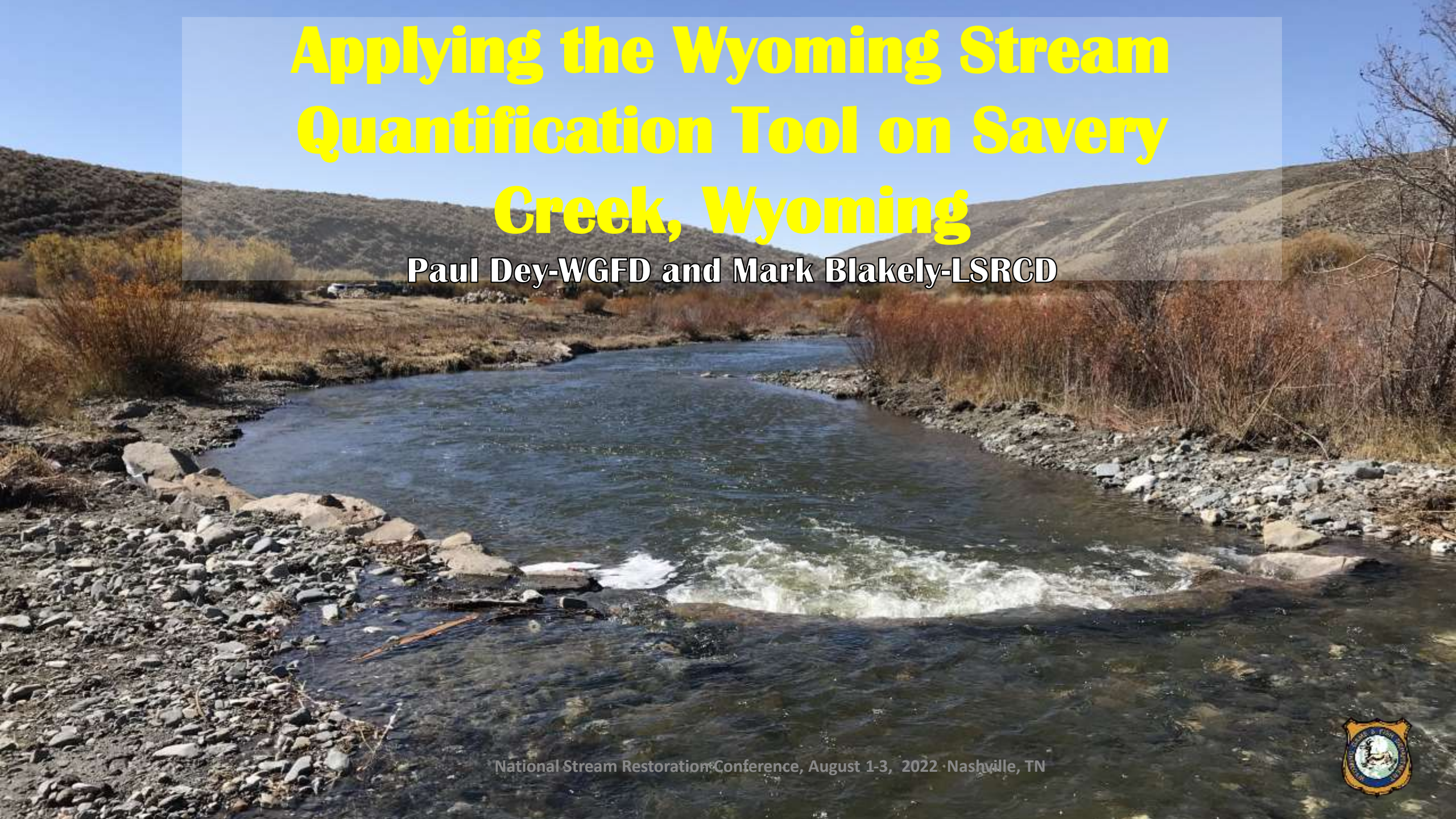
Applying the Wyoming Stream Quantification Tool on Savery Creek, Wyoming

Paul Dey-WGFD and Mark Blakely-LSRCD



National Stream Restoration Conference, August 1-3, 2022 Nashville, TN

Applying the WSQT on Savery Creek

- Compare WSQT predictions on Savery Creek where multiple restoration approaches were used
- **Illustrate effort required**
- Highlight future improvements exposed by the WSQT

Savery Creek Stream Restoration

- Collaboration among Little Snake River CD, BLM, TU, WWDO, and WGFD with major funding from WWNRT

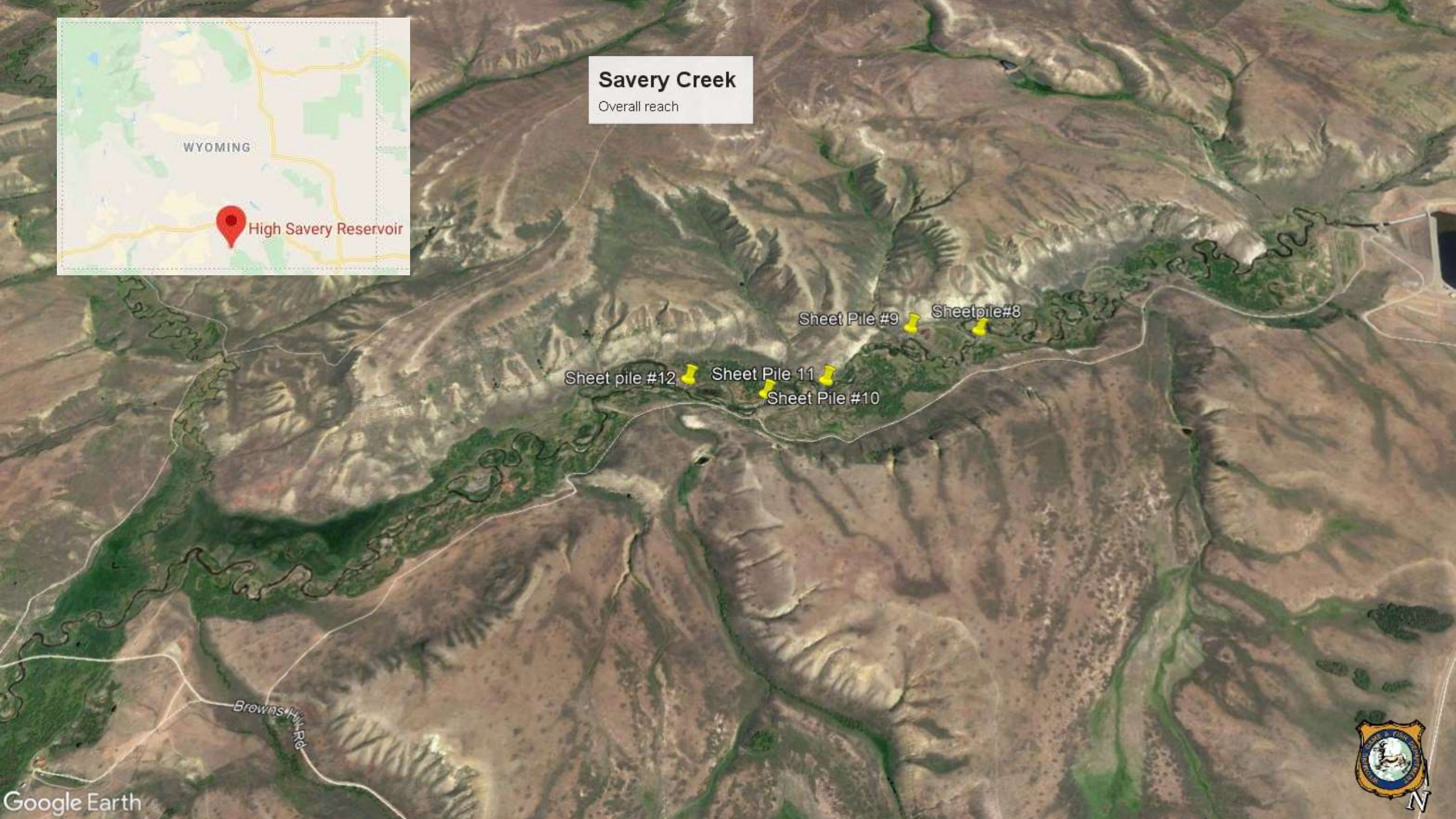
- Restoration to address eroding banks and improve floodplain connectivity, riparian vegetation, and aquatic habitat for trout

Savery Creek Stream Restoration

- ~ 4 mile reach starting from the dam
- 14 vertical sheet pile weirs = sub-reaches
- Restoration mostly within existing channel
- Designer unaware of WSQT

Treatments:

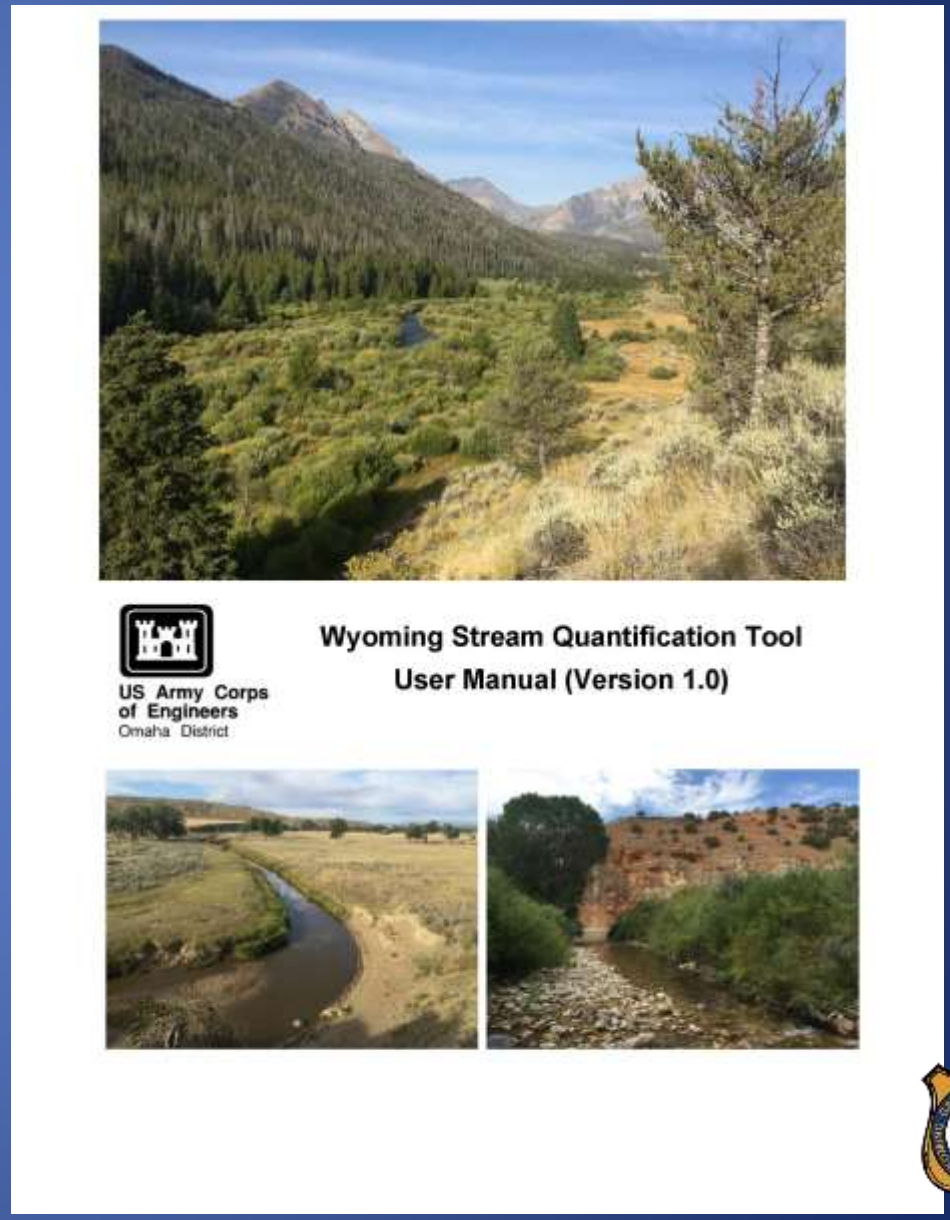
- J-hook vanes
- Cross vanes
- Toe wood banks
- Bankfull benches
- Log vanes
- Bank toe logs
- Log sills
- Rock sills
- Channel narrowing


Savery Creek
Overall reach
WYOMING
High Savery Reservoir
Sheet Pile #9
Sheetpile#8
Sheet pile #12
Sheet Pile 11
Sheet Pile #10
Browns Hill Rd
Google Earth
N

Wyoming Stream Quantification Tool (WSQT ver 1.0)

- Spreadsheet tool that quantifies stream losses (debits) and mitigation credits
- Implemented in 2018 to comply with the 2008 compensatory mitigation rule and provide a basis to mitigate stream impacts
- USACE, USEPA, WDEQ, WGFD and Will Harmon of Stream Mechanics

https://www.nwo.usace.army.mil/Missions/RegulatoryProgram/Wyoming/Mitigation/



Wyoming Stream Quantification Tool (WSQT)

How does the WSQT work?

- Integrates metrics from multiple categories into a reach based score, reflecting functional lift
- Functional Categories comprised of Parameters, measured via several Metrics
- It is NOT necessary to do ALL categories, or parameters or metrics.

Functional Category	Function-Based Parameter	Metric	Field Value
Reach Hydrology & Hydraulics	Reach Runoff	Land Use Coefficient Concentrated Flow Points	
	Flow Alteration	Q_Low, Measured / Q_Low, Expected	
	Floodplain Connectivity	Bank Height Ratio Entrenchment Ratio	
Geomorphology	Large Woody Debris	LWD Index No. of LWD Pieces/ 100 meters	
	Lateral Migration	Greenline Stability Rating Dominant BEHI/NBS Percent Streambank Erosion (%) Percent Armoring (%)	
	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	
	Riparian Vegetation	Riparian Width (%) Woody Vegetation Cover (%) Herbaceous Vegetation Cover (%) Percent Native Cover (%)	
Physicochemical	Temperature	MWAT (°C)	
	Nutrients	Chlorophyll (mg/m2)	
Biology	Macroinvertebrates	WSII RIVPACS	
	Fish	Native Fish Species Richness (% of Expected) SGCN Absent Score Game Species Biomass (% Change)	

Savery Creek WSQT

- Baseline data collected for 4 sub reaches in 2019
- Post-construction data in 2020 & 2021
- 5 Parameters

Functional Category	Function-Based Parameter	Metric	Field Value
Reach Hydrology & Hydraulics	✓ Reach Runoff	Land Use Coefficient Concentrated Flow Points	
	✓ Flow Alteration	Q_Low, Measured / Q_Low, Expected	
	Floodplain Connectivity	Bank Height Ratio Entrenchment Ratio	
Geomorphology	Large Woody Debris	LWD Index No. of LWD Pieces/ 100 meters	
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Savery Creek WSQT

- 13 metrics assessed
  - BHR
  - ER
  - No. wood pieces
  - Dominant BEHI/NBS
  - % Erosion
  - % Armoring
  - Pool Spacing Ratio
  - Pool Depth Ratio
  - % Riffle
  - Riparian Width
  - % Woody Cover
  - % Herbaceous Cover
  - % Native Cover

Functional Category	Function-Based Parameter	Metric	Field Value
Reach Hydrology & Hydraulics	✓ Reach Runoff	Land Use Coefficient Concentrated Flow Points	
	✓ Flow Alteration	Q_Low, Measured / Q_Low, Expected	
	Floodplain Connectivity	Bank Height Ratio Entrenchment Ratio	
Geomorphology	Large Woody Debris	LWD Index No. of LWD Pieces/ 100 meters	
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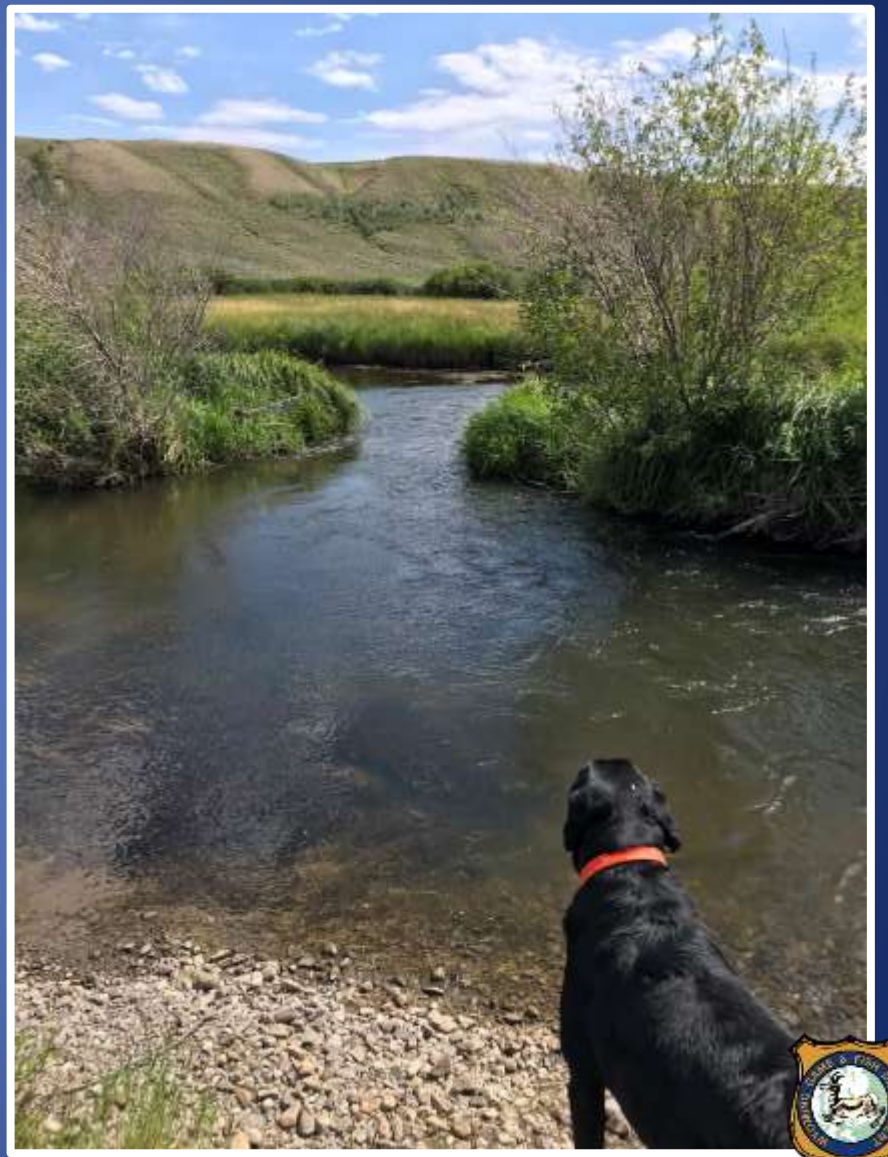
Savery Creek WSQT Take Home #1…

Collecting WSQT data is not onerous…



WSQT Effort (Rapid Method)

Office Preparation = 16 hrs

Field: 2 People, 8 hrs/site, 4 sites X 2 = 128 hrs

Office Analysis = 32 hrs

Total 4 sites representing 5,610 feet = 176 hrs

Cost of WSQT @ $50/hour = $8,800

@ $100/hour = $17,600

VS

Restoring 5,610 feet @ $100 per ft = $561,000

Running WSQT < 2-3% of construction cost

Savery Creek WSQT Take Home #2…

WSQT predicted functional improvement
AND
reflected different levels of restoration

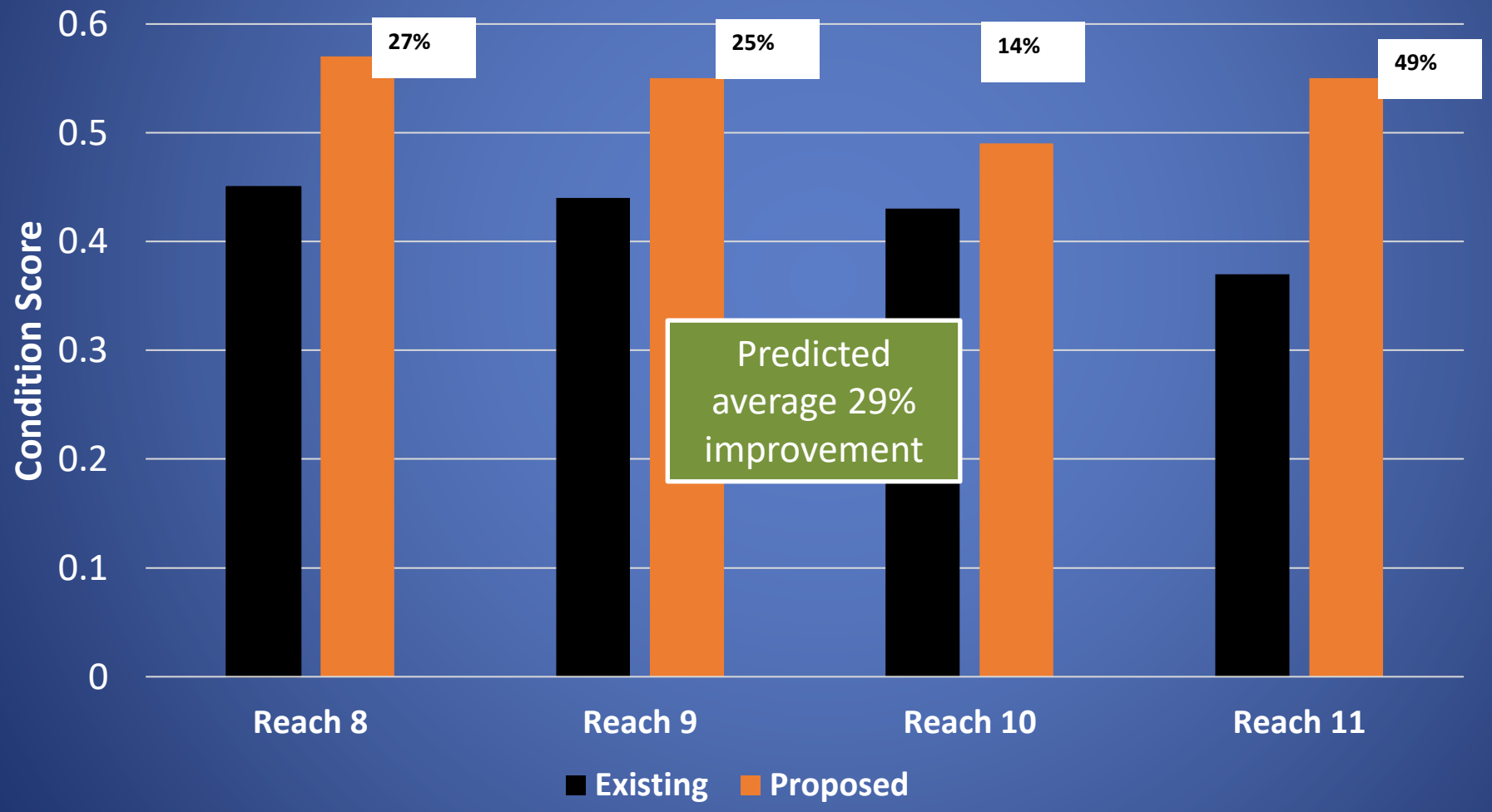
- ✓ Designs ARE restoring functions
- ✓ Counting on woody debris for “lift”
- ✓ Most degraded reach (Reach 11) showed the most improvement

Savery Creek WSQT Results – Reach 11 (Greatest Condition Score Difference)

FUNCTION BASED PARAMETERS SUMMARY			
Functional Category	**Function-Based Parameters**	**Existing Parameter**	**Proposed Parameter**
Reach Hydrology & Hydraulics	Reach Runoff	1.00	1.00
	Flow Alteration	1.00	1.00
	Floodplain Connectivity	0.50	1.00
Geomorphology	Large Woody Debris	0.00	1.00
	Lateral Migration	0.62	0.96
	Bed Material Characterization		
	Bed Form Diversity	0.38	0.64
	Plan Form		
	Riparian Vegetation	0.66	0.72
Physicochemical	Temperature		
	Nutrients		
Biology	Macroinvertebrates		
	Fish		

FUNCTIONAL CATEGORY REPORT CARD			
Functional Category	**ECS**	**PCS**	**Functional Change**
Reach Hydrology & Hydraulics	0.83	1.00	**0.17**
Geomorphology	0.41	0.83	**0.42**
Physicochemical			
Biology			

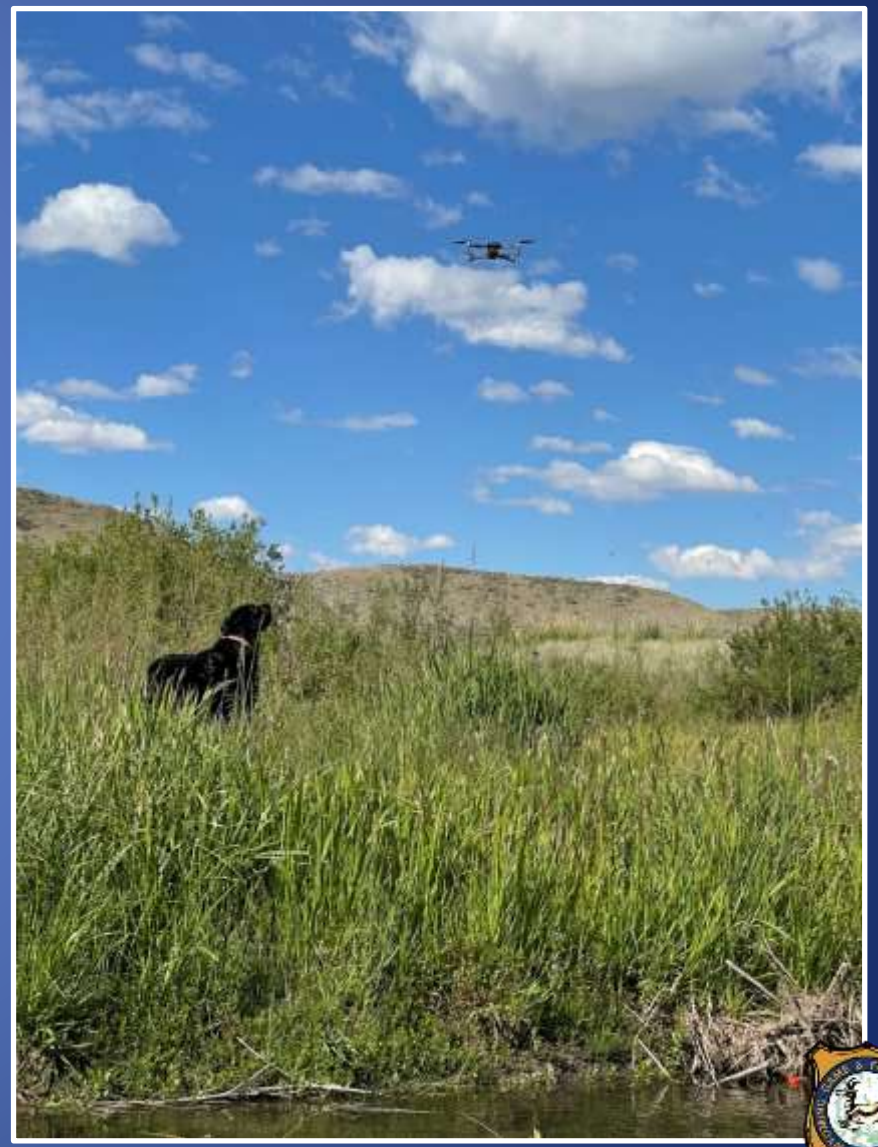
Existing & Proposed Condition Scores



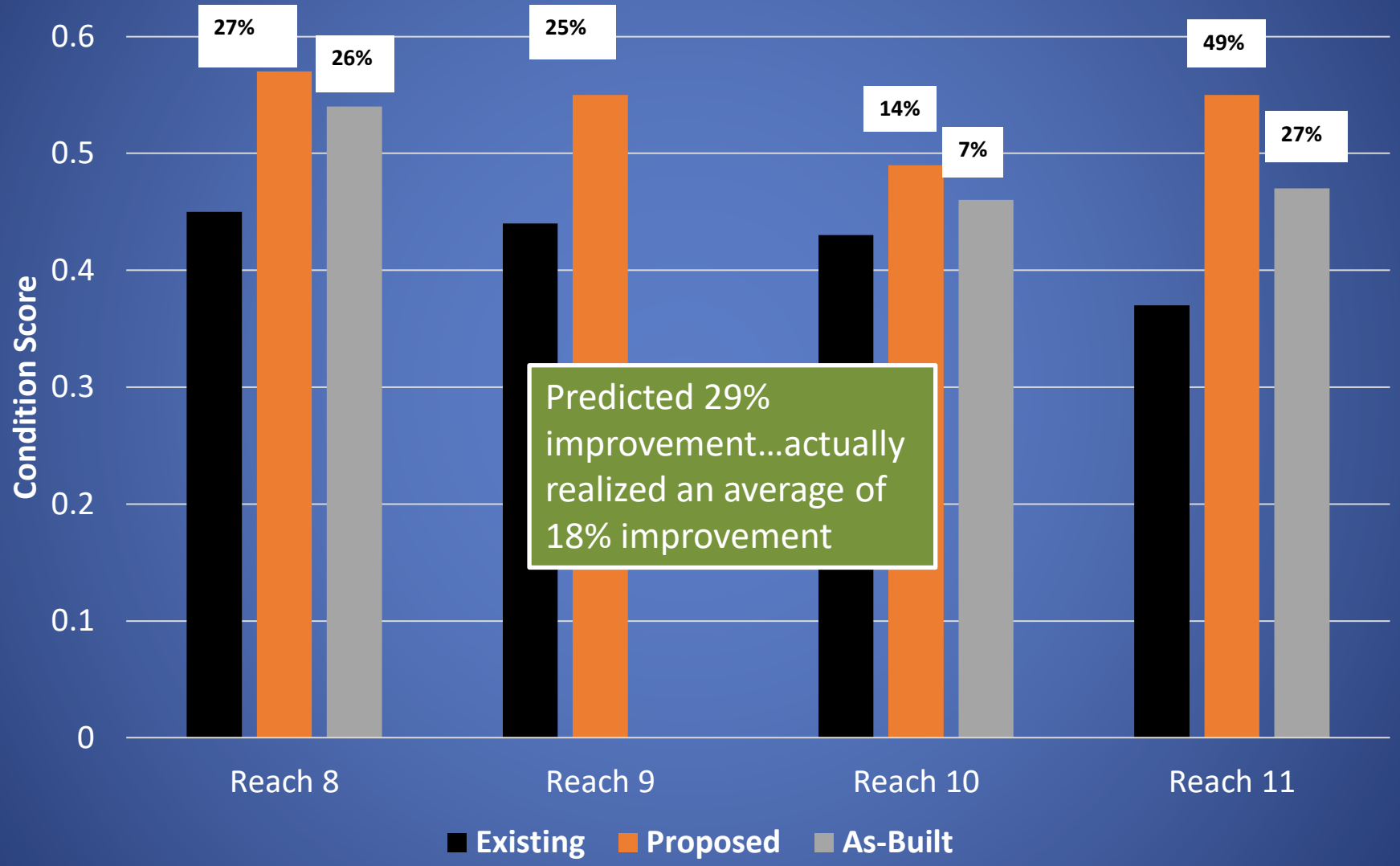
Savery Creek WSQT Take Home #3…

The restorations did not yield the full potential for functional improvement

- ✓ Woody Debris (where is it?)
- ✓ Ideal riffle percentages not achieved
- ✓ Ideal pool-pool spacing not achieved
- ✓ Riparian vegetation needs to recover



Existing, Proposed, Realized Scores



WSQT Savery Creek

Reach 11

		EXISTING		PROPOSED		AS-BUILT	
Parameter	**Metric**	**Field Value**	**Index Value**	**Field Value**	**Index Value**	**Field Value**	**Index Value**
Floodplain Connectivit	Bank Height Ratio	1	1.00	1.0	1.00	1.0	1.00
	Entrenchment Ratio	1.7	0.00	5.0	1.00	3.8	0.86
Large Woody Debris	No. of LWD Pieces/ 100 meters	0	0.00	31	1.00	4	0.22
Lateral Migration	Dominant BEHI/NBS	M/H	0.30	L/L	1.00	L/L	1.00
	Percent Streambank Erosion (%)	14	0.66	1	1.00	0	1.00
	Percent Armoring (%)	3.3	0.89	3.3	0.89	3.3	0.89
Bed Form Diversity	Pool Spacing Ratio	9.7	0.00	9.9	0.00	8.7	0.19
	Pool Depth Ratio	2.2	0.70	3.2	1.00	3.9	1.00
	Percent Riffle (%)	78	0.43	48	0.93	40	0.72
Riparian Vegetation	Riparian Width (%)	13	0.00	23	0.00	14.1	0.00
	Woody Vegetation Cover (%)	85	0.81	95	0.87	57	0.60
	Herbaceous Vegetation Cover (%)	88	1.00	88	1.00	42	0.52
	Percent Native Cover (%)	95	0.83	100	1.00	97	0.90

WSQT Savery Creek: Woody Debris

Woody debris count improvement < anticipated

Reach	Pre-	Design	As-Built
8	0	23	13
10	0	0	0
11	0	31	4

- ✓ Reach 11: installed 70’ toewood, not 130’
- ✓ Toewood footer logs buried… not yield 1 piece / 6’
- ✓ Rootwads did not yield countable pieces (1 per 15’)

Estimate woody debris count only from obvious wood structures
Consider using woody debris index

Bedform Diversity: % Riffles

- % Riffle improvement was limited comparing pre-project, design and as-built:

Note: C-channel, reference curve recognizes 50-60% riffle as ideal

Reach	Pre-	Design	As-Built
8	60% (1.0)	59% (1.0)	33% (0.53)
10	71% (0.66)	36% (0.61)	30% (0.45)
11	78% (0.43)	48% (0.93)	40% (0.72)

Not enough riffle designed and even less riffle installed

Bedform Diversity: Pool-Pool Spacing Ratio

- Pool-pool spacing improvement was limited because we did not change planform (add meanders)
- Adding pools in a long straight reach does not help
- Reach 10 existing, design and as-built all had good pool-pool spacing
- Reach 11 existing, design and as-built all had poor pool-pool spacing

Bedform Diversity: Pool-Pool Spacing Ratio

TIPS:

- ✓ **Follow the manual:**
  - ➢ Measure geomorphic (outside meander bends) pools
  - ➢ Compound pool – deepest pool
  - ➢ Compound bend – both pools
- ✓ Use design long. profile as guide
- ✓ **List stations for existing, design, and as-built pools side-by-side.**

WSQT Savery Creek: Riparian Vegetation

Riparian vegetation shows effects of bare banks post-construction

↓ % Woody & Herbaceous

↑ % Native
(less plots on high ground)

WSQT Savery Creek: Riparian Vegetation

WSQT Savery Creek Overall Summary

Although SQT's are <u>not</u> meant to serve as design tools, being aware of their metrics and approach could provide inspiration to improve restoration designs and implementation.

<u>Hindsight:</u>

- ✓ Designs should consider planform changes…it helps bedform diversity
- ✓ Always add wood and lots of it
- ✓ Less structures in riffles…and more riffles
- ✓ Build the riffles as long as designed