

## Process-based Principles for Restoring River Ecosystems

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Process-based restoration aims to re-establish normative rates and magnitudes of physical, chemical, and biological processes that sustain river and floodplain ecosystems. Ecosystem conditions at any site are governed by hierarchical regional, watershed, and reach-scale processes controlling hydrologic and sediment regimes, floodplain and aquatic habitat dynamics, and riparian and aquatic biota. To help guide river restoration toward sustainable actions, we outline and illustrate four process-based principles that ensure actions: (1) address root causes of degradation, (2) are consistent with the physical and biological potential of the site, (3) are at a scale commensurate with environmental problems, and (4) have clearly articulated expected outcomes for ecosystem dynamics. Applying these principles will help avoid common pitfalls in river restoration, such as creating habitat types that are outside the range of a site's natural potential, attempting to build static habitats in dynamic environments, or constructing habitat features that are ultimately overwhelmed by untreated system drivers. However, human constraints on restoration (e.g., competing land uses, desire for other ecosystem services) often limit the degree to which processes can be restored. In some cases, only partial restoration is likely and actions can only achieve a limited level of restoration. Where constraints are most severe, habitat creation is often substituted for process restoration. In such cases, it remains important to apply the four process-based principles to assure that habitat creation actions achieve maximum effectiveness and sustainability.