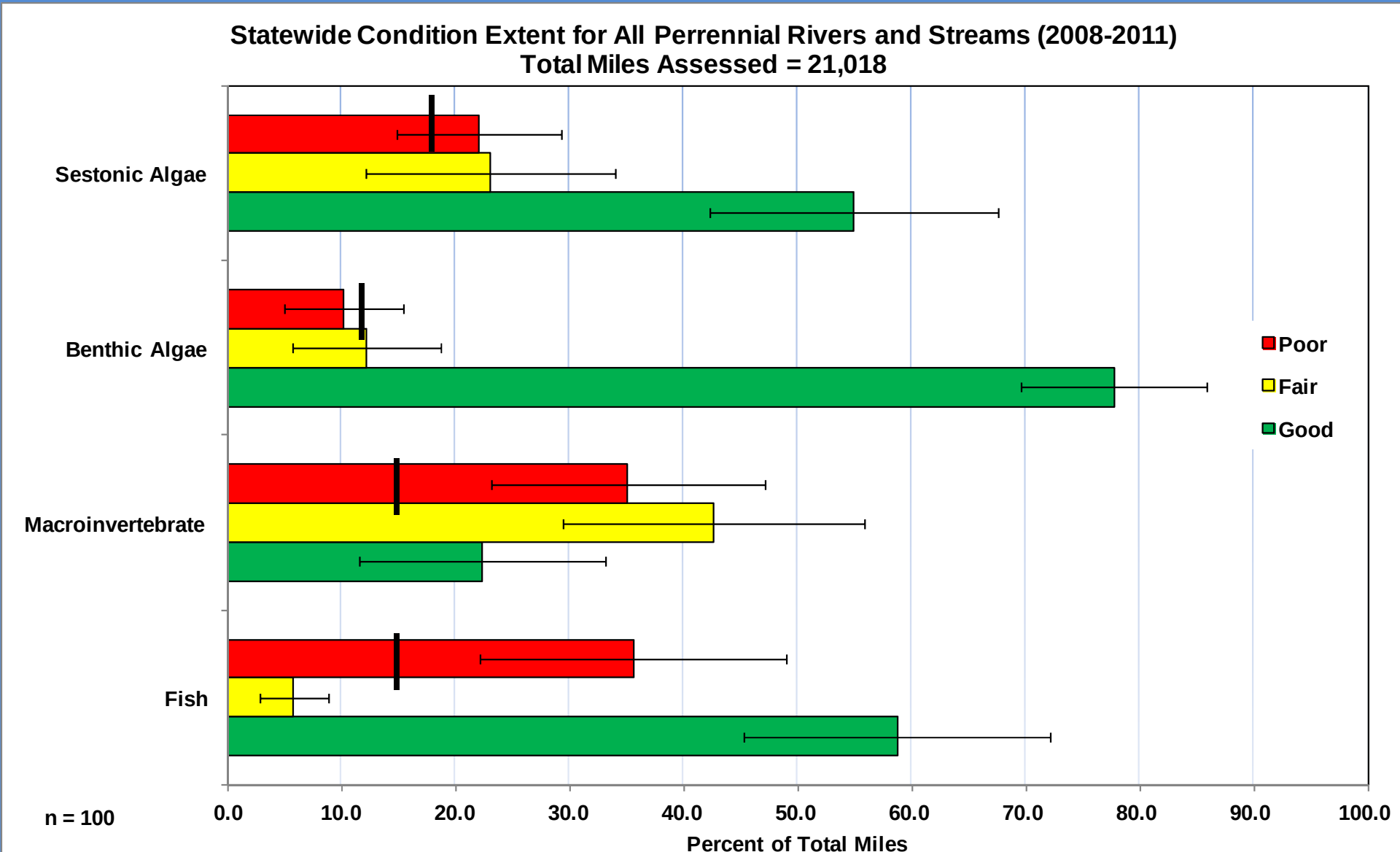
% Comparison to the Reference Score	Biological Condition	Characteristics
>83%	Non-impaired	Comparable to the best situation expected in that ecoregion; balanced trophic and community structure for stream size
54 - 79%	Slightly Impaired	Community structure and species richness less than expected; percent contribution of tolerant forms increased and loss of some intolerant species
21 - 50%	Moderately Impaired	Fewer species due to loss of most intolerant forms; reduction in EPT index
<17%	Severely Impaired	Few species present; may have high densities of 1 or 2 taxa

Algal Biomass Indicator Analysis

- Collection Methodology
  - Benthic is Reachwide/Transect Composite
  - Sestonic is Single Grab Sample
- To estimate condition of algal biomass, chlorophyll-a concentrations were compared to several screening levels.
  - Benthic Chlorophyll-a Cut-Points
    - 100 mg/m^2 (USAP nuisance level) used as the cut-point for poor-fair condition.
    - 45.7 mg/m^2 (25^{th} percentile of all OWRB data) used as the cut-point for fair-good condition.
  - Sestonic Chlorophyll-a Cut-Points
    - 10 mg/m^3 (OWQS standard for sensitive water supplies) used as the cut-point for fair-good condition
    - 19 mg/m^3 (mean of all concentrations) used as the cut-point for poor-fair condition
- Developing Phytoplankton and Periphyton Community Indicators

Condition Extent for All Perennial Stream Miles

(Black line represents 2005-2007 study.)



Extent of Perennial Stream Miles in Poor Condition Comparing Large/Small and Sample Periods Bio-indicator Results

Indicator/Stressor	2008-09 %Poor	2010-11 %Poor	Trend	Large %Poor	Small %Poor	Change
Fish	43.9%	21.7%	↓**	50.1%	30.4%	**
Macroinvertebrate	40.6%	25.7%	↓	62.3%	24.7%	**
Benthic Algae	3.7%	21.3%	↑**	21.7%	5.9%	**
Sestonic Algae	18.2%	28.3%	↑	60.6%	6.8%	**

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Stressor Analysis

Stressor Description	Stressor (code)	Source
Total nitrogen SL from the National Rivers and Streams Assessment (NRSA)	TN_NRSA	USEPA
Total nitrogen SL from USEPA's regional nutrient criteria development	TN_ECO	USEPA
Total phosphorus SL from the NRSA	TP_NRSA	USEPA
Total phosphorus SL from USEPA's regional nutrient criteria development	TP_ECO	USEPA
Conductivity SL from the NRSA	Cond_NRSA	USEPA
Conductivity SL based on regional OWRB historical data	Cond_ECO	USEPA
Turbidity SL from USEPA's regional nutrient criteria development	Turb_ECO	USEPA
Sediment based on sediment metric from NRSA and combination of %loose bed material, % embeddedness, and % deep pools from Oklahoma's Rapid Bioassessment	Excess_Sed	USEPA/ OWRB
Instream cover assessment from the NRSA	InstCov	USEPA
Riparian vegetation cover from the NRSA	RipVegCov	USEPA
Metals chronic criteria for fish/wildlife propagation beneficial use housed in App. G, Table 2 of OWQS	XxChronic	OWRB

Stressor Analysis Cut-Points

Ecoregion	TN _NRSA Poor_Fair (mg/L)	TN _NRSA Fair_Good (mg/L)	TN _ECO Poor_Fair (mg/L)	TN _ECO Fair_Good (mg/L)	TP _NRSA Poor_Fair (mg/L)	TP _NRSA Fair_Good (mg/L)	TP _ECO Poor_Fair (mg/L)	TP _ECO Fair_Good (mg/L)
Southwest Tablelands	1.570	0.698	1.050	0.450	0.095	0.052	0.055	0.025
Central Great Plains	1.570	0.698	1.600	0.840	0.095	0.052	0.130	0.090
Cross Timbers	1.570	0.698	0.900	0.680	0.095	0.052	0.110	0.038
Arbuckle Uplift	1.570	0.698	1.500	0.680	0.095	0.052	0.050	0.038
South Central Plains	2.078	1.092	0.750	0.385	0.108	0.056	0.070	0.050
Ouachita Mountains	0.535	0.296	0.450	0.300	0.024	0.018	0.025	0.010
Arkansas Valley	0.535	0.296	0.683	0.270	0.024	0.018	0.060	0.043
Ozark Highlands	0.535	0.296	1.500	0.379	0.024	0.018	0.070	0.007
Central Irregular Plains	3.210	1.750	1.150	0.712	0.338	0.165	0.160	0.093

Ecoregion	Cond _NRSA Poor_Fair (uS/cm2)	Cond _NRSA Fair_Good (uS/cm2)	Cond _ECO Poor_Fair (uS/cm2)	Cond _ECO Fair_Good (uS/cm2)	Turb _ECO Poor_Fair (NTU)	Turb _ECO Fair_Good (NTU)
Southwest Tablelands	2000	1000	2300	1000	20	12
Central Great Plains	2000	1000	2925	1000	45	22
Cross Timbers	2000	1000	1000	550	40	4
Arbuckle Uplift	2000	1000	1000	500	7	4
South Central Plains	1000	500	500	180	20	10
Ouachita Mountains	1000	500	500	65	10	5
Arkansas Valley	1000	500	500	160	20	7
Ozark Highlands	1000	500	500	285	5	2
Central Irregular Plains	2000	1000	1000	450	40	16

Physical Habitat Assessment

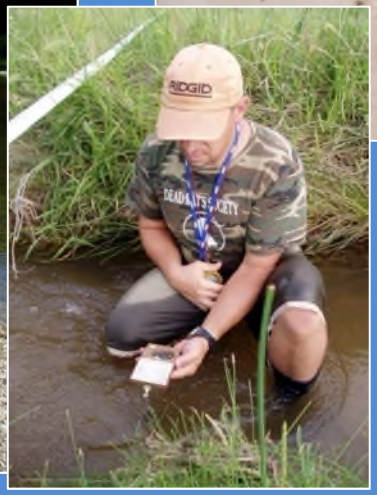
- RBP Method and NRSA Quantitative Method

- Measure
  - In-stream characteristics
  - Riparian Structure and Vegetation
  - Bank Stability
  - Human Influence

Red River – Love County

Barren Fork – Adair County

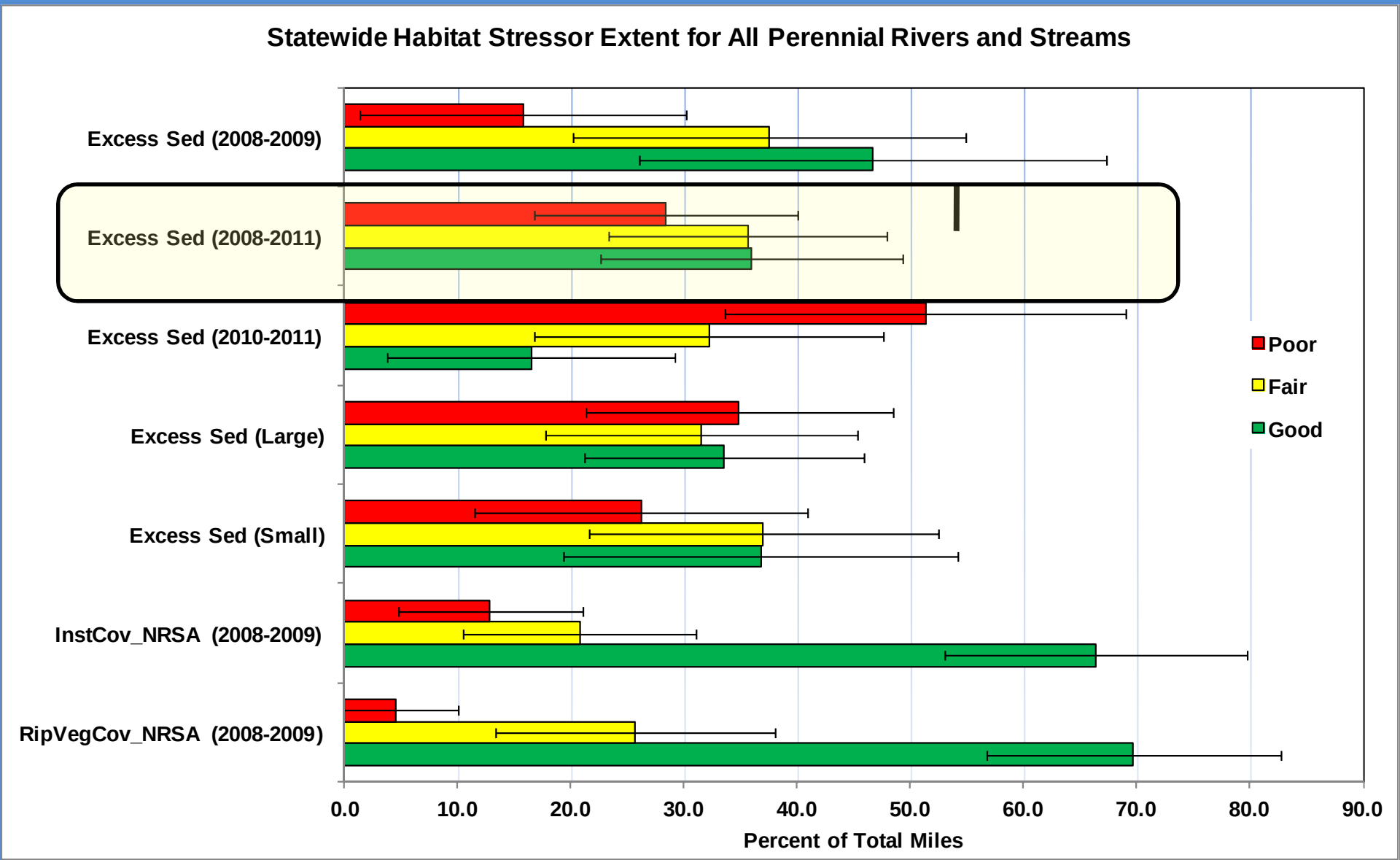
Washita River – Kiowa County



Sweetwater Creek – Beckham County

Stressor Extent for All Perennial Stream Miles

(Black line represents 2005-2007 study)



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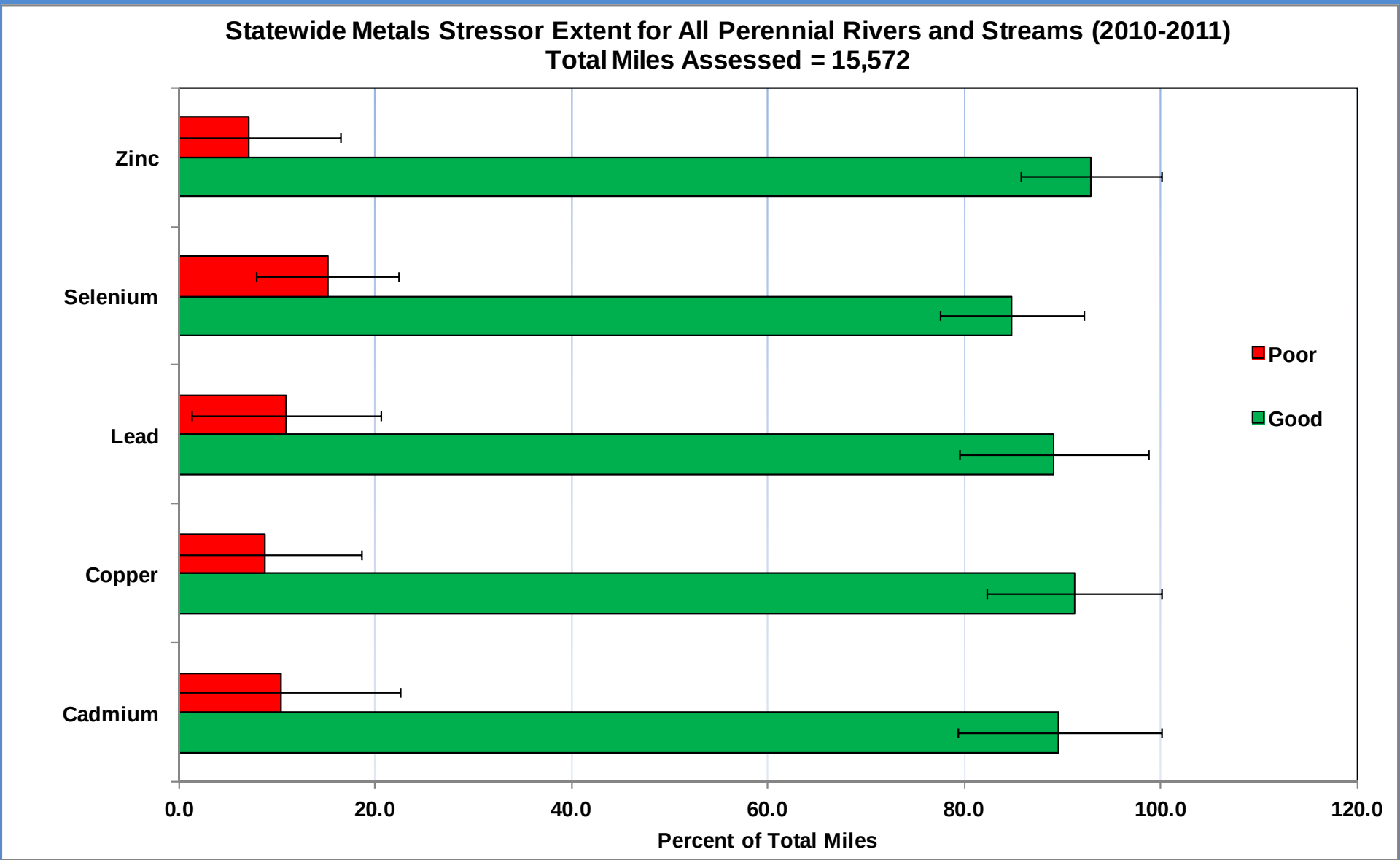

Extent of Perennial Stream Miles in Poor Condition Comparing Large/Small and Sample Periods Stressor Results

Indicator/Stressor	2008-09 %Poor	2010-11 %Poor	Trend	Large %Poor	Small %Poor	Change
Conductivity_ECO	10.6%	21.4%	↑	38.5%	5.5%	**
Conductivity_NRSA	16.7%	22.7%	↑	55.0%	5.1%	**
TN_ECO	23.4%	37.5%	↑	40.3%	24.1%	**
TN_NRSA	12.2%	22.3%	↑	31.3%	10.1%	**
TP_ECO	40.7%	36.9%	↓	73.8%	26.2%	**
TP_NRSA	31.0%	40.1%	↑	76.4%	18.3%	**
Turbidity_ECO	11.5%	26.6%	↑**	36.9%	9.5%	**
Sediment	15.8%	51.3%	↑**	34.9%	26.2%	NS

Extent of Perennial Stream Miles in Poor Condition Comparing Large/Small and Sample Periods Bio-indicator Results

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TP_NRSA	31.0%	40.1%	↑	76.4%	18.3%	**
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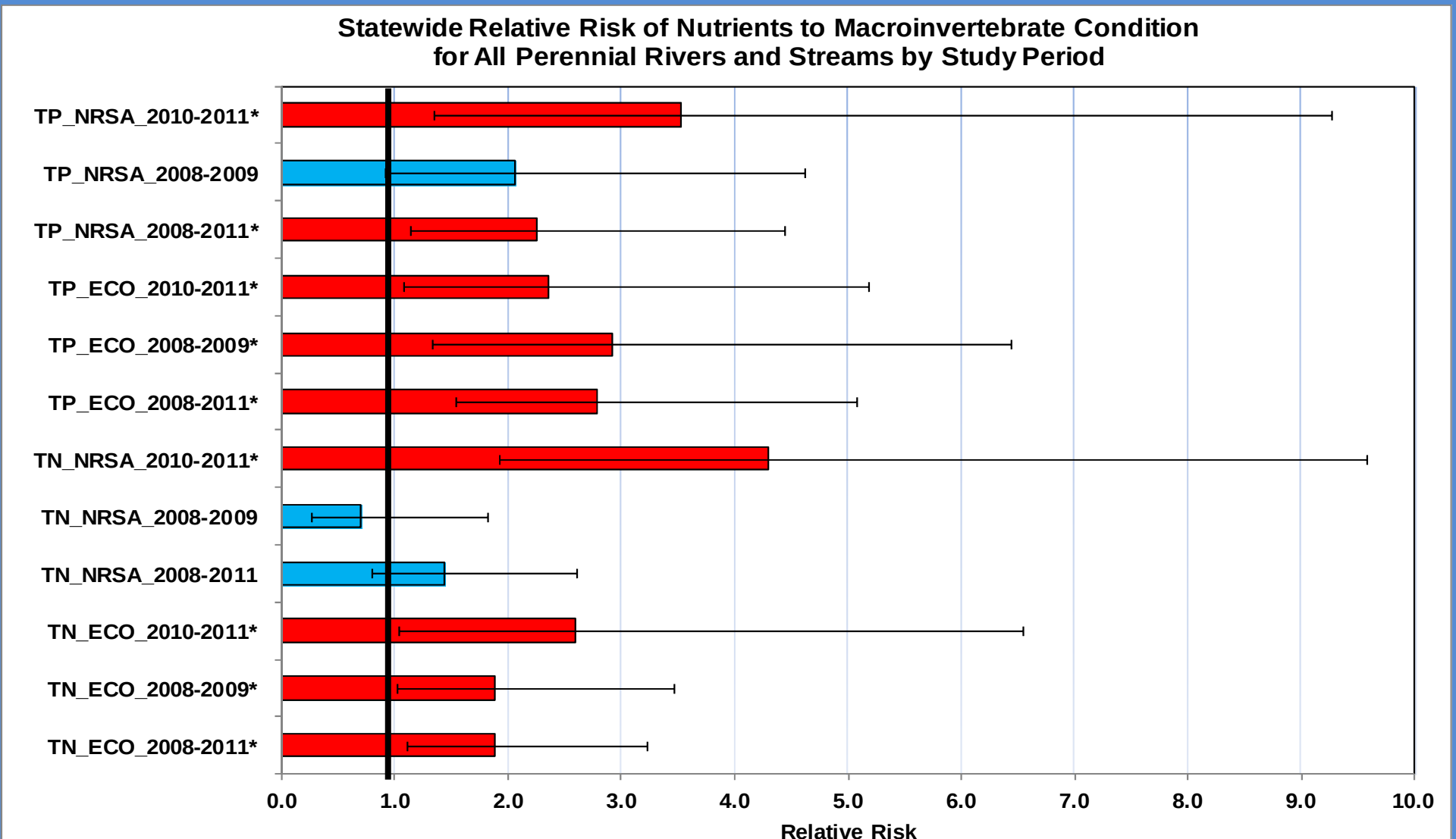
Sediment	15.8%	51.3%	↑**	34.9%	26.2%	NS

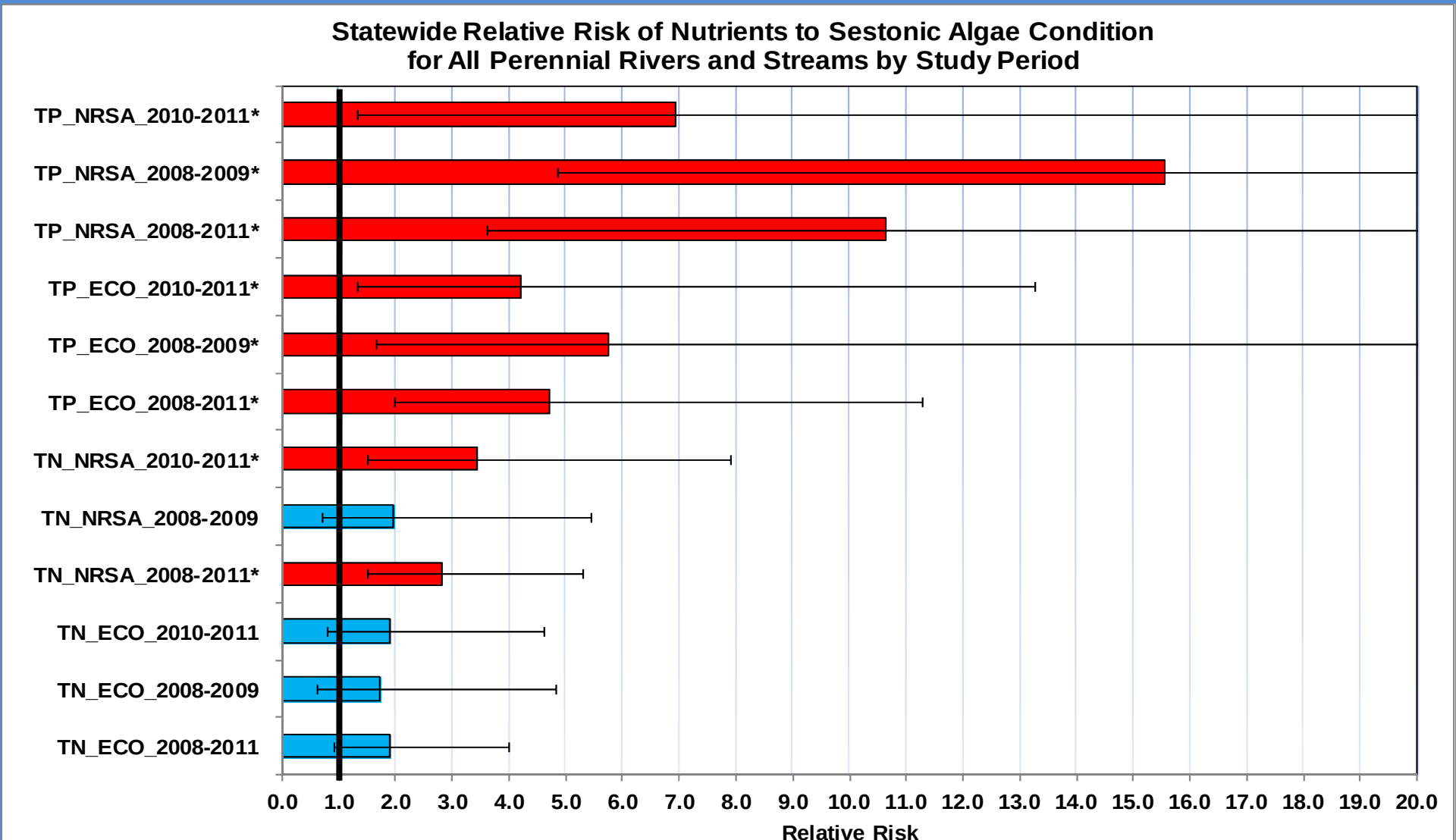
Relative Risk

- Used to explain relationships between biological condition and stressor extent
- Concept developed initially for USEPA's National Wadeable Streams Assessment (USEPA, 2006).
- Van Sickle et al. (2006) drew upon a practice commonly used in medical sciences to determine the relationship of a stressor (e.g., high cholesterol) to a medical condition (e.g., heart disease).
- Based upon a two-way contingency table
  - Calculates a ratio between the number of streams with **poor biological condition/high stressor** concentration and those with **poor biological condition/low stressor** concentration.
  - Ratio above 1 indicates that biological condition is likely affected by high stressor concentrations (i.e., concentrations above a preset level).
  - As the ratio increases beyond 1, the relative risk of the stressor increases.
- Analysis uses a binomial designation of good/poor for condition and high/low for stressor concentration.
  - These binomial designations are then placed in a two-way contingency table to determine relative risk. Two initial ratios are determined.
  - The ratio for poor condition given high stressor concentration is compared to the total number of sites having high stressor concentration, regardless of condition.
  - Likewise, the ratio for poor condition given low stressor concentration is compared to the total number of sites having low stressor concentrations, regardless of condition.
  - These two ratios are then used to calculate relative risk.

Relative Risk of Nutrient Stressors Affecting Poor Macroinvertebrate Condition



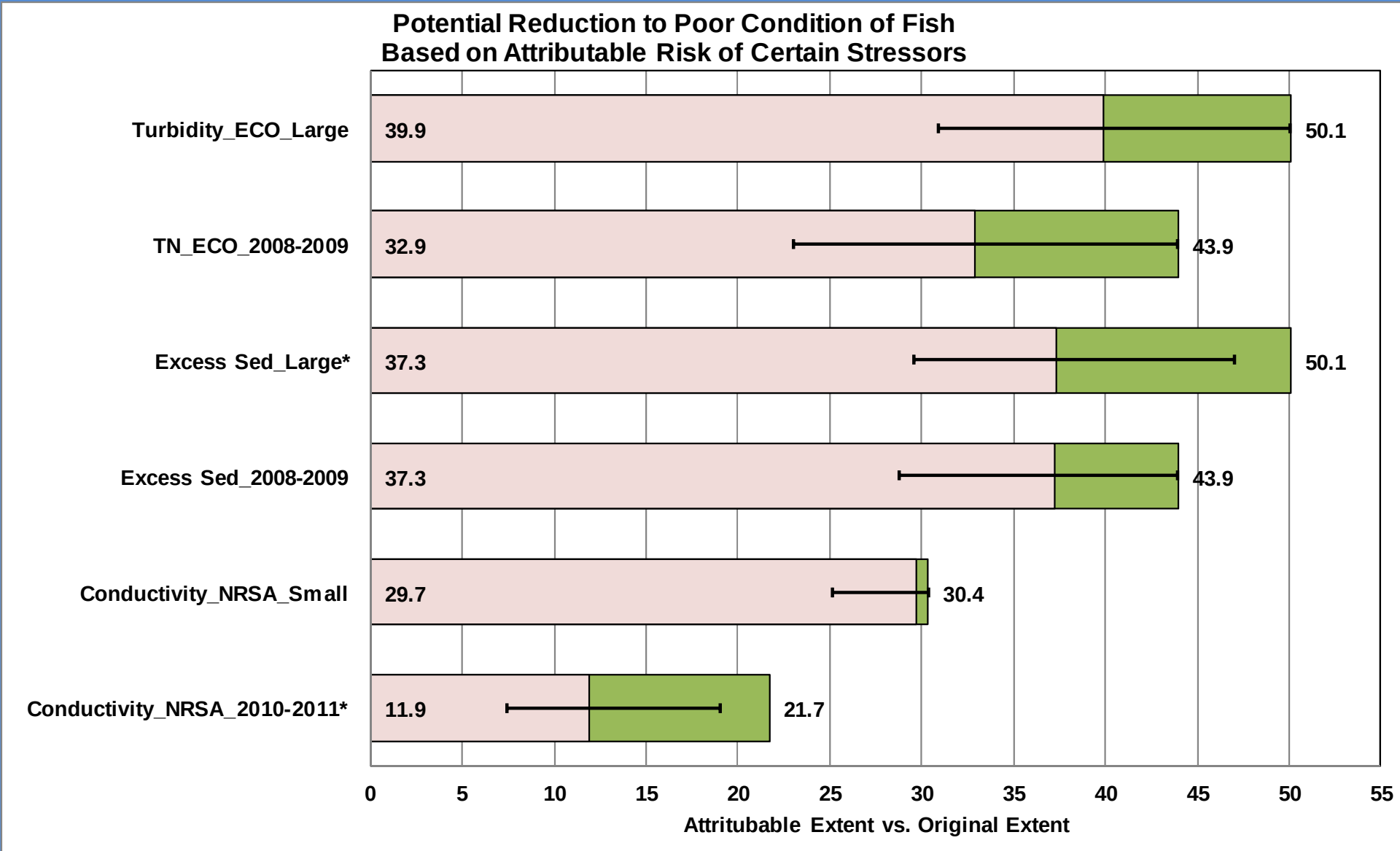
Relative Risk of Nutrient Stressors Affecting Poor Sestonic Algal Biomass Condition



Attributable Risk

- Concept developed for NRSA (Van Sickle and Paulsen, 2008)
- Can you determine how much affect a proportional reduction in a stressor would have on the incidence of poor condition in an indicator?
- Attributable risk provides an elimination scenario to investigate this relationship and potential beneficial outcomes of reduction.
- From 2013 NRSA Draft Report (USEPA, 2013)
  - Represents the magnitude or importance of a potential stressor and can be used to help rank and set priorities for policymakers and managers.
  - Attributable risk is derived by combining relative extent and relative risk into a single number for purposes of ranking.
  - Conceptually, attributable risk provides an estimate of the proportion of poor biological conditions that could be reduced if high levels of a particular stressor were eliminated.
  - This risk number is presented in terms of the percent of length that could be improved

Potential Reduction to Poor Condition of Fish Based on the Attributable Risk of Stressors




Cabela's
Questions?