

# Natural Community Stratified Random Stream Monitoring Program 2010-2013

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# Outline

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- ▶ What is Stratified Random Sampling
- ▶ Wisconsin's Natural Community Stratified Random (NCSR) stream monitoring program
- ▶ Recommendations for the future of NCSR
- ▶ Overview 2014 Baseline Streams Monitoring Program
- ▶ Discussion



# Wisconsin Stream Resources



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- ▶ ~72,000 km of perennial streams and rivers
  - ▶ Potentially doubled considering intermittent and ephemeral streams
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# What is Stratified Random Sampling?

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- ▶ Survey design used on large or difficult to measure populations
- ▶ Every discrete unit has some probability of selection
- ▶ Stratifying ensures all types of the population are represented in the sample
- ▶ Units are selected in some random fashion
  - ▶ Equal or Unequal probability
- ▶ For all practical purposes
  - ▶ Stratified Random = Probabilistic



# Why Use Stratified Random Sampling?

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- ▶ **Statistically valid estimation of the condition of a large resource**
  - ▶ Minimal sampling locations – cost effective
  - ▶ Resource balanced
  - ▶ Easily understood analyses for public consumption (305b)
  - ▶ Trend analyses
- ▶ **Estimate the importance of stressors too numerous or expensive to collect everywhere**
  - ▶ Extent and Risk
- ▶ **Visit sites often ignored by traditional assessment (unnamed, hard to access, non-gamefish)**



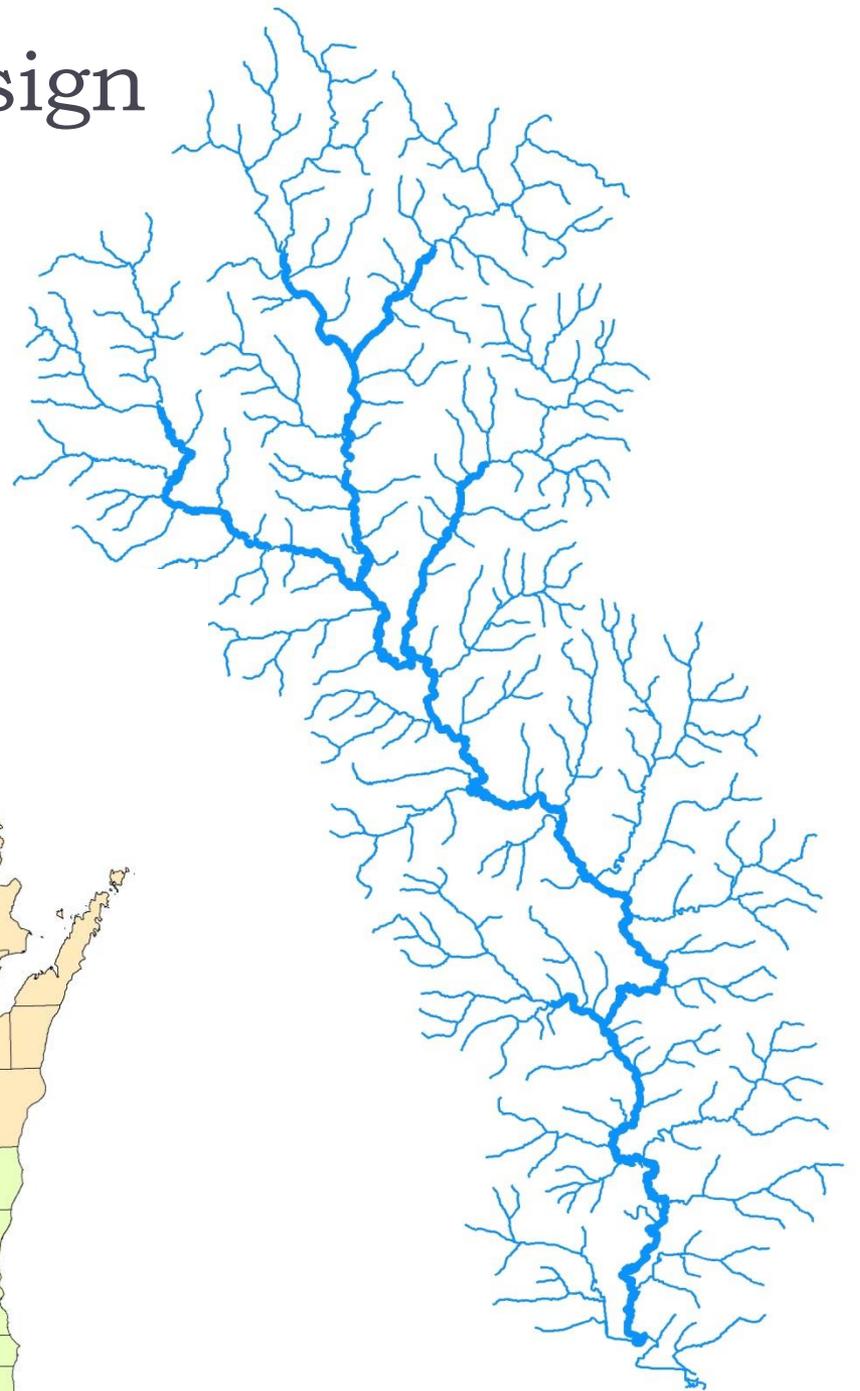
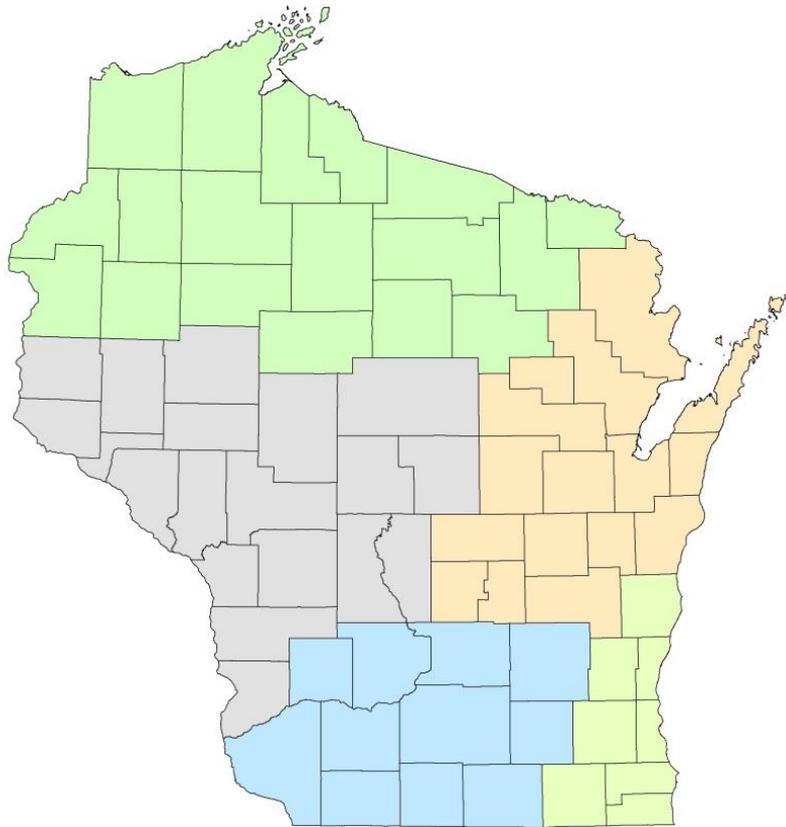
# Stratified Random Design

- ▶ **Stratified Random**

**Strata:**

- ▶ DNR Region

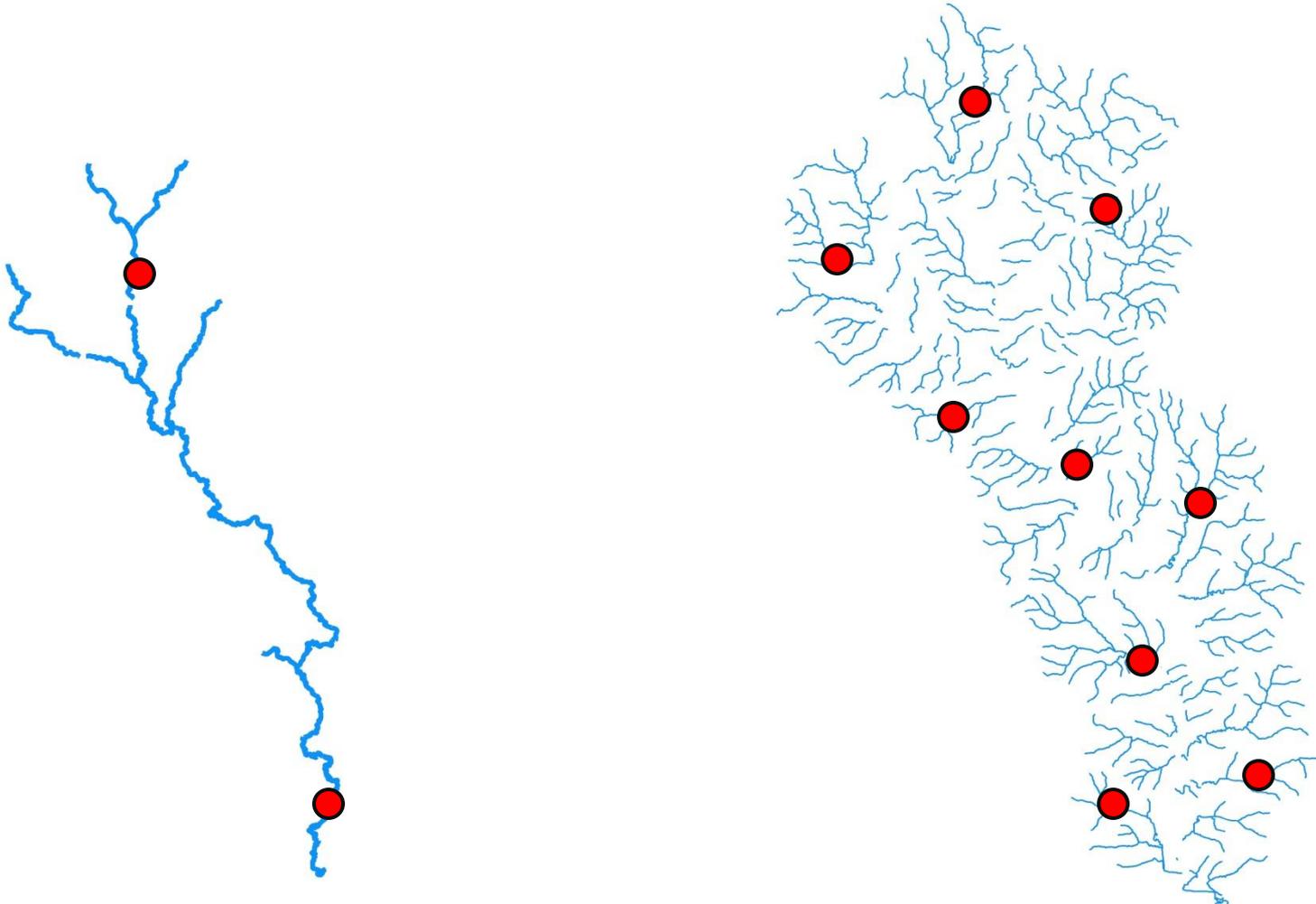
- ▶ Natural Community



# Stratified Random with Spatial Balance

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- ▶ Sample Size Based on Resource Abundance



# NCSR Design By Year

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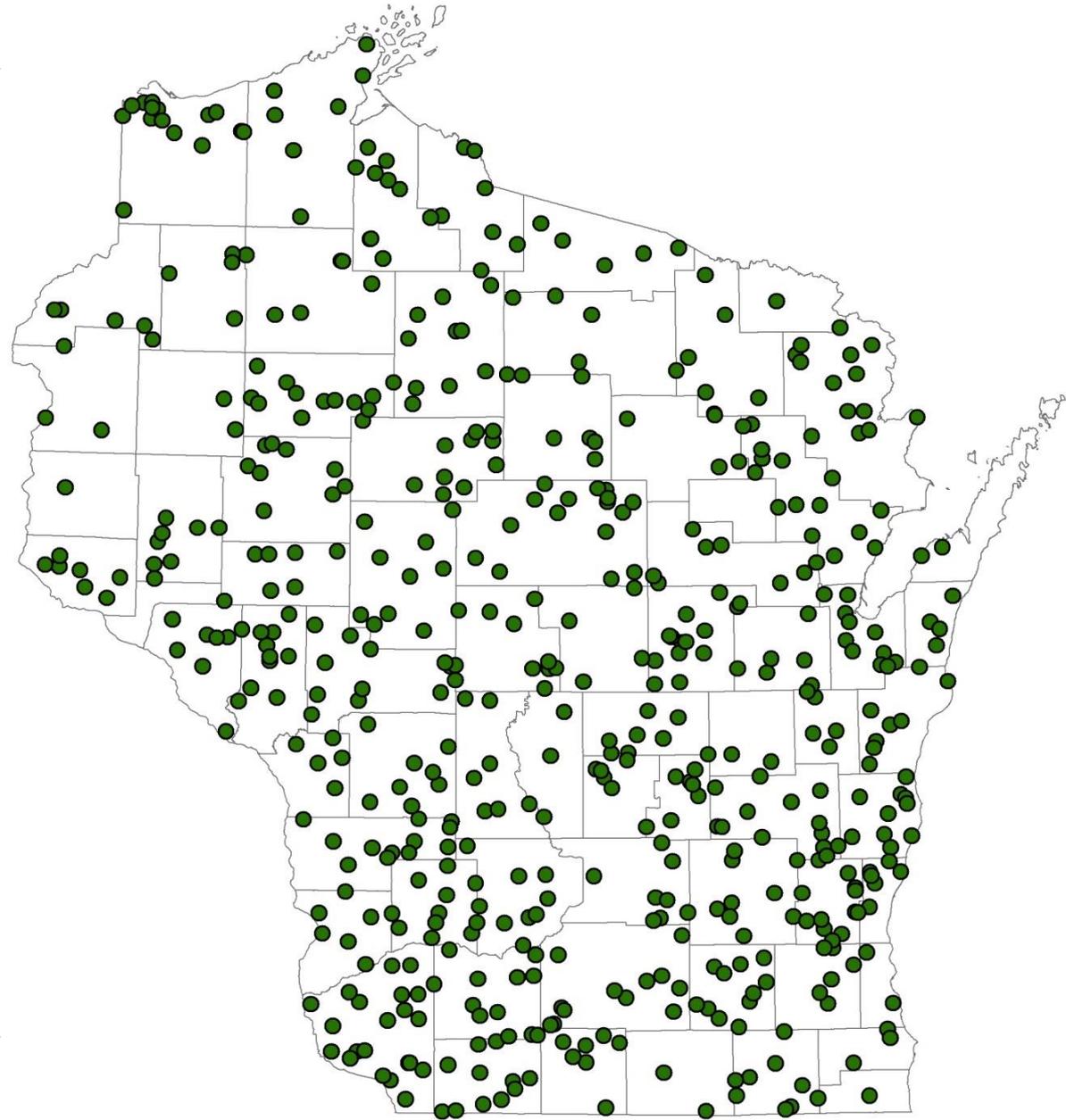
- ▶ 2010 – 200 sites, bioassessment (bugs and fish) and WQ – metered
- ▶ 2011 – 200 sites, bioassessment, 1 TP grab and WQ – metered, subset Nitrogen and TSS
- ▶ 2012 – 100 sites, bioassessment, 1 TP grab and WQ – metered, subset Nitrogen and TSS
- ▶ 2013 – 100 sites, bioassessment, 1 TP grab and WQ – metered



# Natural Community Stratified Random Sampling

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- ▶ 2010-2013
  - ▶ 548 Sites
- ▶ Chemical, Physical and Biologic samples
- ▶ Inconsistent paired stressor-response sampling



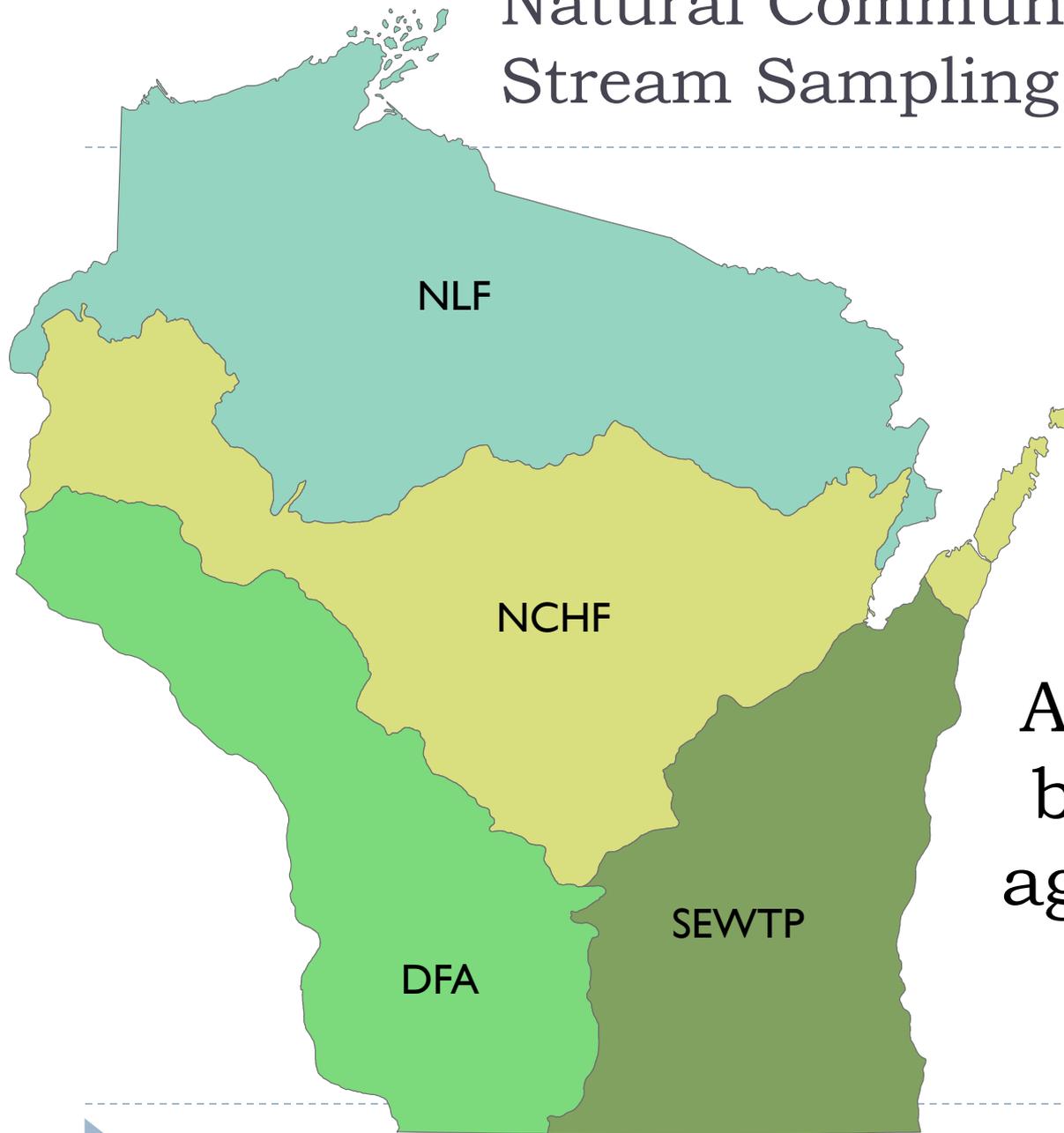
# Data Collection

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- ▶ ~14,000 water quality measurements
- ▶ 72,000 macroinvertebrates collected and ID'd
  - ▶ 741 unique taxa
- ▶ 98,000 individual fish collected and ID'd
  - ▶ 117 unique taxa



# Natural Community Stratified Stream Sampling Results 2010-2013



Analysis stratified  
by Ecoregion and  
aggregated Natural  
Community

# Stratification

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- ▶ Natural Communities were lumped to reach minimum sample sizes for each strata

Cold Headwater  
&  
Cold-Cool  
Headwater

Cold Mainstem  
&  
Cold-Cool  
Mainstem

Warm Headwater  
&  
Warm-Cool  
Headwater

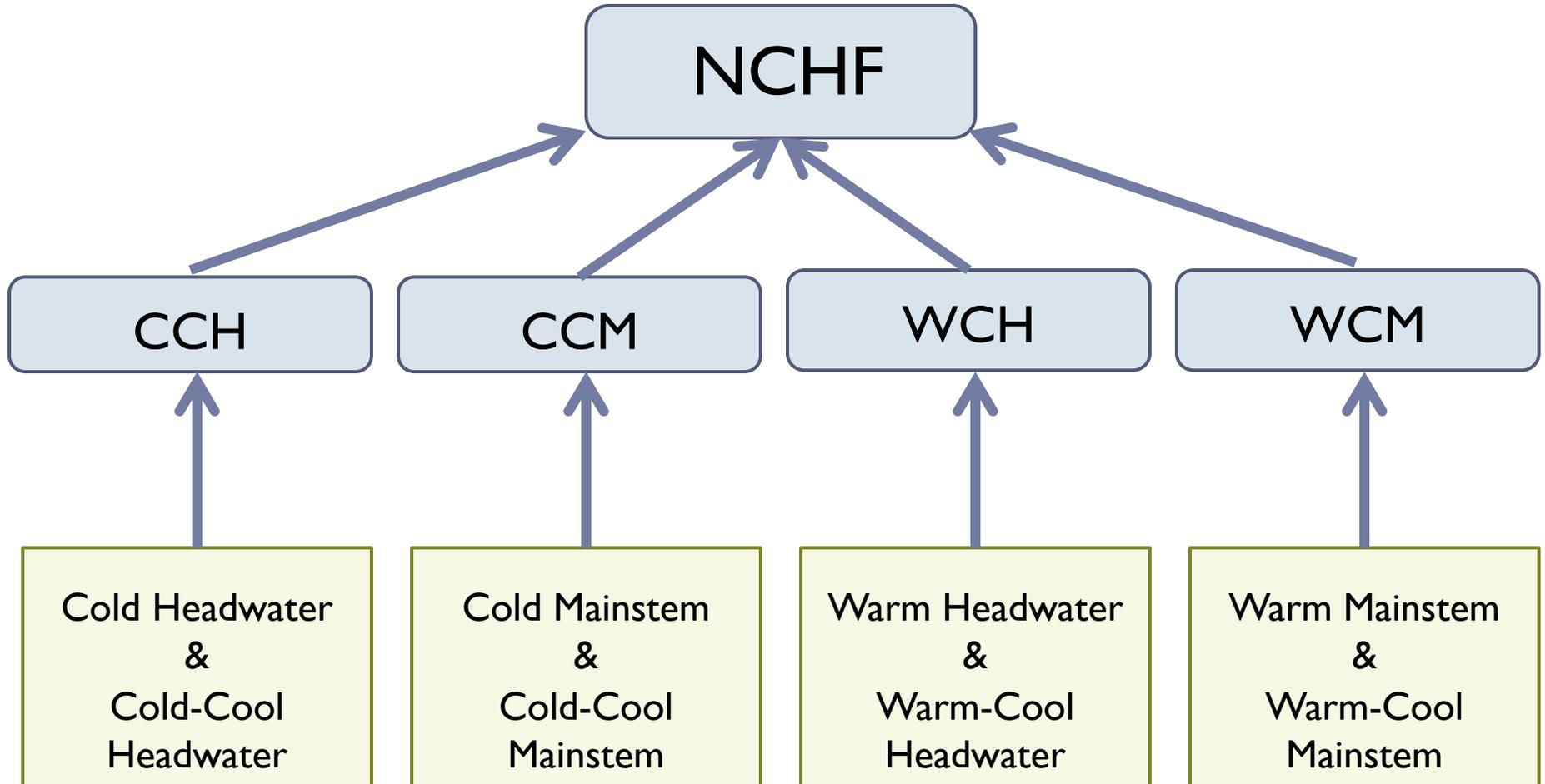
Warm Mainstem  
&  
Warm-Cool  
Mainstem

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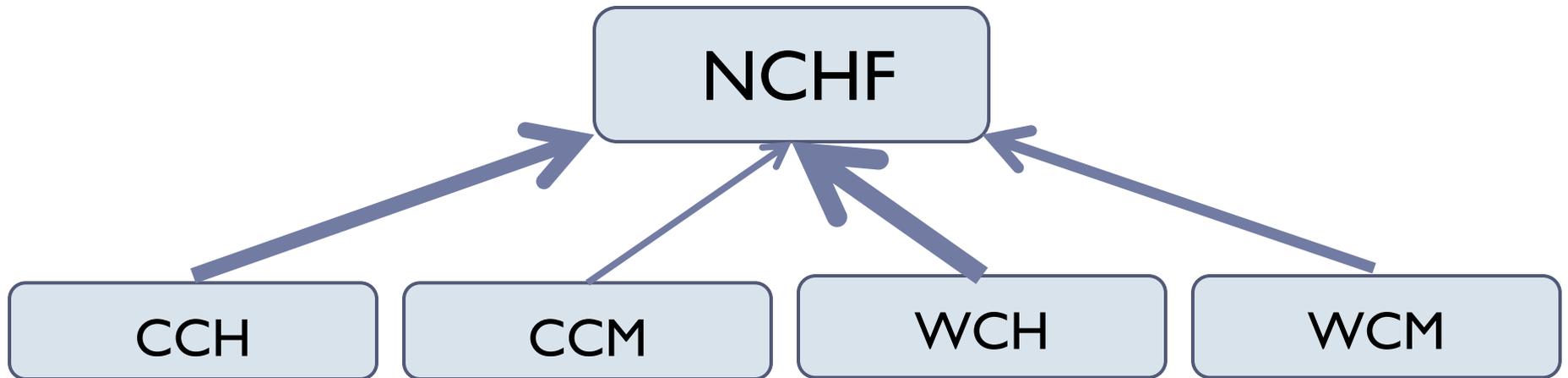
# Stratification

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# Stratification

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Population Size  
6,050 km

Population Size  
820 km

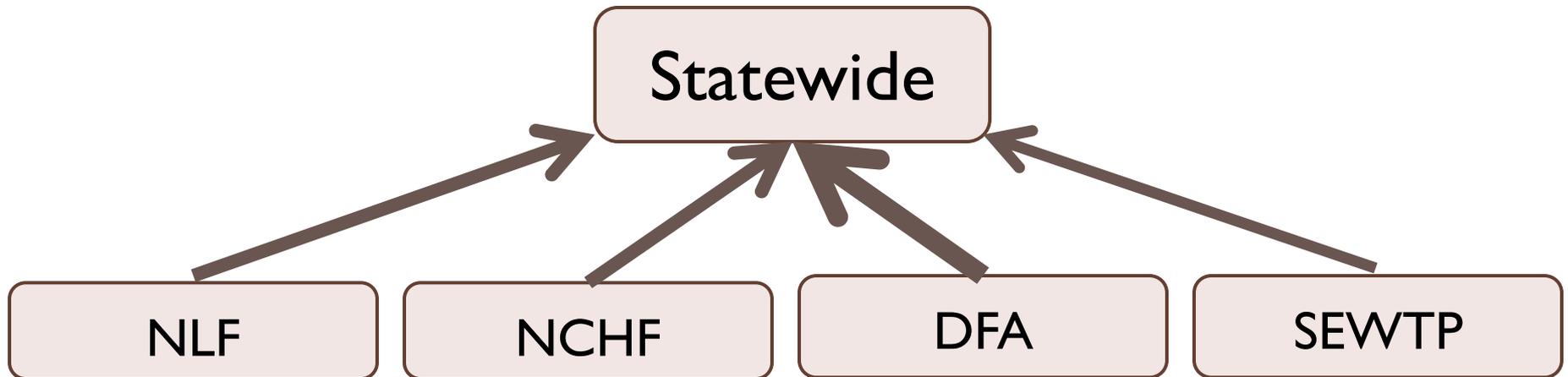
Population Size  
8,700 km

Population Size  
3,300 km



# Stratification

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Population Size  
19,800 km

Population Size  
18,900 km

Population Size  
23,520 km

Population Size  
13,700 km



# Relative Extent of Stressors

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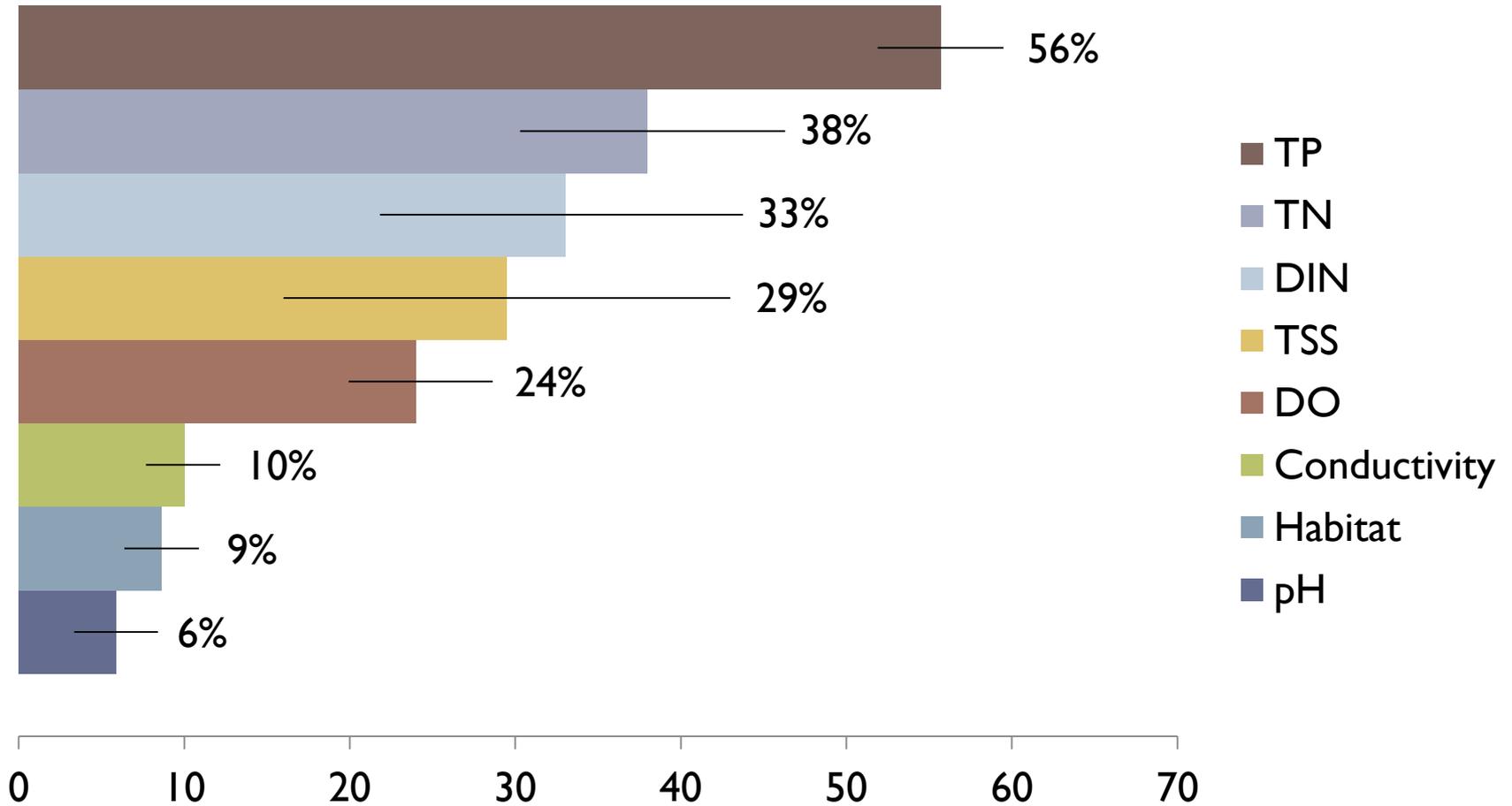
- ▶ What percent of streams, by length, are in “Poor” condition?

Parameter	Threshold Source	Number Samples
Total Phosphorus	WI WQS	348
Conductivity, Dissolved Oxygen	Reference Site 90 <sup>th</sup> Percentile	308
pH	WI WQS	308
Nitrogen & TSS	Reference Site 90 <sup>th</sup> Percentile	31
Qualitative Habitat	Categorical Rating	419
Macroinvertebrate IBI	Categorical Rating	392
Fish IBI	Categorical Rating	440

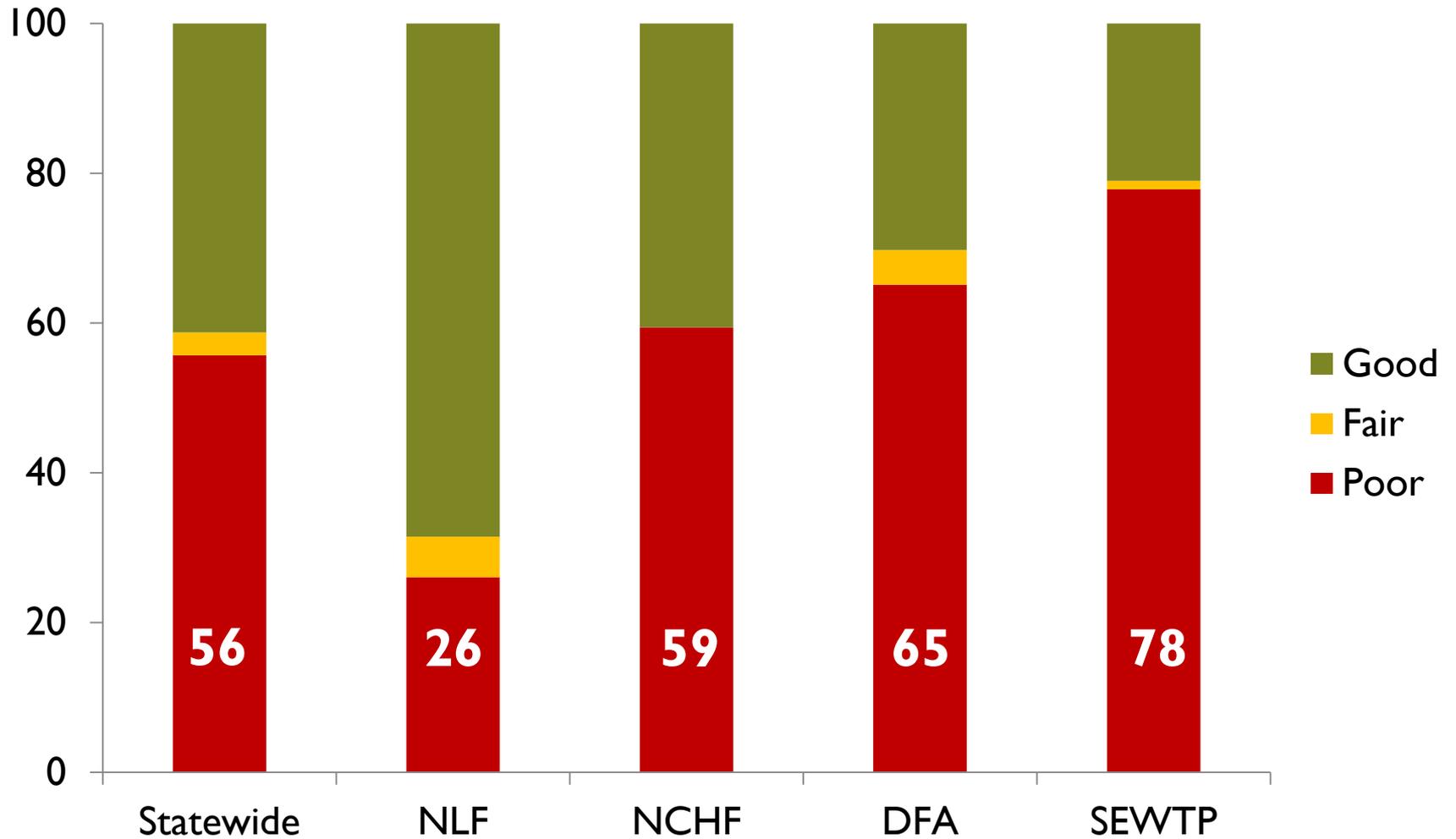


# Relative Extent – Percent “Poor”

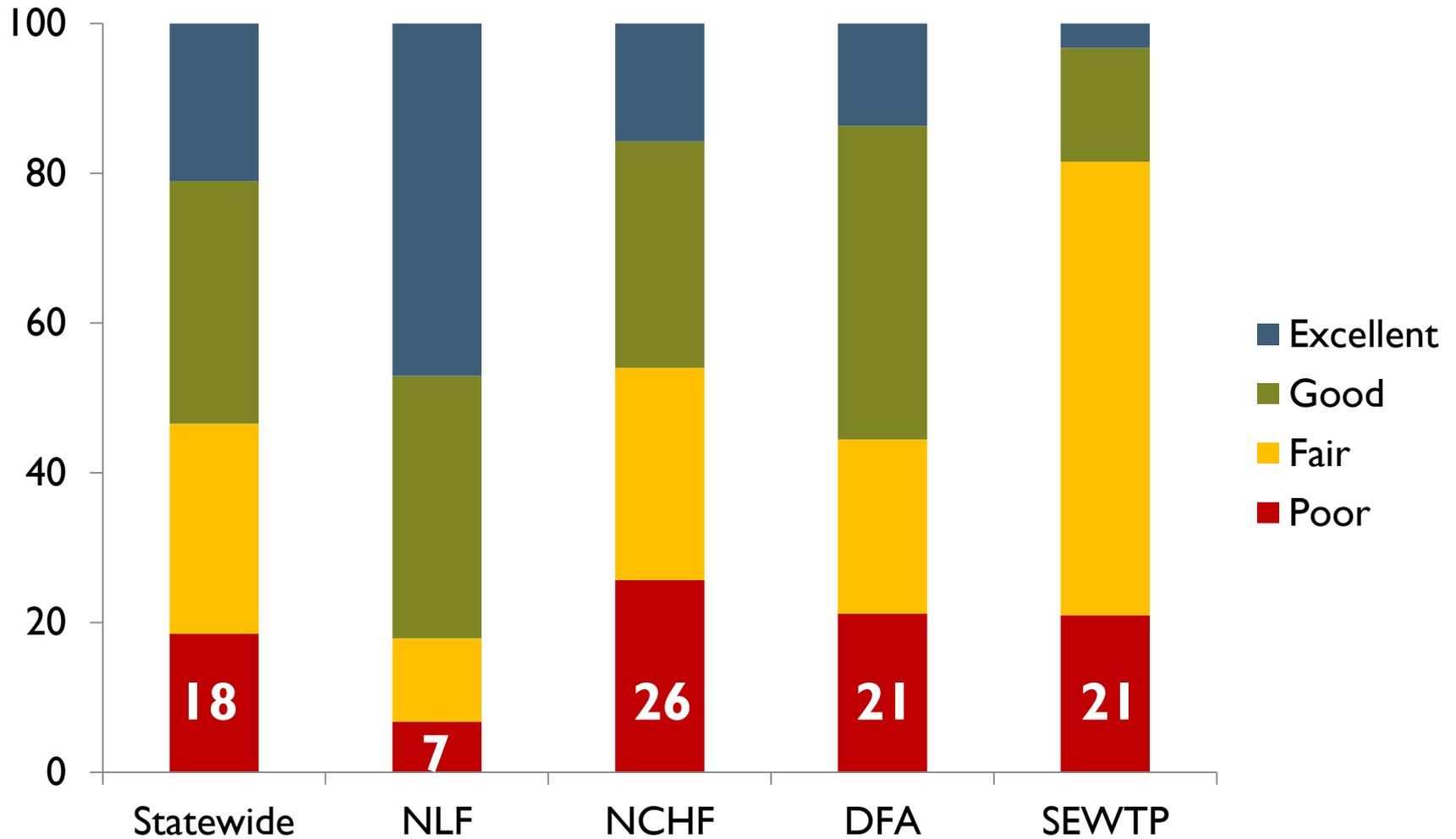
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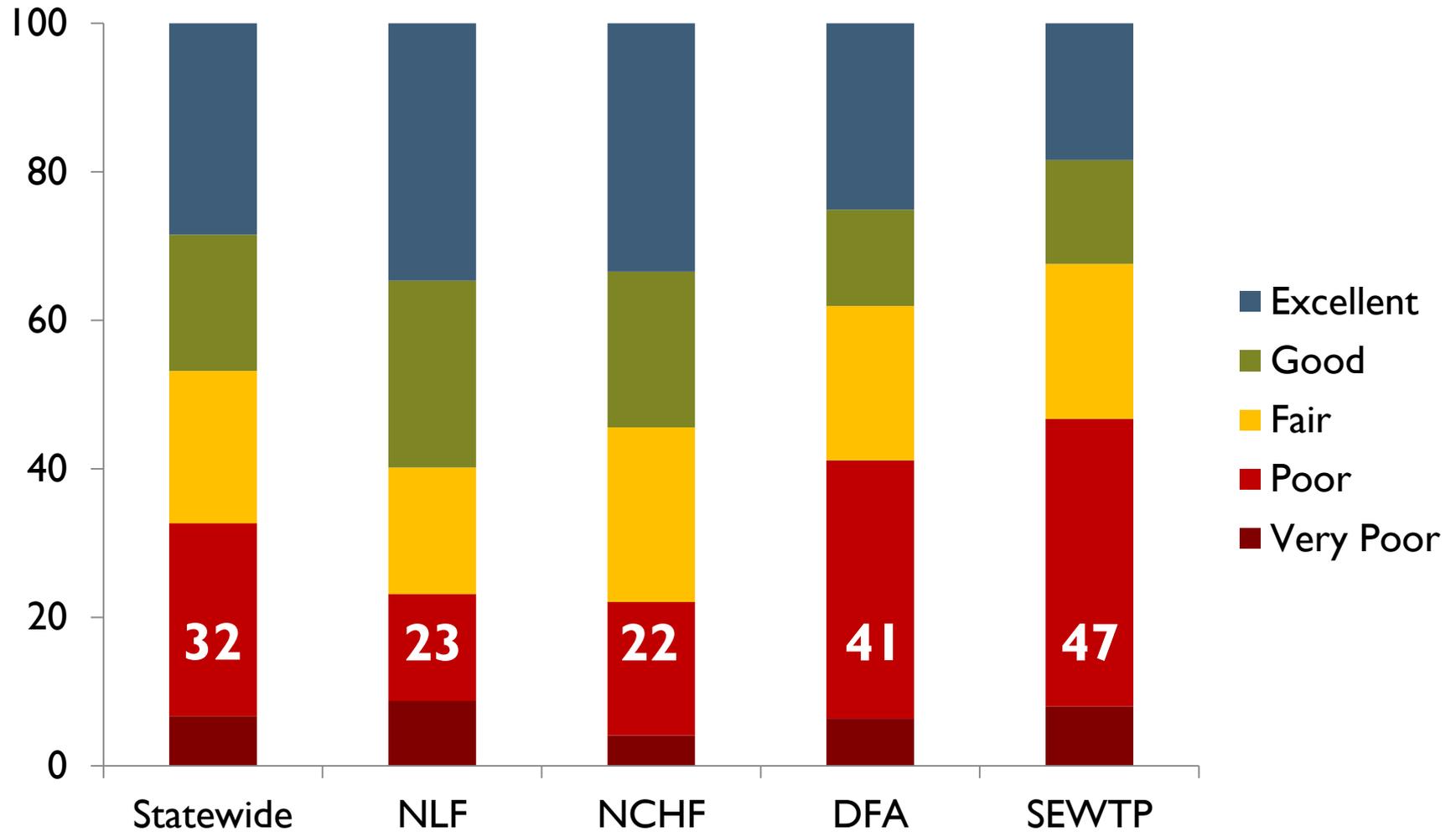
# Total Phosphorus



# Macroinvertebrate IBI



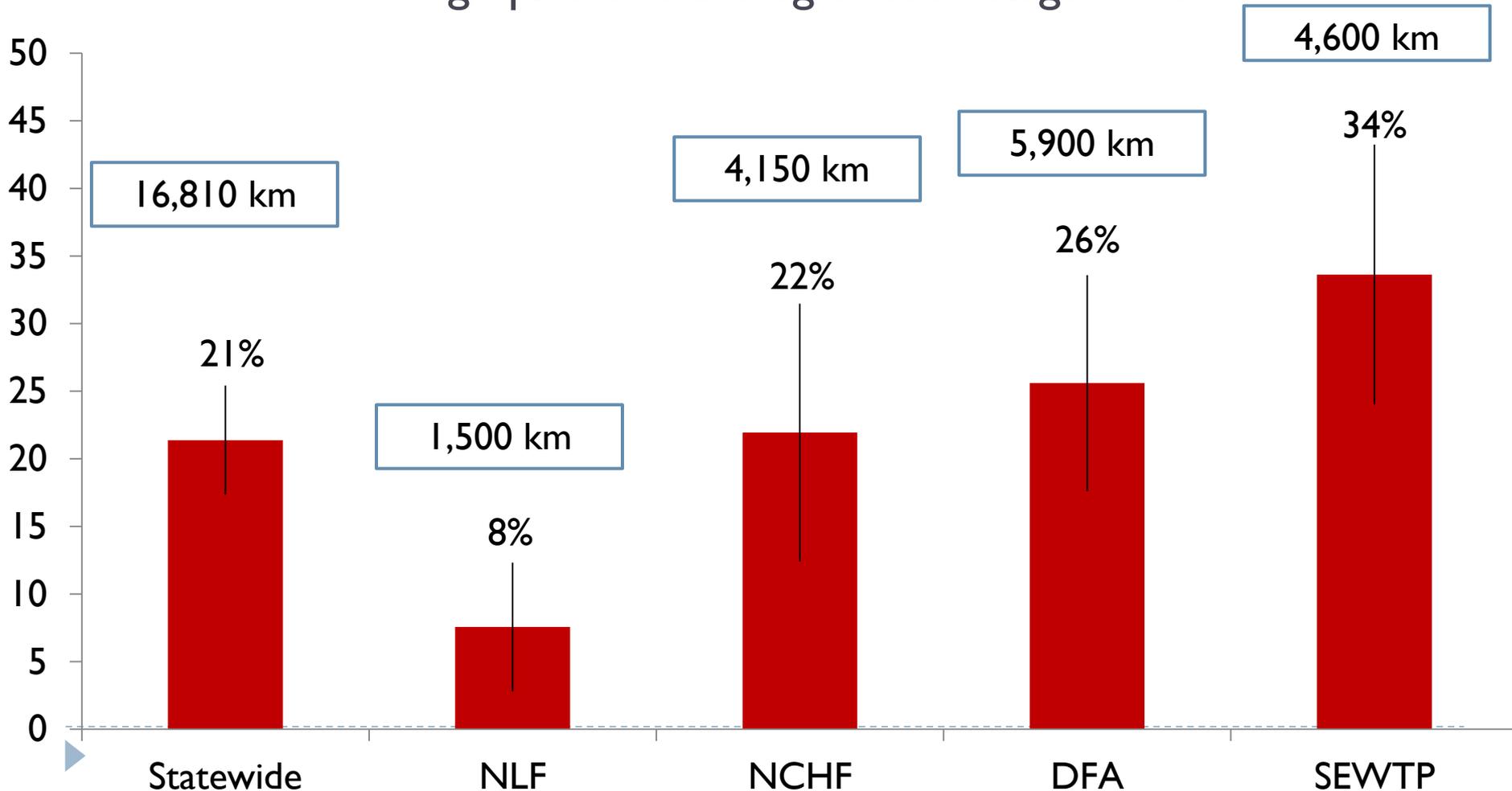
# Fish IBI



# How Many Impaired Waters for TP?

- ▶ Using existing Methodology

- ▶ TP > 0.075 mg/l plus one biologic assemblage “Poor”



# NCSR: Relative Risk Estimates

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- ▶ How “severe” is a stressor?
- ▶ If a Stressor is in “Poor” condition what are the increased chances that a Response will also be in “Poor” condition?
- ▶ Adopted from the medical profession



# Relative Risk

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		Stressor		
		Good	Poor	
Response	Good	0.55	0.05	Risk Poor Response   Poor Stressor $0.35/0.4 = 0.875$
	Poor	0.05	0.35	Risk Poor Response   Good Stressor $0.05/0.6 = 0.083$
	Total	0.6	0.4	

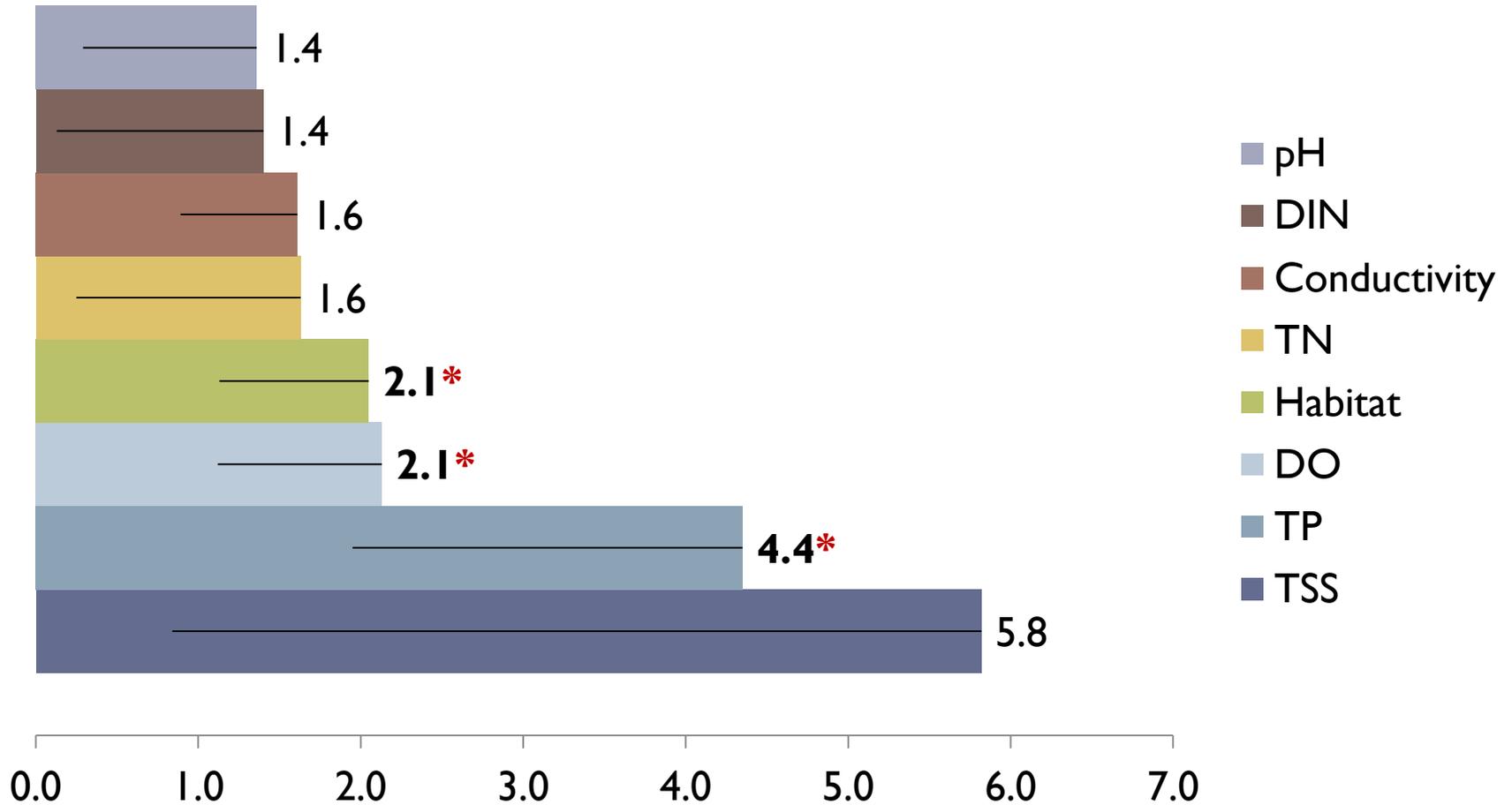
$$RR = \frac{\Pr(Poor|Poor)}{\Pr(Poor|Good)} = \frac{0.875}{0.083} = 10.5$$

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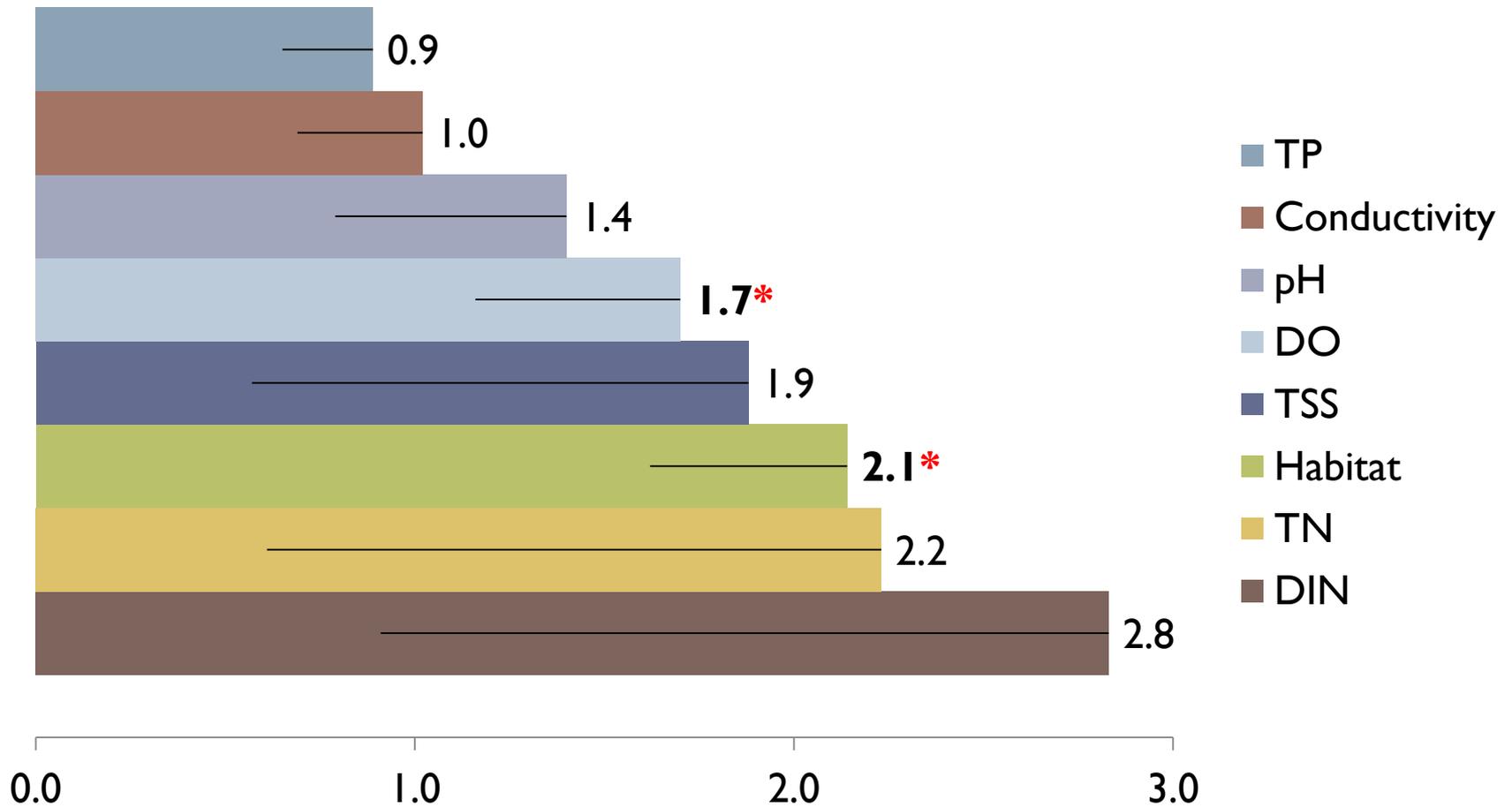
# Relative Risk to Macroinvertebrate IBI Condition

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# Relative Risk to Fish IBI Condition

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# NCSR Key Results

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- ▶ Phosphorus and Nitrogen concentrations statewide commonly exceed thresholds\*
- ▶ Phosphorus has a greater risk to macroinvertebrates than fish
- ▶ Nitrogen and TSS results indicate a risk to biota, although sample sizes are low
- ▶ Qualitative habitat rating impact macroinvertebrate and fish integrity scores
  
- ▶ Is NCSR monitoring necessary?
- ▶ If so, how many sites do we need?



# Is NCSR Monitoring Necessary?

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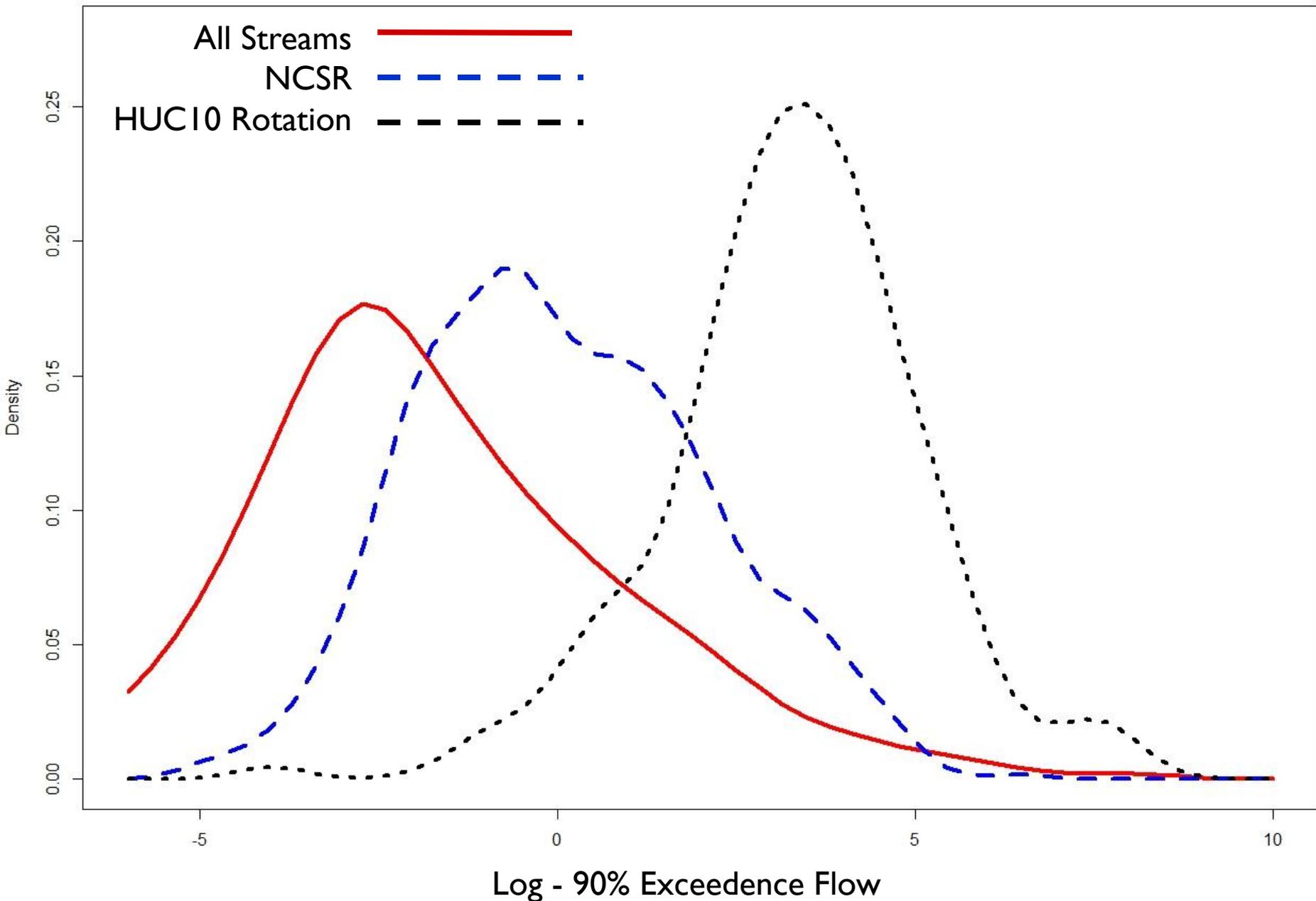
- ▶ Stratified Random vs Fixed Station
- ▶ Wadeable Rotation Monitoring
- ▶ HUC10 Pour Points 2006-2011



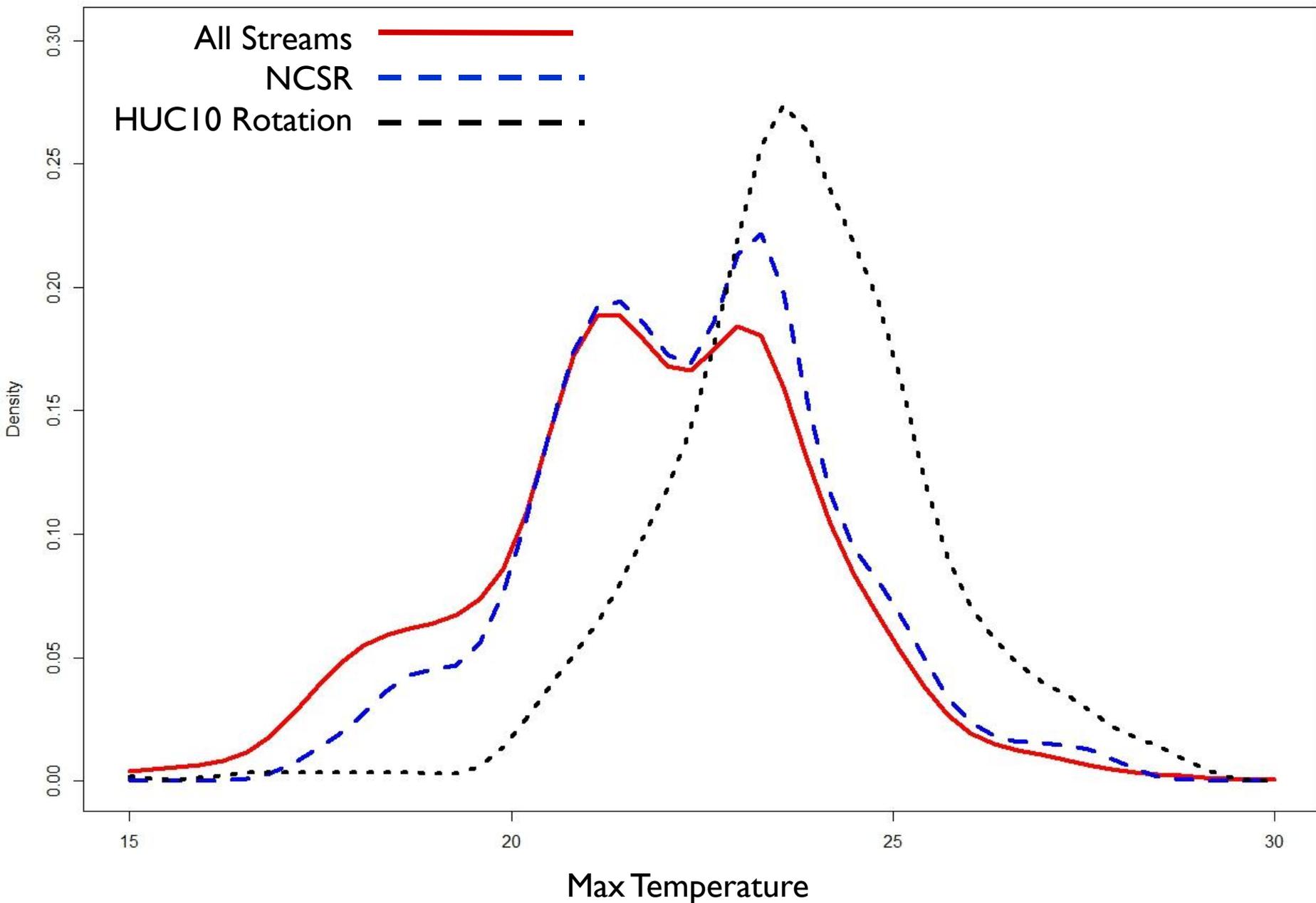
<b>% Poor</b>	<b>TP</b>	<b>TN</b>	<b>n</b>
NCSR	56%	33%	~350
Wadeable Rotation	55%	26%	~4,000



# Scaling Up to Population Estimates



# Scaling Up to Population Estimates



# Stratified Random vs Fixed Station

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## ▶ Fixed Station

- ▶ Target locations based on needs
- ▶ Identify "hot spots"
- ▶ Multiple visits to sample variability
- ▶ Detecting trends

## ▶ Stratified Random

- ▶ Better representation of all stream types
- ▶ Statistically valid estimation of whole resource
- ▶ Less samples need to cover large geographic area



# How Many Sites Do We Really Need?

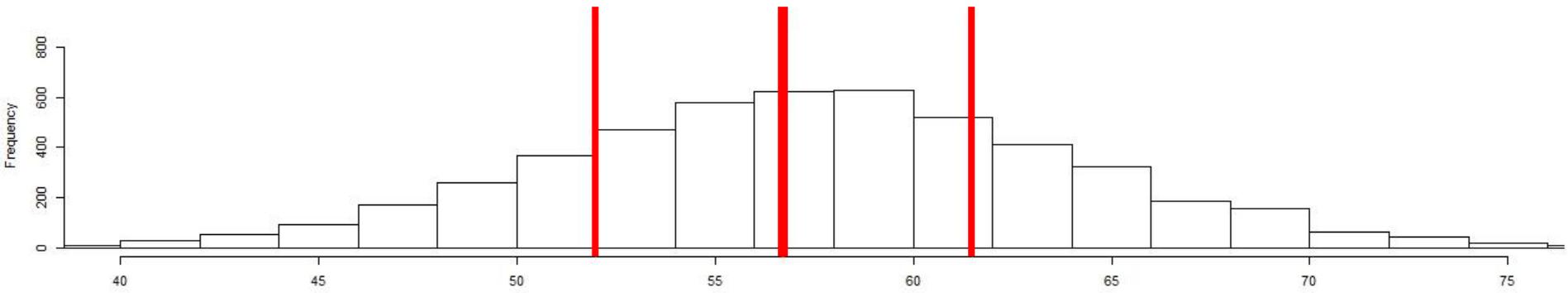
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- ▶ Randomly subset sites and rerun analysis with smaller sample sizes
- ▶ Do we get the same answer using 50, 100, 150 sites instead of ~550?

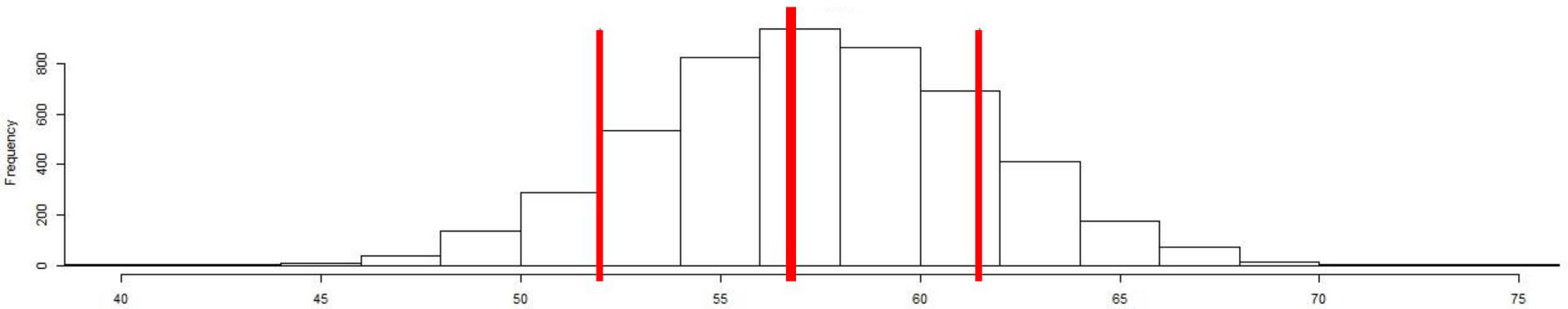


# Total Phosphorus

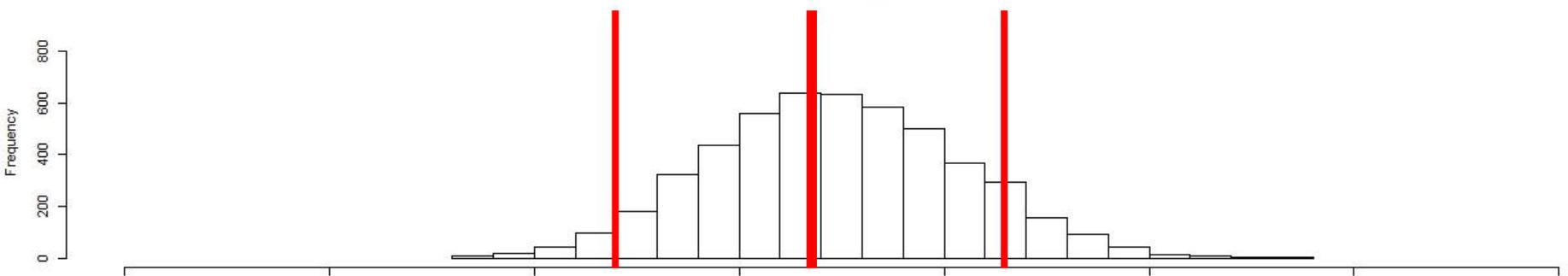
n=50



n=100



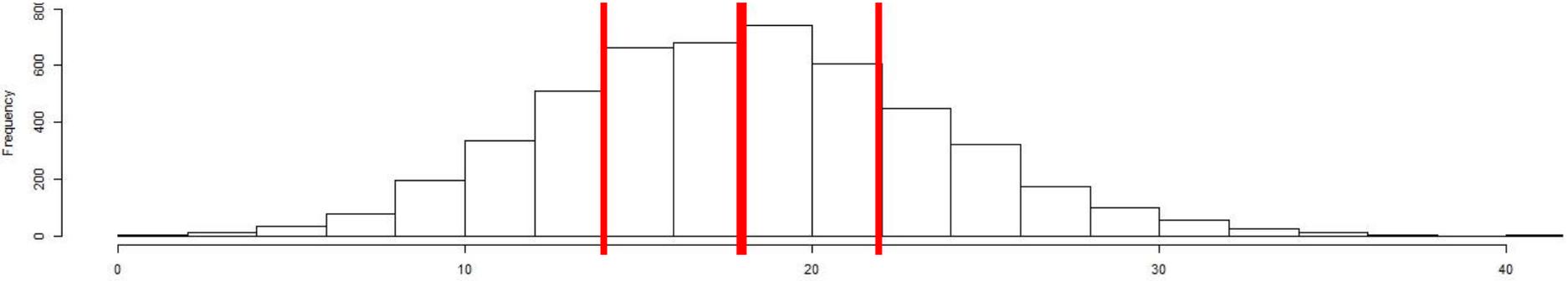
n=150



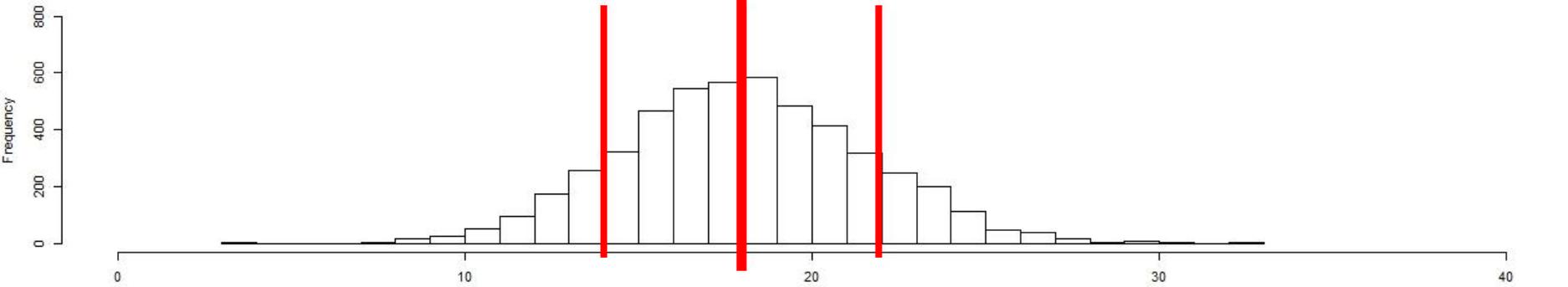
Percent Stream Length TP > 75 ug/l with Random Resampling

# Macroinvertebrate IBI

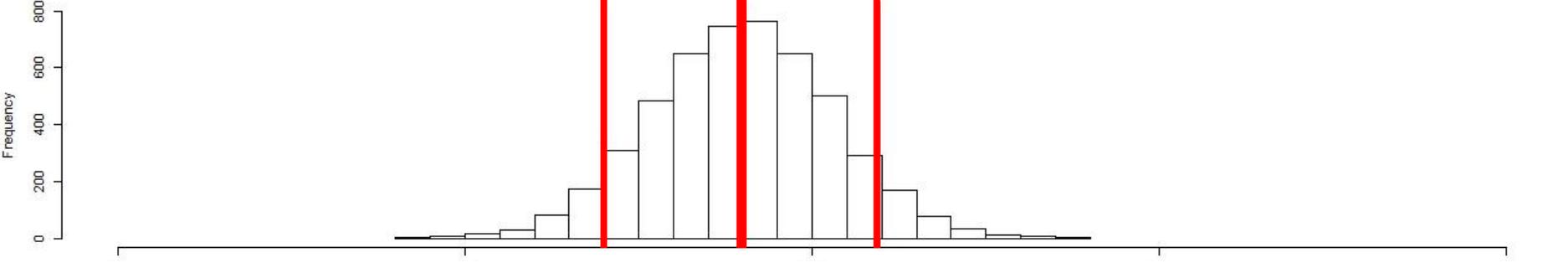
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n=100



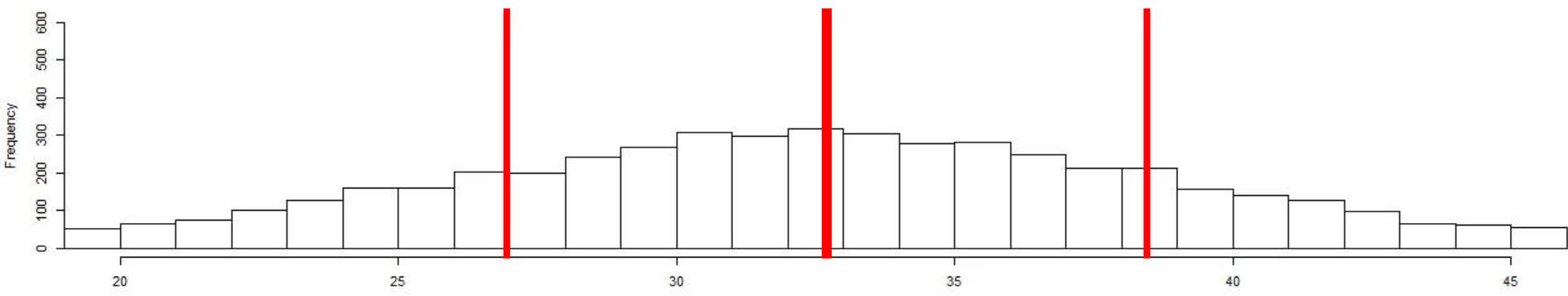
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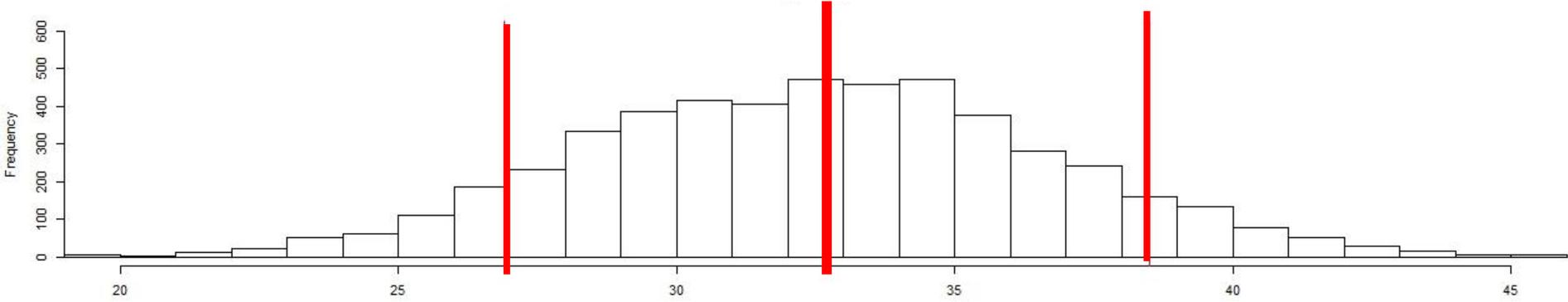
Percent Stream Length mIBI = "Poor" with Random Resampling

# Fish IBI

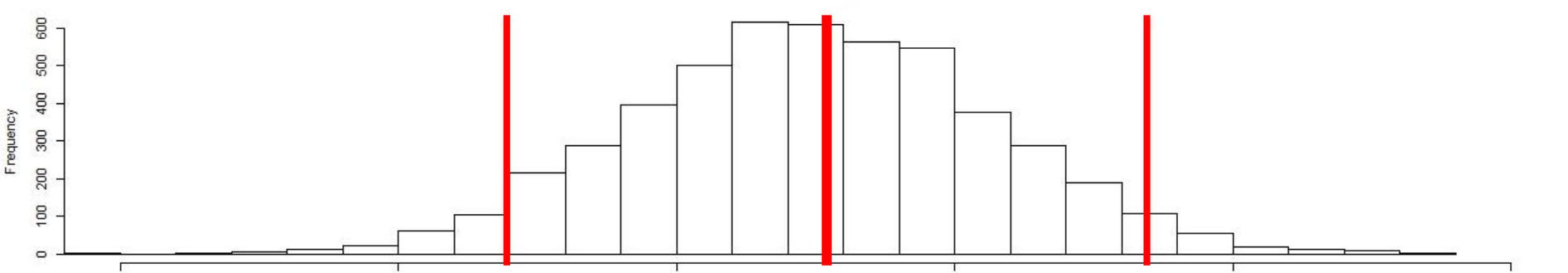
n=50



n=100



n=150



Percent Stream Length fIBI = "Poor" with Random Resampling

# Future of NCSR monitoring program

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- ▶ Reduce number of sites per year to 50
  - ▶ Starting in field season 2014
- ▶ NCSR “cycle” is every 2 years
  - ▶ Total of 100 sites for analysis
- ▶ Include Nitrogen series and TSS at all sites
- ▶ Analyze for status and trends every 2 years
  - ▶ Consistent with 305b reporting



# Changes To Baseline Monitoring Program

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- ▶ Reduce number of NCSR sites
- ▶ Severely Impacted program's 2 year monitoring plan completed in 2013
- ▶ Include a standardized 303d evaluation monitoring program
- ▶ Include a standardized intensive watershed monitoring program



# 2014 Baseline Streams and Rivers Monitoring program

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- ▶ **Natural Community Stratified Random**
  - ▶ 50 Sites
  - ▶ Statewide Condition Assessment
    - ▶ Extent and Risk of stressors
  - ▶ Water Quality Trends
  - ▶ Impaired Waters Identification
  
- ▶ **Large River Macroinvertebrates**
  - ▶ Large River Biologic Evaluation – 22 sites
  - ▶ Trend and Annual Variation of IBI



# 2014 Baseline Streams and Rivers Monitoring program

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- ▶ **Wadeable Long Term Trends**

- ▶ 44 sites
- ▶ Annual Variation of Biologic Indices
- ▶ Statewide and Regional Ranges of Reference Condition

- ▶ **Rivers Long Term Trends**

- ▶ 43 Sites
- ▶ Water Chemistry Trends
  - ▶ All Land Use Conditions
- ▶ Adding Site on Grant River in 2014



# 2014 Baseline Streams and Rivers Monitoring program

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- ▶ **Follow Up Monitoring**

- ▶ 78 sites
- ▶ Identify Suspected Impaired Sites
- ▶ Fulfill WisCALM Minimum Data Requirements

- ▶ **Targeted Watershed Assessments**

- ▶ 15 HUC 12 Watersheds
- ▶ 5-8 Monitoring Locations per Watershed
- ▶ Evaluation, Effectiveness, Protection and Planning



# EPA's Elements of a State Monitoring Strategy

	Statewide Condition	Trend Analysis	Impaired Waters ID	Setting Expectations	Effectiveness Monitoring
NCSR	●	◐	◐		
River Macro-invertebrates		◐	◐	◐	
River LTT	◐	●	◐		◐
Stream LTT		●		●	
Follow Up Monitoring			●		
TWA			◐		◐

● Fully Meets



◐ Partially Meets

# Questions?

	Statewide Condition	Trend Analysis	Impaired Waters ID	Setting Expectations	Effectiveness Monitoring
NCSR	●	◐	◐		
River Macro-invertebrates		◐	◐	◐	
River LTT	◐	●	◐		◐
Stream LTT		●		●	
Follow Up Monitoring			●		
TWA			◐		◐

● Fully Meets

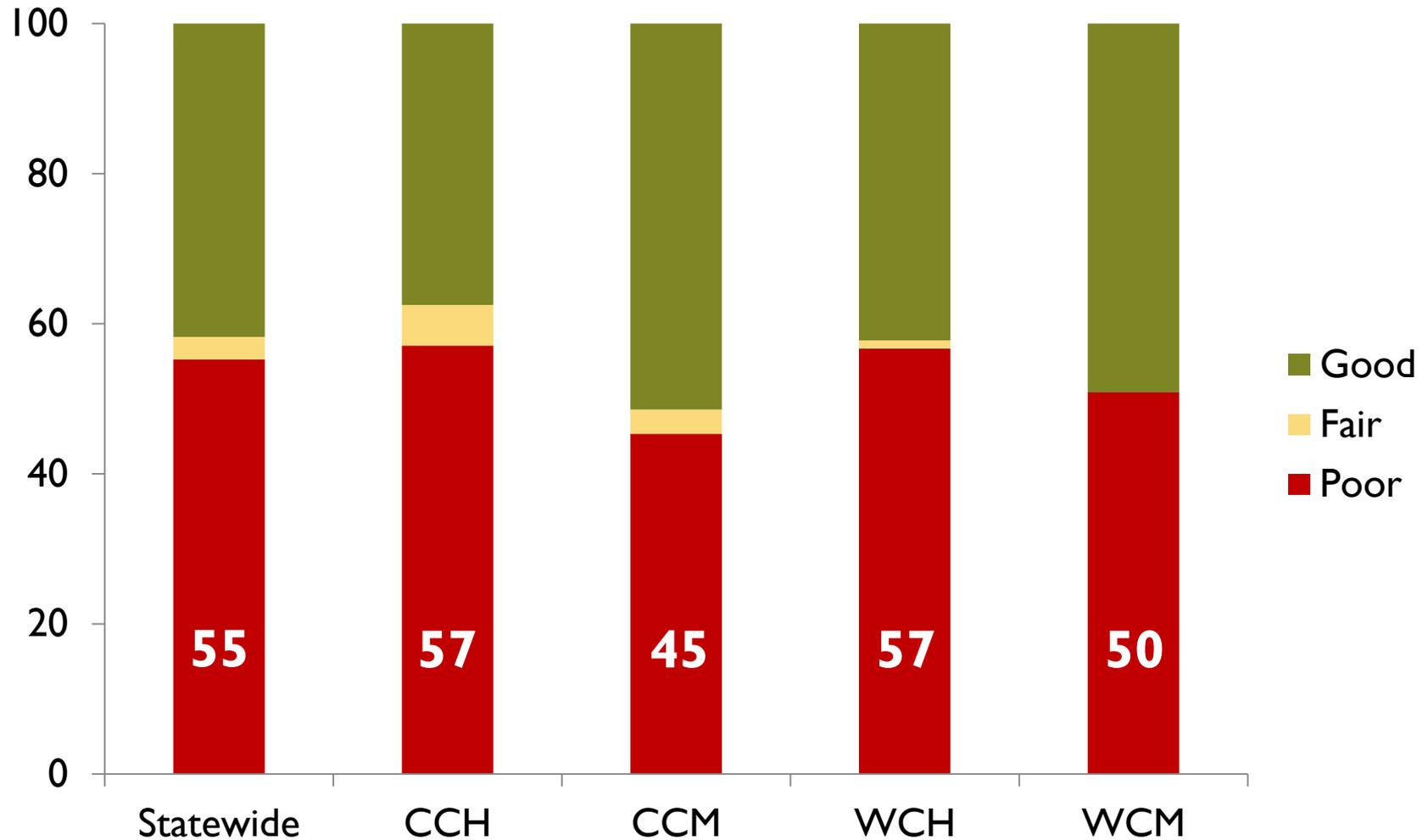
▶ ◐ Partially Meets

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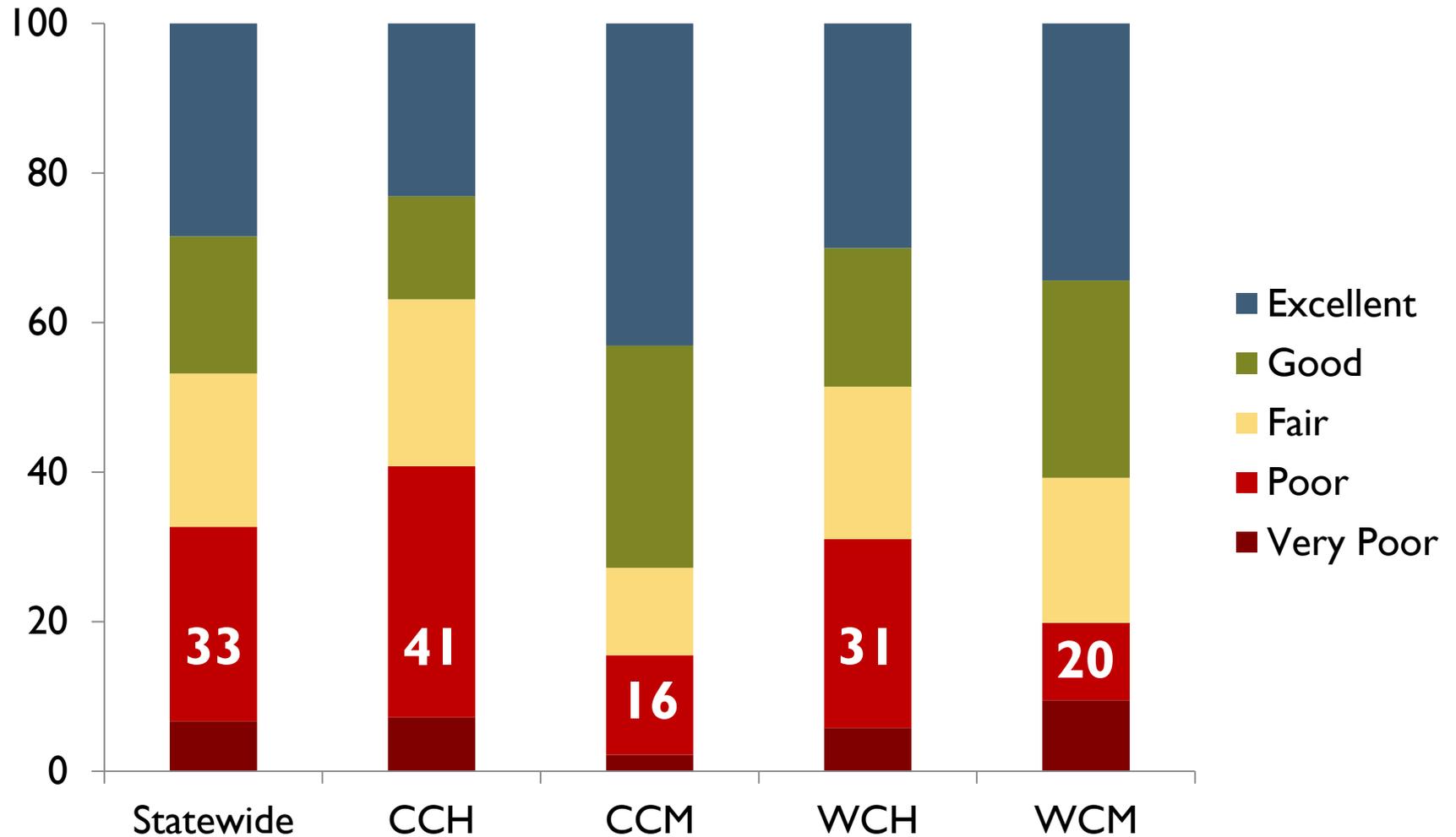
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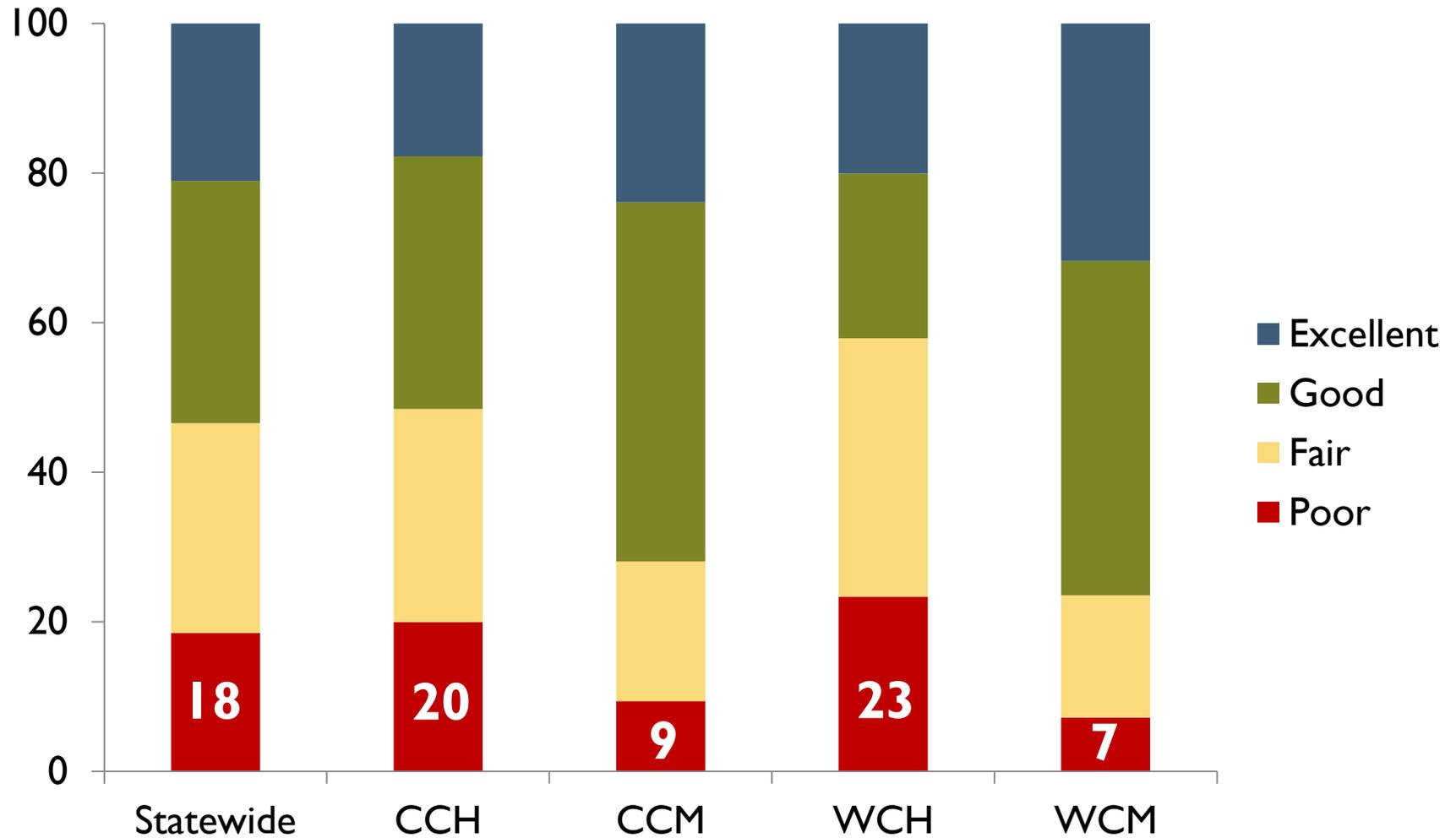
# Stratify by Combined NCs - TP



# Stratify by Combined NCs - fIBI

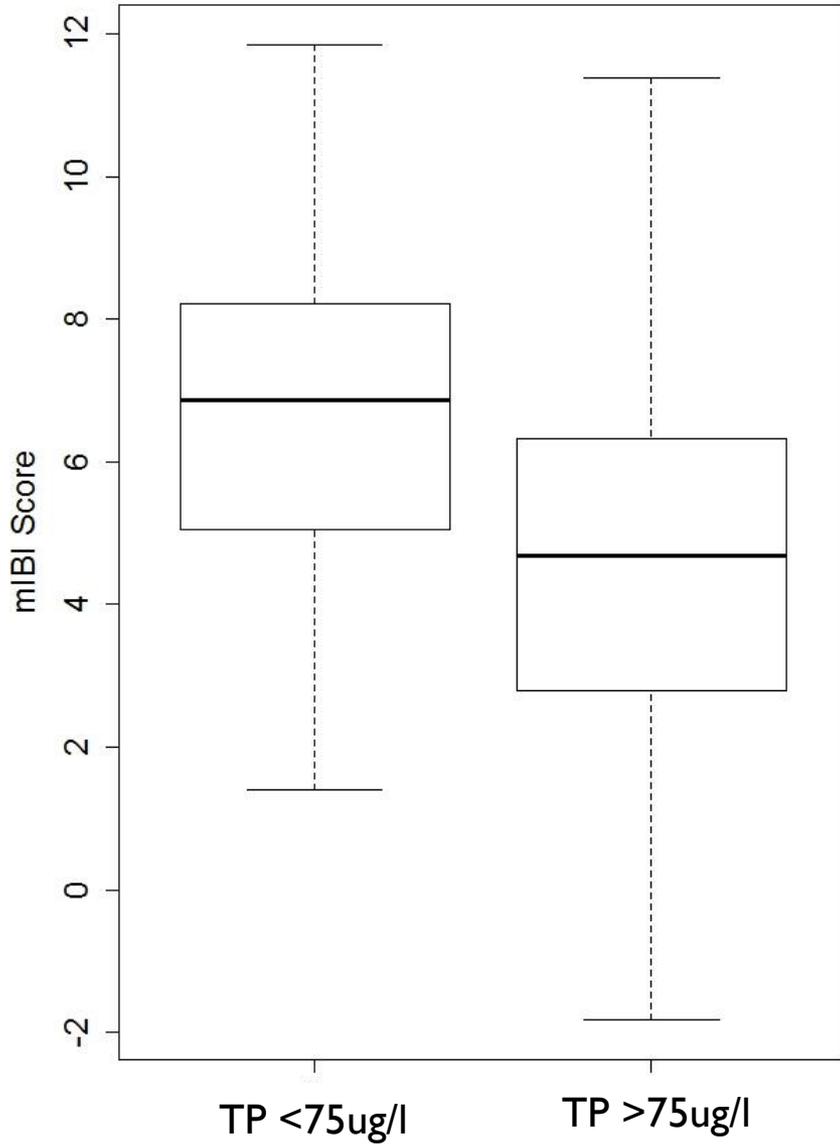


# Stratify by Combined NCs - mIBI

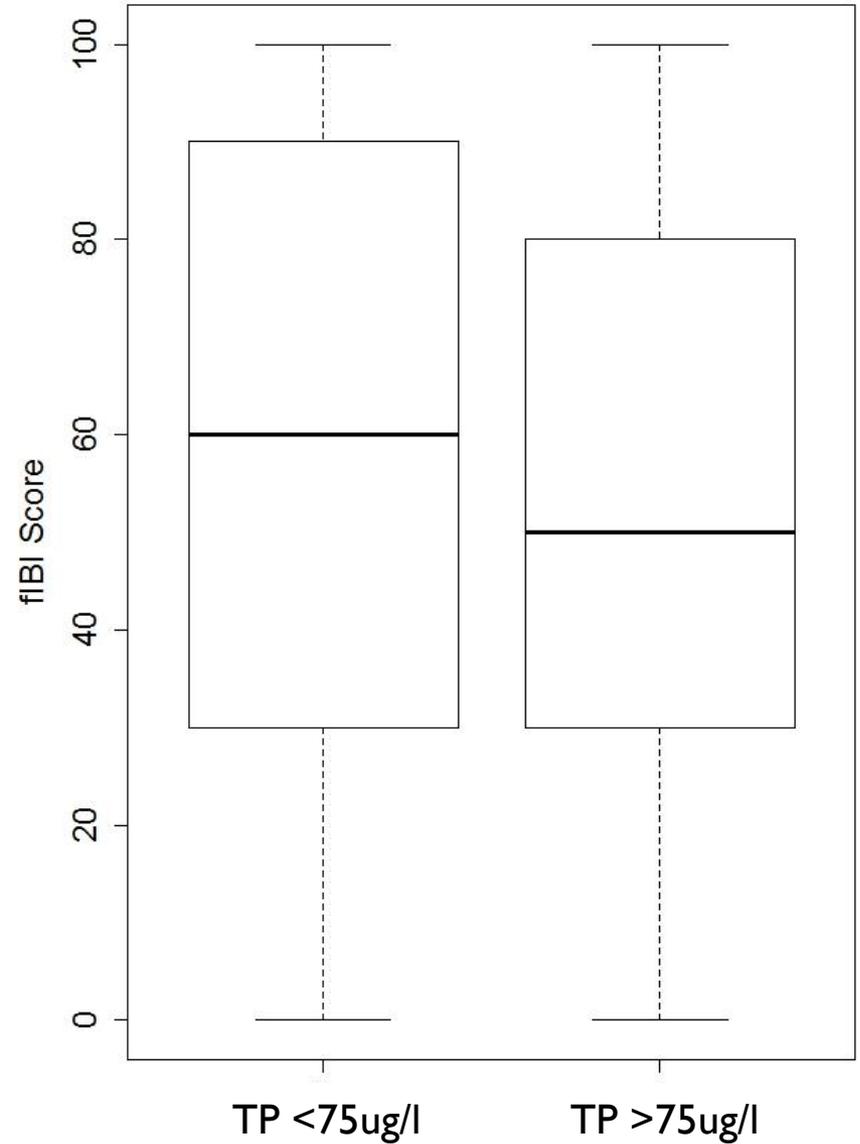


# Phosphorus and Biology

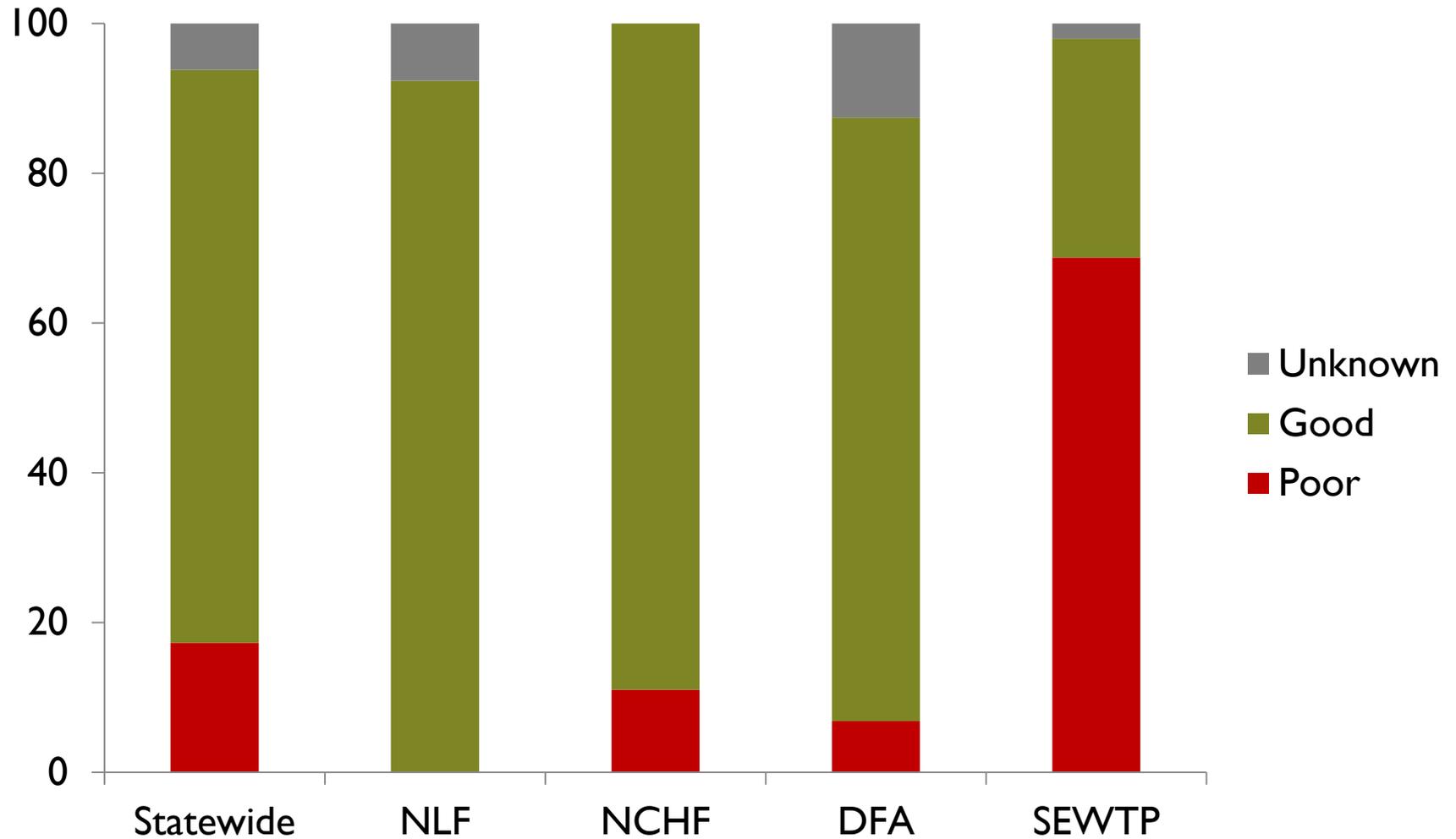
mIBI Scores vs TP Condition



fIBI Scores vs TP Condition

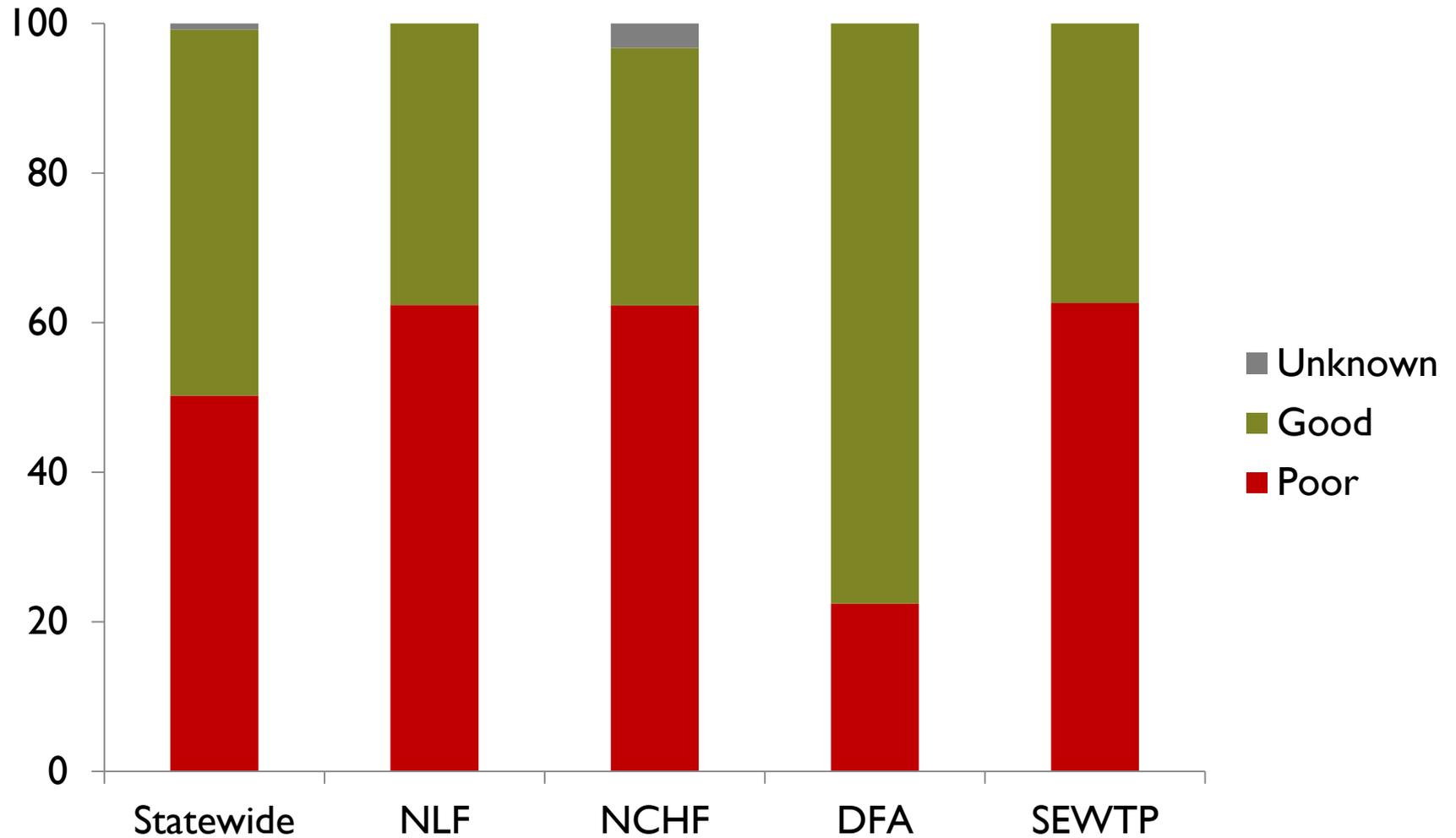


# Field WQ Parameters- Conductivity



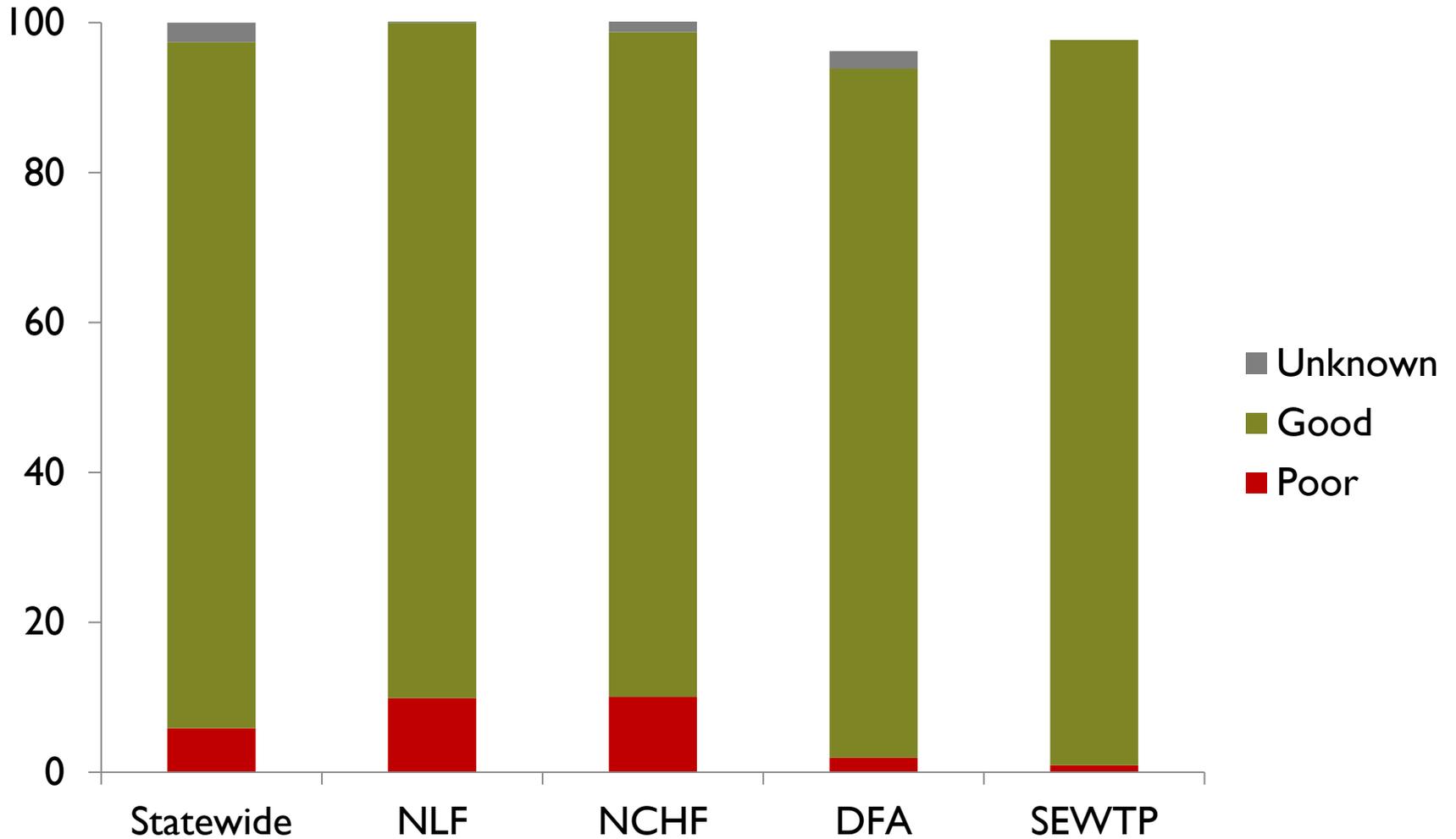
# Field WQ Parameters- Dissolved Oxygen

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# Field WQ Parameters- pH

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# Qualitative Habitat

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