experiments[6] and numerical modelling[7] have demonstrated robust feedbacks between river flows, sediment transport and vegetation. These factors profoundly affect the styles of rivers and floodplains that evolve in different environmental settings and the ecosystems that they support[8].

As Collins and colleagues point out, rivers that are naturally influenced by significant inputs of large dead wood are likely to change rapidly to a completely new state if the supply of wood is reduced or removed. This complex interplay between vegetation and fluvial systems complicates attempts at land management. For instance, the removal of wood in river systems affected by sprouting wood also causes channel widening and the disappearance of wooded islands[9]. Similarly, the overgrazing of wooded floodplains leads to floodplain unravelling and a transition from single- to multi-thread channel patterns[10]. Conversely, changes in river discharge can allow alien woody species to invade the floodplain; the encroaching vegetation can cause the channel to narrow, and can stabilize the new channel edges[11].

These examples, along with the floodplain large-wood cycle identified by Collins and colleagues[1], demonstrate that a landscape-scale approach to river management is needed to underpin sustainable restoration of river ecosystems. Restoration plans need to allow crucial components of the native vegetation to establish and interact freely with water and sediment to reinstate the natural dynamics of rivers and their floodplains, albeit within more restricted corridors than may have existed historically. ❐

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ECOLOGY

Plants on the edge

The base of a steep mountain is a foreboding place. Debris — ranging from sand-sized grains to massive boulders — rains down constantly, forming what are known as talus slopes. These slopes are at the edge of stability, prone to failing and sliding. The debris piles hold little water and are seemingly inhospitable to plant life.

Yet on the alpine talus slopes of the Lassen Volcanic Park in the Cascades Range, North America, an abundance of vascular plants, ranging from herbs to the occasional pine tree, make their home on the debris-swept slopes. Francisco Pèrez of the University of Texas, Austin, documented these plants and their interaction with the geomorphology of the talus slopes (*Geomorphology* **138,** 29–48; 2012).

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The talus vegetation — which commonly includes buckwheat plants, herbs and low-lying shrubs — shows a number of adaptations for life on a slippery slope. Young, mostly perennial plants typically have shallow root systems that allow them to be carried downslope with the shifting talus. Many of these plants have root systems that trail back up the slope. Only older plants have deep root systems that allow them to resist the downward debris flow. Annual plants are rarely observed in the talus.

Once the plants establish themselves against the frequent grain and rock slides, snow avalanches and frost creep, they in turn begin to influence the dynamics of the debris flow. Mat-forming plants capture fine-grained debris as it moves downhill, eventually growing up through the accumulating sediment. Compact herbs and shrubs with dense foliage also block debris from moving down the slope. The blockages form mounds, debris wedges and even small terraces. The sheltered areas beneath the blocking plants are often less steeply sloped and contain a higher percentage of fine-grained debris than the surrounding slope. In some cases, the presence of a strong root network even prevents some surface sliding.

This hardy, if uneven, assemblage of plants in such an extreme environment highlights the ability of some plants to cope with the most trying of habitats, and shows how plant tenacity can eventually add some stability to the immediate surroundings.

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