The Economics of Culvert Replacement: Fish Passage in Eastern Maine

Introduction

The Natural Resources Conservation Service (NRCS) in Maine is working with Project SHARE (Salmon Habitat and River Enhancement) in the Dennys, Machias, East Machias, Pleasant, and Narraguagus River watersheds to restore fish passage and to reduce stream habitat degradation from poorly-designed stream crossings. Project SHARE is a non-profit organization located in Washington County. This organization consists of a partnership of local landowners, government agencies, businesses and local watershed councils focused on recovery efforts of the federally-endangered Atlantic salmon listed in the five rivers.

Since 2006 NRCS and Project SHARE have been working with landowners and partners to remove undersized and hung culverts (culverts hanging above water level) on forest logging roads and replace them with arch culverts, to restore stream flows to natural width and flow conditions. As a result, 48 sites have been planned, totaling $1.6 million in Wildlife Habitat Incentive Program (WHIP) funds. To date, 39 of the 48 planned arch culverts, totaling $1.3 million, have been installed. This has resulted in opening up 90 miles of stream habitat to Atlantic salmon.

These projects are designed primarily to benefit the recovery of Atlantic salmon; however, other diadromous species and native aquatics such as brook trout and mussels will greatly benefit.

Economics

From an economic viewpoint, any conservation practice selected for installation should satisfy the requirement that it be the least costly alternative for accomplishing the same objective. Comparing costs for all alternatives is essential and should include operation, maintenance, and replacement (OM&R) expenditures in addition to the installation costs. Future costs need to be estimated and converted to a common time base.

Usually arch culverts have high up-front installation costs, ranging in the tens of thousands of dollars. A landowner thinking about replacing a smaller round culvert with a properly-sized arch culvert should weigh this up-front, one-time cost against the future periodic OM&R costs of keeping the smaller, non-stream or non-fish friendly culverts in place.

A large part of a round culvert maintenance cost is cleaning out debris and removing or controlling beaver activity. In some cases, crews have had to go out every two to four weeks to unplug undersized round culverts. The cleanout procedure often involves large forestry equipment that rams a delimbed section of a tree through the culvert like a plunger to unplug it. Often the culvert is damaged in the process, which impedes

function and increases risk of plugging and blow-outs. Similar maintenance is seldom required for properly-sized arch culverts.

An additional cost is culvert replacement after roadbed failure, a consequence of debris dams or storm events, using either existing culverts blown downstream or with new culverts when the previous culvert is damaged beyond use. Depending on the site, beaver activity, or storm frequency, replacement at problem sites can occur multiple times a year, annually, or once every several years.

An economic analysis was performed to compare the long-term costs of continually replacing and repairing undersized culverts versus installing a properly-sized arch culvert.

Cost data was collected from four sites that had arch culverts installed. The existing or "before project" scenario in each case is an undersized round culvert that on average needs replacing every 10 years. A maintenance cost was estimated at $600 per year, consisting of a $200 mobilization charge for a piece of heavy equipment, and 4 hours of use at $100 per hour at the site of the culvert. Anecdotal evidence suggests these costs could be much higher because there are more plug-ups and blowouts than estimates indicate.

Figure One.

Before
(Two 2.5' diameter round culverts)

After
(10' x 4'5" arch culvert)

Above are before and after photos of the Site 1 installation. Work was completed in 2007. Photos by Ricky Hall, NRCS.

Figure Two displays the analysis graphically to give the reader a better sense of the costs involved in the time frame. The 10' wide x 4'5" high arch culvert has a one-time installation cost of $28,189 and virtually no maintenance costs. The existing two 2.5' round culverts have a replacement cost of $3,780 every 10 years (in 2007 $), and $600 in maintenance every year in between (also in 2007 $). The purpose of the economic analysis is to compare these costs and determine which alternative--arch culvert installation or round culvert OM&R-- is the least cost for the landowner during a 25-year period. A three percent inflation rate is assumed for the future expenses.

Figure Two. Comparison of Installation, Replacement and Maintenance Costs Over 25 Years for Site 1

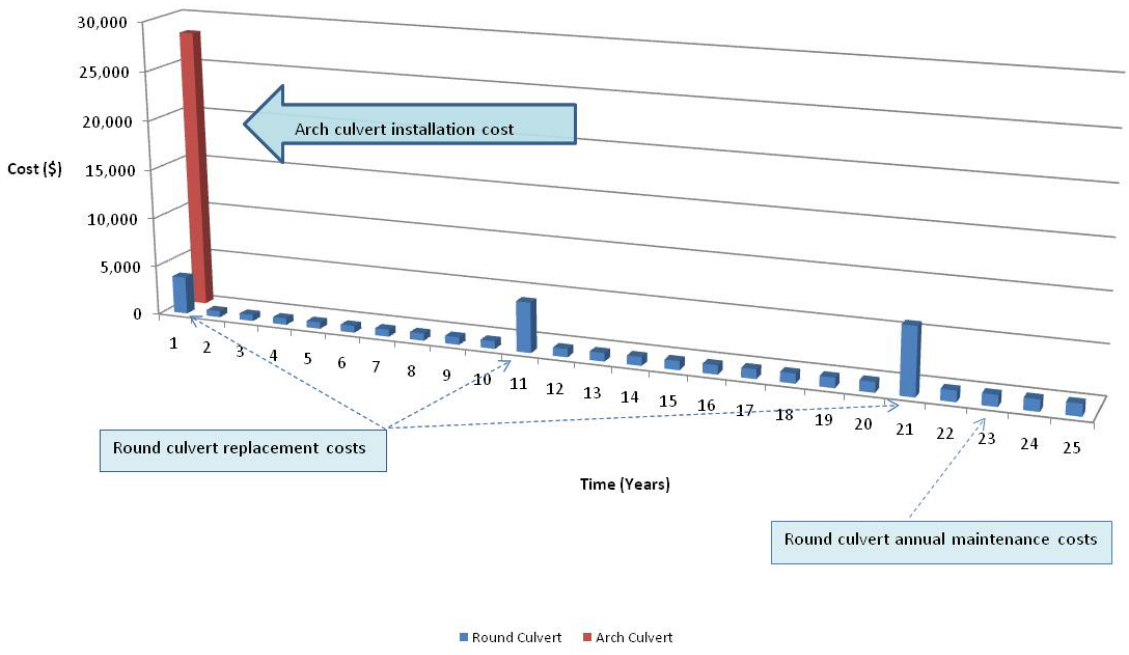

Table One. Data for Culverts

Site	Existing Round Culvert Data			Arch Culvert Data		
	Diameter[1] (feet)	Length of Culvert(s) Replaced[1] (feet)	Estimated One Time Replacement Cost[2] (2007 $)	Dimensions[1] (W x H) (feet)	Length[1] (feet)	Installation Cost[1] (2007 $)
1	Two 2.5’	30’	3,780	10’ x 4’5”	46’	28,189
2	3.5’	44’	4,752	12’ x 5’	48’	32,088
3	3’	30’	2,460	12’ x 5’	48’	47,031
4	4’	40’	5,360	12’ x 5’	48’	50,910

[1]From actual NRCS project installation site data.
[2]Costs estimated from 2007 NRCS estimates of culvert prices and installation costs.

The replacement costs of the existing smaller culverts is based on cost estimates used in NRCS financial assistance (FA) programs in previous years, and includes both the purchase price of the culvert and the installation cost. The total installation costs (material and labor) for the arch culverts are the actual costs recorded by NRCS

personnel. Costs are in 2007 dollars. Note that the three 12' x 5' arch culverts had different installation costs. The difference in costs is most likely due to differences in site conditions and the culvert being replaced.

One can see the difference in installation costs between the arch and round culverts. However, in order to get an accurate picture of the economics, one has to consider the OM&R costs associated with keeping smaller, undersized culverts over several years.

Another factor to consider is any FA available to help install the properly-sized culvert. Currently the WHIP program is offering 90 percent FA, leaving the landowner to cover the remaining 10 percent. No WHIP assistance would be available for replacing or maintaining an undersized round culvert that is restricting fish passage.

In order to compare economic costs, the net present value (NPV) of 25 years of undersized culvert OM&R costs were calculated using a 4.2 percent discount rate (used in accordance with Office of Management and Budget Circular A-94, Appendix C, Discount Rates for Cost-effectiveness, Lease purchase, and Related Analyses, July 2009 time frame).

This NPV was then amortized over 25 years to arrive at an average annual cost. This was then compared with the amortized installation cost of the arch culvert over the same time frame. These costs are comparable because they are both in average annual dollars. Results are displayed in Table Two below. The culverts in each scenario are based on actual projects completed by Maine NRCS in Washington County.

A time frame of 25 years was chosen to analyze costs. It is generally thought that the lifespan of an arch culvert is much greater, such as 50 or even 75 years, but 25 years was used so as not to forecast conditions out too far in the future. In each case, the average annual cost is much lower for the arch culvert.

Table Two. Average Annual Costs for Culverts.

Site	Arch Culvert Without FA ($/year)	Arch Culvert With 90% FA ($/year)	Round Culvert ($/year)	Cost Savings ($/year)
1	1,843	184	1,357	1,173
2	2,098	210	1,521	1,311
3	3,075	307	1,135	828
4	3,328	333	1,623	1,290

Conclusion

This case study intended to assess the potential cost impacts of installing properly-sized arch culverts and crossings in place of undersized round culverts. It used actual data from projects installed during 2007 in Washington County, Maine in order to develop four scenarios to analyze.

While the arch culvert costs in this study were from actual projects, one should be cautioned that site conditions and costs can vary considerably across the landscape. A landowner assessing this type of project on their own property should carefully weigh their own site conditions, installation costs, and OM&R costs.

These projects can greatly benefit many species of aquatic wildlife in Maine by restoring fish passage. It can also benefit landowners financially through reduced OM&R costs over the long term.

If you are interested in learning more about this subject or have questions, visit the Maine NRCS web site at www.me.nrcs.usda.gov for contact information for any of our local service centers. The primary author of this document is John Long, Maine NRCS State Economist, and can be reached at (207) 990-9504 or john.long@me.usda.gov.