Planning for Flood Resilient and Fish Friendly Road-Stream Crossings

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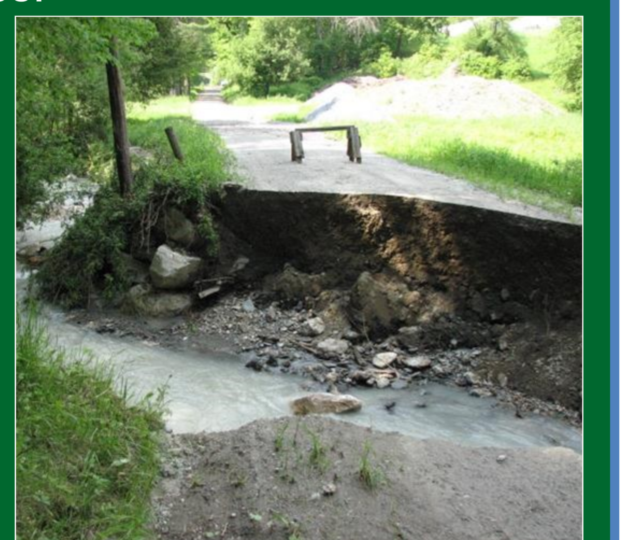
Overview

Project Goal

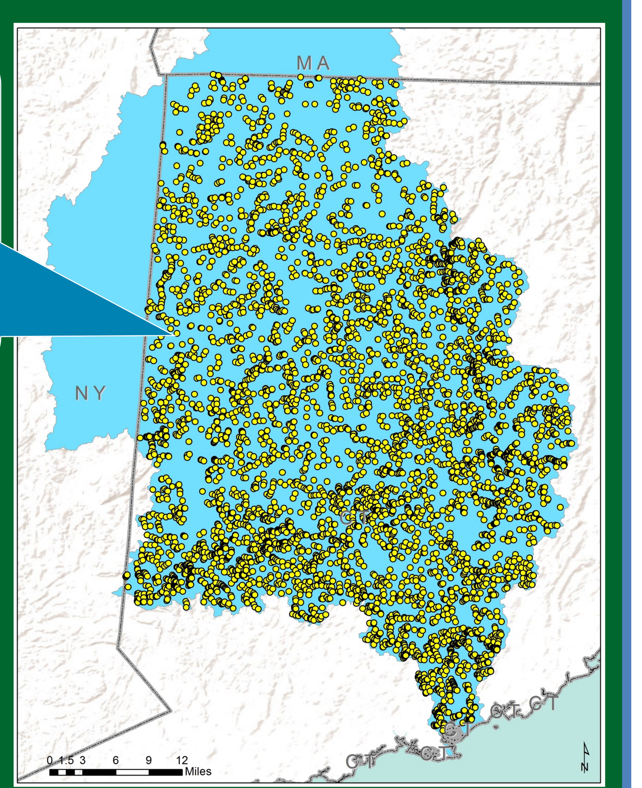
Identify flood risks and habitat barriers at road-stream crossings, and develop new resources CT municipalities can use to reduce flood risk and restore habitat connectivity at problem structures

Management Challenges

Road-stream crossings (bridges and culverts) are structures designed to carry a road over a stream. Undersized and/or misaligned road-stream crossings are more vulnerable to flood damage and can be barriers to fish and wildlife movement. Municipalities are tasked with managing hundreds of structures with limited resources.



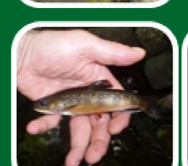
In the Connecticut portion of the Housatonic watershed there are an estimated 6000+ road-stream crossings.



Climate change exacerbates both habitat and flood risk issues. More rain and larger floods mean more structures are undersized, and also increase pollution from stormwater runoff and stream instability; warming waters mean less habitat for cold-water obligate species

More rain (volume & intensity)

Increase in polluted runoff &erosion



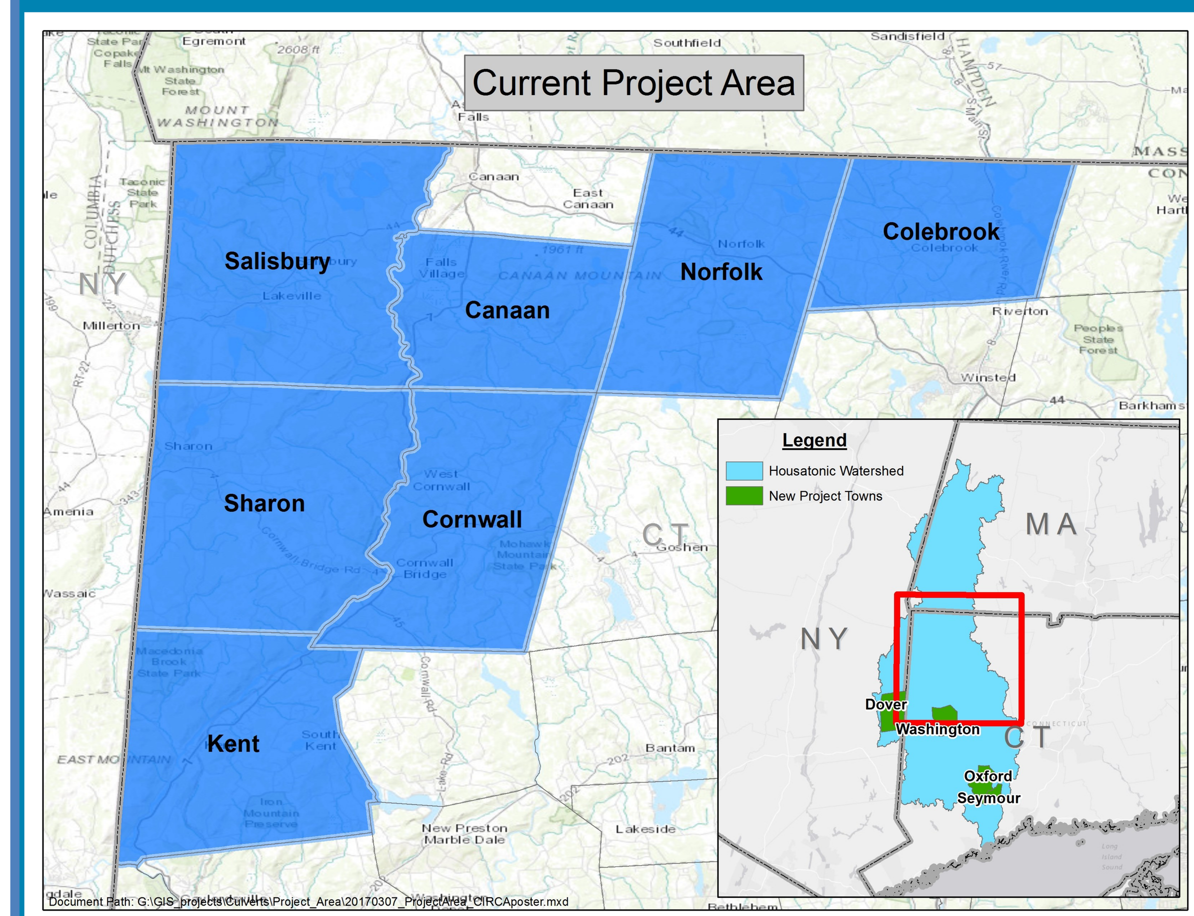
Less coldwater habitat

Given the scale of the road-stream crossing management challenge, a STRATEGIC approach is essential!

Project Scope and Products

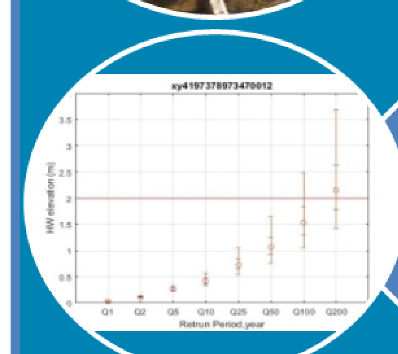
Project Area

The current project area covers 7 towns in northwest Connecticut, and will expand into 4 additional towns in 2017.



Field assessments

Use North Atlantic Aquatic Connectivity Collaborative (NAACC) protocol to assess fish passability & collect data to support flood risk modeling



Habitat & Flood Risk Modeling

UCONN models risk-of-failure with CREST distributed hydrologic model. UMASS models habitat restoration potential with Critical Linkages.

Prioritization

Compile results of field assessments and modeling into a Road-Stream Crossing Inventory, and use them to work with municipalities to prioritize crossings for replacement.

Conceptual Plans & Implementation Strategies

Return to priority crossings for detailed survey; Princeton Hydro draws up plans for new structures demonstrating the use of Stream Simulation Design.

Assemble and Integrate

Combine inventory, conceptual plan and implementation strategies into a comprehensive Road-Stream Crossing Management Plan that can be incorporated into hazard mitigation planning in each municipality.

Assessment and Modeling

Habitat

Structure data collected in the field is used by NAACC to determine degree of barrier based on factors such as:

- Outlet drop (see photo right) and Inlet grade
- Degree of constriction compared to bankfull width
- Physical barriers such as debris, sediment or rocks
- Water depth and velocity

"Critical Linkages" modelling conducted by NAACC scores replacement projects based on potential to enhance ecological integrity of the surrounding landscape

Flood Risk

Peak flood flows at each crossings are determined using the CREST v3.0 hydrologic model developed by UCONN Civil and Environmental Engineering Department.[1] A hydraulic model developed by UCONN uses these peak flows in conjunction with data collected in the field to determine risk-of-failure (overtopping the road) for the 2-, 5-, 10, 25-, 50-, 100– and 200-year recurrence interval flood at each structure

Results

Recurrence Interval Failure	Number of Culverts	Percentage
2-Year	8	4%
5-Year	6	3%
10-Year	14	7%
25-Year	42	20%
50-Year	29	14%
100-Year	20	10%
200-Year	27	13%
Passing	63	30%

33% (2-Year through 25-Year)

A third of culverts assessed fail during the 25-year flood

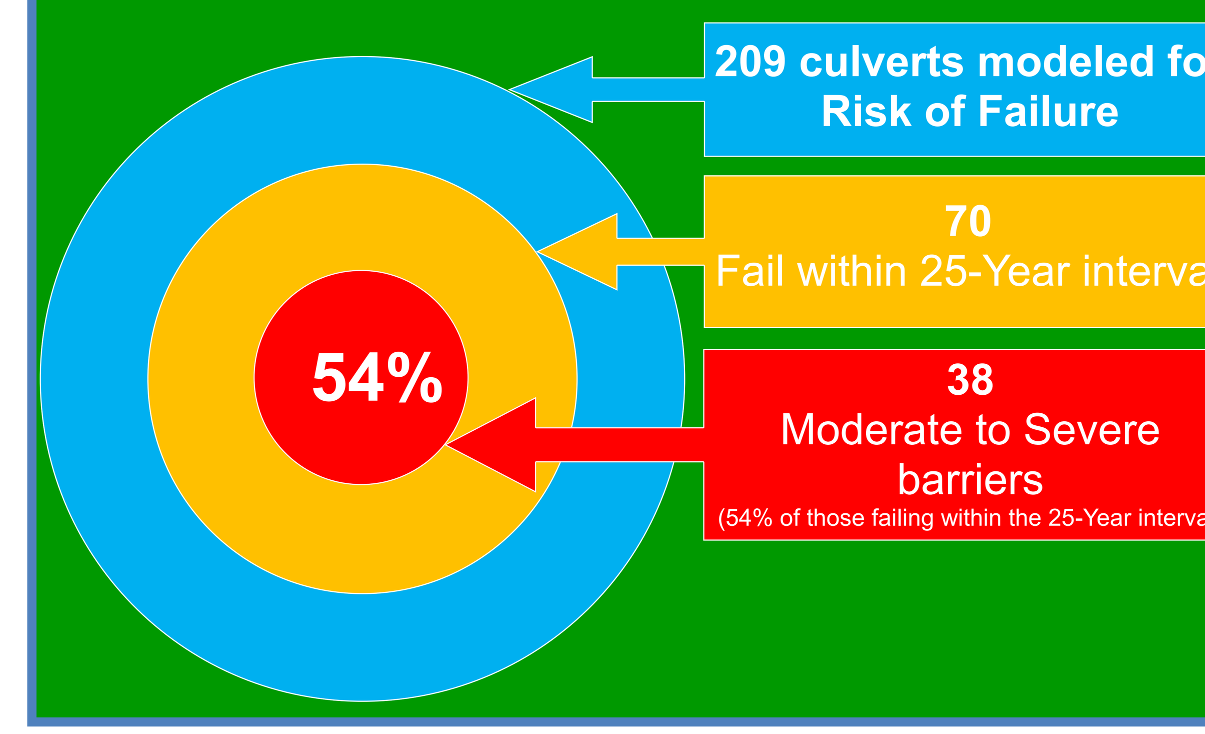
Barrier Evaluation	Number of Culverts	Percentage
Severe barrier	176	24%
Significant barrier	71	10%
Moderate barrier	177	24%
Minor barrier	244	33%
Insignificant barrier	56	8%
No barrier (full passage)	0	0%

58% (Severe, Significant and Moderate barrier)

More than half of the culverts assessed are moderate or worse barriers

Results

More than half of high-risk structures are also barriers to fish and wildlife movement



Management Strategies

Stream Simulation Design is a method for developing crossings that mimic the natural stream channel through a structure, as if the crossing didn't exist.[2]

Benefits of Stream Simulation Design:

- Reduced likelihood of clogging, upstream ponding and road overtopping (reduced flood risk and maintenance costs)[3]
- Greater longevity than hydraulically-designed structures[4]
- Full, unobstructed passage for fish and wildlife[2]

References

1. Shen and Anagnostou, (2017). "A Framework to Improve Hyper-resolution Hydrological Simulation in Snow-Affected Regions", Journal of Hydrology .
2. US Forest Service. "Stream Simulation Design: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings." 2008.
3. Gillespie et al. "Flood Effects on Road-Stream Crossing Infrastructure: Economic and Ecological Benefits of Stream Simulation Designs." Fisheries. 2014. p.66
4. MA DER. "Economic & Community Benefits from Stream Barrier Removal Projects in Massachusetts." 2015. p.3-6

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