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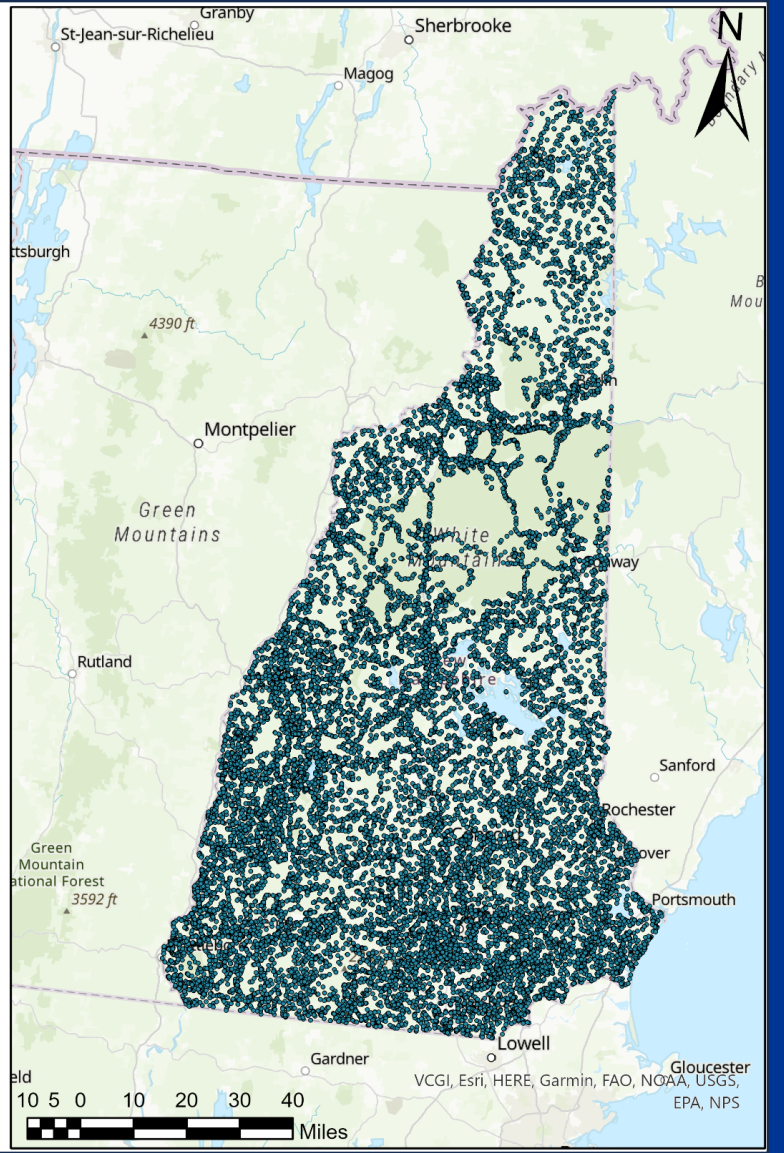
College of Engineering and Physical Sciences

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

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- 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.

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Project Team

Project Team

NHDES	
Kevin Lucey	**Polly Crocker**
Coastal Program – Habitat Coordinator	Coastal Program – Watershed Specialist
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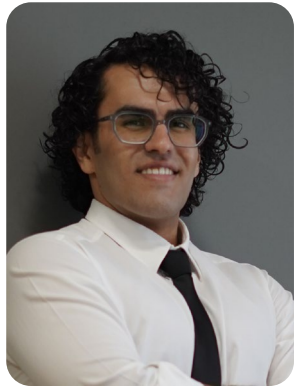


Technical Advisory Committee

22 individuals from:

NHDES

NHDOT

NHFG

North Country Council

Upper Valley Lake Sunapee Regional Planning Commission

Southern New Hampshire Regional Planning Commission

The Nature Conservancy

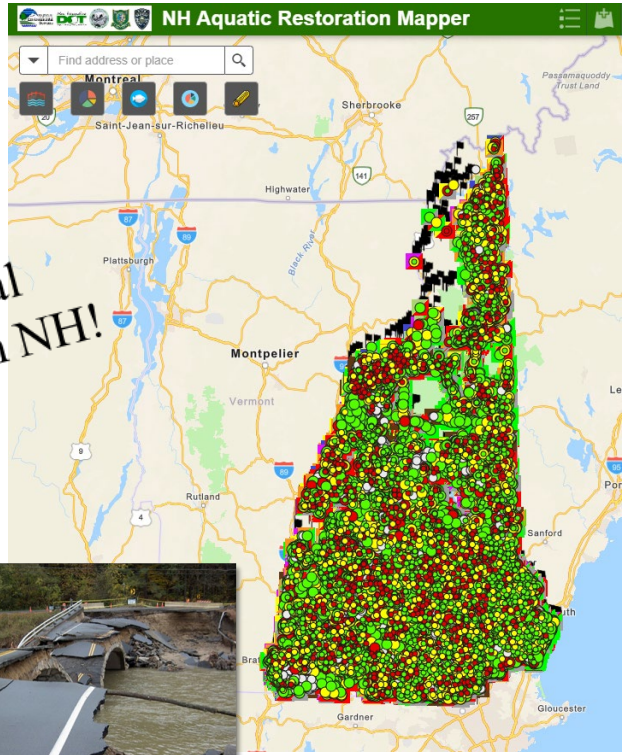
UNH T2

Streamworks PLLC

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

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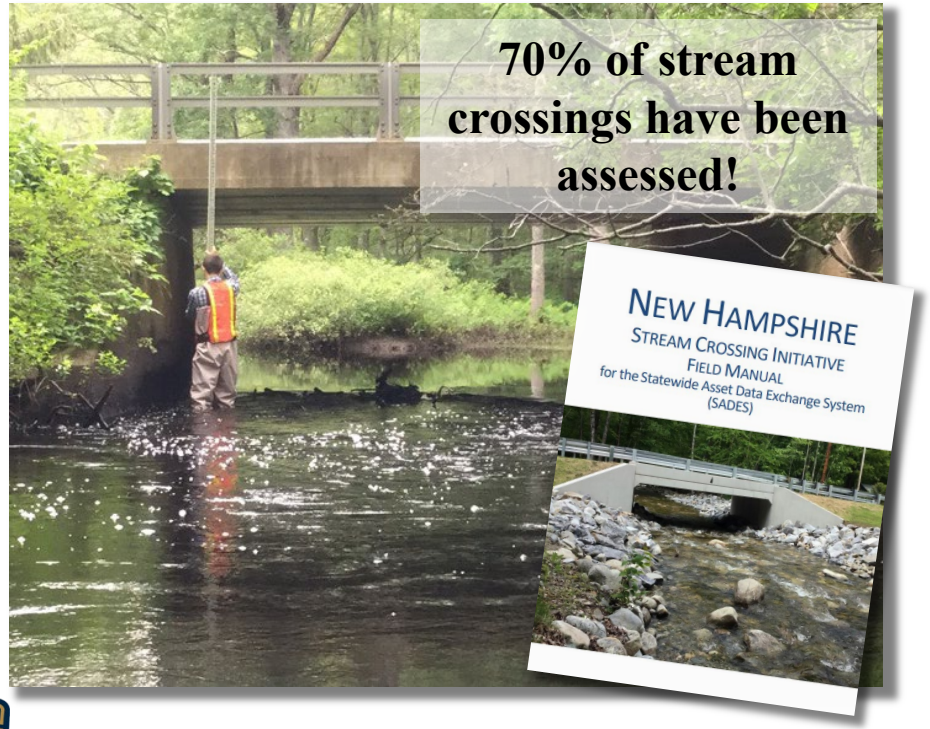
- Coordinate stream crossing assessments across the state
- Consistent data management
- Outreach and annual training

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



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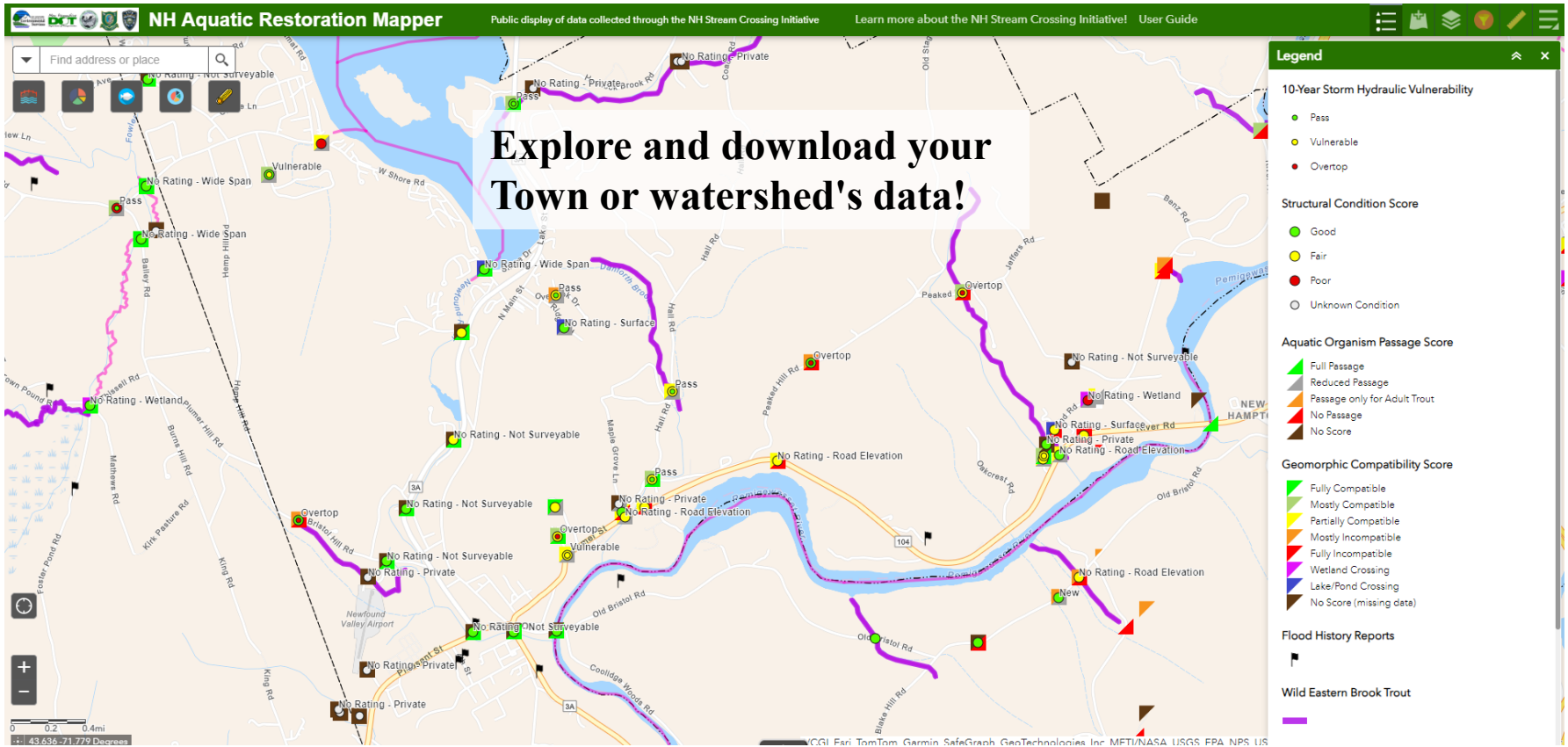
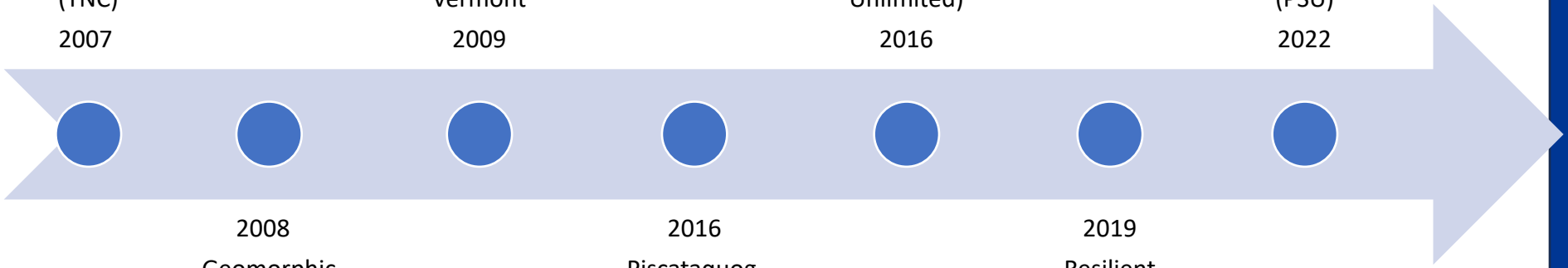
New Hampshire DOT Department of Transportation
T2 New Hampshire Technology Transfer Center
FISH AND GAME
HSEM NEW HAMPSHIRE DEPARTMENT OF SAFETY

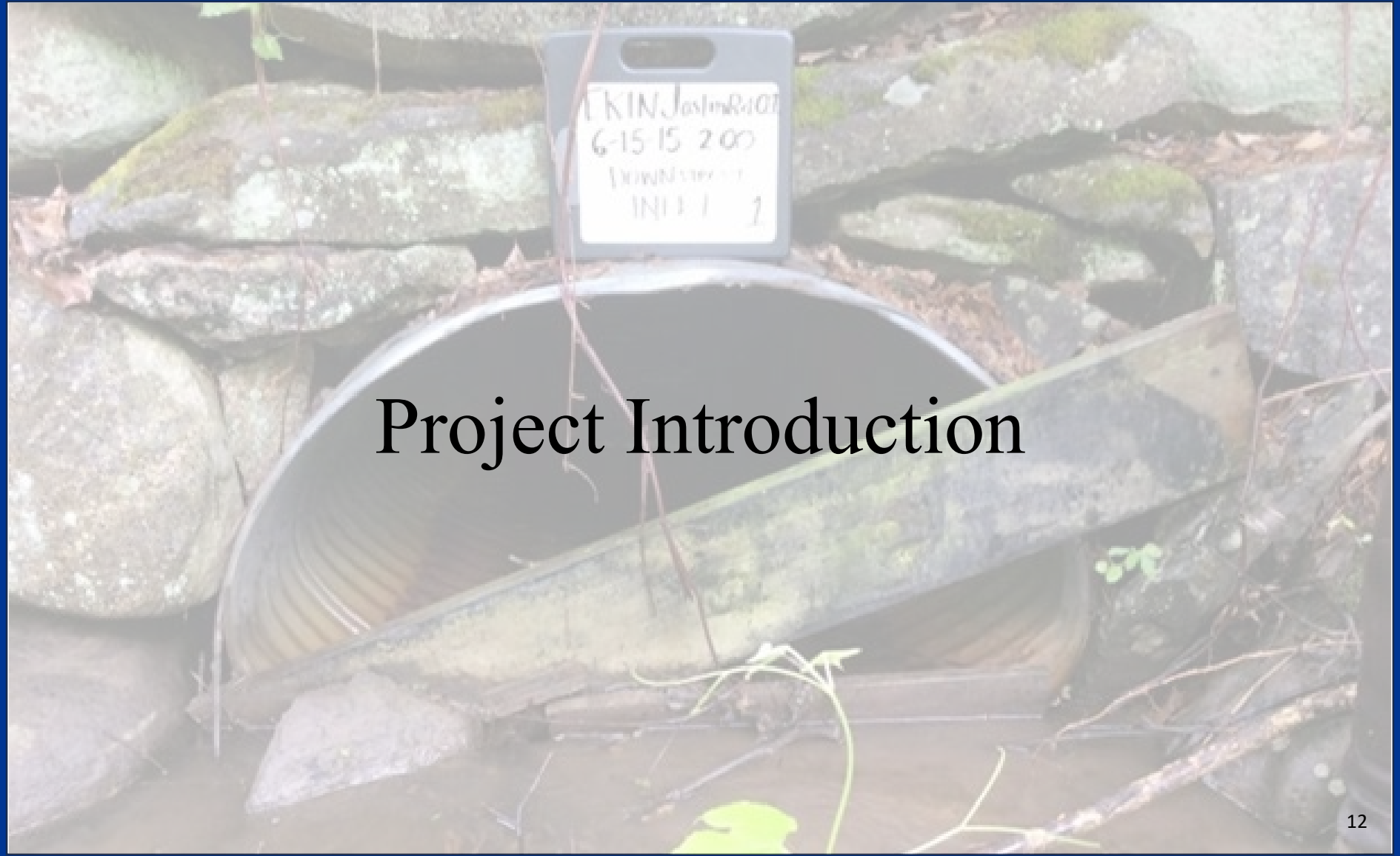
https://www4.des.state.nh.us/NH-Stream-Crossings

SADES Data and Aquatic Restoration Mapper



Project Need





Project Introduction

Stream Crossing Replacement Prioritization Project

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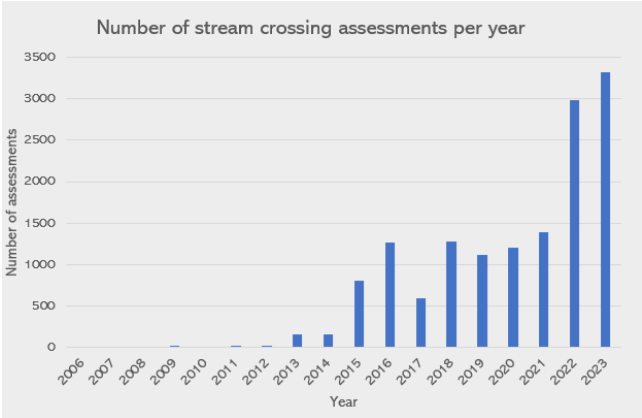
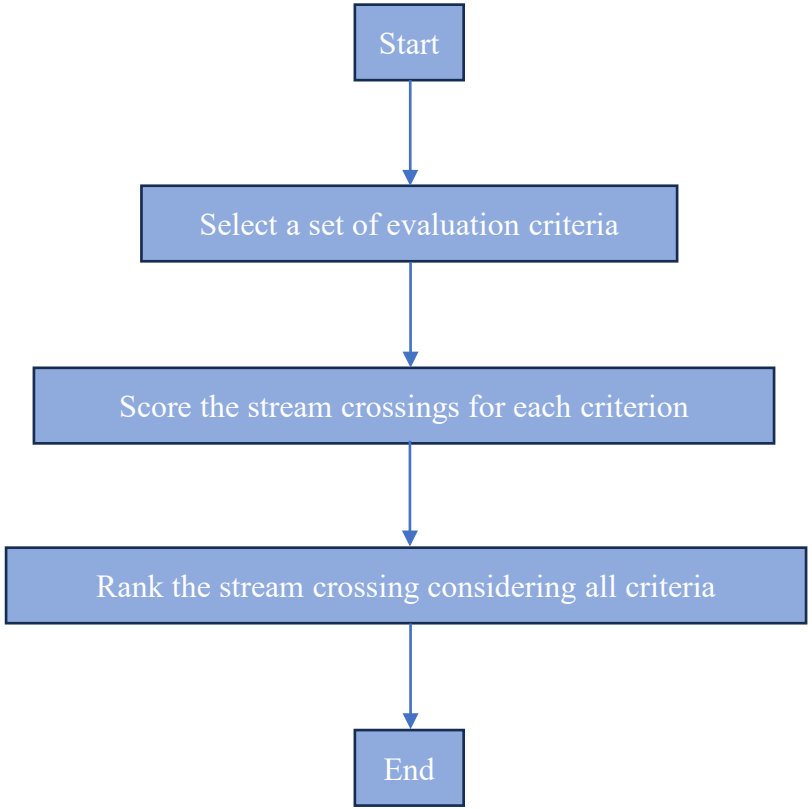
- >$315K from American Rescue Plan Act (ARPA) for this project to:
  - Create comprehensive **stream crossing assessment** dataset in **Salmon Falls-Piscataqua** and **Merrimack River** watersheds
  - Understand and characterize stakeholder interests and priorities related to stream crossing management 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 initiated



Conventional Methods: Scoring & Raking

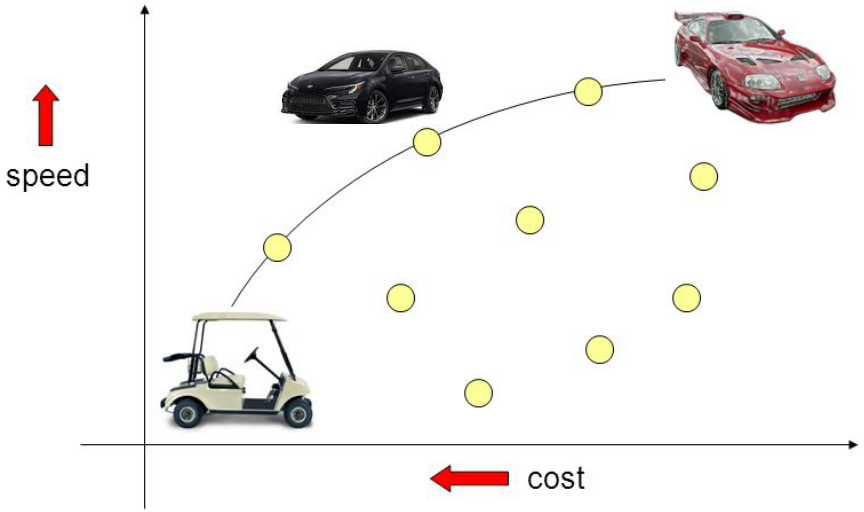


Evaluation criteria

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



https://slideplayer.com/slide/9863758/

Method Comparison: Small Example

Method Comparison: Scoring and Ranking

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Scoring and Ranking for Environmental Score

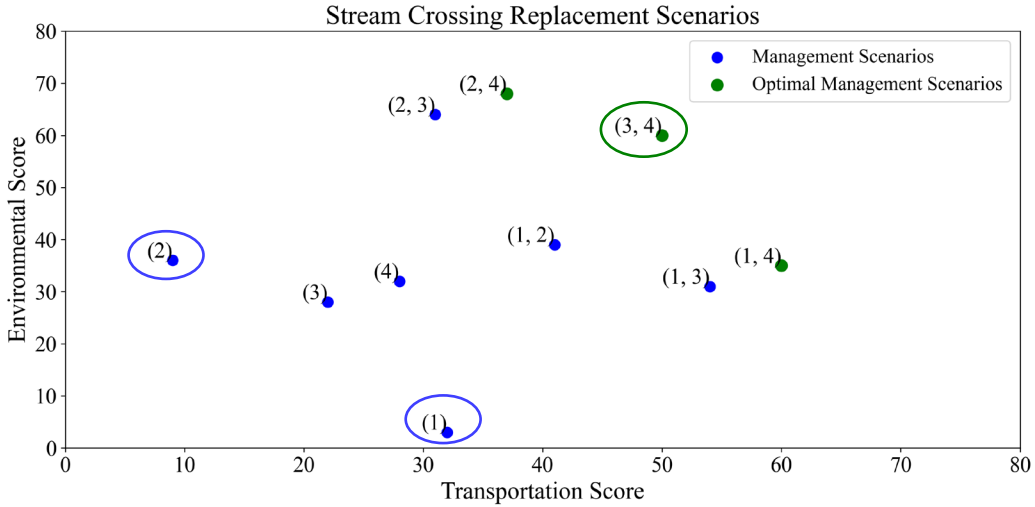
Stream Crossing	Aquatic Organism Passage (0-10)	Geomorphic compatibility (0-10)	Flood Vulnerability (0-10)	Structural Condition (0-10)	Environmental Score	Rank
Stream Crossing #1	0	0	0	3	**3**	**4**
Stream Crossing #2	9	10	10	7	**36**	**1**
Stream Crossing #3	6	5	7	10	**28**	**3**
Stream Crossing #4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

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Wildlife Conservation and Restoration


Environmental Quality


Road Criticality


Economic Impact


Flood Vulnerability


Structural Risk


Community Support and Readiness


Environmental Justice

Evaluation Criteria Example

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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.

Stakeholder Engagement

Stakeholder Engagement Process

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Survey

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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
○	○	○	○	○	○	○

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
○	○	○	○	○	○	○

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
○	○	○	○	○	○	○

Next Steps

- Survey open **March 25th - April 22nd**
  - Three week window
  - 25-30 minutes to complete
  - Email coming
- 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?