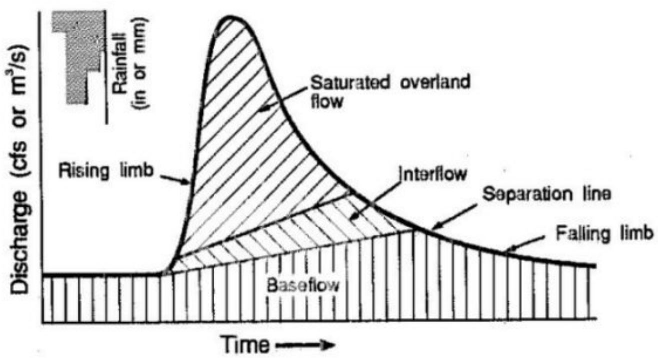
Introduction to Seasonally Varying Flows—What we are trying to protect and why it matters

Streamflow and hydrographs

Streamflow is the fundamental temporal and qualitative characteristics of streams, and is considered the "master variable" in stream ecology. The flow of water in a stream has units of volume per unit of time (in the U.S. as cubic feet per second), measured as the volume of water passing a particular point along the stream in a given amount of time. The measure of streamflow as a function of time is called a hydrograph, which is composed of three components: baseflow, interflow, and overland flow. The interflow and overland flow components are part of the fast runoff to the stream and occur in response to rainfall or snowmelt, while baseflow is visible during the dry season when streamflow is dominated by inflow from groundwater. Note that streams interact with groundwater either by gaining water via inflow through the riverbed, losing water to groundwater through the riverbed, or both losing and gaining water throughout different stream reaches.

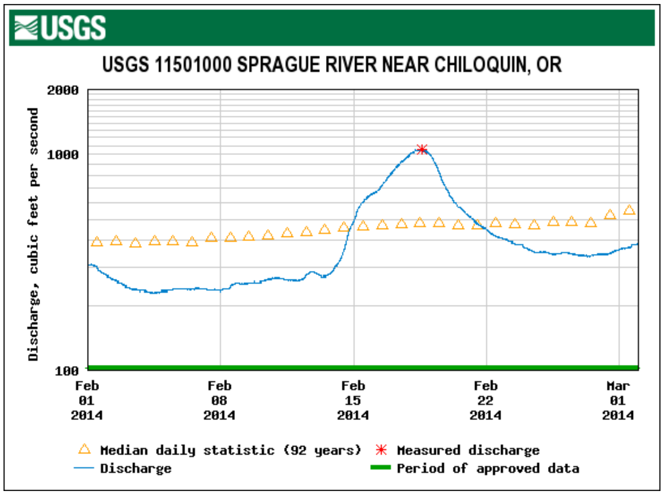


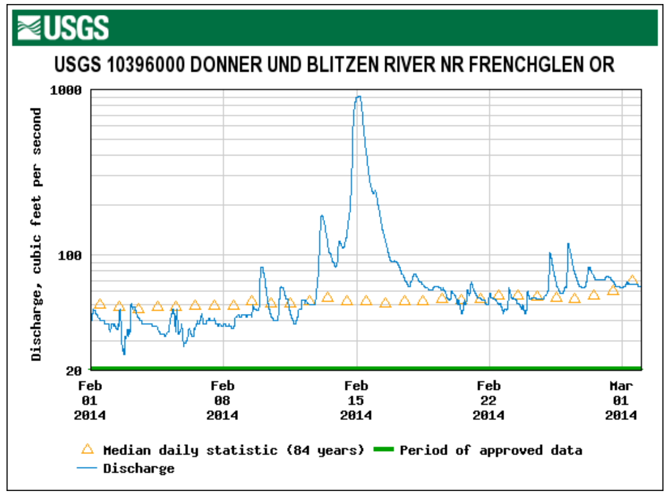
Seasonally varying flows

Streamflow is considered the "master variable" in stream ecology because it exerts a primary influence on (1) the volume and availability of habitat in streams (e.g. by maintenance of gravel bars and access to side channels); (2) water quality (e.g. by impacting changes in stream temperature and dissolved oxygen); (3) the availability and type of food resources (especially related to the occurrence of large wood); and (4) the type of biological interactions (e.g. by determining the extent to which species can avoid each other). Ecologically-relevant components of the hydrograph are defined in terms of the features that determine the nature of these influences: the magnitude of flow (e.g. the occurrence of flood or drought conditions), the frequency of flows (e.g. is the event common or rare), the duration of a specific flow condition (that may provide access to critical habitat), the timing of a specific flow event (e.g. the regularity of annual flood or low flow condition relative to key life history stages) and the rate of change or how quickly flow changes in magnitude (e.g. whether juvenile fish may get stranded in side channels).

The new paradigm in stream ecology proposes that these flow features describe the characteristic patterns of variability for natural streams, which vary according to geologic, climatic, topographic, soil, and vegetation factors, especially according to season. This characteristic variability in flow conditions exerts strong evolutionary pressure on a wide range of biological features for species ranging from riparian vegetation to invertebrates to fish, including morphology and behavior but especially the expression of reproductive strategies. As a result, alteration of the natural flow regime is an important factor contributing to the decline of native species and the invasion of non-native species. Because the full range of streamflow variability provides the basic habitat template upon which native species depend for survival, protection of ecologically relevant features of the flow regime protects the native integrity of the stream biota.

Sample hydrographs are provided for two streams in Oregon for the month of February 2014, showing how these flow features vary according to region.





Why a percent-of-flow approach?

It is proposed that protection of natural flow variability is comparable to the protection of water quality in streams, and that both should be considered as central to sustainable water management because they are necessary to ensure protection of the full range of socially-valued goods and services provided by healthy stream systems. Attempts to mimic natural flow variability with complex flow prescriptions are difficult and certain to become unworkable when water availability changes unexpectedly due to a range of factors. The percent-of-flow approach is recommended because it provides a way to shape human water use dynamically in a sustainable fashion that reflects changing societal needs and values over time while sustaining the biodiversity of stream ecosystems.

This approach defines the degree to which natural flow conditions can be altered by human abstraction without degrading flow-dependent ecosystem benefits beyond an acceptable level, as defined by a percentage of deviation from natural conditions and determined by stakeholders. This approach is particularly beneficial because it avoids the significant challenges in determining precise flow prescriptions from empirical data. It also is preferable to defining some preferred target condition based on historical data in a world of changing climate, so that restoration to historical conditions is no longer reasonable to expect.