Where's the science? Rethinking river restoration and enhancement

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In Nova Scotia, many second and third order high gradient tributaries have been the focus of restoration and enhancement efforts in an attempt to re-establish Brook Trout (*Salvelinus fontinalis*) and Atlantic Salmon (*Salmo salar*) populations. We have re-evaluated both enhanced and unaltered tributaries with the intent of understanding the natural conditions that influence both habitat quality and enhancement efforts. We have found that a lack of understanding of watersheds as physical systems has, in some cases, led to ineffectual restoration and enhancement efforts.

Studies on Elderkin Brook and Mill Brook indicated that the pyrite-rich Kentville and Halifax Formation slates dominating the watershed geology do not govern the pH of the river water. The carbonaceous New Canaan Formation, which is a minor geological but major hydrological component of each watershed, buffers regional groundwater and has resulted in elevated pH levels (7.5-8.0). These conditions have resulted in the production of an iron precipitate. During the winter and spring increased discharge and dilution of the groundwater chemistry by precipitation combine to keep the iron in either solution or suspension. During low flow periods (primarily the summer and fall) flocculated accumulations develop coincident with the spawning of both target fish species. These conditions result in both temporally and spatially constrained habitat quality degradation that is difficult to recognise using the short term habitat evaluation techniques that are presently being employed by river management groups. Habitat enhancement efforts on Mill Brook, Elderkin Brook and the South Annapolis River have focussed on the application of restoration and enhancement techniques developed using low gradient, graded rivers as models. These models do not apply to the streams examined in this study and, as such, the in-stream structures that have been introduced have been largely ineffectual. Analysis of the natural distribution of in-stream features (e.g., spacing of pools and runs) has determined that their frequency is not consistent and is determined by a variety of physical conditions unique to each site. We conclude that, to be effective, restoration and enhancement protocol must be flexible and must include a rigorous evaluation of natural in-stream processes at each site.

These studies have shown that effective river restoration and enhancement must include an understanding of both the hydrodynamics of the river and the regional geology and hydrogeology of the watershed.