

Regional Assessments of Ecological Integrity: Sensitivity of Inferences to Data Sources, Scoring and Aggregation

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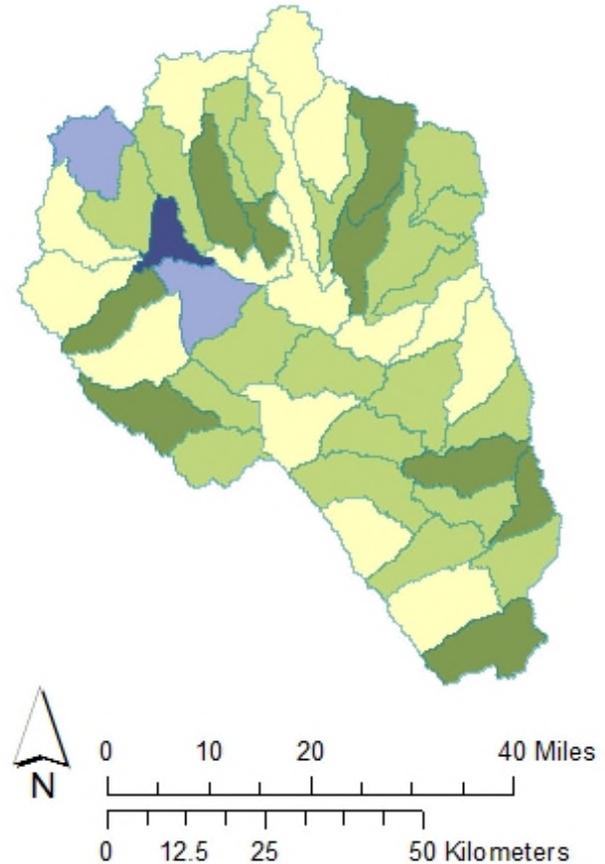
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Common watershed management questions

- Where to prioritize conservation, restoration or development actions?
- Where do problems exist?
- How does one watershed compare to another?
- What is the vulnerability of watersheds to development, climate change or drought?

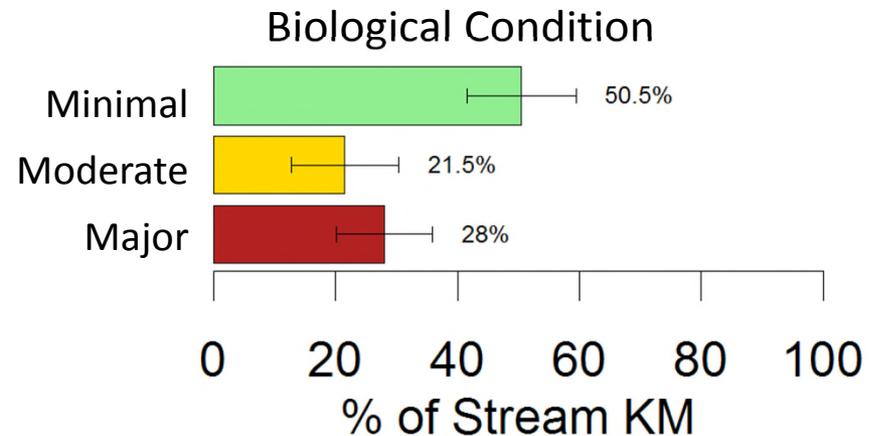
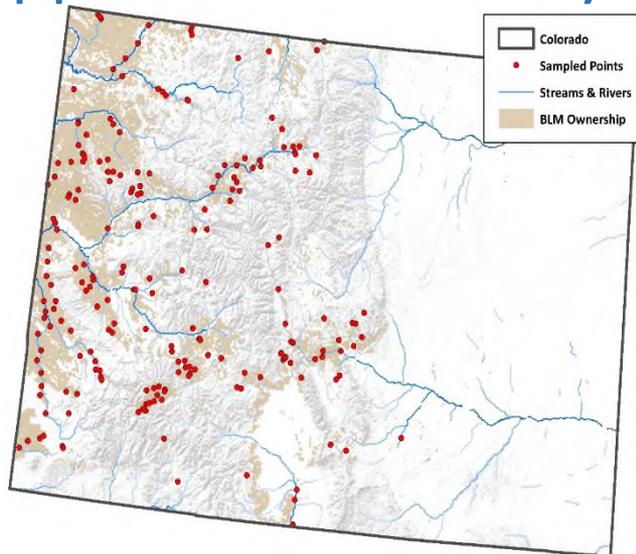


Traditional approaches to stream assessment

- Reach-based assessments

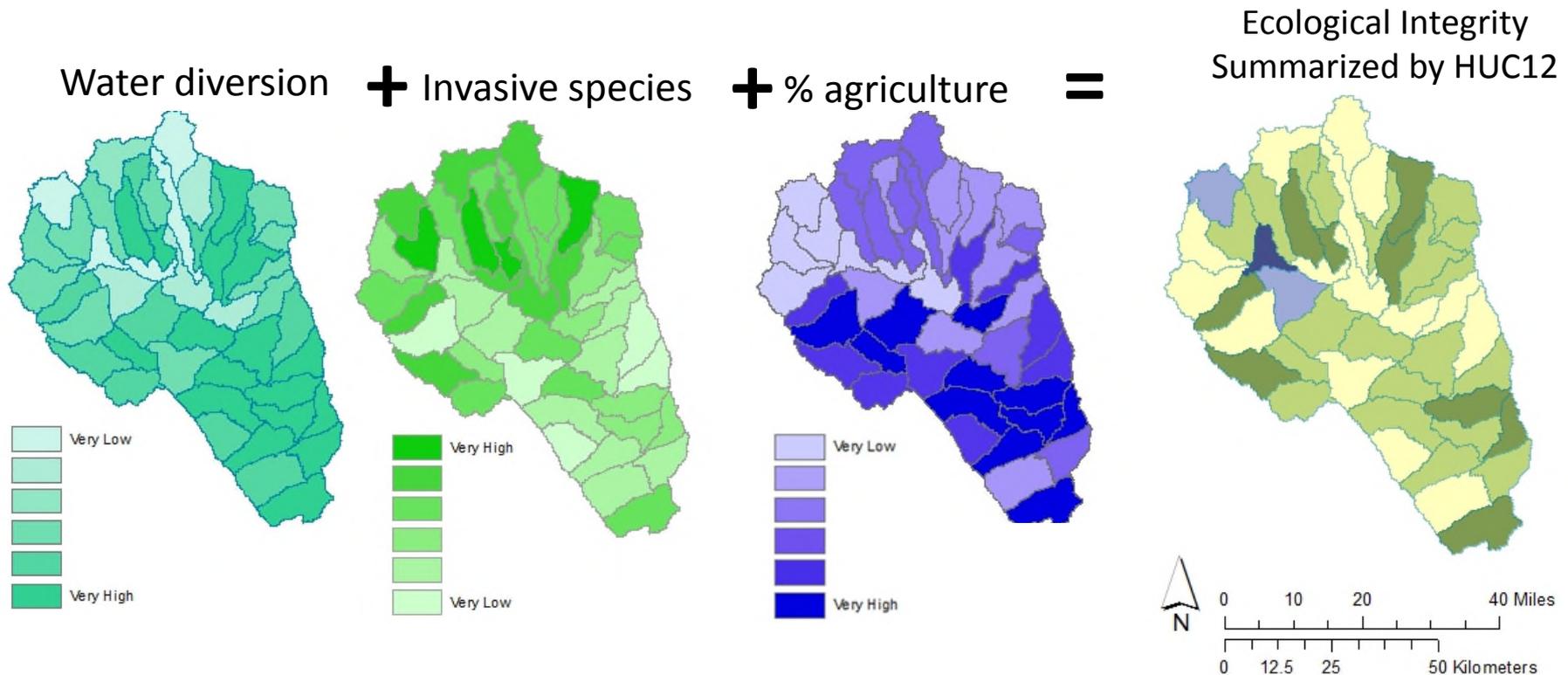


- Application of survey-based statistics to scale results



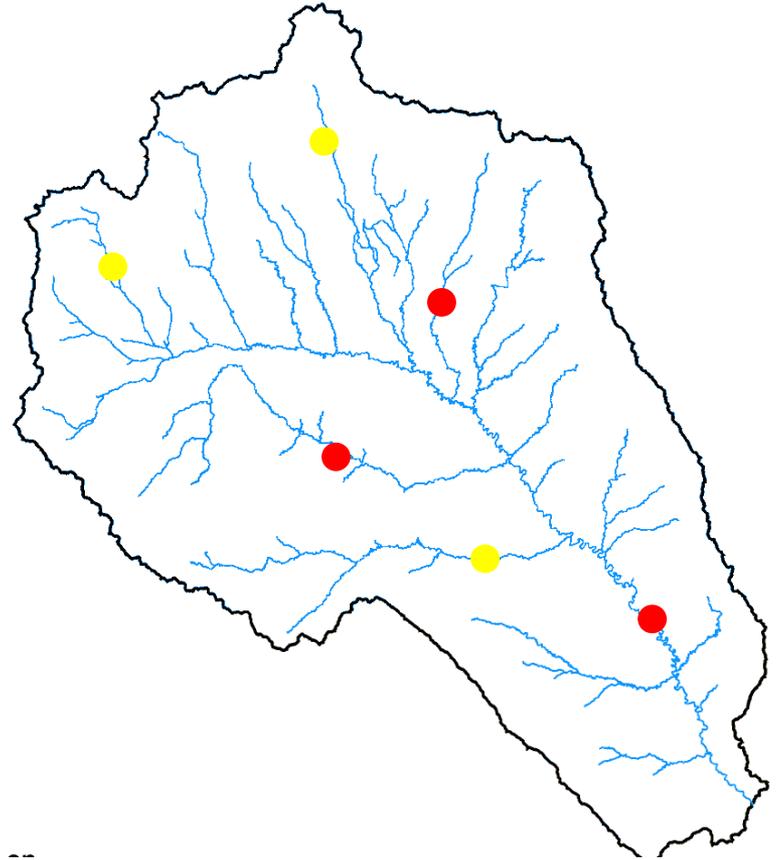
Regional assessments defined

- Geospatial analyses to *infer* ecological integrity from readily available measurements of land uses and surface disturbances



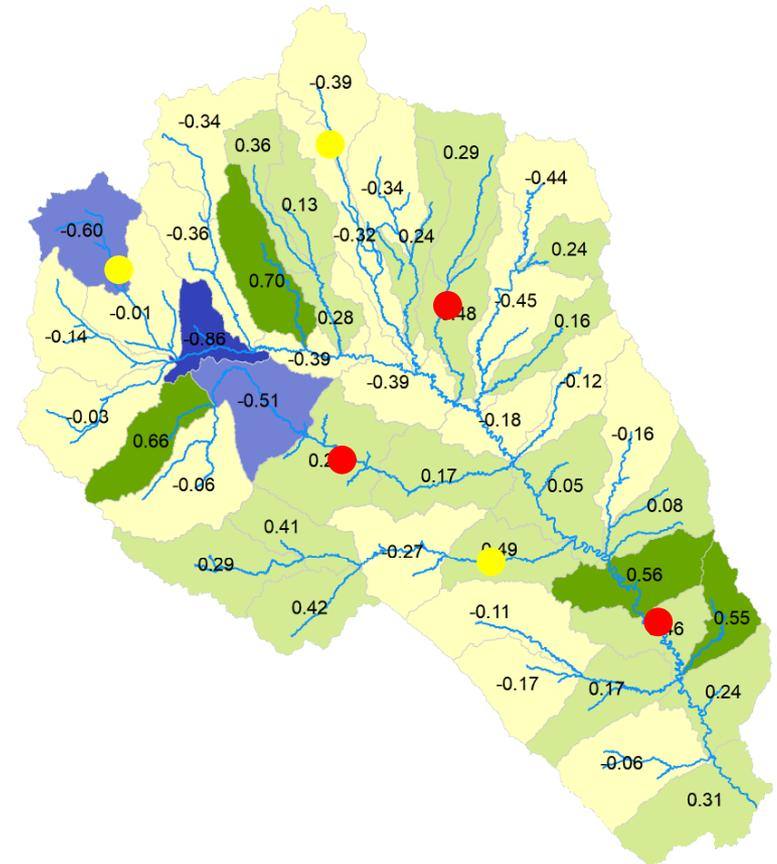
Regional assessments: Assessment & planning

- Need for spatially contiguous maps of resource condition
- Some attributes not easily measured at the reach-scale
- Vulnerability and causal assessments
- Cost is right



Regional assessments: Assessment & planning

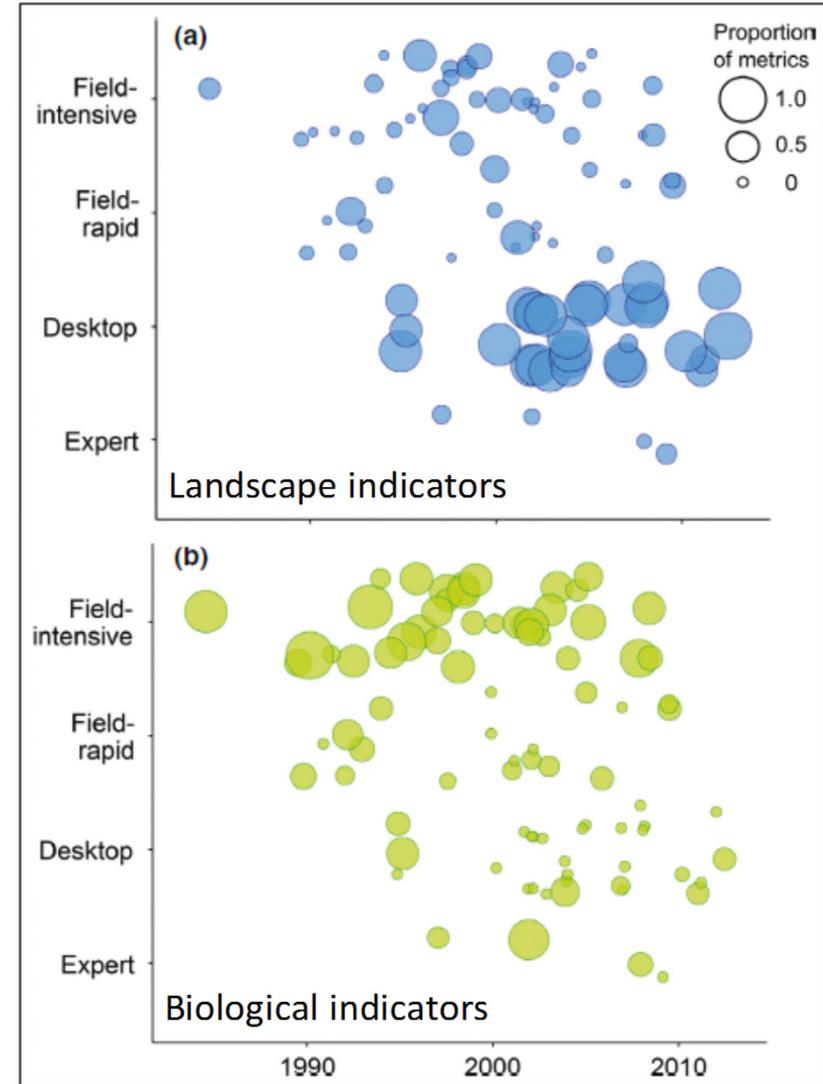
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Regional assessments: Rising popularity

- Increasing use of regional assessments
- Know very little about how they work and merit as assessment and planning tool

Trends in types of indicators to assess ecological integrity (Kuehne et al. 2017)



Study objectives

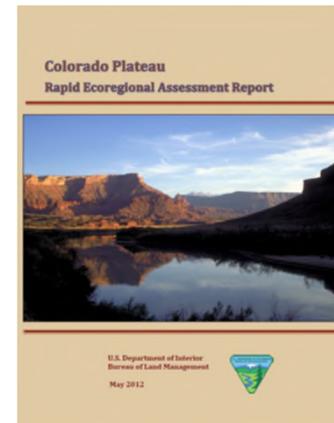
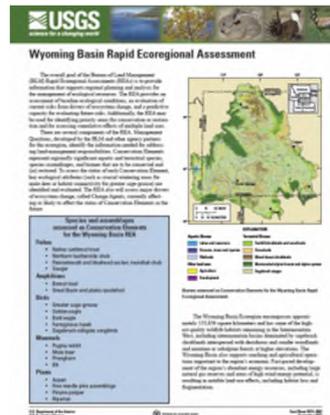
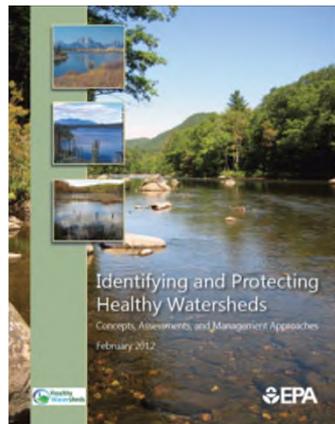
- Review regional assessments of ecological integrity – focus on streams and rivers
- Use case studies to compare how differences in data types, methods of scoring and aggregation affect assessment results
- Suggest best practices for the evolution and application of these tools

Methods

- Conducted literature review of regional assessments
- Rubric for comparing regional assessments
 1. Stated objectives, geographic scope & reporting units
 2. Types of input datasets
 3. Methods of data scoring and aggregation

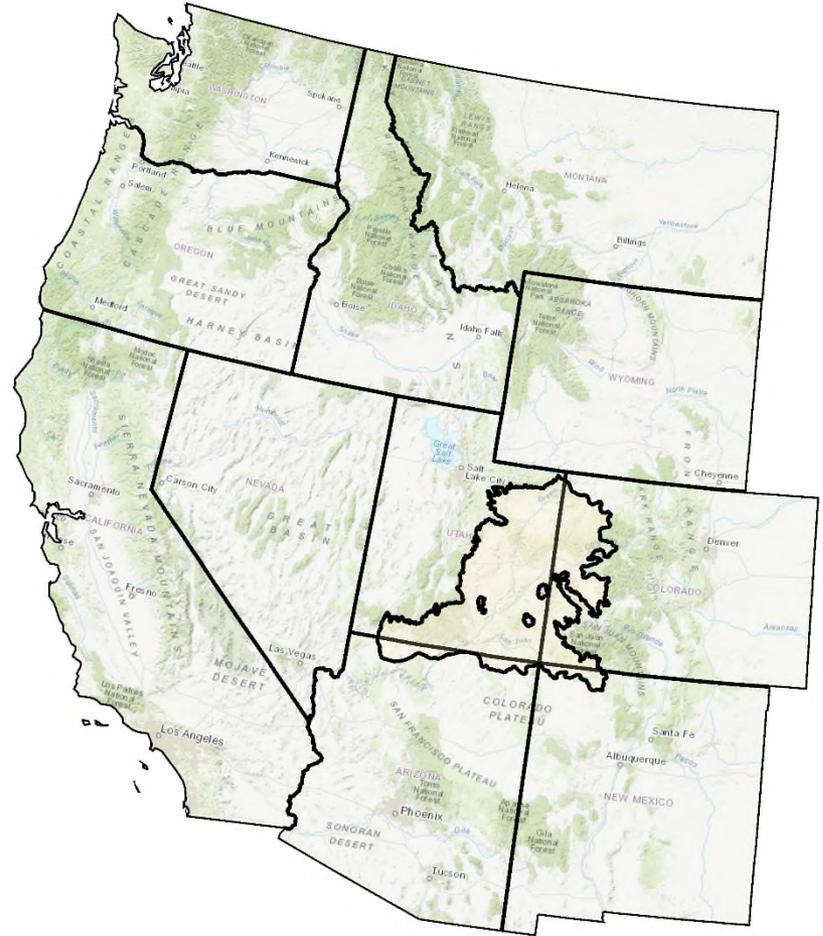


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Case studies: 3 regional assessments

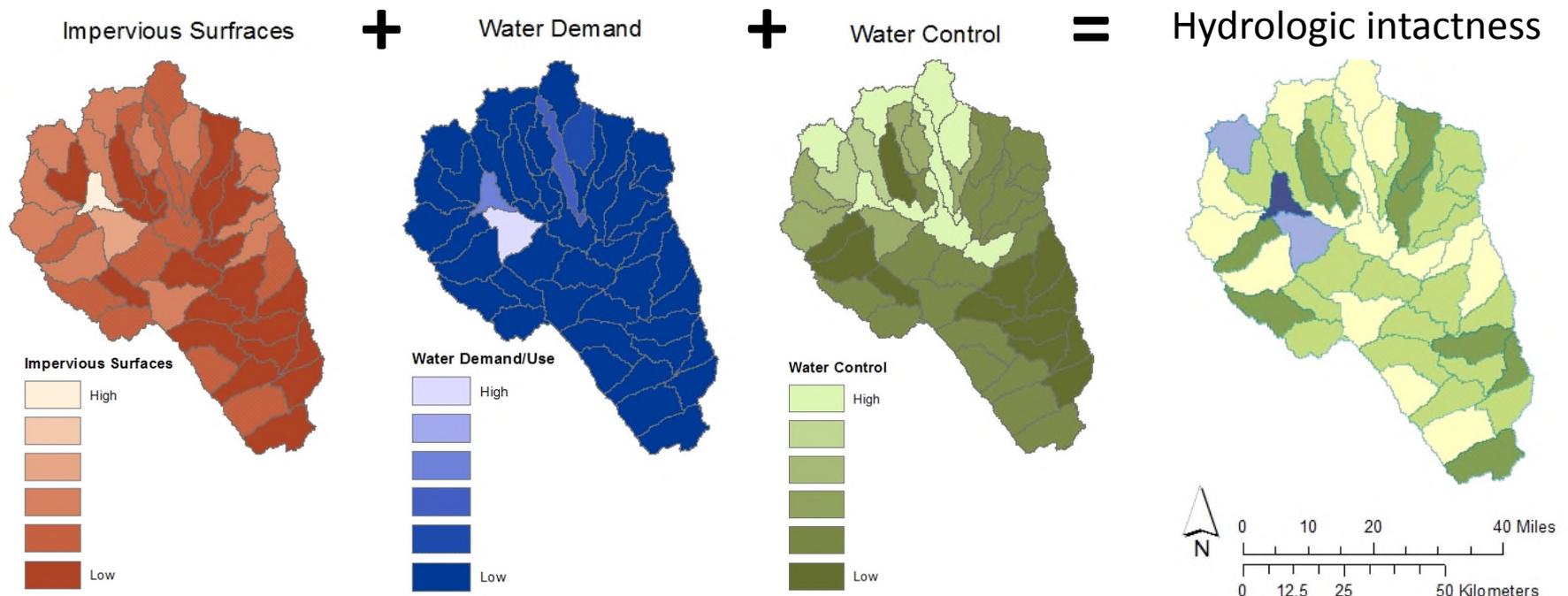
- BLM's Rapid Ecoregional Assessment (REA) – Strittholt et al 2012
- Trout Unlimited Conservation success Index (CSI) – Williams et al 2007
- Anthropogenic Threat Index (ATI) – Whittier and Sievert 2014



Case study assessment objectives

Watershed integrity: the capacity of a watershed to support and maintain the full range of ecological processes and functions (Flotemersch et al. 2015)

Aquatic Intactness: absence of anthropogenic activities that influence key ecological processes, functions and services



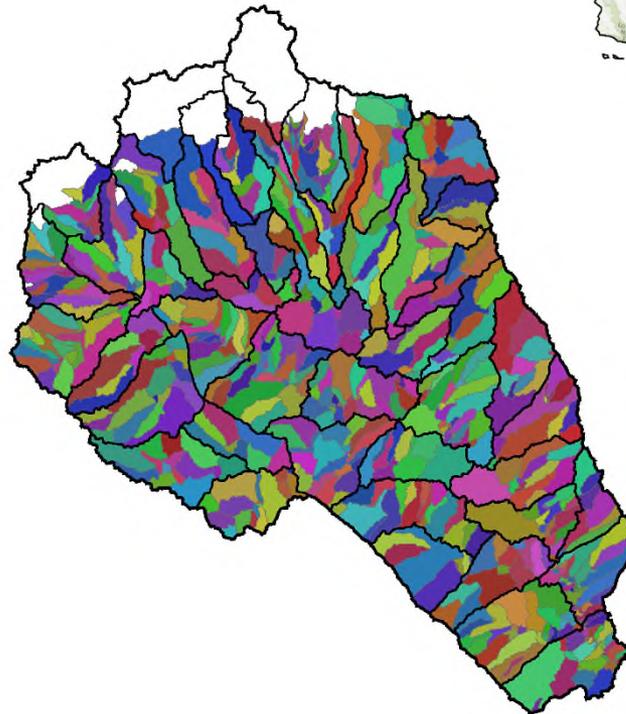
Case study spatial extent and reporting units

Geographic extent:

- Upper Colorado River Basin
- Level III ecoregions

Reporting units:

- NHD segment catchments
- HUC12
- HUC10



Case study data inputs

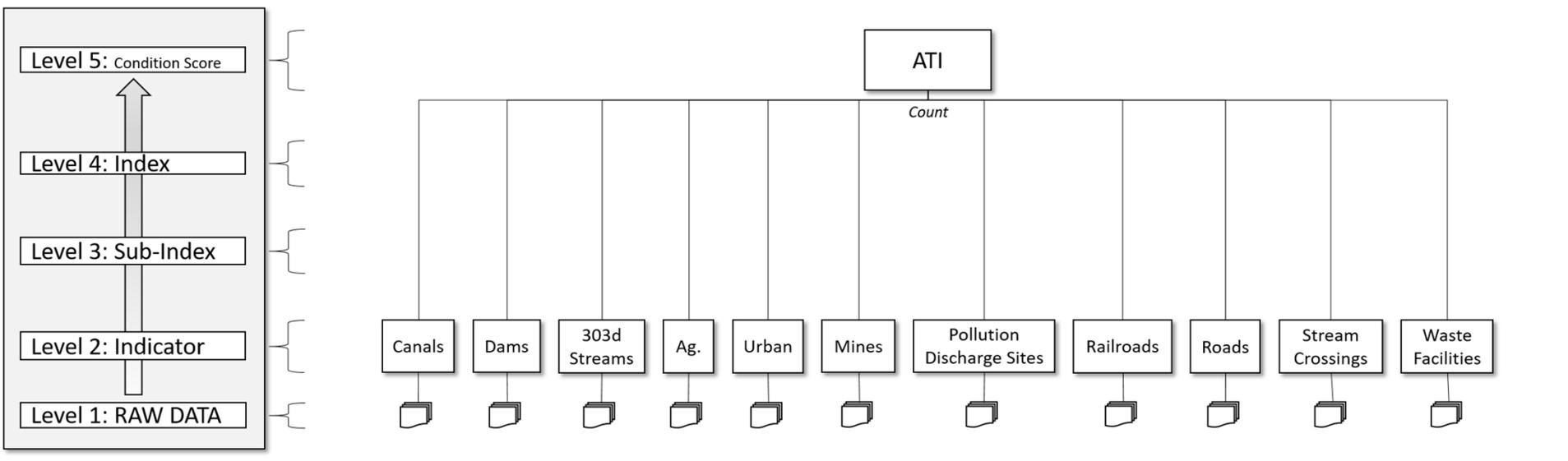
- Land use: % ag, density of mines, timber harvest
- Connectivity: road density, dam density
- Water quality: NPDES, 303(d) streams
- Hydrologic regime: artificial flow paths, dam density
- Biological condition: invasive riparian vegetation, macroinvertebrate condition



Data scoring and aggregation: ATI

Simplest of the approaches

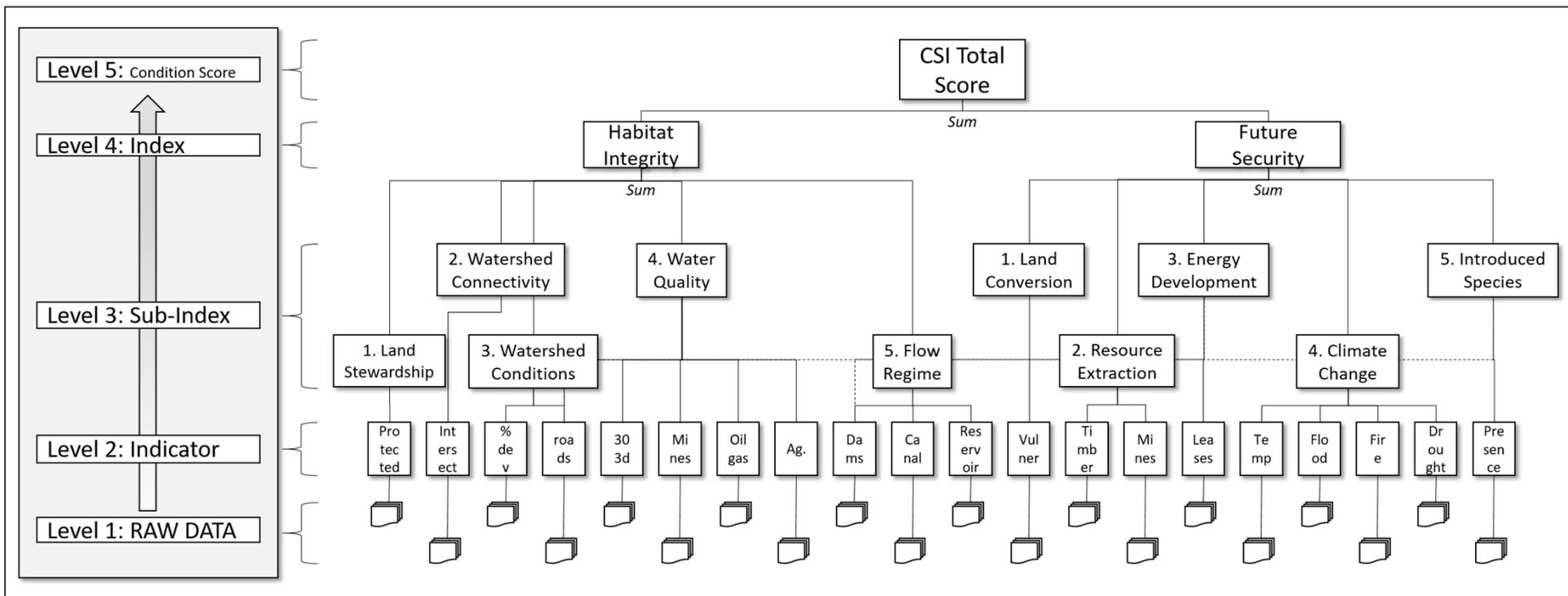
- Raw data scoring: Presence / absence
- Data aggregation: summation



Data scoring and aggregation: TU-CSI

Middle of the road complexity

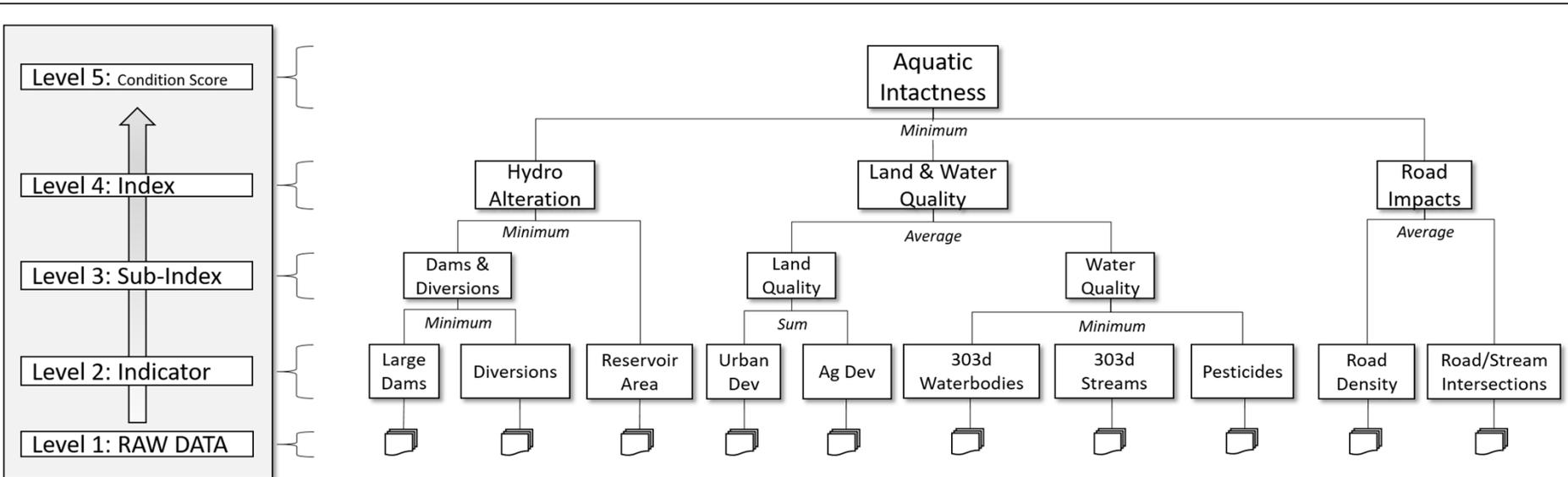
- Raw data scoring: ranked frequency (1 – 5) based on density of threat
- Data aggregation: summation



Data scoring and aggregation: BLM-REA

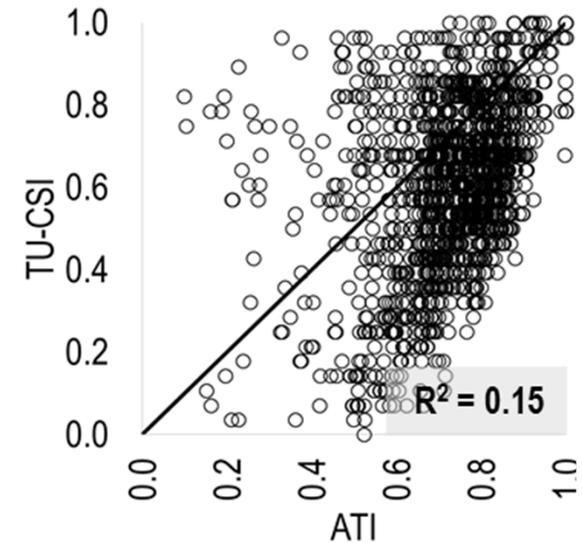
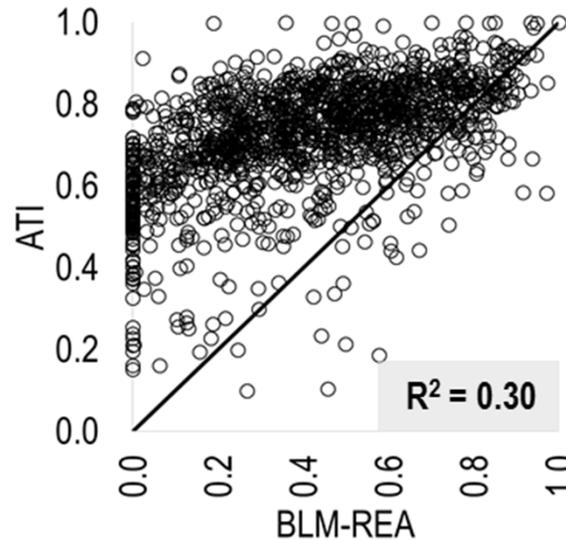
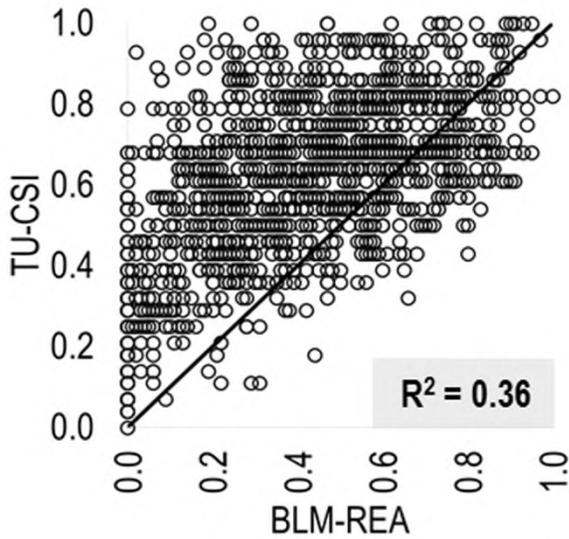
Most complex of the approaches

- Raw data scoring: re-scaling (-1 to +1) based on density of threat. Consider mix of proportional and threshold responses
- Data aggregation: various operators (e.g., sum, min, max)



Aquatic intactness scores among case studies

Low degree of comparability among three case studies

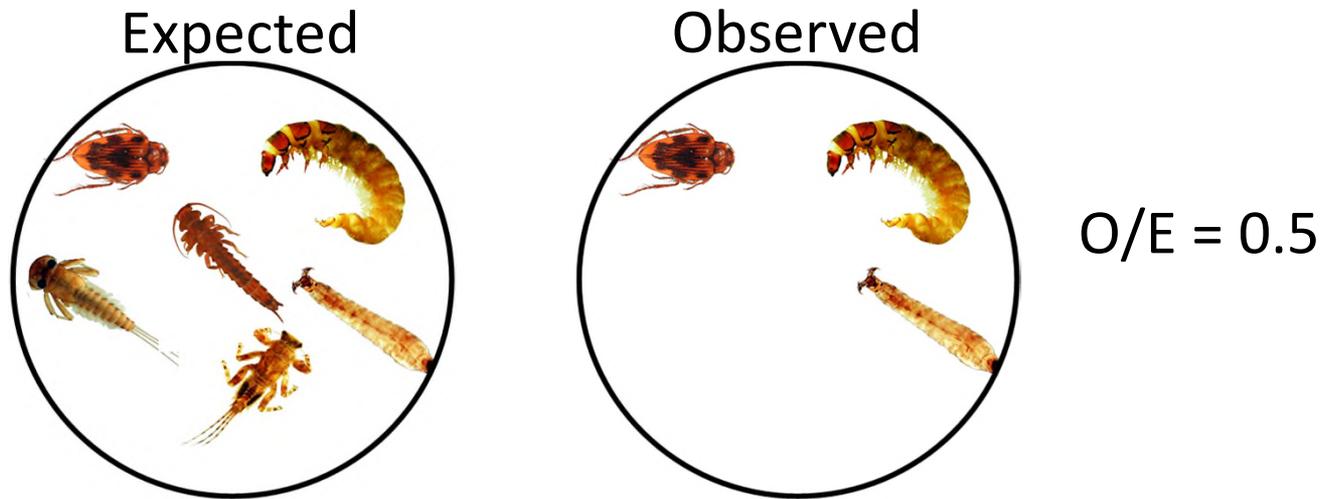


On average: $ATI > CSI > REA$

Validation of case study results

Do assessment scores correlate with direct measures of aquatic intactness?

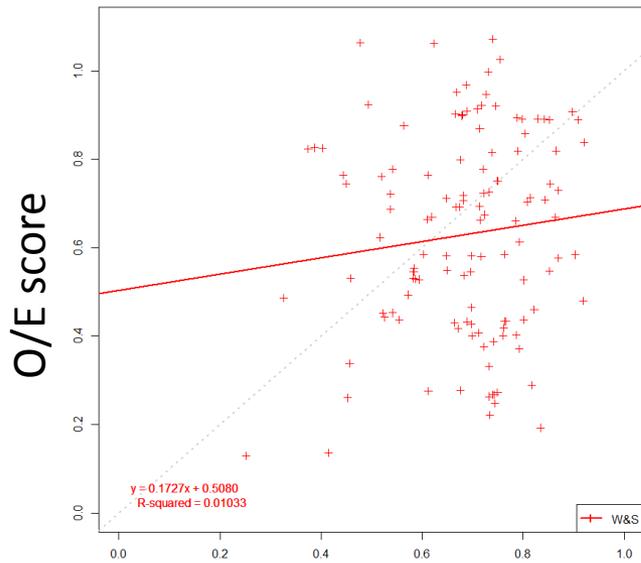
- Condition measure: macroinvertebrate O/E index
- 123 HUC12s (~10%) had O/E scores



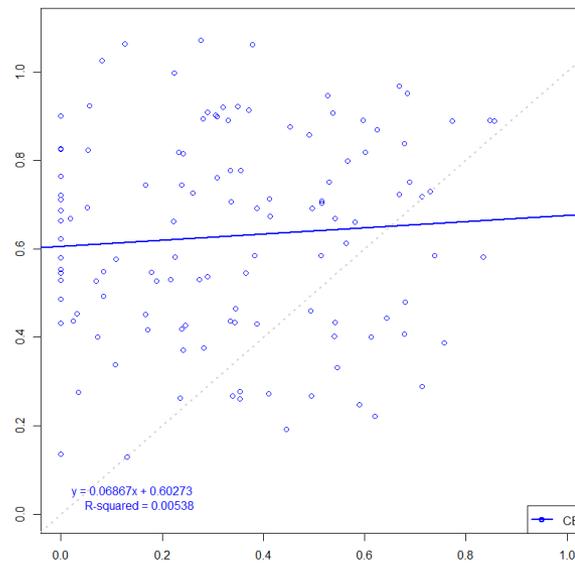
Validation of case study results

Poor correlations between regional assessment scores and macroinvertebrate biological condition

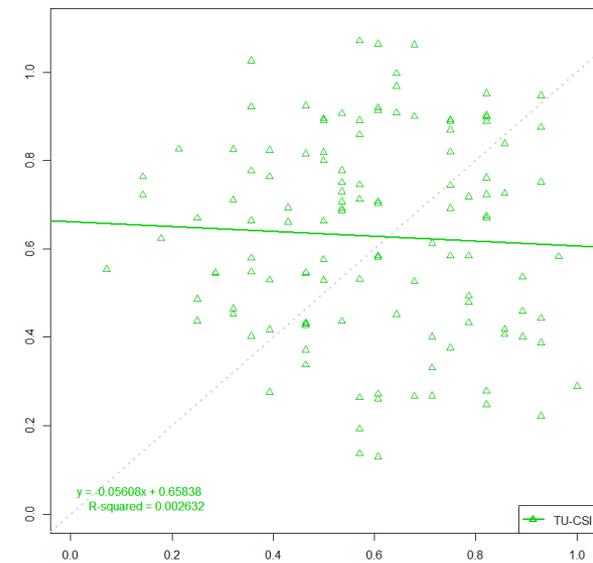
ATI



BLM – REA



TU – CSI



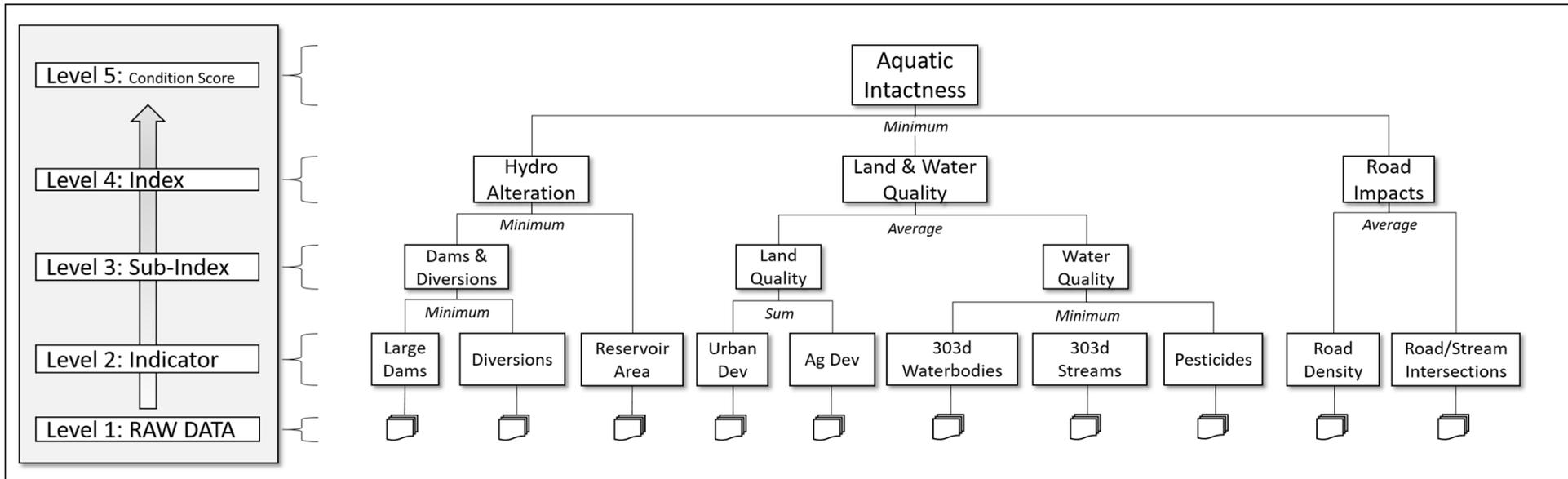
Regional assessment score

What have we learned so far

- Large diversity of regional assessment approaches; many share common objectives and data inputs
- Low degree of comparability among assessment scores
- Weak correlations with measured biological condition
- No measures of uncertainty included in assessment results

Recommendations: Back to ecological basics

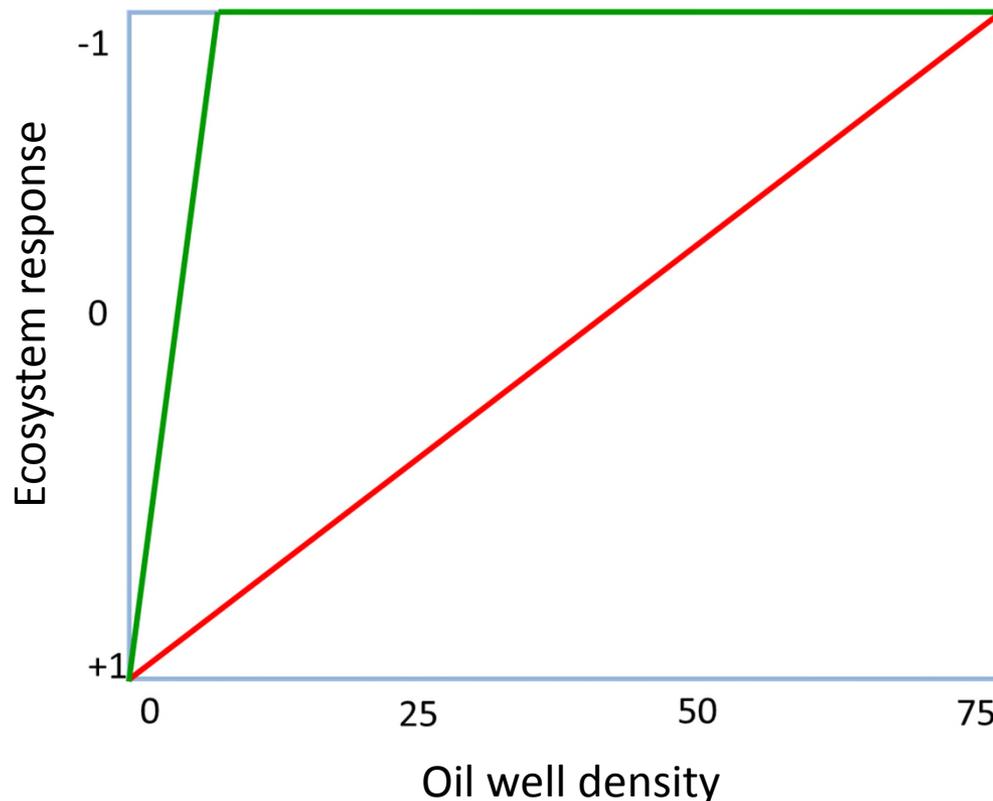
Rationale for a given data scoring and aggregation schema



Recommendations: Back to ecological basics

Rationale for a given data scoring and aggregation schema

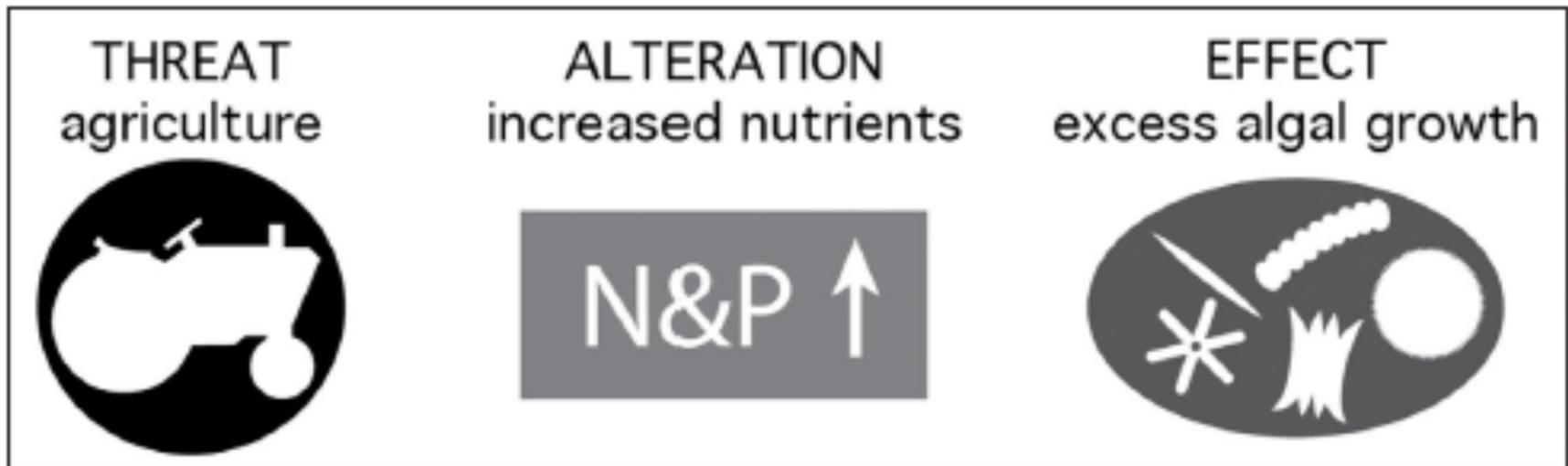
- Threat – response relationships
 - Type of response curves - empirical support



Recommendations: Back to ecological basics

Rationale for a given data scoring and aggregation schema

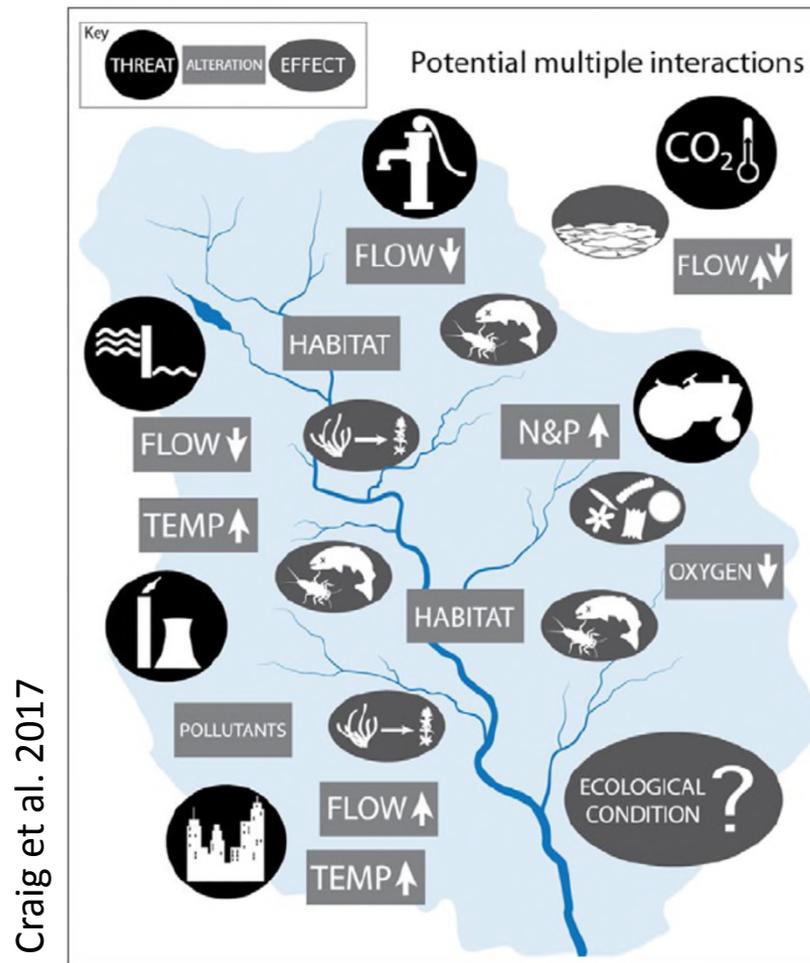
- Threat – response relationships
 - Continuity of threat – response relationships
 - Context dependencies



Recommendations: Back to ecological basics

Rationale for a given data scoring and aggregation schema

- Ecosystem responses to multiple, co-occurring stressors
 - Individual versus net effects

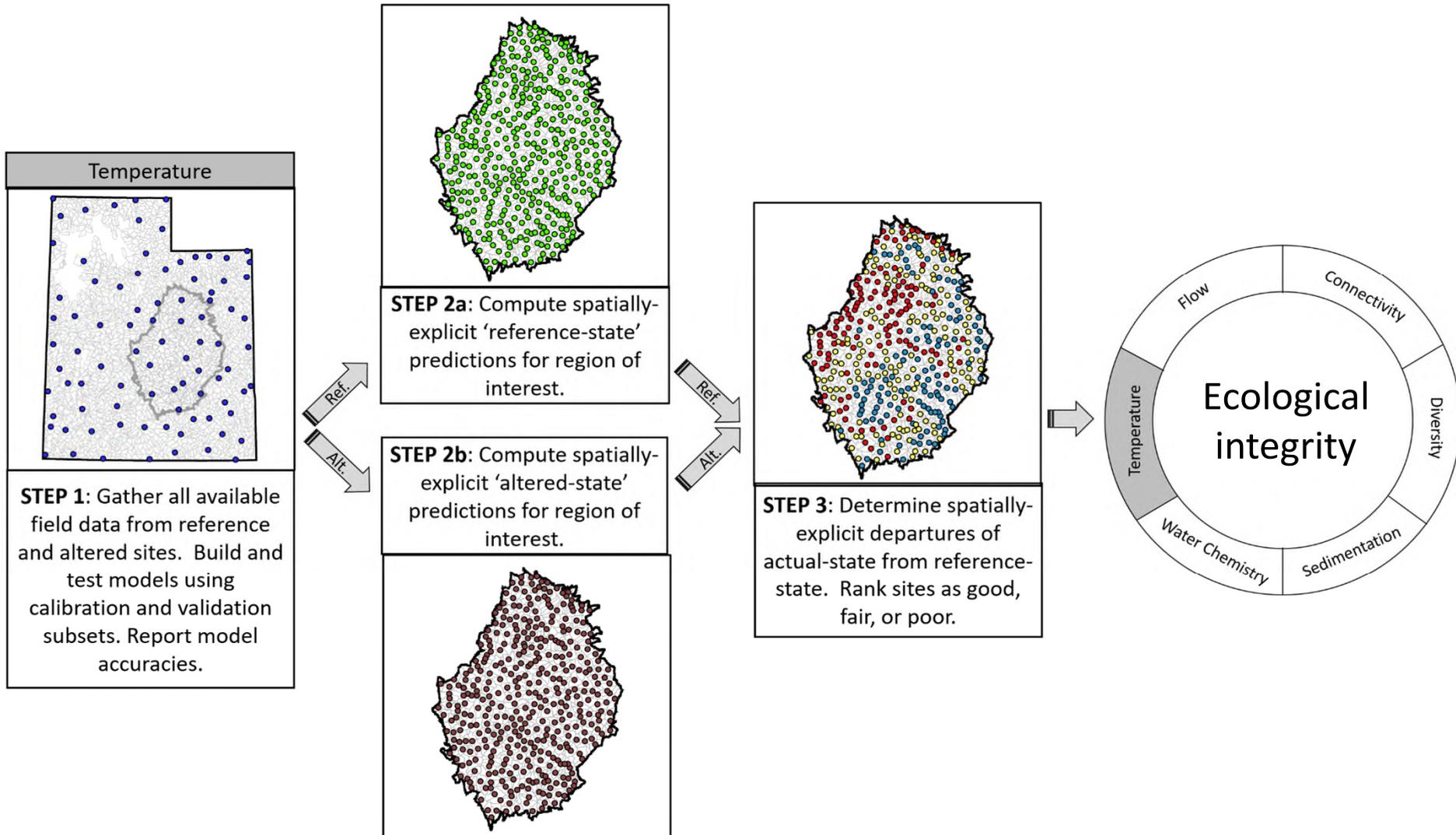


Recommendations: Empirical modeling

Model calibration and validation

- Kitchen sink syndrome: Effect of correlated variables on model performance
- Optimal data scoring and aggregation approaches
- Issues of scale and context dependency
- Including measures of uncertainty

Recommendations: Empirical modeling



Conclusions

- Regional assessments playing an increasingly important role in watershed planning and assessment
- Importance of looking beyond the reach-scale
- Beware of pretty maps - devil is in the details
- Quantify and reduce uncertainty and bias in regional assessments