Planning for Flood Resilient and Fish-Friendly Road-Stream Crossings

Project Fact Sheet 02/2020

The Housatonic River watershed spans 3 states, 83 towns, and 1,948 square miles. Within the watershed, there are thousands of points where roadways, driveways, and trails cross rivers and streams. In these locations the road is carried by structures collectively referred to as **road-stream crossings** (i.e., culverts and bridges).

Initial results of an ongoing study conducted by the Housatonic Valley Association (HVA) indicate that approximately 55% of the non-bridge road-stream crossings evaluated to date in the Housatonic watershed are considered moderate or worse **barriers to fish and wildlife movement** (n = 1231). Furthermore, modeling by project partners at the University of Connecticut indicates that approximately 15% of non-bridge structures evaluated fail (i.e., water reaching the road elevation) in a 25-year recurrence interval flood or less (n = 910). Given the large number of problem structures, a strategic approach to **restoring habitat connectivity** and **reducing flood risk** at road-stream crossings is necessary.

Barrier Evaluation	Number of Culverts	Percentage
Severe barrier	290	24%
Significant barrier	115	9%
Moderate barrier	266	22%
Minor barrier	430	35%
Insignificant barrier	130	11%
No barrier (full passage)	0	0%

Recurrance of Interval Failure	Number of Culverts	Percentage
2	22	2%
5	16	2%
10	25	3%
25	70	8%
50	46	5%
100	57	6%
200	70	8%
Passing	604	66%

In 2015, HVA began a pilot project to develop road-stream crossing management plans (RSCMPs) in 7 towns in Northwest CT; as of 2020, there are 24 plans in various stages of completion across our watershed (see map). The primary objectives of this work are to help communities identify the **highest priority replacement projects** based on conservation value, flood risk and maintenance need; encourage adoption of culvert design Best Management Practices; and create a new tool for securing financing for replacement projects.

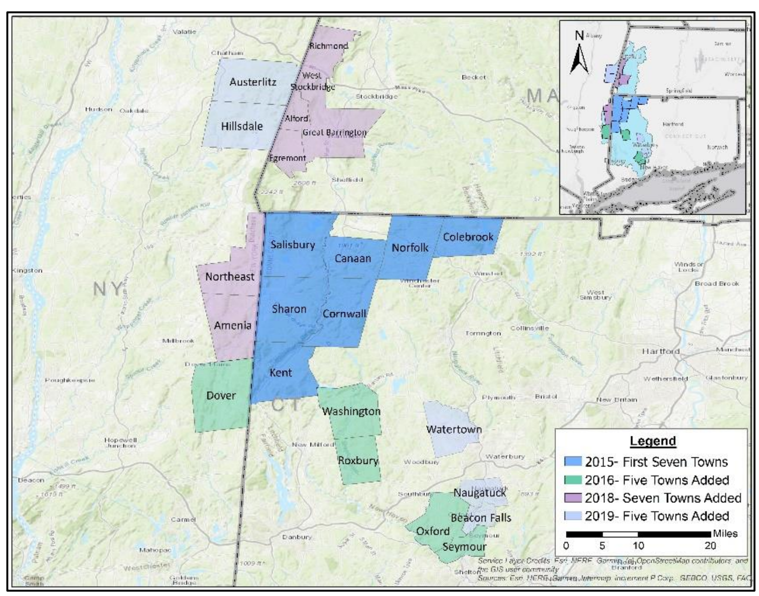


Figure 1: Towns with completed plans or plans currently in progress.

After data collection and analysis, HVA works with the community and a Project Engineer to develop preliminary designs and implementation strategies for high-priority replacements, and to integrate assessment results into local highway infrastructure and hazard mitigation planning.

Even more important than the construction of a flagship replacement project in each town is the opportunity to show local highway managers and decision makers that the same **best management practices** that restore fish and wildlife passage also reduce flood risk and long-term maintenance costs. The impacts of climate change (i.e., more frequent extreme precipitation events, rising temperatures) will increase the risk of culvert failures, as well as increase stressors to native fish and wildlife populations. Replacing problem culverts with structures that conserve natural stream processes is a single solution that can increase the climate resiliency of both the built and natural environment.

The Road-Stream Crossing Management Planning Process:

1) **Assessments of all road-stream crossings within selected towns:** Assessments for fish and wildlife passage (stream habitat continuity) are conducted using the North Atlantic Aquatic Connectivity Collaborative (NAACC) protocol. Data collected in the field is uploaded to a regional online database which produces a "passability score" and barrier evaluation, ranking the site's ability to pass fish and wildlife and ranging from 0 (complete/ severe barrier) to 1 (no barrier, full passage).

2) **Flood Risk Analysis:** All closed-bottom structures (culverts) within each town are assessed for flood resiliency, through a collaboration with UConn Department of Civil and Environmental Engineering (UConn.). UConn uses data collected by HVA in a hydraulic capacity model that predicts failure (water reaching the road elevation) at multiple flood frequencies (2-, 10-, 25-, 50-, 100-, 200-year recurrence intervals). Peak flows for each modeled recurrence interval are derived from the Coupled Routing and Excess Storage (CREST) 3.0 hydrologic model, developed by UConn.

3) **Road-Stream Crossing Inventory documents:** Town-wide inventory documents are developed for partner municipalities, containing maps, photos, all data collected in the field, and barrier status for each crossing, as well as the results of UConn's flood-risk analysis.

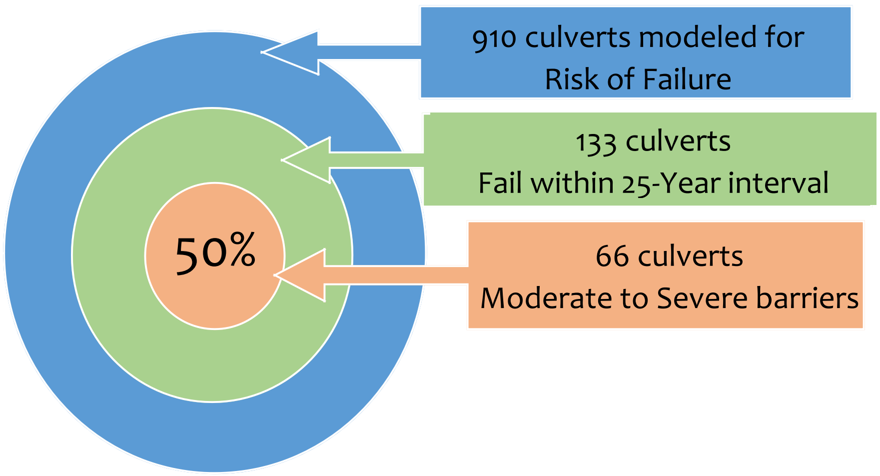
4) **Collaborative prioritization:** Inventory documents are used to guide prioritization workshops for each town that include but aren't limited to representatives from the Executive Board, Public Works and Emergency Services Departments. An important goal of these meetings is to document local knowledge of flood-risk issues at road-stream crossings in the community, such as frequent overtopping, sediment/debris accumulation and interference with emergency response. These workshops inform a town-wide ranking of replacement projects based on flood hazard mitigation potential, conservation value and expected reduction in maintenance costs. Projects that meaningfully address all three of these issues are ranked the highest.

5) **Preliminary designs (where funding is available):** Preliminary designs and implementation strategies for the highest priority replacement project in each town are developed in collaboration with a Project Engineer. Replacement projects are designed using the Stream Simulation method, which not only preserves safe roadways and minimizes expenses associated with more frequent repair and replacement, but also serve to reconnect critical wildlife corridors for ecologically and economically important native species like Eastern Brook Trout.

6) **Road-Stream Crossing Management Plans:** All of the above information, along with conclusions and management recommendations, is assembled as a draft Road-Stream Crossing Management Plan document for each partner town. The draft plan is made available for review by stakeholders and the public, and any comments received are integrated into the final RSCMP. Final RSCMPs are suitable for official municipal adoption as an annex to local Natural Hazard Mitigation plans, or as a stand-alone document.

Flood risk and barrier status:

As of March 2020, HVA has completed RSCMPs for 12 communities, and there are 12 more town-scale RSCMPs in progress. Our research to date shows an overlap in local knowledge and UConn's flood risk model results. Of all the crossings that were both identified by town staff and officials as flood risks and modeled by UConn, 45% failed within a 50-year flood interval or less (*n* = 82).



Our results also show that the intersection of culvert barrier status and flood risk is significant. 50% of all culverts predicted to fail at the 25-year flood interval or less by UConn's modeling are also considered moderate or worse barriers to fish and wildlife movement, based on NAACC assessment (see figure at left).

Project status and next steps:

We continue to use the RSCMP process to illuminate the relationship between flood risk, maintenance need and habitat fragmentation at road-stream crossings, and advocate for the adoption of Best Management Practices (BMPs) that can address all of these issues. Key to this is documenting the life-cycle costs of structures built with BMPs like Stream Simulation Design, as compared to structures that don't conserve stream processes. A growing body of research shows that, while it is more expensive on the front-end to use BMPs that conserve stream processes, those costs are recouped over the life of a structure through reduced need for regular maintenance and increased resilience to large floods.

The RSCMPs are meant to be a tool Towns can use to take advantage of every opportunity to reduce flood risk and restore stream habitat connectivity at road-stream crossings, including capital planning and regular maintenance, grant programs, and recovery operations in the wake of large floods. We recognize, though, that the RSCMPs alone do not address the barriers that communities face when trying to incorporate BMPs into replacement projects. Even though the life-cycle cost-benefit of using these practices is clear, increased front-end costs for site assessment, engineering and construction still make it very difficult for communities to incorporate them into replacement projects. HVA and our partners are developing strategies for reducing these front-end costs. HVA has built internal capacity to conduct professional-grade surveys and other site assessments necessary for Stream Simulation design development, which has reduced per-project costs of culvert replacement projects for several of our partner communities. Similarly, our partners at Trout Unlimited have brought on design staff who are able to develop culvert replacement designs that incorporate BMPs at costs that are very competitive with consulting engineers that specialize in highway infrastructure. Together, HVA and TU have been able to significantly reduce the cost of culvert replacement design development for several projects in our partner communities, and we have many more planned for 2020 and 2021. We also see opportunities for working regionally to find per-project cost savings for the construction phase of culvert replacement, and we're working with watershed communities and other partners to develop these ideas.

Partner Towns: Phase I (CT): Canaan, Colebrook, Cornwall, Kent, Norfolk, Salisbury, Sharon
Phase II (NY. CT): Dover (NY), Oxford, Roxbury, Seymour, Washington
Phase III (MA, NY): Amenia (NY), Egremont, Great Barrington, North East/Millerton (NY), Richmond, West Stockbridge
Phase IV (NY, CT): Austerlitz (NY), Beacon Falls, Hillsdale (NY), Naugatuck, Watertown

Other Project Partners:
UConn Civil and Environmental Engineering Department, Princeton Hydro LLC, CTDEEP-Inland Fisheries, Trout Unlimited, Northwest Hills Council of Governments (COG), Naugatuck Valley COG, Berkshire Regional Planning Commission, MA Department of Ecological Restoration, CT Department of Transportation, NYSDEC- Hudson River Estuary Program, Cornell Cooperative Extension (Dutchess, Columbia-Greene), Lower Hudson Coalition of Conservation Districts, North Atlantic Aquatic Connectivity Collaborative, Farmington River Watershed Association

Funders:
Housatonic River Natural Resource Damages Fund; National Fish and Wildlife Foundation's (NFWF) New England Forests and Rivers Fund; NFWF Long Island Sound Futures Fund; New England Interstate Water Pollution Control Commission/Hudson River Estuary Program; Patagonia World Trout Initiative; Farmington River Coordinating Committee; Connecticut Institute for Resilience and Climate Adaptation; Northwest Connecticut Community Foundation; Connecticut Community Foundation; New York State Climate Smart Communities Grant Program

Figure 2 Before (top) and after (bottom) photo of a culvert replacement project on Churchill Brook in Pittsfield, MA. The bottom structure is an-bottomed culvert that was designed with the natural stream channel in mind.

For More Information:
Call or e-mail Watershed Conservation Director Mike Jastremski (mj.hva@outlook.com) or Conservation Projects Manager Lindsay Keener-Eck (lkeenereck.hva@gmail.com) at HVA:

PO Box 28
Cornwall Bridge, CT 06754
(860) 672-6678
www.hvatoday.org