Lessons learned from the USEPA Environmental Monitoring Assessment Program for Great River Ecosystems

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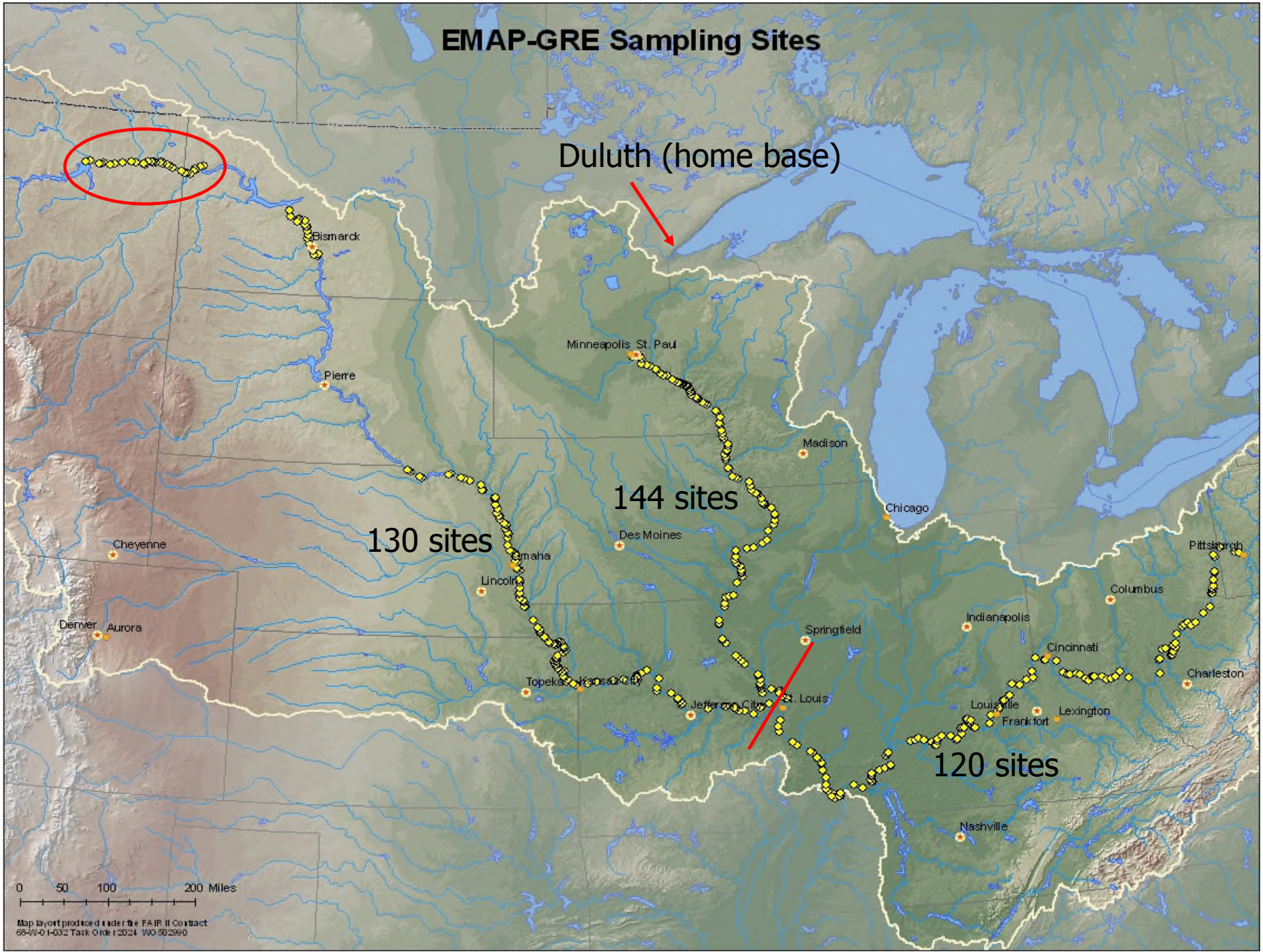
Talk Outline

- EMAP-GRE overview
  - Objectives of EMAP-GRE
  - Other data types, landscape and hydrological
  - Sample design
- Lessons learned (along the way)
  - Stressor response indicators
  - Reference condition
  - Biotic indices
    - Fish assemblage MMI example
  - Fish sampling methods
  - Main channel vs side channel and backwaters
- Summary

EMAP-GRE Overview

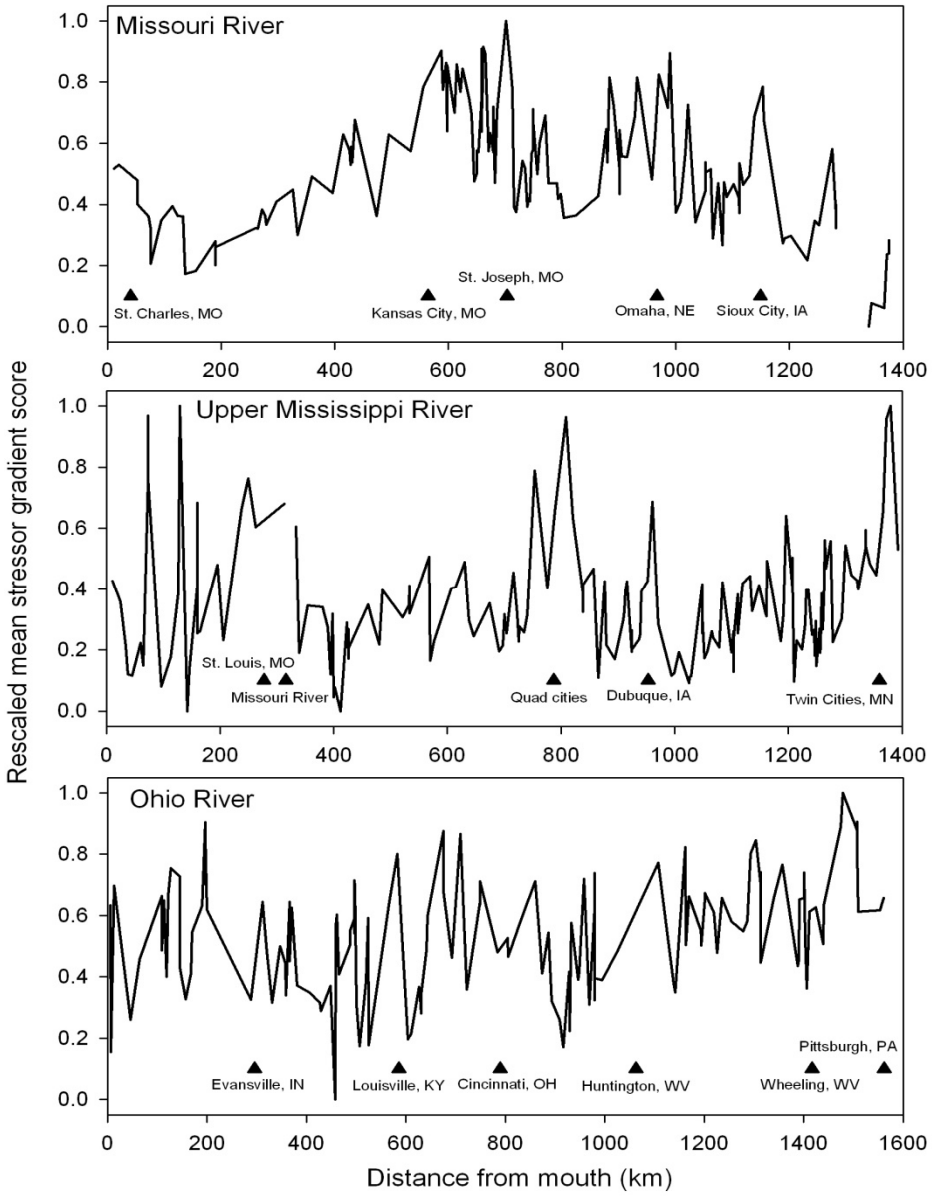
- The objectives of the EMAP Great River Ecosystems Program (EMAP-GRE) were to develop and demonstrate, in collaboration with states, tribes, and EPA regions, an assessment approach to estimate the condition of the Upper Mississippi, Missouri, and Ohio Rivers
- Sampling was conducted in 2004-2006 at 447 sites for multiple biotic assemblages, water quality, and physical habitat
- Parallel with the field effort, landscape and hydrological data were assembled for each of the 447 sites
- EMAP-GRE utilized a probabilistic sampling approach to ensure spatial balance of sites for each river or major reach
  - This approach avoids issues such as large gaps with no sites and clusters of sites


EMAP-GRE Sampling Sites
Duluth (home base)
Bismarck
Pierre
Minneapolis St. Paul
Madison
144 sites
130 sites
Chicago
Des Moines
Cheyenne
Omaha
Lincoln
Denver
Aurora
Springfield
Topeka
Kansas City
Jefferson City
St. Louis
Indianapolis
Columbus
Pittsburgh
Cincinnati
Charleston
Louisville
Frankfort
Lexington
120 sites
Nashville
0 50 100 200 Miles
Map layout produced under the FAIR II Contract
68-W-01-032 Task Order 2024 WO-502990

Indicators used for Assessment

- We used 11 stressor response indicators and 9 biotic response indicators to assess extent of condition of Mid-Continent great rivers
  - MDC = Most-disturbed condition
  - LDC = Least-disturbed condition
- Common stressor response indicators include:
  - Total N, total P, Total suspended solids (TSS)
    - TN, TP, 25th and 75th percentiles = LDC and MDC, respectively
    - TSS, used 30 mg/L criterion (UMRCC-WQTF)
  - Sediment toxicity
    - LDC=≥95% survival; MDC ≤75% survival
  - Invasive species presence (Asian Carp, Zebra mussels)
    - Used presence/ absence; LDC MDC, respectively
  - Floodplain urbanization and agriculture (landscape data)
    - Impervious surface = surrogate for urbanization
    - NLCD data used for % agriculture
- Detail in Angradi et al. 2011

Stressor Gradient and MMIs



•Compile and screened water chemistry, turbidity, sediment toxicity, habitat stressors, and human disturbance metrics at site and landscape scales

• Constructed four reach specific stressor gradients based on distinct fish assemblages among the reaches

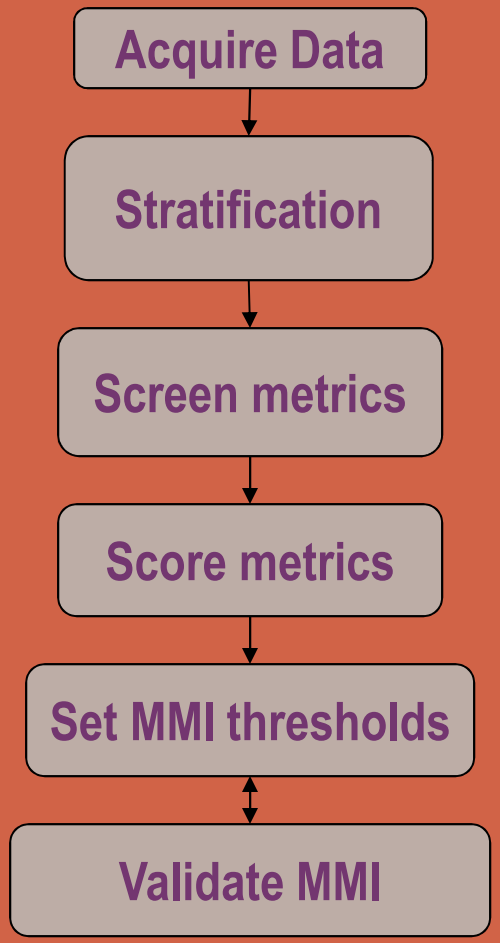
- Lower Missouri
- Impounded Mississippi
- Unimpounded Mississippi
- Ohio River

• Found 3-18 metrics needed for good fit.

• Good urban signal in each reach.

(Angradi et al. 2008, Ecological Indicators)

GRFIn Development
Pearson et al. 2011



- The process is always a combination of statistics and professional judgment
- Stratification of river reach is same as for stressor gradient (multivariate analysis of the fish assemblage)
- We screened 80+ fish metrics
  - Selected metrics needed to correlate ($p \leq 0.05$) with the stressor gradient in the expected direction
  - One metric of redundant pairs was used
- The selected 8-10 metrics for each reach were rescaled (0-10) and averaged to create the GRFIn
- Condition class thresholds based on slope and spread of the GRFIn with the stressor gradient
  - Upper range of GRFIn was defined as Least Disturbed (LDC) and lower range was Most Disturbed (MDC)
- 75% of data set was used in the development and 25 % for the validation

Blocksom 2003, Env. Man.

Fish Sampling Methods

- The intent of fish sampling was to collect a representative sample of all but the rarest fish species in a 1-km nearshore zone
- Electrofished 1-km reach in a downstream manner for a minimum of 60 minutes
  - Our results show that based on other sampling programs and efforts (varying methods and spatial aspects) we collected similar number of fish species
  - For example, on the Ohio River we collected 83 fish species; ORSANCO collected 114 species from greater than 1700 sites since 1992
- We are confident that electrofishing the main-channel border at randomly selected sites is adequate for development of MMIs and assessing biological condition of large rivers
- ORSANCO assisted us with developing fish sampling techniques and training crews

Main channel vs side channel

- EMAP-GRE excluded side-channels, backwaters, floodplain lakes, etc
  - It was a tradeoff between fewer sites (if we included backwaters) and more sites (no backwaters); in the end it was deemed a higher *n* was better for the assessment
- We recommend that future regional and large river bioassessments might include these habitats
  - These habitats are critical to river ecosystem structure and function at most any scale
  - Many human benefits derived from river ecosystems are based on non-channel habitats
    - Waterfowl hunting, denitrification, production of recreational fish, etc

Summary

- If considering EMAP-GRE examples, remember it was a research program, not a monitoring program
- Sample enough abiotic stressor types (TN, TP, TSS, etc) to derive stressor gradient or select reference sites
- GRFIn MMI was more sensitive to stressors than the macroinvertebrate MMI (inverts respond at smaller scales)
- More sites with core indicator data is better than fewer sites with questionable indicators or one you can live without
- If documenting human benefits derived from ecosystems are important for the assessment, include backwaters, side-channels

Indicators

- Biotic condition response indicators include:
  - Fish MMI
  - Marcoinvertebrate MMI
  - SAV MMI
  - Zooplankton, phytoplankton, and periphyton indicators
- Stressor indicators include:
  - Total N, total P, total suspended solids (TSS)
  - Sediment toxicity
  - Invasive species presence (Asian Carp, Zebra mussels)
  - Floodplain urbanization and agriculture

Bugs, periphyton, habitat stations

E-fishing transect 1000 m

Water quality stations

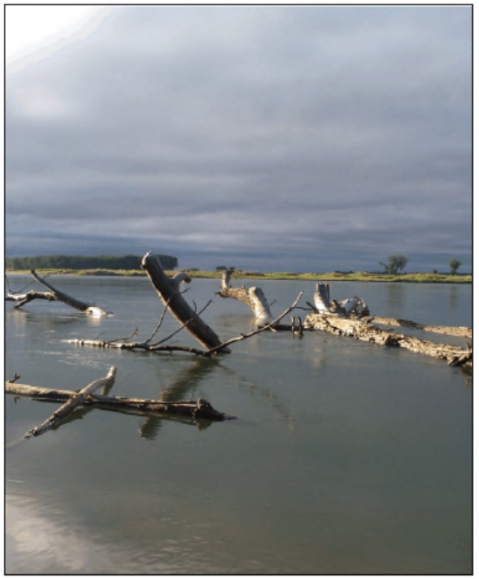
ORS04466-0003

200 m

500 ft

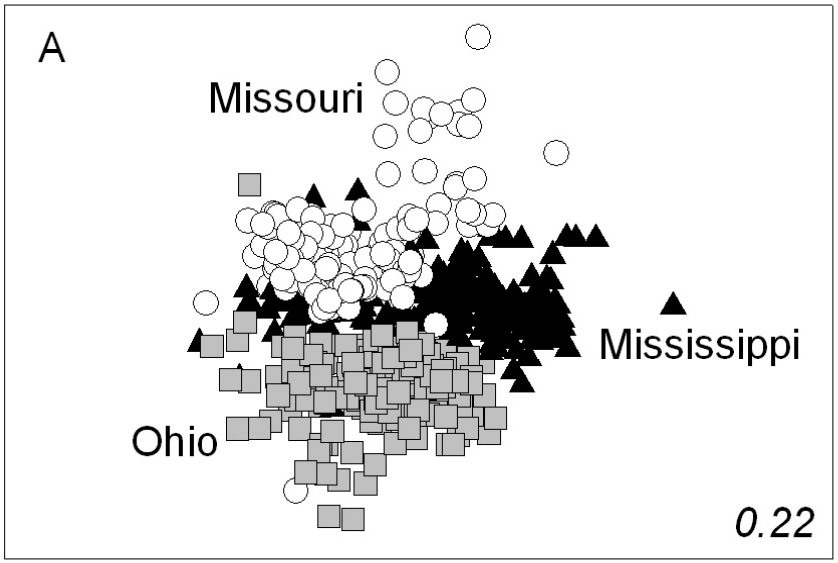
United States Environmental Protection Agency | Office of Research and Development Washington, DC 20460 | February 2006

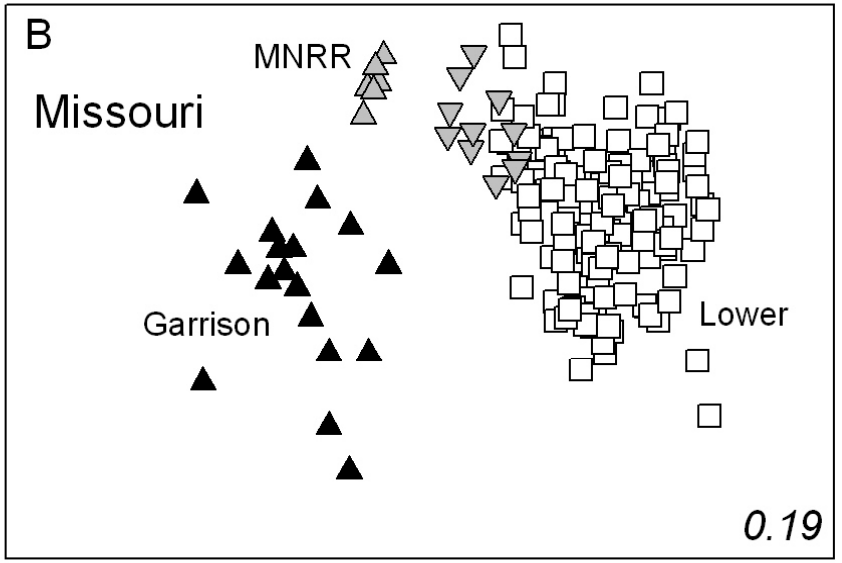
Great River Ecosystems Field Operations Manual

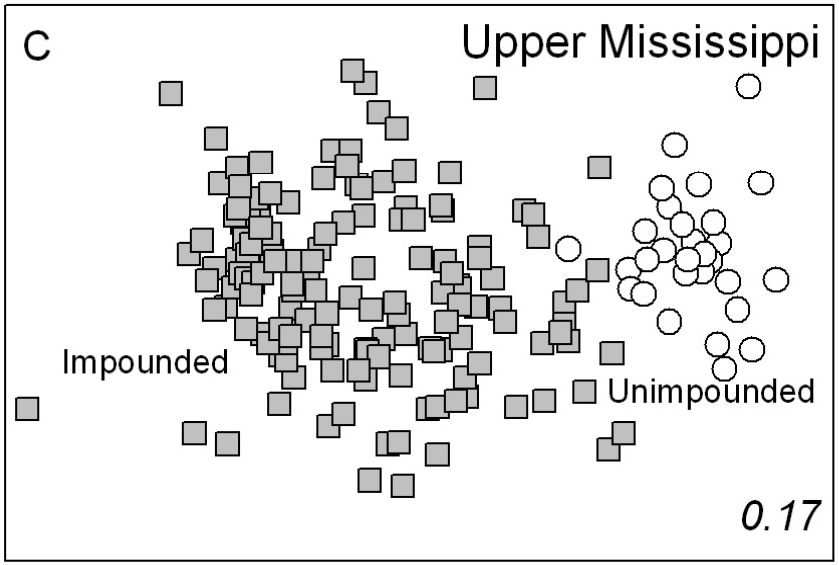


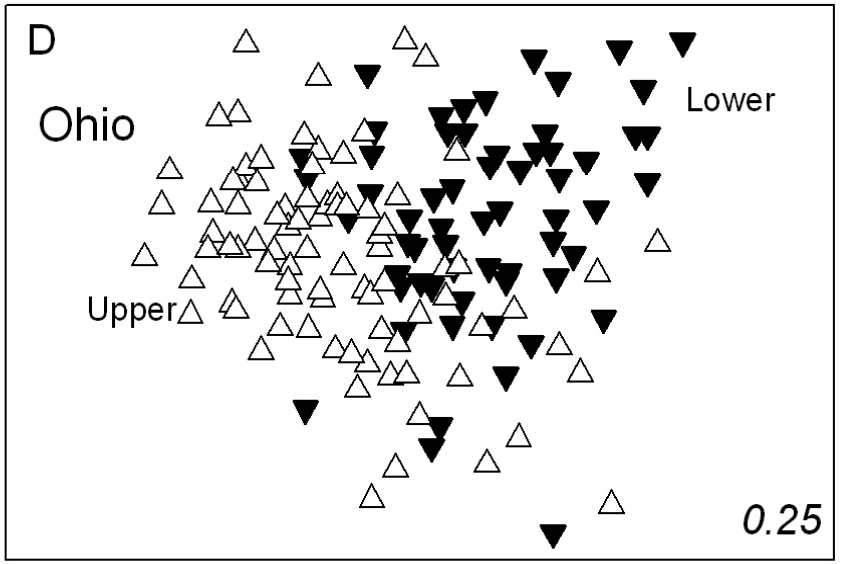
Environmental Monitoring and Assessment program

Stratification based on M-V Analysis of fish assemblage

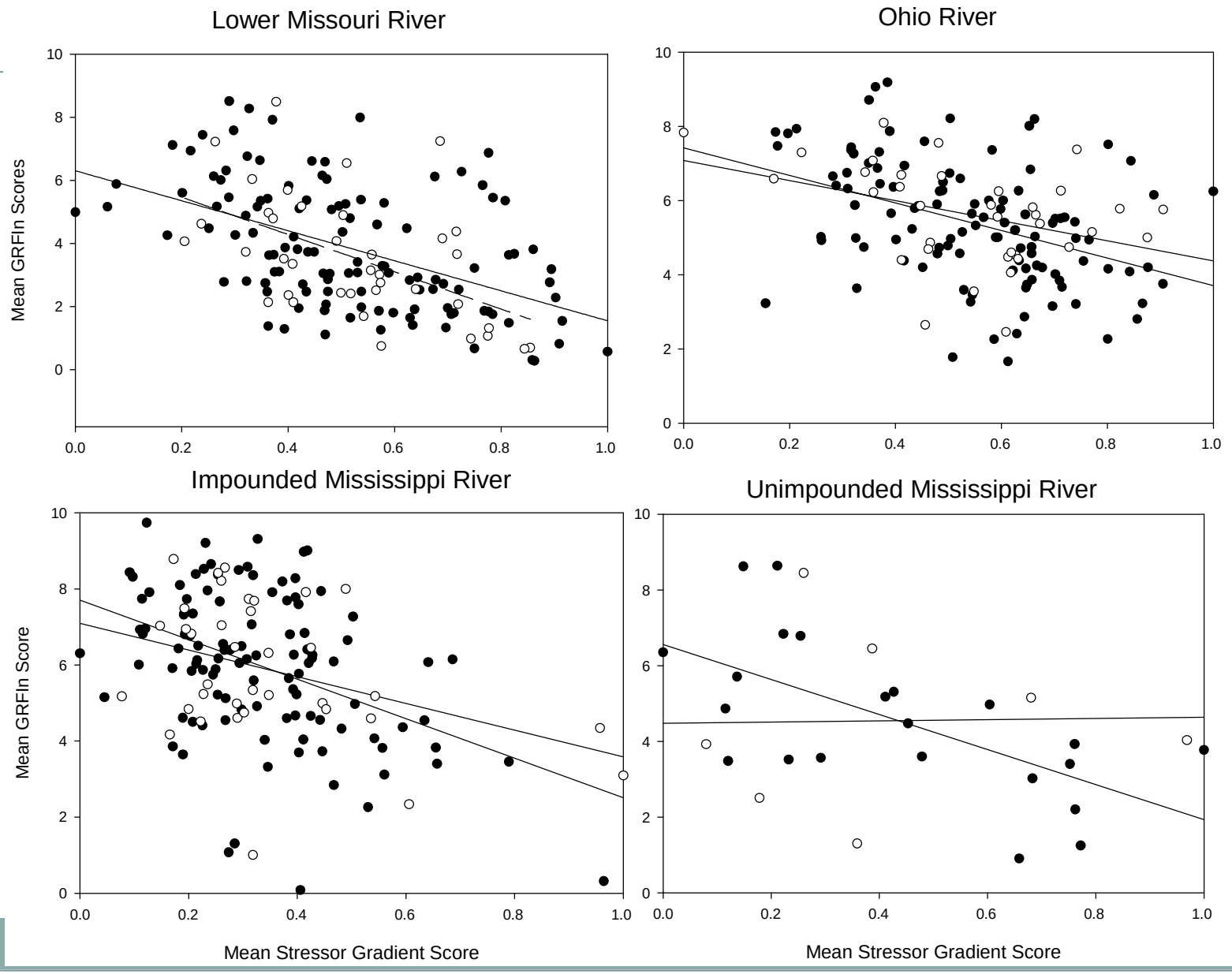




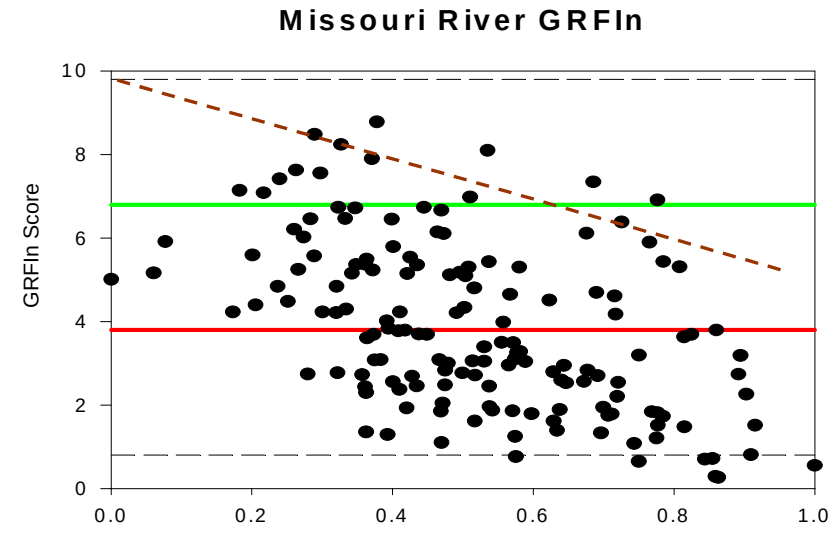


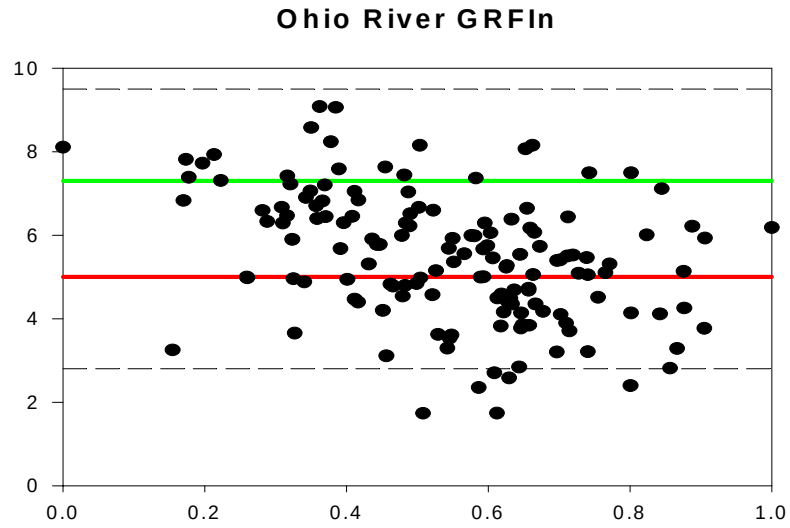


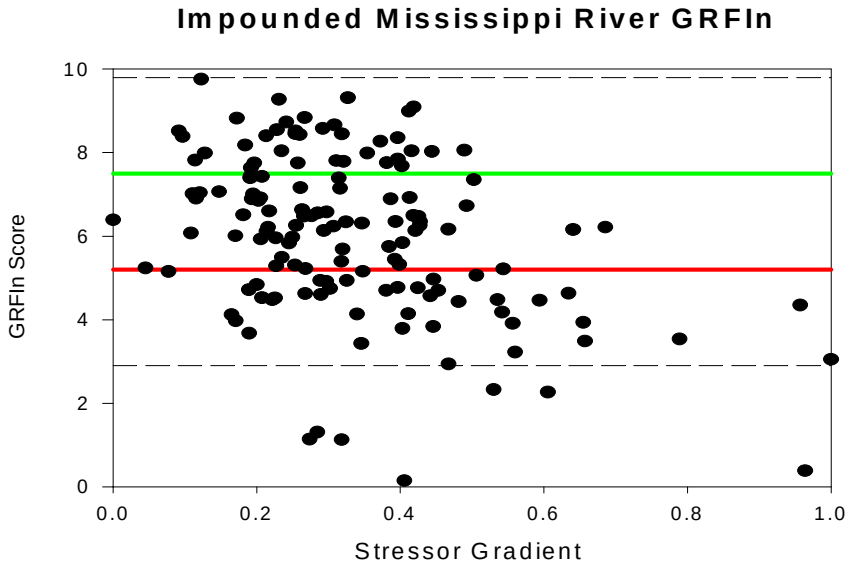
Screening, Scoring, and Validation

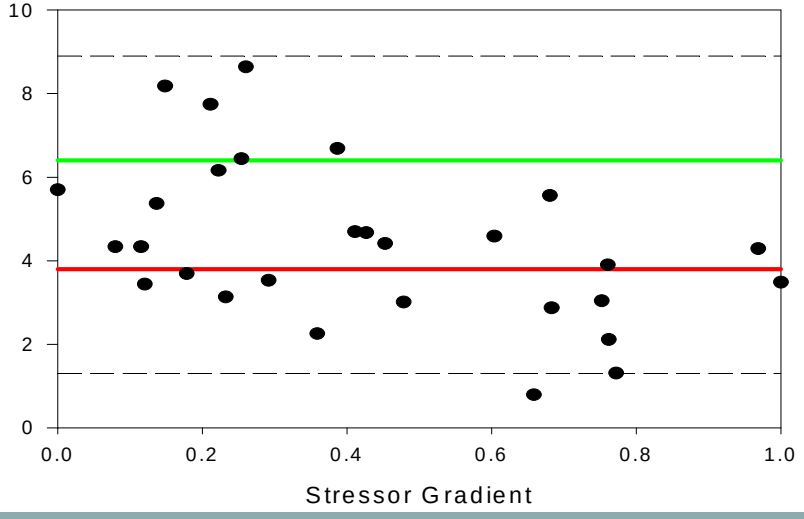


Setting GRFIn Thresholds





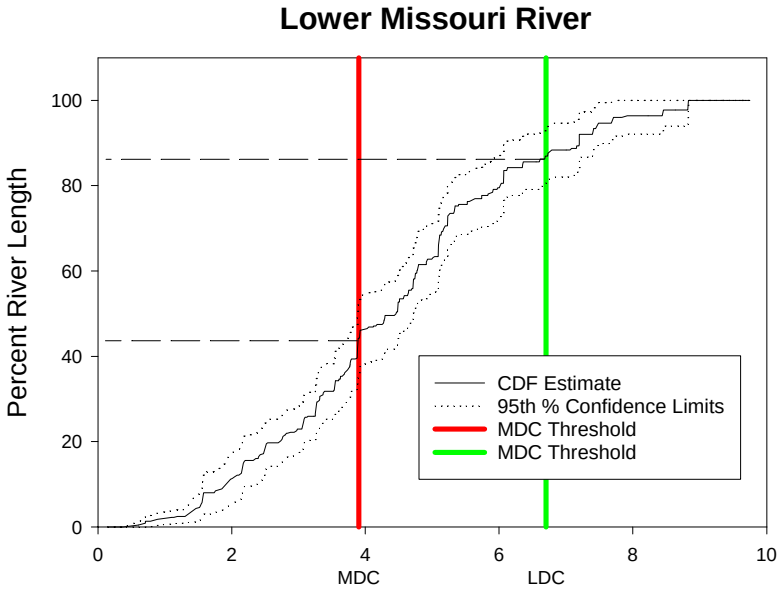


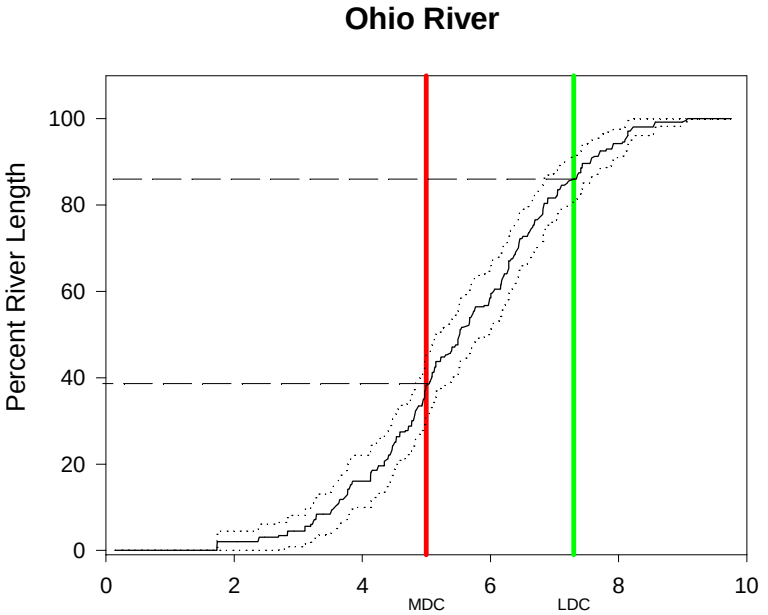


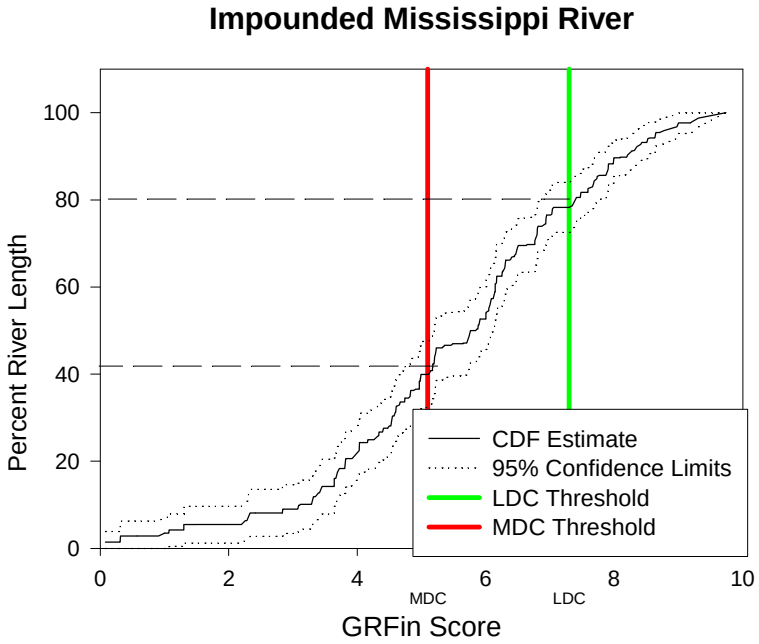
Assessment of Condition based on Fish

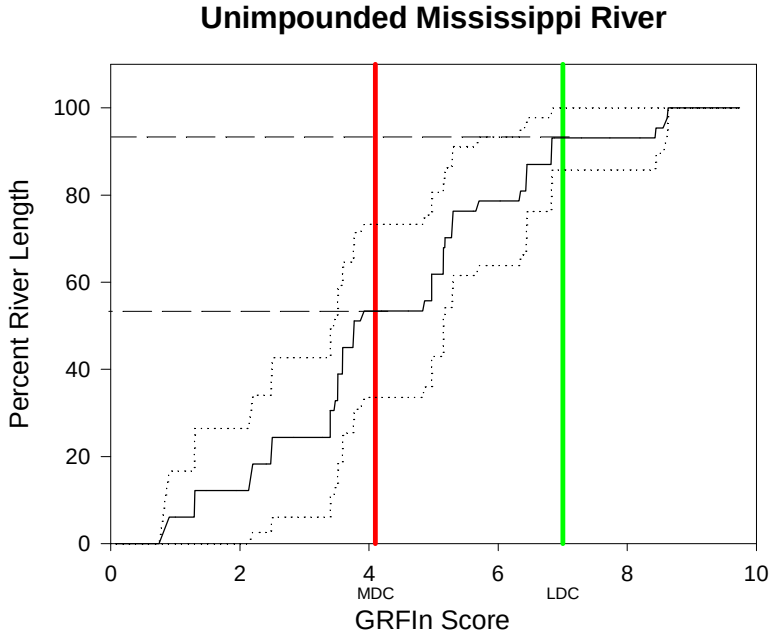
Reach	Floor (5th pct.)	Ceiling (Y-int of 95th pct of qreg)	Condition Class thresholds		% of river length in (±95% C.I.)	
			MDC to IDC	IDC to LDC	MDC	LDC
Lower MO	1.2	9.4	3.9	6.7	44 (8)	13 (6)
Impounded MS	2.9	9.8	5.2	7.5	42 (8)	19 (5)
Unimpounded MS	1.3	8.9	3.8	6.4	51 (20)	13 (12)
Ohio River	2.8	9.5	5.0	7.3	38 (7)	14 (5)

Assessments of Condition









Other Lessons Learned

- Training is important but not more important than having a good operations manual
  - Training covers important aspects of safety
- EMAP-GRE operations manual had a lot of detail
  - We recommend simplifying forms
  - Don't collect data you will never realistically use
  - GRE was a research program, not a monitoring program
  - Limit the crew's decision making burden with respect to the design file
    - Be very clear about site replacement (safety and site access)
- More sites with core indicator data is better than fewer sites with questionable indicators or ones you can live without

Adoption of EMAP-GRE Methods

- Upper Mississippi River Basin Association
  - Organization of five states that border the Upper Mississippi River
- Pennsylvania DEP
  - Monongahela and Allegheny Rivers