

REVIEW OF STREAM ASSESSMENTS FOR EVALUATING ECOLOGICAL IMPACTS AND BENEFITS

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EMRRP Webinar Series
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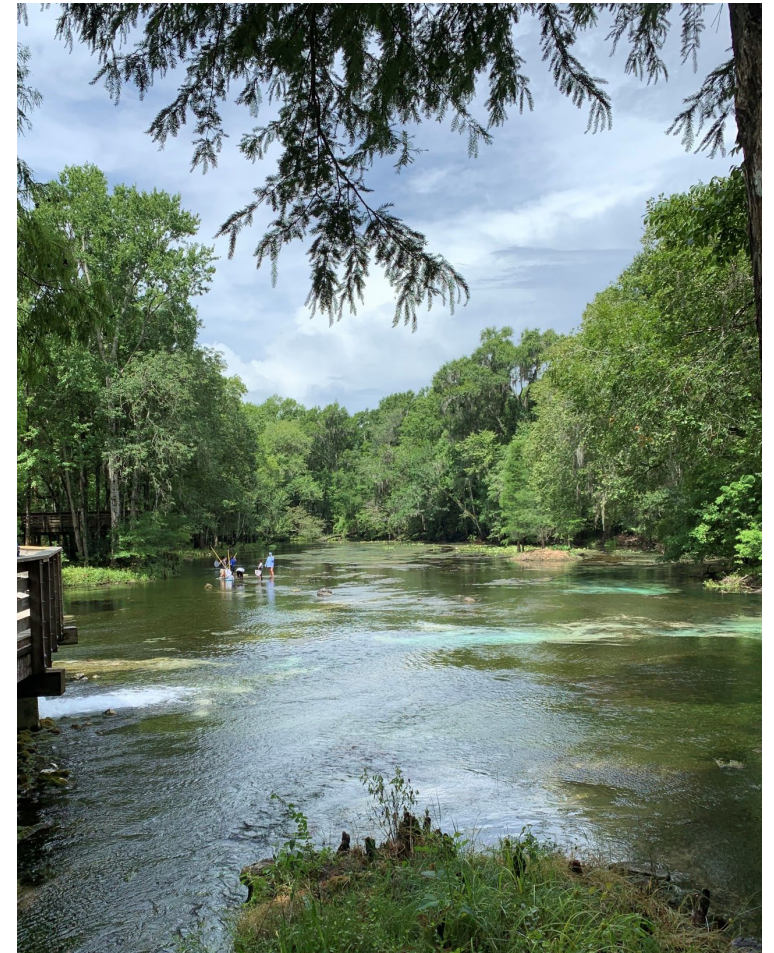
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PRESENTATION OVERVIEW



- Background on stream assessment methodologies
- Literature review methodology
- Literature review results + analysis
- Online resource for stream assessment
- Summary and takeaways
- Next steps



BACKGROUND: STREAM ASSESSMENT METHODOLOGIES



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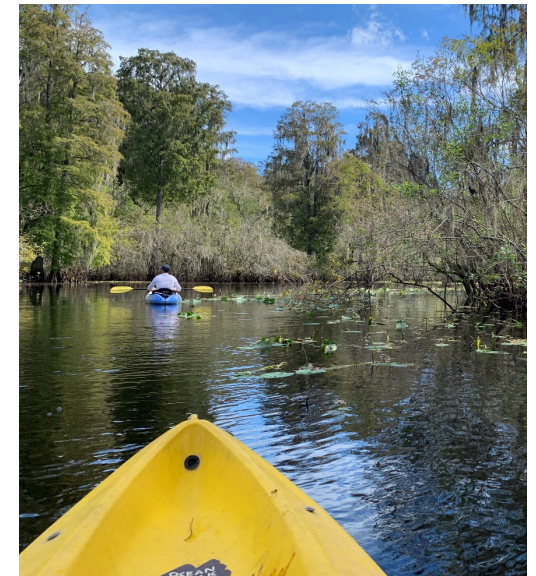
STREAMS + STREAM ECOSYSTEM FUNCTIONS



- Streams provide a range of ecosystem goods and services
 - Provide habitat, food, and shelter for organisms
 - Mitigate flood damage
 - Serve as drinking water sources
 - Support commercial and recreational uses
 - Serve as hotspots for biodiversity and ecosystem function



- Therefore stream management often includes a diverse range of objectives
 - Aquatic ecosystem restoration
 - Flood risk planning
 - Regulatory mitigation
 - Calculation credits and debits



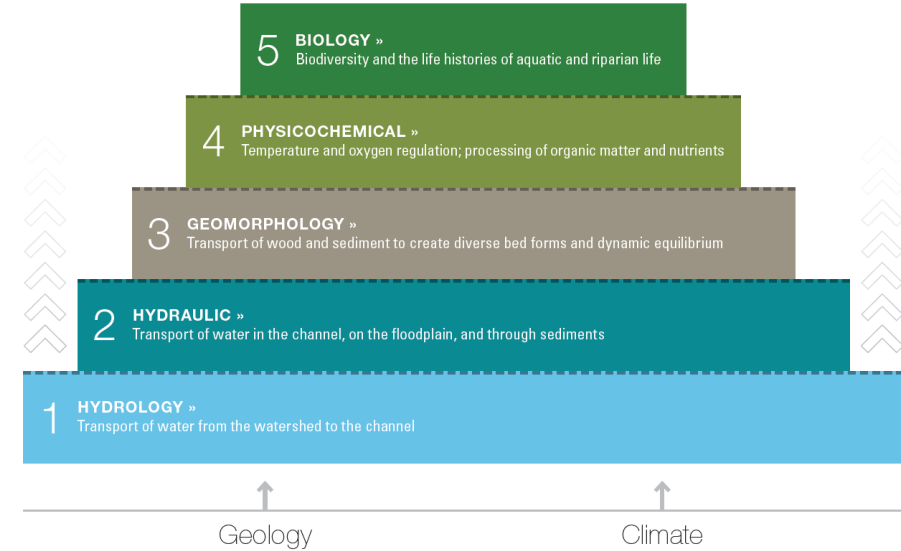


EXISTING STREAM ASSESSMENT FRAMEWORKS

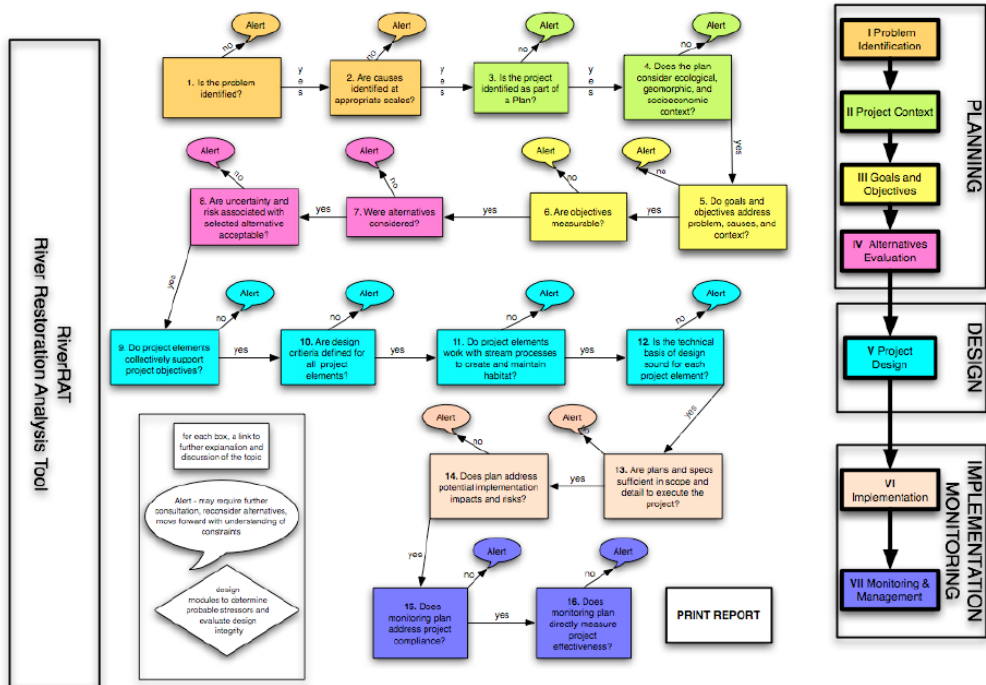


System Dynamics	Hydrologic Balance	Sediment Processes and Character	Biological Support	Chemical Processes and Pathways
Stream Evolution Processes	Surface Water Storage Processes	Sediment Continuity	Biological Communities and Processes	Water and Soil Quality
Energy Management	Surface / Subsurface Water Exchange	Substrate and Structural Processes	Necessary Habitats for all Life Cycles	Chemical Processes and Nutrient Cycles
Riparian Succession	Hydrodynamic Character	Quality and Quantity of Sediments	Trophic Structures and Processes	Landscape Pathways

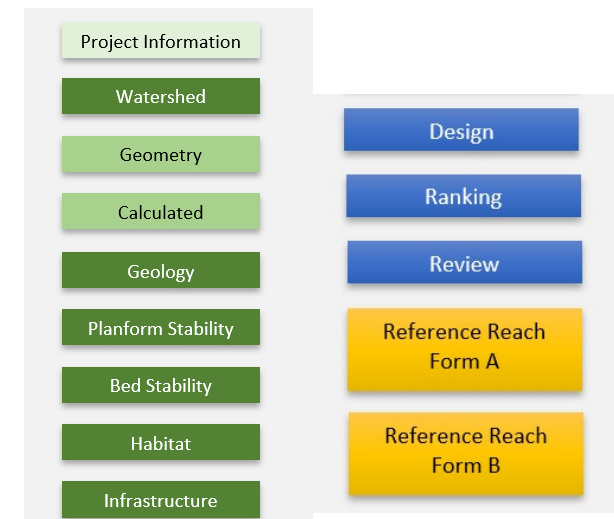
Fischenich (2006): Primary Functions



Harman et al. (2012): Stream Function Pyramid



IOWA DNR: River Restoration Toolbox

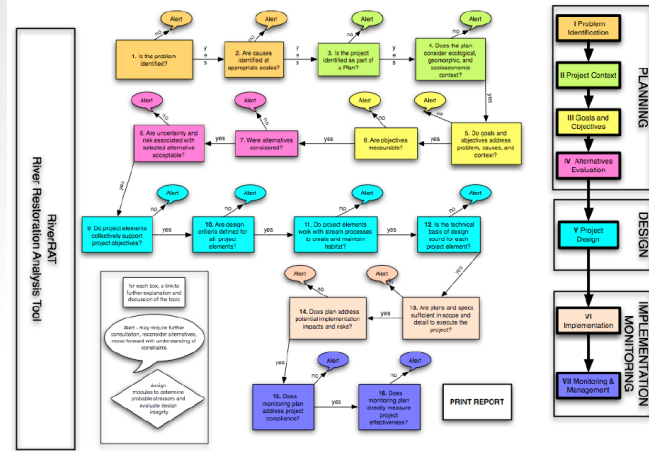
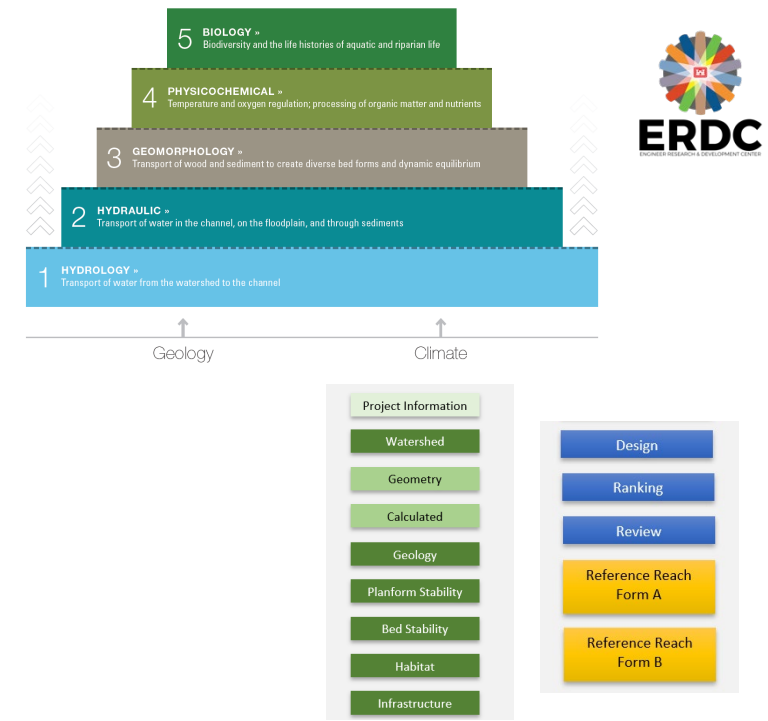




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UNCLASSIFIED

Other assessments



Individual stream assessment resources are limited in focus, scope, and range of objectives:

- Levels of effort not clearly defined
- Focus on only one or a few functions → lack of balance
- Emphasis on certain disciplines → loss of depth in others, loss of ability to analyze interdisciplinary data
- Combination of variables + normalizing data erases some data complexity

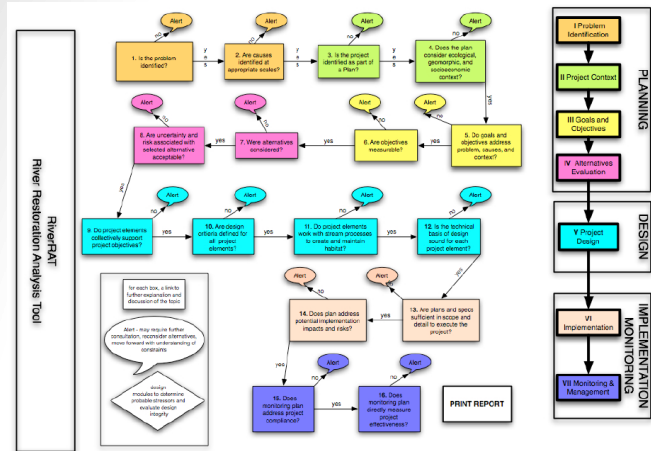
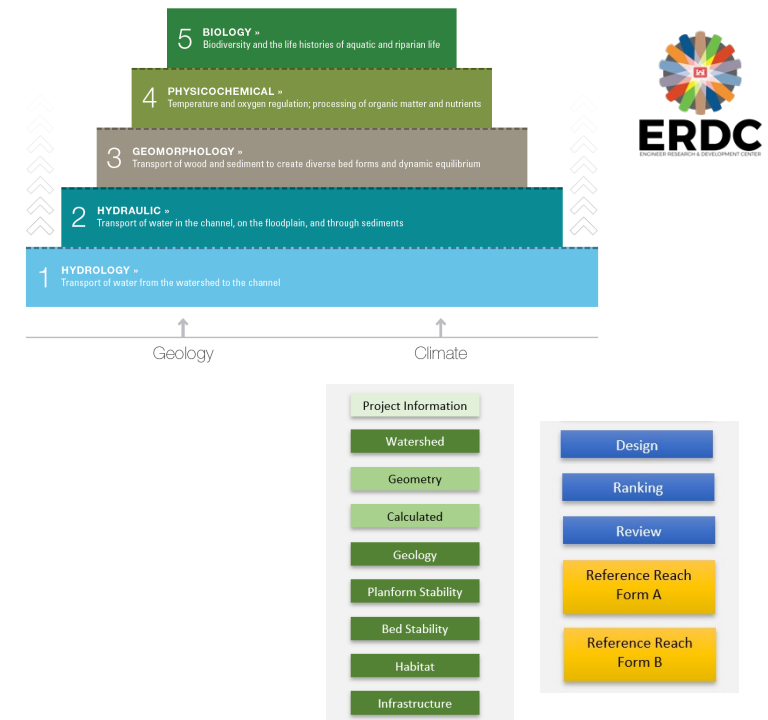
UNCLASSIFIED



System Dynamics	Hydrologic Balance	Sediment Processes and Character	Biological Support	Chemical Processes and Pathways
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UNCLASSIFIED

Other assessments

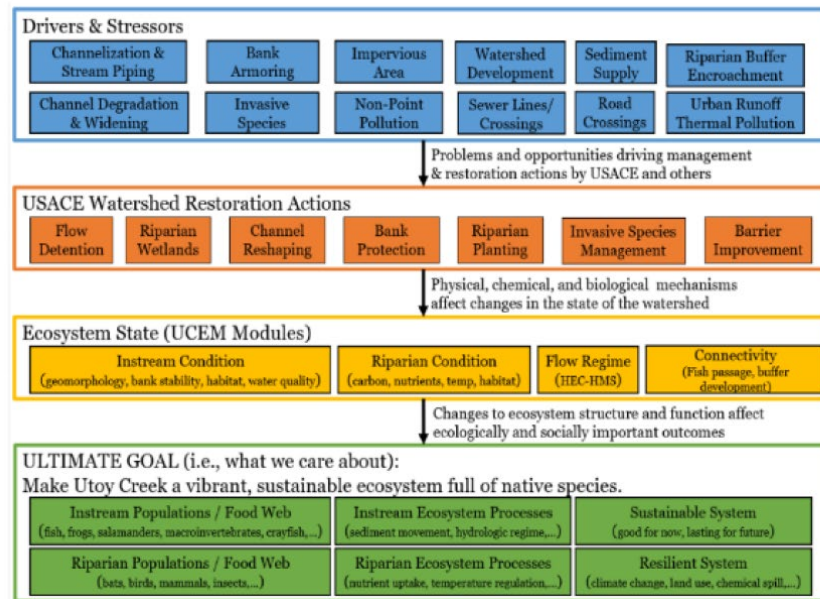


- Narrow focus, scope, and objectives → limits scope + performance of assessments
- Individually, most assessments cannot capture full structure, function, and dynamic nature of stream functions and processes
- We aimed to synthesize and improve on these and other existing frameworks

UNCLASSIFIED



How can we compare, contrast, and select assessments when there are so many different objectives, contexts, and levels of effort available across the options?



Over time, the state of the watershed improves as management actions address the drivers and stressors and reduce the need for restoration.



Menichino et al., 2023



EXAMPLE: UTOY CREEK STUDY



Utoy Creek, Atlanta, GA





EXAMPLE: UTOY CREEK STUDY

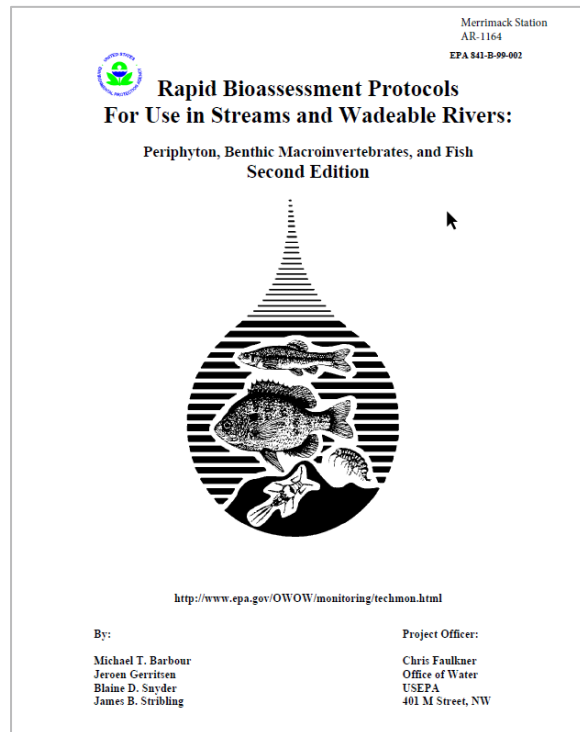


Georgia IBI

Part III:
Scoring Criteria for the Index of Biotic Integrity to Monitor Fish Communities in Wadeable Streams in the Apalachicola and Atlantic Slope Drainage Basins of the Southeastern Plains Ecoregion of Georgia

Georgia Department of Natural Resources
Wildlife Resources Division
Fisheries Management Section

2020



EPA RBP

Georgia SQT

U.S. Army Corps of Engineers, Savannah District

User Manual & Scientific Support for the Georgia Stream Quantification Tool



Version 2.0 (October 2021)

ERDC/EL-TR-18-11

US Army Corps of Engineers
Engineer Research and Development Center

Ecosystem Management and Restoration Research Program

Proctor Creek Ecological Model (PEM)

Phase 2-Benefits Analysis

S. Kyle McKay, Bruce A. Pruitt, Brian A. Zettle, Niklas Hallberg, Vince Moody, Allan Annaert, Meredith Ladart, Marshall Hayden, and Justin McDonald

August 2018

Approved for public release; distribution is unlimited.

Proctor Creek Ecological Model



- Many models, methods, protocols have been developed to address these challenges
- We aim to help practitioners compare and contrast assessments with the goal of assisting in the assessment selection process
- **Here we compile and review existing stream assessment approaches to inform model selection and application**

LITERATURE REVIEW OF STREAM ASSESSMENT RESOURCES



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STREAM ASSESSMENT LITERATURE REVIEW



- Conducted a literature review of stream assessment resources for evaluating stream ecosystem structure and function
- Stream assessment tools, procedures, models, and methods were compiled through:
 1. Stream assessment review documents or reports
 - e.g., EPA or USGS reviews
 2. USACE databases or online repositories
 - e.g., USACE RIBITS database
 3. Tools developed by federal agencies
 - e.g., USGS and U.S. Forest Service
 4. Tools developed by private industry, non-profits, academia, and research institutions



STREAM ASSESSMENT LITERATURE REVIEW



- Over 190 stream assessments were identified during this process
- Approaches varied from purely qualitative to quantitative empirical data collection
- Minimum criteria were established for inclusion in the analysis. Assessments must fulfill each of the following:
 1. Evaluate stream structure, function, or condition
 2. Are not used primarily for design purposes
 3. Are well-documented or published, including user guidance or past evaluation
 4. Are of a singular level (assessments with multiple levels of frameworks are split into separate entries)
 5. Are frequently used in the United States
- This is a non-exhaustive snapshot of current and most commonly used stream assessments



DATA COLLECTED



- **Resource metadata:**
 - E.g., name, developer organization or agency, geographic applicability
 - Programmatic application, regional breadth, site objectives, level of effort
- **Resource technical data:**
 - Stream function metadata:
 - Hydrology, hydraulics, geomorphology, physiochemistry, biology
 - Other functions and themes:
 - Aquatic organism passage (connectivity)
 - Stream habitat
 - Riparian zone
 - Spatial/Temporal variability (e.g., seasonality)
 - Input data type + source, output data type
 - Performance Standards/Reference Curves used





RESOURCE DATA: LEVEL OF ASSESSMENT



- **None/Qualitative Only (-):**
 - A parameter was either not assessed, no measurement was taken, or assessment was purely qualitative
- **Semi-Quantitative (S):**
 - Assessment was semi-quantitative
 - Includes visual assessment producing a quantitative score (e.g. RVP, RSAT, SVAP)
- **Rapid Empirical Procedure (E):**
 - A rapid empirical procedure was conducted
 - Includes collection of a few key data (e.g., GIS or field data), or with regional methods
 - These few key metrics are then used as a surrogate for overall functioning
- **Detailed data collection and analysis (D):**
 - Significant empirical data collection and/or modeling activities
 - Often involves detailed field data collection and comparison to reference curves



EXAMPLE ASSESSMENT REVIEW: STREAM QUANTIFICATION TOOL (SQT)



Functional Category	Function-Based Parameters	Measurement Method
Hydrology	Catchment Hydrology	Curve Number
	Reach Runoff	Curve Number
		Concentrated Flow Points
Hydraulics	Floodplain Connectivity	Soil Compaction
		Bank Height Ratio
Geomorphology	Large Woody Debris	LWD Index
		# Pieces
	Lateral Stability	Erosion Rate (ft/yr)
		Dominant BEHI/NBS
		Percent Streambank Erosion (%)
	Riparian Vegetation	Left Canopy Coverage (%)
		Right Canopy Coverage (%)
		Left Buffer Width (ft)
		Right Buffer Width (ft)
		Left Basal Area (sq.ft/acre)
		Right Basal Area (sq.ft/acre)
		Right Stem Density (stems/acre)
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)
	Bed Form Diversity	Pool Spacing Ratio
		Pool Depth Ratio
Percent Riffle		
Aggradation Ratio		
Plan Form	Sinuosity	
Physicochemical	Temperature	Summer Daily Maximum (°F)
	Bacteria	Fecal Coliform (Cfu/100 ml)
	Organic Carbon	Leaf Litter Processing Rate
		Percent Shredders
	Nitrogen	Total Nitrogen (mg/L)
Phosphorus	Total Phosphorus (mg/L)	
Biology	Macros	Biotic Index
		EPT Taxa Present
	Fish	North Carolina Index of Biotic Integrity

Category or Theme	Level of Assessment
Hydrology	RE
Hydraulics	-
Geomorphology	DC
Physicochemical	DC
Biology	DC
Aquatic Organism Passage	-
Riparian Zone	RE



EXAMPLE ASSESSMENT REVIEW: STREAM VISUAL ASSESSMENT PROTOCOL (SVAP)



Date: _____ Page _____ of _____

Site ID: _____

Data Recorder: _____

Element Scores

Element	Notes	Score
1. Channel Condition		
2. Hydrologic Alteration		
3. Bank Condition		
4. Riparian Area Quantity		
5. Riparian Area Quality		
6. Canopy Cover		
7. Water Appearance		
8. Nutrient Enrichment		
9. Manure or Human Waste		
10. Pools		
11. Barriers to Movement		
12. Fish Habitat Complexity		
13. Aquatic Invertebrate Habitat		
14. Aquatic Invertebrate Community		
15. Riffle Embeddedness		
16. Salinity		
A. Sum of all elements scored		
B. Number of elements scored		

Overall score: A/B _____

1 to 2.9 Severely Degraded

3 to 4.9 Poor

5 to 6.9 Fair

7 to 8.9 Good

9 to 10 Excellent

1 to 2.9 Severely Degraded (list elements)

3 to 4.9 Poor (list elements)

9 to 10 Excellent (list elements)

Category or Theme	Level of Assessment
Hydrology	S
Hydraulics	S
Geomorphology	S
Physicochemical	S
Biology	S
Aquatic Organism Passage	S
Riparian Zone	S

LITERATURE REVIEW RESULTS



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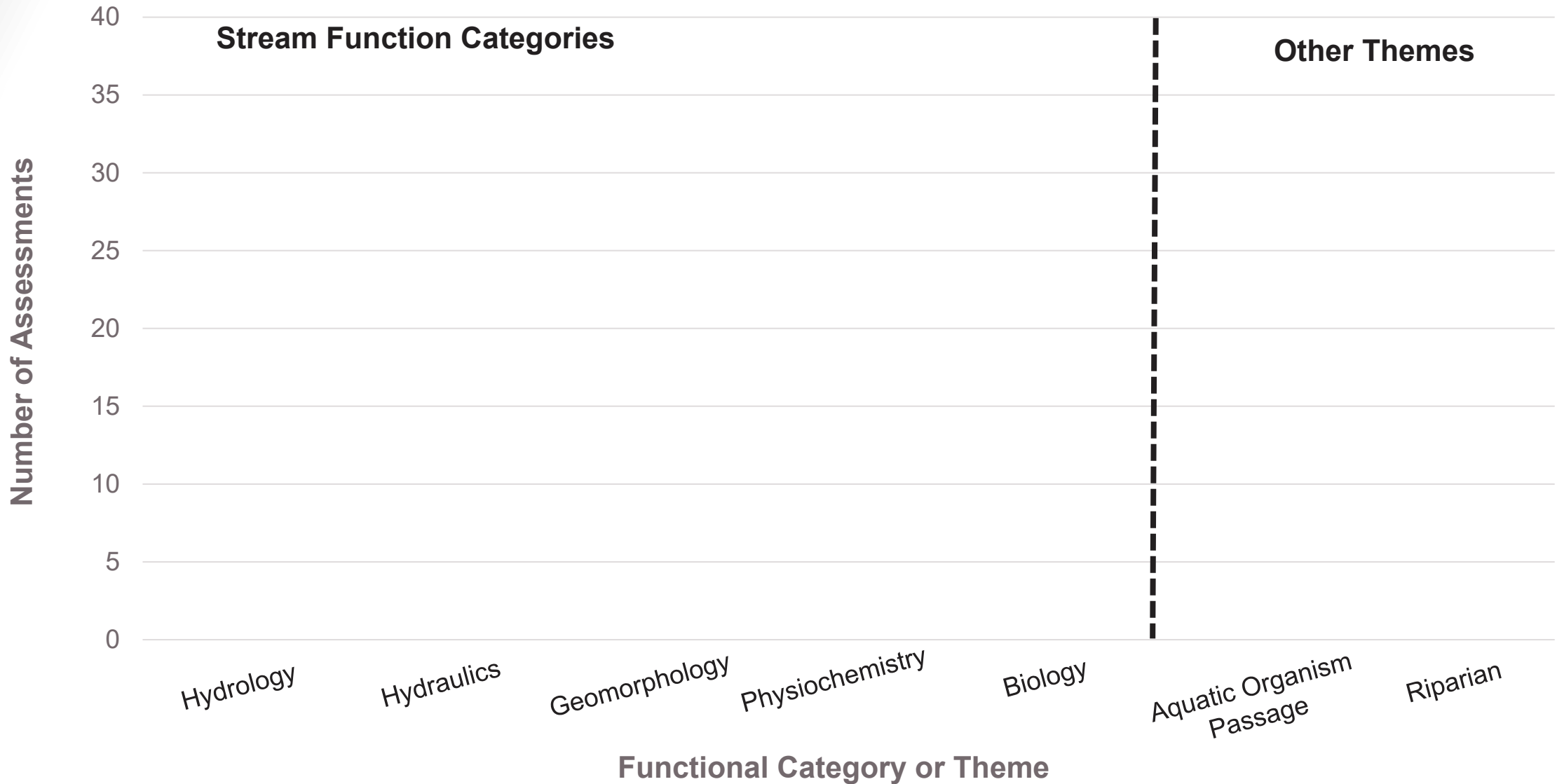
LITERATURE REVIEW RESULTS



- Considered > 190 resources
- Types of assessments:
 - Calculators, tools, methods, models, and other resources
- Range of sources:
 - From nationally applicable and publicly available methods to regional and locally-focused methods
- **Stream function categories:**
 - Hydrology, hydraulics, geomorphology, physiochemistry, biology
- **Cross-cutting themes:**
 - Aquatic organism passage (also “connectivity”)
 - Riparian zone

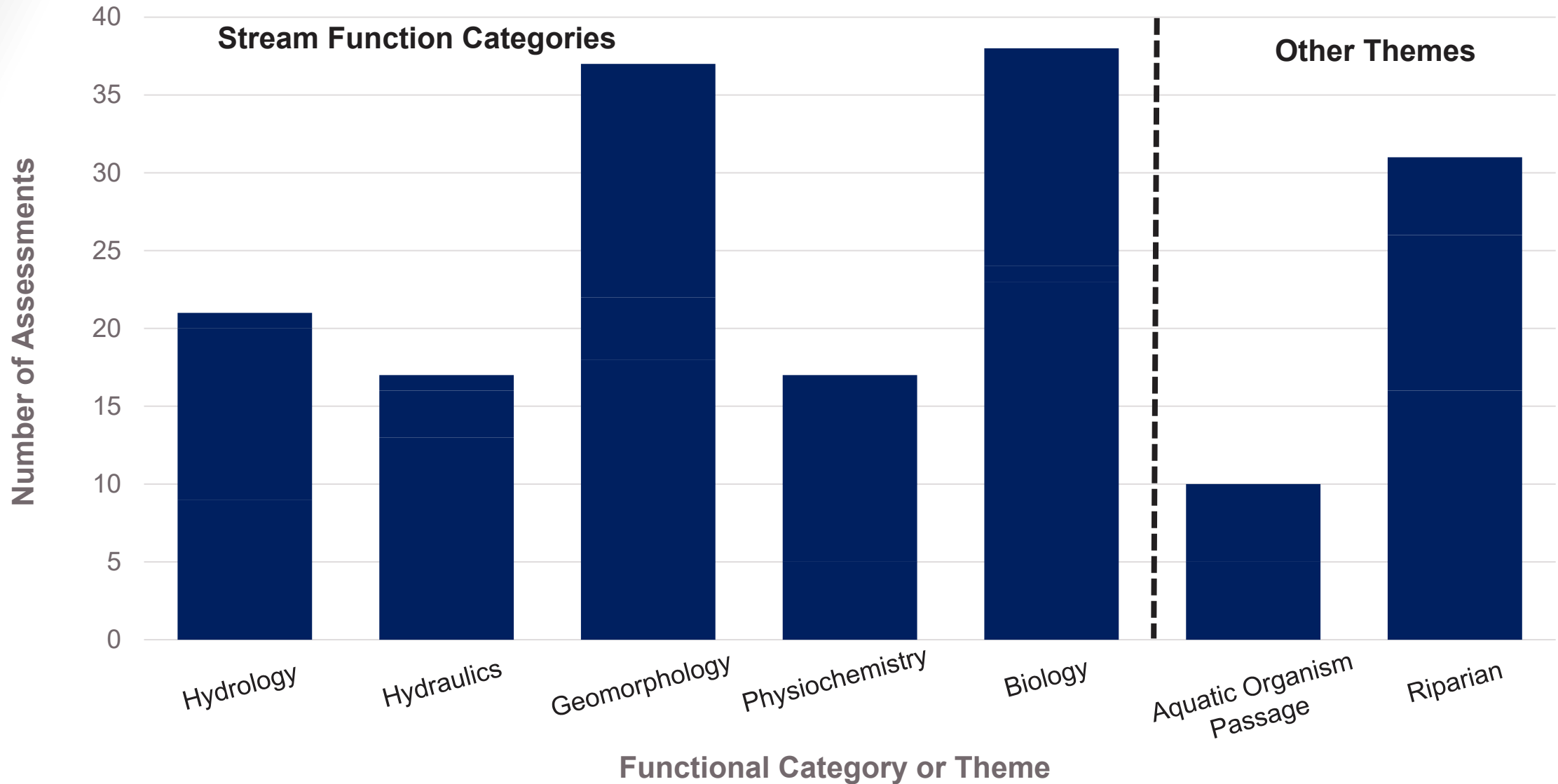


NUMBER OF RESOURCES PER CATEGORY OR THEME



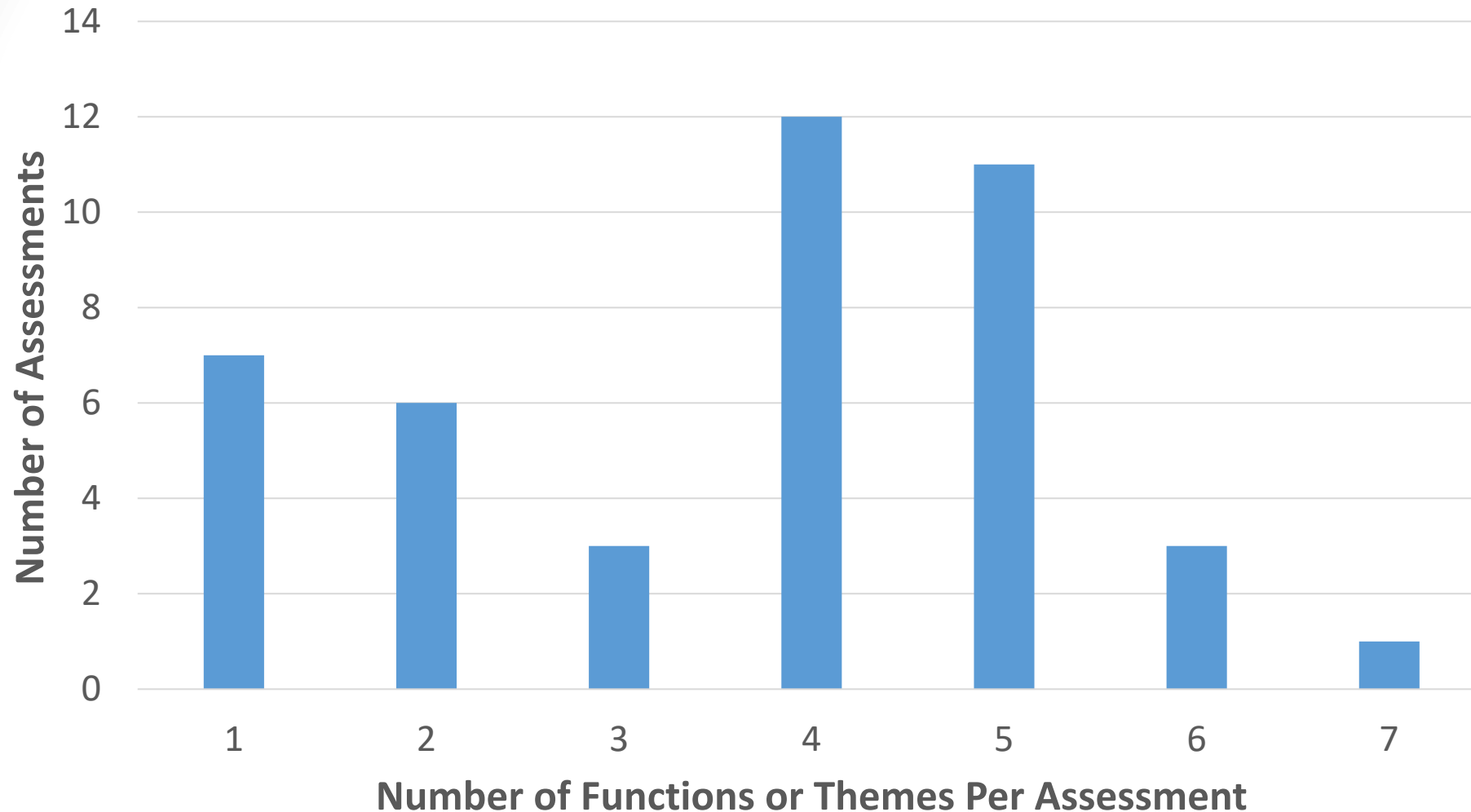


NUMBER OF RESOURCES PER CATEGORY OR THEME





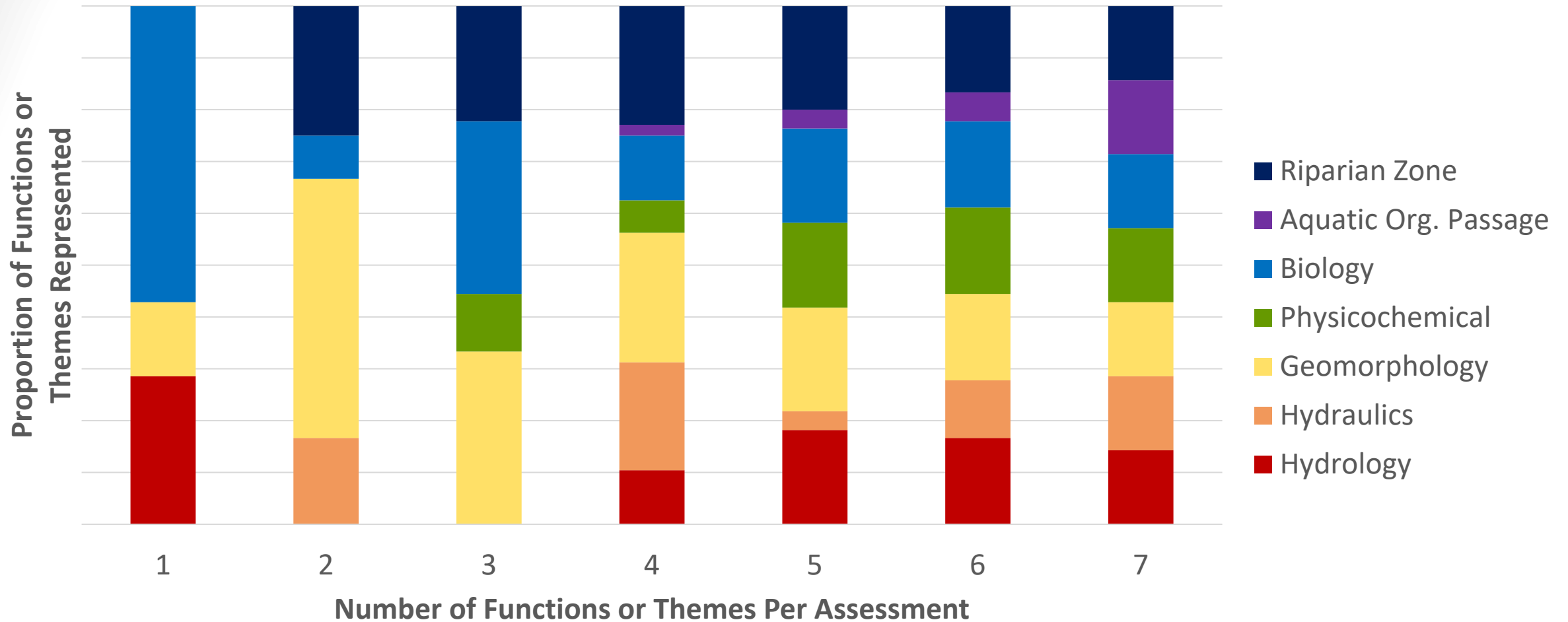
CATEGORIES AND THEMES IN THE ASSESSMENTS



- Hydrology
- Hydraulics
- Geomorphology
- Physiochemistry
- Biology
- Aquatic organism passage (connectivity)
- Riparian zone



CATEGORIES AND THEMES IN THE ASSESSMENTS

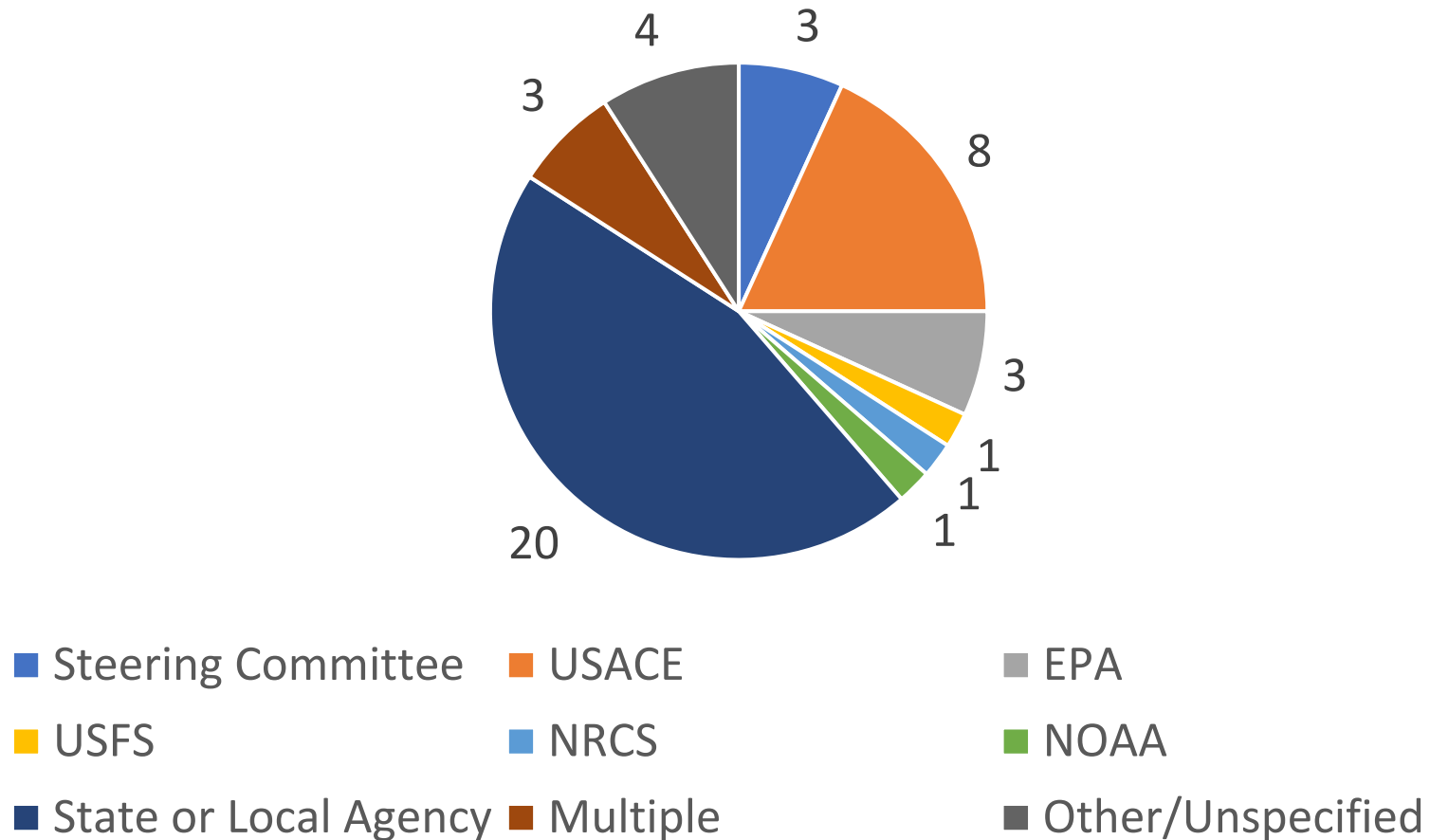




DEVELOPERS OF MOST COMMON STREAM ASSESSMENTS



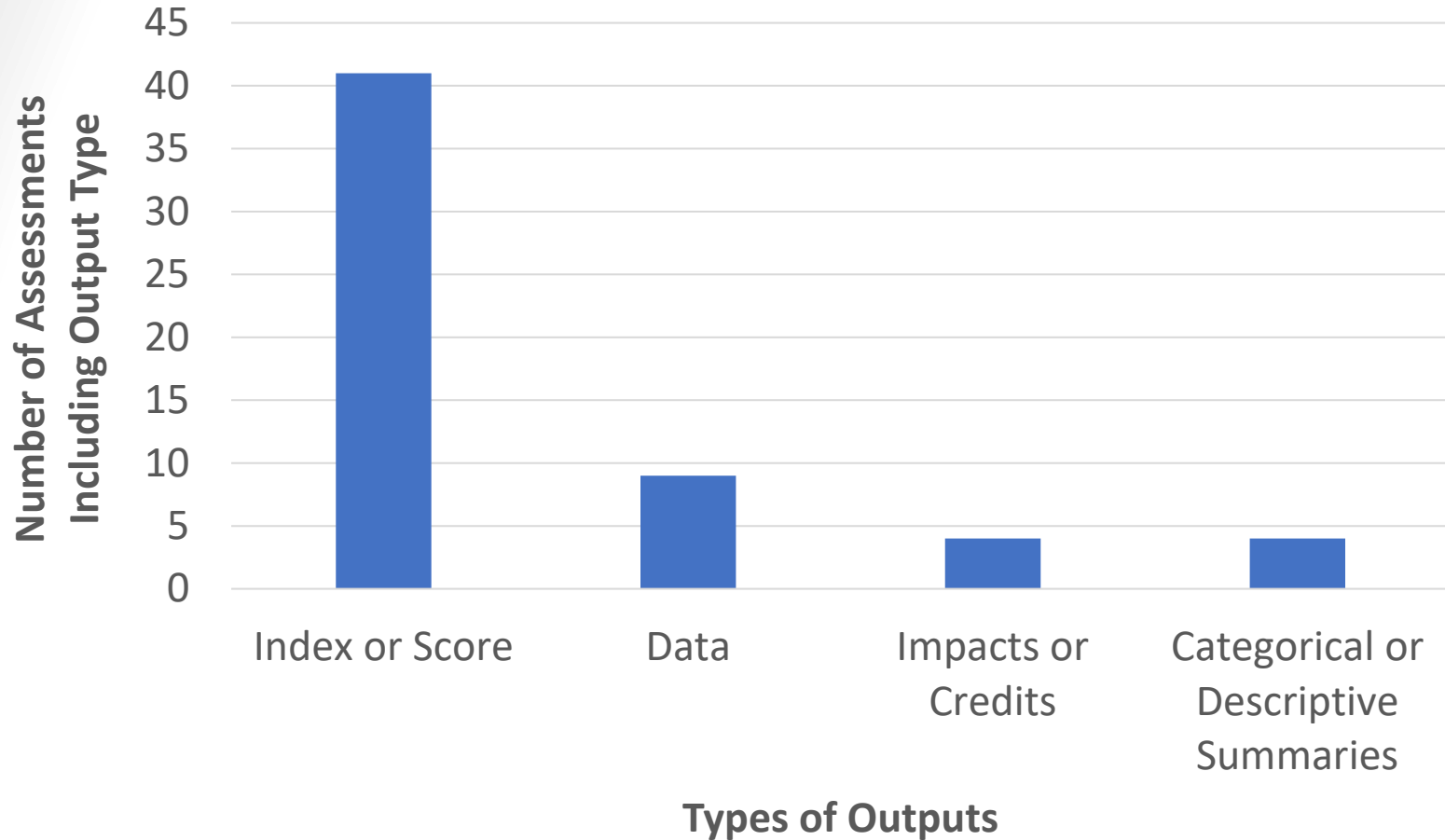
Number of Assessments Per Developer Type



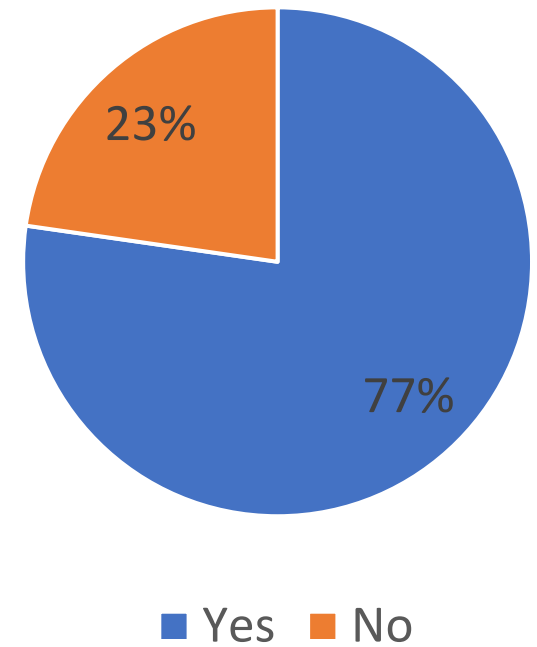


OUTPUTS AND PERFORMANCE STANDARDS

Distribution of Types of Outputs

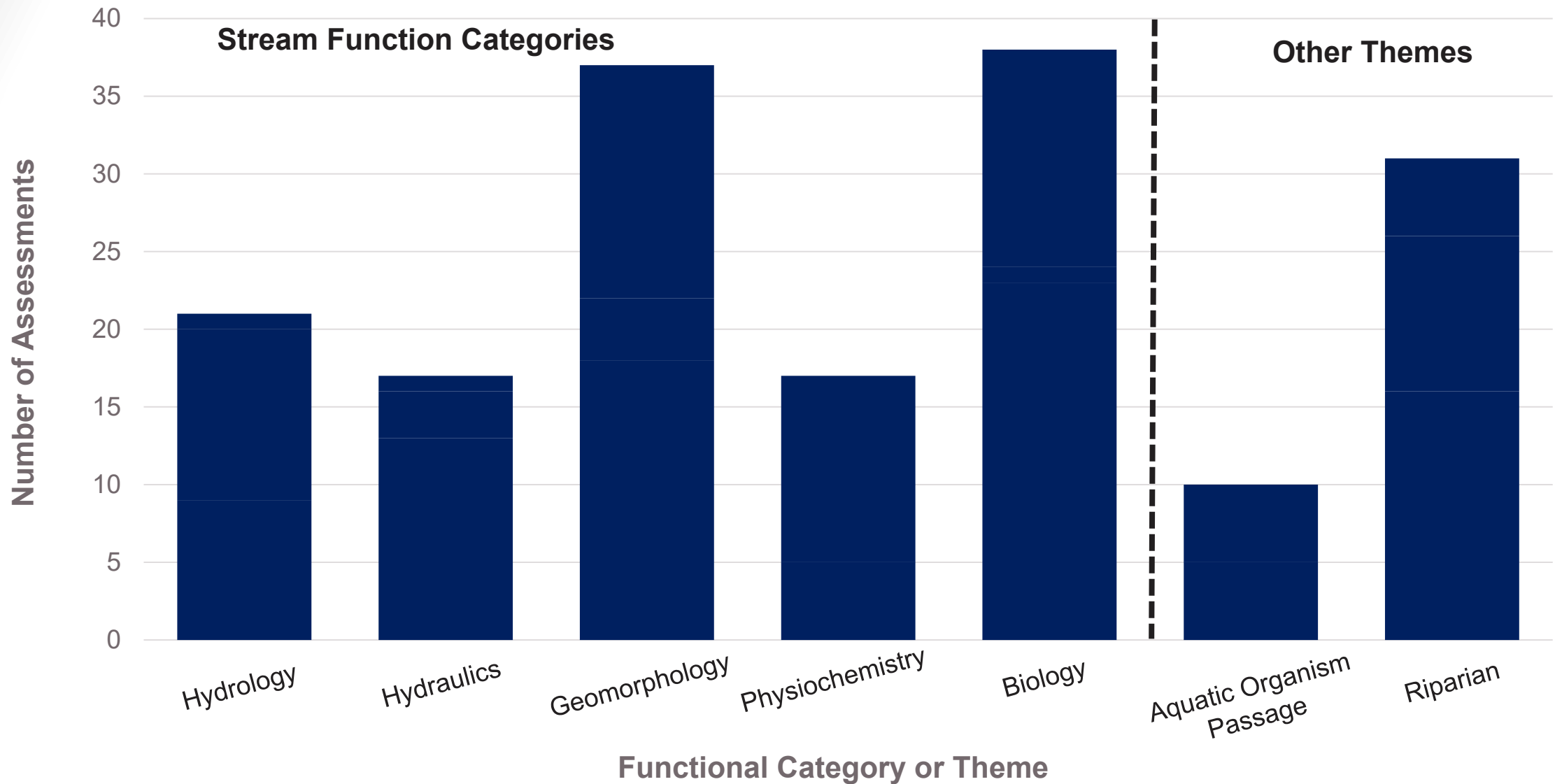


Has Reference Curves or Performance Standards



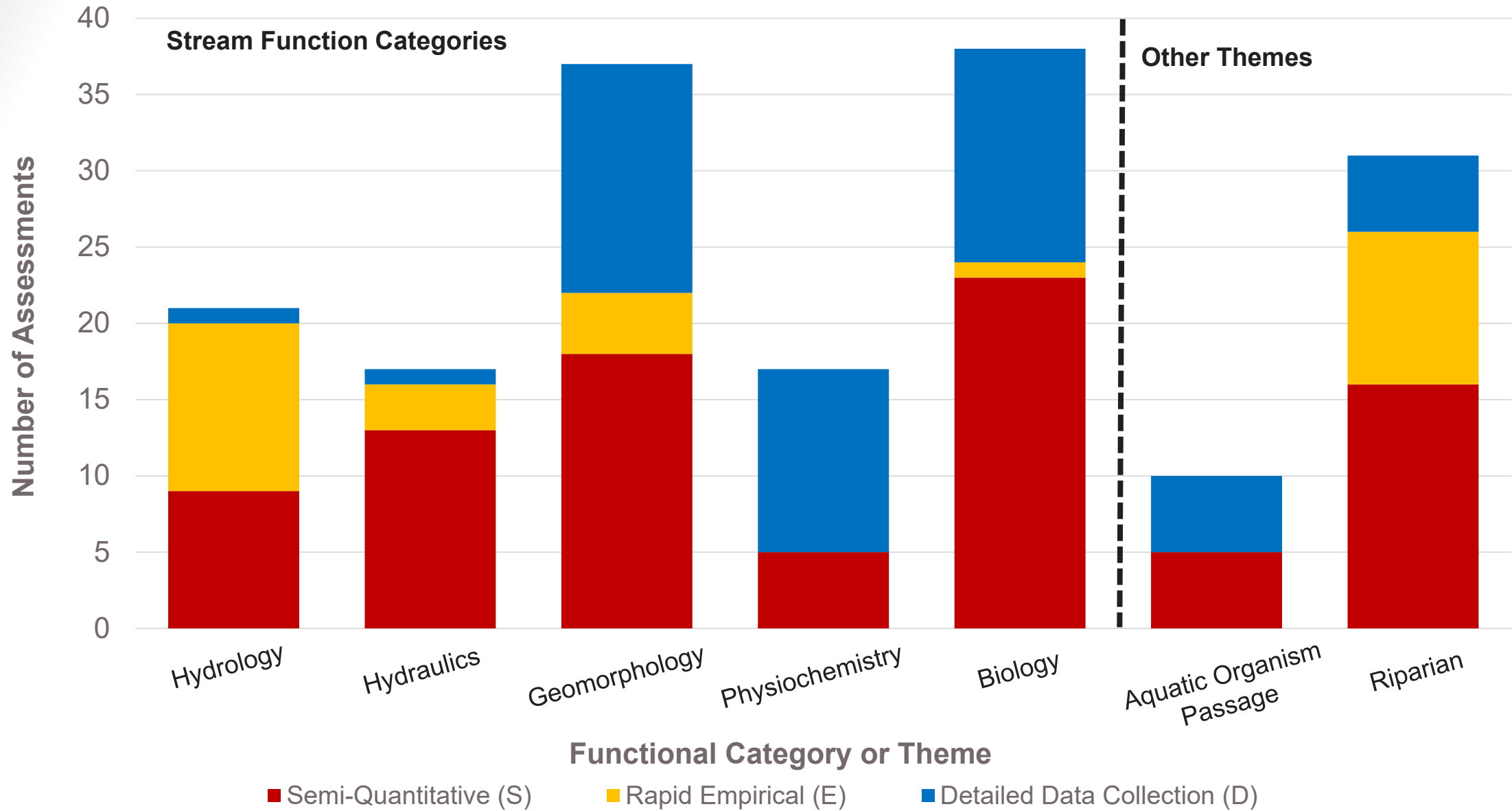


NUMBER OF RESOURCES PER CATEGORY OR THEME





LEVEL OF ASSESSMENT



ONLINE RESOURCE FOR STREAM ASSESSMENT



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ONLINE TOOL/DATABASE




- Contains literature review data
 - Updates will reflect new information as it becomes available
- Query based on given objective or context
- Filter results based on the desired criteria
- Users can view matching results or explore additional tools outside of their input parameters

- Intended to help practitioners find and assess potential tools
- Also in use to assess currently available methods



DATABASE WEB APP MOCK-UP



 River Engineering Resources

ENGINEERING

ASSESSMENT

Database Columns

Functional Categories

	S	RE	DC
<input type="checkbox"/> Hydrology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Hydraulics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Geomorphology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Physicochemical	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Biology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Aq Org Passage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Riparian	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Metadata

<input type="checkbox"/> Citation
<input type="checkbox"/> Sector
<input type="checkbox"/> Developer
<input type="checkbox"/> Year
<input type="checkbox"/> Assessment Type
<input type="checkbox"/> Location Assessment
<input type="checkbox"/> Programmatic Use
<input type="checkbox"/> Region
<input type="checkbox"/> State
<input type="checkbox"/> USACE Division Use
<input type="checkbox"/> USACE District Use

Technical Data

<input type="checkbox"/> Stream Type Requirements
<input type="checkbox"/> Geography
<input type="checkbox"/> Impact
<input type="checkbox"/> Adaptable
<input type="checkbox"/> Time Required
<input type="checkbox"/> Training
<input type="checkbox"/> Input Type
<input type="checkbox"/> Output Type
<input type="checkbox"/> Data Availability
<input type="checkbox"/> Reference Required
<input type="checkbox"/> Performance Standards



EXAMPLE QUERY: STREAM ASSESSMENTS IN OHIO



Database Columns

Functional Categories				Metadata			Technical Data		
	S	RE	DC						
<input checked="" type="checkbox"/> Hydrology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Citation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Stream Type Requirements	<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/> Hydraulics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Sector	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Geography	<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/> Geomorphology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Developer	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Impact	<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/> Physicochemical	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Year	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Adaptable	<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/> Biology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Assessment Type	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Time Required	<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/> Aq Org Passage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Location Assessment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Training	<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/> Riparian	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Programmatic Use	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Input Type	<input type="checkbox"/>	<input type="checkbox"/>
				<input type="checkbox"/> Region	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Output Type	<input type="checkbox"/>	<input type="checkbox"/>
				<input checked="" type="checkbox"/> State	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Data Availability	<input type="checkbox"/>	<input type="checkbox"/>
				<input type="checkbox"/> USACE Division Use	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Reference Required	<input type="checkbox"/>	<input type="checkbox"/>
				<input type="checkbox"/> USACE District Use	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> Performance Standards	<input type="checkbox"/>	<input type="checkbox"/>

ohio

Name	Hydrology	Hydraulics	Geomorphology	Physicochemical	Biology	Aq Org Passage	Riparian Zone	State
> Ohio Headwater Habit...Ohio HHEI	-	-	RE	-	RE	-	-	OH, IN
> Primary Headwater St...PHW	-	-	RE	-	DC	-	-	OH
> Qualitative Habitat ...Ohio QHEI	-	S	S	-	S	-	S	OH, IN
> Stream and Wetland V...SWVM	S	-	S	DC	DC	-	S	WV,OH

↓ DOWNLOAD



DATABASE WEB APP: FILTER RESULTS BY COLUMN VALUES



Search

Name	Developer	State
> State: AK		
> State: -		
> State: CO		
< State: KY < EKSAP: Eastern Kentu... [PROTOCOL] EKSAP: Eastern Kentucky Stream Assessment Protocol KY Interagency Review Team, USACE, EPA, etc - 2002 An interagency team including members from the U.S. Army Corps of Engineers (COE), the U.S. Environmental Protection Agency (EPA), the U.S. Fish and Wildlife Service (USF... Cite	KY Interagency Review Team, USACE, EPA, etc	KY
> Kentucky Stream Asse...	KY Division of Water	KY
> Qualitative Habitat ...QHEILS	USACE	KY
> State: GA		
> State: OH		



DATABASE WEB APP: DROPDOWN OPTIONS FOR MORE INFORMATION



<input type="text" value="Search"/> Y			
Name	Developer	Y	State
> State: AK			
> State: -			
> State: CO			
∨ State: KY			
∨	EKSAP: Eastern Kentu...	KY Interagency Review Team, USACE, EPA, etc	KY
[PROTOCOL] EKSAP: Eastern Kentucky Stream Assessment Protocol KY Interagency Review Team, USACE, EPA, etc - 2002 An interagency team including members from the U.S. Army Corps of Engineers (COE), the U.S. Environmental Protection Agency (EPA), the U.S. Fish and Wildlife Service (USF... Cite			
>	Kentucky Stream Asse...	KY Division of Water	KY
>	Qualitative Habitat ...QHEILS	USACE	KY
> State: GA			
> State: OH			


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SUMMARY AND TAKEAWAYS



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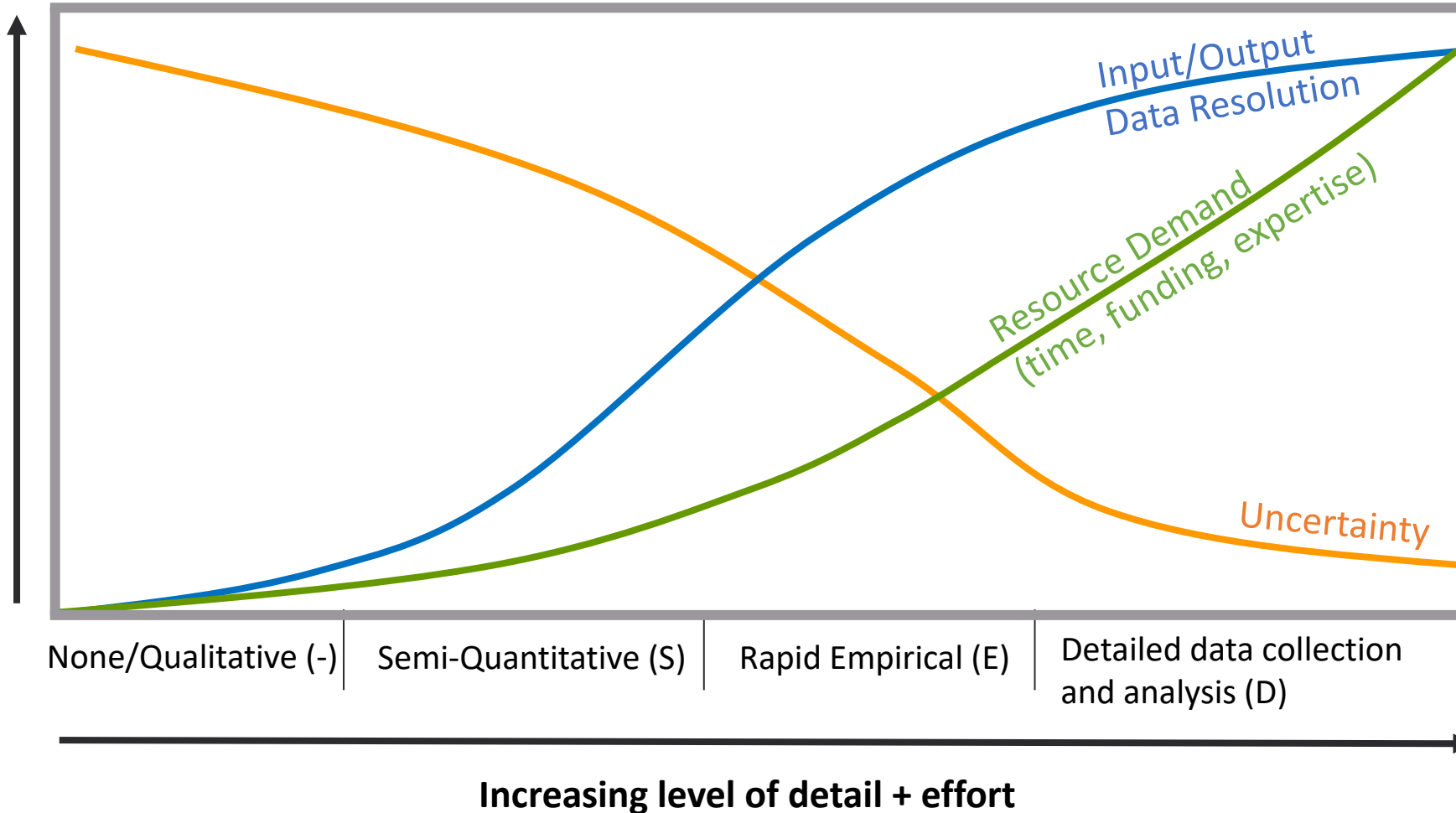


MAKING DECISIONS WITH A DIVERSE TOOLBOX



Increasing:

Data Resolution
Resource Demand
Uncertainty





SUMMARY + TAKEAWAYS



- Reviewed and analyzed some of the currently most commonly used stream assessment resources
- Resources covered wide ranges of detail, discipline, regional focus, and effort
- Most currently available individual stream assessment resources are limited
- Limitations are influenced by local/regional needs and resource availability
- Identified strengths and gaps in stream assessment resources
- Identified opportunities to develop and utilize a diverse toolbox of assessment resources to meet a range of practitioner needs



SUMMARY + TAKEAWAYS



- Stream assessment practitioners require a **diverse toolbox** of stream assessment resources
- Resources should include methods, models, and protocols across a **range of levels of effort** and degrees of input data resolution
- Ideal tools would evaluate ecological outcomes relative to **ecosystem functions** and habitat provision
- The assessments should be **conceptually linked**
- Future toolkits would ideally be **nationally applicable** in scope

NEXT STEPS



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NEXT STEPS...

- **Development of conceptual framework for tiered approach to stream assessment**
- Society of Freshwater Sciences Conference (June 2024)
- National Stream Restoration Conference (June 2024)
- Technical note in review
- Web app: making resources widely available, incorporating feedback from practitioners





ACKNOWLEDGEMENTS



- We received input from ERDC collaborators in Environmental Lab + Coastal Hydraulics Laboratory
- The study was conducted with support from the Ecosystem Management and Restoration Research Program (EMRRP).
- For information on EMRRP, please contact the program manager, Dr. Brook Herman (Brook.D.Herman@erdc.usace.army.mil), or consult <https://emrrp.el.erdc.dren.mil/>.





THANK YOU

Web tool URL:

<https://gtmenichino.github.io/RiverEngineeringResources/assessment>

Web tool QR code:



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<https://emrrp.el.erdcdren.mil/>