Stream Crossings - Protecting and Restoring Stream Continuity

This information was developed for those involved in designing and constructing stream crossings – with an eye toward protecting and restoring stream continuity.

The guidelines and standards presented here describe minimum criteria to avoid fragmentation of streams. The objective is to maintain natural conditions that do not restrict the movement of fish and wildlife through the stream system. Although these guidelines meet this objective, additional engineering design may be necessary to ensure structural integrity and appropriate hydraulic capacity.

Introduction

Photo by Scott Jackson

New York State is rich with many miles of high quality, productive streams. This valuable resource sustains natural communities by nourishing vegetation and providing food sources, shelter and spawning areas for fish and wildlife. It also provides innumerable additional benefits to us, such as recreation and aesthetic enjoyment and economic support.

Streams are long, linear ecosystems. The processes that nourish these ecosystems are interrelated and dependent on “continuity” of the stream corridor. Our transportation and access needs often result in fragmentation of streams. Many stream crossings, such as bridges and culverts, act as barriers to fish and wildlife. Awareness of the effects of stream crossings plays an important role in maintaining stream continuity.

The design and condition of stream crossings determines whether a stream can function naturally and whether animals can move unimpeded along the stream corridor. These are key elements in assuring the overall health of the system. This web page describes stream crossing designs that promote natural stream conditions and allow unrestricted movement within stream corridors while maintaining our access and transportation needs.

Stream Continuity and Natural Communities

The continuity of streams, as well as their connection to riparian and upland areas, is necessary to the well being of all species that inhabit or are associated with stream ecosystems. When designing and installing stream crossings, the needs of invertebrates, fish, amphibians, reptiles, and mammals must be taken into account. These animals rely on being able to move unimpeded, both daily and seasonally, through the stream and adjacent areas. Finding shelter, escaping danger, searching for food, and maintaining genetic diversity are some of the many activities that require stream continuity and connection to the watershed.

Continuity for Healthy Stream Ecosystems

As organisms move through their various life stages, they need access to a variety of habitat areas. Their needs may change as they grow and develop; however, in general they rely on adequate spawning and nursery areas; optimal temperatures and oxygen levels; natural substrates; good cover and food supplies; and optimal hydrologic conditions such as water depth and velocity. Disrupting the continuity of a stream can affect these conditions as well as an animal's ability to access prime areas.

Access to coldwater habitats

During the summer, species such as brook trout travel to and congregate in cold water sections of streams and tributaries. If fish are prevented from reaching these areas, they can become susceptible to heat stress and mortality. Also, if travel is limited, they may become overcrowded and vulnerable to disease and predators.

Access to feeding areas

Different habitats provide various feeding opportunities throughout a day or season, and species regularly travel to take advantage of these resources. Restricting access to prime feeding areas can affect a variety of species.

Access to breeding, spawning, and nursery areas

Some species need to travel to reach spawning areas in streams. Barriers and restrictions can prevent adult fish from traveling to spawning areas, and offspring from dispersing into juvenile and eventually adult habitat.

Natural dispersal

Natural dispersal is important, especially when streams are damaged by major events such as pollution, flooding, or severe drought. Dispersal is a critical aspect in returning a stream to a healthy, productive environment. When animals are impeded from traveling in and along stream corridors, they may be subject to increased predation and mortalities, reducing the ability to repopulate an area.

Other

Streams nourish nearby habitats. Poor crossing design and installation can result in degradation of these areas and adversely affect native plants and animals.

Recognizing Problems

The following three common stream crossing problems can create barriers to fish and wildlife and lead to several consequences. Recognizing poor crossing structures and installations is an important step in evaluating whether they should be fixed or replaced.

Undersized Crossings: Undersized crossings can result in restrictions of natural flow, scouring and erosion, high flow velocities, clogging and ponding.

Shallow Crossings: Water depths are too low for many organisms to move through, and the bottom may lack appropriate stream bed material.

Double Culverts: Restriction of natural flow, clogging with debris, ponding and flooding.

Perched Crossings: Low flow, unnatural bed material, scouring and erosion, ponding.

Consequences of Poor Crossings

Low Flow

Species movement within the stream is restricted during low flow. Fish and other aquatic organisms need sufficient water depth to move through a stream crossing. Low flows may also lead to stagnant conditions within the crossing.

Unnatural Bed Materials

Metal and concrete are not appropriate materials for species that travel along the streambed. The substrate in or under a crossing should match the natural substrate of the surrounding stream in order to maintain natural conditions.

Scouring and Erosion

In undersized crossings, high water velocities may scour natural substrates in and downstream of the crossing, degrading habitat for fish and other wildlife. High water velocities and related flow alterations may also erode stream banks. In perched culverts, scour pools often develop downstream of the culvert and eventually undercut the culvert and impede upstream passage.

High Flow

Water velocity is higher in a constricted crossing than it is upstream or downstream. This high flow degrades wildlife habitat and weakens the structural integrity of a crossing. During floods, undersized crossings may be filled with fast-moving water, exacerbating the problems associated with poorly designed crossings.

Clogging

Some crossings – especially under-sized ones – can become clogged by woody debris, leaves, and other material. This may intensify the effect of floods and make a crossing impassable to wildlife. In addition, costly, routine maintenance is often required.

Ponding

Under-sized crossings can cause water to backup in areas upstream of the crossing. It may occur year-round, during seasonal high water or floods, or when crossings become clogged. Ponding can lead to property damage, road and bank erosion, and severe changes in upstream habitat.

Solutions

Stream crossings should be properly sized, placed and installed. They should be large enough to allow fish, wildlife, and floods to pass, and so that stream flows and velocities are not altered. They should also have either an open bottom or be imbedded into the stream bed so that substrate and water depth are similar to the surrounding stream.

Stream Crossing Guidelines

A goal of this information is to provide practical, effective, long-term solutions for protecting and restoring stream continuity. Crossings that meet this goal are those that are “invisible” to fish and wildlife. They should be designed and installed so that natural stream flow and substrate are mimicked throughout the crossing and so that they do not constrict or fragment the stream.

Good crossings that create no noticeable change in the stream include bridges and open-bottom arches and culverts that sufficiently span the stream channel bed, and box and pipe culverts that sufficiently span and are adequately sunk into the stream channel bed.

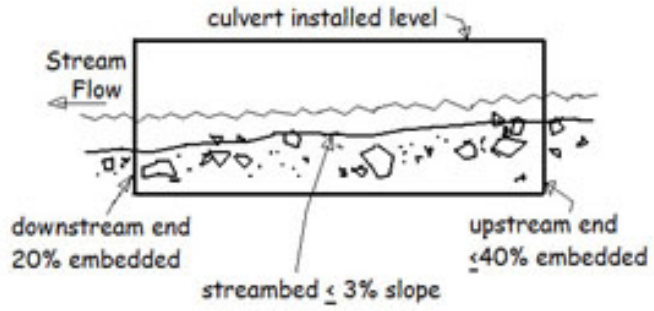
Stream Crossing Standards

The following recommended standards are effective for reducing stream barriers and impediments to fish and wildlife.

I. TYPE

A. Bridges and bottomless arches are preferred and should be used whenever possible.

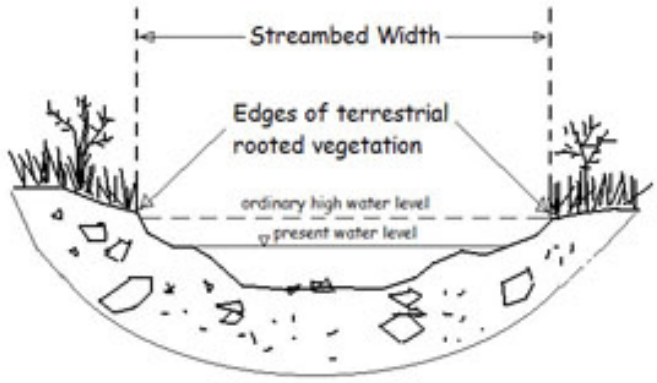
B. Box and Pipe culverts, if used, must be:



- Embedded into the streambed to at least 20 percent of the culvert height at the downstream invert
- Used only on “flat” streambeds (slopes no steeper than 3 percent)
- Installed level

II. WIDTH

The crossing opening (whether open arch, bridge, or culvert) should be at least 1.25 times the width of the stream channel bed. This width is measured bank to bank at the ordinary high-water level (ohwl) or edges of terrestrial, rooted vegetation.



Determining Streambed Width

An average of three measurements, (project location and straight sections of the stream upstream and downstream) should be used to determine the channel bed width.

III. DEPTH AND VELOCITY

At low flows, water depths and velocities should be the same as they are in natural areas upstream and down stream of the crossing.

IV. SUBSTRATE

Natural substrate should be used within the crossing, and it should match the upstream and downstream substrates. It should resist displacement during floods and should be designed so that appropriate material is maintained during normal flows.

Conclusion

Awareness of the benefits of maintaining stream continuity is essential to protecting this valuable resource. The stream crossing designed standards presented here promote stream continuity, allowing unrestricted movement of fish and wildlife within the stream corridor while maintaining our access and transportation needs.

This information should be used as a supplement to sound engineering designs that provide appropriate structural integrity and hydraulic capacity.

Required DEC Permits

DEC permits are required for projects involving:

- All streams classified as C(T) or higher
- All navigable waters
- NYSDEC regulated freshwater wetlands outside the Adirondack Park. (NOTE: Wetlands in the Adirondack Park are regulated by the Adirondack Park Agency.)

Other Potential Permits

Permits may also be required from other government agencies, such as but not limited to:

Adirondack Park Agency (518-891-4050) – If your proposal involves stream crossing work in the Adirondack Park, please contact the Adirondack Park Agency before finalizing plans. This will help to eliminate unnecessary delays and assure that your project design satisfies both agencies.

U.S. Army Corps of Engineers (NY District: 518-266-6350, Buffalo District: 716-879-4330) – The Corps of Engineers regulates activities involving dredging, excavation, placement of fill, or construction of certain structures in waterways and wetlands of the United States.

Further Information and Jurisdictional Inquiries

Contact the appropriate regional DEC Environmental Permits office, based on the county where the project is located.

References

Singler, A. and Graber, B., 2005. Massachusetts Stream Crossings Handbook. Massachusetts Riverways Program, Massachusetts Department of Fish and Game

Bates, K. P.E., 2003. Design of Road Culverts for Fish Passage. Washington Department of Fish and Wildlife

River and Stream Continuity Project, 2004. River and Stream Continuity Project Web Page (see link in right column). University of Massachusetts Amherst.