

## CONSERVATION

# Why Should We Care about Temporary Waterways?

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A proposed ruling by the U.S. Environmental Protection Agency (EPA), aimed at clarifying which bodies of water that flow intermittently are protected under law (1), has provoked conflict between developers and environmental advocates. Some argue that temporary streams and rivers, defined as waterways that cease to flow at some points in space and time along their course (see the figure, left) (Fig. 1) (2), are

Failure to recognize, understand, and manage temporary waterways leads to serious degradation of aquatic ecosystems accompanied by negative impacts to the societies that depend upon them.

### Current Conservation Status

Traditional flow-gauging systems have vastly underestimated the number of intermittently flowing streams and rivers in most regions,

Intermittently flowing streams and rivers should be recognized, afforded protection and better managed.

and services. They are critical conduits for water, energy, material, and organisms even when surface water is not present (10). Shallow subsurface flows may connect dry parts of a stream or river to downstream sections that have permanent flows, are often critical for the supply of water in permanent downstream parts of a river basin, and support diverse hyporheic biota (11).

Temporary streams and rivers are also important conduits for lateral exchanges,



essential to the integrity of entire river networks. Others argue that full protection will be too costly. Similar concerns extend far beyond the United States. Debate over how to treat temporary waterways in water-policy frameworks is ongoing (3), particularly because some large permanent rivers are shifting to temporary due to climate change and extraction of water (4). Even without human-induced changes, flow intermittency is part of the natural hydrology for streams and rivers globally.

We stress here the importance of policies to protect intermittently flowing streams and rivers and outline information needs that are critical to implementation of those policies.

and digital hydrological data sets used widely by water resource managers are thus unrepresentative (5). With development of novel, affordable sensors, advances in remote sensing, and new modeling approaches, researchers are now showing that flow intermittency is not only very common (6, 7) but makes up the majority of river networks in many regions (8). Recent work indicates that 69% of first-order streams (the smallest) below 60° latitude flow only intermittently (see the figure, right), as do even a substantial fraction (~34%) of larger, fifth-order rivers (9).

Waterways that are naturally temporary support high biodiversity and important ecosystem processes and provide valuable goods

**Different seasonal flows.** (Left) The Fuirosos stream (northeast Iberian Peninsula) and (right) an intermittent tributary in Parker's Creek (mid-Atlantic U.S.) during the wet and dry seasons.

as they move nutrients and organisms back and forth between the channel and the floodplain or riparian vegetation region because of changes in flow. These exchanges are critical to maintenance of riparian and floodplain ecosystems and, in some arid regions, support the majority and persistence of riparian vegetation (12). Riparian vegetation, as well as vegetation that grows in dry sections of temporary river channels, provides essential habitat for wildlife, natural forage for livestock, and wood and other ecosystem services for local people (13). Several fish species maintain healthy populations in temporary waterways; some species exhibit higher survival and reach larger sizes if they use temporary streams during early life stages (14).

Temporary streams are being buried or degraded at alarming rates due to development, mining, hydrologic alteration, and

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channel modification (15). Temporary rivers are also vulnerable because they are often used as drains to dispose of mine effluent and waste water, corridors for vehicles and livestock, and quarries for sand and gravel (13). Temporary waterways are sometimes managed as if they were permanent and, thus, may be subject to flow augmentation that leads to introduction of invasive plant and animal species (16). This widespread degradation stems from lack of recognition, poor understanding, and inadequate management.

### Current Management Status

The legal status of intermittently flowing streams and rivers and the extent to which they are incorporated into policy, management, and regulatory decisions vary widely depending on how temporary waters are defined by the authorities, as well as what kinds of protection are given to temporary waterways. Even where flow intermittency is prevalent, temporary waterways may not be legally recognized as part of the river network. For example, navigable streams or tributaries in the United States are considered “jurisdictional waters” and are thus protected from filling or direct polluting. In contrast, the jurisdictional status of tributaries that do not flow continuously is determined on a case-by-case basis (17); depending on the outcome, a temporary water body may or may not be protected (table S1). This results in costly delays in regulatory decisions and confusion among land owners and natural resource managers and regulators. A proposed EPA rule that would remedy this and provide greater protection for most temporary waterways is pending public release (1).

In the European Union (EU), a temporary stream or river may or may not be considered a water body (and therefore may or may not be protected) depending on the “typology” or water body classification method adopted in a particular region (table S1) (18). Under the EU Water Framework Directive (WFD) (19), each river basin district has the authority to select from one of two methods for classifying a waterway. The method that is generally preferred allows flexibility in what criteria other than watershed size are used in the classification process. The different criteria followed by authorities in each river basin district has fostered a patchy implementation of the WFD, which has resulted in recognition of temporary waterways in few river basin districts in the EU (table S2) and in divergent outcomes for temporary waterways.

In contrast, federal and state legal definitions in many parts of Australia explicitly include temporary streams and rivers as watercourses (table S1) (20) and thus include

them in management plans that may afford protection. For example, there is a focus on the provision of flows to protect environmental values of temporary waterways in the state of Queensland, such as by setting thresholds for the maximum duration of no-flow spells to protect the persistence of drought refuge habitats or to prevent loss of condition of river-dependent vegetation from water stress.

### Policy Supported by Science

For policies to be consistent with current science, naturally temporary waterways should be legally defined as part of the river network if (i) they flow at some times and this flow connects them to a river network, or (ii) if they are habitat for obligate aquatic organisms or terrestrial organisms unique to dry river beds. Because temporary waterways exchange water and material with the riparia and floodplains via subsurface or intermittent surface flows, for policies to be consistent with current science, these lateral aquatic ecosystems must also be considered in management of temporary waterways.

To implement these policies, we need improved mapping of temporary waterways. In the field, they can be identified by the presence of definable channel banks or evidence of linear water flow such as fluvially sorted bed sediments or deposits of transported organic matter. In lowland areas with poorly drained soils, channels may appear more like wetlands at points along their course because of subsurface water seepage above or below channel initiation (21). New methods to measure and predict flow intermittency are emerging (6, 22, 23). Development and refinement of biological indicators to assess and monitor the ecological status of temporary waterways, a process ongoing in some regions, will be advantageous in promoting management under new policies (11, 17).

Temporary waterways are critical hydrologically, ecologically, and socially, and their number is expected to increase in many regions over the next several decades. Policies to protect them must recognize that flow intermittency per se is not necessarily a stressor but a natural component of the flow regime of many waterways. Although economic implications of implementing new policies are likely to be debated, an economic analysis completed by the U.S. EPA concluded that costs may be minimal or offset by positive economic benefits (24). Particularly in regions where societies intimately depend on temporary waterways (e.g., arid and semi-arid regions), further degradation of water resource quality and quantity generates critical problems, with mitigation costs far

exceeding those required today to halt degradation with improved waterway management. Not only would broader consideration of temporary waterways in management conserve the direct values of these systems without necessarily imposing additional costs, but it would also generate indirect benefits such as reducing the costs to society of flooding.

### References and Notes

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