MOSCAP

MULTI-OBJECTIVE STREAM CROSSING ASSESSMENT PROTOCOL

Customizable Scoring & Prioritization Guidance

Cornell Cooperative Extension
Ulster County

Ashokan Watershed
Stream Management Program

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Introduction

This document provides detailed explanations and guidance on the customizable scoring methods used in the Multi-Objective Stream Crossing Assessment Protocol (MOSCAP). This is a highly technical document and assumes a thorough understanding of the MOSCAP. For a full description of the MOSCAP, see the *Multi-Objective Stream Crossing Assessment Protocol (MOSCAP): Field Data Collection Instruction Manual* available at https://www.dropbox.com/s/amg368sx6cxzn9r/MOSCAP-Field-Manual-2022.pdf?dl=0 or the publications page of the AWSMP website at ashokanstreams.org.

The customization procedures described in this guidance document are implemented in a Microsoft Excel workbook included in the MOSCAP Project Package download titled "MOSCAP_Scoring-BLANK.xlsx." This workbook merges field data from road-stream crossing assessments into a single database (as described in the workbook's "Instructions" tabs), and scores entries for prioritization using the customizable formulas described in this guidance document.

Although pre-loaded scoring formulas are provided, the MOSCAP scoring and prioritization strategy is highly customizable. It is meant to reflect stakeholder priorities whether those stakeholders include a municipal highway department, a watershed group, a county agency, a wildlife group, or any combination of individuals, agencies, and groups. The scoring and prioritization formulas that come pre-loaded in the scoring workbook were developed for the 2018 MOSCAP assessment of public road-stream crossings in the Ashokan Reservoir watershed in Ulster County, New York. This scoring formula places significant emphasis on the Geomorphic Compatibility component score to pursue funding for replacement projects that reduced erosion, sediment supply, and improved channel stability. However, the user may customize the final scoring and prioritization strategy to fit their needs and instructions are provided in this document. The expanded suite of collected data and the ability to customize the final prioritization matrix are what make the MOSCAP a versatile tool for assessment, prioritization, and securing funding for replacement projects.

The MOSCAP's scoring algorithms can be customized at multiple levels. Customization at the summary level where data are merged to create a final numeric score and categorical priority level allows site prioritization to be uniquely tailored to project objectives. For those interested in a more finely tuned assessment, the algorithms for component scores of Structural Condition and Flood Flow Capacity are also customizable. The Geomorphic Compatibility and Aquatic Organism Passage formulas are not customizable. However, a brief overview of these scoring strategies is provided, as well as references to the source materials.

Funding for this project was provided by the New York City Department of Environmental Protection through the Ashokan Watershed Stream Management Program that is implemented by the Ulster County Soil and Water Conservation District and Cornell Cooperative Extension of Ulster County.

Suggested Citation

Koch, T. 2021. Multi-Objective Stream Crossing Assessment Protocol Customizable Scoring and Prioritization Guidance. Cornell Cooperative Extension of Ulster County, Ashokan Watershed Stream Management Program. https://www.dropbox.com/s/p01lf8oh0o56cn1/MOSCAP-Customization-Guidance-2022.pdf?dl=0.

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1. MOSCAP Score and Prioritization Screen

Columns A and B in the "Scoring Sheet" tab of the MOSCAP_Scoring Excel workbook are the end data products of a MOSCAP assessment:

- **MOSCAP_Screen** (Column A)
- **MOSCAP_Weighted_Score** (Column B)

The **MOSCAP Weighted Score** (column B) is a continuous numeric score between zero and 100. It is the weighted percentile sum of the four MOSCAP assessment objective scores:

- Geomorphic Compatibility
- Structural Condition
- Aquatic Organism Passage
- Flood Flow Capacity

The **MOSCAP Screen** (Column A) groups crossings into one of four categorical bins based on the numeric score: *Critical, High, Medium, Low*. These categories are often referred to as the **MOSCAP Priority Level**. Crossings rated as *Critical* received the lowest numeric scores and thus are the highest priority for intervention.

The following sections describe how to customize the MOSCAP Weighted Score and MOSCAP Priority Level screen thresholds to best suit prioritization objectives.

1.1 MOSCAP Weighted Score Customization

The weighting scheme described in this section is the primary way to customize the MOSCAP scoring and prioritization process. Due to the importance of the assigned weights on the final data products, weights should be determined collaboratively and mutually agreed upon by all project stakeholders.

Customization of the MOSCAP Weighted Score (Column B) is quickly and easily accomplished by modifying the MOSCAP Customizable Scoring Weights Table found at the top of the "Scoring Sheet" tab in the "MOSCAP_Scoring" Excel workbook (Table 1).

Table 1. The MOSCAP Customizable Scoring Weights table found at the top of the "Scoring Sheet" tab of the MOSCAP_Scoring Excel workbook.

B	C	D	E	F
MOSCAP Customizable Scoring Weights				
For Crossings WITH Hydraulic Modeling		**For Crossings WITHOUT Hydraulic Modeling**		
Assessment Objective	Weight %*	Assessment Objective		Weight %*
Geomorphic Compatibility (GC)	30	Geomorphic Compatibility (GC)		45
Structural Condition (SC)	30	Structural Condition (SC)		45
Aquatic Organism Passage (AOP)	10	Aquatic Organism Passage (AOP)		10
Flood Flow Capacity (FFC)	30	**Total:**		**100**
Total:	**100**			

In this table, each MOSCAP assessment objective is assigned a weight value that determines how much impact that assessment objective score has on the MOSCAP Weighted Score. The higher the weight value, the greater impact that assessment objective will have on the final score. If an assessment objective is assigned a weight of zero, it will have no impact on the final score.

There are two weight columns in the Customizable Scoring Weights Table (Table 1) for crossings with and without a Flood Flow Capacity score. Not all crossings will have a Flood Flow Capacity score due to constraints of the underlying hydrology and hydraulic model (see Section 2.2 below). Column C assigns scoring weights for crossings that have scores for all four MOSCAP assessment objectives. Column F assigns weights for crossings that do not have a Food Flow Capacity score and are thus scored using the remaining three assessment objectives.

The sum of the weights in both columns of the table must equal 100. Conditional formatting in cells C8 and F7 will turn the cell backgrounds green when the sum equals 100 (Table 1) and red when it does not (Table 2).

A conditional statement in the MOSCAP Weighted Score formula in column B determines whether a crossing has been modeled using the hydrology and hydraulic model and automatically scores each crossing using the assigned weights from the correct column. Modifying the values in the table will automatically update the numeric score calculations and subsequently update the MOSCAP Priority Level in column A (see below).

Table 2. The MOSCAP Customizable Scoring Weights Table when the sum of the assessment objective weights does not equal 100. Conditional formatting will turn cells C8 and F7 red when the sum of the weights does not equal 100.

B	C	D	E	F
MOSCAP Customizable Scoring Weights				
For Crossings WITH Hydraulic Modeling		**For Crossings WITHOUT Hydraulic Modeling**		
Assessment Objective	Weight %*	Assessment Objective		Weight %*
Geomorphic Compatibility (GC)	30	Geomorphic Compatibility (GC)		45
Structural Condition (SC)	25	Structural Condition (SC)		55
Aquatic Organism Passage (AOP)	10	Aquatic Organism Passage (AOP)		10
Flood Flow Capacity (FFC)	30		**Total:**	**110**
Total:	**95**			

1.2 MOSCAP Prioritization Screen

The MOSCAP_Screen (Column A), also known as the **MOSCAP Priority Level**, groups crossings into four descriptive categories based on the weighted score (Column B). The Priority Level categories are *Critical, High, Medium*, and *Low* and represent the relative priority for intervention at each site.

The MOSCAP Priority Level screen serves as a categorical, rather than numeric method for grouping, prioritizing, and communicating about sites. Descriptive words can be more effective than numeric scores for expressing site prioritization results to non-technical audiences and stakeholders. For example, it is sometimes more impactful to say a site has been deemed a *Critical Priority* rather than saying it received a MOSCAP score of 24.87.

For the Priority Level groupings to be most effective, threshold values that generate a near normal distribution of the data should be used. That is, the *Medium* and *High* priority bins should contain the majority of sites (Figure 1).

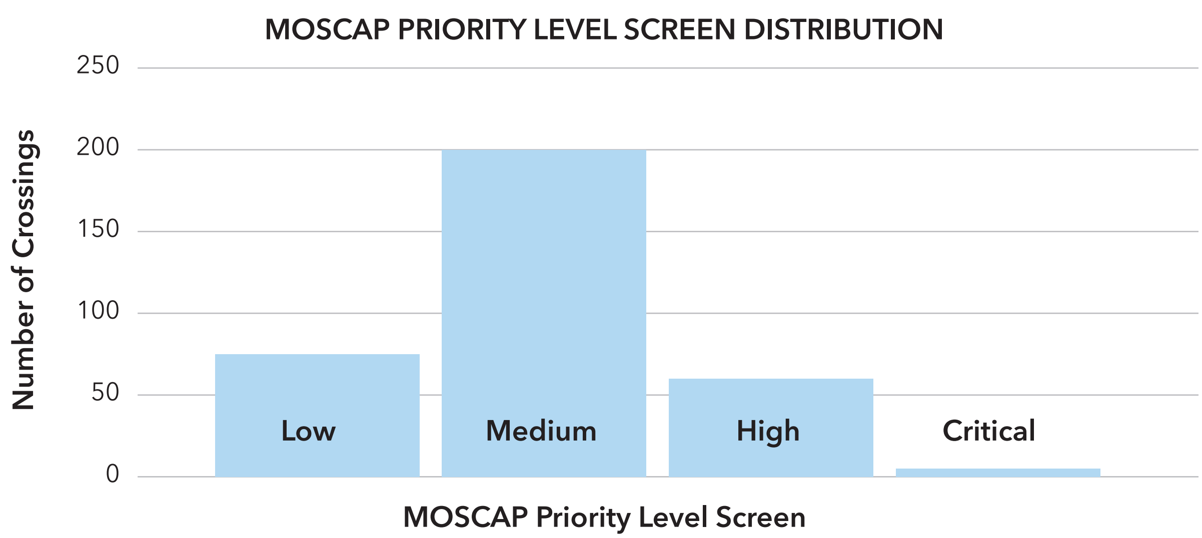

Figure 1. MOSCAP Priority Level data distribution from the 2018 Ashokan Reservoir watershed assessment. Approximately 3% of crossing sites received a Priority Level rating of Critical.

Especially important is setting a *Critical* value threshold that draws meaningful attention to a relatively small number of the highest priority sites. If too many sites are categorized as *Critical*, it negates the impact of the rating and reduces the screen's effectiveness at prioritizing sites. Similar problems arise when too few sites are designated as *Critical*.

The threshold values preloaded in the MOSCAP_Scoring workbook (Table 3) produced the data distribution seen in Figure 1. These thresholds generated *Critical* Priority Level ratings for just over 3% of assessed sites (11 of 343).

Table 3. Priority Level score thresholds preloaded in the MOSCAP_Scoring workbook.

MOSCAP Priority Level	Weighted Score Threshold Values
Critical	X <= 25
High	25 < X <= 50
Medium	50 < X <= 75
Low	X > 75

The threshold values defining categorical groups can be adjusted to create the desired distribution by modifying the numbers in the following formula, found in cell B11[1] of the MOSCAP_Scoring workbook:

=IF((AND(B11>50,B11<=75)),"Medium",IF((AND(B11>25,B11<=50)),"High",IF(B11>75,"Low", IF(B11<=25,"Critical",""))))

Where,

B11 = MOSCAP_Weighted_Score,
And the numbers (25, 50, 75) are the threshold values.

Attention must be paid to use of arithmetic operators in the formula (e.g., <, <=, >, >=) to ensure that every score falls into at least one category and cannot fall into two.

1.3 MOSCAP Unweighted Score

The MOSCAP_Unweighted_Score, column C in the MOSCAP_Scoring workbook, is a continuous numeric score between 0 and 100, calculated by adding all component scores together and diving by the highest possible score, then multiplying that value by 100. For crossings hydraulically modeled, the highest possible score is 400. For sites not modeled, the highest possible score is 300. A conditional statement in the MOSCAP_Unweighted_Score formula determines whether each crossing has been modeled and automatically applies the correct highest possible score to the unweighted score calculation.

The MOSCAP_Unweighted_Score is the equivalent of assigning an equal weight value to each assessment objective. If project stakeholders collaboratively decide an evenly weighted scoring strategy is preferred, equal values must still be entered into the MOSCAP Customizable Scoring Weights table to populate the MOSCAP_Weighted_Score and MOSCAP_Screen fields.

[1] *Row 11 is the first row in the MOSCAP_Scoring workbook that contains data. The formulas presented in this manual will use Row 11 as the template. As described in the "Instructions" tab of the scoring workbook, the formulas found in Row 11 are extended down the column to generate values for the entire dataset.*

2. Assessment Objectives with Customizable Scoring Algorithms

In addition to customizing the final weighted assessment score and the priority level categories, MOSCAP users have the option to customize some component scores. The structural condition component contains both a numeric score and a descriptive condition rating. Like the final MOSCAP Score and Prioritization Screen, both the numeric scoring algorithm and the threshold values for the categorical bins of the structural condition component can be modified to generate the desired data distribution and to reflect stakeholder priorities. It is highly recommended that any State, County, or local highway department staff involved with a MOSCAP assessment project review the scoring strategy for structural condition detailed in the following section.

The flood flow capacity component has only a single numeric score based on the modeled return interval discharge capacity. However, the score is customizable based on what recurrence interval streamflow is considered acceptable by project stakeholders, as well as whether that is based on modeling using current conditions or future (predicted) climate change scenarios.

The following sections describe how to customize the MOSCAP Structural Condition score, Structural Condition screen, and Flood Flow Capacity score to best suit prioritization objectives.

2.1 Structural Condition Score & Condition Screen

The MOSCAP Structural Condition (SC) assessment is based on the protocol described in the *New York State Department of Transportation Culvert Inventory and Inspection Manual* (NYSDOT, 2006). However, because the NYSDOT protocol needed to be modified from the original version for integration into the MOSCAP, a new and unique scoring algorithm was developed.

The AWSMP Highway Managers Working Group collaboratively developed the base SC scoring algorithm for the MOSCAP. This group consisted of Highway Superintendents from the New York State towns of Shandaken, Woodstock, Olive, and Hurley, as well as staff from the Ulster County Departments of the Environment and Public Works, the New York City Department of Environmental Protection, and the AWSMP. This algorithm calculates a continuous numeric score from zero to 100 based on the sum of seven structural component ratings and subtracts points for each structural component that was observed as being significantly deteriorated, in imminent danger of failing, or that have already failed.

Seven structural components are visually assessed during a MOSCAP Structural Condition assessment:

- Pavement
- Settlement
- Embankment
- Abutments
- Span Barrel
- Wingwalls
- Headwall

The physical condition of each component is rated with scores ranging from 1 (failing) to 7 (new, Table 4).

Table 4. Inspection rating scale for individual structural components (NYSDOT, 2006b).

Numeric Field Rating	Rating Description
7	New condition. No deterioration.
6	Used to shade between rating of 5 and 7.
5	Minor deterioration but functioning as originally designed.
4	Used to shade between ratings of 3 and 5. Functioning as originally designed.
3	Serious deterioration or not functioning as originally designed.
2	Used to shade between ratings of 1 and 3.
1	Totally deteriorated or in failed condition. Potentially hazardous.
Not Applicable / Unknown	Used to rate an item the structure does not have. Condition and/or existence unknown.

Those components rated in the field as *Not Applicable* or *Unknown* are omitted from the scoring calculation. For example, a round culvert structure typically does not have any abutments, therefore the abutments would be rated as *Not Applicable*.

To normalize the scores and make them comparable, the sum of the field ratings for the assessed components is divided by the total number of possible points and multiplied by 100 to generate a percentile score. For example, a crossing with all components present has a total possible score of 49 points. A crossing with only five components has a total possible score of 35 points.

The final SC score is designed to account for individual components that were field rated as *Significantly Deteriorated* (Score = 2 or 3) or Failed (Score = 1) by using percent score modifiers of -15% and -25%, respectively (Table 5). The percent score modifiers are subtracted from the calculated percent score for each component rated as deteriorated or failing.

Table 5. Structural condition percent score modifier table. More information on the numeric Field Ratings and Deterioration Descriptors can be found in (NYSDOT, 2006) and (NYSDOT, 2006b).

Structural Condition Field Rating	Deterioration Descriptor	Percent Score Modifier
3	Significantly deteriorated	-15%
2	Significantly deteriorated	-15%
1	Failed	-25%

By applying percentile deductions in this way, it is possible to have a SC score less than zero. Sub-zero SC scores do not cause problems in the final MOSCAP Score calculations or Priority Level determinations. They do however generally represent crossing sites where multiple structural components are significantly deteriorated and/or failing. If the SC assessment objective is given little weight in the final MOSCAP weighting strategy, sub-zero SC crossings may not be rated as *Critical* Priority Level. However, due to the potentially hazardous structural condition, such sites nonetheless warrant closer investigation and should be brought to the attention of the appropriate agency.

Customization of the SC numeric score is accomplished by adjusting the percent score modifiers in cell H11[2] of the MOSCAP_Scoring workbook:

=((K11/L11)*100)-(J11*15)-(I11*25)

Where,

K11 = the sum of all assessed component ratings,

L11 = the total possible score,

J11 = the number of significantly deteriorated components (Rating = 2 or 3),

15 = percent score modifier for significantly deteriorated components,

I11 = the number of failed components (Rating = 1), and

25 = percent score modifier for significantly deteriorated components.

Conditional formulas in columns I-M in the MOSCAP Scoring workbook automatically extract the sum of all assessed components, the total possible SC score, the number of significantly deteriorated components, and the number of failed components from the collected field data. These formulas are described in the Scoring Formulas tabs of the MOSCAP_Scoring workbook.

Like the MOSCAP Priority Level screen, the "SC_Screen" field (Column G) groups crossings into descriptive categories based on their numeric SC score. The condition categories are: *Good, Fair, Poor*, and *Bad*. The threshold values that define categorical groups can be adjusted to create the desired data distribution (Figure 2) by modifying the numbers in the following formula in cell G11[3] :

=IF(H11>80, "Good",IF(AND(H11>60, H11<=80), "Fair",IF(AND(H11>40, H11<=60), "Poor", IF(H11<=40, "Bad","")))

Where,

H11 = SC score,
And the numbers (80, 60, 40) are the threshold values.

[2] *Row 11 is the first row in the MOSCAP_Scoring workbook that contains data. The formulas presented in this manual will use Row 11 as the template. As described in the "Instructions" tab of the scoring workbook, the formulas found in Row 11 are extended down the column to generate values for the entire dataset.*

[3] *Row 11 is the first row in the MOSCAP_Scoring workbook that contains data. The formulas presented in this manual will use Row 11 as the template. As described in the "Instructions" tab of the scoring workbook, the formulas found in Row 11 are extended down the column to generate values for the entire dataset.*

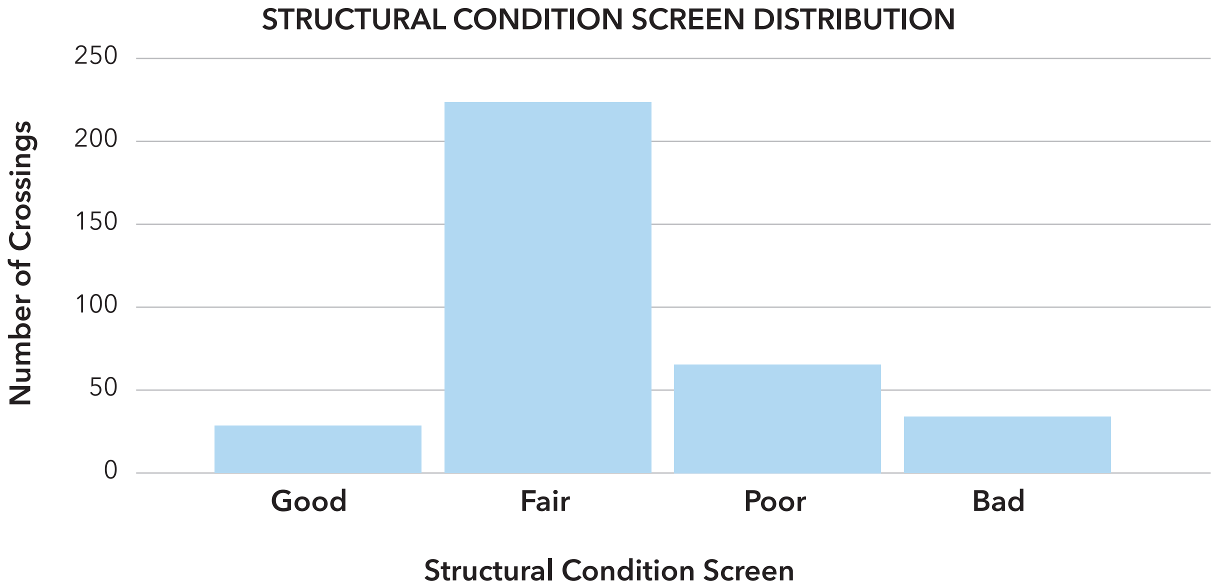

Figure 2. Data distribution of the MOSCAP structural condition screen from the 2018 Ashokan Reservoir watershed assessment.

Attention must be paid to use of arithmetic operators in the formula (e.g., <, <=, >, >=) to ensure that a score cannot fall within two descriptive categories.

2.2 Flood Flow Capacity Score

The MOSCAP Flood Flow Capacity (FC) module utilizes the Cornell Culverts Model (CCM, Marjerison, et al., 2019, https://github.com/SoilWaterLab/CulvertModel_2.1). The CCM is an ArcGIS and Python based tool that models hydrology and hydraulics at crossing sites with culverts or box bridges with an inlet width less than 20 feet. The MOSCAP FC score is based on one of two primary output variables of the CCM: the Current Max Return Interval (CMRI) flow capacity or the Future Max Return Interval (FMRI) flow capacity.

The CCM estimates discharge for nine return interval events, the 1, 2, 5, 10, 25, 50, 100, 200, and 500-year storms. Future precipitation scenarios are estimated as 115% of current extreme precipitation scenarios (Truhlar et al., 2020).

The CMRI and FMRI values are the highest estimated return interval storm discharges that do not exceed the estimated hydraulic capacity of the crossing structure(s) under current and predicted future precipitation scenarios, respectively. These values do not represent the return interval discharge that overtops the road.

It is recommended to use CMRI rather than FMRI for FC scoring because version 2.1 of the CCM is a doubly conservative model. It generally overestimates storm peak discharge and underestimates the hydraulic capacity of the structure(s) (Archibald, 2019). If the FMRI is used, a large number of crossings may receive less than suitable scores weakening the usefulness of the FC score as a prioritization tool.

The FC score is a percentile value based on a suitable CMRI flow capacity as decided by project stakeholders. All structures with CMRI capacities greater than or equal to the suitability threshold receive a perfect score of 100. Structures with CMRI capacities less than the suitability threshold receive a lower score, as assigned by project stakeholders.

The FC scoring formula pre-loaded in the MOSCAP_Scoring workbook uses a CMRI suitability threshold of the 50-year storm. All crossings estimated to have a CMRI of 50 or greater receive a score of 100. Crossings with a modeled CMRI less than 50 receive scores as shown in Table 6.

Table 6. Flood capacity scoring strategy that comes pre-loaded in the MOSCAP Scoring workbook.

CMRI Capacity	FC Score
500	100
200	100
100	100
50	100
25	80
10	80
5	50
2	20
1	10

Customization of the FC score is achieved by determining a suitable CMRI and assigning FC score values for crossings with unsuitable CMRIs. The values can be modified in cell F11[4] in the MOSCAP_Scoring workbook:

=IF(EM11>=50,100,IF(OR(EM11=25,EM11=10),80,IF(EM11=5,50,IF(EM11=2,20,
IF(EM11=1,10,IF(EM11="","NA",0))))))

Where, EM11 = estimated CMRI flow capacity,
the phrase "EM11>=50" sets the CMRI suitability threshold at the 50-year storm, and
the subsequent numbers (10, 20, 50, 80, 100) are the assigned FC scores.

[4] *Row 11 is the first row in the MOSCAP_Scoring workbook that contains data. The formulas presented in this manual will use Row 11 as the template. As described in the "Instructions" tab of the scoring workbook, the formulas found in Row 11 are extended down the column to generate values for the entire dataset.*

3. Assessment Objectives with Non-customizable Scoring Algorithms

3.1 Geomorphic Compatibility Scoring

The MOSCAP Geomorphic Compatibility scoring algorithm is non-customizable. The complete scoring procedure can be found in The Vermont Culvert Geomorphic Compatibility Screening Tool (VTANR, 2008).

To summarize, various field collected geomorphic data are used to generate integer scores (0-5) for five components (VTANR, 2008):

1. Percent Bankfull Width (VTANR, pg. 6)
2. Sediment and Debris Continuity (VTANR, pg. 8)
3. Slope (VTANR, pg. 10)
4. Approach Angle (VTANR, pg. 13)
5. Armoring and Erosion (VTANR, pg. 15)

Component scores are then summed for a possible maximum score of 25 points and assigned one of five compatibility ratings from *Fully Compatible* to *Fully Incompatible*. However, threshold conditions are applied that may alter the sum-based compatibility rating (Table 7). For example, a site with a score sum of 11 (*Partially Incompatible*), will receive a final designation of *Mostly Incompatible* if the sum of the percent bankfull width and approach angle components is less than or equal to two.

Table 7. Geomorphic compatibility scoring rubric (from VTANR, 2008).

Category Name	Screen Score	Threshold Conditions	Description of Structure-Channel Geomorphic Compatibility
Fully compatible	20<GC≤25	N/A	Structure fully compatible with natural channel form and process. There is a low risk of failure. No replacement anticiapted over the lifetime of the structure. A similar structure is recommended with replacement is needed.
Mostly compatible	15<GC≤20	N/A	Structure mostly compatible with current channel form and process. There is a low risk of failure. No replacement anticiapted over the lifetime of the structure. Minor design adjustments recommended when replacement is needed to make fully compatible.
Partially compatible	10<GC≤15	N/A	Structure compatible with either current form or process, but not both. Compatibility likely short term. There is a moderate risk of structure failure and replacement may be needed. Redesign suggested to improve geomorphic compatibility.
Mostly incompatible	5<GC≤10	% Bankfull Width + Approach Angle scores ≤ 2	Structure mostly incompatible with current form and process, with a moderate to high risk of structure failure. Redesign and replacement planning should be initiated to improve geomorphic compatibility.
Fully incompatible	0≤GC≤5	% Bankfull Width + Approach Angle scores ≤ 2 AND Sediment Continuity + Erosion and Armoring scores ≤ 2	Structure fully incompatible with channel and high risk of failure. Redesign and replacemnt should be performed as soon as possible to improve geomorphic compatibility.

The only modification from the geomorphic compatibility assessment (VTANR, 2009) and scoring methods (VTANR, 2008) is that the MOSCAP uses an *active channel width* measurement in place of a *bankfull channel width* measurement. This is because geomorphic indicators of bankfull channel dimensions can be absent or prohibitively difficult to observe in heavily modified, potentially non-alluvial environments such as road-stream crossings. Conversely, active channel width measurements are made from easily observable features that non-experts can identify as outlined in the MOSCAP Field Data Collection Instruction Manual (Koch, 2021).

The use of active channel width instead of bankfull width was discussed at length by MOSCAP stakeholders. While perhaps less scientifically vigorous than bankfull width, active channel width measurements make no claim of representing the geomorphically significant bankfull dimensions and are meant to serve as a conservative proxy for bankfull channel width. Data from 2018 show that active channel width field measurements from MOSCAP assessments are consistently less than bankfull width dimensions predicted from regional hydraulic geometry curves (Figure 3).

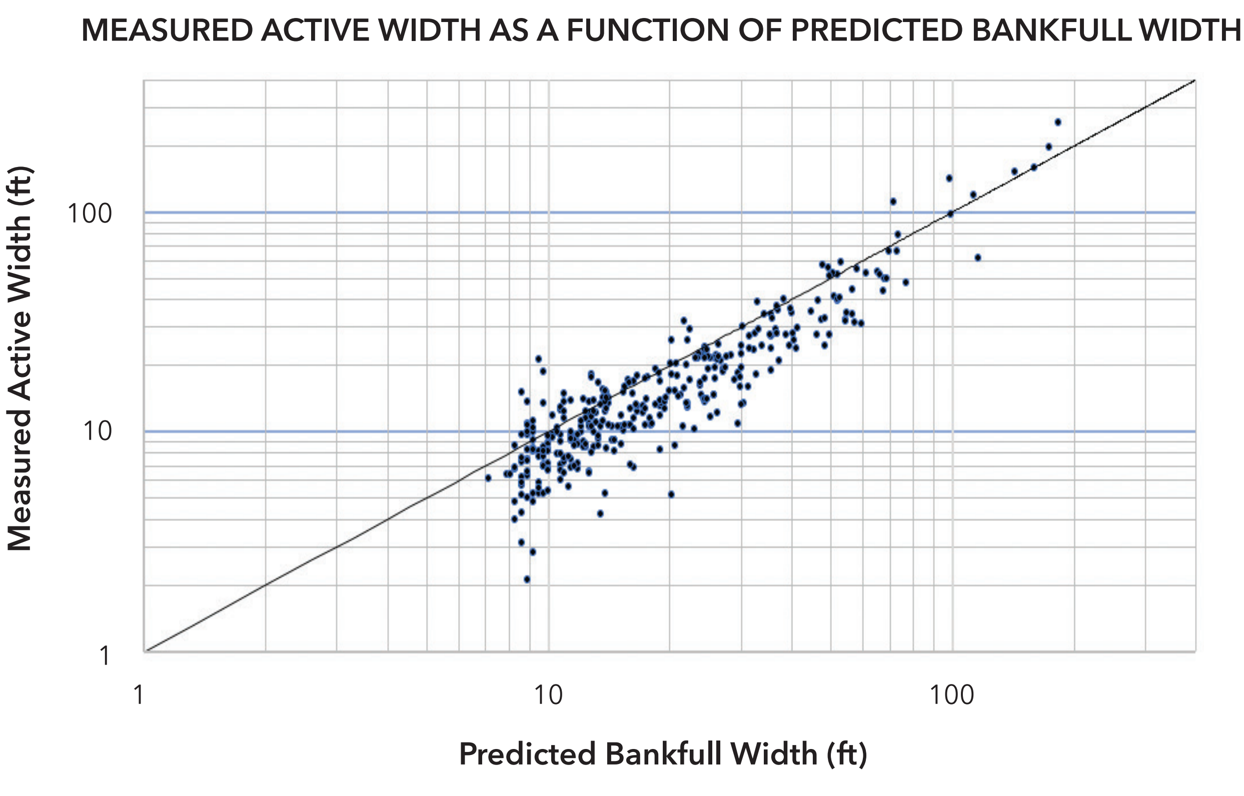

Figure 3. Relationship between active channel width field measurements from a 2018 MOSCAP assessment project and predicted bankfull channel width values from regional hydraulic geometry curves (Miller & Davis, 2003) showing active width measurements consistently less than predicted bankfull widths (Koch, Unpublished data, 2019).

3.2 Aquatic Organism Passage Scoring

The MOSCAP Aquatic Organism Passage (AOP) scoring algorithm is non-customizable. The AOP score is calculated using data collected in accordance with the North Atlantic Aquatic Connectivity Collaborative (NAACC) Stream Crossing Instruction Manual for Aquatic Passability Assessments in Non-tidal Streams and Rivers (Abbot & Jackson, 2019).

Once data are submitted to the online NAACC database by a certified Lead Observer with database credentials and approved by a certified L1 Coordinator, crossings are automatically scored using three different methods (NAACC, 2015).

1. Coarse Screen

The NAACC Coarse Screen uses eight variables to place road-stream crossings into one of three categories: *Full AOP, Reduced AOP*, or *No AOP* (Table 8).

Table 8. Coarse screen rubric for NAACC AOP scoring (NAACC, 2015).

Full AOP

Metric	Crossing Classification: Full AOP – if all are true
Inlet grade	At stream grade
Outlet grade	At stream grade
Outlet drop to water surface	=0
Inlet or outlet water depth	Typical-Low flow condition: > 0.3 ft Moderate flow condition: > 0.4 ft
Structure substrate matches stream	Comparable or contrasting
Structure substrate coverage	100%
Physical barrier severity	None

Reduced AOP

Metric	Crossing Classification: Reduced AOP – if any are true
Inlet grade	Inlet drop or perched
Structure substrate coverage	< 100%
Physical barrier severity	Minor or moderate

No AOP

Metric	No AOP – if any are true
Outlet grade	Cascade, free fall onto cascade
Outlet drop to water surface	≥ 1 ft
Outlet drop to water surface / Outlet drop to stream bottom	> 0.5 ft
Inlet or outlet water depth	Typical-Low flow condition: <0.3 ft with outlet drop to water surface >0 Moderate flow condition: <0.4 ft with outlet drop to water surface > 0
Physical Barrier Severity	Severe

2. Aquatic Passability Score

The Aquatic Passability Score is a numeric score (0-1) that uses 13 weighted variables (Table 9). The algorithm is "based on the opinions of experts who decided both the relative importance of all the available predictors of passability as well as a way to score each predictor" (NAACC, 2015, p. 2).

Table 9. Weights associated with each parameter in the NAACC AOP scoring algorithm (NAACC, 2015).

Parameter	Weight
Outlet drop	0.161
Physical barriers	0.135
Constriction	0.090
Inlet grade	0.088
Water depth	0.082
Water velocity	0.080
Scour pool	0.071
Substrate matches stream	0.070
Substrate coverage	0.057
Openness	0.052
Height	0.045
Outlet armoring	0.037
Internal structures	0.032

3. Barrier Severity Rating

The Barrier Severity Rating is a categorical grouping of road-stream crossings based on the Aquatic Passability Score and shown in Table 10.

Table 10. Barrier severity rating value thresholds for NAACC AOP scoring (NAACC, 2015).

Aquatic Passability Score	Barrier Severity Rating
0.00-0.19	Severe barrier
0.20-0.39	Significant barrier
0.40-0.59	Moderate barrier
0.60-0.79	Minor barrier
0.80-0.99	Insignificant barrier
1.0	No barrier

The MOSCAP uses the unmodified NAACC Aquatic Passability Score as the AOP component score. To integrate the AOP with other objective scores, the value is multiplied by 100 to turn it into a percentile score.

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