The Nature Conservancy
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Groundwater for Ecosystems

Water flowing underground through soils and rocks is commonly known as groundwater. Groundwater is a vital source of water that sustains ecosystems, aquatic species, and human communities worldwide. The springs, wetlands, rivers, and lakes that develop where groundwater flows to the surface are known as groundwater-dependent ecosystems, or "GDEs".

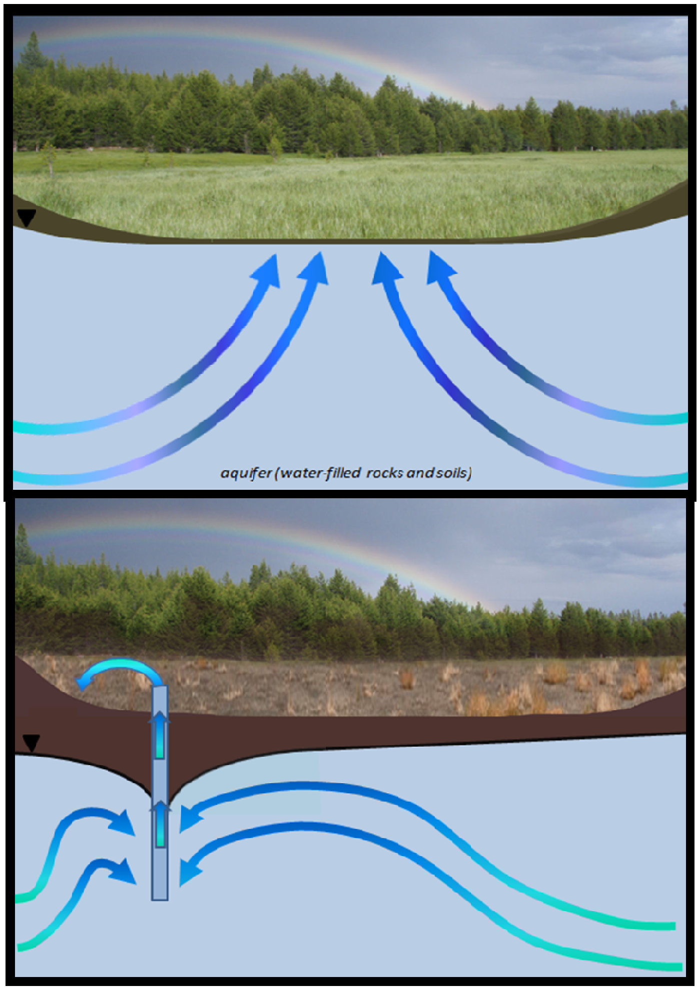
GDEs are different from other aquatic habitats. They rely on groundwater to provide stable flows and water levels, as well as distinctive chemical conditions. They often are small, but support abundant and diverse flora and fauna relative to their size. Groundwater and GDEs contribute to human well-being through water storage, water purification, flood attenuation, and other ecosystem services. However, pressures on groundwater, including pumping for irrigation, municipal, and industrial uses, as well as contamination from chemicals and pesticides, have the potential to severely impact the ability of GDEs to support both ecological and human uses. To address this issue, The Nature Conservancy in Oregon is collaborating with the US Forest Service to develop and test approaches for determining the groundwater flows and levels required to sustain freshwater ecosystems and the human livelihoods and well-being that depend on them.

Environmental Flows and Levels is founded on the concept that a balance can be achieved between groundwater left underground to support GDEs, and groundwater withdrawal for human uses. To find this balance, scientists and managers study the ecosystem to determine the following:

1. *The amount and timing of groundwater flow required to support the species and ecosystem processes in the GDEs*
2. *How groundwater flow into the GDEs will be altered under different withdrawal scenarios*
3. *The amount or degree of ecological change expected at different levels of withdrawal*
4. *The acceptable level of change in ecological conditions and ecosystem function*

Photo credits: above: groundwater-fed lake, Wallowa National Forest, OR © Leslie Bach/TNC; below: headwaters of the Deschutes River, OR © Allison Aldous/TNC; diagram 1: fen with rainbow, Fremont-Winema National Forest, OR ©Michelle Blackburn/TNC; Diagram 2: Fens in the Fremont-Winema National Forest, OR ©Allison Aldous.

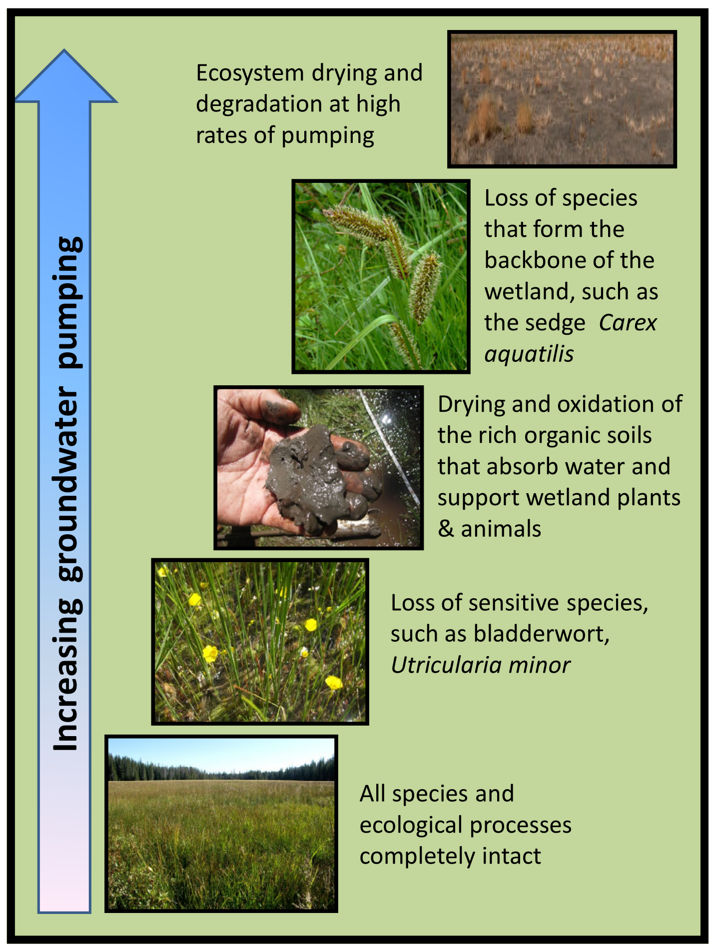
Example: Allocating groundwater for wetland ecosystems



The following schematics illustrate this concept for a groundwater-dependent wetland, where a pumping well is installed to draw water from a wetland.

The diagram to the left shows a vertical cross section through the wetland. In the upper panel, groundwater flows to the surface from the aquifer (shown in blue), maintaining the wetland soils and plant and animal communities.

In the lower panel, a pumping well is installed on the edge of the wetland. As groundwater is pumped, the water table drops below the surface, which dries the soils (shown in brown). The degree of response of the wetland ecosystem depends on the extent of water table drawdown, as illustrated in the diagram below.



The diagram to the right illustrates the ecological responses in the wetland to water table drawdown. At low levels of pumping, there is little effect. At a slightly higher rate, the initial effects are to sensitive species. At increasing rates of pumping, water table drawdown leads to changes in wetland structure and function, and ultimately to a complete loss of the wetland.

To develop the Environmental Flows and Levels for GDEs, scientists first study the groundwater flow system to understand how much water is entering the wetland and when, **as shown in the upper left diagram.** Then they determine what pumping rates produce the response thresholds **illustrated in the lower right diagram.** Once water managers, regulators and stakeholders have determined an acceptable level of ecological impact, a maximum pumping rate can be set.

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