To: Laidlaw, Tina[Laidlaw.Tina@epa.gov]
From: Suplee, Mike
Sent: Wed 4/30/2014 6:08:54 PM
Subject: Talk 2-Site specific criteria
RTAG_5-2014_SiteSpecifics_Suplee.pptx

Methods for Developing Site-specific Numeric Nutrient Criteria in Montana

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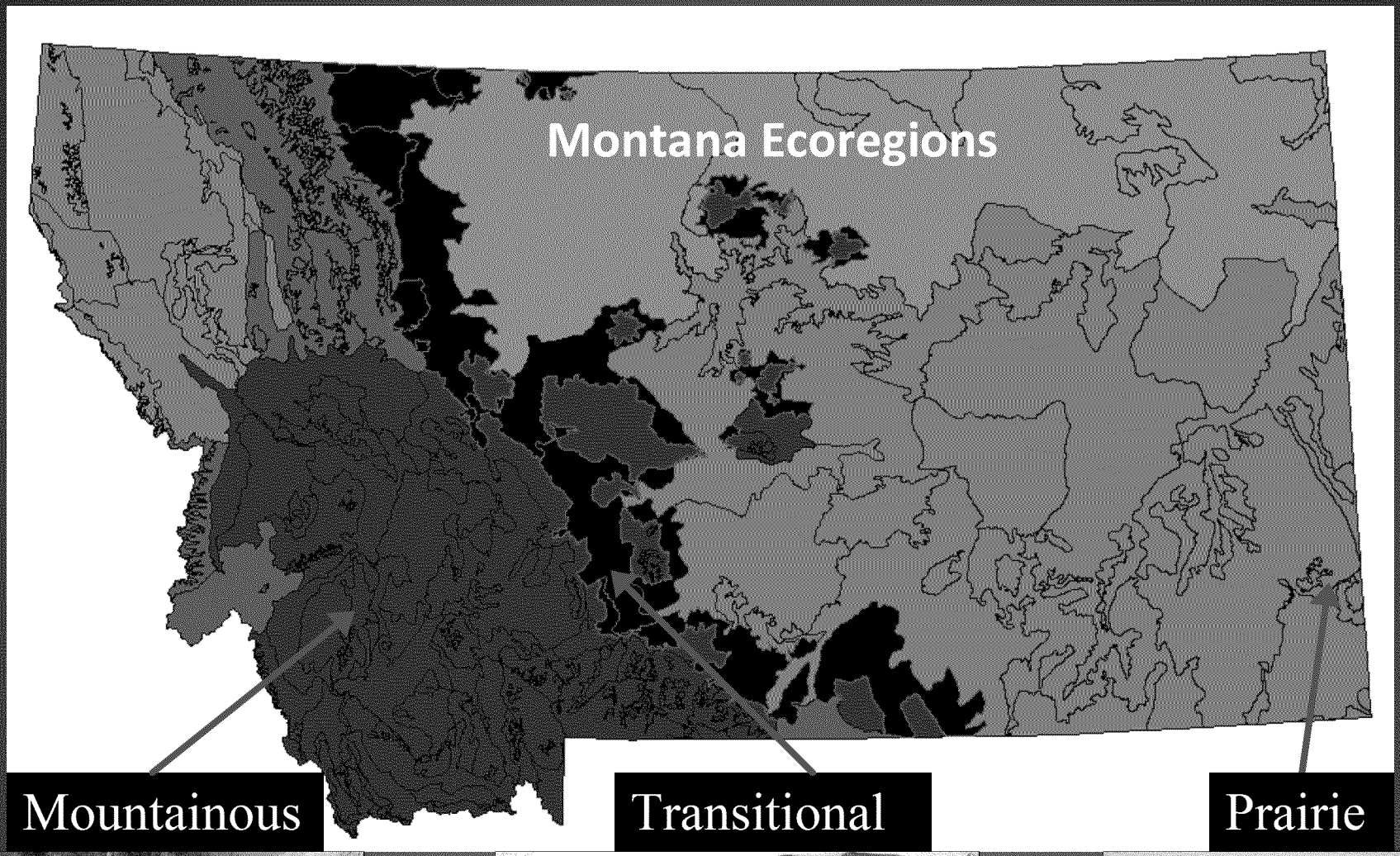
EPA Region VIII RTAG and Numeric Nutrient Criteria Technical Workshop

Denver, CO

May 6th, 2014

Outline

- Brief review of ecoregionally-based criteria
- Site-specific criteria based on mixing
- Streamlined site-specific criteria 1. Based on comparison to reference dataset
- Streamlined site-specific criteria 2. Based on comparison to regional dose-response studies


Montana Ecoregions
Mountainous
Transitional
Prairie

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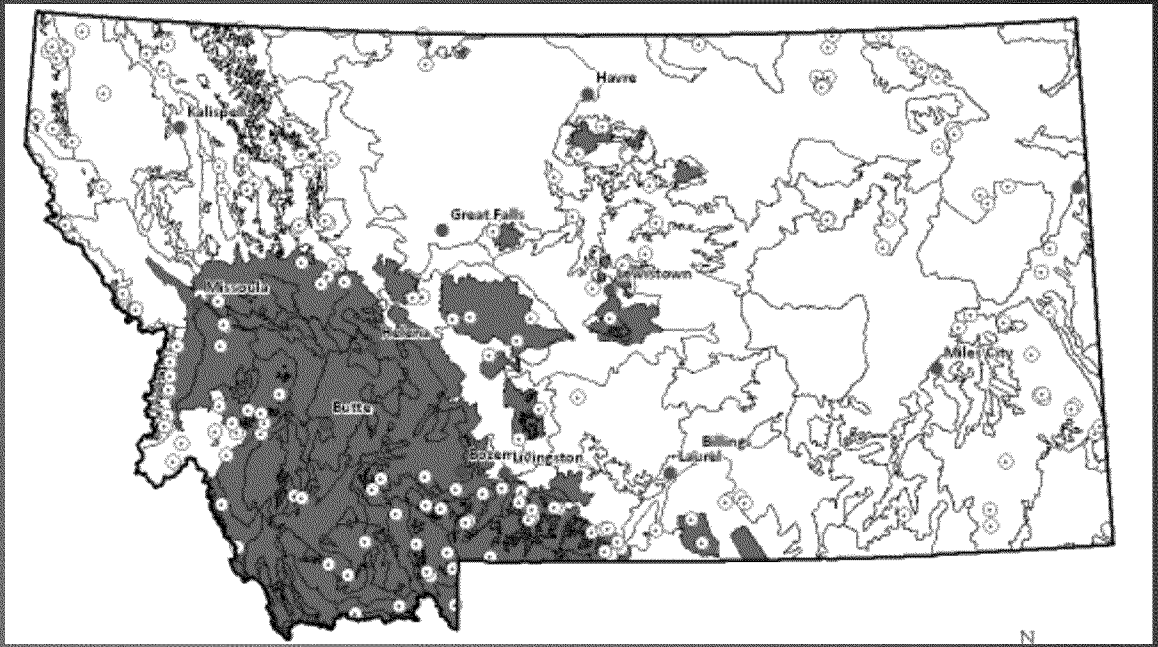
The Middle Rockies Ecoregion (Level III)



<u>Numeric Nutrient Criteria</u>

Total Phosphorus: **30 µg TP/L**

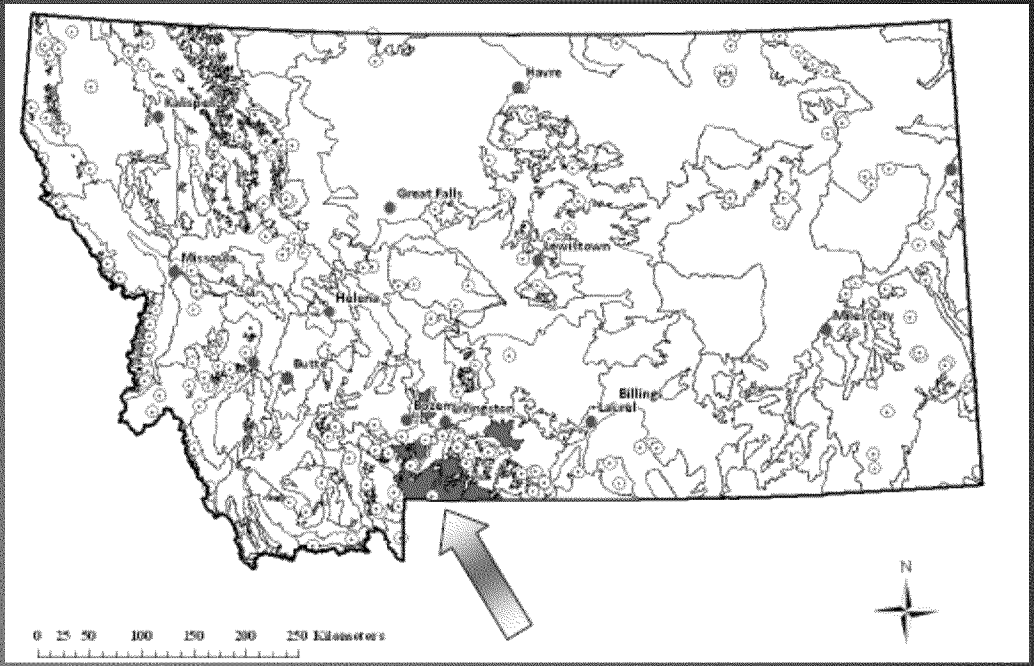
Total Nitrogen: **300 µg TN/L**

Table 3-1B. Descriptive Statistics for TN and TP concentrations in Reference Streams of the Middle Rockies ecoregion. Data are from the median dataset (all site samples first reduced to a median).

		Concentration at given Percentile (µg/L)			
Nutrient	**Number of Reference Sites**	**25th**	**(Median) 50th**	**75th**	**90th**
TN	**57**	**51**	**90**	**136**	**181**
TP	**61**	**4**	**8**	**15**	**43**

Absaroka-Gallatin Volcanic Mountains Ecoregion (Level IV)

(level IV ecoregion within the Middle Rockies)



<u>Numeric Nutrient Criteria</u>

Total Phosphorus: **105 µg TP/L**

Total Nitrogen: **250 µg TN/L**

Table 3-2B. Descriptive Statistics for TN and TP concentrations in Reference Streams of the Absaroka-Gallatin Volcanic Mountains level-IV ecoregion. Data are from the median dataset.

		Concentration at given Percentile (µg/L)			
Nutrient	**Number of Reference Sites**	**25th**	**(Median) 50th**	**75th**	**90th**
TN	**4**	**42**	**65**	**83**	**93**
TP	**4**	**62**	**77**	**90**	**106**

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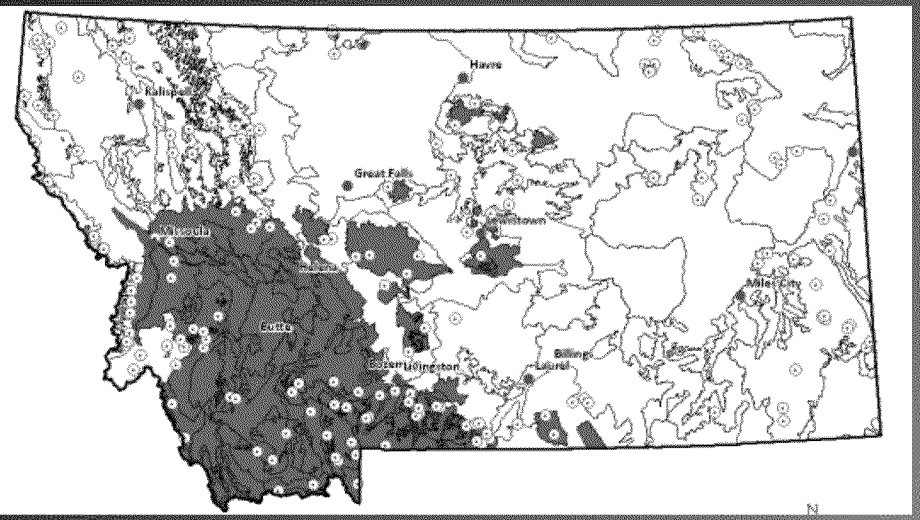
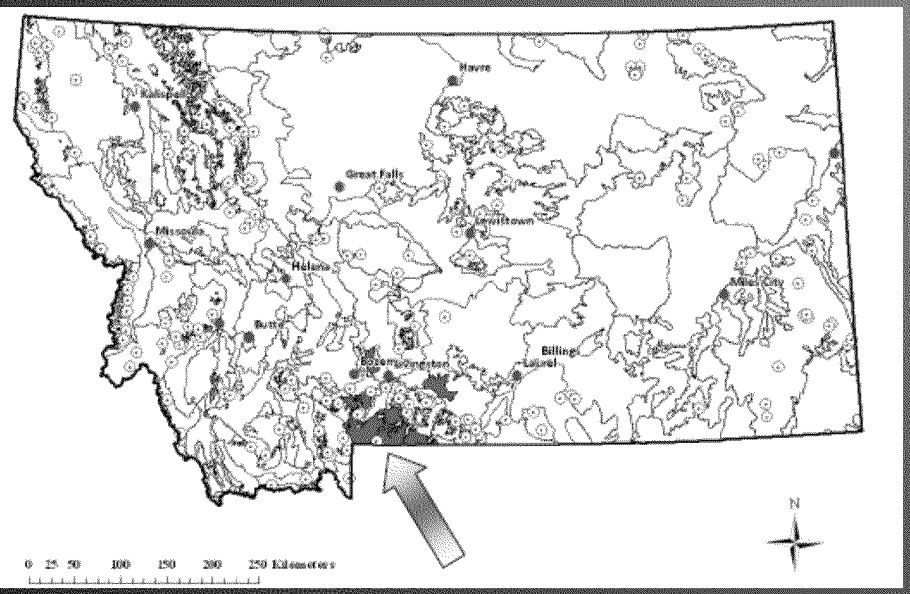
Reach Specific Criteria



Middle Rockies TP Criterion:

30 µg/L



Absaroka-Gallatin Volcanic Mountains TP Criterion:

105 µg/L

How to set criteria for streams flowing from Absaroka-Gallatins to the Middle Rockies?

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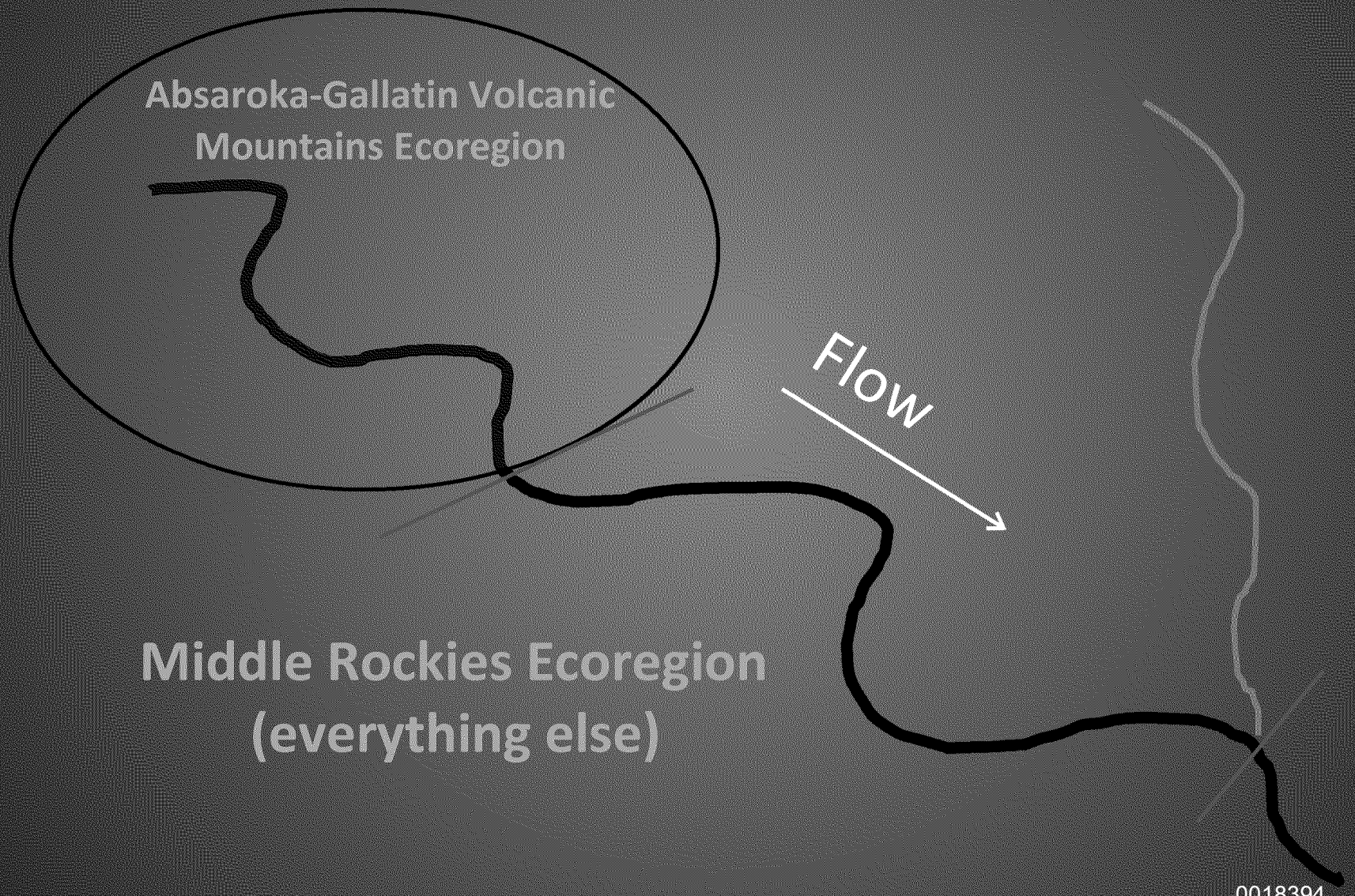
Reach Specific Criteria-Example



Reach Specific Criteria

Not undertaken for all cases; as-need basis (e.g., WWTP on reach)

$$\text{Reach-specific Criteria } (\mu g/L) = \frac{(Conc_1 * Q_1) + (Conc_2 * Q_2)}{Q_1 + Q_2}$$

Based on the mixing equation

Reach Specific Criteria

$$\text{Reach-specific for reference condition } (\mu g/L) = \frac{(Conc_1 * Q_1) + (Conc_2 * Q_2)}{Q_1 + Q_2}$$

Where:

$Conc_1$ = Level IV ecoregion nutrient conc. (µg/L) @ 75th percentile of reference*

$Conc_2$ = Level III ecoregion nutrient conc. (µg/L) @ 75th percentile of reference*

Q1, Q2 = average summer flows (L/sec) allocated to the respective ecoregions

If the reach specific value based on reference is ≥ the nutrient criterion established for the ecoregion in which the stream resides, a reach-specific criterion is developed

*Based on all-observations reference dataset. See Suplee and Watson (2013).

Reach Specific Criteria-Example

75th percentile of Reference in the Absaroka Gallatin Volcanic Mountains

75th percentile of Reference in the Middle Rockies

Reference-condition value exceeds Middle Rockies criterion of 30 µg/L

([105 µg TP/L * 833 L/sec] + [20 µg TP/L * 481 L/sec]) ÷ (833 + 481 L/sec) = 74 µg TP/L

A reach-specific criterion was then calculated for TP using the ecoregional numeric criteria:

([105 µg TP/L * 833 L/sec] + [30 µg TP/L * 481 L/sec]) ÷ (833 + 481 L/sec) = 76 µg TP/L

Criterion for the Absaroka Gallatin Volcanic Mountains

Criterion for the Middle Rockies Ecoregion

Reach-specific Criterion

There was good support for this approach by all three academic peer reviewers of our 2012 draft document

0018397

Streamlined Site-specific Nutrient Criteria

Per Nutrient Work Group meetings:

- Stakeholders requested a simple, repeatable method to develop site-specific nutrient criteria
- Address streams that “don’t fit the mold” of the ecoregion
- Should not have an onerous dataset requirement

DEQ's Nutrient Criteria Derivation Process

CRITERION

[redacted]

N:P ratio
(Redfield Ratio)

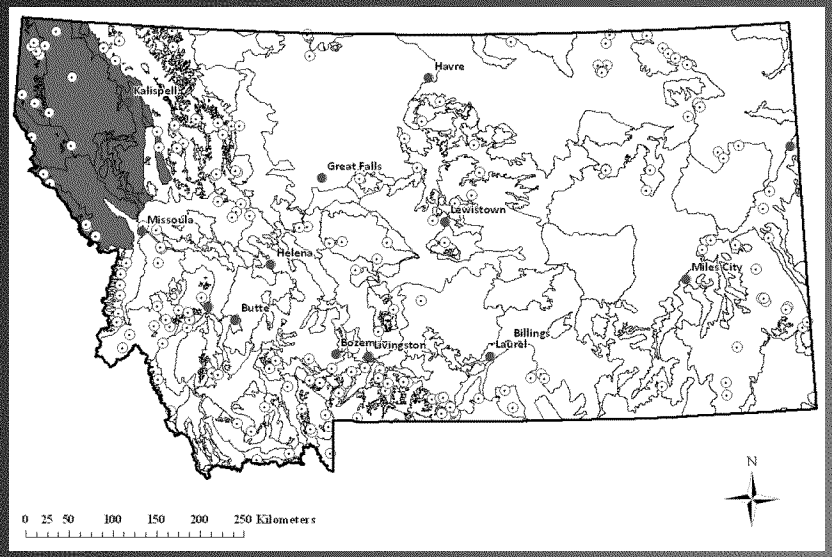
Comparison to
Regional
reference data

Regional Dose-response studies

Nutrient Criteria Derivation Process

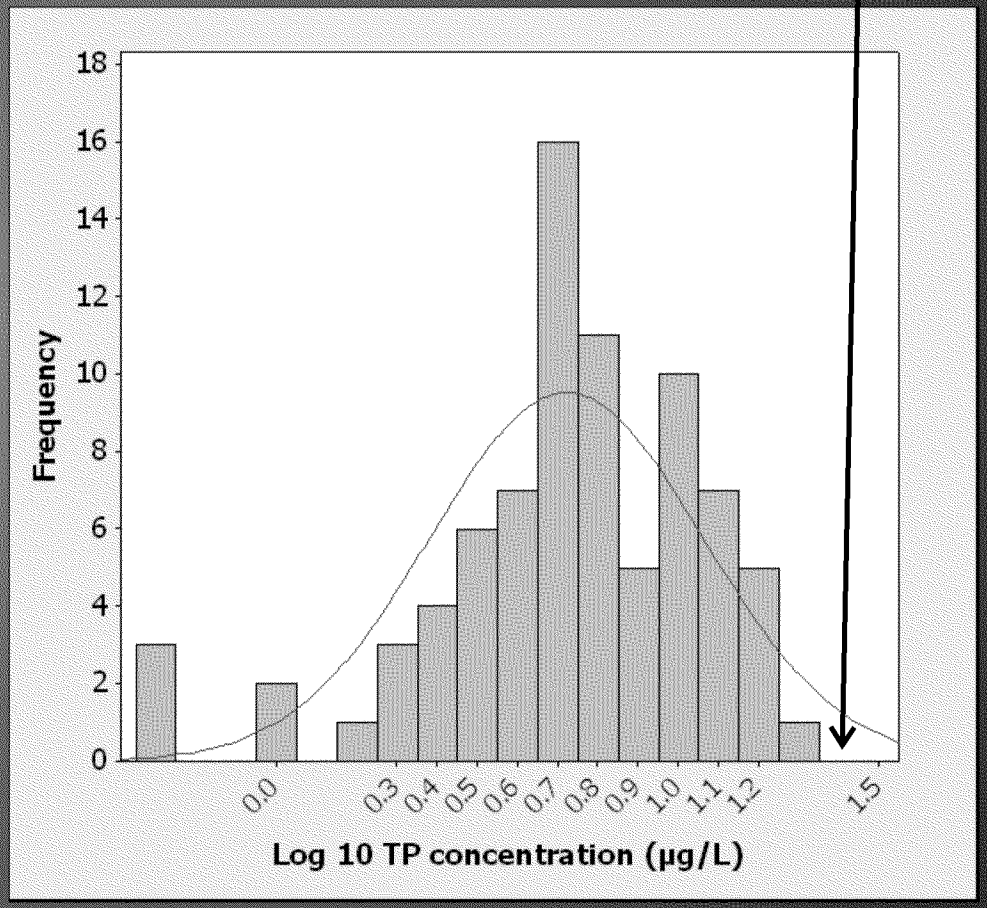
Because regionally-applicable dose response studies are the *main* drivers of the criteria, in some ecoregions the criteria concentrations are higher than the reference data

Nutrient Criterion > Regional Reference



Northern Rockies Ecoregion (dark gray)

TP Criterion = 25 µg/L
(1.4 $\log_{10}$)



Northern Rockies Reference Stream TP (Growing Season)

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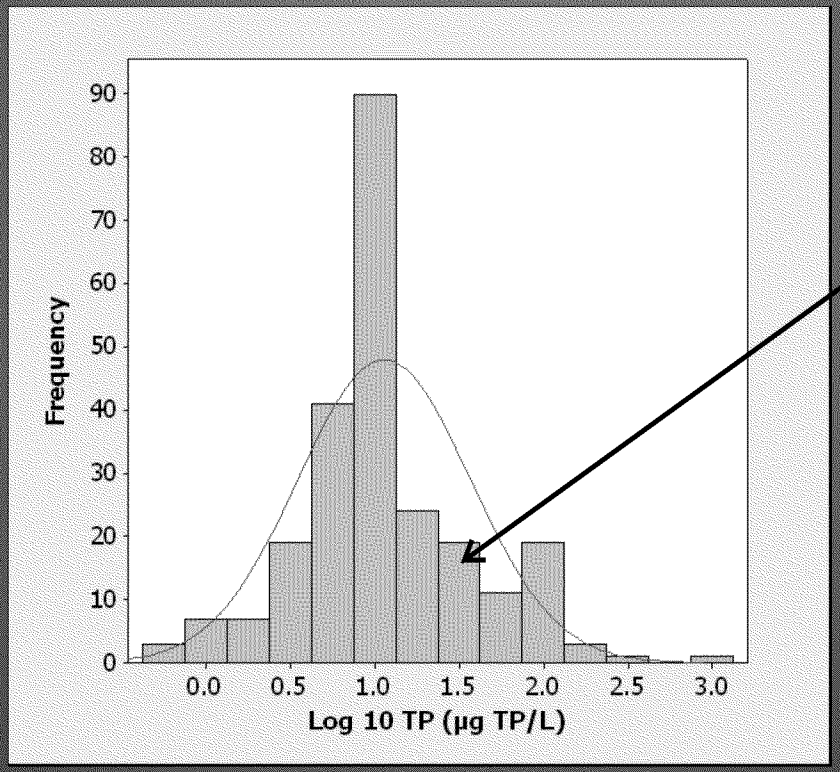
Nutrient Criteria Within Regional Reference

In other ecoregions, nutrient criteria are often between the 75th and 90th percentiles of reference



TP criterion = 30 µg/L
(1.48 $\log_{10}$)

Reference Stream TP (Growing Season)

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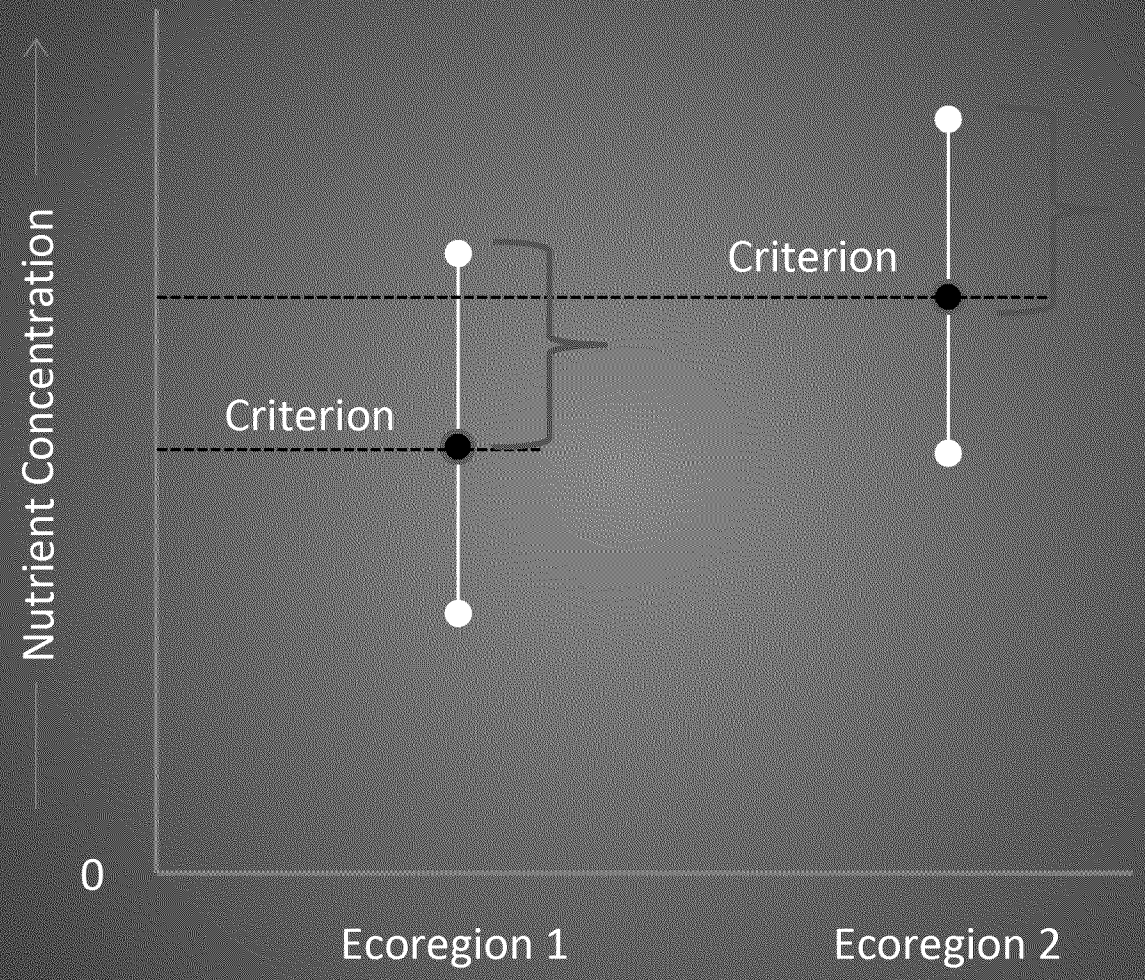
Streamlined Site-specific Method

- For streams with full biological support but nutrient concentrations higher than DEQ's ecoregional criteria
  - Biological support assessed via SOPs
- *Basic Idea*: If nutrient concentrations fall within uncertainty range around criteria, site-specific criteria can be set using a fairly small dataset
- Minimum 3-year dataset for key parameters
  - Nutrients, chlorophyll *a*, diatoms & macroinverts

There is a definable amount of uncertainty around each criterion



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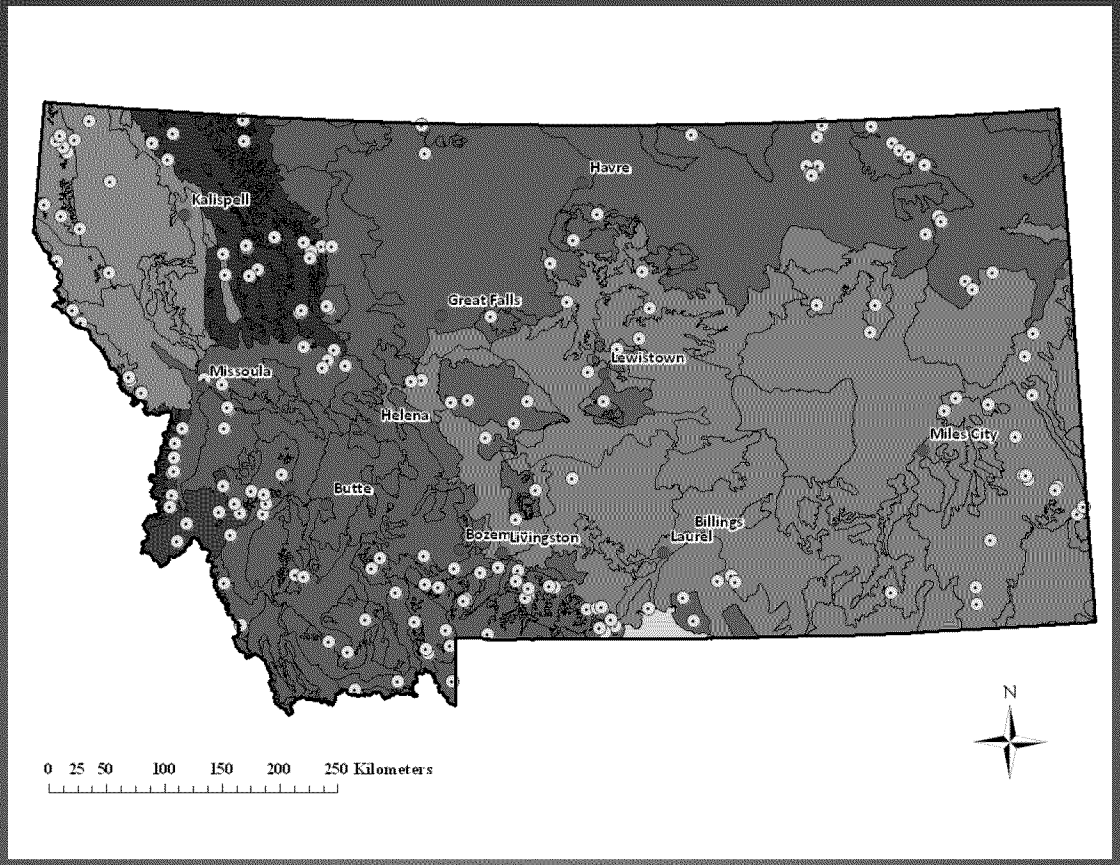
Reference Stream Sites



Western MT reference site

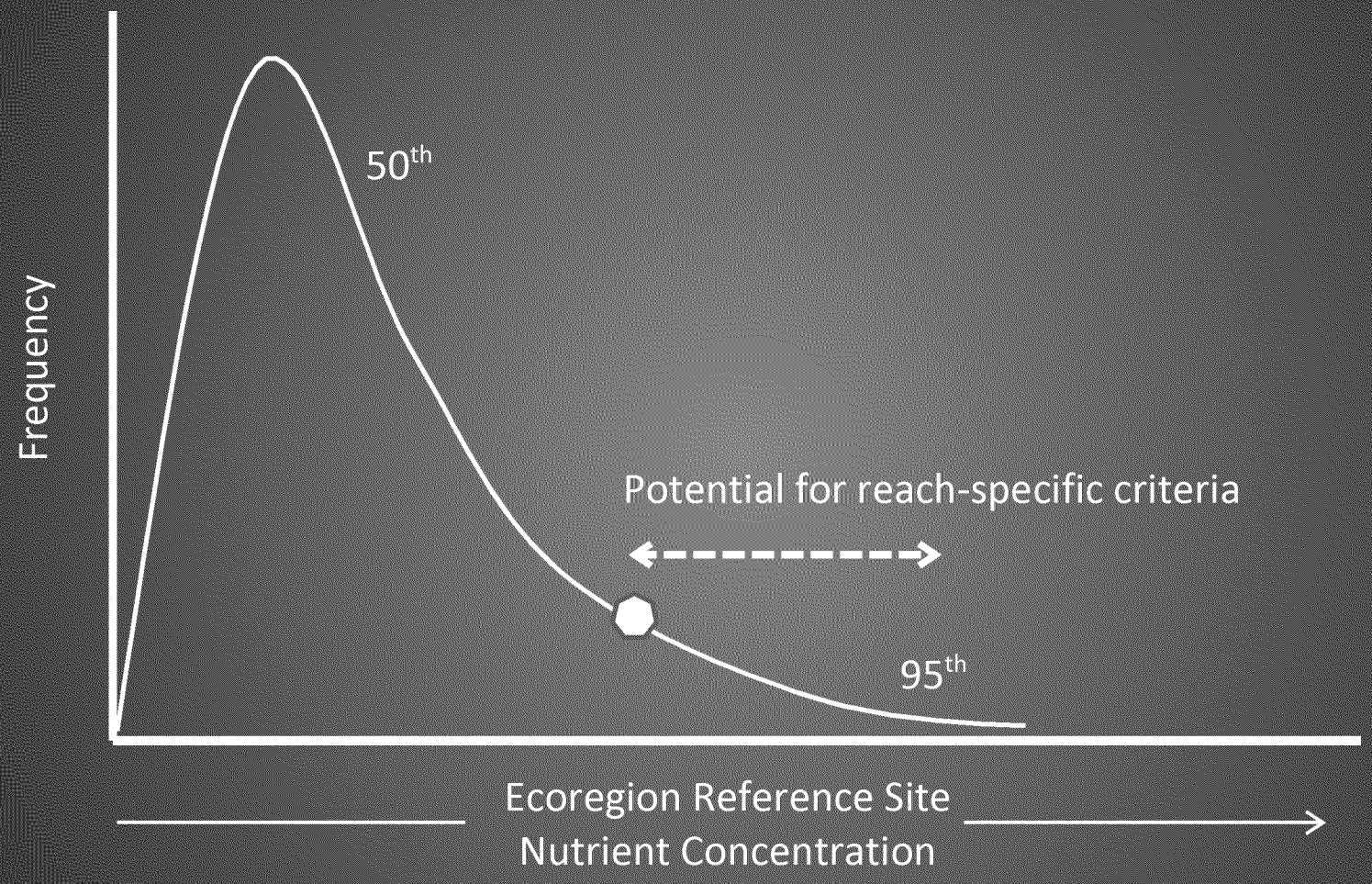
185 sites

>10 years data

Thousands of samples

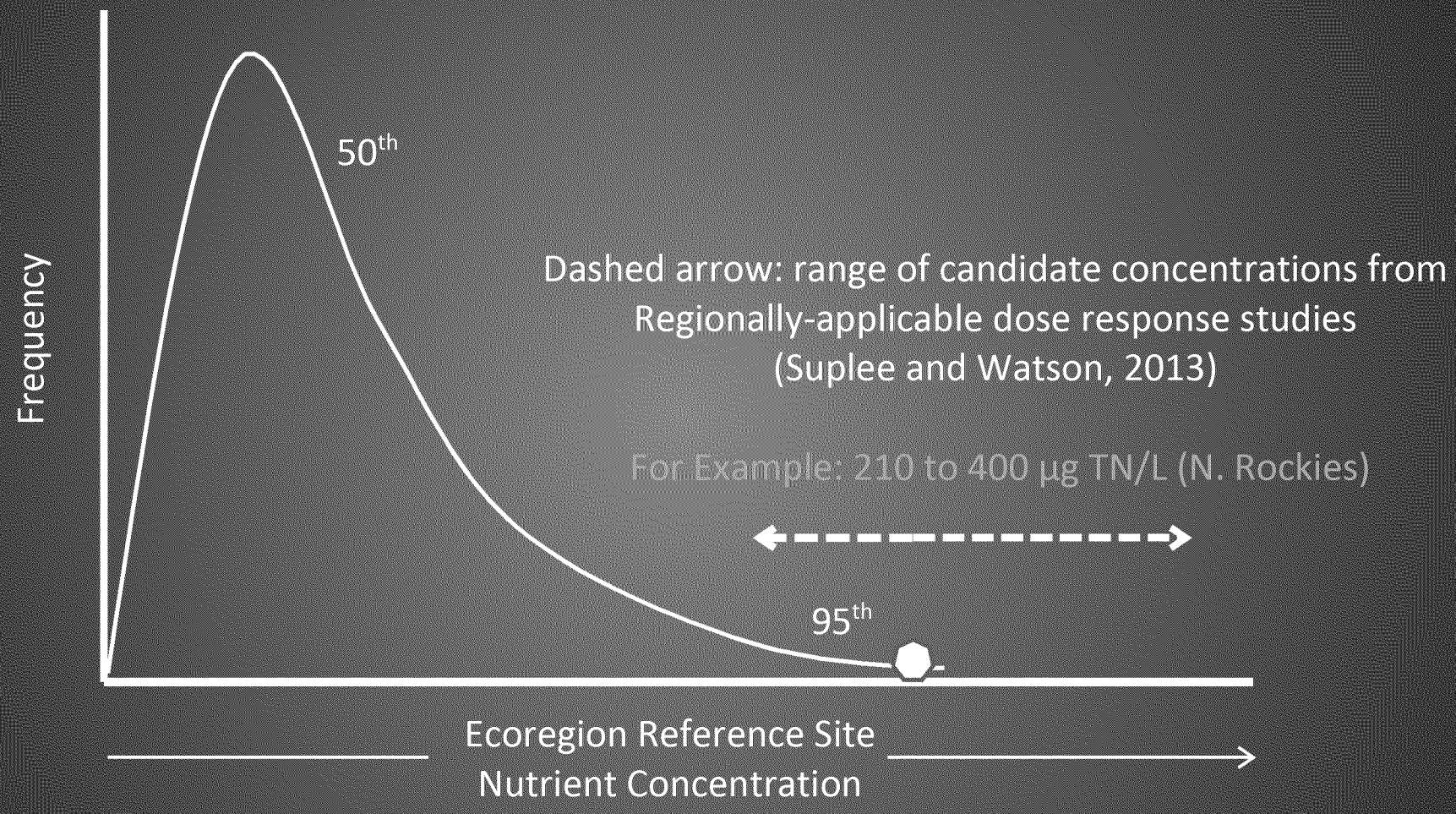
Eastern MT reference site

Scenario 1: criterion is within reference dataset



MT DEQ's ecoregional criterion

Scenario 2: criterion was set beyond the reference dataset, but within uncertainty of the dose-response studies



MT DEQ's ecoregional criterion

0018407

Streamlined Site-specific Method

Case study for Fred Creek (Middle Rockies)

- *Years data*: 3 (2004, 2011, 2012)
- *Nutrient Samples*: n=12-14 (meets minimum)
- *Average Total Phosphorus*: 35 µg/L Exceeds 30 µg/L
- *Average Total Nitrogen*: 40 µg/L
- *Benthic Chlorophyll a*: n=3 (meets minimum)
- *Diatom Samples*: Not applicable (No model for Middle Rockies ecoregion at this time)
- *Macroinvertebrate Samples*: n=3 (meets minimum)

Full biological support was indicated by MT DEQ's assessment (following SOPs), but TP is high

Streamlined Site-specific Method

- New criterion is to be based on the 80th percentile of the stream's dataset

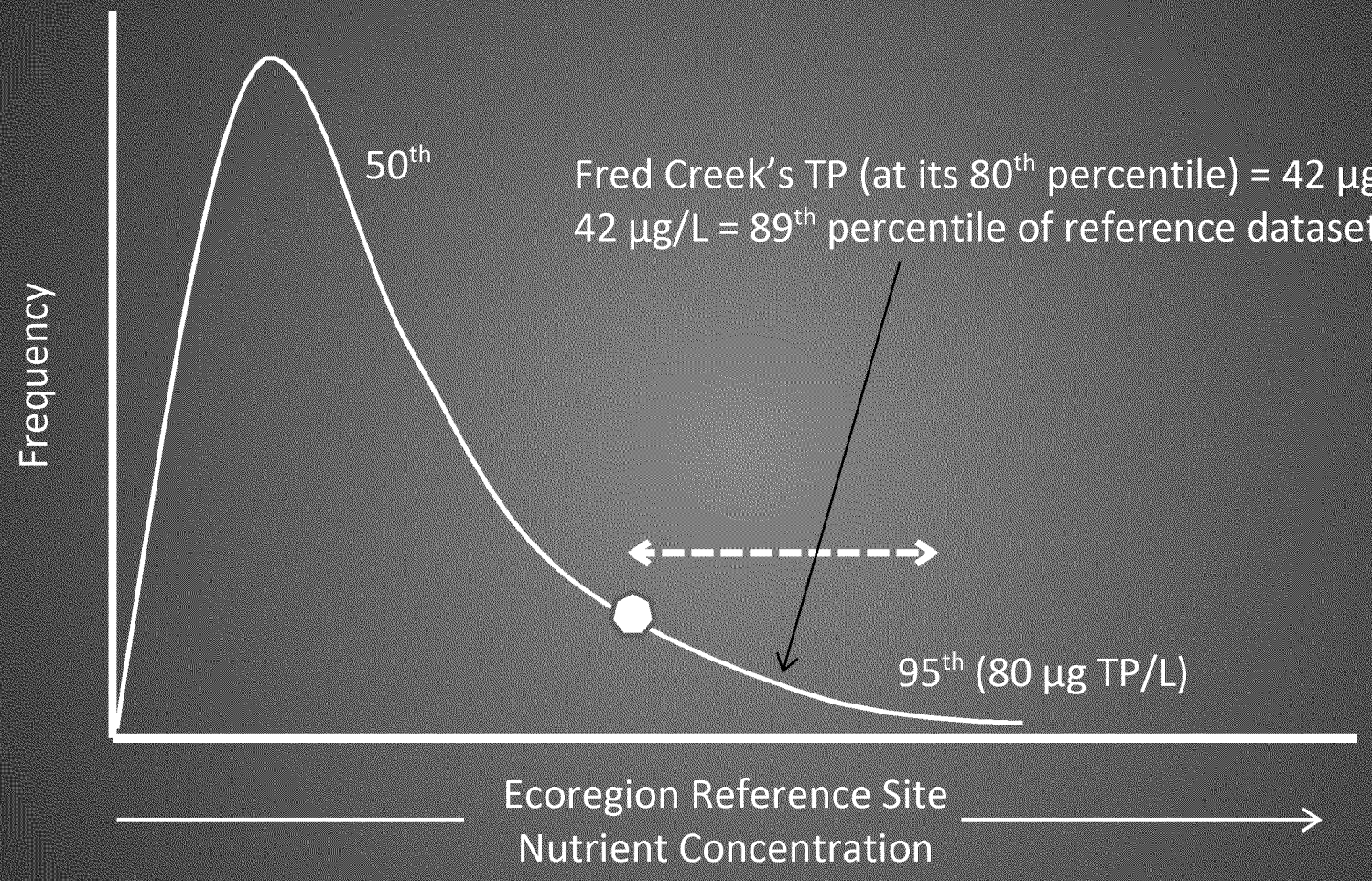
TP concentrations (µg/L):

5, 23, 29, 32, 36, 37, 37, 37, 40, 41, 43, 44, 44

↑ 80th

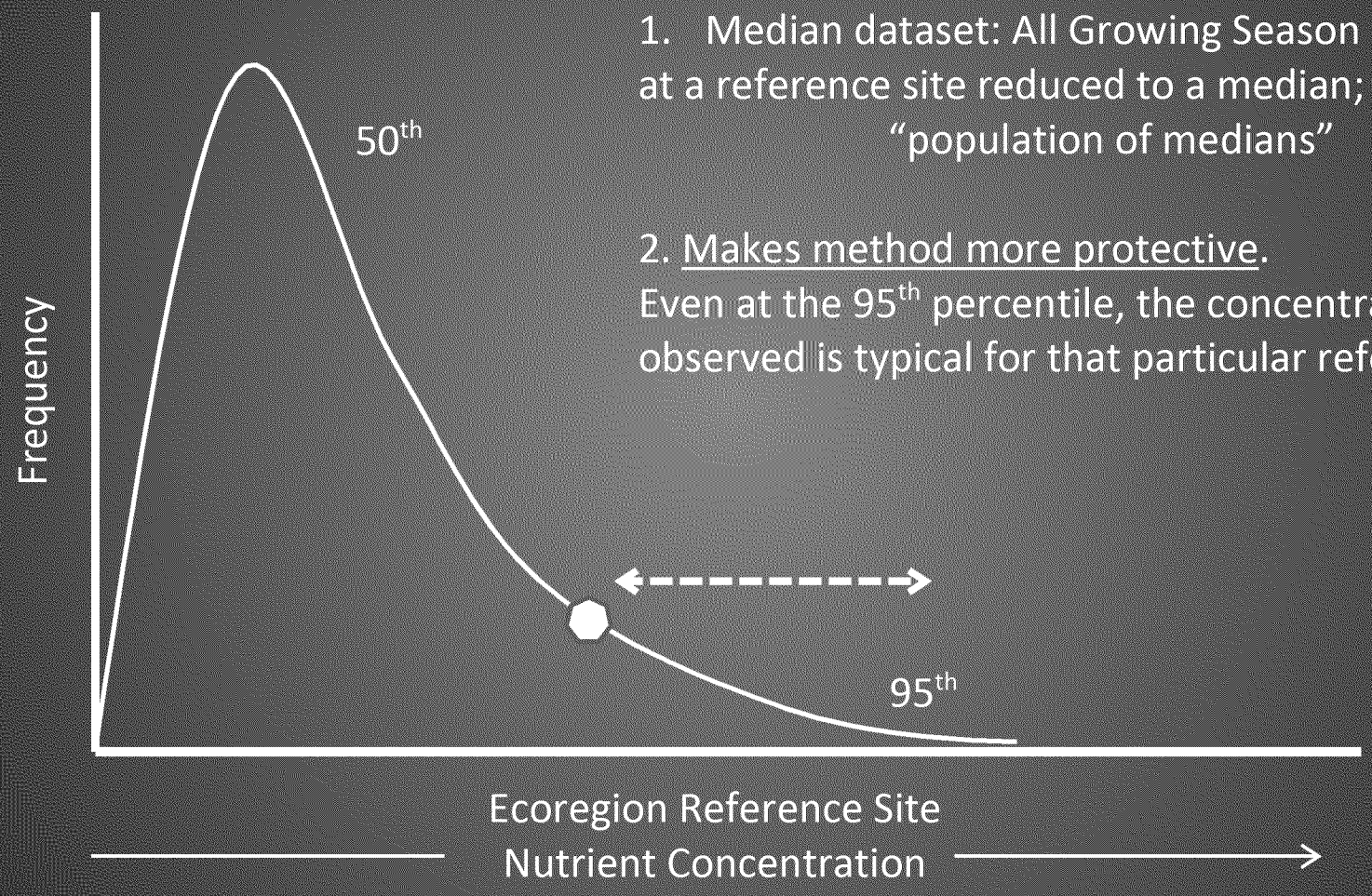
- Assures stream will PASS statistical tests in future monitoring (assuming stream's conditions are unchanged)

Fred Creek fits Scenario 1:



MT DEQ's criterion here is 30 µg TP/L

Method requires comparison of the study stream to the median reference dataset



1. Median dataset: All Growing Season data at a reference site reduced to a median; "population of medians"

2. Makes method more protective.
Even at the 95th percentile, the concentration observed is typical for that particular reference site.

Streamlined Site-specific Method

- New TP criterion = 42 µg/L

- TN criterion lowered to help assure N limitation (which is the current status: N:P ~1:1)
- N:P ratio: 6 (infers slight N limitation)

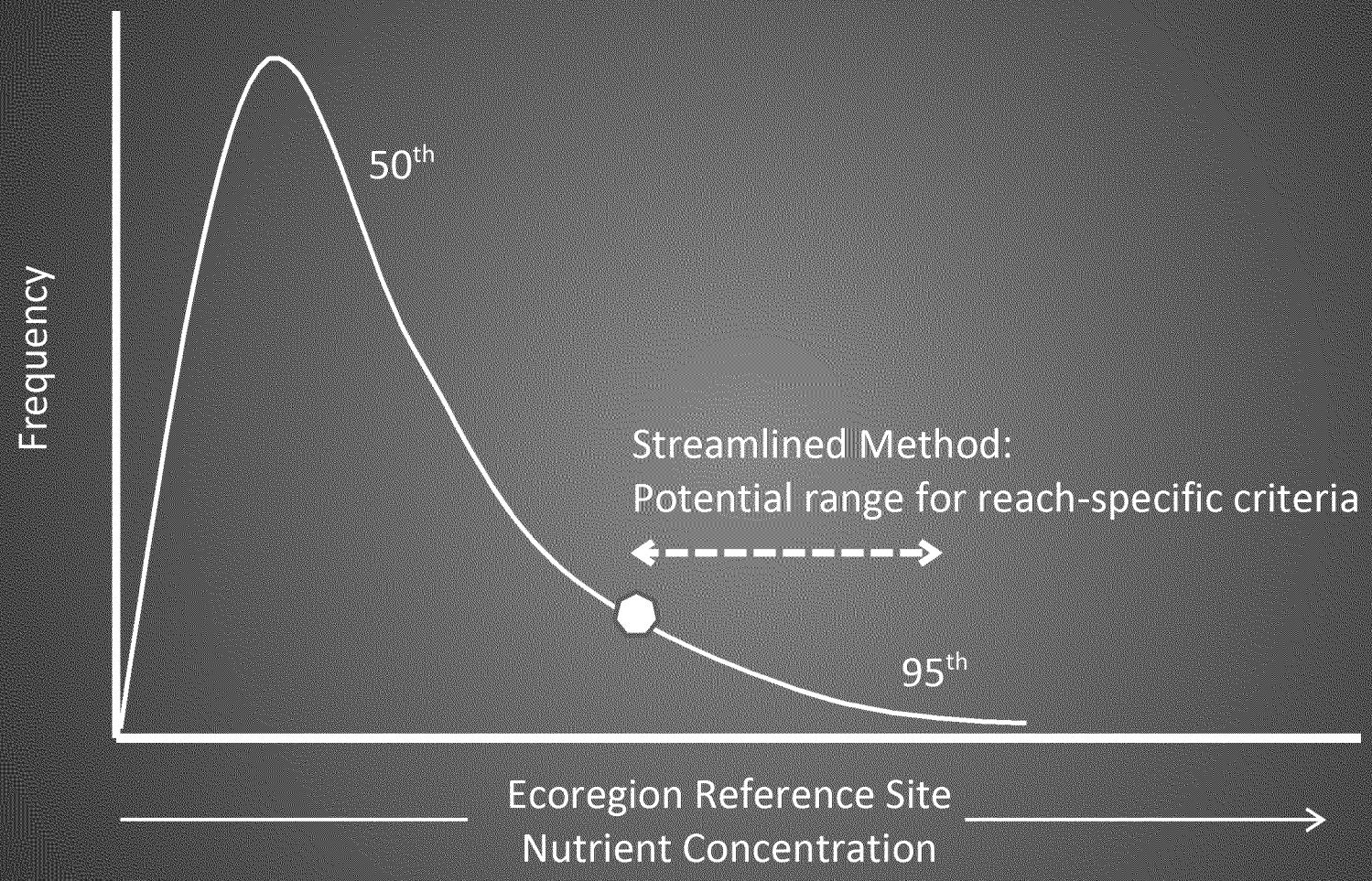
- New TN criterion = 250 µg/L

- New criteria can be adopted by the Board of Environmental Review as standards
  - Standards Section will provide analytical review, and handle Board adoption process

Summary

- MT DEQ has several ways to establish site-specific nutrient criteria
  - Relative flow contribution from different ecoregions to a stream
  - Streamlined method 1: comparison to reference
  - Streamlined method 2: comparison to regionally-applicable dose-response studies
- Streamlined methods: for streams with full biological support but which have nutrient concentrations higher than proposed standards
  - Site-specific criteria may be established with a modest dataset, so long as nutrient concentrations are within defined bounds
  - Method is in Dept.'s *Nutrient Standards Guidance Document*
- Site-specific criteria can be adopted into rule on a case-by-case basis
- Site-specific methods assure stakeholders that appropriate numeric nutrient criteria can be identified and adopted for a given stream
  - Addresses issue of nutrient criteria variability

Thank You



MT DEQ's ecoregional criterion