

6 Defining and assessing river health

Defining river health

The concept of river health allows us to think about rivers in the same way as we do the human body. Analogies can be drawn between the two, helping us understand the pressure-response relationship that various approaches to management can have on the freshwater environment. As elements of the river get damaged or removed, not only is the function that they provide lost, but the function of associated ecosystem elements may become impaired, reducing the overall well-being of the system. Furthermore, individual pressures on the river ecosystem may be of limited consequence, but the cumulative effect of multiple pressures may lead to severe loss of function and service. A river where all the interconnected elements of the ecosystem are in good condition and able to function naturally is likely to support the many benefits that society derives from our rivers. A critical component is the presence of natural fluvial processes, discussed throughout the book, that sculpt the river channel and sustain the diversity of river habitats.

Measuring river health

Assessment of river health is useful for predicting future problems, checking compliance with legislation, prioritising management options and for monitoring restoration. Measurement may be a direct measure of well-being akin to a blood test or bone x-ray. Tools include SEPA's Morphological Impact Assessment System, Fish Barrier Assessment Tool, analysis of water chemistry, fluvial audits and flow duration curves. These all assess the underlying factors that support a healthy river system, i.e. physical habitat, water quality and river flow. Measurement may also be diagnostic, basing assessment on indicator organisms and communities. Low salmon numbers may be symptomatic of simplified stream morphology or low oxygen levels. Aquatic insects can be used to assess water quality issues caused by chemical pollution and nutrient enrichment. These approaches would be equivalent to measuring blood pressure or calculating a body mass index.

Whether the health of rivers is measured with regard to its physical condition, the natural biota present or the ecosystem services it is able to provide, the underlying health issues are likely to remain the same. All approaches have a role in informing, guiding, regulating and appraising river management options, and commonly a combination of tools will be used.

Valuing river health

The value of maintaining healthy river networks across Scotland is most easily interpreted in terms of the 'service' that river ecosystems can provide to society. Biodiversity, flood storage, salmon fishing, water sports, drinking water, hydropower, and disposal of effluent are all ecosystem services potentially affected by river health issues. These services have social and economic value. For example, biodiversity, or amenities supported by habitat diversity, may be valued in terms of human well-being or tourism. Flood storage enabled by connection of the river to the floodplain may be valued in terms of the cost of potential flood damage downstream.

Protection

A healthy river can be protected from pollutants by the riparian zone in the same way that skin provides a barrier to disease. The width and diversity of the riparian zone is key to the provision of an effective buffer. Where vegetation is removed, habitats are lost and water quality may be affected.

Purification

Our liver and kidneys provide an important role in removing toxins. Rivers also have some capacity for self purification. Riffles can re-oxygenate water. Vegetation can take up excess nutrients. Riparian tree shading helps cool water down. Individually these factors may have little obvious effect but together they increase the resilience to external impacts.

Structural support

The human body has a skeleton to provide structural support that allows organs to function. The structure of a river is provided by the morphology of the bed and banks, and by large pieces of wood. These deflect flow and shape the river, diversifying the habitats present, and promoting ecological processes.

Breathing space

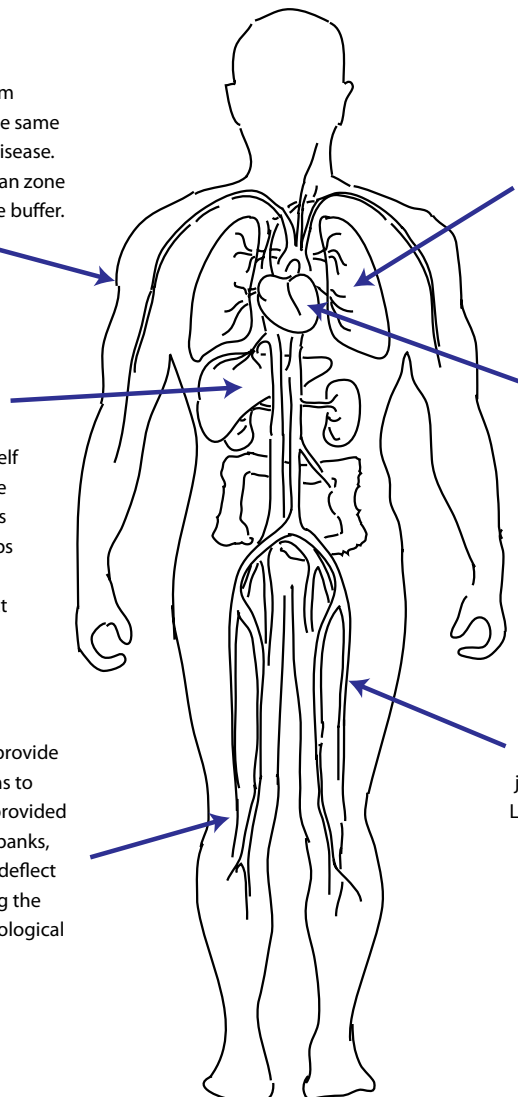
Space to breathe is an important aspect of river health. Constriction of rivers to a single thread with high, uniform banks is one of the most widespread pressures on Scottish rivers.

Regulation

Flow is regulated by human activity in some form on many rivers. Although this is undertaken for benefits such as hydropower generation, river health can be severely affected. River habitats and biota respond to natural patterns of flow and the pulse of floods. This needs to be considered when planning compensation flows.

Circulation

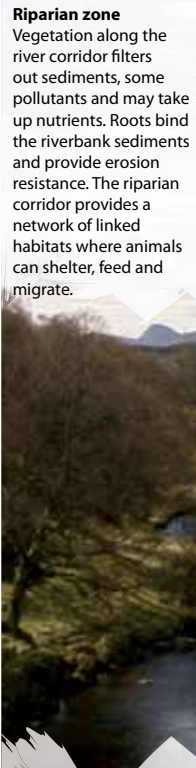


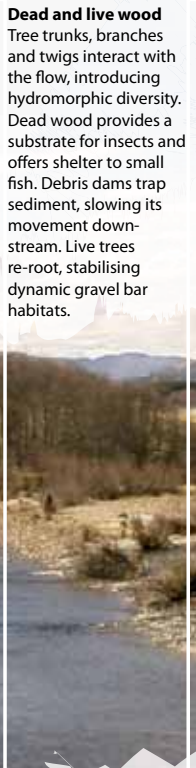



Blood vessels need to convey more than just blood cells to keep the body healthy. Likewise, healthy rivers convey more than just water. The transport of sediment, nutrients, wood and organic matter across the landscape are all essential to maintaining high ecological condition.



Concepts of human health can also be used to help us understand some of the many factors that contribute to a healthy river ecosystem.

KEY FACTS

River health can be thought of in terms of the ability of a river to deliver the range of natural ecosystem functions and services which can be assessed using a number of methods. Over centuries, human actions have led to a steady reduction of river ecosystem functions and services.

Riparian zone Vegetation along the river corridor filters out sediments, some pollutants and may take up nutrients. Roots bind the riverbank sediments and provide erosion resistance. The riparian corridor provides a network of linked habitats where animals can shelter, feed and migrate.	Meanders Meandering rivers are longer than straightened channels. This increases the time that water takes to flow downstream. Channel habitat area is greater.	Riffles Turbulence created by riffle features helps to oxygenate the water, essential for creatures that live in the channel. The flow through the gravels also creates conditions that support egg development in salmonids and other fish species.	Dead and live wood Tree trunks, branches and twigs interact with the flow, introducing hydromorphic diversity. Dead wood provides a substrate for insects and offers shelter to small fish. Debris dams trap sediment, slowing its movement downstream. Live trees re-root, stabilising dynamic gravel bar habitats.	Backwaters and pools Side channel features increase habitat availability. Areas of still and slow flowing water provide refuge for animals during floods. Pools provide resting habitat for larger fish and other organisms. Fine sediments that settle out provide habitat for juvenile lamprey.	Exposed bars and berms Deposition of sediments provides fresh habitat for pioneer vegetation including many rare plants. Open areas provide sunny habitats for insects and reptiles.	Wide river corridor A wide and diverse river corridor increases habitat availability and complexity. More area is available for flood waters.
						
Service Improved water quality. Enhanced biodiversity. Reduced maintenance.	Service Flood peaks in the lower catchment are delayed and dampened.	Service Improved water quality. Increased salmonid populations. White water for rafting and canoeing.	Service Enhanced biodiversity. Reduced sediment conveyance.	Service Flood water storage. Enhanced biodiversity. Conservation of rare species.	Service Sediment storage. Enhanced biodiversity.	Service Flood water storage. Enhanced biodiversity. Reduced management.

Examples of ecosystem functions and services provided by an upland river in a healthy condition.

These assessments are undertaken by economists and can be balanced against the river restoration and management costs by using a cost-benefit analysis approach. Improvements to river health could, where land owners and managers are willing, involve the return of land to the river corridor to provide habitat space for a buffer zone of riparian vegetation. The costs, including conversion of farmland to riparian woodland, can be compared to the benefits in terms of improved water quality and reduced water treatment for drinking water.

Regulating river health

Efforts to improve the health of Scotland's rivers are being undertaken through Controlled Activities Regulations (CAR).

This requires the licensing of activities that may put pressure on river health and describes general rules governing river management, in order to safeguard the ecosystem services that they provide and the diversity of species they support. The river health analogy has advantages over concepts of naturalness because the focus is on ecosystem function. Knowledge of the natural condition of Scottish rivers prior to human disturbance is obscured by centuries of land management, river engineering and flow regulation. Such activities were particularly prevalent in lowland areas, meaning examples of rivers in a natural 'reference condition' are difficult to find and making management guidance using 'naturalness' problematic.

From a regulatory perspective, the health of rivers is considered in terms of ecological status. Measurements of a range of morphological, physicochemical and biological parameters are used to grade rivers into five ecological status categories from bad to high. Measures for restoring health and achieving good or high ecological status are planned for the rivers in Scotland that are at moderate status or lower. Across Europe, all countries signed up to the EU Water Framework Directive have the same obligation.

Class						
Year	High/ maximum (%)	Good (%)	Moderate (%)	Poor (%)	Bad (%)	Proportion good or better (%)
2007	8	40	31	16	5	48
2008	8	46	23	15	8	54
2009	7	47	24	15	8	54
2010	8	48	23	15	8	54

The ecological condition of rivers in Scotland as monitored by SEPA between 2007 and 2010. Assessment is based on biological, water quality, hydrology, morphological status and river continuity factors.

FURTHER READING

SEPA. Monitoring and classification of water bodies in Scotland.

www.sepa.org.uk/water/monitoring_and_classification.aspx

UK National Ecosystem Assessment (2011). The UK National Ecosystem Assessment: Synthesis of the Key Findings, UNEP-WCMC, Cambridge. http://archive.defra.gov.uk/environment/natural/documents/UKNEA_SynthesisReport.pdf