STREAM FUNCTIONS ASSESSMENT AND RAPID INDEX (SFARI)

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OBJECTIVES

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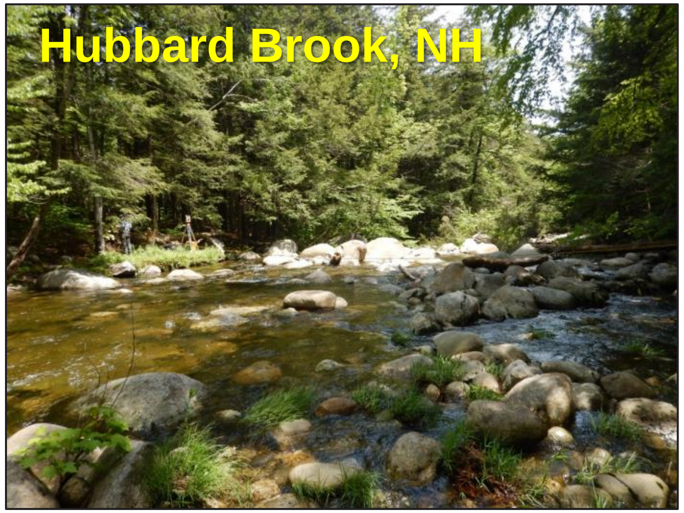
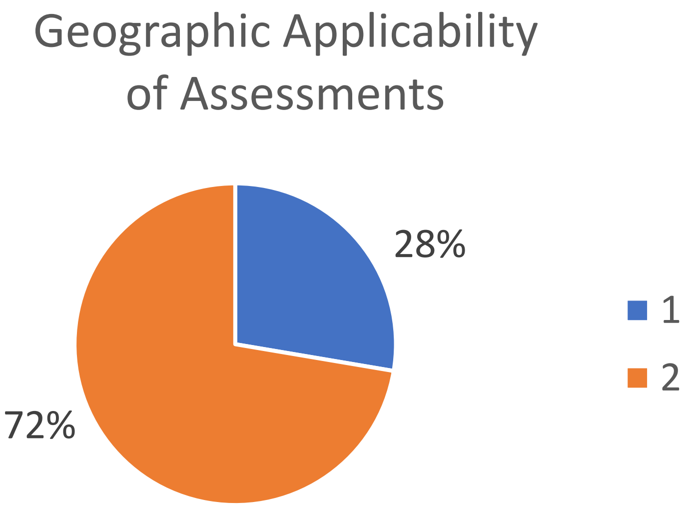
Stream Functions Assessment and Rapid Index (SFARI)

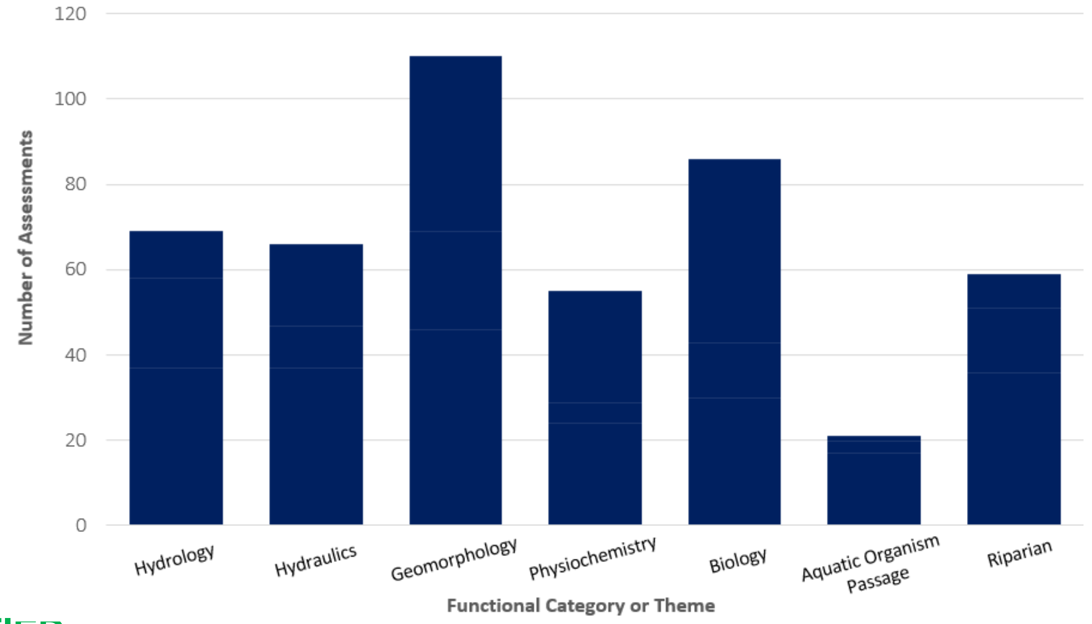
1. **Why do we need it?** Addresses key challenges in stream assessment.
2. **What is it?** A rapid, semi-quantitative, function-based stream assessment.
3. **Where can you use it?** Use cases. Applicability. Tiered approach.
4. **How does it work?** Workflow, scoring, example outputs, next steps



WHY DO WE NEED SFARI?

- We've reviewed over 188 stream assessments (90% grey)
- Coverage gaps: Geomorphic (59%) and Biological (46%) dominate
  - Few (<5%) span the full suite of functions.
- Only 28% are nationally applicable. Only 25% apply to all stream types.
- **Takeaway**
  - We don't have a rapid assessment, that is nationally applicable, covers all stream types, and covers the full set of stream functions





WHERE SFARI FITS: RAPID ASSESSMENT

Align assessment level with your project needs to support efficient decision making.

SCREENING LEVEL

Desktop GIS, Brief Recon
(Minutes to Hours)

Scoping, site screening

RAPID LEVEL

Focused field work, limited modeling/lab
(Hours to Day)

Design, alternatives comparison

DETAILED LEVEL

Intensive field work, extensive modeling/lab
(Days to Week)

Final design, post-construction monitoring, regional studies

WHO IS SFARI FOR?

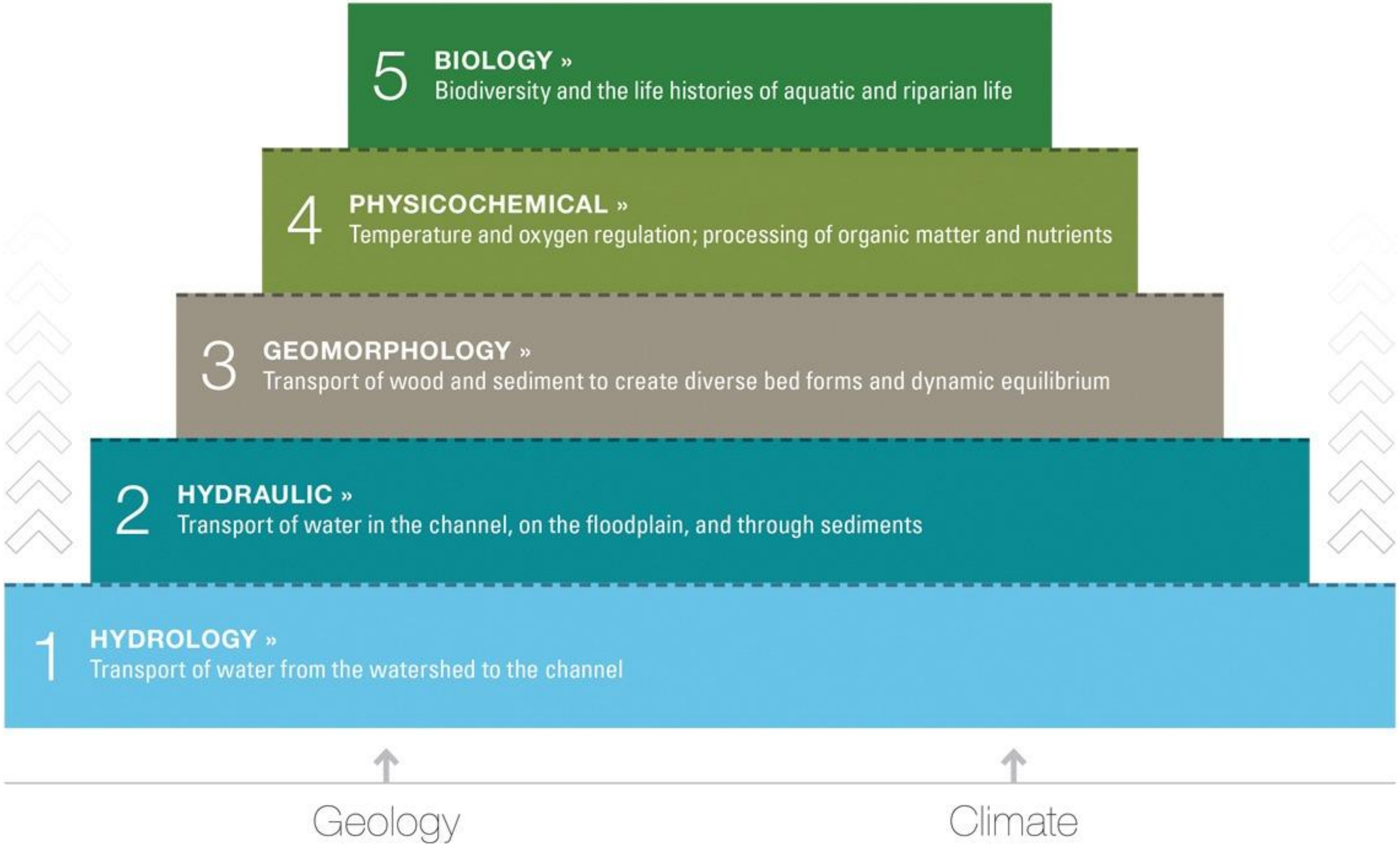
- USACE Planning-Level Ecosystem Restoration Studies
  - Existing conditions evaluation
  - Forecasting/alternatives evaluation-estimate functional lift and compare options
- USACE mitigation teams in regulatory, IRT teams
  - Compare SFARI with other rapid regulatory tools at similar level of effort
  - Identify gaps and inform improvements to regulatory tools
- Applicability:
  - National, wide range of stream types
  - Wadeable streams

Utoy Creek, GA

Stepchinski LM, McKay SK, Menichino GT. 2025. A Tiered Approach to Developing Function-Based Stream Assessments. (In-Review)

STREAM FUNCTIONS

- Adopts stream functions from guiding frameworks on Stream Assessment
- Functions organized by discipline
  - Hydrology
  - Hydraulics
  - Geomorphology
  - Physicochemistry
  - Biology



Harman et al., 2012

24 STREAM FUNCTIONS

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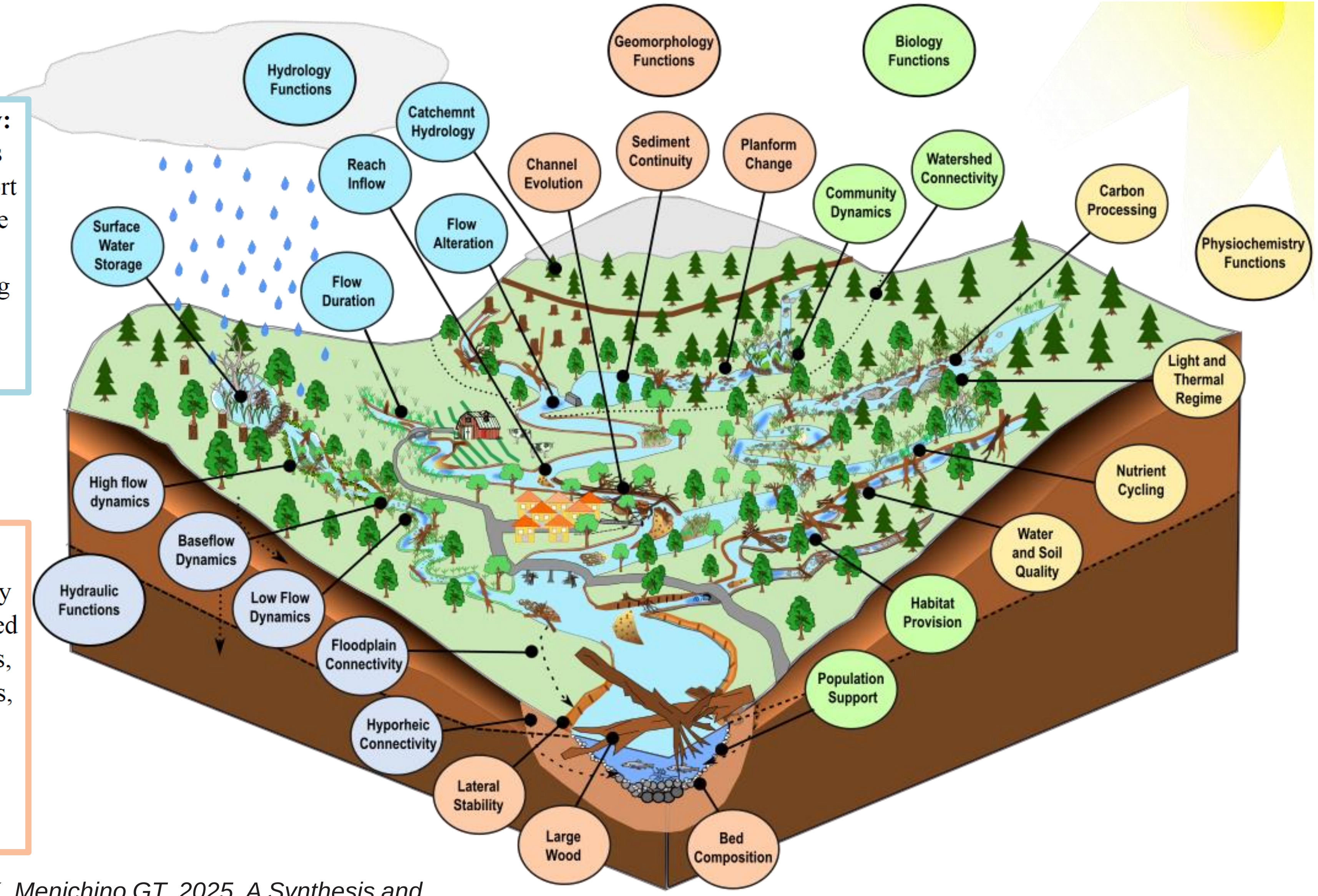
Floodplain Connectivity: Frequent overbank flows reduce flood peaks, support riparian vegetation, create off-channel refugia, and extend nutrient processing time.

Score:

Sediment Continuity Balanced sediment supply and transport preserves bed elevations, substrate sizes, spawning/benthic habitats, and supports riparian succession.

Score:



Carbon Processing: Organic matter is captured and broken down, fueling food webs, balancing production/ respiration, moderating pH/ redox, and supplying nutrients.

Score:

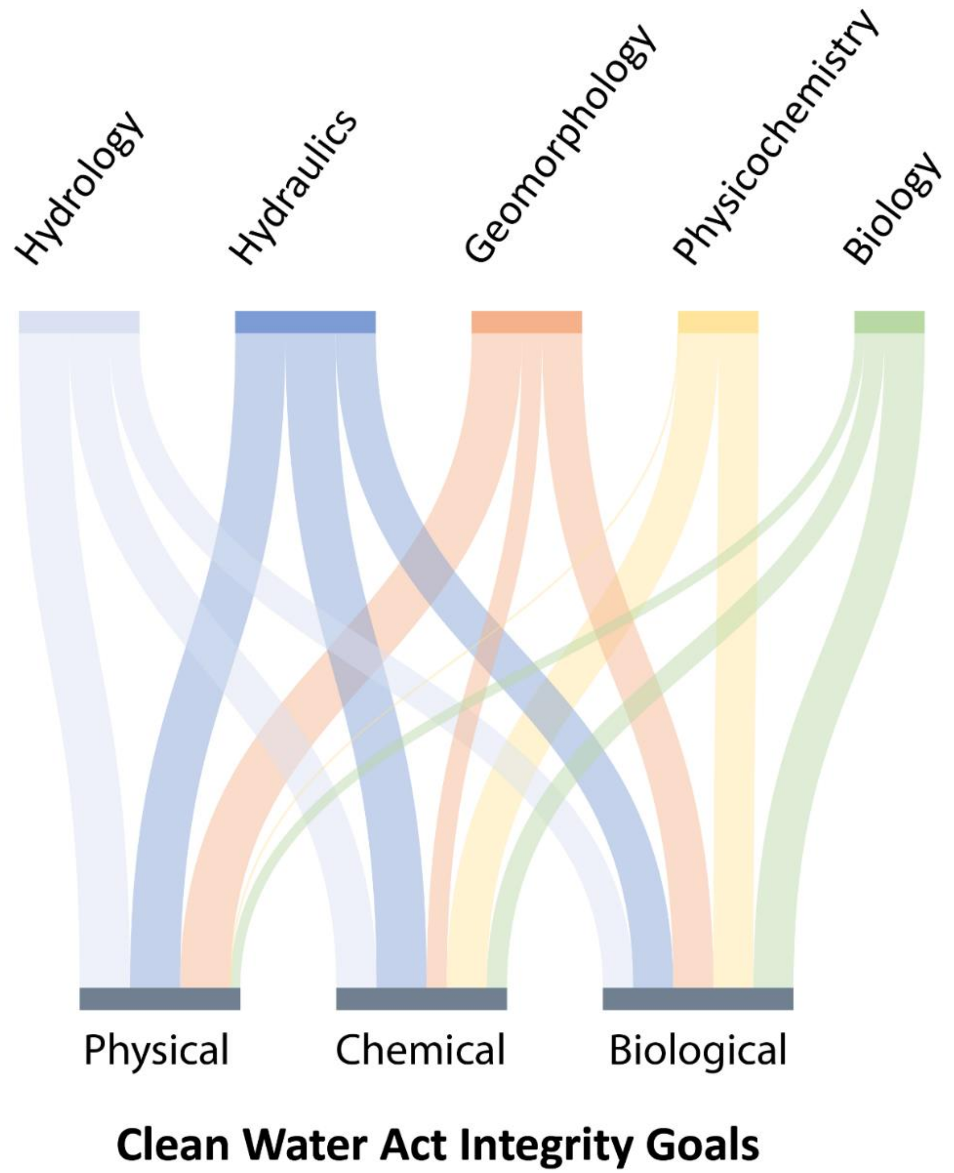
Habitat Provision: Channel and floodplain structure supply depth, velocity, substrate diversity, and vegetation to support native organisms through all life stages.

Score:

Stepchinski LM, McKay SK, Menichino GT. 2025. A Synthesis and Inventory of Stream Functions. (In-Review)

CLEAN WATER ACT FRAMING

- 24 stream functions across 5 disciplines
- Functions aligned with Clean Water Act integrities: physical, chemical, biological
  - Fischenich (2006)
  - Harman et al. (2012)
- Enables consolidation into defensible, decision-ready scores
- Supports holistic assessment aligned with regulatory goals



Stepchinski LM, McKay SK, Menichino GT. 2025. A Synthesis and Inventory of Stream Functions. (In-Review)

SFARI
CONCEPTS AND STRUCTURE

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WHAT IS SFARI?

What can it be used for?

- Screening
- Alternatives evaluation
- Tracking stream condition over time

What type of assessment is it?

- Semi-quantitative
- Function-focused
- Combination of field + desktop-based metrics

How is the assessment performed?

- Uses semi-quantitative scoring, qualitative evaluation, and field observations

Where can it be applied?

- Nationally applicable: portable across US with regional reference anchors

Limitations:

- Not a credit calculator or a detailed assessment

Assessment steps

Desktop Analysis
- Select reach
- Locate aerial imagery + maps
- Perform desktop analysis

Field Analysis
- Systematic walk of stream reach
- Record observations with photos + notes

Scoring
- Score qualitative metrics in the field on form
- Score quantitative functions
- Record additional notes

SFARI Index
- Roll-up scores with calculator
- Calculate indices
- View charts + summary table

Field + desktop analyses

Desktop analyses:

- Perform before field analysis
- 30% metrics require desktop evaluation
- Indicated on form
- Guidelines provided in documentation and training material
  - Streamlined data collection process
- Time: ~ 1 hour

Example:

- Using EPA EnviroAtlas to evaluate Impervious Surface Area

Stream Functions Assessment and Rapid Index (SFARI) Field Worksheet (Version 1.0)

Reach ID: Reach Length: Date: Assessor(s): Coordinates:

SCORING INSTRUCTIONS

Function scores are judgment-based evaluations reflecting the stream condition relative to physical or ecological function. Metrics record the logic embedded in the function and can be used to calculate a function score. Each metric has a specific context: W = Watershed, F = Floodplain, C = Channel and Bank. Metrics may be omitted with "NA", or metrics may be added. A minimum of three metrics per function is recommended. Metrics requiring field analysis or desktop analysis are noted with F or D. Assessment involves two steps:
1) Score metrics for agreement with statements: Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D), Strongly Disagree (SD), Not Appl (NA)
2) Score functions using metrics based on the following scale: Functioning (15 to 11), Functioning At-Risk (10 to 6), or Non-Functioning (5 to 0)

Function	Metrics	Score
HYDROLOGY FUNCTIONS		
Catchment Hydrology: Runoff and infiltration sustain natural flow regime, carry appropriate sediment and nutrients from uplands, and reliably cue spawning/ migration of aquatic life.	**Impervious surface area**$^{W, D}$: Coverage is minimal, preserving near-natural infiltration/runoff timing, consistent with reference levels.	
	Road density$^{W, D}$: Road density is low enough to avoid significant runoff or sediment inputs, consistent with minimal watershed impact.	
	Land use change$^{W, D}$: <5% land cover shift in ~15–20 years, indicating stable infiltration/runoff consistent with historical conditions.	
	Impoundments$^{W, D}$: Flow is near-natural, with no major dams or only negligible small ones, unless larger dams are historically normal.	
Score:	Notes/Other Metrics:	
Surface Water Storage: Wetlands and storage features store floodwater, recharge groundwater, sustain baseflow, and provide low-velocity habitat.	**Wetland coverage**$^{F, D}$: Sufficient wetlands/ponds for flood attenuation/baseflow support, unless minimal wetlands are historically normal.	
	Floodplain water retention$^{F, F}$: Moderate floods (~1–5 yr) reach the floodplain, providing water retention/infiltration per regional norms.	
	In-channel ponding/beaver$^{C, F}$: Small beaver-type impoundments aid baseflow/habitat; no major fragmentation unless historically normal.	
	Off-channel storage$^{F, F}$: Side channels/beaver ponds/oxbows connect during moderate floods, providing off-channel storage and habitat	
Score:	Notes/Other Metrics:	

Field + desktop analyses

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Field analyses:

- 70% metrics are evaluated in the field
- Indicated on form
- No equipment necessary
  - Options to bring equipment if desired
- Time: ~ 1 - 1 ½ hour

Example:

- Using visual inspection to evaluate streambed vegetation

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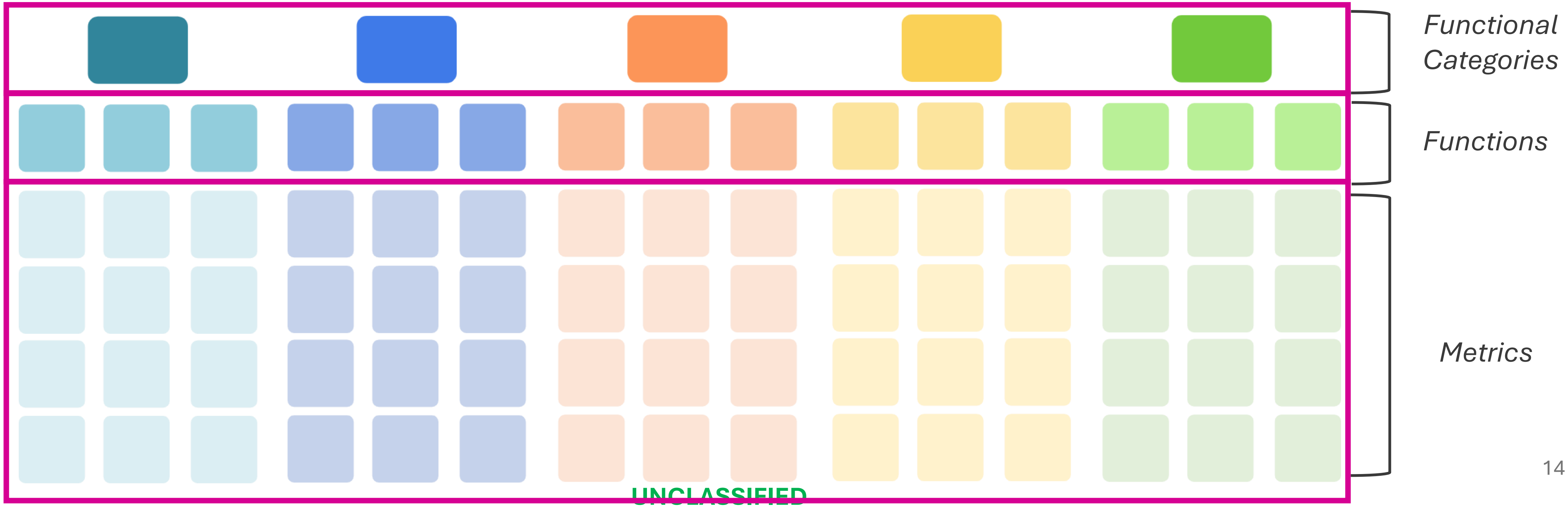
Score:	Notes/Other Metrics:	

SFARI STRUCTURE

Functional Categories
- Hydrology, Hydraulics, Geomorphology, Physicochemistry, Biology

Functions
- e.g. Catchment Hydrology, Surface Water Storage, Flow Duration

Metrics
- e.g., Impervious surface area, Wetland coverage, Streambed vegetation

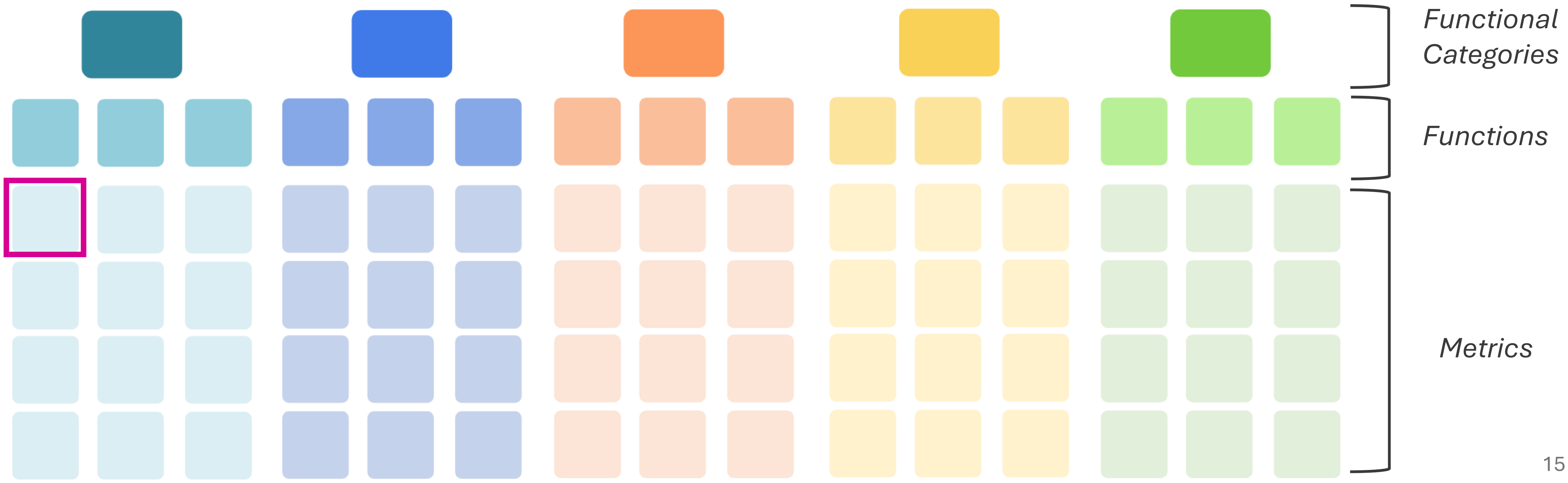


Metrics are scored qualitatively: Likert Scale

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

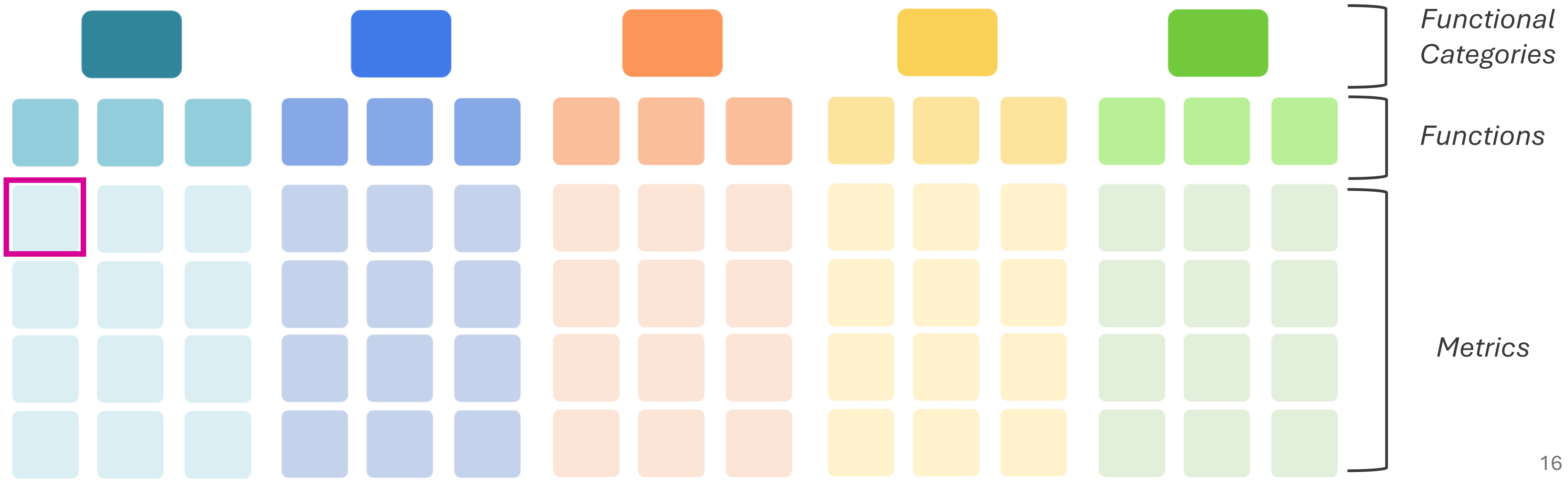
Not applicable

Road/highway drainage[C, F]: Runoff is minimal or well-managed, causing no significant direct inflows or pollutant pulses.	**A**



Metrics are scored qualitatively

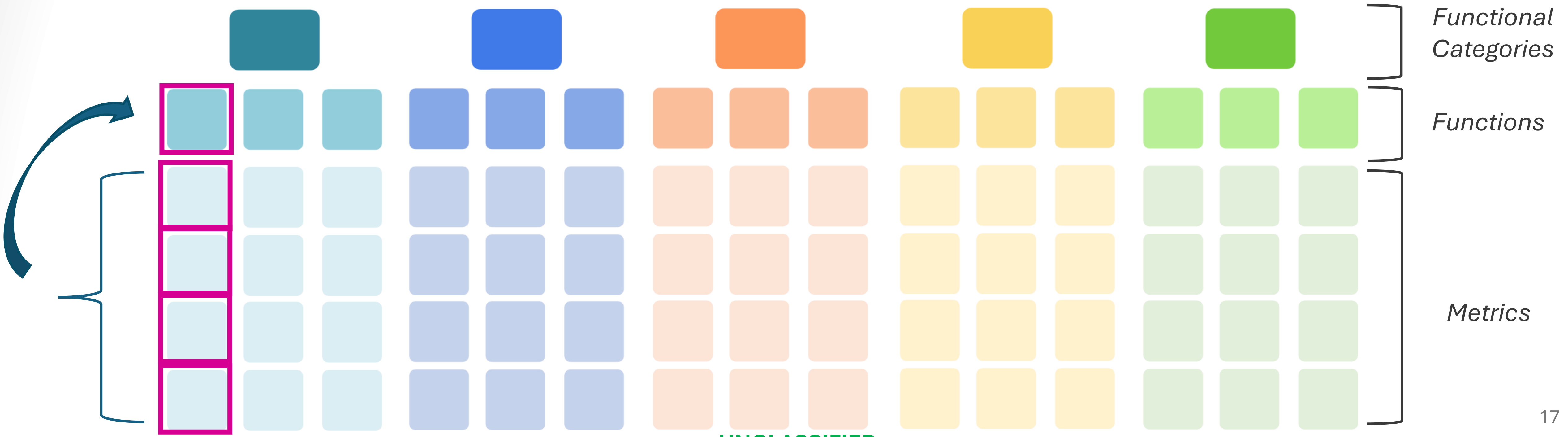
Based on: visual observations, desktop, expertise, reference condition (historical), landscape

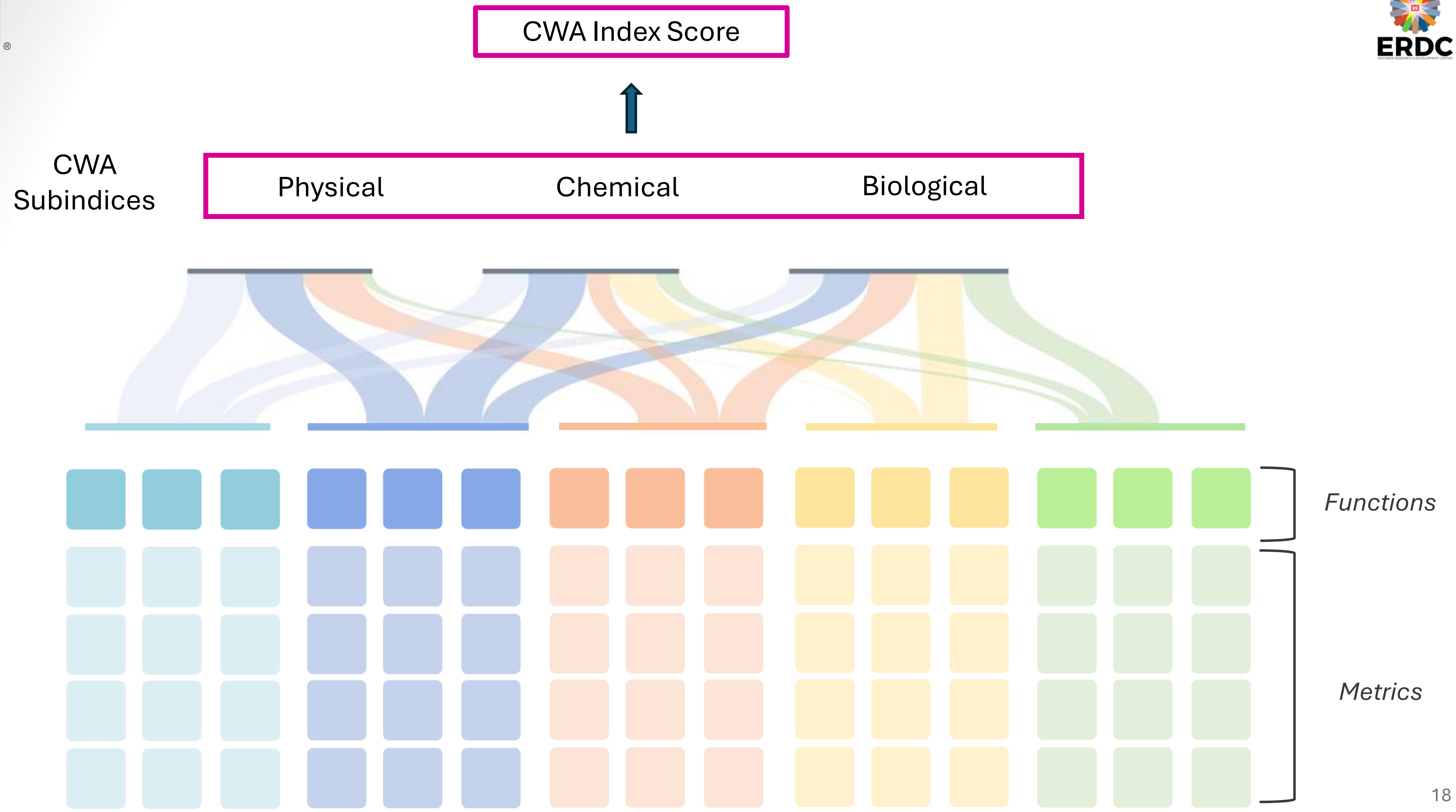


Functions are scored semi-quantitatively

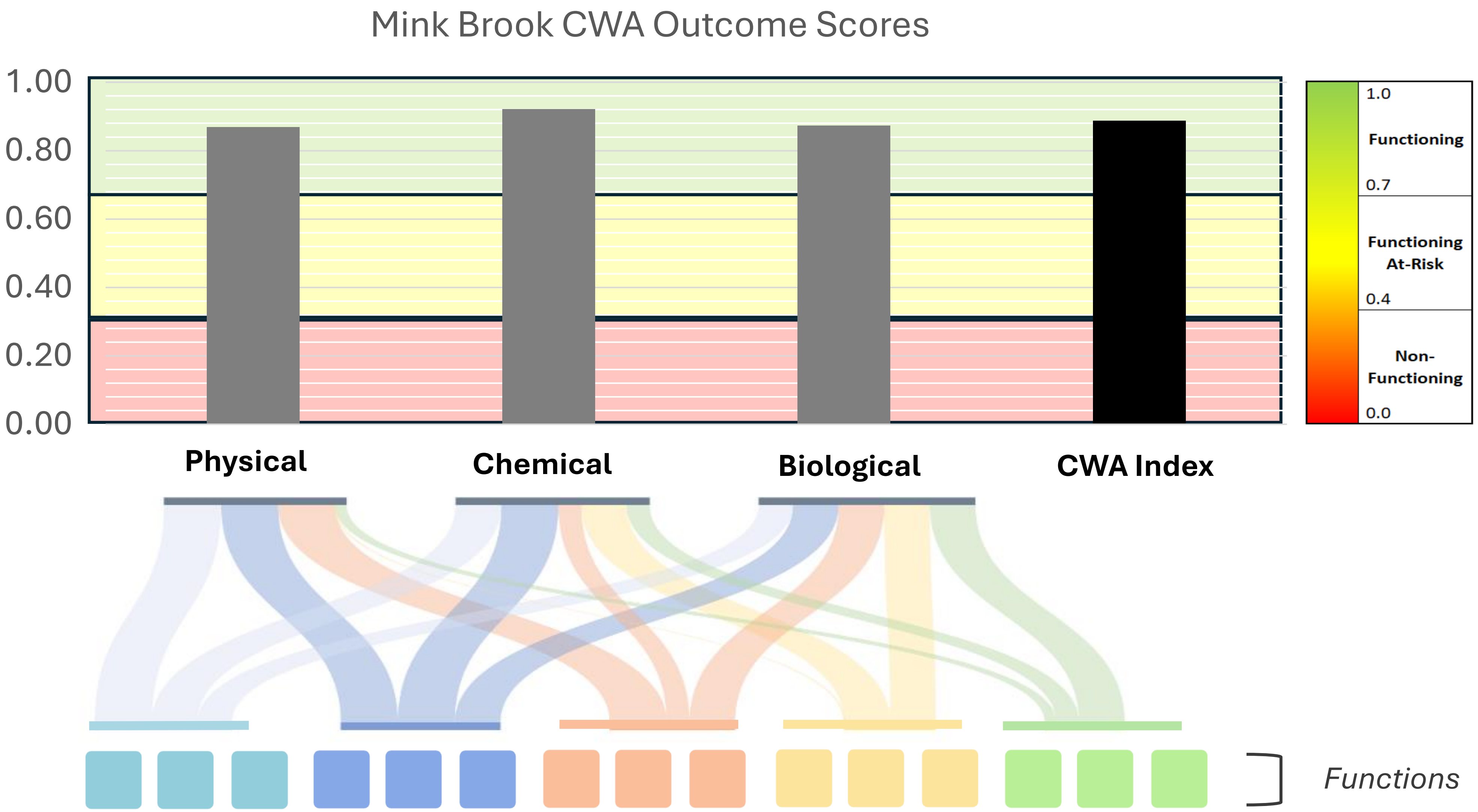
Based on: logic from metric scoring

15	Functioning
14	
13	
12	
11	
10	Functioning At-Risk
9	
8	
7	
6	
5	Non-Functioning
4	
3	
2	
1	
0	



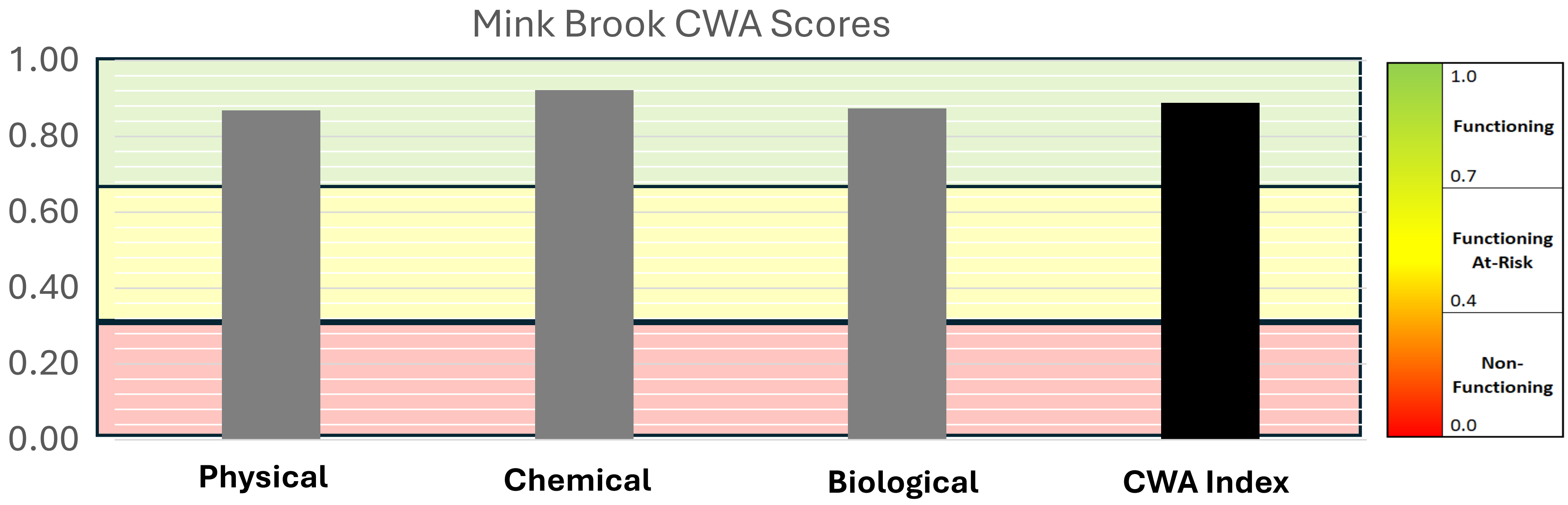

CWA Index Score
CWA Subindices
Physical
Chemical
Biological
Functions
Metrics

CWA SCORING


Mink Brook CWA Outcome Scores
1.00
0.80
0.60
0.40
0.20
0.00
Physical
Chemical
Biological
CWA Index
1.0
Functioning
0.7
Functioning At-Risk
0.4
Non-Functioning
0.0
Functions

CWA Scoring

- Clean Water Act scores capture stream condition
  - Physical, Chemical, Biological Sub-indices
  - Overall CWA Index
- Use to evaluate stream conditions, identify + prioritize management actions, and forecast conditions with action



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APPLICATION AND TESTING

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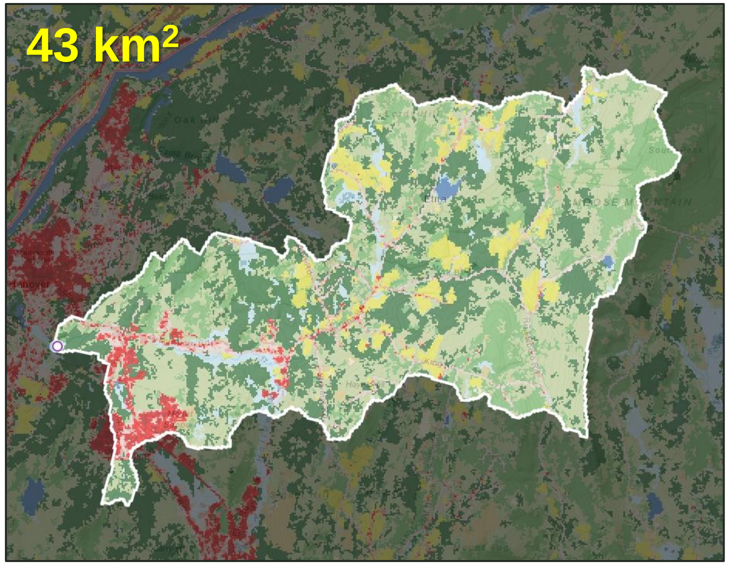
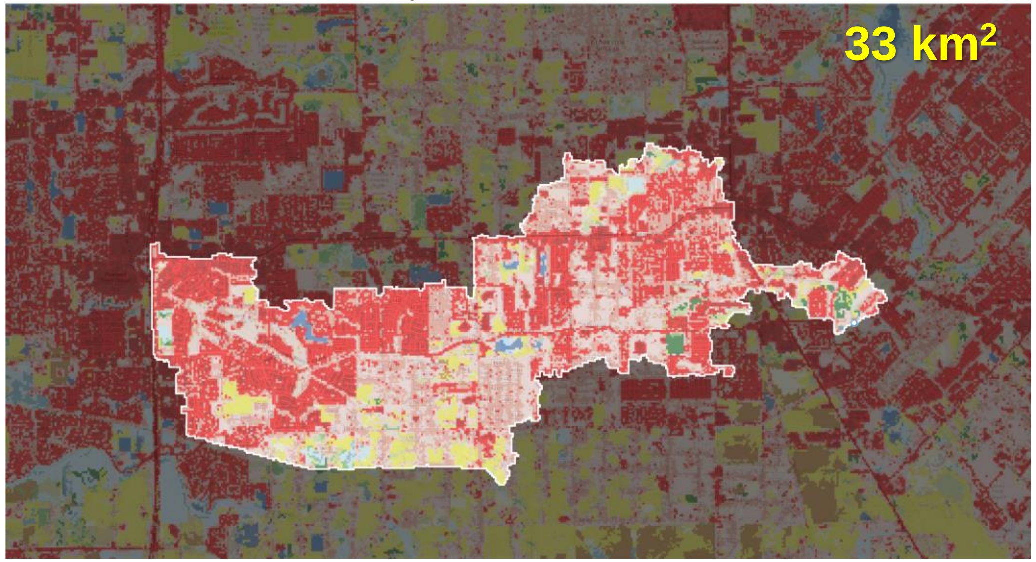
CASE STUDIES: MINK BROOK AND MARY’S CREEK

Mink Brook, New Hampshire



Mary’s Creek, Texas



CASE STUDY – MINK BROOK STREAM FUNCTIONS

Hydrology

Hydraulics

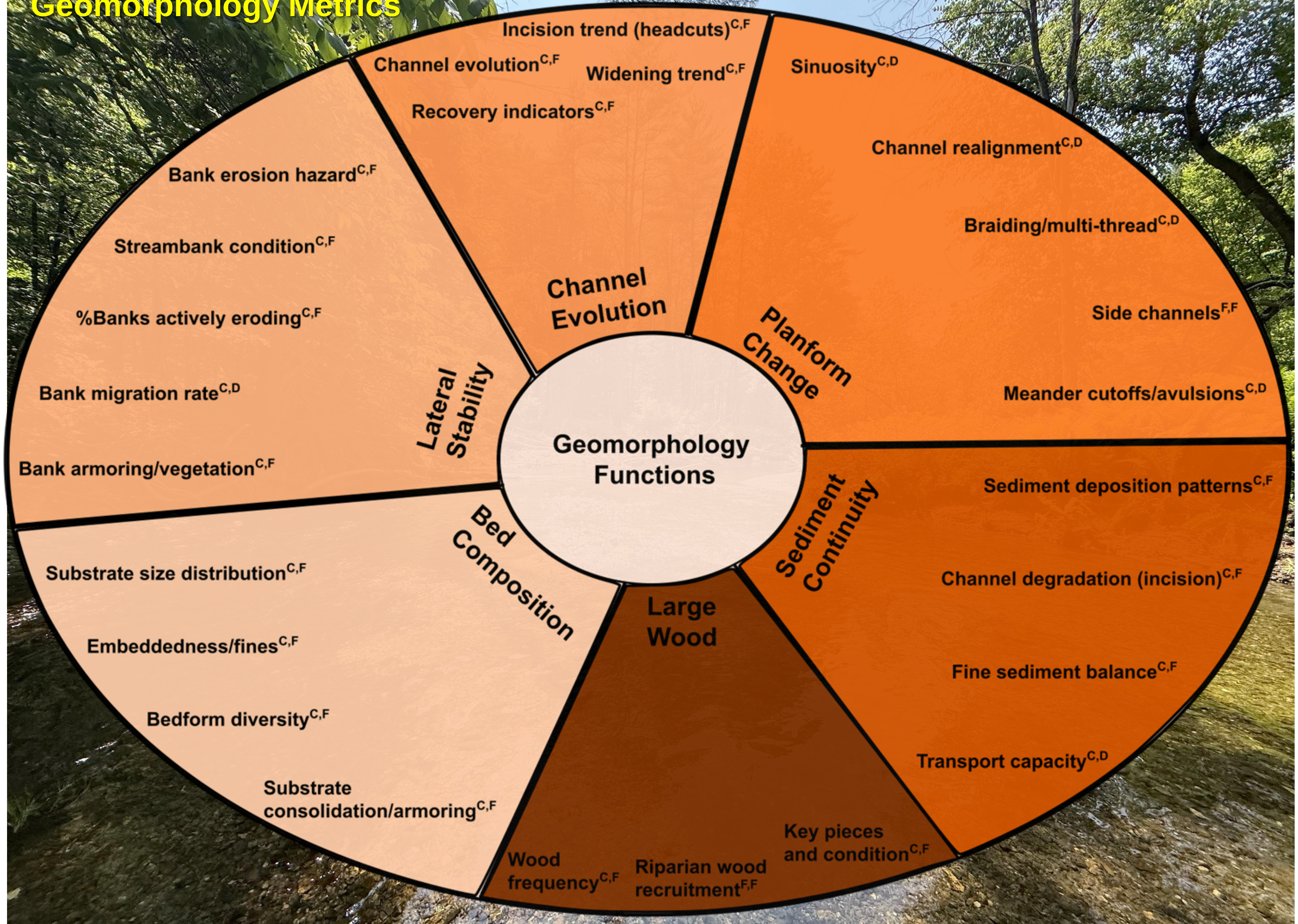
Physicochemistry

Geomorphology

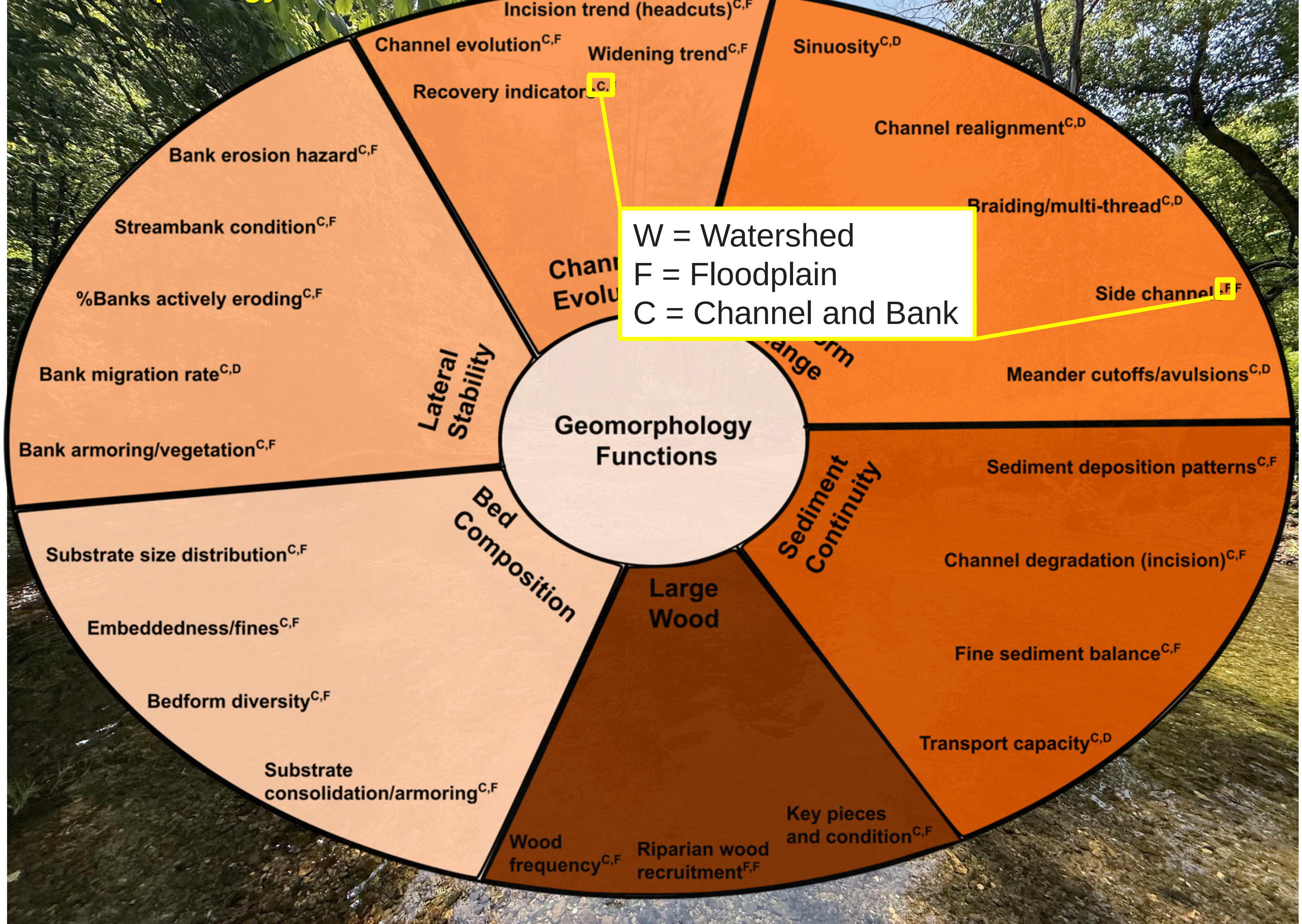
Biology

GEOMORPHOLOGY FUNCTIONS

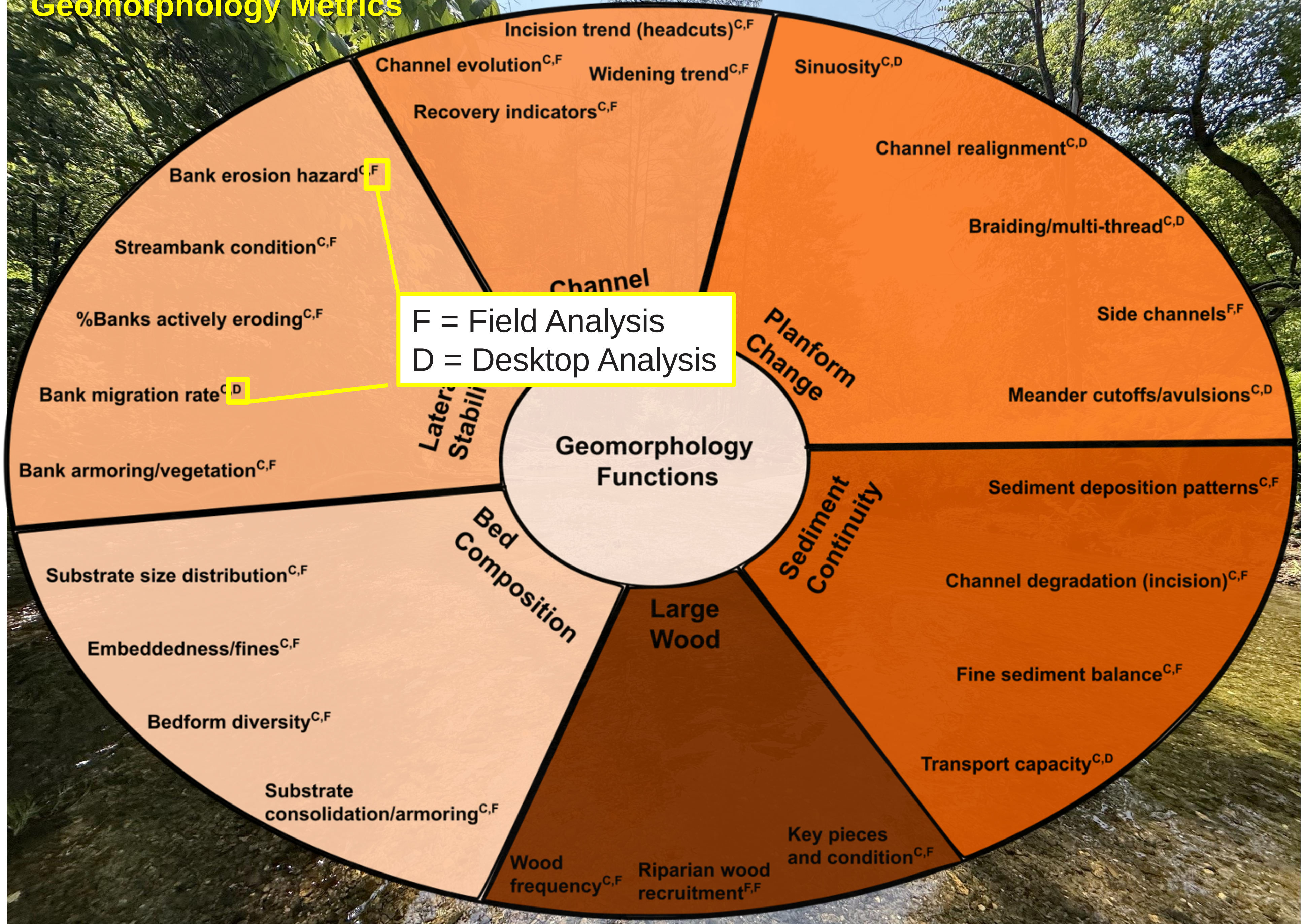
Geomorphology Metrics



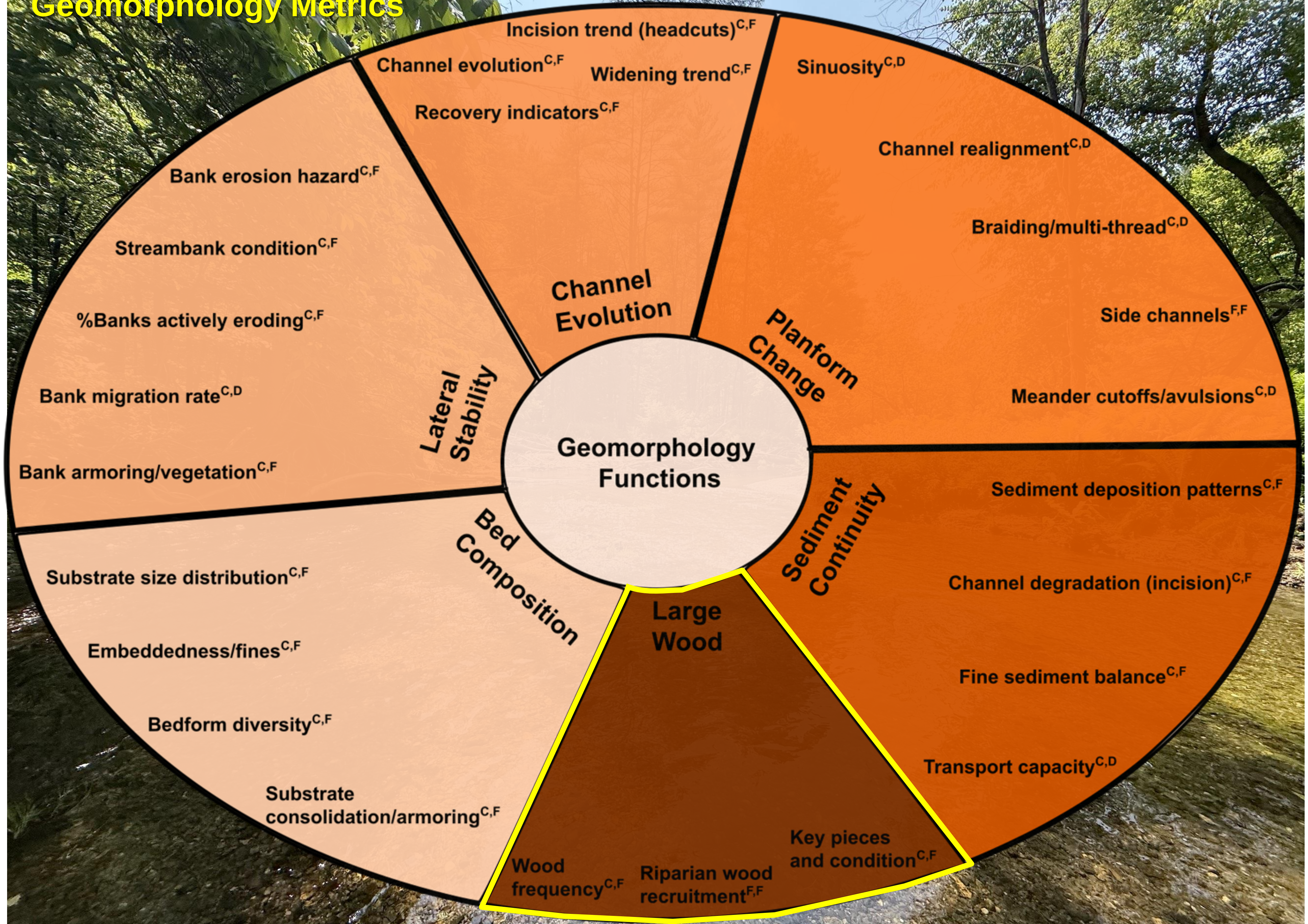
Geomorphology Metrics



Geomorphology Metrics



Geomorphology Metrics



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GEOMORPHOLOGY: LARGE WOOD FUNCTION

Large Wood Adequate recruitment and retention of large wood to deflect flow, form pools, stabilize banks, trap carbon, and build complex habitat.	**Wood Frequency**$_{C, F}$: Large woody debris is consistent with forested regions, unless historically minimal (e.g., treeless prairies).	N
	Key Pieces and Condition$_{C, F}$: Enough large woody debris (rootwads, stable pieces) fosters robust habitat in this forested stream.	N
	Riparian Wood Recruitment$_{F, F}$: The corridor has mature/mid-successional trees ensuring long-term large woody debris input.	A
Score: 10	**Notes/Other Indicators**: Except for jam there's not a lot of LW in center of channel.	

GEOMORPHOLOGY: LARGE WOOD FUNCTION

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

Not applicable

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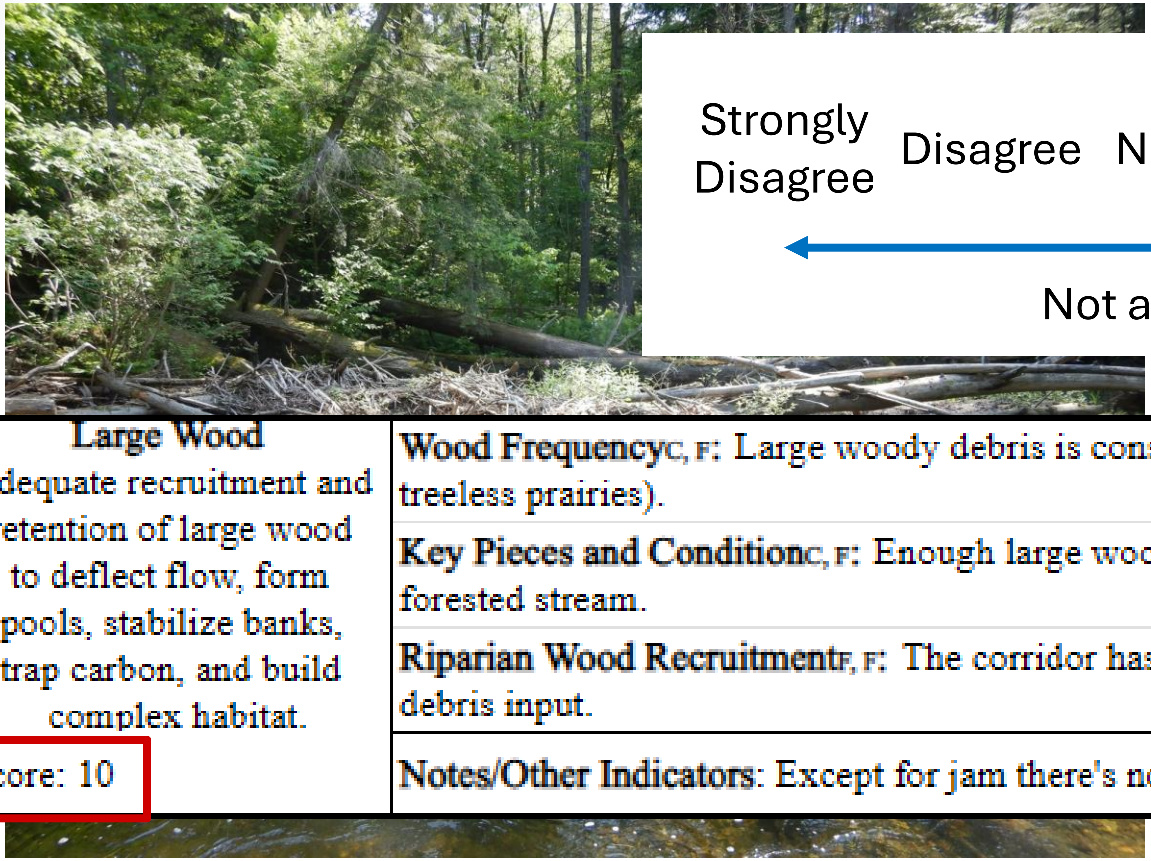

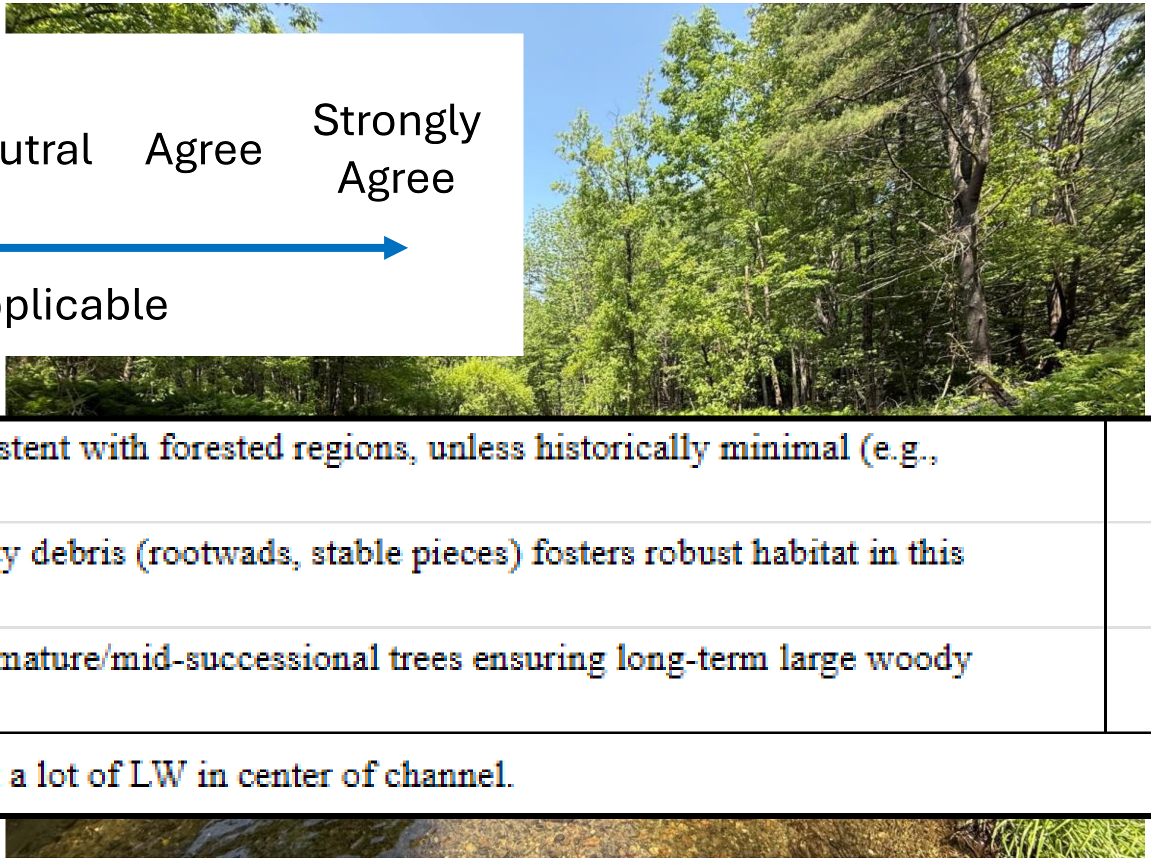

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

Not applicable

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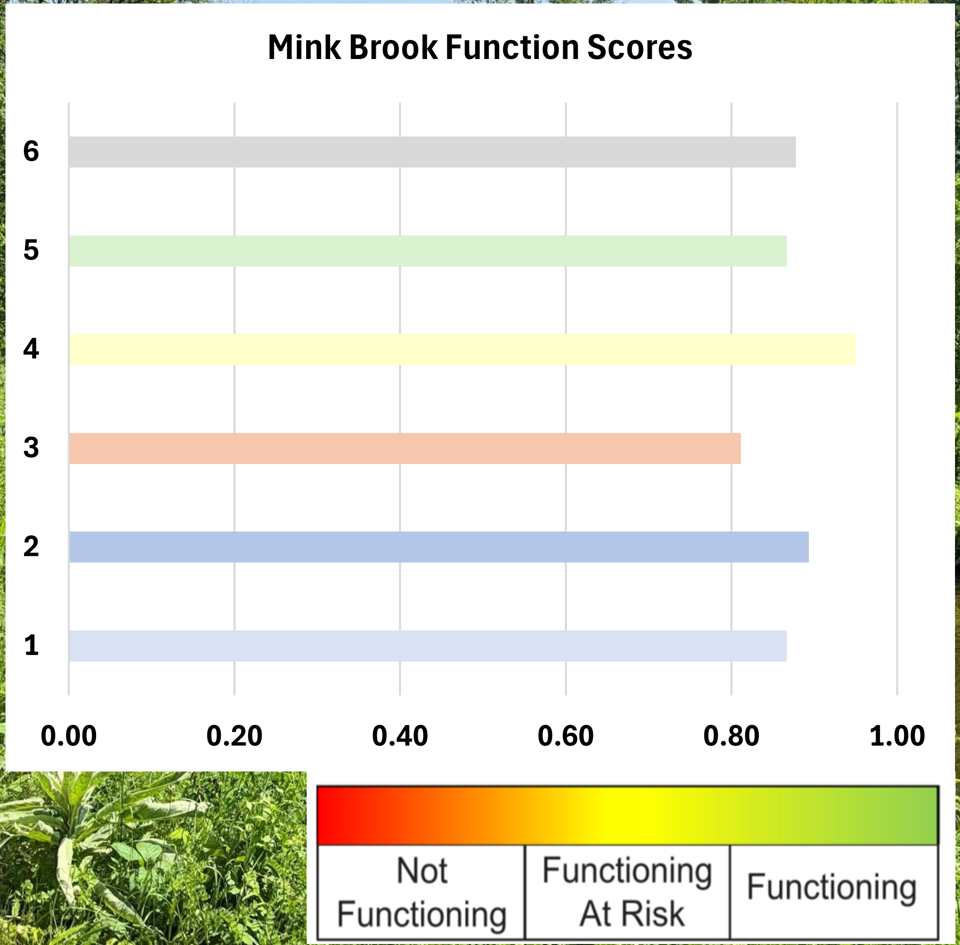
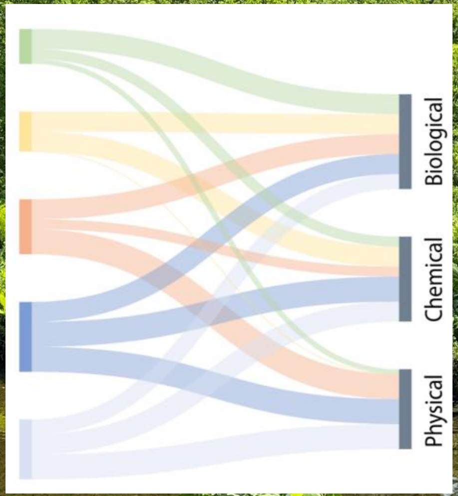
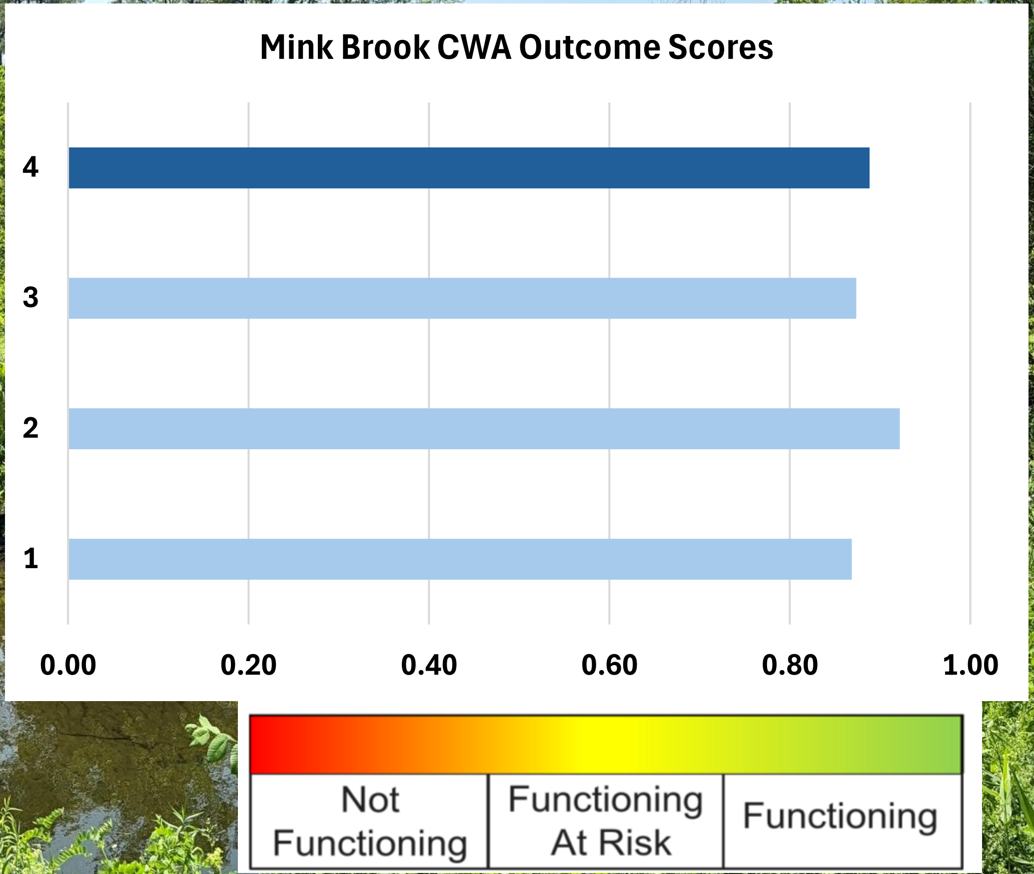
Non-functioning (0 to 5); Functioning at-risk (6 to 10); Functioning (11 to 15)

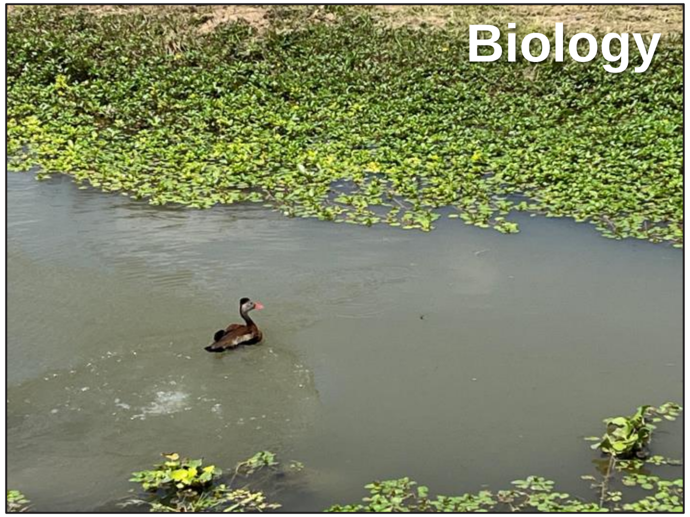
CASE STUDY: MINK BROOK FUNCTION SCORES



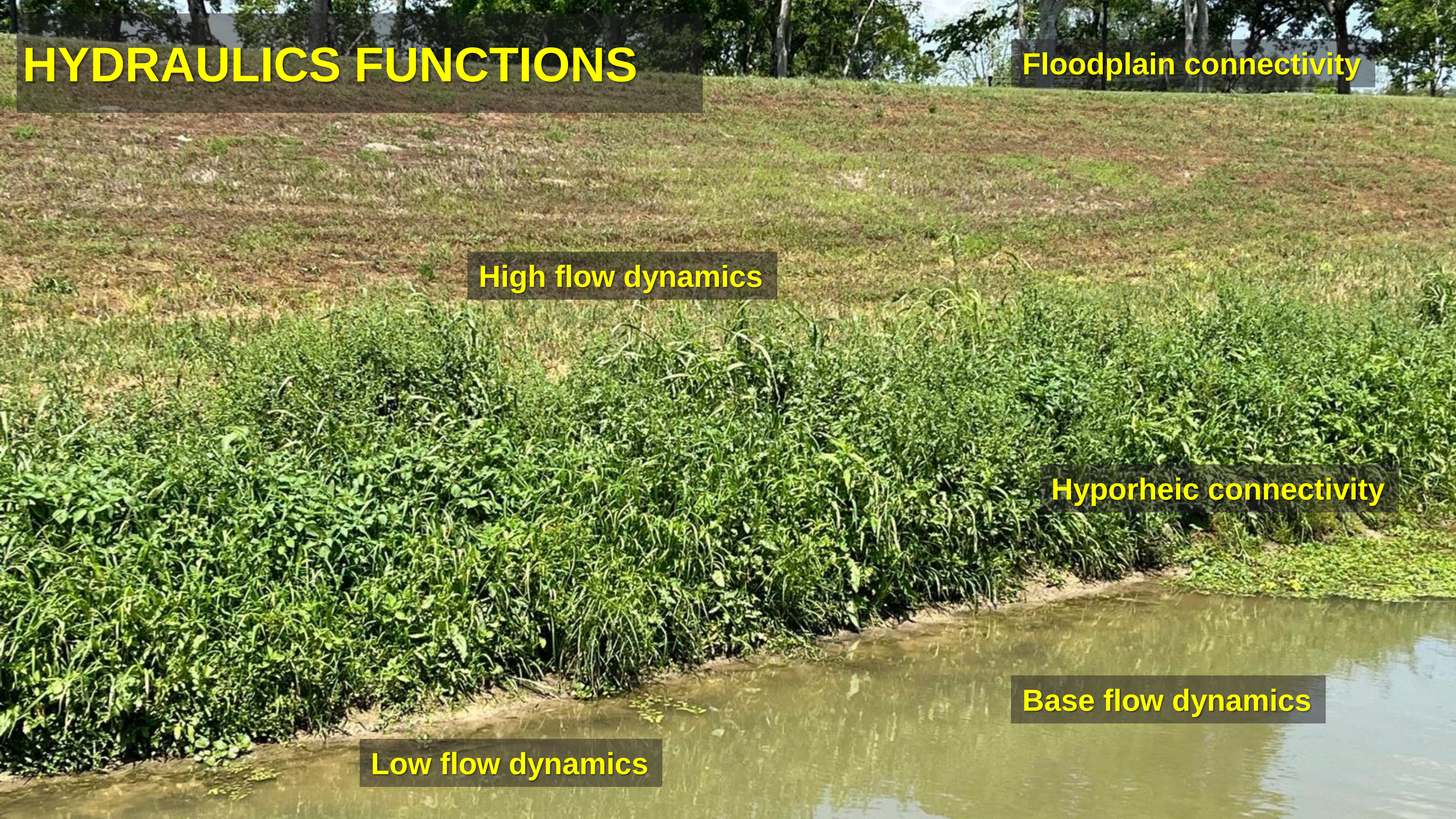




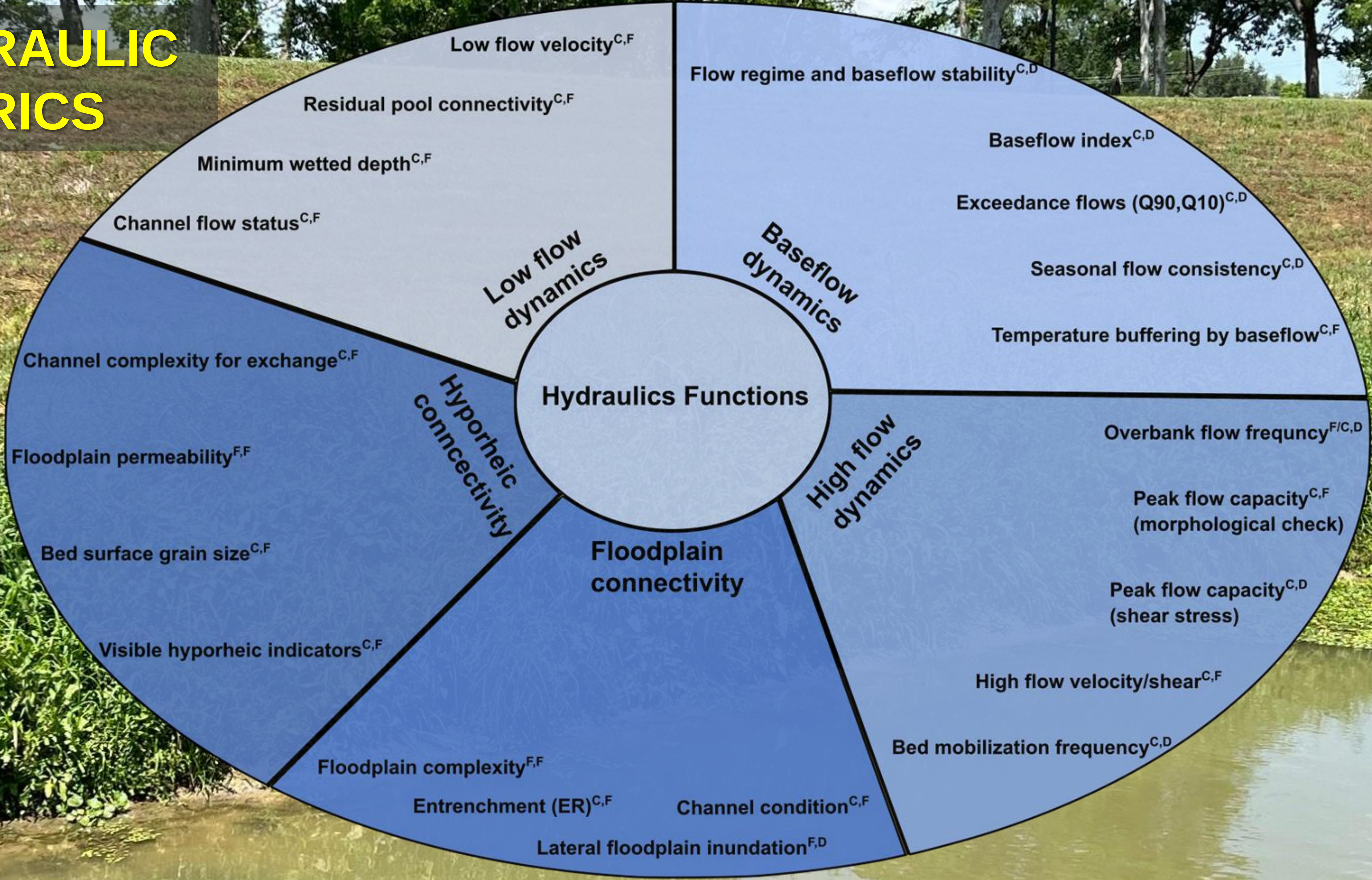
CASE STUDY: MARY'S CREEK



HYDRAULICS FUNCTIONS



HYDRAULIC METRICS



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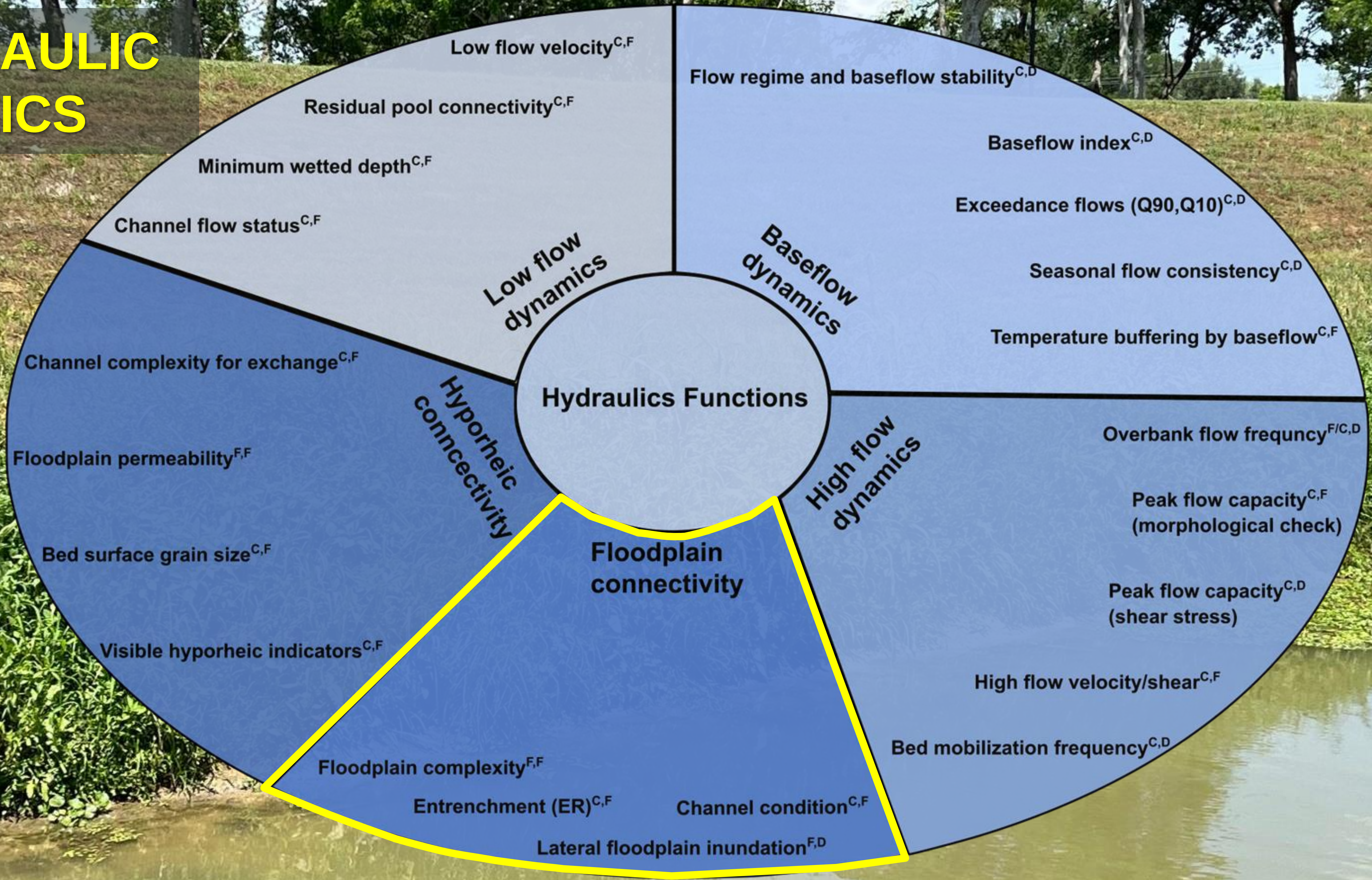

HYDRAULICS: FLOODPLAIN CONNECTIVITY

Floodplain Connectivity Enhances nutrient cycling and habitat availability via water exchange.	**Floodplain Complexity:** Floodplain/off-channel features stay diverse/connected at moderate floods, reflecting minimal loss.	SD
	Entrenchment (ER): Channel is not deeply incised; moderate floods access a broad floodplain, matching reference conditions.	SD
	Channel Condition: Stable, not heavily dredged/incised, allowing normal overbank flows/meanders unless dredging is historical.	SD
	Lateral Floodplain inundation: 1–2 yr floods routinely access the floodplain, matching reference inundation patterns.	SD
Score: 0	**Notes/Other Indicators:**	

HYDRAULICS: FLOODPLAIN CONNECTIVITY

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

Not applicable

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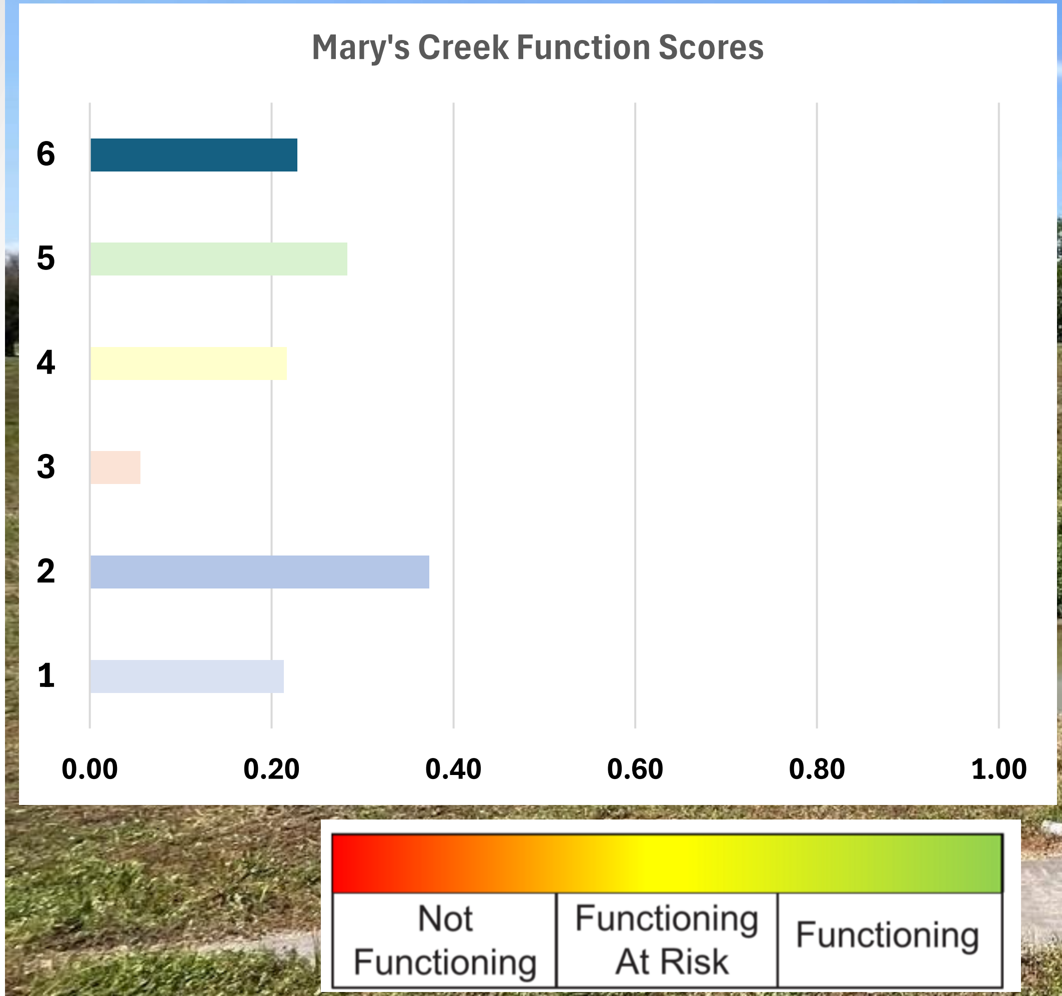
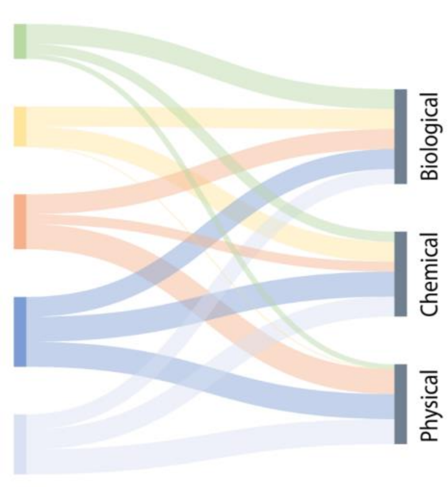
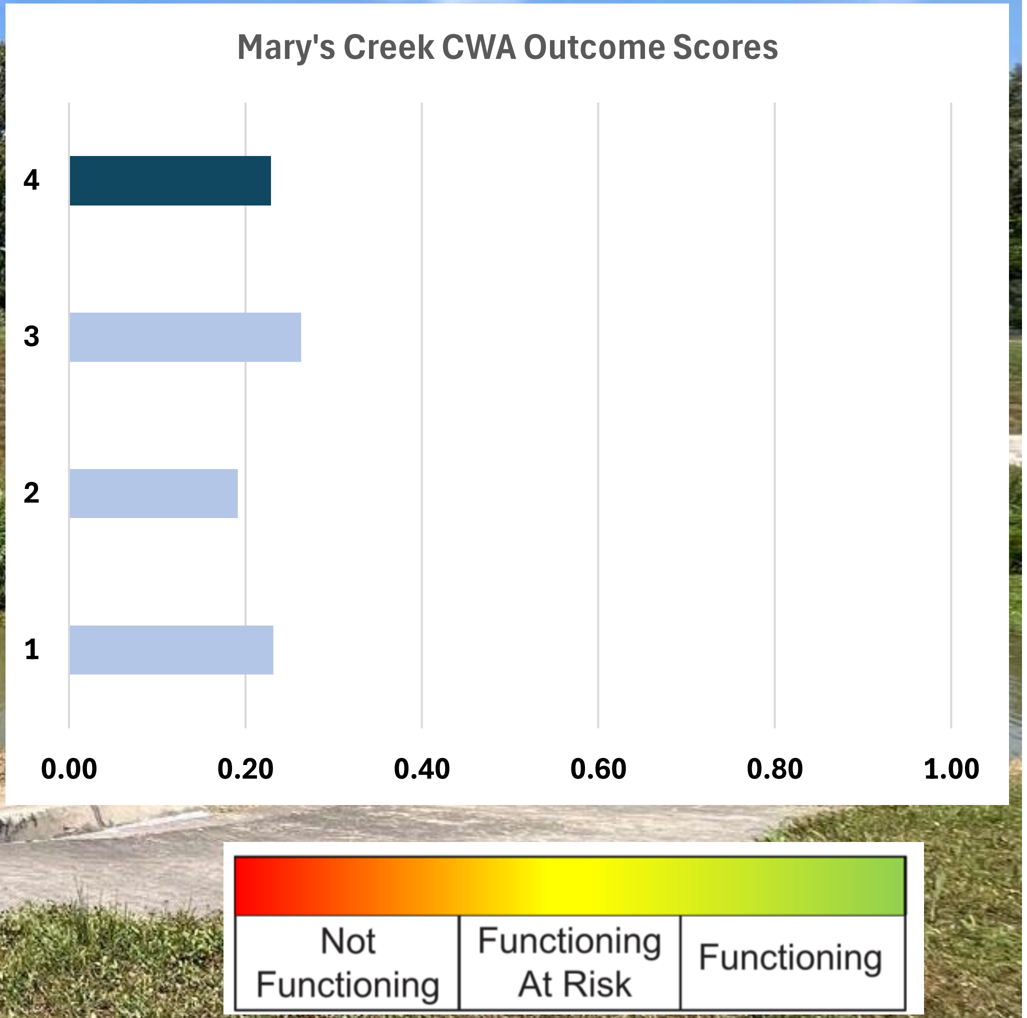


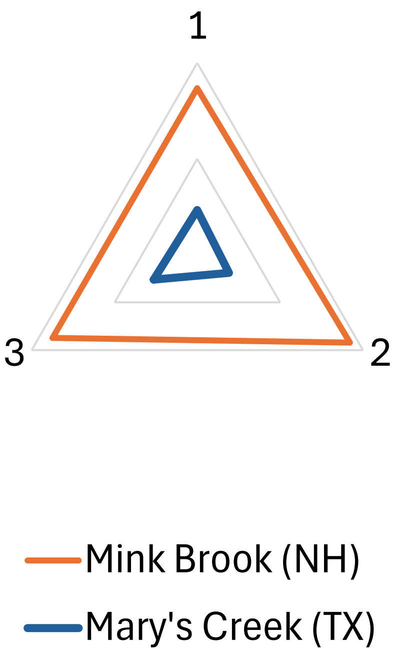




CASE STUDIES RESULTS COMPARISON

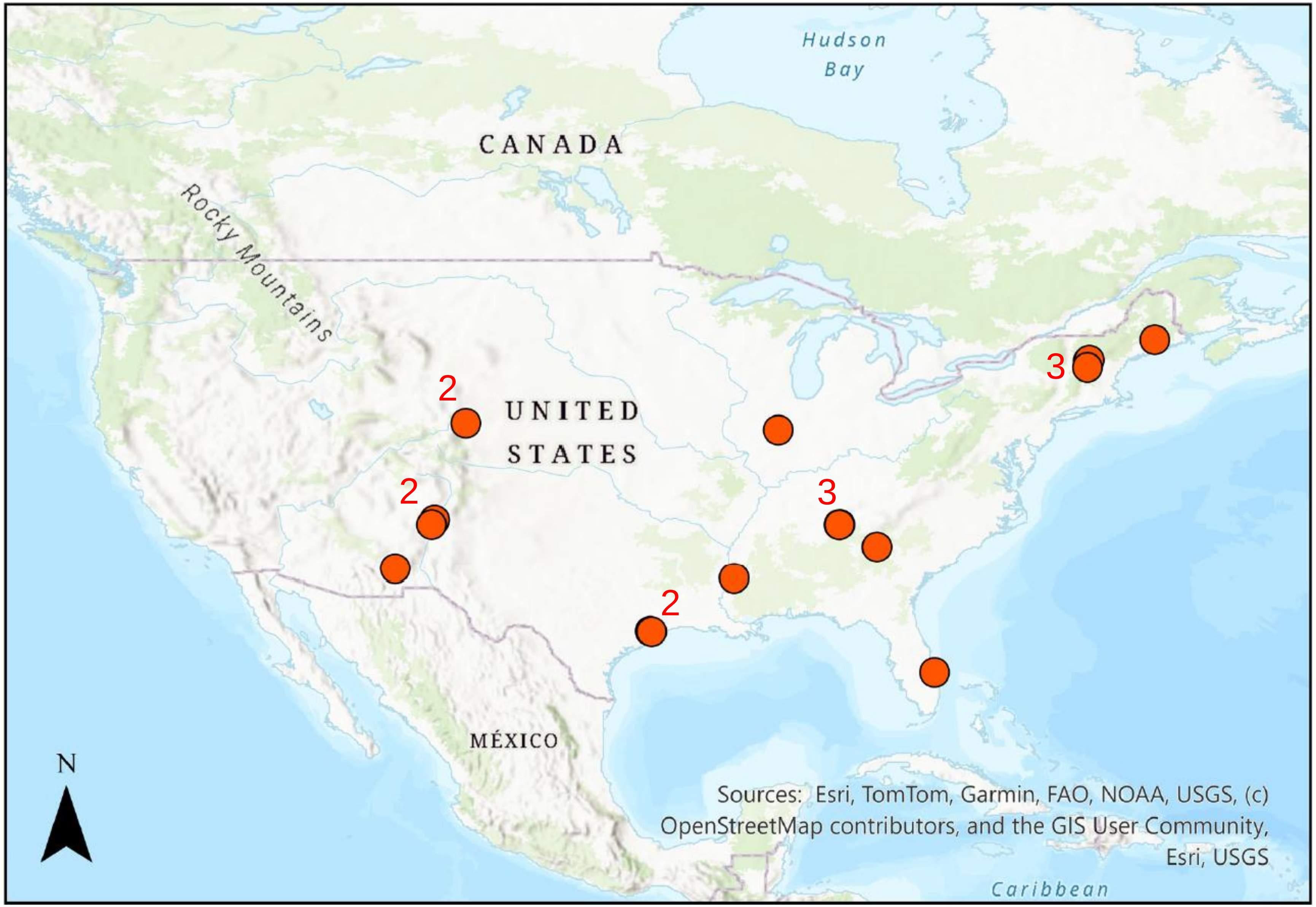
Mink Brook, NH

High Functioning



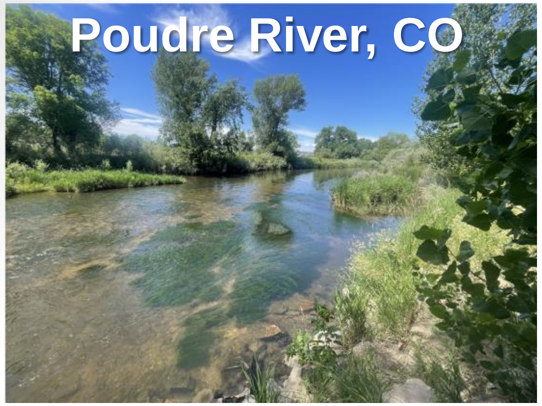
Mary's Creek, TX

Low Functioning

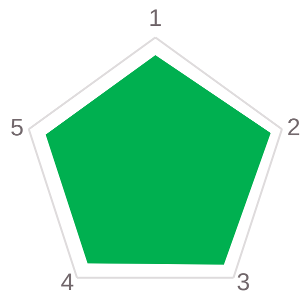


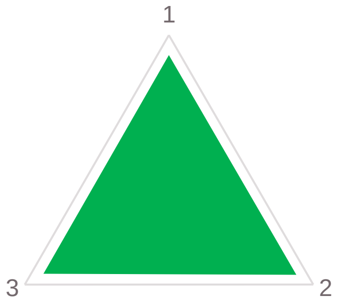
18 Sites
10 States

FIELD VERIFICATION OF METHOD



PR CO SW

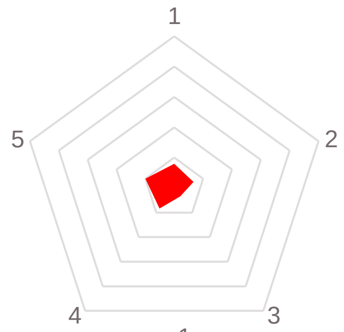


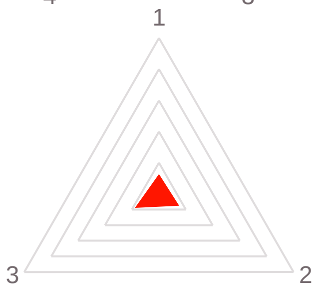


Functional Categories	Functions	Score
Hydrology	Catchment hydrology	13
	Surface water storage	13
	Reach inflow	14
	Flow duration	12
	Flow alteration	
Hydraulics	Low flow dynamics	
	Baseflow dynamics	
	High flow dynamics	13
	Floodplain connectivity	14
	Hyporheic connectivity	14
Geomorphology	Channel evolution	14
	Lateral stability	13
	Planform change	13
	Sediment continuity	13
	Large wood	12
	Bed composition	14
Physicochemical	Light and thermal regime	12
	Carbon processing	12
	Nutrient cycling	14
	Water and soil quality	14
Biology	Habitat provision	13
	Population support	
	Community dynamics	
	Watershed connectivity	13

Functional Categories	Functions	Score
Hydrology	Catchment hydrology	6
	Surface water storage	0
	Reach inflow	2
	Flow duration	1
	Flow alteration	3
Hydraulics	Low flow dynamics	5
	Baseflow dynamics	2
	High flow dynamics	1
	Floodplain connectivity	1
	Hyporheic connectivity	1
Geomorphology	Channel evolution	1
	Lateral stability	1
	Planform change	1
	Sediment continuity	1
	Large wood	1
	Bed composition	1
Physicochemical	Light and thermal regime	2
	Carbon processing	3
	Nutrient cycling	2
	Water and soil quality	3
Biology	Habitat provision	2
	Population support	3
	Community dynamics	3
	Watershed connectivity	4

CC TX

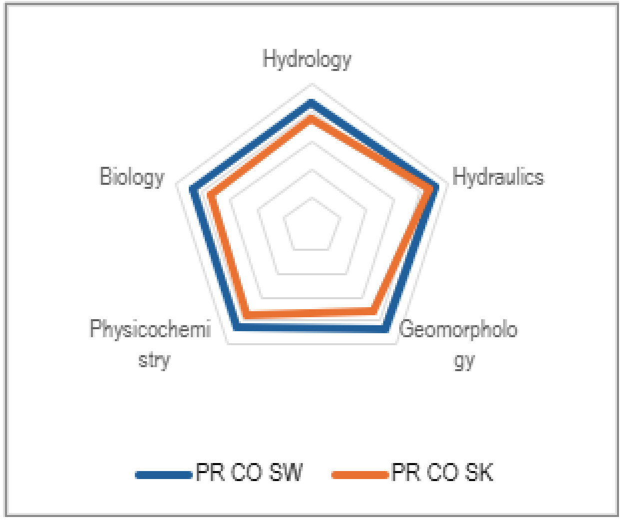


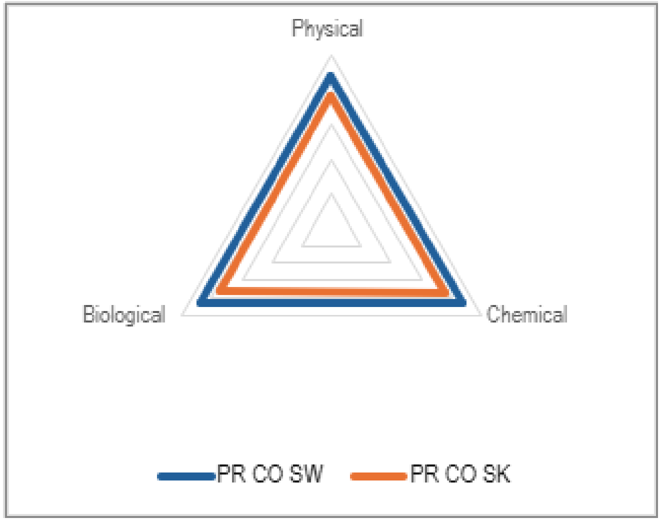


FIELD VERIFICATION: VARIABILITY AND REPEATABILITY CHECKS

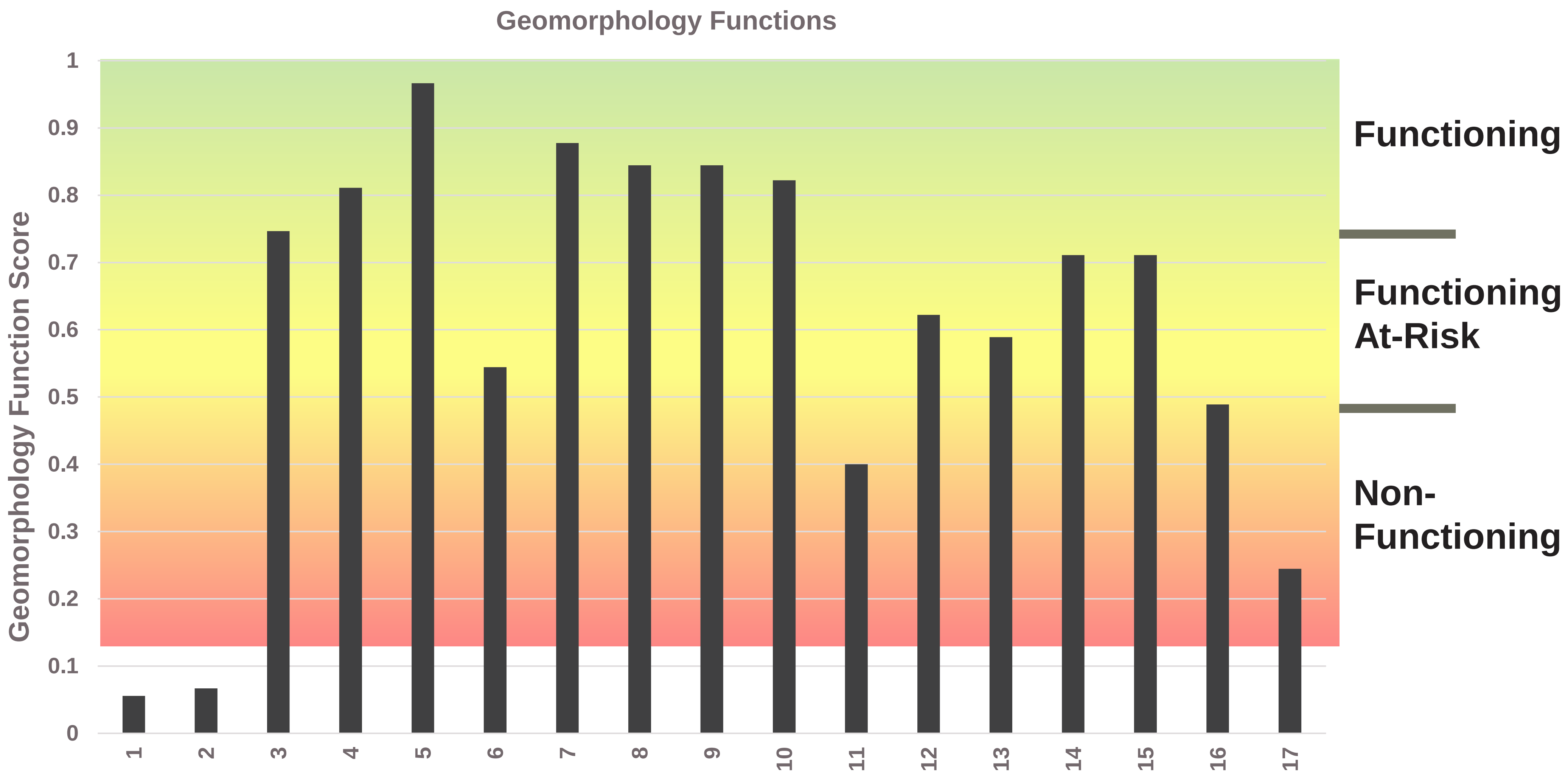
- Multiple users agreement at site: replicate scoring; quantify agreement; calibrate with photo evidence.

- Within vs. between-site variance: verify that between-site differences exceed rater noise.

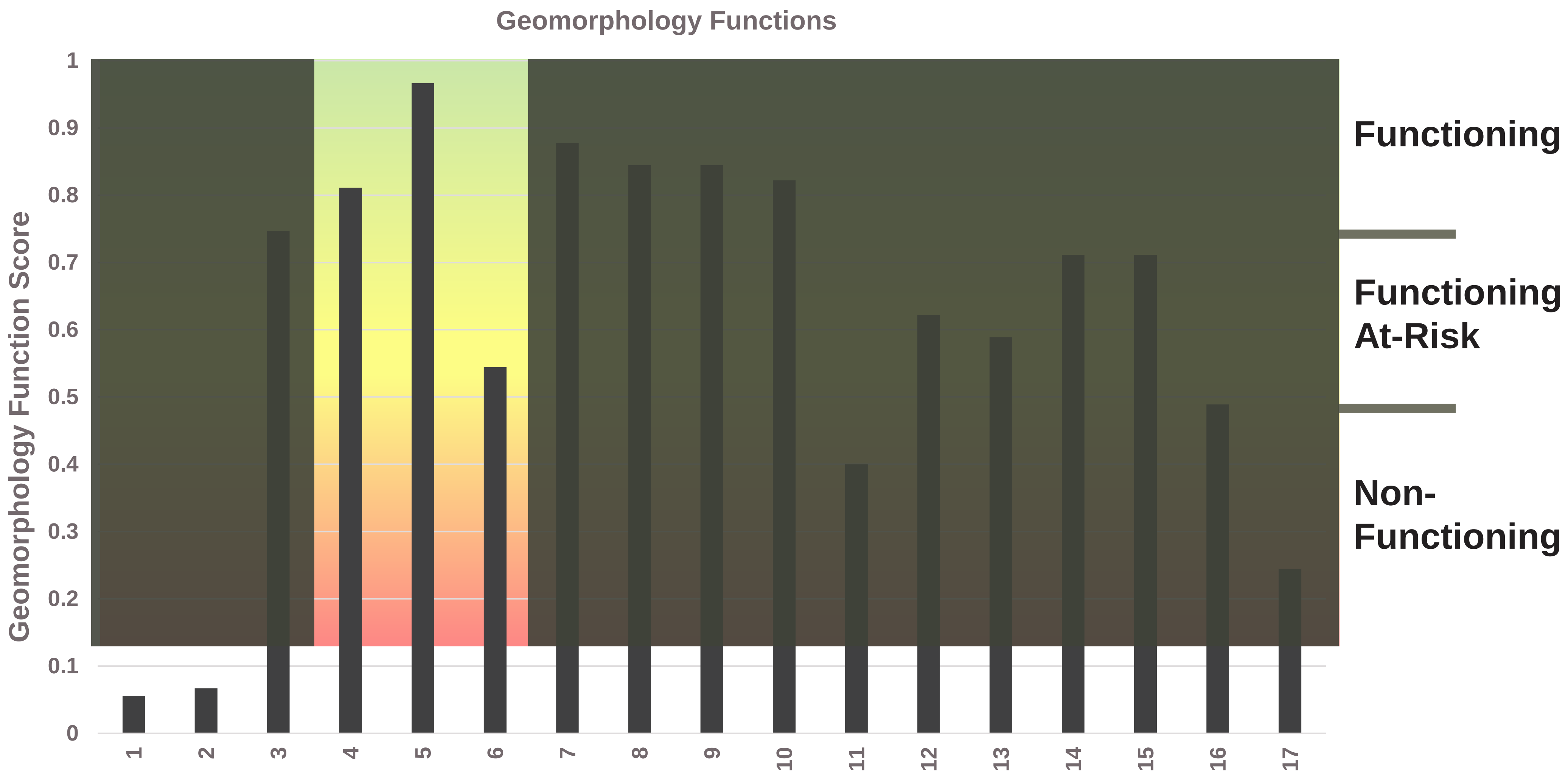




VERIFICATION AND VALIDATION



VERIFICATION AND VALIDATION



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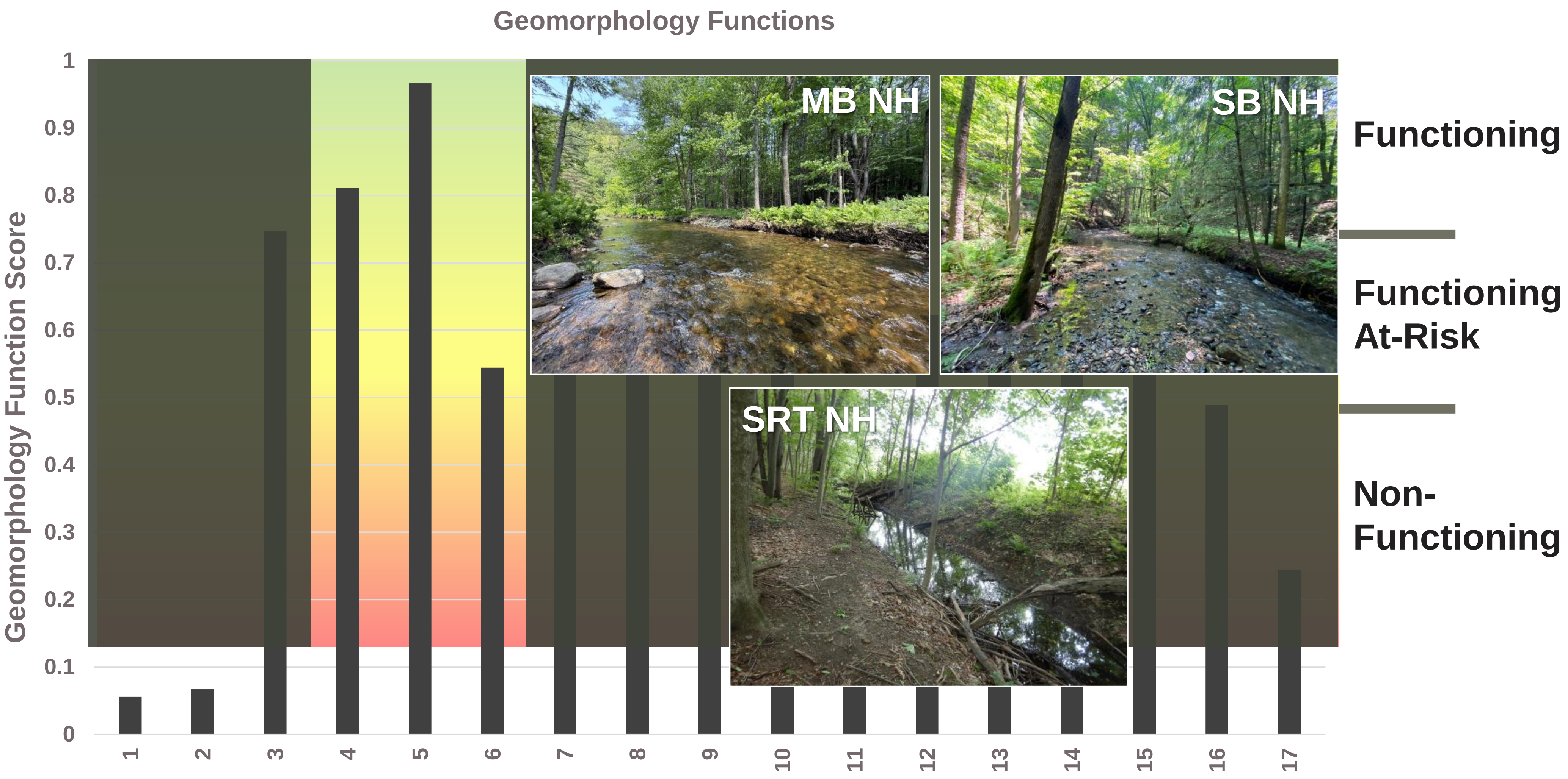
VERIFICATION AND VALIDATION



WRAP-UP AND NEXT STEPS

U.S. ARMY

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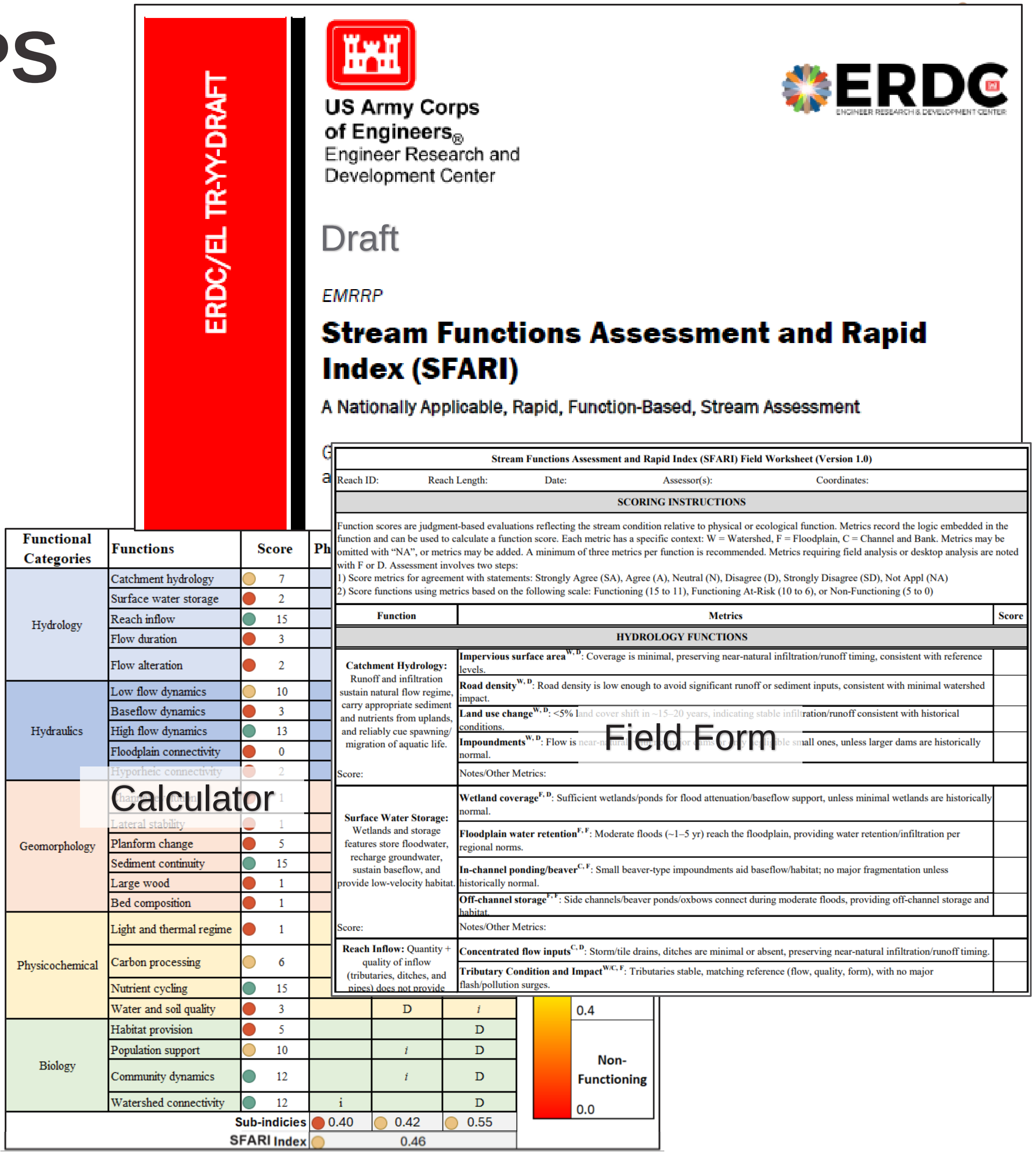
ENGINEER RESEARCH & DEVELOPMENT CENTER

SUMMARY AND NEXT STEPS

- Rapid, function-based assessment
- Comprehensive stream functions
- Nationally applicable; wadeable streams
- Functions aligned with Clean Water Act Physical, Chemical, Biological conditions
- Potential Use Cases
  - USACE Planning Studies
  - Mitigation teams in USACE Regulatory
- SFARI: field form, calculator, Draft Tech Report
- Working toward ECO-PCX certification
- More field testing



GM

THANK YOU!

Contact us about field testing!

We want to hear from you!

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https://emrrp.el.erdc.dren.mil/