National Biological Assessment and Criteria Workshop

Advancing State and Tribal Programs

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LR 201

Bioassessment and Potential for Biocriteria Development in the Lower Missouri River: A Case Study Using Benthic Macroinvertebrates

Presented by

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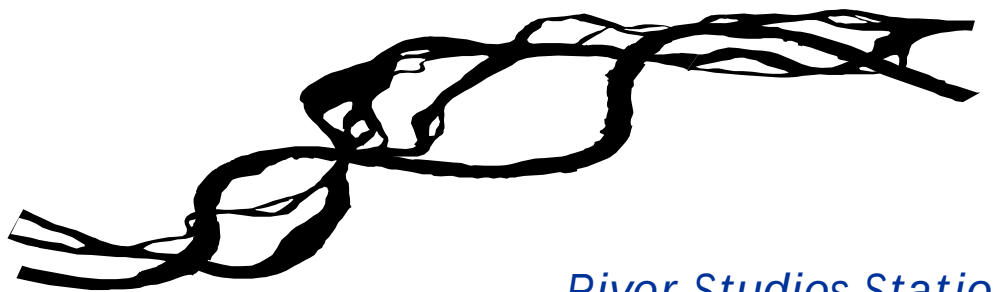


River Studies Station

Columbia Environmental Research Center

Components Included in this Presentation

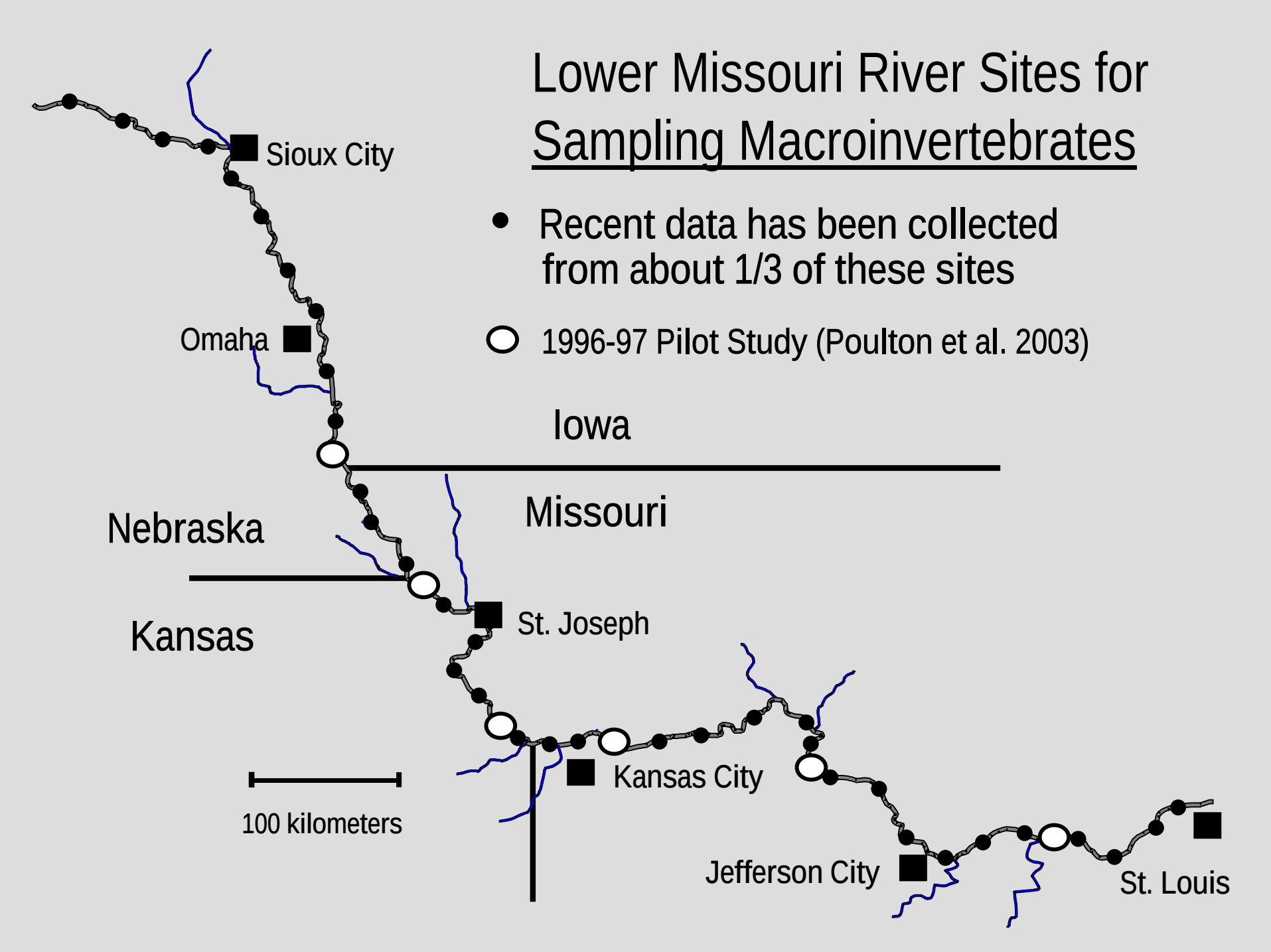
A. Background, history and emphasis of past studies
   1. Map of sampling sites
   2. Large River alterations

B. Summary of goals and objectives
   1. Large river bioassessment and biocriteria issues
   2. Flow chart – sequence of recent studies

C. Summary of recently completed and current pilot studies
   1. Results of 1996-1997 pilot study
      a. Methods slides (2), showing key habitats
      b. Bar graph of macroinvertebrate species distribution
      c. List of candidate metrics
   2. Ongoing EPA-funded study (2002-2004)
      a. Large river bioassessment assumptions
      b. Summary of design and approach

D. Potential evaluation approaches for bioassessment
   1. Examples of other similar studies
   2. Graphs showing examples (5 total) of options for Lower Missouri

E. Summary
   1. What we think we know so far
   2. Future research needs (wish list)


Lower Missouri River Sites for
Sampling Macroinvertebrates
Recent data has been collected from about 1/3 of these sites
1996-97 Pilot Study (Poulton et al. 2003)
Sioux City
Omaha
Iowa
Missouri
Nebraska
Kansas
St. Joseph
Kansas City
Jefferson City
St. Louis
100 kilometers

Alterations Observed in Large Rivers

- ✓ Relative Contribution and Distribution of Habitats and Substrate Types
- ✓ Organic Matter (Storage, Transport, Entrainment)
- ✓ Hydrology (Flow Regime, Depth & Velocity)
- ✓ Cumulative Urban (CSO's, Wastewater, Contaminants)
- ✓ Collective Agricultural (Contaminants, Nutrients)
- ✓ Water Quality (D.O., turbidity, thermal effects)

USGS
science for a changing world

- ✓ Free-flowing Lower Missouri River (1211 km or 752 miles)

Summary of Large River Bioassessment / Criteria Issues

1. Basic Ecological Knowledge of Fauna
2. Sampling Methods / Habitats
3. Index Period
4. Statistical Design & Analysis
5. Degree of Similarity with Wadeable Streams
6. Response Attributes (Metrics)
7. Metric Expectations (Reference ?)

USGS
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Goals, Objectives, and Sequence of Macroinvertebrate Studies

Lower Missouri River

Past

Characterize community in different habitats & substrate types

↓

Examine efficiency and suitability of sampling methods

↓

Ongoing

Identify longitudinal response gradients due to cumulative impacts

↓ ◄····· ***We Are Here***

Validate large river metrics and develop multi-metric indices

↓

Future

Identify best reaches and evaluate relative biological condition

↓

Develop biocriteria & evaluate water resource use attainment status

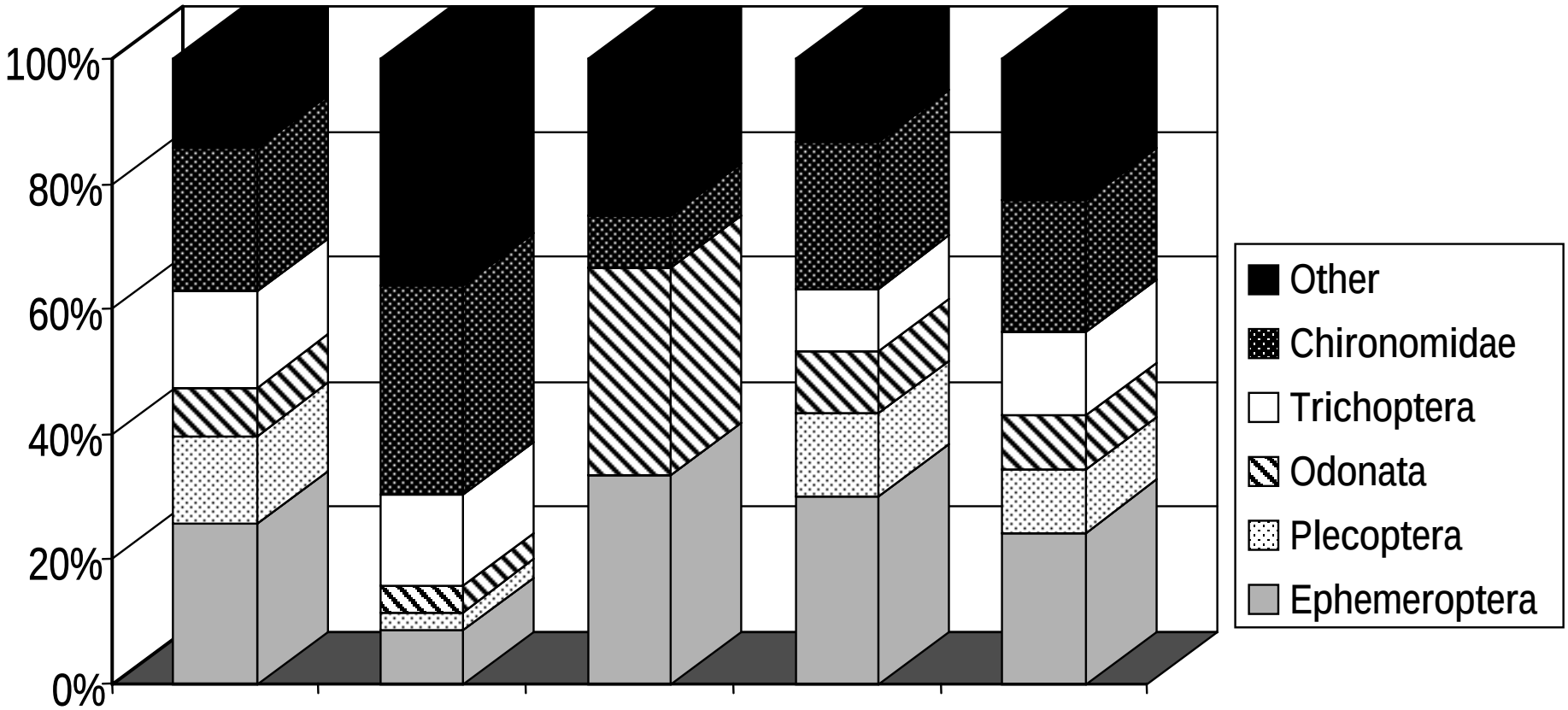
Bold = Partially covered in this presentation

Rock revetments, located on the outside bend of meanders, are sampled with rock basket artificial substrates. This habitat contains the highest diversity.

Depositional mud substrate, located behind wing dikes, is sampled with a Ponar. This is habitat for burrowing mayflies and many other taxa

Percent (%) of Taxa Richness in 4 Substrate Types

Benthic Invertebrates - Lower Missouri River mainstem



	Rock	Mud	Sand	Organic	Total
Total No. Species	78	69	12	30	132
Unique Species within habitat	49	21	4	2	X

Total # Species unique and restricted to large rivers = 21

List of Candidate Metrics
Lower Missouri River Macroinvertebrates

For Coarse Substrate (Rock)

* % Filtering Trichoptera
* EPT (% and richness)
* EPOT (% and richness)
* Hilsenhoff Biotic Index

  Scraper/Filtering Collector Ratio

  EPT/ Chironomidae Ratio
* % Large River Taxa

* Response trend or statistical significance among sites detected in '96-'97 pilot study

For Depositional Substrate (Mud)

* % Ephemeroptera

  Density (# / m^2)
* Chironomidae Taxa Richness

For Both Substrates

Shannon - Wiener Diversity Index

% Chironomidae

* Total Taxa Richness
* % Oligochaeta

% Dominant Taxon

Assumptions – Large River Bioassessment

A. Wadeable stream approaches will work with some modifications or adjustments

B. Longitudinal evaluations of sites / reaches possible with data from 1 or 2 key habitats (vs. “total community”)

C. Some reliable metrics used to evaluate wadeable streams tell us the same story in large rivers

D. Communities in large rivers must be viewed as integrators of all combined or cumulative stressors

E. Cumulative effects of perturbations can be separated from other effects (biogeography, geology, latitude)

F. Each “Great” river needs to be evaluated individually

Summary - Ongoing Lower Missouri Benthos Study

USEPA 104 (b) Grant, WQ Cooperative Agreement with Missouri DNR

Goal

Establish longitudinal response gradient to validate endpoint metrics

- 18 sites, 2 habitats, 3 methods, Autumn index period
- Simultaneous basic water quality and sediment contaminants

Sampling Design & Approach

- Upstream/downstream site selection based on longitudinal features (urban areas, tributaries), with pre-stratification by habitat
- Identification of “best” sites, or reaches with highest metric scores

“Site” Definition

A 10 km reach that includes repetition of the 2 selected habitats

Evaluation Approaches for Bioassessment – Example studies

Modifying an existing IBI or develop new indices for a specific water body or region

A. Ohio River IBI – Simon & Emery 1995
B. Coldwater Wisconsin streams – Lyons et al. 1996
C. Benthic IBI - Kerans & Karr 1994
D. Invertebrate Community Index (ICI), Ohio streams – DeShon 1995
E. Florida streams - Barbour et al. 1996
F. Lower Missouri River - Poulton et al. 2003

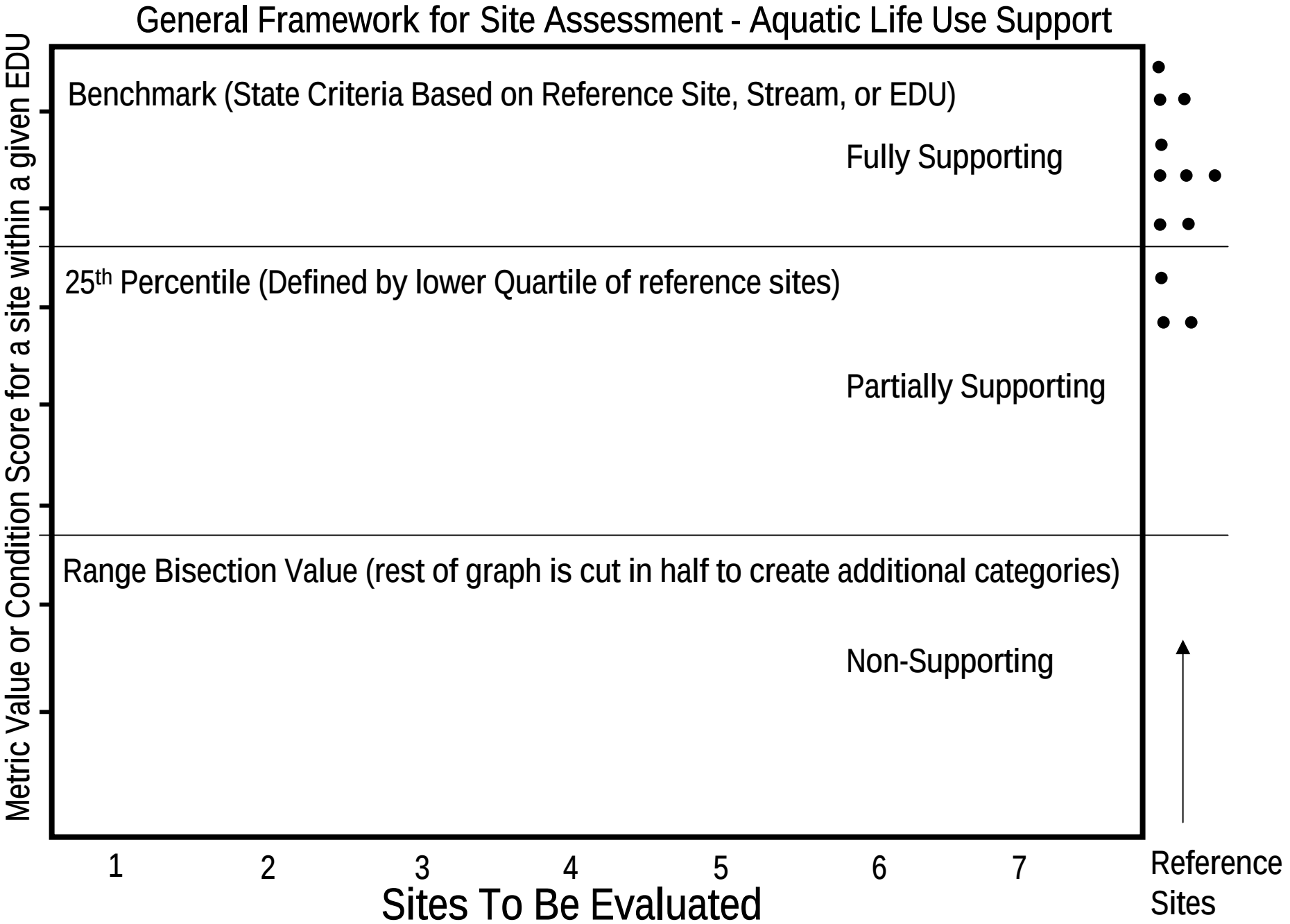
Options For Establishing Benchmarks, Criteria, or Metric Expectations

* Example slides given for each

A. Existing data distribution of reference sites – Example #1
✓ B. Existing data distribution of all sites (true reference unknown) – Example #2
✓ C. Data from sites / reaches with best overall scores – Example #3
✓ D. Percent of reference (best value for a metric) – Example #4
E. Data from nearest, adjacent, or most similar watershed – Example #5

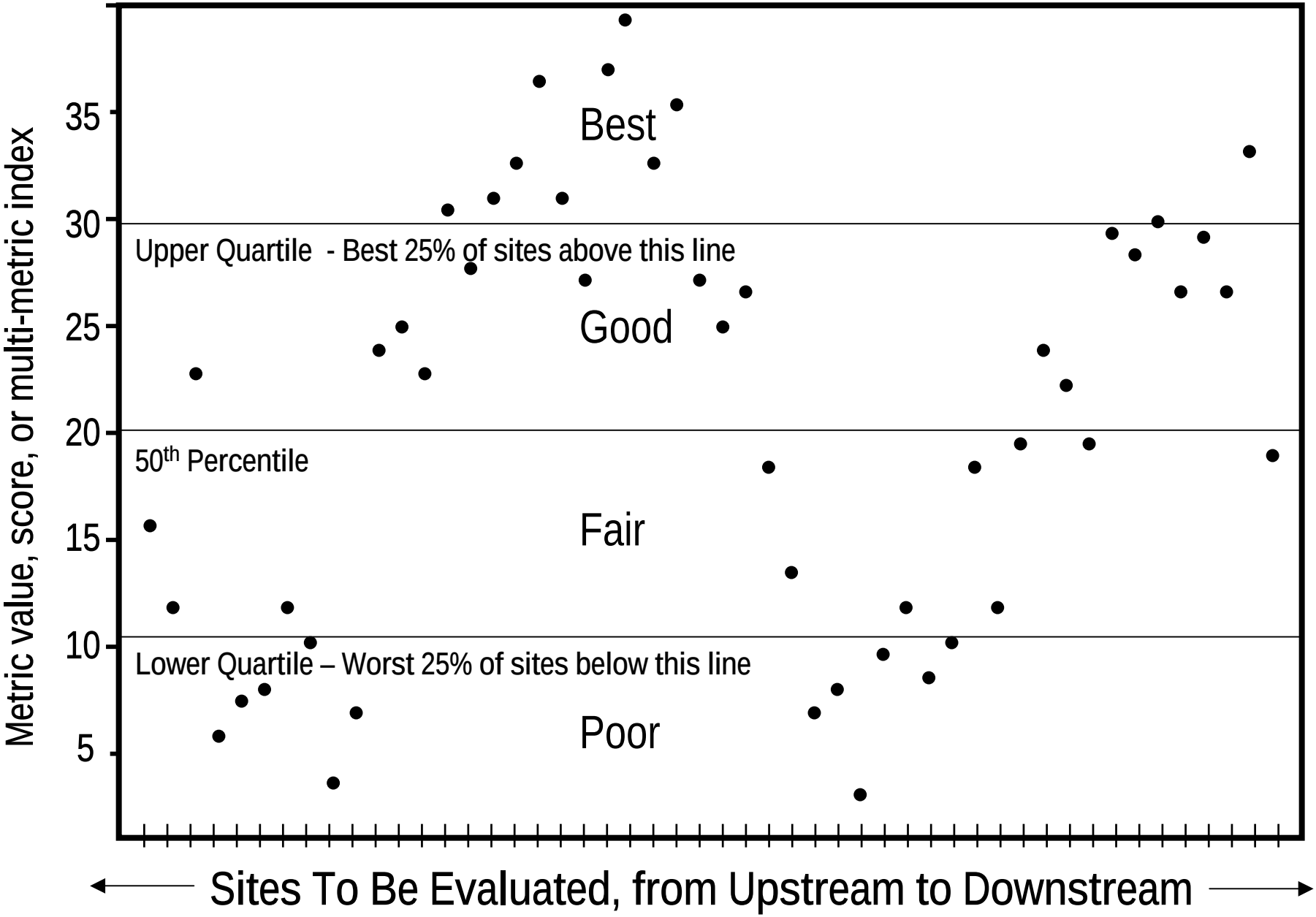
✓ Option for Lower Missouri

Example #1 - State of Missouri, Wadeable/Perennial Streams (MDNR)

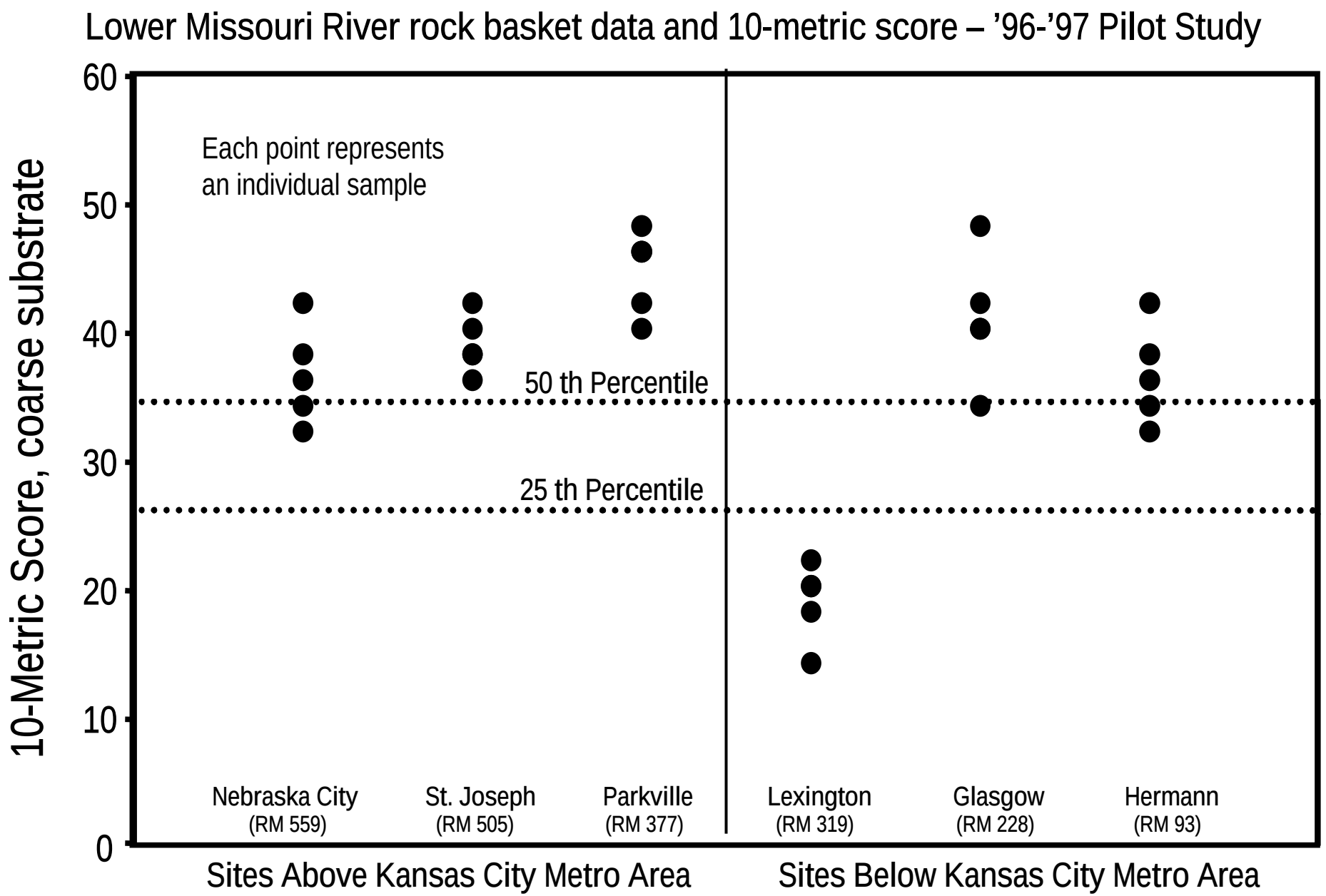


Example #2 – Possible approach for Lower Missouri River

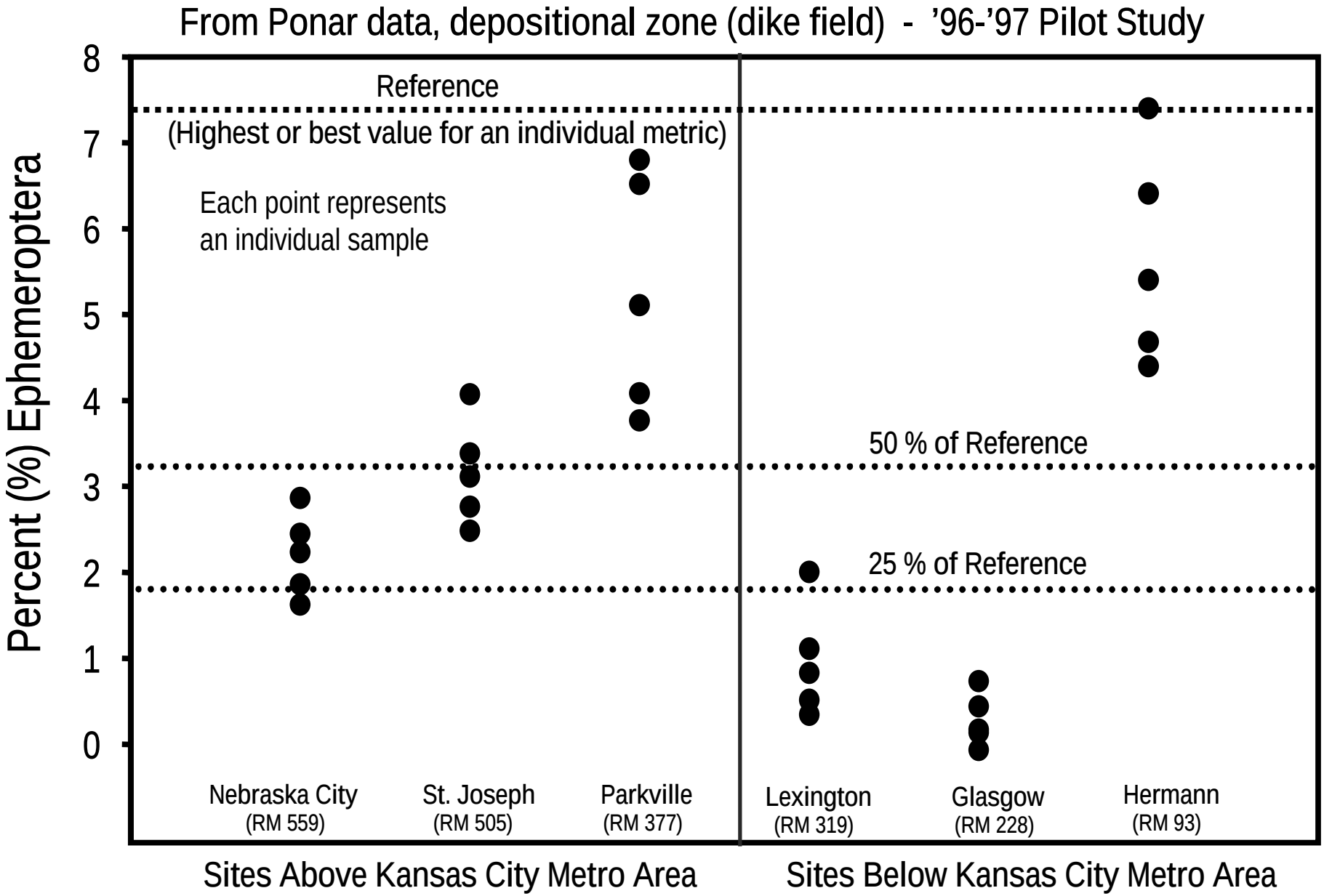
Tiered category framework including distribution of theoretical data from 50 sites



Example #3 – Site evaluation using overall multimetric scores

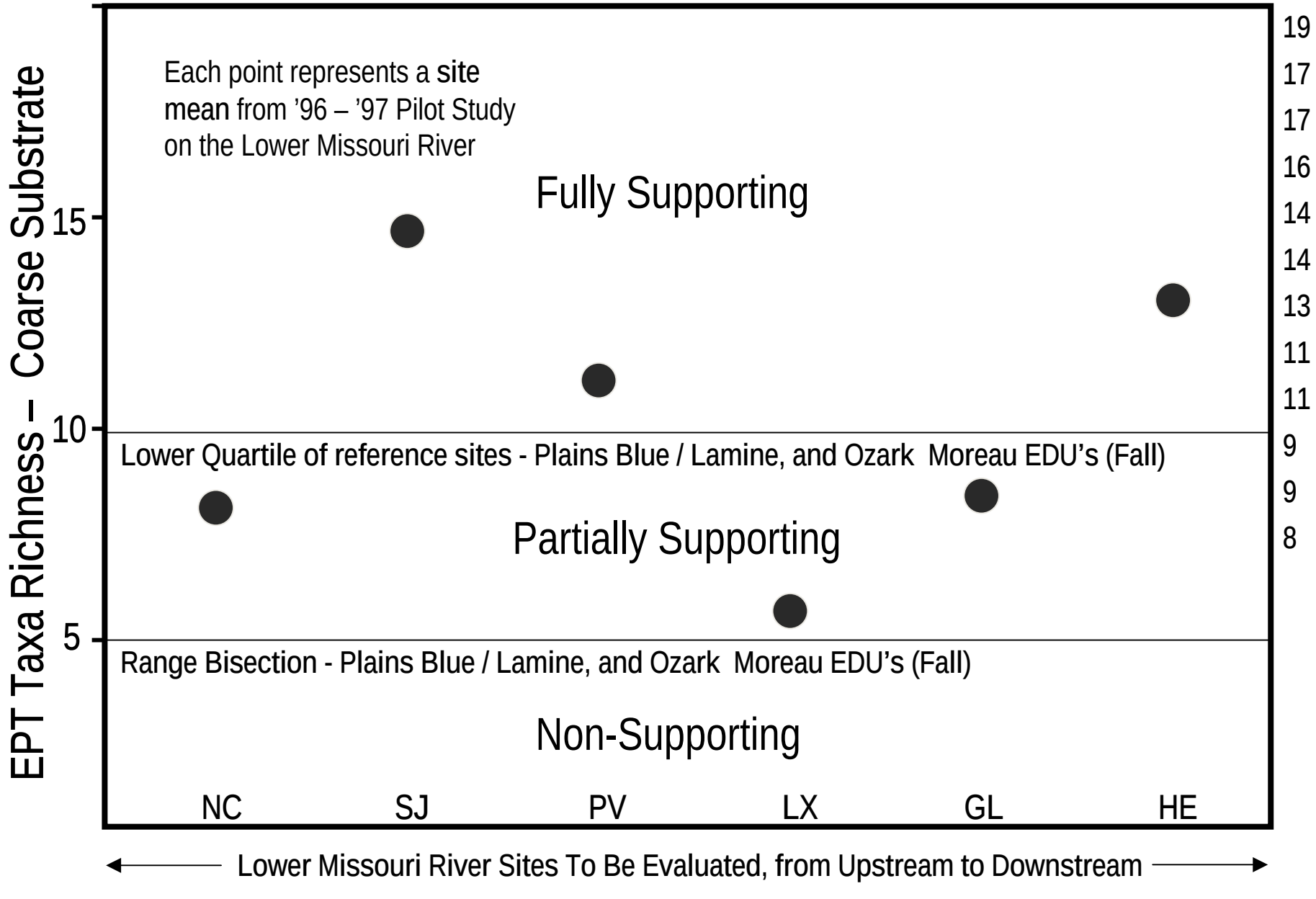


Example #4 – Percent of reference, defined by best value for a metric



Example #5 – Nearest, adjacent, or similar watershed used for reference

From State of Missouri Wadeable / Perennial stream data - MDNR



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What we know so far about Lower Missouri River Bioassessment

- Habitats / substrates are distinct and longitudinally repeatable, and can be successfully sampled using standard methods
- Community contains both generalists and habitat specialists, including some taxa that are restricted to large rivers
- Most of the rock is artificial, but has the highest diversity, and yields data parallel to that from coarse substrate in wadeable streams
- Site assessment possible with standard metrics and approaches, but modifications needed are not yet well understood
- Relative condition assessment probably requires “best site / reach”, “highest value”, or data distribution analysis for defining reference
- Longitudinal evaluation & relative site / reach comparisons involving benthos in large rivers may not require complete spatial coverage or inclusion of all habitats in the sample design

Future Research Needs

Lower Missouri River

- Validation of large river metrics
- Higher site density – 50 or more
- Establish uniform aquatic life categories
- Large River habitat scoring / ranking protocols
- Biological condition gradient tiers
- Biological response signatures
- Multi-state consortium