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Protecting and Enhancing River and Stream Continuity

Scott Jackson
University of Massachusetts Extension, Amherst, Massachusetts

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Abstract: As long linear ecosystems, rivers and streams are particularly vulnerable to fragmentation. There is growing concern about the role of road crossings – and especially culverts – in altering habitats and disrupting river and stream continuity. The River and Stream Continuity Project began in the year 2000 with a startup grant from the Massachusetts Watershed Initiative. The University of Massachusetts took the lead in convening a group of people from a variety of agencies and organizations who were concerned about the impact of road-stream crossings on fish and other aquatic organism passage. Since its beginning, the River and Stream Continuity Project has:

- Developed "Massachusetts River and Stream Crossing Standards" to facilitate river and stream continuity as well as fish and wildlife passage. These standards are referenced in federal and state regulations and policies affecting road-stream crossings.
- Created a field protocol for volunteer assessment of road-stream crossings, including data forms, instructions, and training materials.
- Developed a system for scoring crossing structures for their effects on river and stream continuity and aquatic organism passage based on volunteer assessments.
- Created an online database for data on road-stream crossings collected by volunteers. All crossings are geo-referenced and information from the database can be easily used in a GIS to depict the location and score of all assessed structures in participating states.
- Developed a statewide GIS coverage prioritizing all mapped stream segments in Massachusetts into three categories based on information about their importance for fish and wildlife.
- Conducted volunteer assessments of road-stream crossings in Massachusetts, Connecticut, Rhode Island, Vermont and New Hampshire.
- Initiated demonstration projects to mitigate known barriers to aquatic organism passage on high-priority streams.
- Developed workshops, presentations and other educational material on the subject of river and stream continuity and the Massachusetts River and Stream Crossing Standards.

Key Words: culvert, ecological restoration, fish passage, river and stream continuity, Stream Simulation, road-stream crossing, wildlife passage

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Introduction

As long linear ecosystems, rivers and streams are particularly vulnerable to fragmentation. A number of human activities can disrupt the continuity of river and stream ecosystems. The most familiar human-caused barriers are dams. However, there is growing concern about the role of road crossings – and especially culverts – in altering habitats and disrupting river and stream continuity.

Road and highway systems, as long linear elements of the transportation infrastructure, can result in significant fragmentation of river and stream ecosystems. Road systems and river and stream networks frequently intersect, often with significant negative consequences for river and stream ecosystems. Within Massachusetts there are an estimated 30,000-35,000 road-stream crossings, creating a reason for serious concern that the river and stream networks are highly fragmented (Figure 1).

Most of the culverts currently in place were designed with the principal objective of moving water across a road alignment. Little consideration was given to ecosystem processes such as the natural hydrology, sediment transport, fish and wildlife passage, or the movement of woody debris. It is not surprising then that many culverts significantly disrupt the movement of aquatic organisms.

Much attention has been focused on passage for migratory fish, especially in the Northwestern U.S. In some cases, considerable resources have been invested in projects addressing fish passage only to find that accommodations made for adults did not address the needs of juvenile fish. Long-term conservation of fish resources will depend not only on passage for both adult and juvenile fish but also on maintenance of healthy

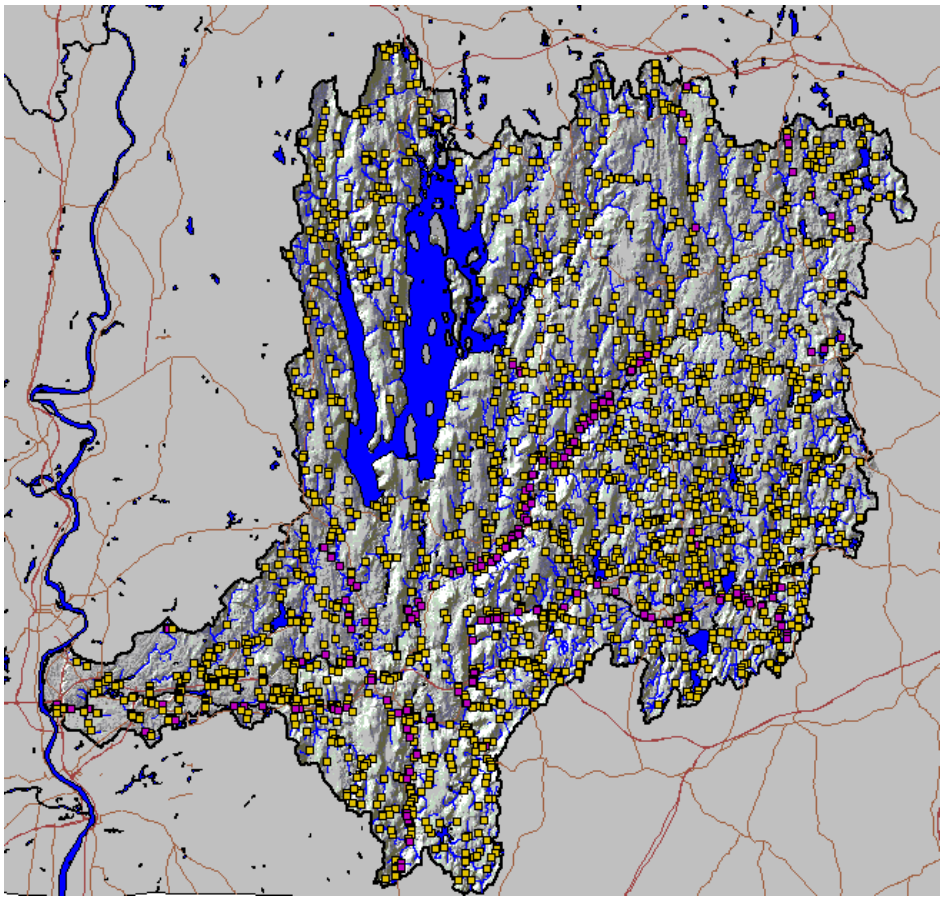

Figure 1. The 721-sq. mi. Chicopee River Watershed is a relatively rural watershed in Central Massachusetts. The watershed contains approximately 2,151 miles of roads and 259 miles of railroad tracks. The intersection of the stream network with roads and railroads results in an estimated 2,230 crossings, raising serious concerns about fragmentation of river and stream ecosystems in this watershed.

stream and river ecosystems. Essential to this approach is a focus on habitat quality and strategies for aquatic organism passage based on communities rather than individual species. Without an ecosystem-based approach to river and stream crossings, we will be at risk of facilitating passage for particular fish species while at the same time undermining the ecological integrity of the ecosystems on which these fish depend.

The River And Stream Continuity Project

The River and Stream Continuity Project began in 2000 with a startup grant from the Massachusetts Watershed Initiative. The University of Massachusetts took the lead in convening a group of people from a variety of agencies and organizations who were concerned about the impact of road-stream crossings on fish and other aquatic organism passage. In 2005, three of the organizations that were key players in initiating and implementing the project joined to create the River and Stream Continuity Partnership. Founding members of the Partnership include: University of Massachusetts Extension, the Massachusetts Riverways Program, and The Nature Conservancy (TNC).

Members of the Partnership have made a commitment to the ongoing implementation of the River and Stream Continuity Project, including updates and revisions to the MA River and Stream Crossing Standards, coordination and implementation of volunteer assessments, management of the Crossings database, and projects to upgrade or replace substandard crossing structures. The River and Stream

Continuity Project is now operating in five states: Massachusetts, Rhode Island, Connecticut, Vermont, and New Hampshire. More information about the project is available from our web site: www.streamcontinuity.org.

Program Elements And Accomplishments

Crossing Standards

Information was compiled about fish and wildlife passage requirements, culvert design standards, and methodologies for evaluating barriers to fish and wildlife passage. This information was then used to develop performance standards for culverts and other stream crossing structures (River and Stream Continuity Partnership 2006). A first draft of the standards was released in 2004. In 2006, the standards were revised and updated. "Massachusetts River and Stream Crossing Standards" is available as a PDF from the stream continuity web site.

The standards were developed by the River and Stream Continuity Partnership with input from an Advisory Committee that includes representatives from UMass-Amherst, Massachusetts Riverways Program, Massachusetts Watershed Initiative, Trout Unlimited, The Nature Conservancy, the Westfield River Watershed Association, ENSR International, Massachusetts Highway Department (MassHighway), and the Massachusetts Departments of Environmental Protection and Conservation and Recreation. In developing the standards, the Partnership received advice from a Technical Advisory Committee that included representatives of the U.S. Fish and Wildlife Service, USGS BRD, U.S. EPA, U.S. Army Corps of Engineers, MA Division of Fisheries and Wildlife, American Rivers, Connecticut River Watershed Council, Connecticut DEP, a hydraulic engineering consultant, as well as input from people with expertise in Stream Simulation approaches to crossing design. The standards are recommended for new permanent crossings (highways, railways, roads, driveways, bike paths, etc.) and, when possible, for replacing existing permanent crossings.

The MA River and Stream Crossing Standards seek to achieve, to varying degrees, three goals:

1. Fish and other Aquatic Organism Passage: Facilitate movement for fish and other aquatic organisms, including relatively small, resident fish, aquatic amphibians and reptiles, and large invertebrates (e.g., crayfish, mussels).
2. River/Stream Continuity: Maintain continuity of the aquatic and benthic elements of river and stream ecosystems, generally through maintenance of appropriate substrates and hydraulic characteristics (water depths, turbulence, velocities, and flow patterns). Maintenance of river and stream continuity is the most practical strategy for facilitating movement of small, benthic organisms as well as larger, but weak-swimming species such as salamanders and crayfish.
3. Wildlife Passage: Facilitate movement of wildlife species including those primarily associated with river and stream ecosystems and others that may utilize riparian areas as movement corridors. Some species of wildlife such as muskrats and stream salamanders may benefit from river and stream continuity. Other species may require more open structures as well as dry passage along the banks or within the streambed at low flow.

There are two levels of standards (General and Optimum) to balance the cost and logistics of crossing design with the degree of river/stream continuity warranted in areas of different environmental significance. These standards have since been incorporated into federal and state regulations and policies affecting road-stream crossings.

On January 20, 2005, the U.S. Army Corps of Engineers reissued the Programmatic General Permit (PGP) for Massachusetts. The PGP (U.S. Army Corps of Engineers 2005) sets terms and conditions that must be met for projects to qualify for Category 1, which doesn't require application to the Corps. In the past, the PGP included general language requiring that crossings of water bodies not "…obstruct the movement of aquatic life indigenous to the waterbody..." The reissued PGP contains more specific language

at General Condition 21 to ensure aquatic organism passage and requires that all new permanent crossings meet the general standards contained in the Massachusetts River and Stream Crossing Standards.

By including the Massachusetts River and Stream Crossing Standards as a requirement for all "new" permanent crossings, the reissued PGP will significantly change the way road/stream crossings are designed and permitted in Massachusetts. Structures will generally be larger and will require more careful engineering, design, and construction to ensure that appropriate flow and channel characteristics are maintained over time. Elements of the crossing standards have since been incorporated into the PGP for Maine, and it is the stated intention of the Corps to use the standards in the reissue of Programmatic General Permits for all the New England states.

The Massachusetts Department of Environmental Protection has included the crossing standards in its recently released "Massachusetts Wildlife Habitat Protection Guidance for Inland Wetlands" (DEP 2006), and it is in the process of requiring that road-stream crossings adhere to the standards as part of the state's water quality standards. There has been a great deal of interest in the Massachusetts River and Stream Crossing Standards, and other New England states are developing their own standards (Maine has crossing standards that predate those developed for Massachusetts).

Assessment of Road-Stream Crossing Structures

The River and Stream Continuity Partnership has developed a program for volunteer assessment of river and stream crossings. A simple data form has been developed for assessing crossing structures in the field, along with instructions and training materials for collecting data and completing the form. Volunteer groups that receive training may enter data into the River and Stream Continuity Crossings Database, an online database available at www.streamcontinuity.org/cdb.

The River and Stream Continuity Crossings Database allows cooperators to input data from volunteer surveys directly into an online database. An algorithm within the database automatically calculates scores for each road-stream crossing based on a scale of 0 (severe barrier) to 10 (meets optimum standards). Data and computed scores from the database are available for viewing and download from the web site. All crossings are geo-referenced and information from the database can be easily used in a GIS to depict the location and score of all assessed structures in participating states. The online database ensures timely availability of data for researchers and volunteers and creates a cost-effective method for gathering information about road-stream crossings throughout New England.

Under the leadership of The Nature Conservancy and the Massachusetts Riverways Program, trained volunteers have now assessed over 2,600 crossing structures. In particular, The Nature Conservancy has been focusing their efforts to get comprehensive assessment of crossings in key watersheds of the Connecticut River. They are using information from these assessments to establish priorities and create action plans for protecting and enhancing river and stream continuity in these target watersheds.

Prioritizing Crossing Structures for Replacement

In order to help prioritize crossing structures for replacement or retrofits, we developed a stream classification system for Massachusetts based on existing GIS data. Three levels of standards were applied– Class A (Highest quality), Class B (High quality), and Class C (General):

Class "A" designations were applied in areas where crossings might adversely impact:

- A select number of BioMap Core habitats for riverine species, or
- Living Waters Core habitats.

Class "B" designations were applied to areas that fell within:

- Areas of Critical Environmental Concern (ACEC),
- BioMap cores (other than select cores used for Class A),
- Known anadromous fish runs,
- Streams that supported coldwater fisheries, or
- Designated federal or state wild and scenic rivers.

Class "C" designations were applied to all other stream segments. The GIS coverage, available as a shapefile, can be downloaded from the stream continuity web site.

Work is under way at the University of Massachusetts to create more sophisticated methods for prioritizing stream segments for protection. An approach piloted in the Westfield River Watershed used the Conservation Assessment and Prioritization System (CAPS) to apply rigorous landscape-based models and predict gains in ecological integrity that could be achieve via the replacement of sub-standard crossing structures (for more information about CAPS go to www.masscaps.org). The Nature Conservancy is developing its own, more detailed system for prioritizing stream and river segments for protection or restoration.

Demonstration Projects

The Massachusetts Riverways Program has taken the lead in providing technical assistance to municipalities on a number of demonstration projects to enhance river and stream continuity. These include Tower Brook in Chesterfield, Bronson Brook in Worthington, and Labor in Vain Brook, Somerset, MA.

Education and Training

Partners in the River and Stream Continuity Project have engaged in extensive education and training programs raising awareness of the ecological issues associated with road-stream crossings, standards and regulations, volunteer assessment protocols, crossing design and construction, and strategies for protecting and enhancing river and stream continuity. Training workshops on crossing design and associated regulations and policy have been developed and implemented for state and federal agency personnel, municipal conservation commissioners, civil engineers, and environmental consultants. Volunteer training and support programs have been developed and implemented. Information has been presented at the Northeastern Wildlife and Transportation Conference, American Fisheries Society annual conference, and International Conference on Ecology and Transportation.

Project personnel also served on an interdisciplinary team organized and coordinated by the USDA Forest Service to develop and implement training programs and a technical guidance document on the "Stream Simulation" approach to road-stream crossing design. Stream Simulation is a design approach that avoids flow constriction during normal conditions and creates a stream channel that maintains the diversity and complexity of the streambed through the crossing. The goal is to create crossings that are essentially "invisible" to aquatic organisms by making them no more of an obstacle to movement than the natural channel. Detailed information about "Stream Simulation" will soon be available in an USDA Forest Service guidance document currently in the final stages of development (USDA *In Preparation*).

Conclusion

Road networks and river systems share several things in common. Both are long, linear features of the landscape. Transporting materials (and organisms) is fundamental to how they function. Connectivity is key to the continued functioning of both systems. Ultimately, our goal should be to create a transportation infrastructure that does not fragment or undermine the essential ecological infrastructure of the land. The River and Stream Continuity Project is an effort to inventory and more effectively address barriers to fish movement and river and stream continuity.

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