



University of
New Hampshire

College of Engineering
and Physical Sciences



NEW HAMPSHIRE
DEPARTMENT OF
Environmental
Services

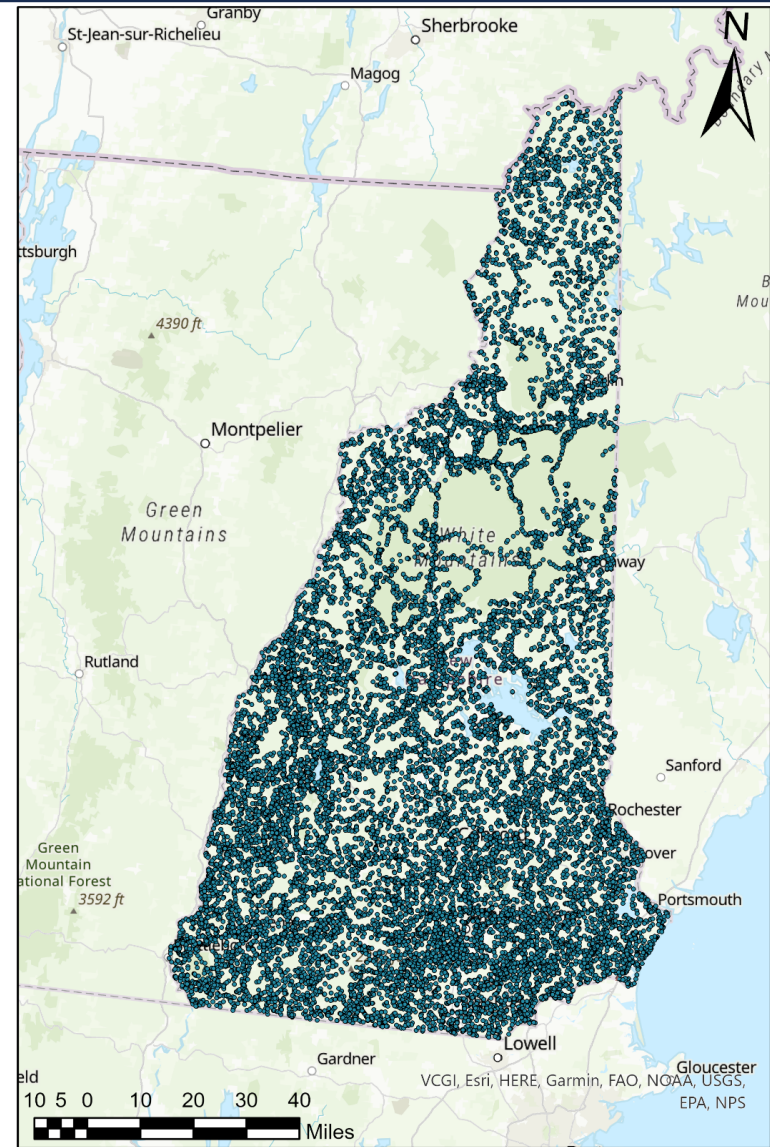
Stream Crossing Replacement Prioritization in New Hampshire

NHDES: **Kevin Lucey** | Coastal Program

Polly Crocker | Grant Manager

UNH: **Koorosh Asadifakhr** | Graduate Student

Dr. Weiwei Mo | Advisor



Outline



Project Team



NH Stream Crossing Overview



Project Introduction



Stakeholder Engagement Survey



Discussion

Project Objective

Develop a stakeholder-informed prioritization framework for stream crossing replacements that aims to achieve optimal ecological, economic, and societal outcomes by identifying win-win management scenarios.





Project Team

Project Team

NHDES

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Technical Advisory Committee



22 individuals from:

NHDES



NHDOT



NHFG



NORTH COUNTRY COUNCIL

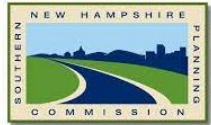
North Country Council

Upper Valley Lake Sunapee Regional Planning Commission



UPPER VALLEY LAKE SUNAPEE
REGIONAL PLANNING COMMISSION

Southern New Hampshire Regional Planning Commission



SNHPC

The Nature Conservancy



UNH T2



Streamworks PLLC



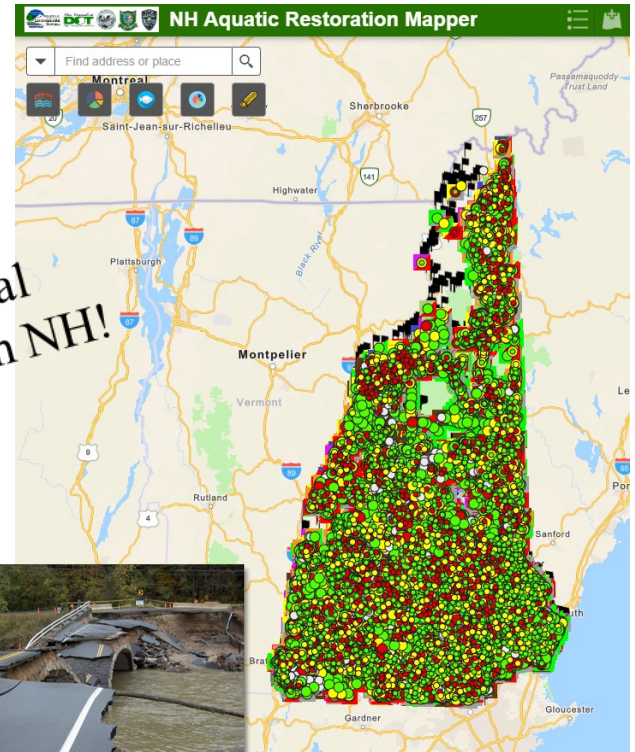
A photograph of a stone arch bridge spanning a river. The bridge is constructed from large, grey, rectangular stone blocks. The arches are prominent, and the water flows through them. The background shows lush green trees. The text "NH Steam Crossing Overview" is overlaid in a black serif font across the center of the image.

NH Steam Crossing Overview

Why Stream Crossings?

- Many stream crossings are old and undersized
- Improve public safety
- Restore habitat and connectivity
 - Stabilized bank and streambed erosion
 - Reconnect wildlife passage

>20,000 total crossings in NH!

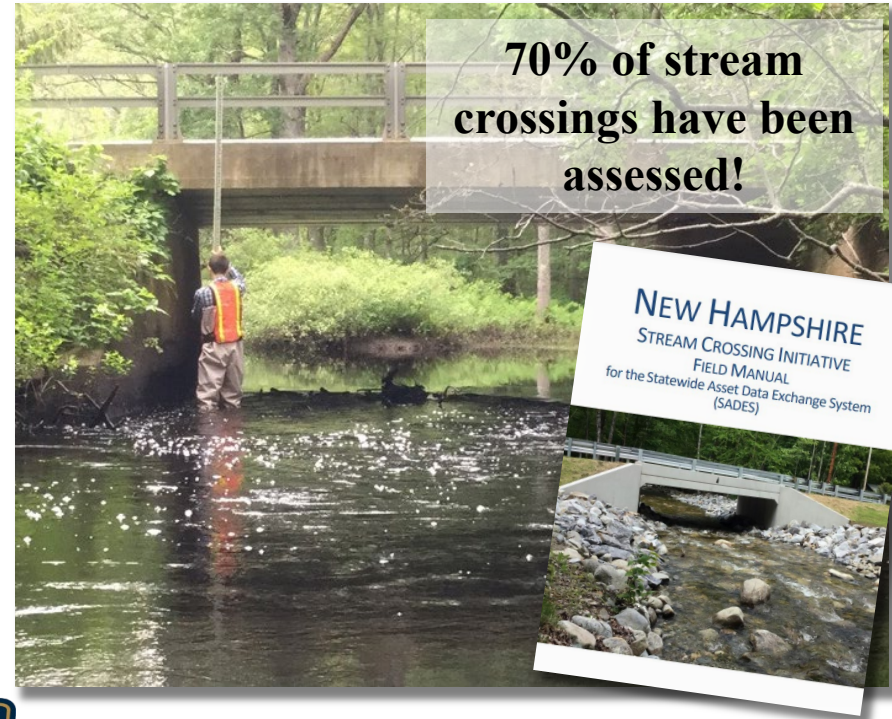


New Hampshire Stream Crossing Initiative

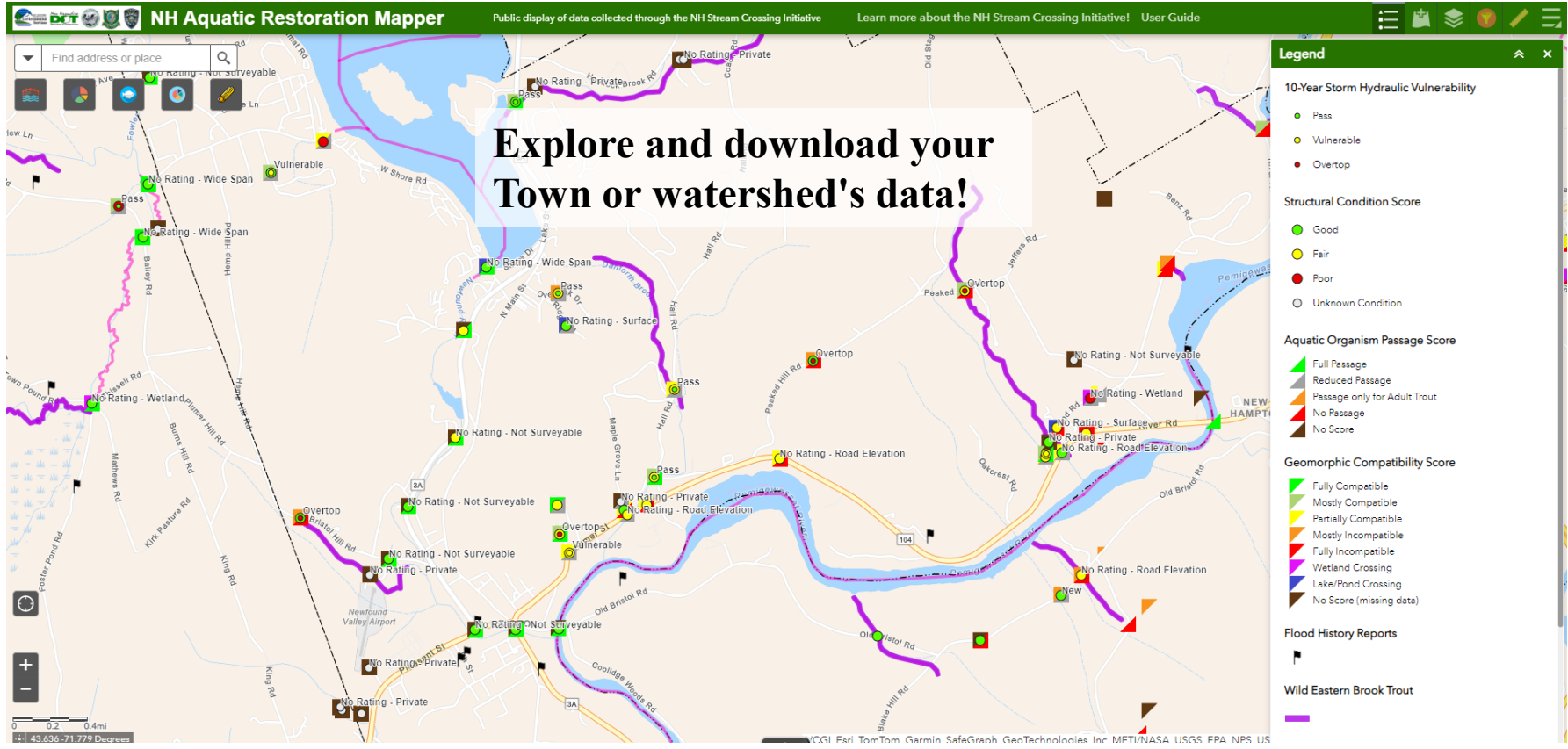
- Coordinate stream crossing assessments across the state
- Consistent data management
- Outreach and annual training

Assessment Scores

- Geomorphic compatibility
- Aquatic organism passage
- Asset condition
- Flood vulnerability



SADES Data and Aquatic Restoration Mapper



Project Need

Ashuelot
River Culvert
Assessment
(TNC)
2007

Aquatic Organism
Passage (AOP)
Screening Tool
Adopted from
Vermont
2009

Hydraulic
Vulnerability
Model (Streamw
orks & Trout
Unlimited)
2016

Warner River-
Prioritizing
Culvert
Replacement
(PSU)
2022



2008
Geomorphic
Compatibility
Screening
Tool adopted
from
Vermont

2016
Piscataquog
River
Watershed
Prioritization
(Milone &
MacBroom)

2019
Resilient
Tidal
Crossings
(NHCP/TNC)

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DOWNSTREAM
INLET 1

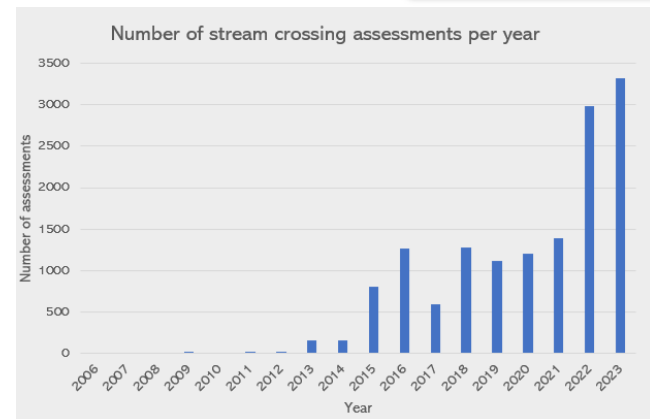
Project Introduction

Stream Crossing Replacement Prioritization Project

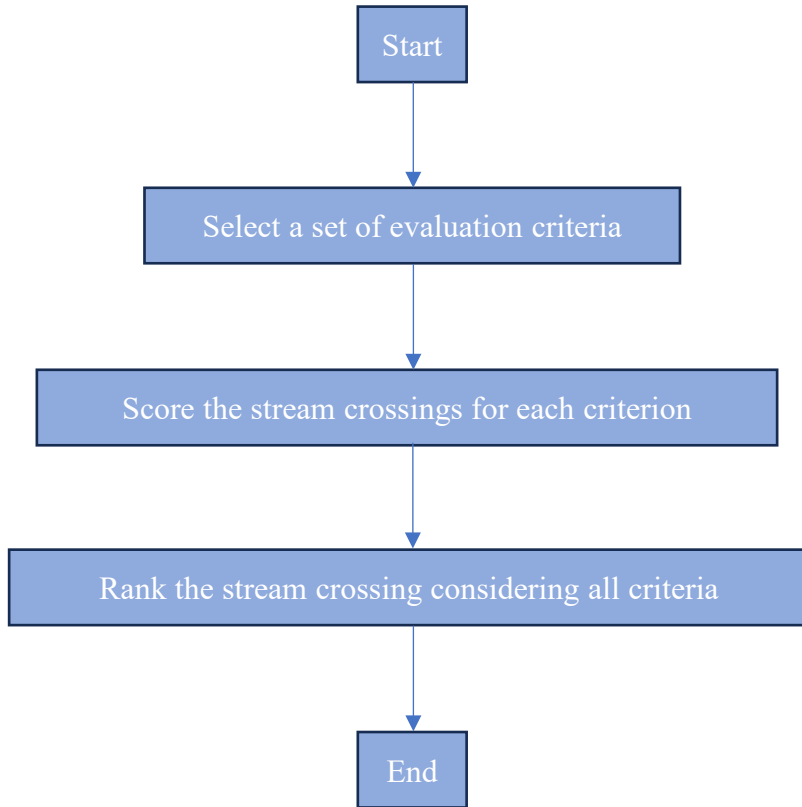
- >\$315K from American Rescue Plan Act (ARPA) for this project to:
 - Create comprehensive **stream crossing assessment** dataset in **Salmon Falls-Piscataqua** and **Merrimack River** watersheds
 - Understand and characterize stakeholder interests and priorities related to stream crossing management through a **structured engagement process**
 - Conduct stakeholder-engaged, data-driven analysis of the SADES field survey data with **pilot prioritization model** in **Salmon Falls-Piscataqua** and **Merrimack River** watersheds
 - **Identify opportunities** for win-win stream crossing management scenarios

Work To-Date

- Field Assessment
 - Completed assessment of ALL accessible stream crossings in the Merrimack and Salmon Falls-Piscataqua watersheds summers 2022-2023
 - Over 4,000 crossings!!!
- Prioritization Model
 - Initiated development
 - Watershed AOP Data Layer
- Stakeholder Engagement
 - Assembled TAC
 - Creating list of Overarching Goals and Evaluation Criteria
 - Creating list of stakeholders
 - Survey launched



Conventional Methods: Scoring & Raking

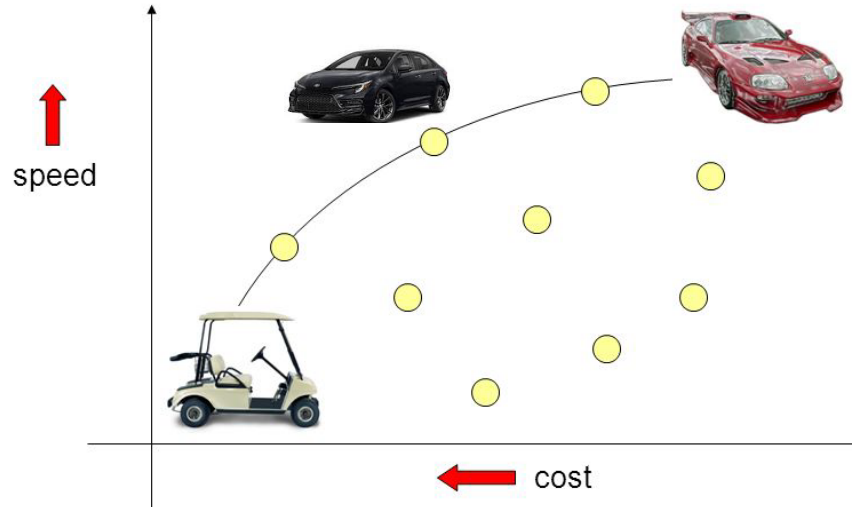


Evaluation criteria

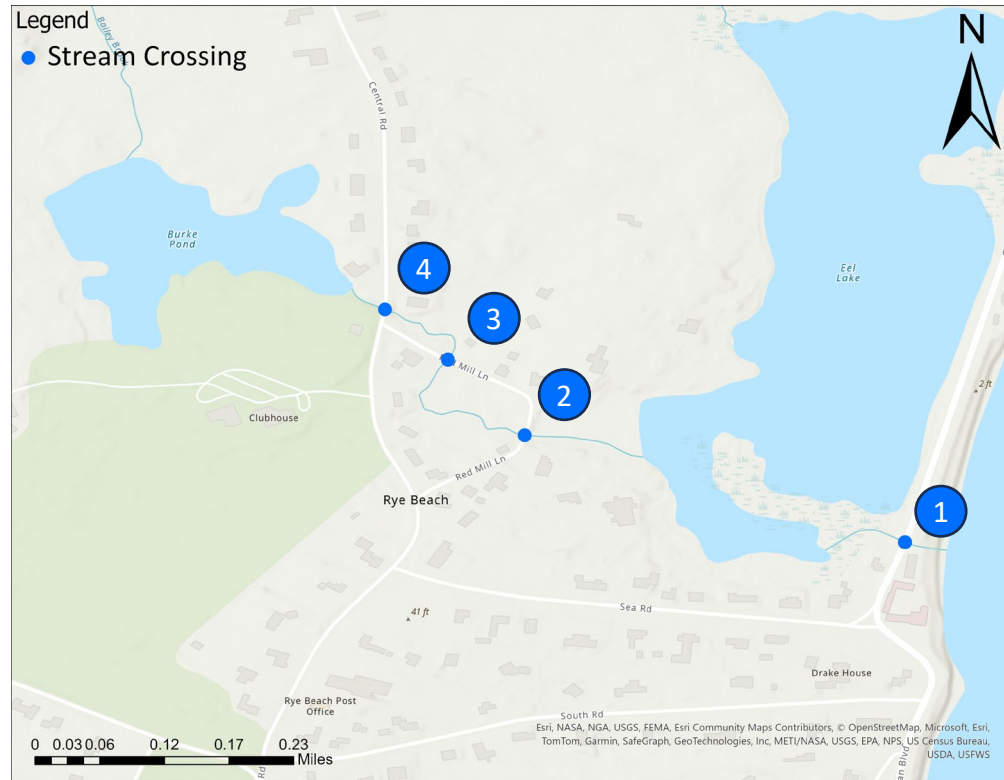
Stream Crossing ID	Aquatic Organism Passage	Geomorphic Compatibility	Flood Vulnerability	Structural Condition	Environmental Score	Rank
220	10	7	8	10	35	1
6276	10	4	8	10	32	2
608	10	7	9	5	31	3
7517	10	7	3	10	30	4
5678	4	7	9	10	30	4
7592	4	5	10	10	29	6
24007	10	5	9	5	29	6
30557	10	6	7	5	28	8
7672	4	4	10	10	28	8
7622	4	6	7	10	27	10

Our Approach: Multi-objective Optimization

Optimizing multiple conflicting objectives simultaneously



Method Comparison: Small Example



Method Comparison: Scoring and Ranking

Scoring and Ranking for Environmental Score

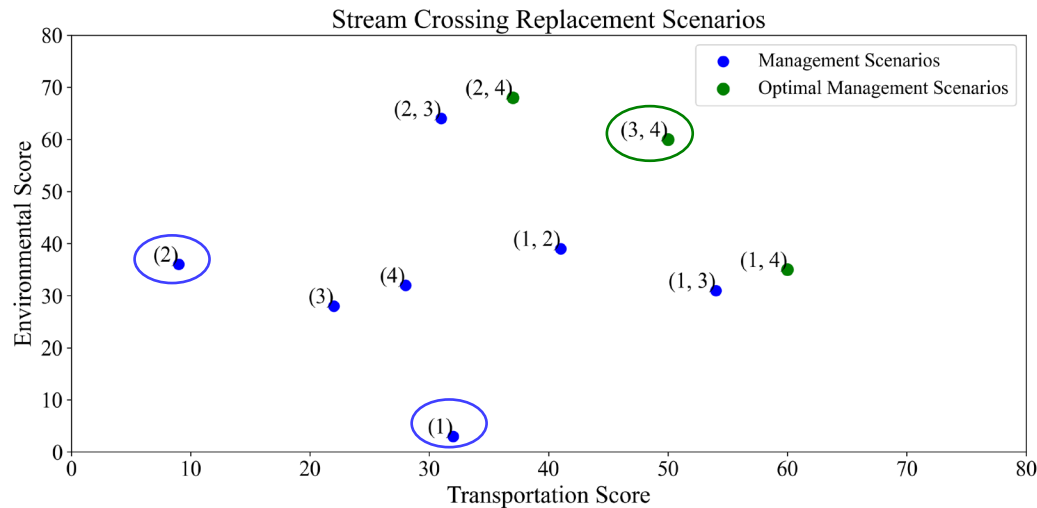
Stream Crossing	Aquatic Organism Passage (0-10)	Geomorphic compatibility (0-10)	Flood Vulnerability (0-10)	Structural Condition (0-10)	Environmental Score	Rank
Stream Crossing #1	0	0	0	3	3	4
Stream Crossing #2	9	10	10	7	36	1
Stream Crossing #3	6	5	7	10	28	3
Stream Crossing #4	9	9	8	6	32	2

Scoring and Ranking for Transportation Score

Stream Crossing	Structural Condition (0-10)	Annual Average Daily Traffic (0-10)	Road Tier (0-10)	Material (0-10)	Transportation Score	Rank
Stream Crossings #1	3	10	10	9	32	1
Stream Crossing #2	7	1	1	0	9	4
Stream Crossing #3	10	1	1	10	22	3
Stream Crossing #4	6	8	7	7	28	2

Method Comparison: Optimal Management Scenario

Replacement Scenarios (Combinations)							
()	(1)	(2)	(3)	(4)	(1, 2)	(1, 3)	(1, 4)
(2, 3)	(2, 4)	(3, 4)	(1, 2, 3)	(1, 2, 4)	(1, 3, 4)	(2, 3, 4)	(1, 2, 3, 4)



Multi-Objective Optimization



Maximize multiple
stakeholders'
benefits



Minimize
replacement cost



Watershed-scale
prioritization



Win-win
management
scenarios

Overarching Goals (aka Objective Functions)



Wildlife
Conservation and
Restoration



Environmental
Quality



Road Criticality



Economic Impact



Flood Vulnerability



Structural Risk



Community Support
and Readiness



Environmental
Justice

Evaluation Criteria Example

Describing specific measurable or observable characteristics of a goal

Overarching goals (Strategic aspiration)	Evaluation criteria	Description of the evaluation criteria
Environmental Quality	Geomorphic compatibility (GC)	Evaluates how well the stream crossing structure fits within the natural shape and form of the stream and whether it alters water and sediment transport. GC is derived from a model that uses the SADES survey data to rank the crossings from “fully compatible” to “fully incompatible”.
	Continuity of sediment, carbon, nutrients, large wood, and other transport constituents	Uninterrupted and stable transport and distribution of these elements through a riverine system, contributing to habitat formation, nutrient cycling, carbon sequestration, and overall ecosystem functioning and resilience.
	Erosion	The removal of sediment from around or beneath a stream crossing, as well as upstream or downstream due to the flow of water.
	Water use	Whether the water is used as a source for public drinking water supply or used for recharging groundwater aquifers
	Water quality impairment	Indicates if the stream crossing is on an impaired water body.
	Entrenchment Ratio	Calculated as the flood-prone width divided by the bankfull width. Entrenchment ratio is the vertical containment of a river as seen by the relationship between the channel (within the bankfull width) and the surrounding floodplain (within the flood prone width). The lower the ratio, the more entrenched a channel is.

A photograph of a concrete bridge over a rocky stream. The bridge has a metal guardrail on top. The stream is filled with large, grey rocks, and the water is flowing over them, creating white rapids. The background shows a grassy area and a line of trees.

Stakeholder Engagement

Stakeholder Engagement Process

Identify key stream-crossing stakeholders

Identify overarching goals and their evaluation criteria

Organize outreach sessions to facilitate knowledge exchange among stakeholders.

Elicit stakeholders' weightings with survey

Report out survey results

Continual
input and
feedback
from TAC



Survey



Road Criticality focuses on the community importance of the road segment and stream crossing structure to the functional operation of the transportation system.

Please submit the importance of each criterion when you assess stream crossings' performance in terms of road criticality. **It is important to rate the criteria below based on your job/organization role, not your personal preferences, and focus solely on their significance and relevance without taking the feasibility of data acquisition or data quality into consideration.**

Annual average daily traffic (AADT)

[Click here to see the description](#)

Not at all important	Slightly important	Moderately important	Very important	Extremely important	Not related to the goal	Unfamiliar
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Road tier

[Click here to see the description](#)

Not at all important	Slightly important	Moderately important	Very important	Extremely important	Not related to the goal	Unfamiliar
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Detour length

[Click here to see the description](#)

Not at all important	Slightly important	Moderately important	Very important	Extremely important	Not related to the goal	Unfamiliar
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Next Steps



- Survey open **March 25th - April 22nd**
 - Four-week window
 - 25-30 minutes to complete
 - Emailed to informed practitioners in private, public, and non-profit sectors
- Identify criteria data, methodologies, and data gaps
- Survey results will be used to inform multi-objective optimization model

Discussion – we want to learn from you!

- Any data sources and/or references that can be used to quantify the evaluation criteria?
- Which organizations, technical experts or other entities do you collaborate with, if any, for prioritizing and replacing stream crossings?
- Besides funding, what are the biggest challenges you see in stream crossing replacement prioritization in New Hampshire?
- What tools, data, and/or resources (besides funding) would help facilitate stream crossing prioritization and replacement in your role?