Water flow is a “master variable” (sensu Power et al. 1995) that governs the fundamental nature of streams and rivers (Poff et al. 1997, Hart and Finelli 1999), so it should come as no surprise that the modification of flow caused by dams alters the structure and function of river ecosystems. Much has been learned during the last several decades about the adverse effects of dams on the physical, chemical, and biological characteristics of rivers (Ward and Stanford 1979, Petts 1984, Poff et al. 1997, Poff and Hart 2002). Increasing concerns about these impacts, together with related social and economic forces, have led to a growing call for the restoration of rivers by removing dams (AR/FE/TU 1999, Pejchar and Warner 2001). For the purposes of this paper, we define restoration broadly as an effort to compensate for the negative effects of human activities on ecological systems by facilitating the establishment of natural components and regenerative processes, although we acknowledge that these efforts rarely eliminate all human impacts (see Williams et al. 1997 for alternative definitions).

Interest in dam removal as a means of river restoration has focused attention on important new challenges for watershed management and simultaneously created opportunities for advancing the science of ecology. One challenge lies in determining the magnitude, timing, and range of physical, chemical, and biological responses that can be expected following dam removal. This information is needed to decide whether and how dam removals should be performed to achieve specific restoration objectives (Babbitt 2002). Opportunities for advancing ecological research also exist because dam removal represents a major, but partially controllable, perturbation that can help scientists test and refine models of complex ecosystems. In contrast to the small-scale experiments that traditionally have been employed in stream and river ecology, the unusually large magnitude and spatial extent of dam removal “experiments” creates the potential for examining river responses by means of both mechanistic and whole-system approaches.

We develop a risk assessment framework for understanding how potential responses to dam removal vary with dam and watershed characteristics, which can lead to more effective use of this restoration method.