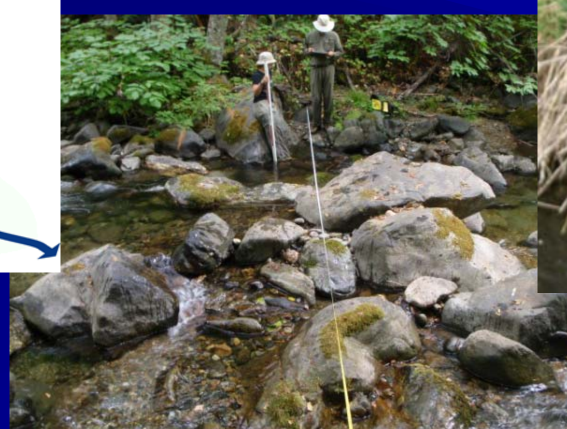
Stream Assessment & Monitoring in Appalachia

Appalachian Stream Mitigation Workshop
Lexington, Kentucky
April 11-15, 2011



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U.S. EPA Region 4

Appalachian Stream Assessment Protocols & Mitigation Guidelines

Kentucky
- KY MBI (KDOW)
- EKSAP (Corps)
- High-gradient HGM (Corps)
- Stream Relocation/Mitigation Guidelines (KDOW)

Ohio
- QHEI (OEPA)
- PHWH (OEPA)
- Compensatory Mit Requirements rev. 5 (OEPA)

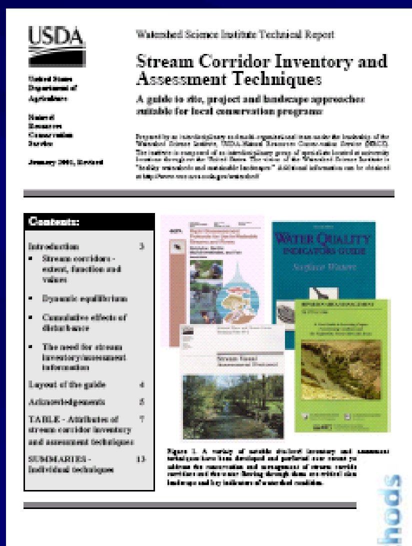
Tennessee
- Stream Mit Guidelines (TDEC)

Virginia
- VA SCI (VDEQ)
- USM (Corps, VDEQ)

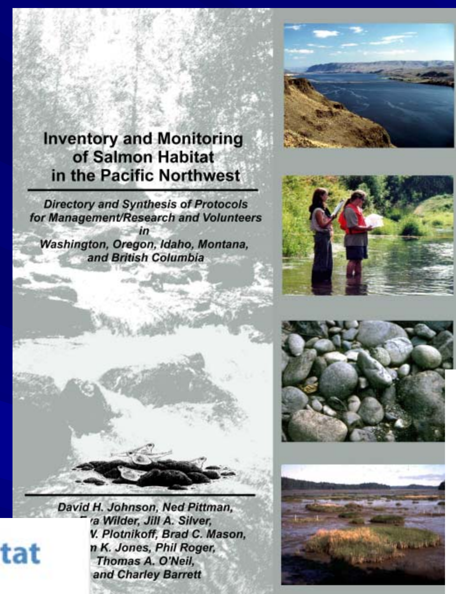
West Virginia
- WVSCI (WVDEP)
- SWVM (Corps, WVDEP)
- High-gradient HGM (Corps)

Other
- PA ICE (PDEP)
- Field Ops for…Headwater Streams (USEPA)

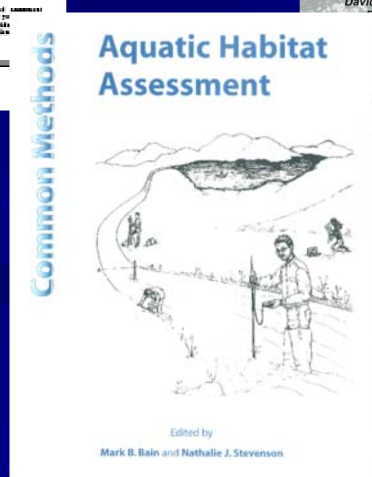
Compilations of Stream Assessment Methods



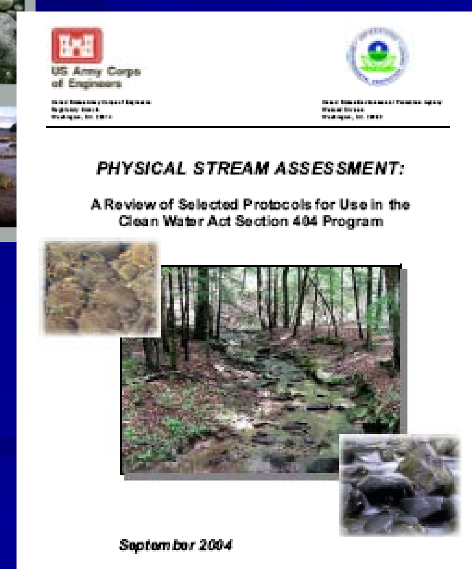
2001



2001

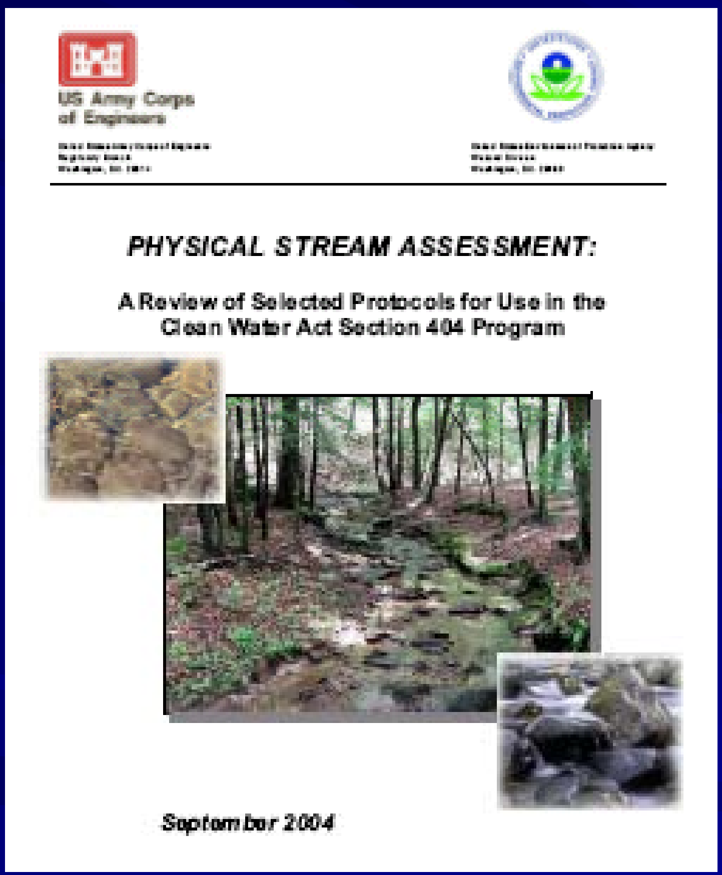


1999



2004

Stream Assessment Compendium 2004


US Army Corps of Engineers

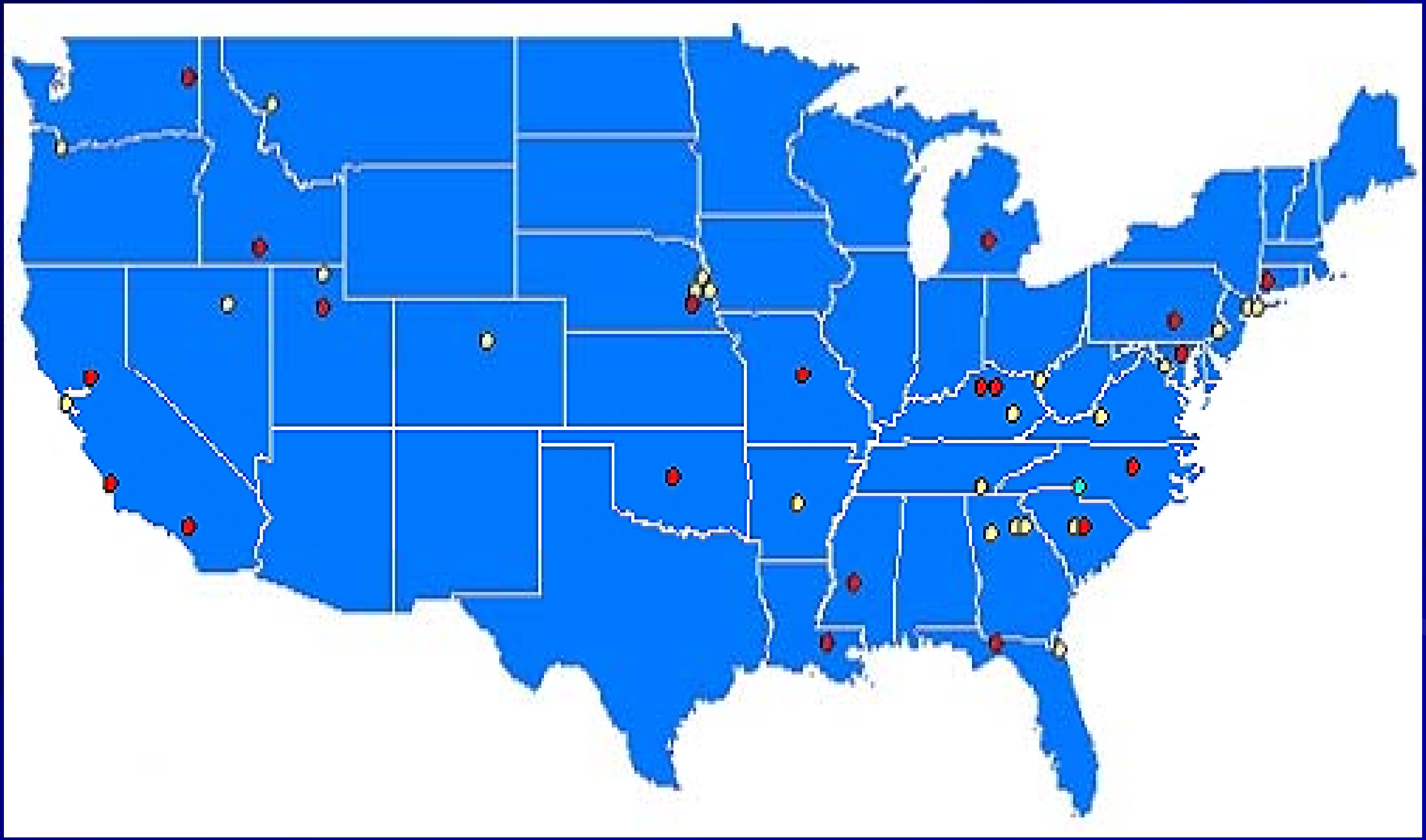
PHYSICAL STREAM ASSESSMENT:

A Review of Selected Protocols for Use in the Clean Water Act Section 404 Program

September 2004

- In support of the National Wetland Mitigation Action Plan.
- Part A: Questionnaire to State and Federal agencies nationwide;
- Part B: Reviewed over 50 existing physical stream assessment & mitigation protocols nationwide;
- Identified:
  - Target scale,
  - Geographic applicability,
  - Level of effort required,
  - Level of expertise required, &
  - Potential utility in the CWA 404 regulatory program.

Stream Assessment Questionnaire Responses 2004



Question	Most Common Responses	
Programmatic Uses for Stream Assessment	Watershed Assessment, Environmental Impacts, Prioritization for Management; Regulatory (CWA 401/404).	60% ± 36%
Classification	Rosgen; Montgomery & Buffington Other (e.g. Strahler stream order)	26% 4% 8%
Common Physical Channel Parameters	Channel cross-sections, Longitudinal profile, "Rosgen" geomorphic assessments; Pebble counts, Pfankuch channel stability	25% ± 15%
Common Physiochemical WQ Parameters	Water temperature; Turbidity, pH, DO, Specific conductance.	52% 30% ±
Methods to Reduce Variability	Training (classroom + field); Standardized protocols, Multiple investigators; Repeat site visits;	40% 17% 9%
Time Required in the Field	<1 hour 1-2 hours >2 hours Variable	13% 21% 25% 11%
Future Needs	National stream assessment database; Fluvial sediment and effects thereof; Standardized protocols; Continued or expanded USGS gauge data; Expanded availability of regional curves.	56% 54% 19% 17% 15%

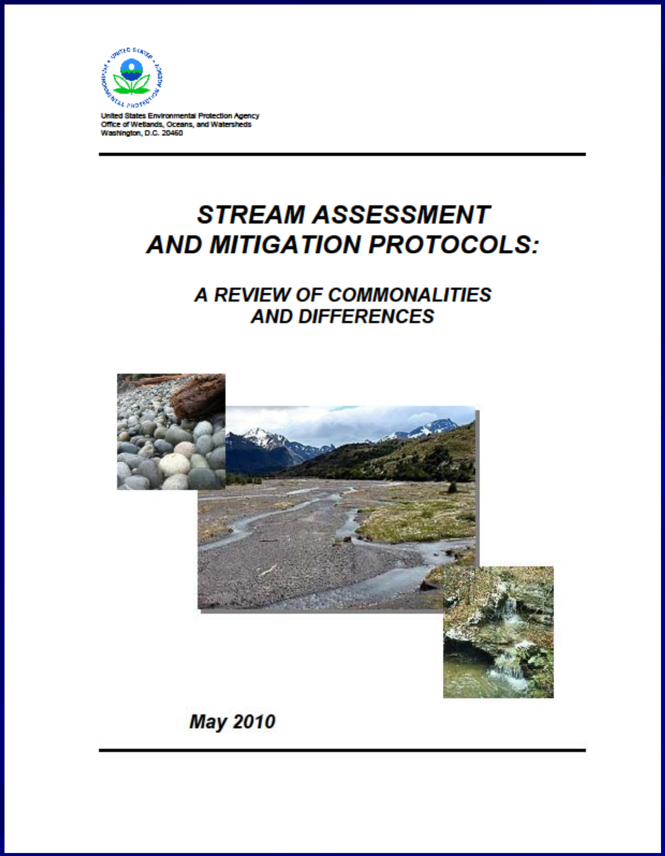
Recommendations 2004

- Classification
  - Narrow the range of natural variability by classifying streams based on physical, chemical, and/or biological attributes.
- Objectivity
  - Minimize observer bias via well-defined procedures based on objective measures of explicitly defined variables.
- Quantitative Methods
  - Maximize use of quantitative measures; Base condition indices on explicit values or narrowly defined ranges of quantifiable stream characteristics.
- Fluvial Geomorphology
  - Emphasize fluvial geomorphic variables where physical channel instability is of concern.
- Data Management
  - Stream assessment data, esp. reference data, should be managed and made publically available on national or regional databases.

Final Mitigation Rule, 2008

- Compensatory mitigation:
  - Capable of compensating for lost aquatic resource functions;
- Site Selection:
  - Site must be ecologically suitable for providing the desired aquatic resource functions;
- Baseline Information:
  - Describes the ecological characteristics of the site(s);
- Ecological Performance Standards:
  - <u>Objective and verifiable</u> attributes based on the best available science / Encourages use of reference sites; and
- Monitoring:
  - Necessary to determine if the project is meeting performance standards.

Compendium Revisited 2010



- Review of 32 nationwide stream assessment protocols & mitigation guidance documents (25 non-reg, 7 reg);
- Criteria for Review:
  - Contemporary use;
  - Stream-reach scale;
  - Multiple attributes/parameters;
  - Emphasis on objectivity.
- Identified:
  - Stream functions or conditions evaluated,
  - Parameters/attributes assessed,
  - Intensity of effort and training required, &
  - Use and source of reference condition information.

Compendium 2010:
Assessment Parameters

32 protocols - - 70 unique parameters

Only 8 parameters common ≥ ½ of protocols:

Stream discharge	Water temperature
Channel sinuosity	Bank stability
Riparian canopy cover	Benthic macroinverts
Substrate PSD*	Habitat units/bed forms*

*common to ≥ ⅔ of protocols

25% of parameters common to <10% of protocols.

Compendium 2010:
Stream & Riparian Zone Functions

- 15 key functions in 5 categories (Fischenich, 2006)
  - System Dynamics
  - Hydrologic Balance
  - Sediment Processes & Character
  - Biological Support
  - Chemical Processes & Pathways
- Descriptions, Indicators, & Direct Measurements

Interrelationships:
Functions Affecting the Most Other Functions

Function (*Category*)	Functions Directly Affected	Functions Indirectly Affected
Maintain stream evolution processes (*System Dynamics*)	12	2
Surface water storage processes (*Hydrologic Balance*)	8	6
General hydrodynamic balance (*Hydrologic Balance*)	13	1
Support biological communities & Processes (*Biological Support*)	5	7

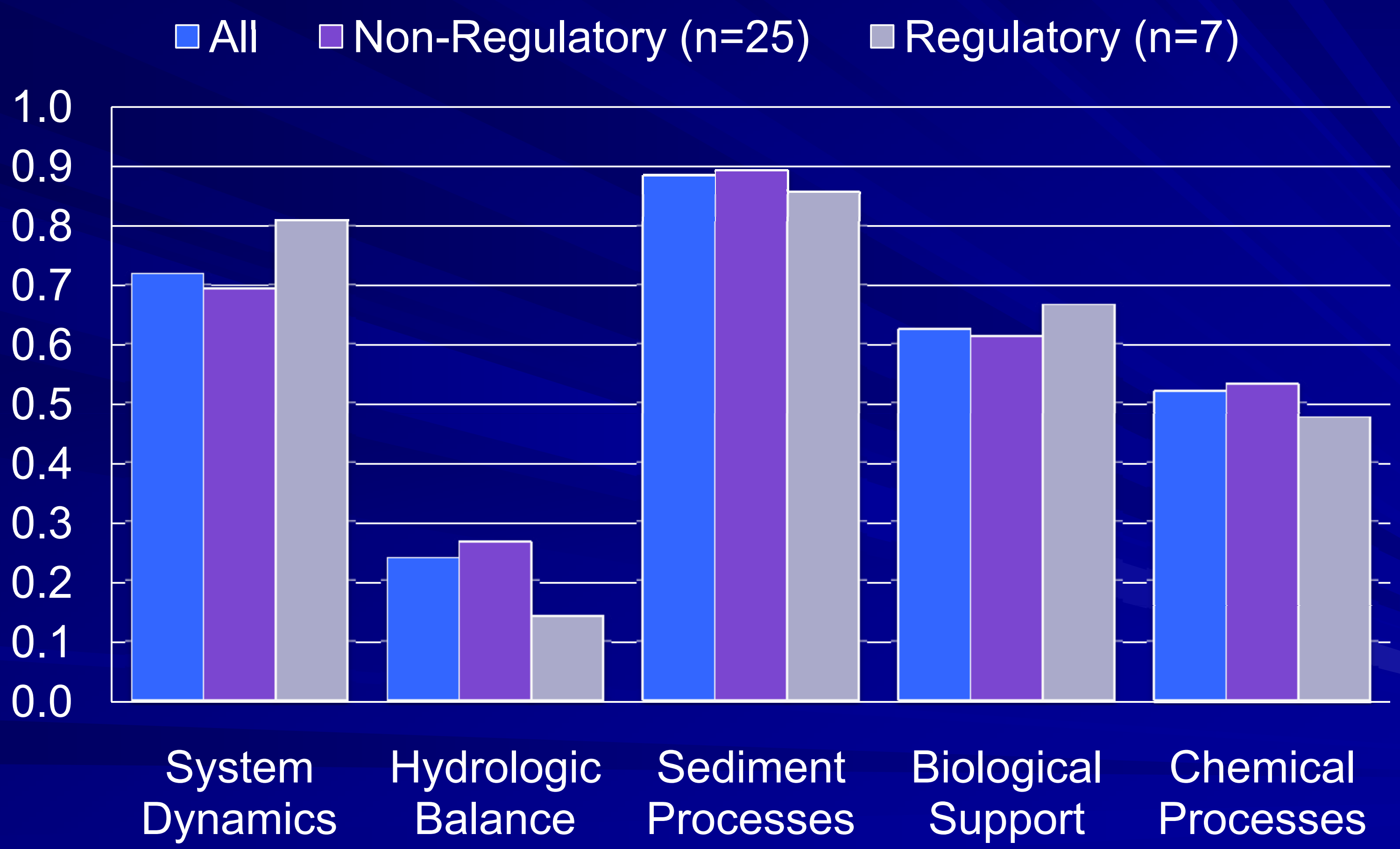
Adapted from Fischenich, 2006.

Interrelationships:
Functions Affecting the Fewest Other Functions

Function (*Category*)	**Functions Directly Affected**	**Functions Indirectly Affected**
Provide necessary aquatic & riparian habitat (*Biological Support*)	3	0
Maintain trophic structure & processes (*Biological Support*)	3	1
Maintain chemical processes & nutrient cycles (*Chemical Processes & Pathways*)	3	1

Adapted from Fischenich, 2006.

Compendium 2010:
Protocols' Representation of Primary Functions



Influence: 28/4 25/11 22/11 11/8 11/3

Recommendations 2010

- Interagency / Interdisciplinary Teams
  - During compilation of new or revised assessment protocols, monitoring standards, mitigation guidelines, etc.
  - Consider inclusion of resource management agencies (USFS).
- Function-based
  - Incorporate considerations of ecosystem function first, then identify representative indicators or parameters. Not *vice versa*.
- Data Management
  - Establish central or regional repository for stream assessment data, esp. reference data, INCLUDING REGIONAL HYDRAULIC CURVES.

    This recommendation was also made in the Corps/EPA Stream Assessment Compendium in 2004, and was the most common request of surveyed practitioners at that time.

    Neither Corps, nor EPA web sites are very thorough at identifying local or regional resources available to practitioners.

Criteria for Monitoring Parameters & Protocols

Criteria	Description
Relevance	(1) Driven by objectives; (2) Well grounded in scientific theory; and (3) Accurately reflect or support the true measure of the condition or function proposed to be represented.
Sensitivity / Resolution	Must be sensitive to the degree of change anticipated over the life of the monitoring period, and capable of differentiating among natural variability.
Repeatability	Minimal observer bias and sampling error: (1) Objective & quantifiable; (2) Directly observed or measured; and (3) Detailed standardized methods.
Comparability / Transferability	Data should meet QA/QC requirements of other programs or agencies.
Operationally Efficient	Capable of being accurately and effectively measured in the field within logical time, labor, and budgetary constraints ~ Cost effective.

Sources: ITFM, 1995; Poole et al, 1997; Johnson et al., 2001, Oakley et al., 2003; McKay et al., 2010

RBP Rapid Habitat Assessment

Over 30 States fail to include any quantitative measurements of stream habitat in their biological assessment programs (USEPA, 2002).

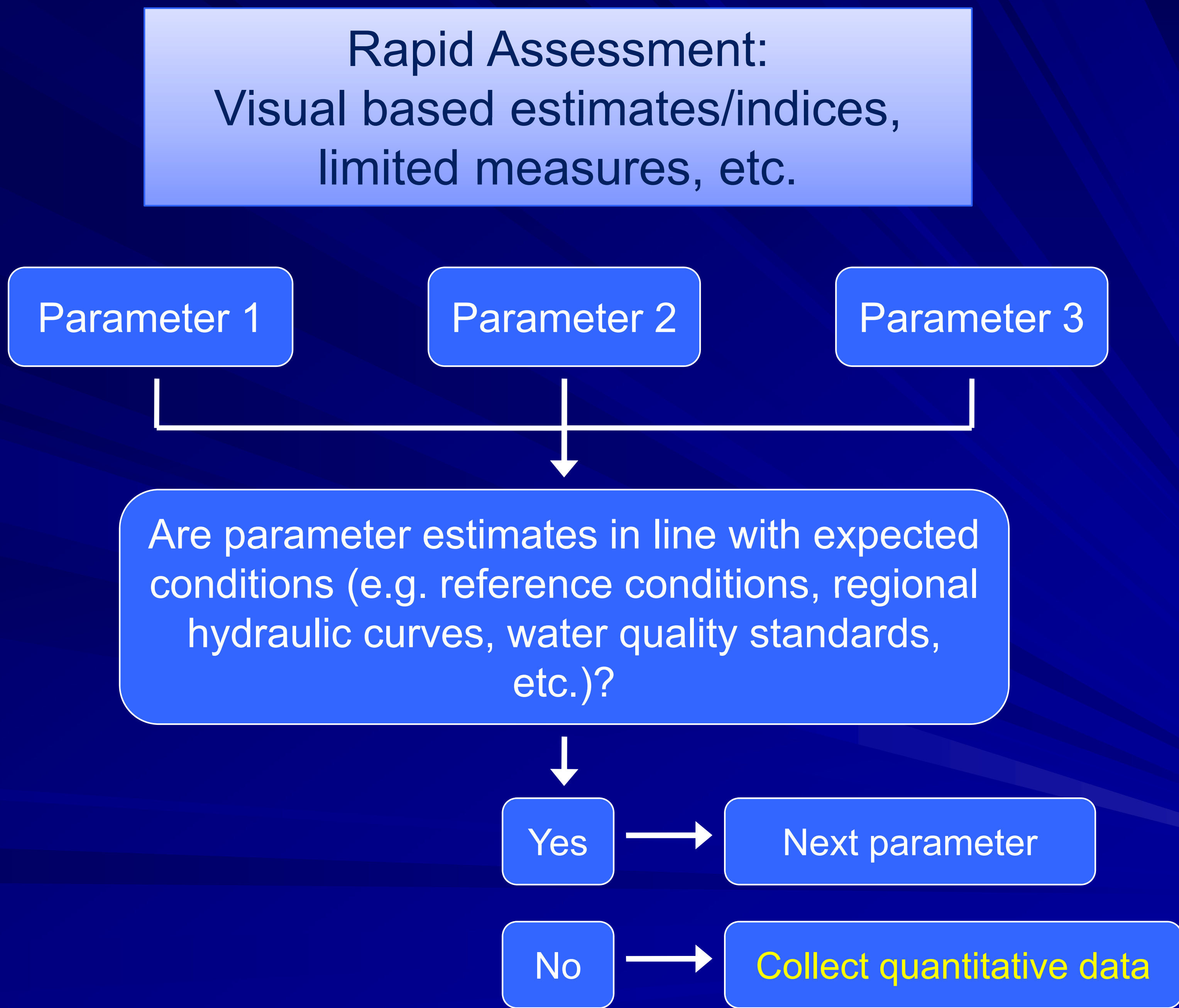
Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Rapid Habitat Assessments: Sources of Potential Error

- Observer bias
  - Knowledge/expertise, experience, etc.
  - Desired outcomes, personal or professional sentiment
    - e.g. Influence of mitigation ratios or success criteria that are defined by classes instead of sliding scales.
- Seasonality / Annual variability
  - Seasonal low baseflow; Regional climatic trends.
- Recent Precipitation
  - Mobilization is expensive & weather is unpredictable.
- Geomorphic position
  - Headwater streams vs. higher order streams.

PRELIMINARY SITE ASSESSMENT



Estimates vs. Measures

RBP Habitat Parameter	Potential Objective Measures
1. Epifaunal substrate / Available cover	Coarse woody debris inventory; particle size distribution (PSD); percent dominant substrate
2. Embeddedness	Measured %-age of embedded depth; depth to embeddedness ; PSD
3. Velocity/depth regime	Longitudinal profile; bed form inventory; velocity:depth ratio
4. Sediment deposition	PSD; channel cross-sections; residual pool depth
5. Channel flow status	Channel cross-sections + wetted widths
6. Channel alteration	Channel cross-sections; bank height ratio; meander width ratio; sinuosity
7. Frequency or riffles	Longitudinal profile; bed form inventory;
8. Bank stability	Percent eroding banks; BEHI; erosion pins; channel cross-sections
9. Vegetative protection	Percent coverage & density
10. Riparian zone width	Riparian width per cover type

Reviewing Stream Assessment Data: Red Flags

- Climatic summary
  - Regional trends (12 months, 6 months, 3 months), local records (30 days, 14 days, 7 days);
- Detailed maps / site coordinates
- Methodology
  - Applicability (scale, setting, objectives, etc.),
  - Assumptions & limitations of the method(s);
- Generalizations
  - Unsupported assumptions or conclusions;
- Raw data / tabulations
  - QA/QC, data assessment & interpretation.

Stream Mitigation Success Criteria

Geomorphic

- Subjective: Stable channel bed and banks with no significant bank erosion.
- Objective: Geomorphic dimensions remain within the max/min design ranges based on reference (e.g. W_{bkf}, d_{bkf}, d_{mbkf}, A_{bkf}, W/D, BHR, ER, K, etc.).

Habitat

- Subjective: Enhance aquatic habitat / Increase rapid habitat assessment score.
- Objective: Variables remain within the max/min design ranges based on reference (e.g. residual pool depth, max pool depth, pool spacing, riffle spacing, CWD volume, riffle PSD, etc.).

Stream Mitigation Success Criteria

Chemical / WQ

- Subjective: Improve water quality downstream.
- Objective: Parameter specific targets based on designated use and State WQ Standards or other site/regional specific numeric criteria.

Biological

- Subjective: Improve diversity of fisheries and other aquatic life.
- Objective: Improve IBI and/or MBI scores by:
  - 15% over baseline if baseline scores are Very Poor, Poor, or Fair;
  - 10% over baseline if baseline scores are Good.

ILF Funding

Kentucky

– NKU $13.2 million 1999-2010

– KDFWR $70.3 million 2002-July 2010

Tennessee

– TSMP $36 million 1999-2010

Virginia

– VARTF $53.4 million 1995-2009 ($22.8 million for stream impacts)

West Virginia

– WVDEP $5.1 million 2006-2010

Closing Remarks: Stream Assessment

Fast, Cheap, & Accurate;

- Pick any 2, but only 2.

Be cautious of the "lowest common denominator;"

- A single protocol can rarely be all things for all people or purposes.

Be wary of ecosystem trading;

- Value judgments can lead to conflicts among parties with disparate interests;

Identify controlling variables that influence (& can represent) structure & function;

Conceptualization, testing, revision, oversight, & <u>training, training, training</u>!

Closing Remarks:
Stream Mitigation

If success criteria are poorly defined, only the poorest projects will fail to meet them.

Mathematical equivalency does not necessarily equate to productive functional stream mitigation;

10,000 feet of a poor quality stream may not effectively mitigate the impacts to 1,000 feet of higher quality stream.

Failure of mitigation projects (or failure to adequately document the efficacy of them) costs money, time, public support, agency credibility…

Stream Restoration is...

Technically complex,
Socially sensitive,
Publically misunderstood,
Politically scrutinized.

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