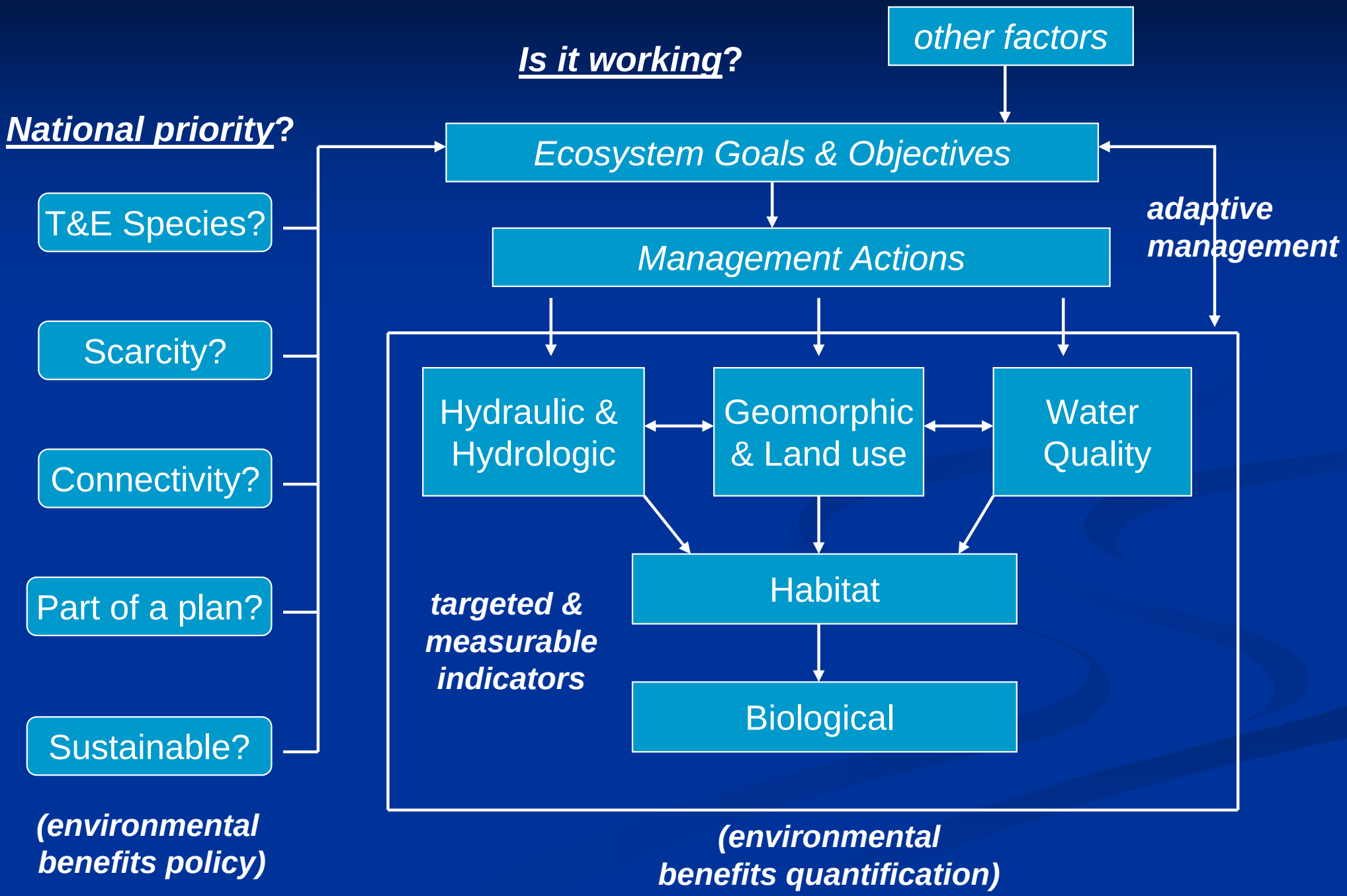
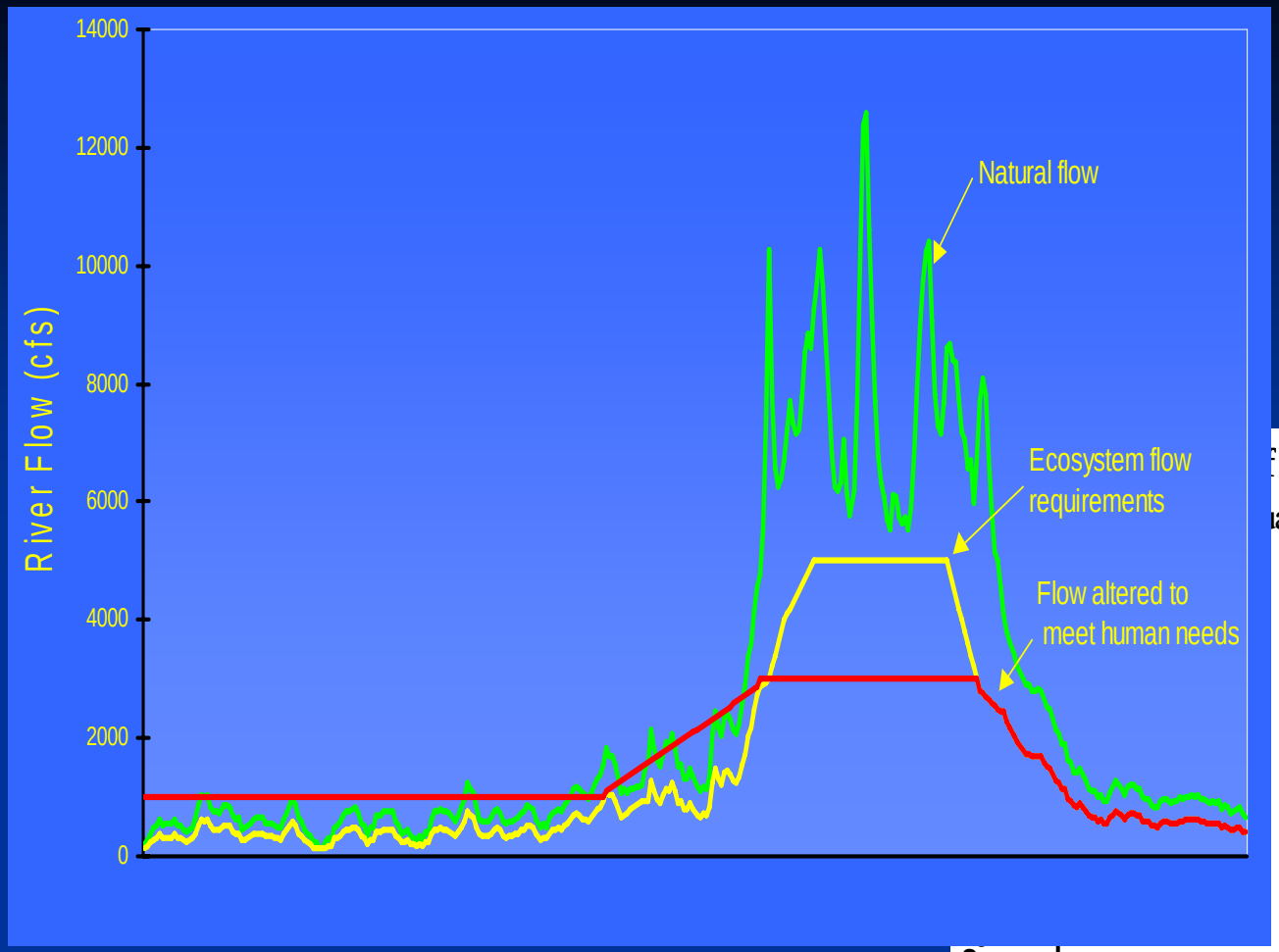
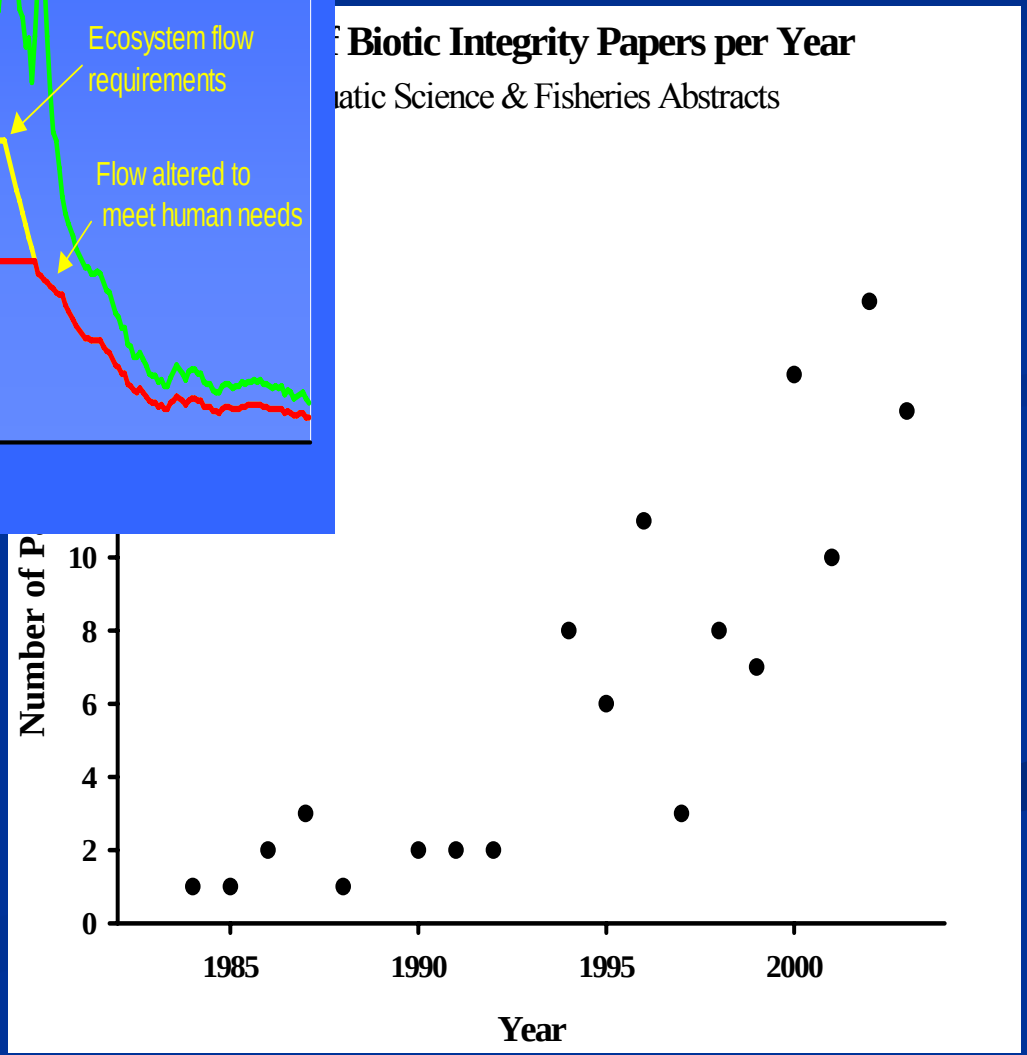
Implementing, Monitoring, and Managing Ecosystem Restoration





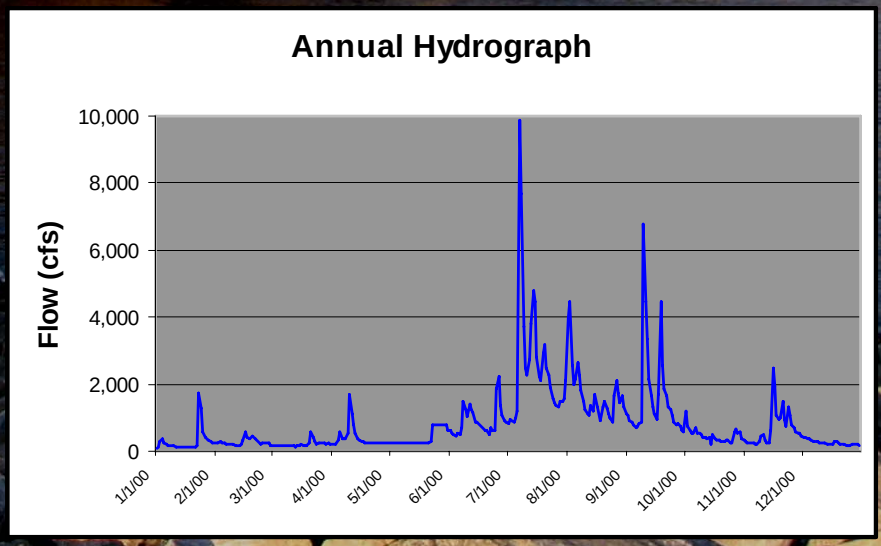
Index of Biotic Integrity



Indicators of Hydraulic Alteration & Range of Variability Method

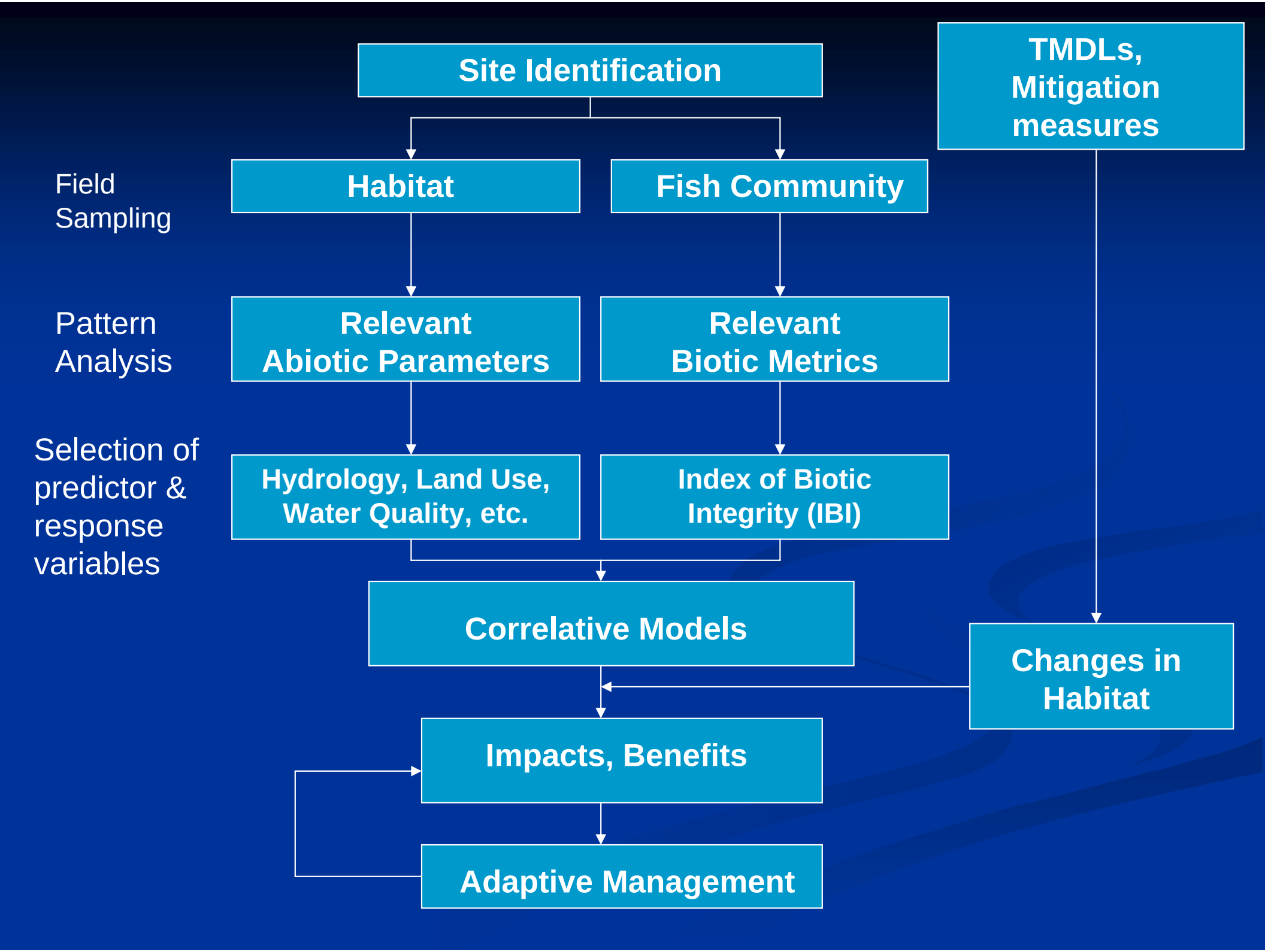
TNC's Indicators of Hydrologic Alteration (IHA)

- Statistical description of flow regime change
- Organizes hydrologic complexity – provides framework to analyze critical geomorphic and ecologically aspects of flow regime alteration
- 33 IHA parameters
- 44 Environmental Flow Components (EFC) parameters
- What changed?
- How did it change?
- Ecological relevance?

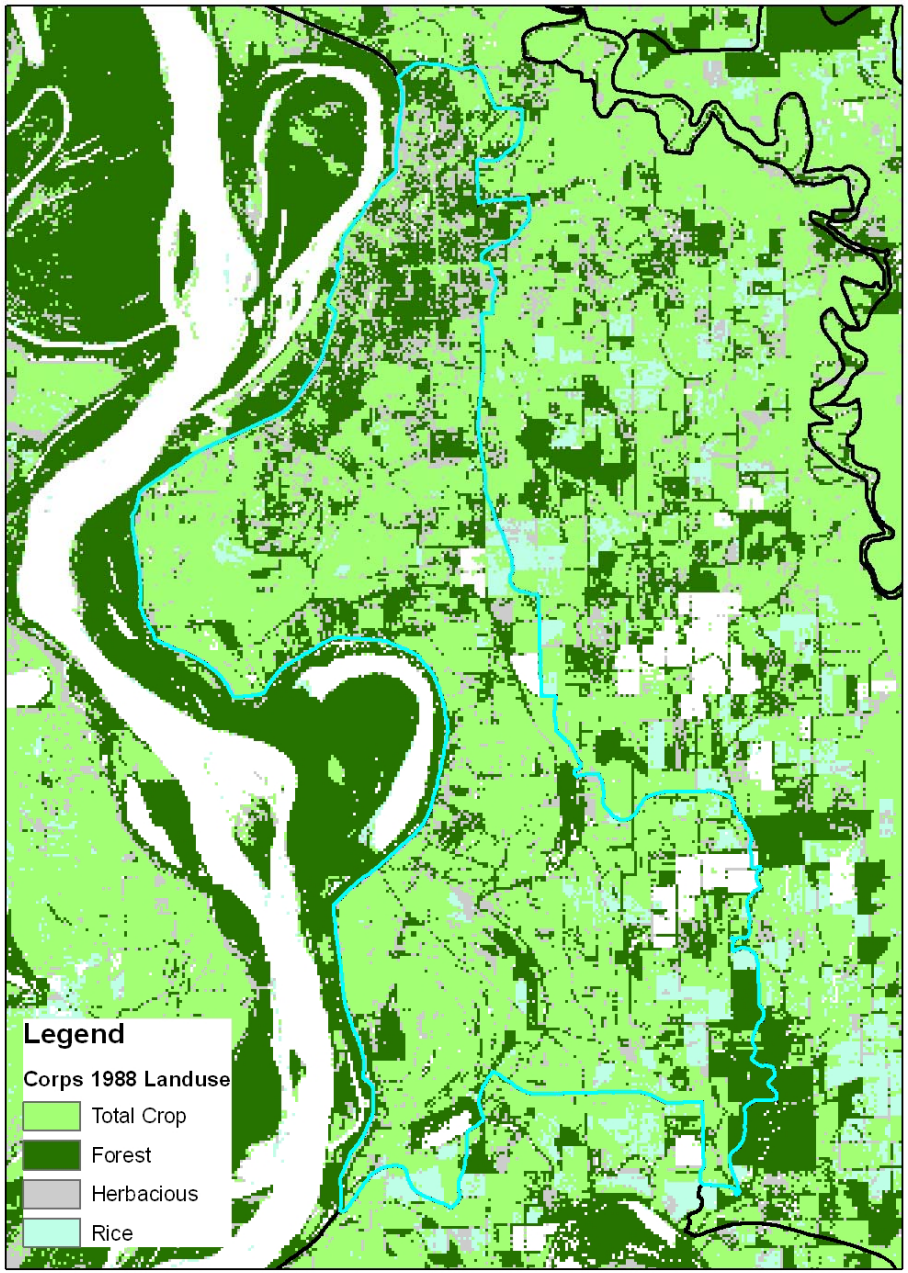


How Much Water Does the Lower White River Need?

- Variability characteristic of natural flow regime is key to diversity of natural system
- Flow regime has been fundamentally changed…natural system is responding
- There are no "magic" flow numbers that are fully protective of diversity…ranges of numbers and variability are the key
- Address essential natural system requirements in water management decisions
- Make hydrograph look as "natural" as possible


Site Identification
TMDLs, Mitigation measures
Field Sampling
Habitat
Fish Community
Pattern Analysis
Relevant Abiotic Parameters
Relevant Biotic Metrics
Selection of predictor & response variables
Hydrology, Land Use, Water Quality, etc.
Index of Biotic Integrity (IBI)
Correlative Models
Changes in Habitat
Impacts, Benefits
Adaptive Management

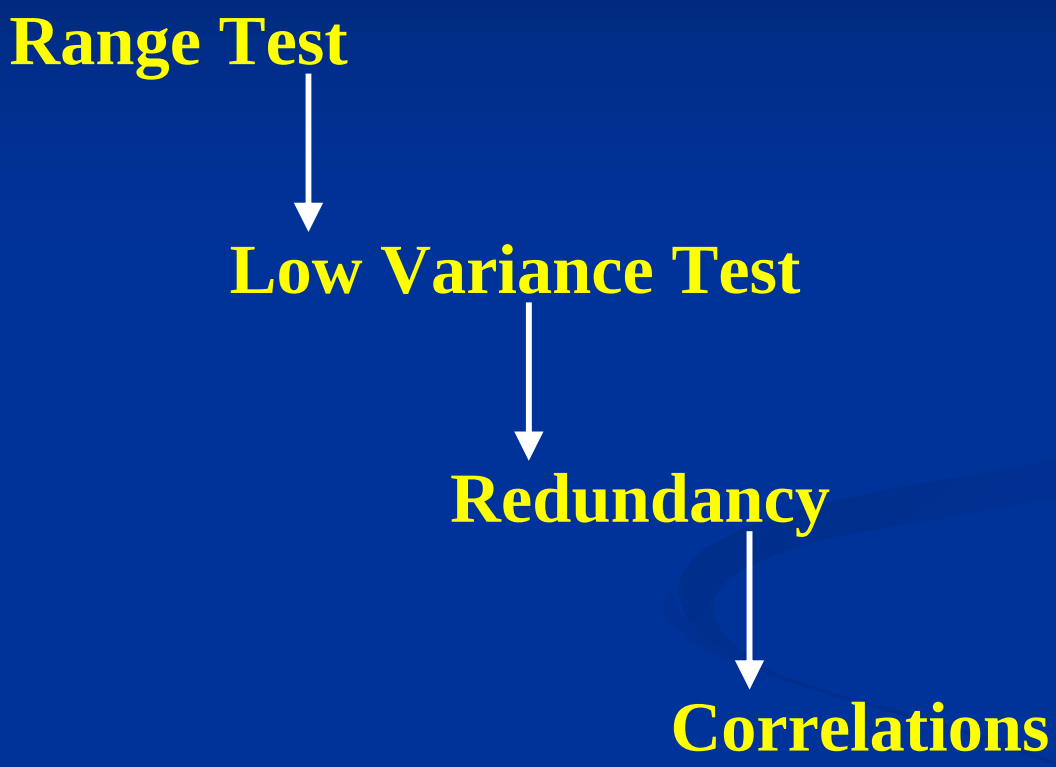
Landscape and Hydrologic Variables



Hydrologic Indices

- Magnitude
- Frequency
- Duration
- Timing
- Rate of Change
- Low Flow events

IBI Metric Screening Process



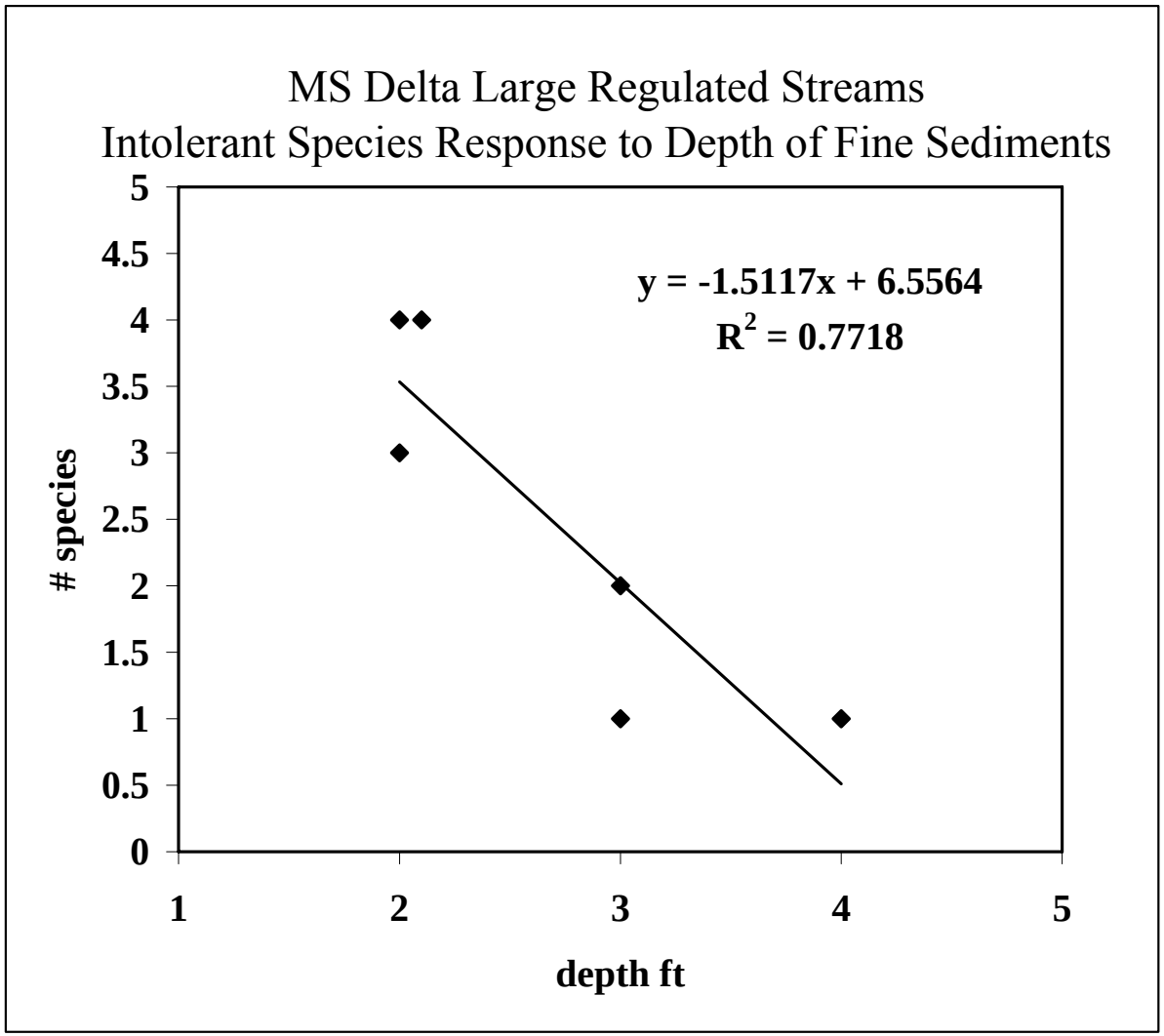
IBI Candidate Metrics (46)

- Taxonomic
- Trophic
- Tolerance
  - Water Quality
  - Habitat
- Affinity to Flow
- Habitat Preference
- Abundance

IBI – Large Unregulated Yazoo Delta Streams

Metric	Metric Score		
	1	3	5
Taxonomic Number of fish species	<9	10-17	≥18
Feeding Proportional abundance of invertivorous individuals	<0.15	0.15-0.61	≥0.62
Tolerance Number of water quality and habitat intolerant species	<3	3-5	≥6
Abundance Catch per unit effort (CPUE)	<165	165-482	≥483
Rheotaxis Proportional abundance of rheophilic individuals	<0.43	0.44-0.88	≥0.89

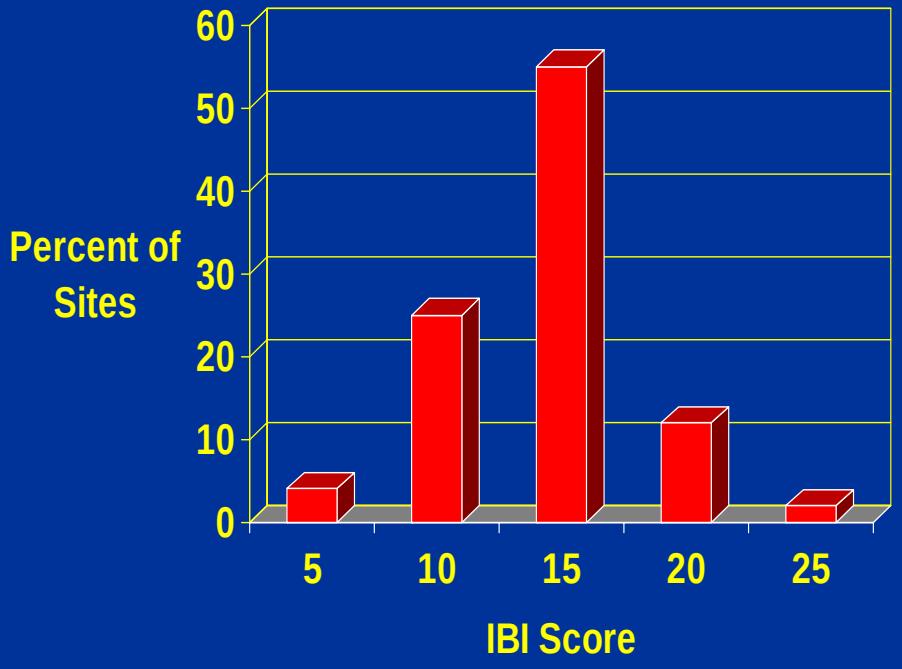
Stressors



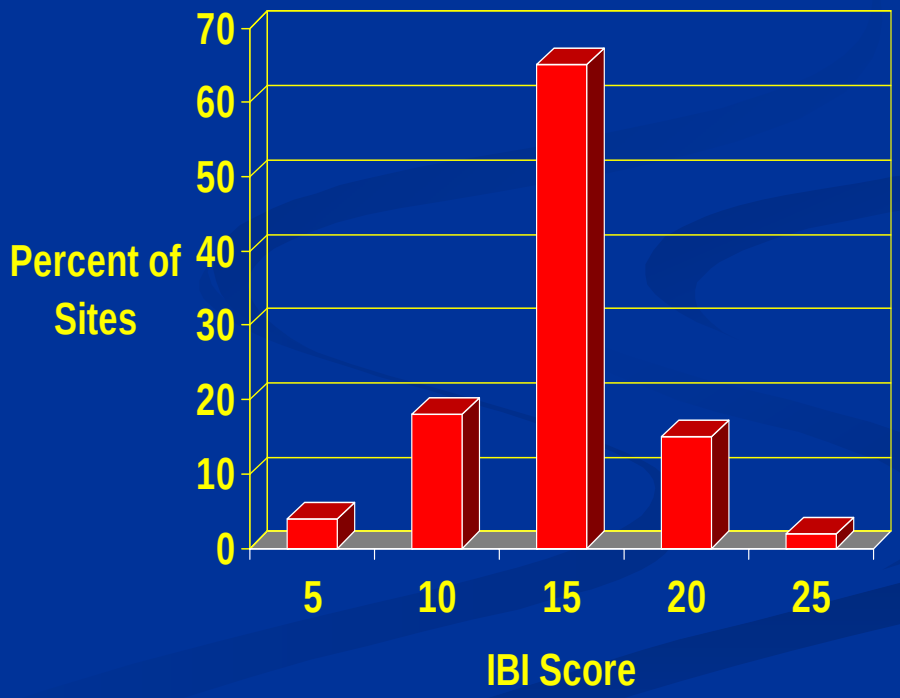
- Sediment
- Low flows
- Lack of structure
- Nutrients?

Scoring Criteria

Small



Large/Medium



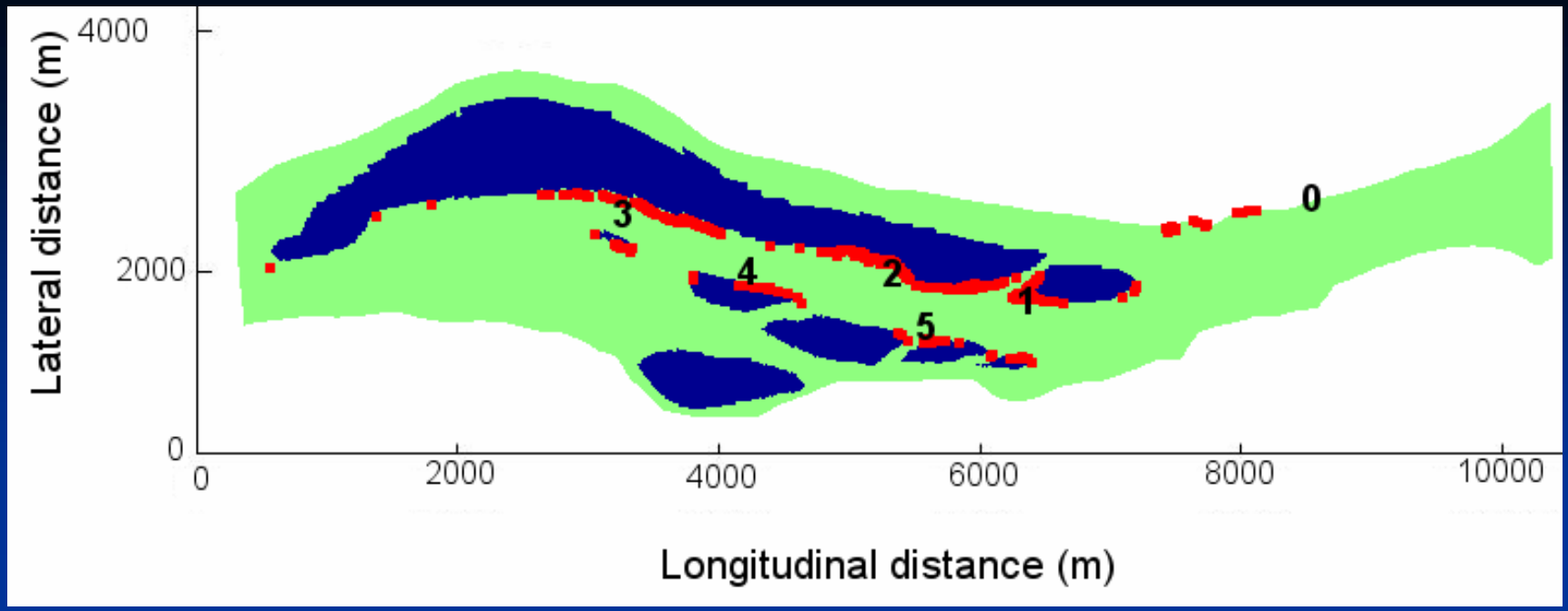
Spearman rank correlations of IBI metrics

IBI Metrics correlated to habitat variables:

- Conductivity
- Depth of Soft Substrate
- Vegetated Area
- Water velocity
- Wetted Width
- Maximum Water Depth

Additional Variables:

- Nutrients
- DEQ Site Scores
- Land use
- Hydroperiod



Upper Mississippi River

(Source: Morales et al., *in press)*

Mussel (particle) settlement

Suitable settlement habitat

Benthic recruitment

Suitable adult habitat

Mussel bed

<u>Lower Ohio River</u>:

- *Annual Recruitment Strength – 1981 to present*
- *Well mapped mussel bed and bathymetry*
- *Olmsted L&D project*
- *Known timing of recruitment & cfs correlation*

Ecologically Sustainable Water Management (ESWM)

(see Richter et. al., 1997)

…protects the ecological integrity of affected ecosystems while meeting inter-generational human needs for water and sustaining the full array of other products and services provided by natural, healthy freshwater ecosystems...

Analysis of Flow Regimes and Flow Alteration

- USGS and USACE gaging data
- Flow duration and flood frequency analysis - overview of flow regime and alteration
- Statistical evaluation of flow regime parameters using IHA to quantify variability of natural flow regime and changes to the regime
- *Magnitude, Timing, Frequency, Duration, and Rate of Change for*
  - *Median Monthly Flows* and *Flow-Duration Curves*
  - *High-Flow Pulses*
  - *Small floods* and *Bankfull Events*
  - *Large Floods*
  - *Low-Flow Events*

Natural Flow Regime Variability

- *Inter-* and *Intra-*annual variability important
- It's the highs ***and*** the lows…each flow level is important to certain geomorphic or ecological functions which together maintain a healthy and sustainable natural system
- Range of magnitudes, frequencies, durations, and timing for flow regime parameters is the key
- Too much alteration of natural flow variability can have serious resource management and ecological implications
- A guide to development of flow prescriptions for ecosystem sustainability

Flow Alteration on the lower White River