National Biological Assessment and Criteria Workshop

Advancing State and Tribal Programs

Coeur d'Alene, Idaho
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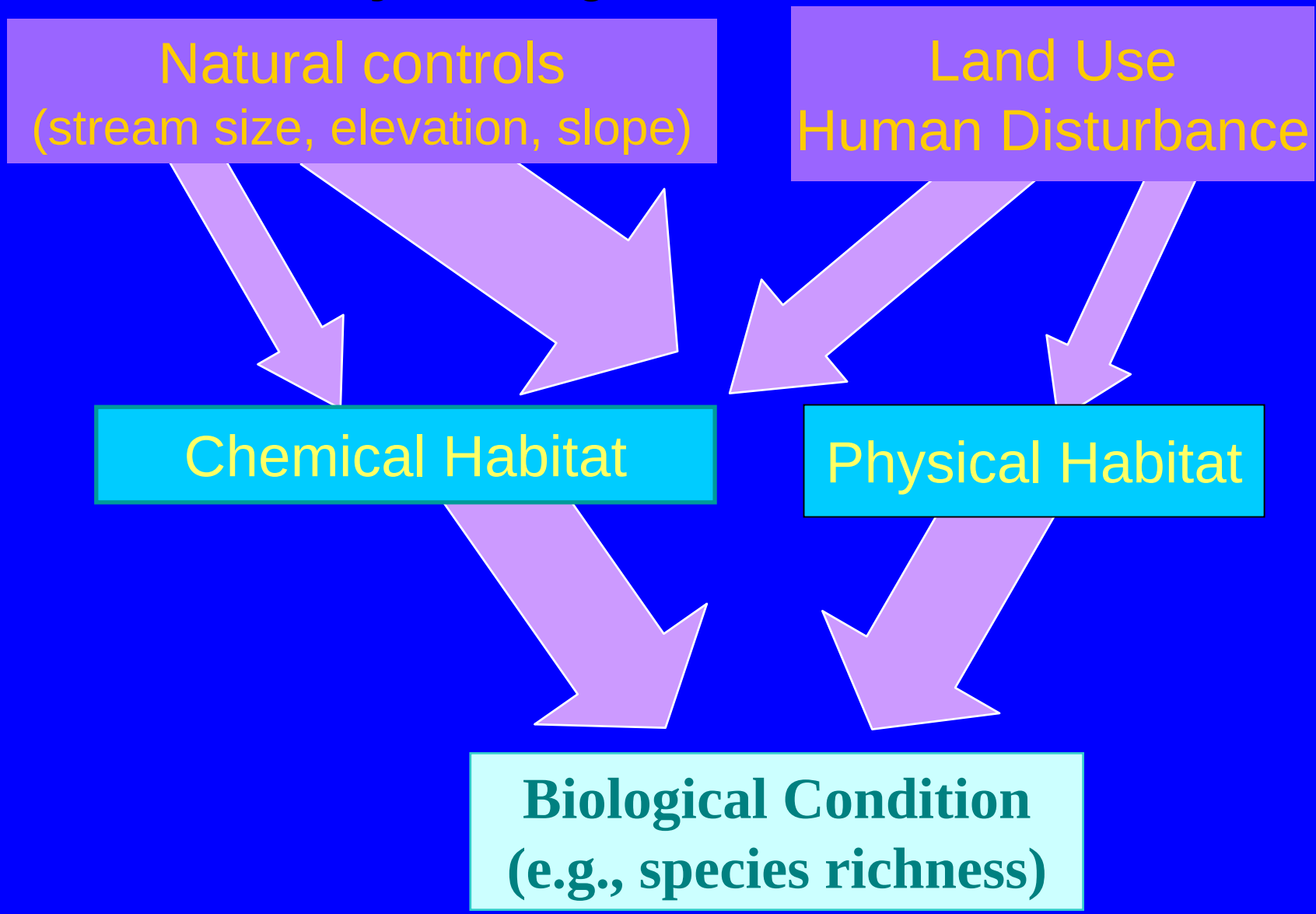
LR 101

Section 4b: W-EMAP Quantitative River Physical Habitat Assessment

Phil Kaufmann, USEPA – Corvallis, OR;
Bob Hughes, Dynamac – Corvallis, OR

Land use and natural controls affect biota indirectly through their effect on habitat



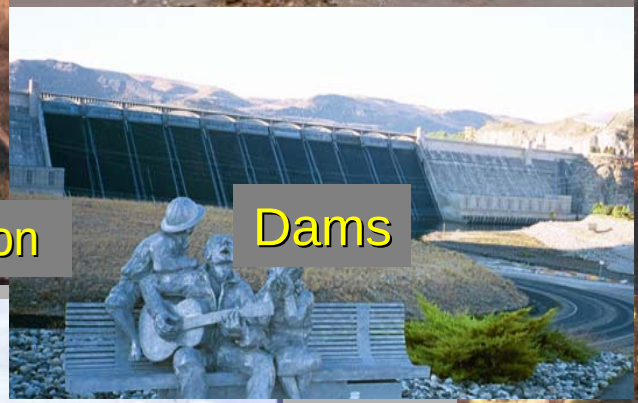
We alter habitat in many ways

Urbanization

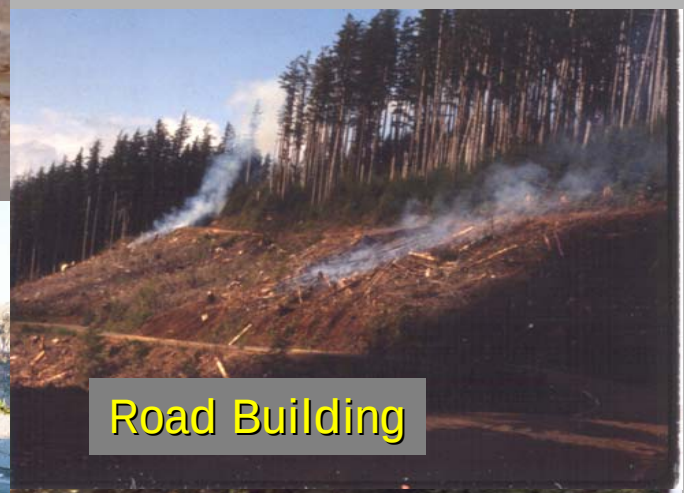
Recreation

Logging

Agriculture, Irrigation



Dams



Road Building

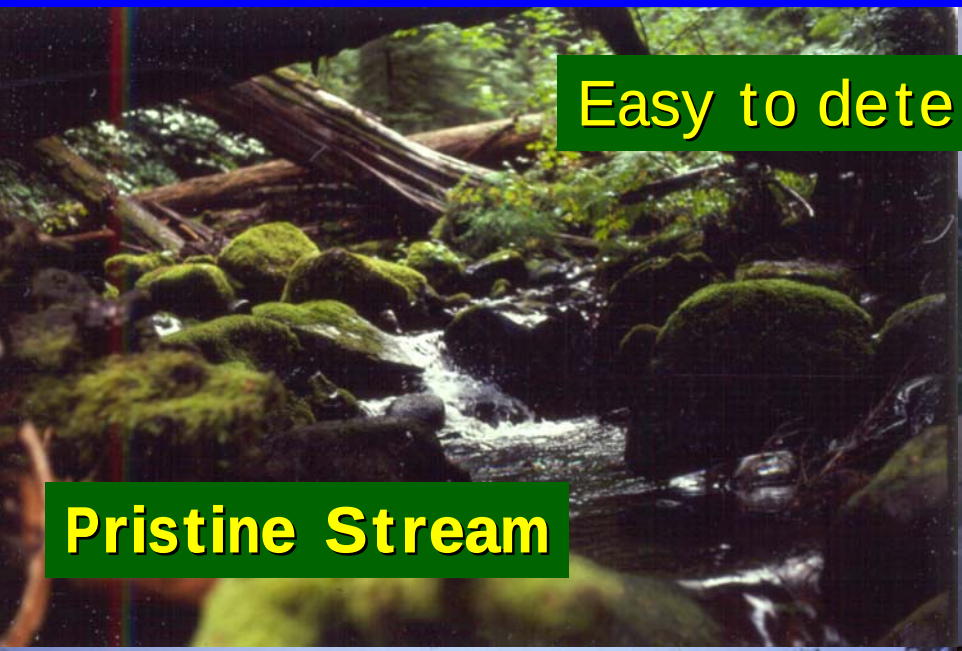
Livestock Grazing, Feedlots

Channel “Improvement”

HABITAT... the set of conditions that support and control species distribution and abundance

- Physical : EMAP restricts consideration to physical habitat structure
  - Includes some "biological" elements like vegetation that affect structure
- Chemical
- Biological
- Consider Landscape and Historical Contexts
  - Measure at several spatial scales
  - Choose metrics that integrate conditions over time

What Constitutes Good Physical Habitat?



Easy to determine these

Pristine Stream

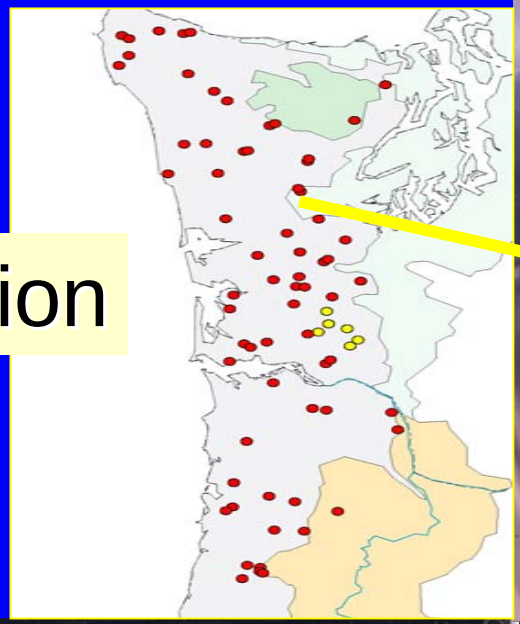
Obviously Poor Habitat

Need quantitative data to accurately & precisely rank these

----------Stream Size ---------->

- - - - - - Gradient - - - - - - - - - - >

Sampling over a range of spatial scales



Region

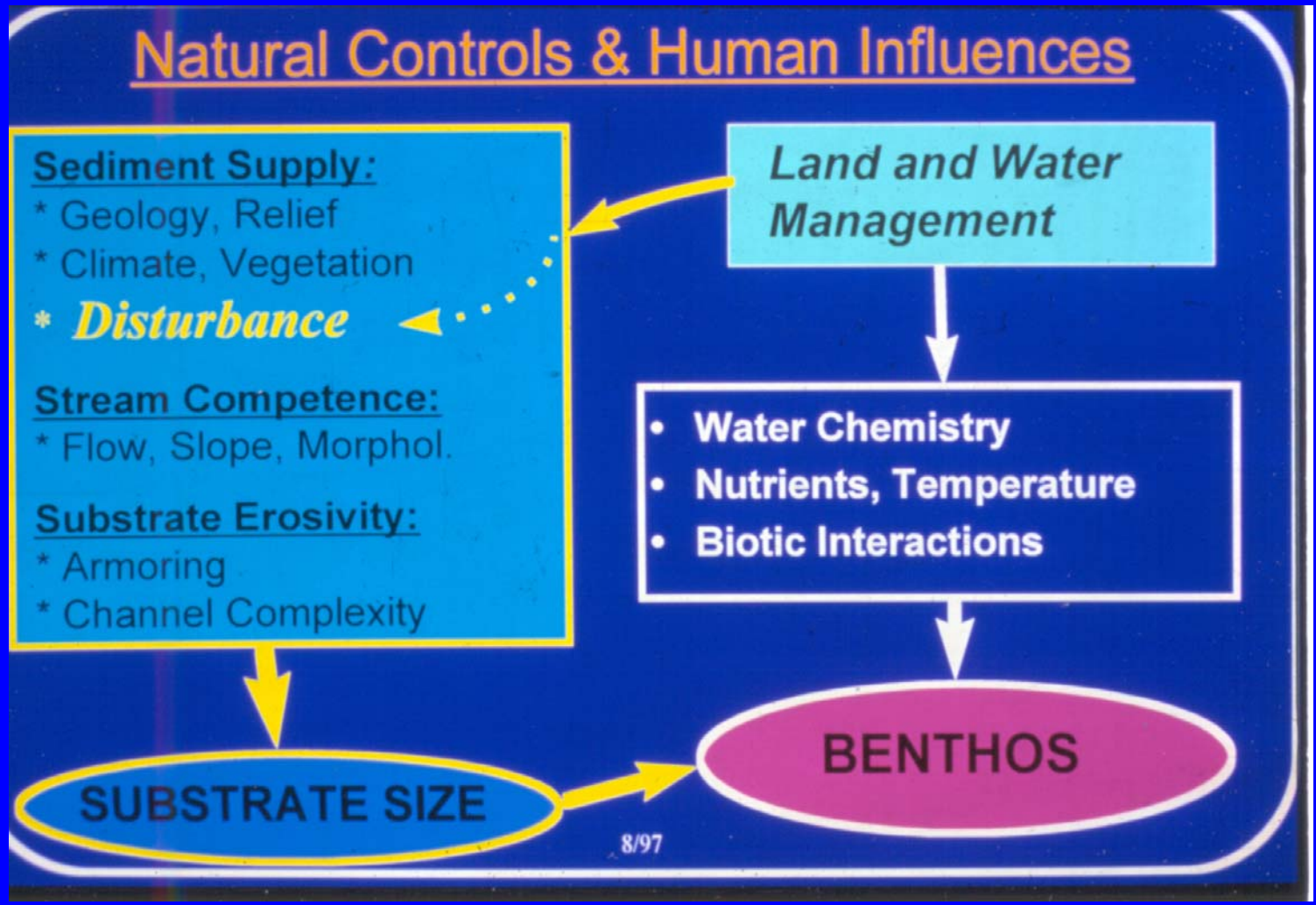
Stream reach

Micro-habitat

Habitat unit

PHYSICAL HABITAT INDICATOR DEVELOPMENT

- **Determine Metrics of Interest**
- Develop Field Monitoring Protocol
- Quantify Variability, Precision
- Demonstrate Ecological Relevance
    - Biological associations
    - Sensitivity to human disturbance



- Identify attributes of physical habitat that adequately describe the major natural and anthropogenic controls on biota
- Consider expected responses of habitat to various types of human disturbance

Essential River Physical Habitat Elements

- Channel Dimensions: Nothing may be more important than space
  - without it other elements do not matter
- Gradient: hydraulic "energy" of a river
  - used with size to determine power and shear stress
- Substrate Size and Type: important for biota - raw material for channel structure.
- Complexity & Cover: Niche diversity, protection from predation
  - one of the first elements to disappear

Essential River Physical Habitat Elements (continued):

- Riparian Vegetation Cover and Structure:
  Microclimates, organic inputs, channel morphology
- Alien Invasive Plants & Legacy Trees:
  Measures degree to which vegetation has changed
- Anthropogenic Alterations:
  River disturbance and "reference condition"
- Note: Chemistry, Nutrients, Temperature:
  Also need other physical and chemical data to interpret biological data

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Adequate Habitat Indicator?

- Accurate & Responsive -- Does it measure what we intend ?
- Precise -- Can we separate changes or differences from measurement error?
- Relevant -- To Biological needs? Ecological processes? Social values?
- Practical -- Can we do it? ...afford it?

- Protocol constrained to a single, 1-day visit
- Must accommodate (and integrate) measurements of multiple indicators (biological, physical, chemical)

River P-Hab -- Can we do it? afford it?

- Best w/ crew of 2 on raft or inflatable kayak.
- Trained in several days.

- Takes 5 to 8 hours for measurements (depends on river size, location of put-in & take-out)
- First few rivers may take much longer.

EMAP P-Hab (Rivers):

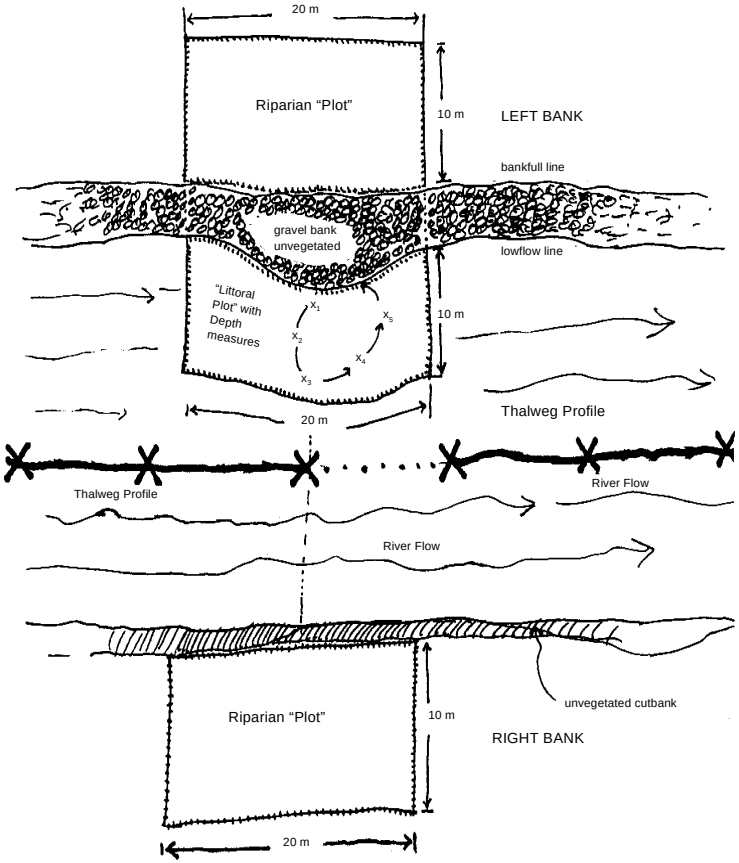
Quantitative Measurements:

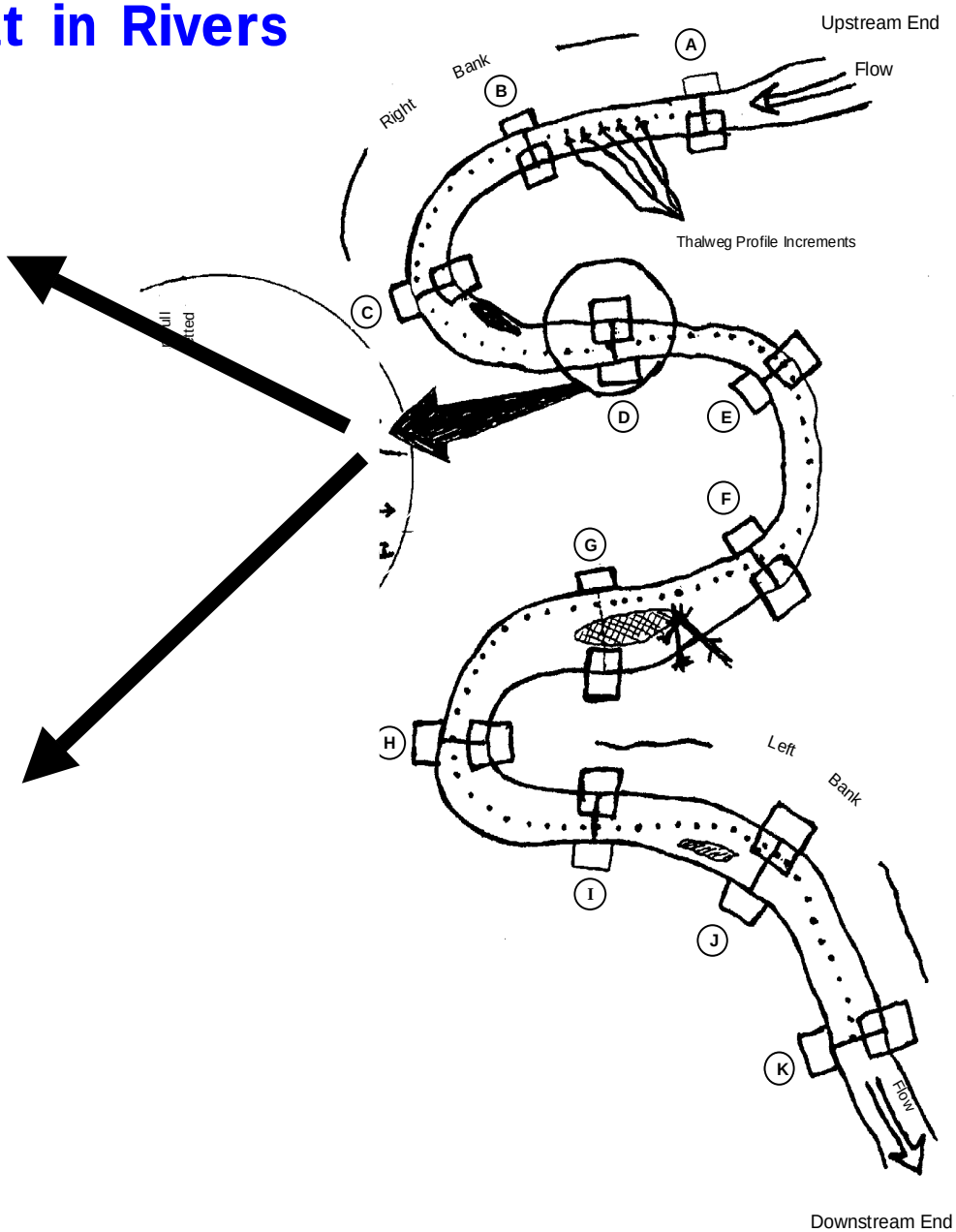
- Channel Dimensions
- Slope, Bearing, Bank Char.
- Near-Shore Canopy Density
- Thalweg/Littoral Depths

Visual Estimates/Tallys:

- Fish Concealment Features
- Woody Debris Tally
- Snags & Backwaters
- Rip. Veg. Cover/Structure
- Dom. Subdom. Substrate
- Human Disturbances
- Constraint

Plot Design: Physical Habitat in Rivers





EMAP River Physical Habitat Characterization

(on 100 Channel-Width Study Reach)

Long Profile at 100 equidistant points:
-- Dominant Substrate, Main Channel Habitat Class,

Long Profile at 200 equidistant points:
-- Thalweg depth, Presence of snags
-- Presence of Backwaters & Off-Channel Habitats

11 Equidistant Cross-Sections and Littoral/Riparian Plots:
Channel Measurements: Slope, Bearing, Main Channel Dimensions, Mid-Channel and Point bar widths, Littoral Depth, Dominant & Subdominant Littoral Substrate, Fish Cover, Large Woody Debris.
Riparian Measurements: Bank Character, Riparian Vegetation Cover & Structure, Presence of Alien Invasive Plant Species, Size/Type/Distance to Largest Tree, Human Disturbance, Dominant & Subdominant Substrate.

For the whole Reach:
Channel Constraint and Valley Width Assessment

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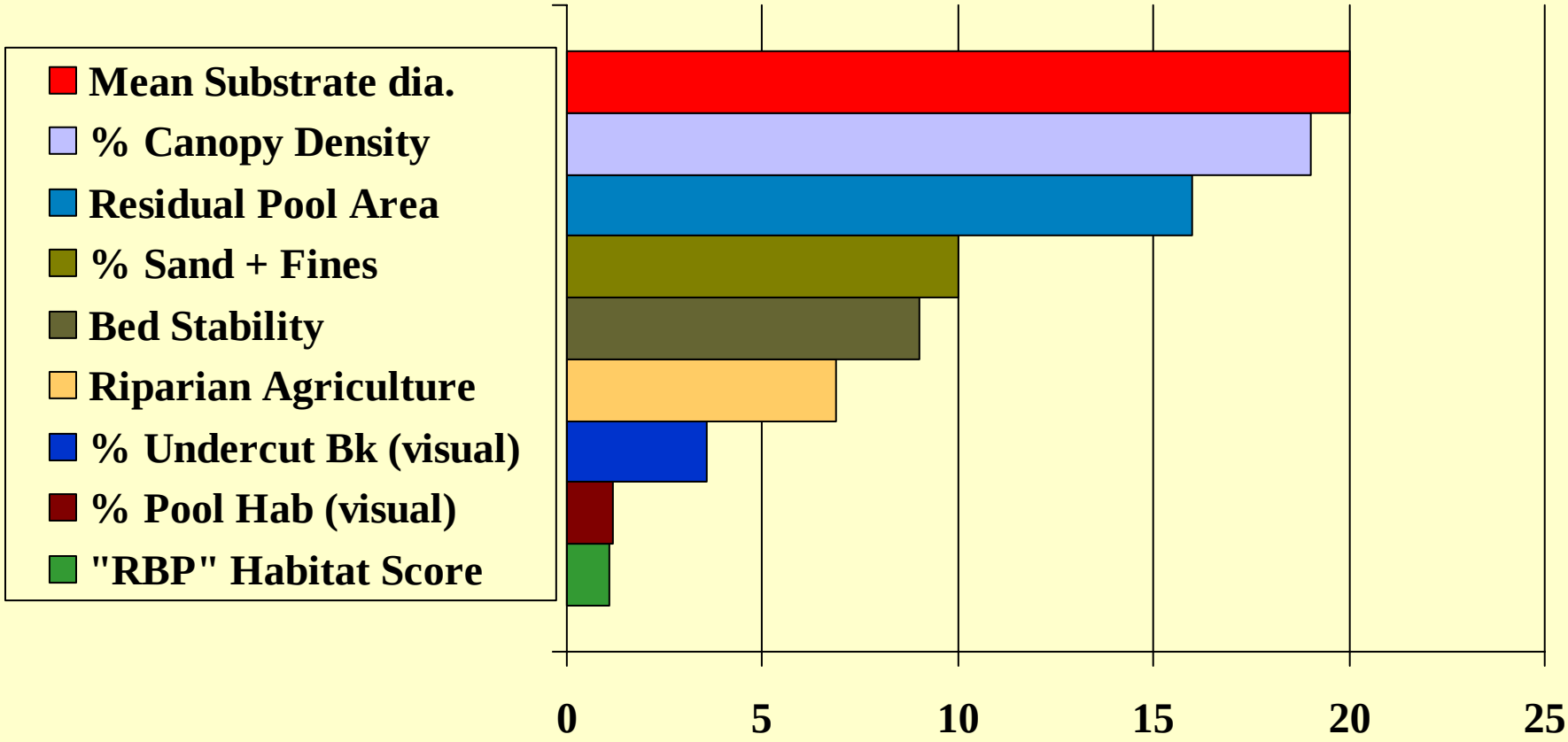
Precision: Quantified through repeat sampling

- Within same day (measurement variance)
- Within same season
  - "index" variance – combines measurement and within-season
- Among Years (Year-to-year temporal variation)
  - Concordant: all sites vary together
  - Interaction: sites vary individually

Signal to Noise Variance Ratio



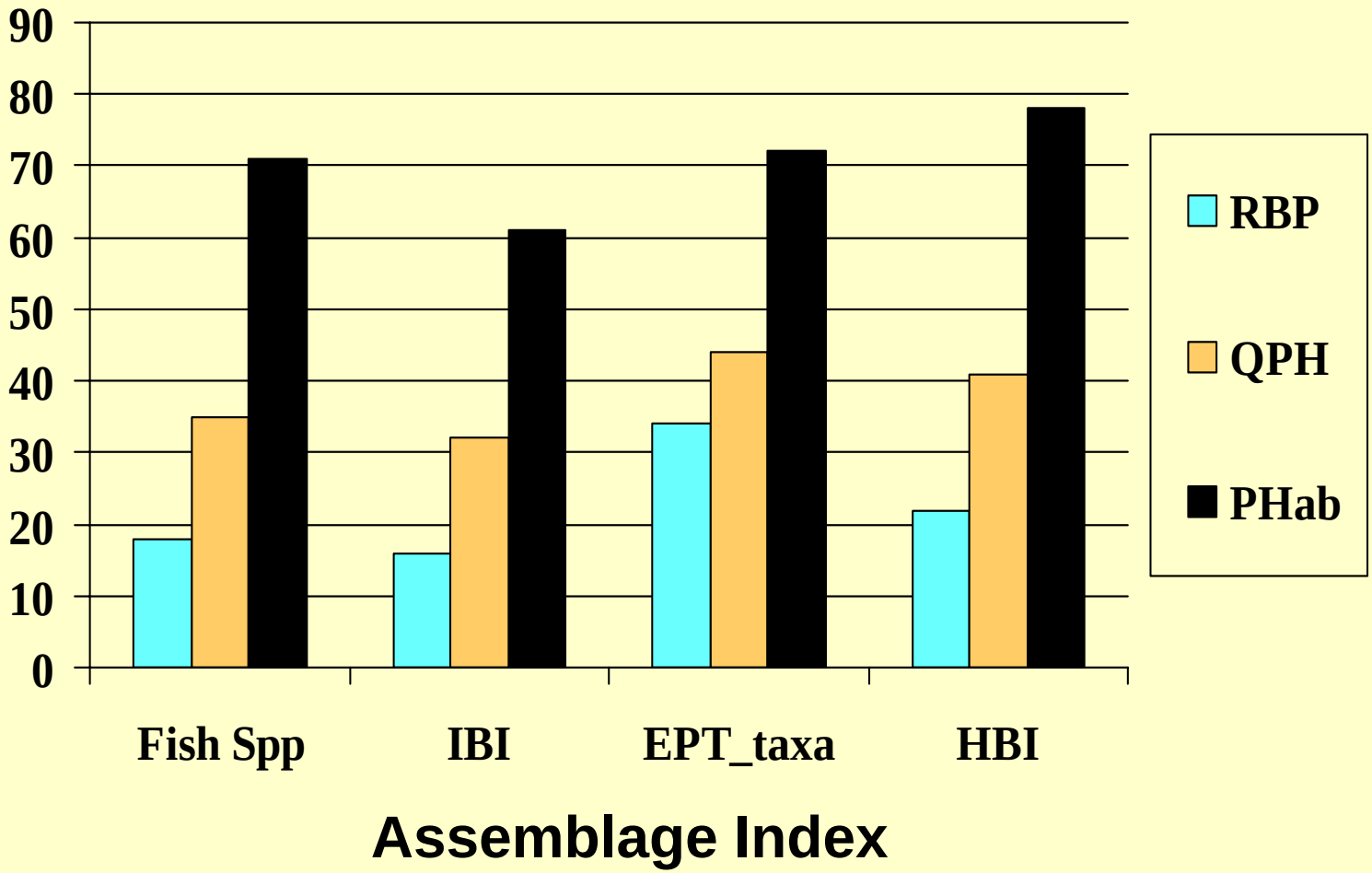
Effect of Measurement Precision on Maximum Observable Correlation (r) between Perfectly Correlated Variables.

Variable 1 $\sigma^2_{strm}/\sigma^2_{rep}$

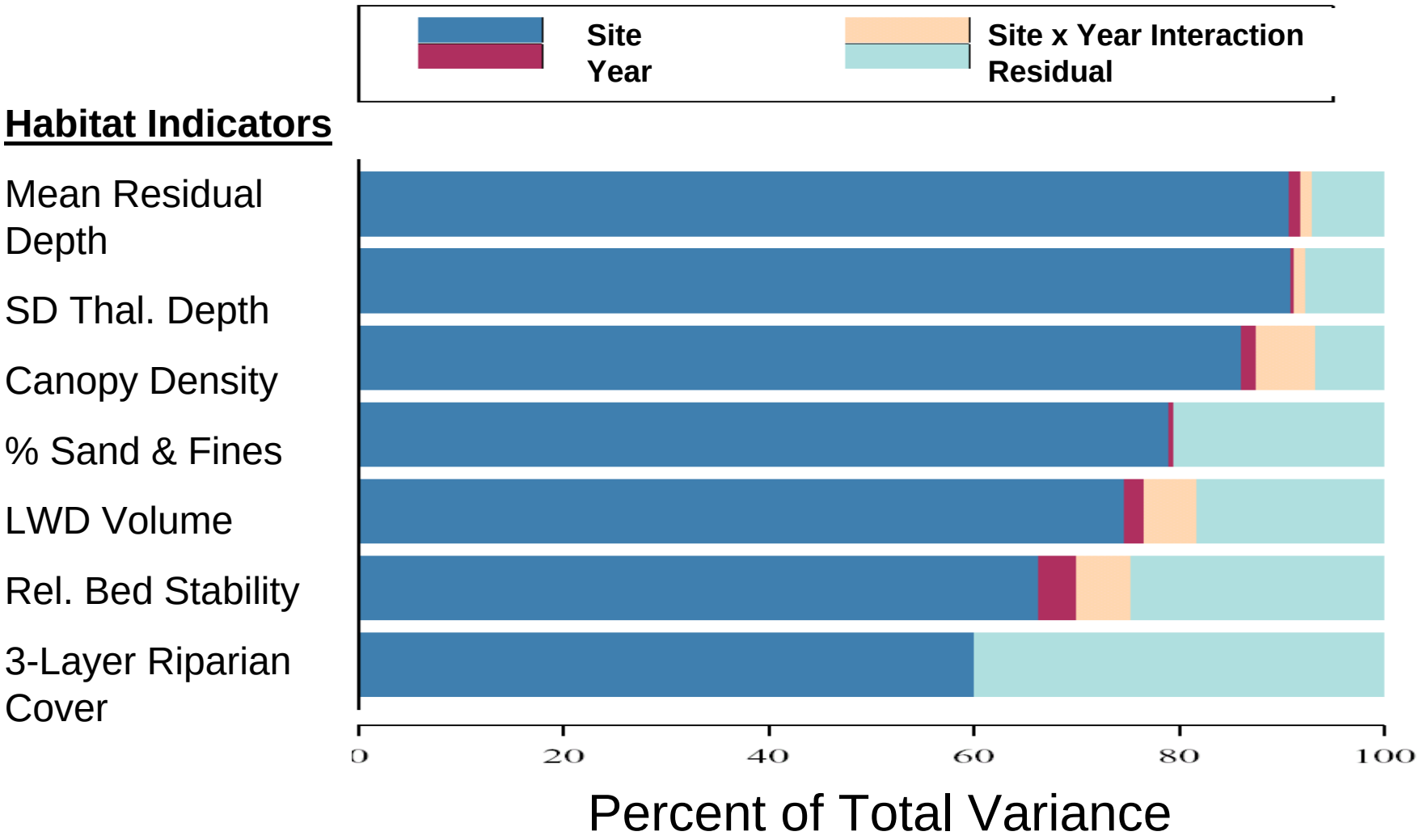
Variable 2 $\sigma^2_{strm}/\sigma^2_{rep}$

	1	2	3	5	10	25	50	100
1	.50	-	-	-	-	-	-	-
2	.58	.67	-	-	-	-	-	-
3	.61	.70	.75	-	-	-	-	-
5	.65	.75	.79	.83	-	-	-	-
10	.67	.78	.83	.87	.91	-	-	-
25	.69	.80	.85	.90	.93	.96	-	-
50	.70	.81	.86	.90	.94	.97	.98	-
100	.70	.81	.86	.91	.95	.98	.99	.99

% Variance Explained
Using Different Habitat Assessment Approaches



Partitioning Total Variance into Components



Trend Detection Potential

- **How long for 50 site network (sampled once/yr) to detect 2% and 1% per year trends?**

	2%	1%
- Std.Dev Thalweg Depth	8 yr	13 yr
- Mean Residual Depth	12	20
- % Sand & Fines	12	20
- % Embeddedness	12	20
- Relative Bed Stability	8	12
- Large Woody Debris Volume	16	25
- 3-Layer Rip. Woody Veg. Cvr.	8	12
- Canopy Density	8	14

PHYSICAL HABITAT INDICATOR DEVELOPMENT

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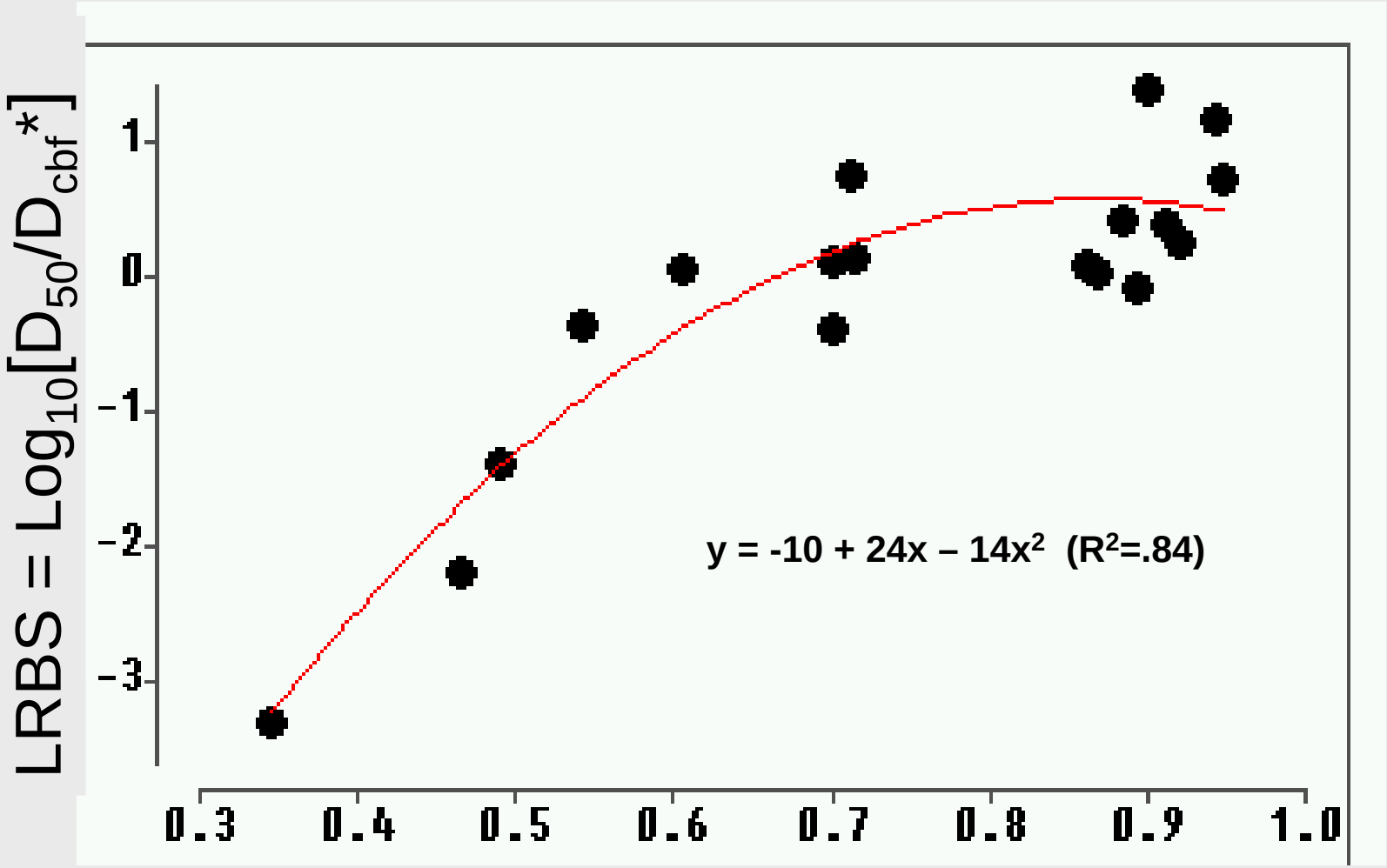
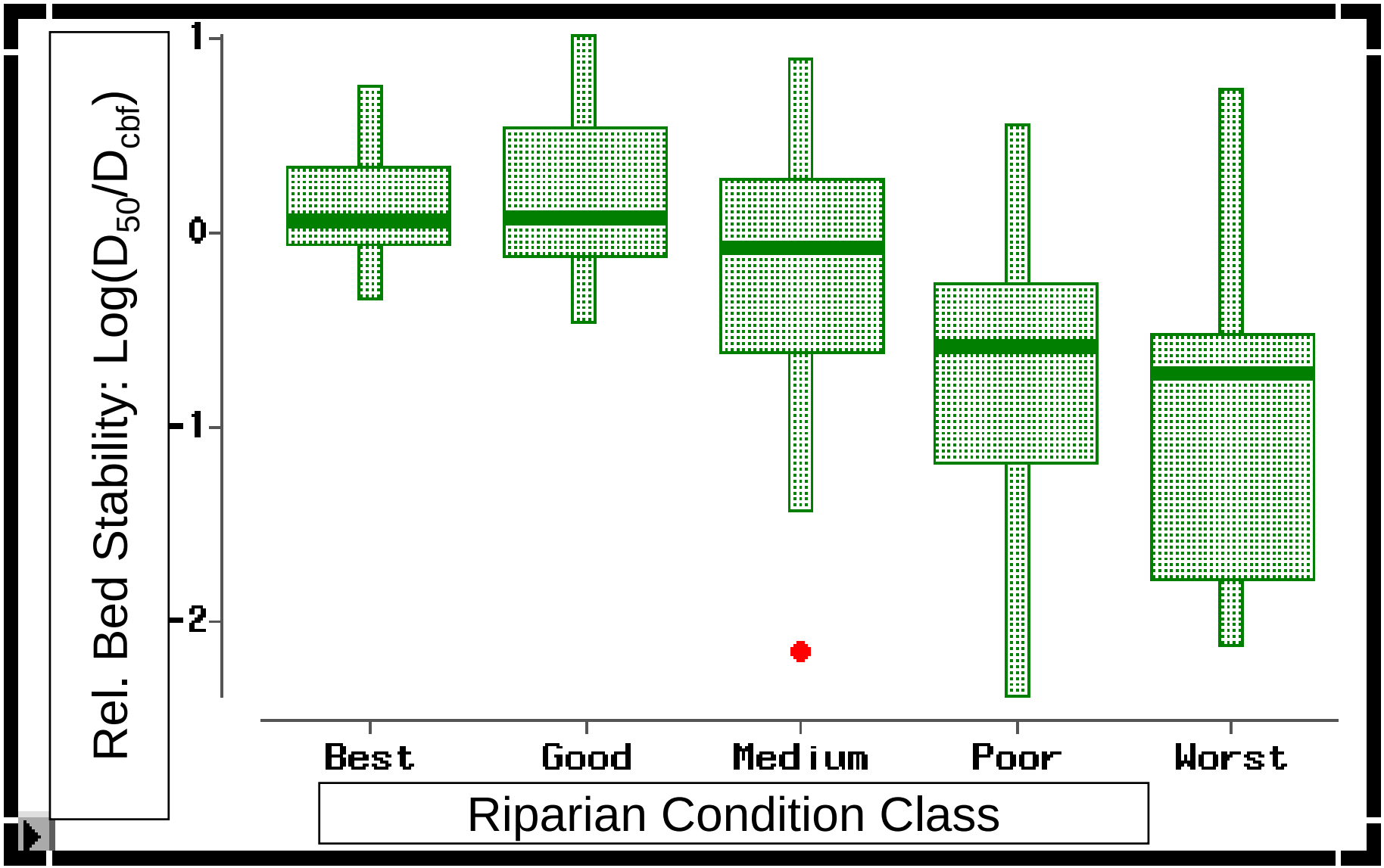
Riverbed Stability vs. Landscape Condition

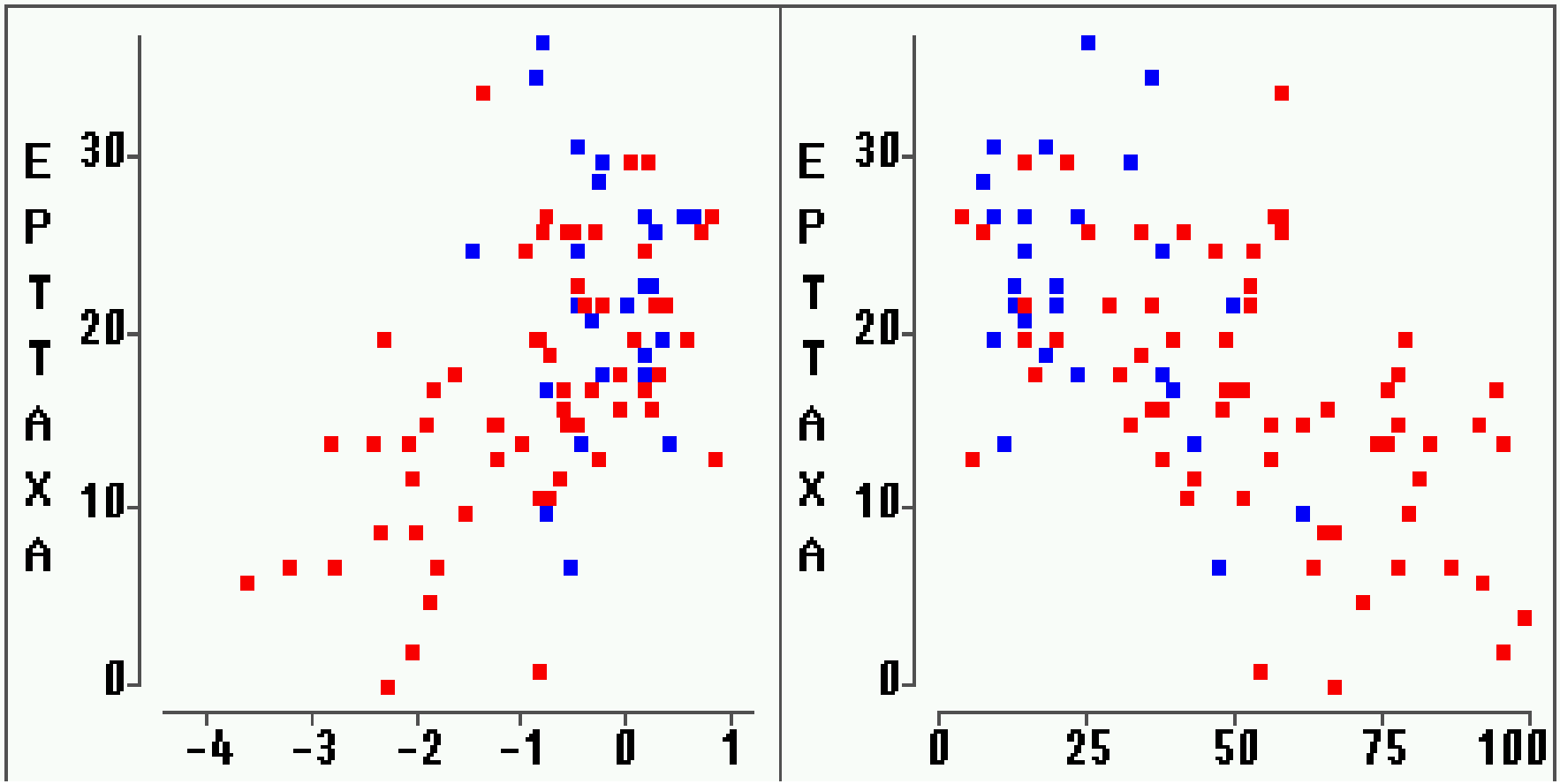


Substrate Stability vs. Riparian Condition



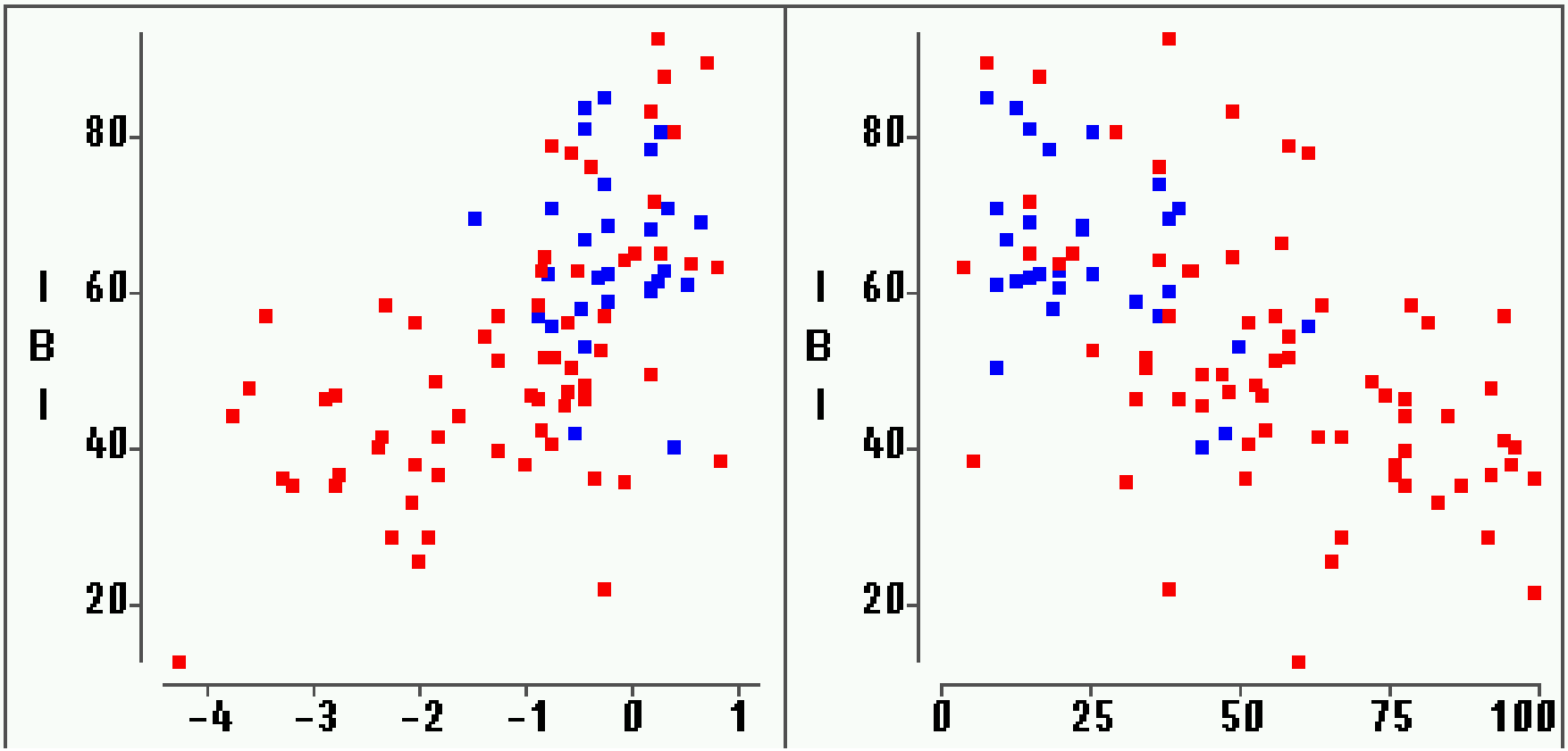
Aquatic Insects vs Channel Substrate

(blue=basalt red=sandstone)



Fish vs Substrate

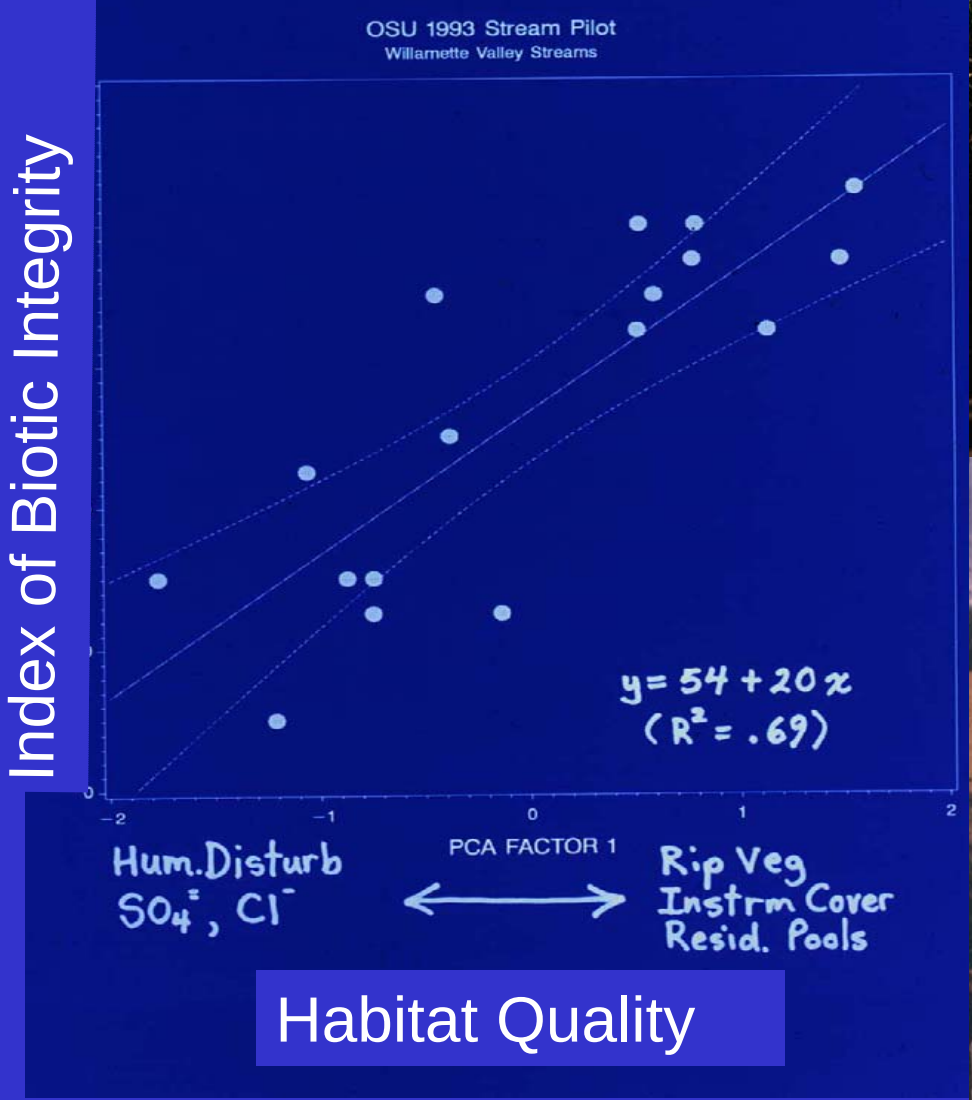
(blue=basalt red=sandstone)



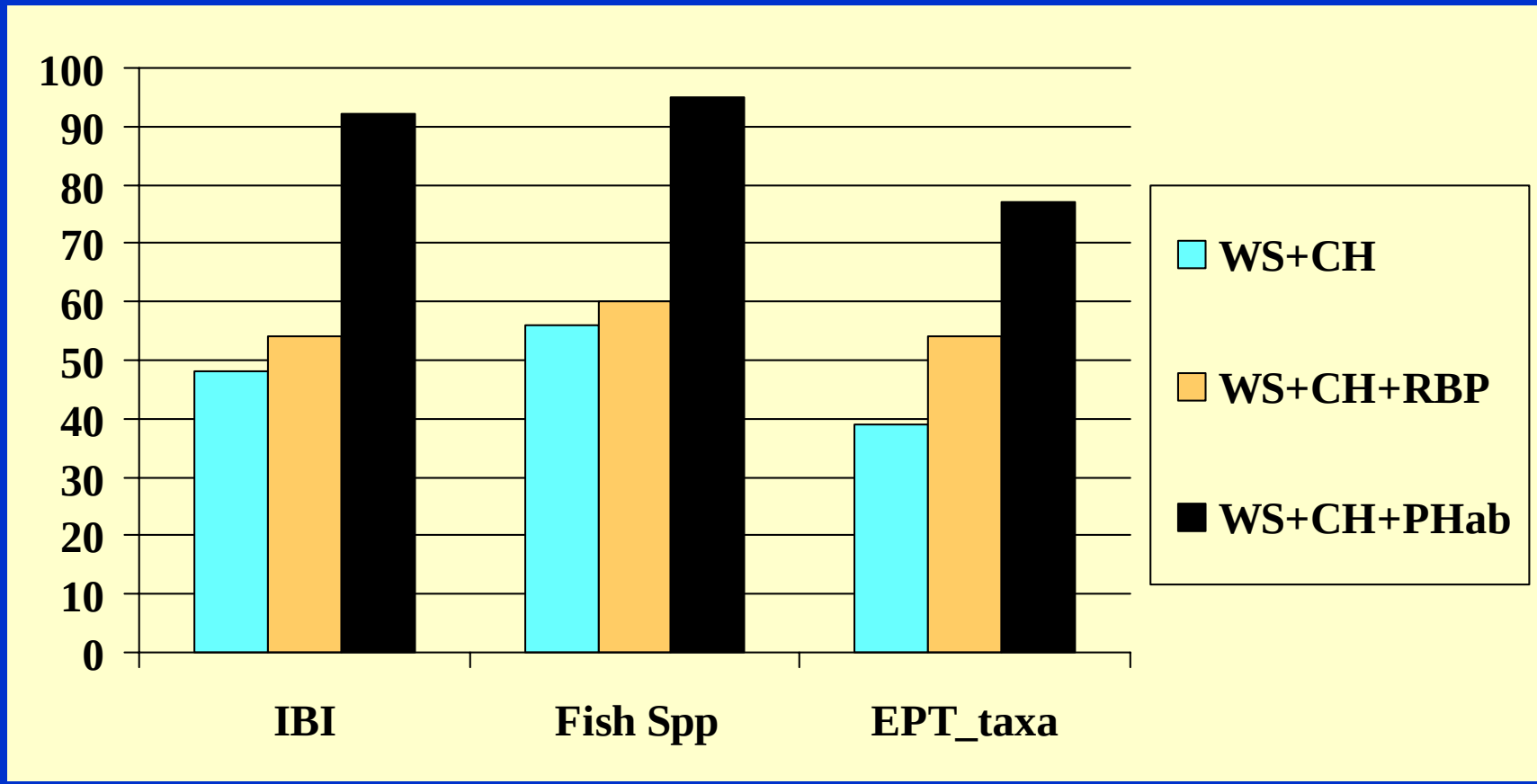
Log10(Relative Bed Stability)

%Substrate<2mm

Fish vs. Physical & Chemical Habitat



% Variance Explained Using Different Habitat Assessment Approaches



Assemblage Index

SUMMARY
EMAP Physical Habitat Field Protocol:

- Can be implemented in regional & local monitoring.
- Yields metrics with adequate precision for analysis of associations.
- Includes natural & anthropogenic metrics important to biota and diagnosis.