Headwater systems, the areas from which water originates within a channel network, are characterized by interactions among hydrologic, geomorphic, and biological processes that vary from hillslopes to stream channels and from terrestrial to aquatic environments (Hack and Goodlett 1960). Although hydrologic, geomorphic, and biological processes in headwater systems have been studied for the last 50 years and much knowledge related to these systems is available (Hack and Goodlett 1960, Hewlett and Hibbert 1967, Likens et al. 1977), the roles of headwater streams within the watershed and the linkages from headwater to downstream systems are poorly understood. Headwater systems are critical areas for nutrient dynamics and habitat for macroinvertebrates, fish, and amphibians within watersheds (Meyer and Wallace 2001). Because of their geographical isolation, headwater systems also support genetically isolated species; thus, they support an important component of biodiversity in watersheds. For instance, new and endangered species are often found in headwater streams because such streams are relatively unexplored (Dieterich and Anderson 2000). Therefore, understanding the spatial and temporal variations of hydrologic, geomorphic, and biological processes in headwater systems is the key to comprehending the diversity and heterogeneity of riparian and riverine ecosystems.

Headwater systems are also important for understanding and protecting downstream ecosystems, because they are intimately linked. However, because headwater streams are small and numerous, the roles of headwater systems are typically underestimated and inadequately managed compared with larger downstream systems. Furthermore, management practices for protecting and restoring headwaters are different from those for larger systems, because headwater systems have greater drainage density and different land use types and intensities. Consequently, for the roles and downstream linkages of headwater systems to be understood, inherent differences between processes in headwater systems and larger watersheds need to be recognized in both conceptual and field studies. Therefore, our objectives for this article are to review characteristics of and differences in processes between headwaters and larger watershed systems; we also demonstrate spatial and temporal variations of hydrologic, geomorphic, and biological processes in headwater systems and the linkages of headwaters to downstream systems.

Our primary focus is on steep headwater systems in forested areas (> 4-degree gradient channels). Geomorphic time and space scales in this study are up to 1000 years and 100 square kilometers (km²), respectively. Thus, we do not consider the effects of glaciation, tectonics, volcanism, and Holocene climate change, although we acknowledge that the landforms

Takashi Gomi (e-mail: gomi@interchange.ubc.ca) is a forest hydrologist and a postdoctoral research fellow in the Departments of Geography and Forest Resource Management, 1984 West Mall, University of British Columbia, Vancouver, BC, Canada, V6T 1Z2. Roy C. Sidle is a hydrogeomorphologist and professor at the Disaster Prevention Research Institute, Kyoto University, Gokasho, Uji, Kyoto 611-0011, Japan. John S. Richardson is an aquatic and riparian zone ecologist and associate professor in the Department of Forest Sciences, University of British Columbia, 2424 Main Mall, Vancouver, BC, Canada, V6T 1Z4. © 2002 American Institute of Biological Sciences.