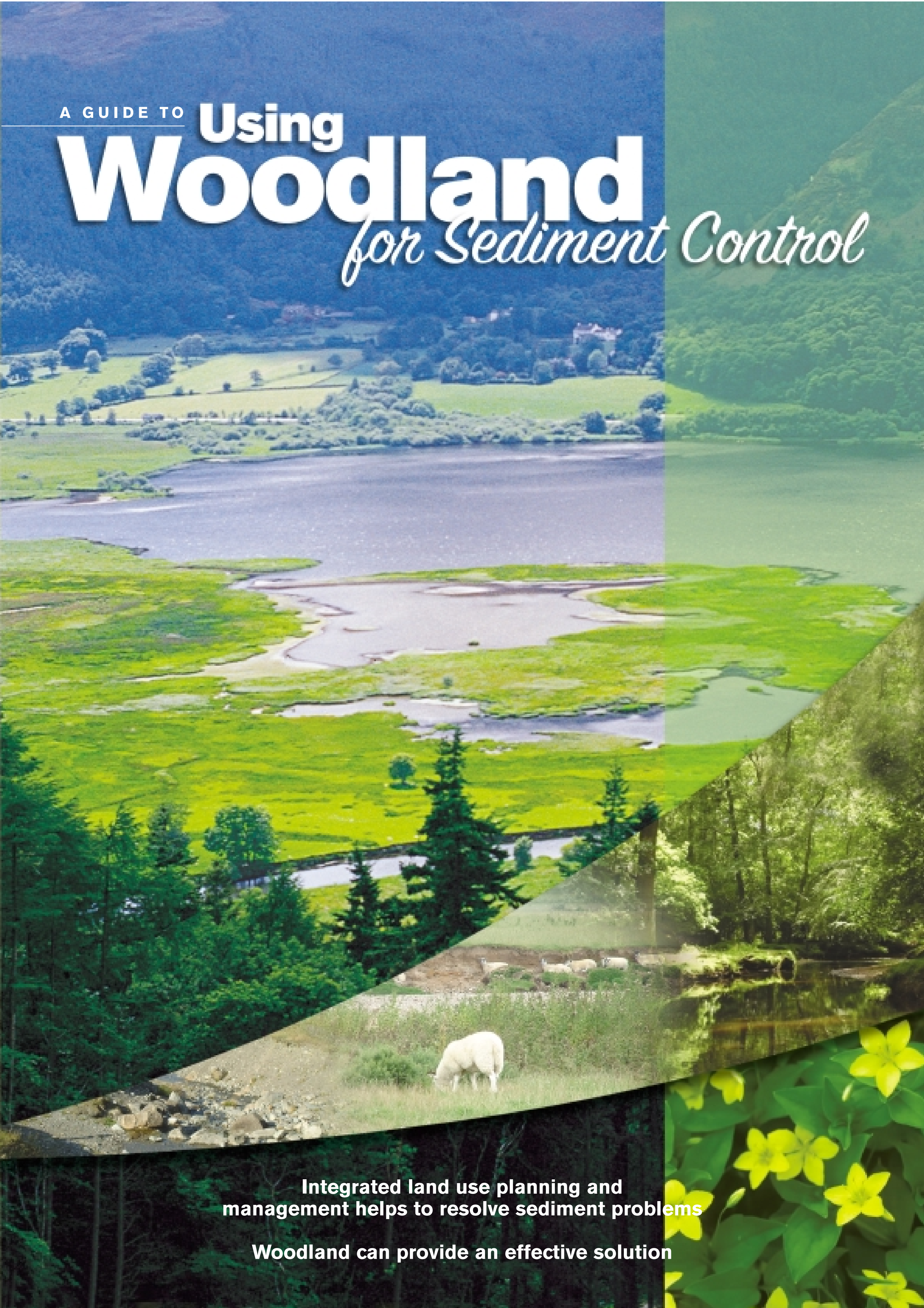
# A GUIDE TO Using Woodland *for Sediment Control*



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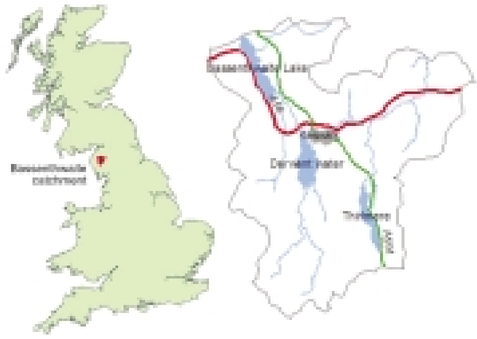


## Integrated land use planning and management can resolve sediment problems. Woodland can provide an effective solution.

**By Tom Nisbet, Harriet Orr and Samantha Broadmeadow**

**Figure 2** **A view of the catchment of Bassenthwaite Lake showing the traditional mix of lowland and upland farming, with woodland mainly confined to the steeper slopes. The location and area of the catchment are displayed above.**

## Background

It is widely acknowledged that soils under woodland are generally well protected and are often improved (Forestry Commission, 1998). The development and implementation of best practice as exemplified by the Forestry Commission's *Forests & water guidelines* (Forestry Commission, 2003) means that the planting and establishment of new woodland offers an effective approach to reducing sediment losses in problem areas. Woodland has been shown to benefit sediment control in the following ways:

- By providing physical shelter from the wind
- By reducing water run-off
- By increasing the entry of rainwater into the soil: see Figure 1
- By improving soil strength and stability

The introduction of the European Community Water Framework Directive in 2000 requires Member States to achieve good ecological and chemical quality status of surface waters by 2015. This has led to a major drive to identify and address the main causes of diffuse water pollution, one of which is the entry of excessive amounts of sediment into watercourses. Solving the sediment problem will require integrated action to improve overall land use planning and management. Woodland is one land use option that has the potential to reduce soil erosion at source, to limit the delivery of sediment to watercourses, to protect river banks from erosion and to encourage sediment deposition within the floodplain. It therefore presents an effective means of tackling diffuse sediment pollution, in addition to providing a wide range of other environmental, social and economic benefits.

**Figure 1** **A typical woodland soil with a relatively open, organic rich upper layer. This facilitates the rapid entry and storage of rain water which is commonly referred to as a 'sponge effect'.**

This guide describes the catchment approach that is being developed by a partnership of organisations in Cumbria in northwest England to control sediment inputs to Bassenthwaite Lake (Figure 2). It sets out the steps taken to identify the main sources of sediment and explores how woodland could help to alleviate the problem. Although the results may not be directly transferable outside of Bassenthwaite, the guide provides a useful framework for addressing the sediment issue in other catchments.

# Case Study | Evaluating the role of woodlands in managing soil erosion and sedimentation within the catchment of Bassenthwaite Lake

Bassenthwaite Lake lies in the Lake District National Park and is of high conservation importance, being designated as a National Nature Reserve, Site of Special Scientific Interest and candidate Special Area of Conservation. This makes it very vulnerable to disturbance and highly sensitive to pollution. A key issue is the high level of soil erosion in the catchment caused by a range of pressures, including overgrazing, land cultivation, drainage and human trampling (see Figure 3). Erosion has led to scarring of the landscape and a loss of the soil resource. It has also been linked to high water turbidity and excessive sedimentation, with consequent damage to priority species and wildlife habitats. The eroded sediment may also be an important source of phosphate, which has contributed to enrichment of the lake and associated problems.

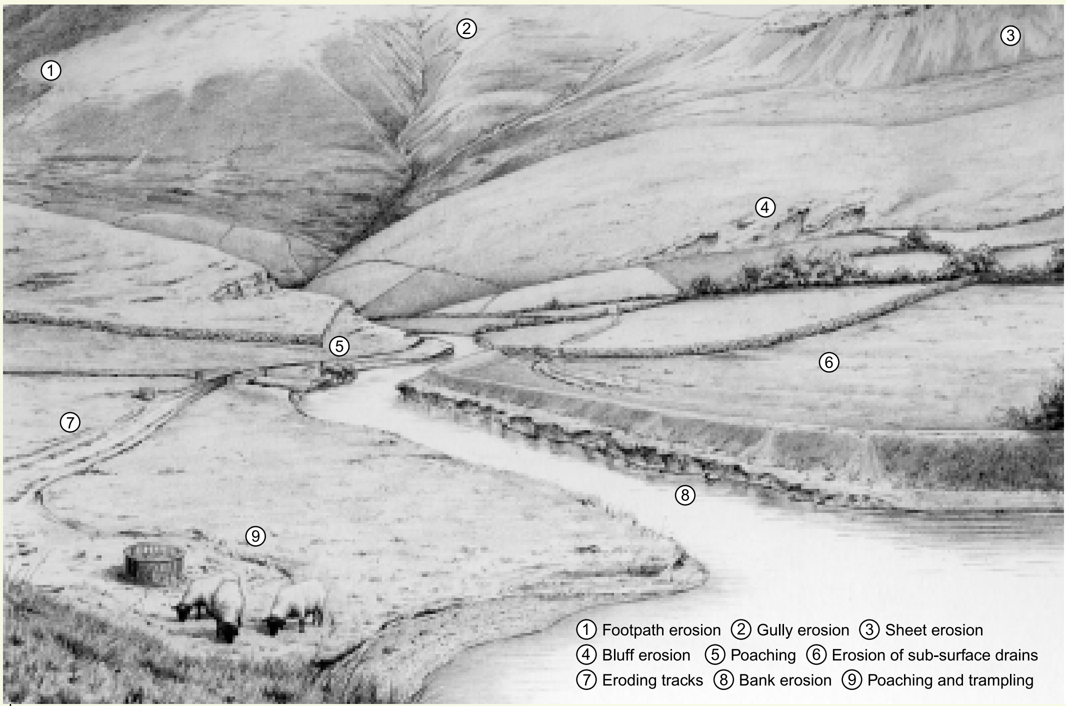



**Figure 3 A 3-d diagram depicting the movement of sediment along the source-receptor pathway in the catchment of Bassenthwaite Lake.**

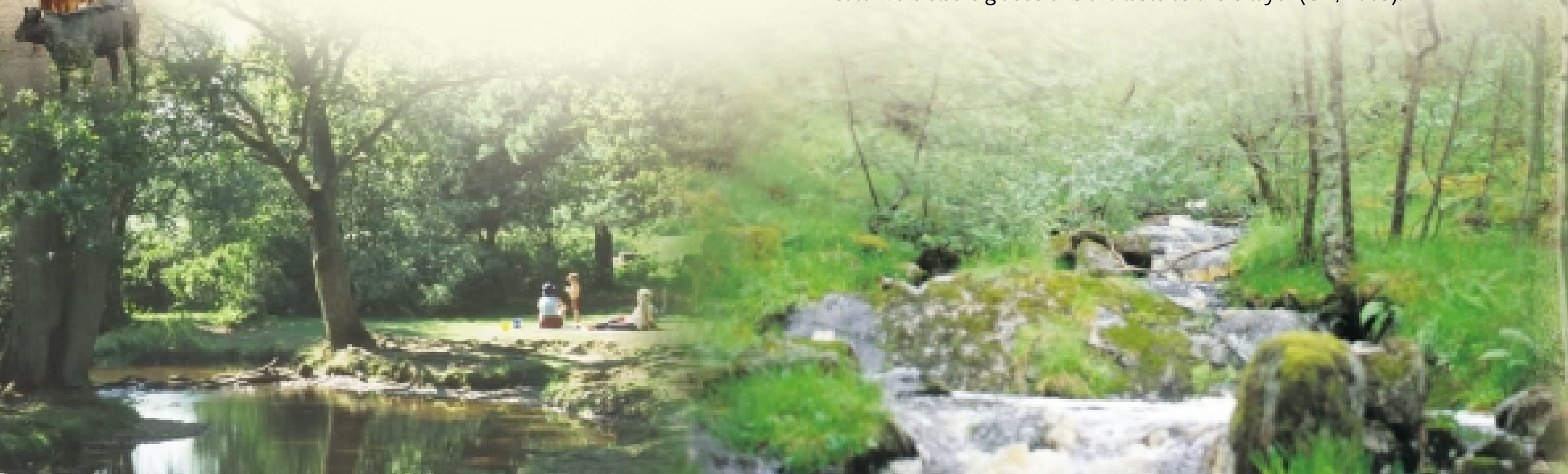
## Identification of sediment sources

The Forestry Commission recognised that woodland could have an important role to play in solving the sediment problem and therefore formed a partnership with the Environment Agency (EA) to identify where woodland might be able to help. Forest Research and Lancaster University were appointed to conduct the assessment, the first stage of which was to identify the main sources of sediment. Unfortunately, as in most areas, knowledge was lacking about the spatial and temporal variation in soil erosion rates and levels of sediment within the river catchment. Thus a key need was to undertake a catchment sediment audit. This involved drawing on four important sources of data:

- Recent digital aerial photography (2000) in 1 km squares of the whole catchment showing the occurrence of erosion scars, scree slopes and sediment deposits. A polygon was drawn around each patch of bare ground and the percentage of exposed soil or rock estimated (Figure 4). The data were stored on GIS.
- The National Soil Map at a scale of 1:250 000 and related digital data sets concerning the Hydrology of Soil Types (HOST) and soil vulnerability to poaching by livestock (Boorman *et al.*, 1995; Harrod, 1998).

**Figure 4 Digital aerial photographs were used to quantify the area of bare ground (highlighted by red polygons) in the catchment.**

- Environment Agency digital maps of predicted erosion vulnerability and sediment delivery to watercourses for 1-in-10 year events at a 1 km grid scale (McHugh *et al.*, 2002).
- The results of a fluvial audit that recorded the length of the river channel system that was subject to erosion or bank collapse. These data were also digitised and available as a GIS layer (Orr, 2003).



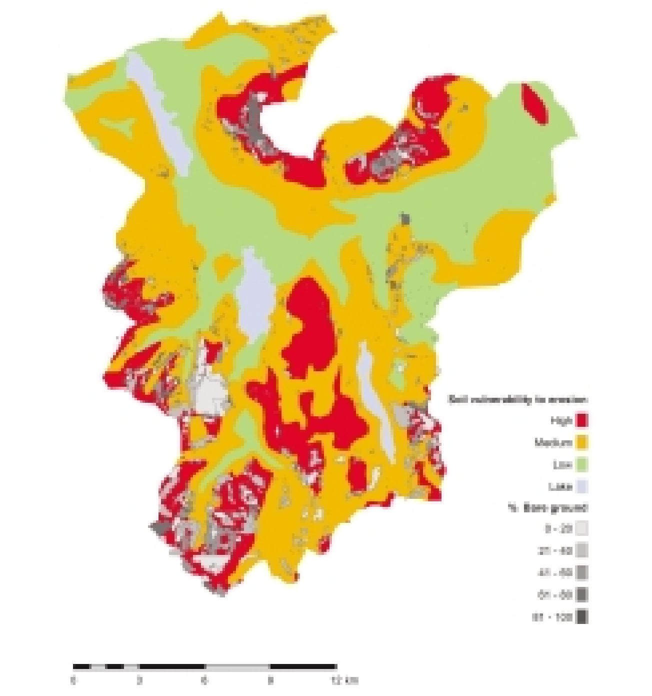



**Figure 5 Distribution of soils in high, medium and low vulnerability classes and observed areas of bare ground (recorded in 2000).**

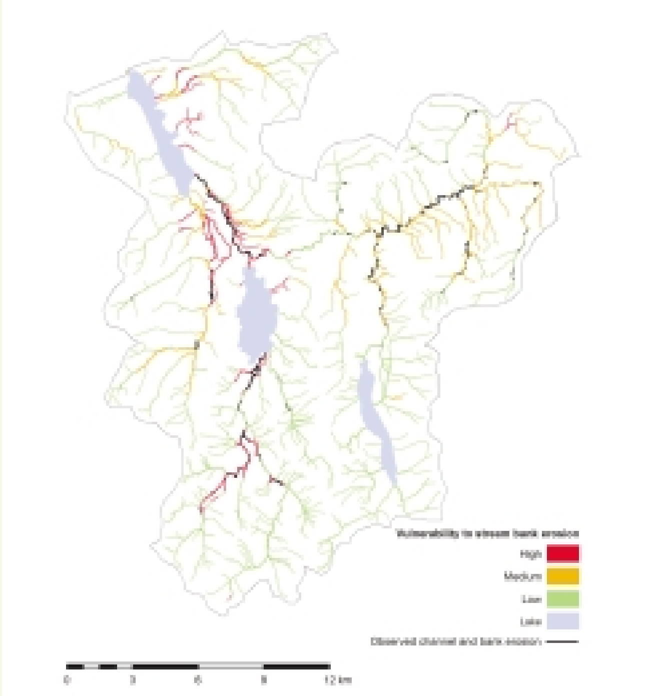



**Figure 6 Classification of riparian zones according to high, medium and low vulnerability to bank erosion and observed reaches exhibiting significant channel and bank erosion.**

## Integrating catchment data

The next step was to integrate these data sets using GIS to highlight those areas of the catchment that had been subject to erosion in the past or were considered to be at a moderate or high risk of eroding in the future. Separate maps were produced for the soil and stream/river system, dividing areas or river lengths (by Soil Association) into low, medium and high classes of vulnerability to erosion.

The maps showed that:

- A large part (20–25%) of the catchment comprising the hill tops and upper slopes is covered by soils that are: at an extreme risk of structural damage by poaching; highly vulnerable to erosion; and subject to prolonged waterlogging, resulting in rapid surface run-off and a high risk of eroded soil moving to streams (Figure 5). Two-thirds of the bare ground (830 ha) observed in 2000 occurred in these areas. The main pressures contributing to erosion are considered to be overgrazing and human trampling.
- A further 40–50% of the catchment has soils that are at a moderate risk of poaching, medium vulnerability to erosion and also subject to rapid surface run-off. The remaining third of bare ground (394 ha) lay within this area and was subject to the same pressures as above.
- A total length of 20.7 km of river channel exhibits evidence of significant erosion on one or both banks and a total of 61 km and 138 km are considered to be at high and medium risk of damage, respectively (Figure 6). The majority of soils within the high risk area are also at a very high risk of structural damage by poaching. Most main river channels have been subject to some engineering works in the past and a lack of channel and bank maintenance combined with livestock trampling and overgrazing is probably one of the main factors contributing to the current level of damage (Figure 7).
- Less than 1% of the observed bare ground was associated with woodland, confirming the advantages of woodland for soil protection and sediment control.

**Figure 7 Overgrazing and trampling are thought to have contributed to unstable river banks and extensive bank erosion in parts of the Bassenthwaite catchment.**

## Woodland options for sediment control

These findings were then used to identify where woodland planting could best assist sediment control. A range of options was considered, some directed at protecting sediment sources, while others were aimed at interrupting the transport of sediment to rivers or fixing deposited material.

These included:

- Large-scale woodland planting on soils classed as having a high or medium vulnerability to erosion.
- Targeted planting of woodland on and immediately around areas of bare ground (particularly downslope to retain mobilised sediment).
- Targeted planting of riparian woodland along river reaches with a medium or high risk of bank erosion, especially on those that are actively eroding (Figure 8).
- Medium-scale planting and restoration of floodplain woodland around the confluence of major tributaries and the main inflows into Bassenthwaite Lake.

**Figure 8 Riparian woodland can be particularly effective at stabilising river banks and retaining sediment in run-off from adjacent fields.**

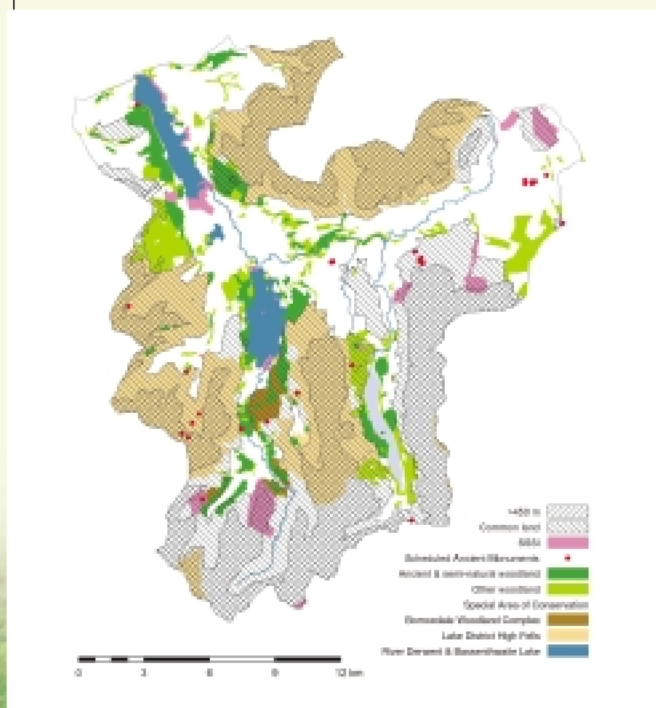
**The otter is a key indicator of the health of the freshwater environment. After many years of decline, it is now responding to conservation efforts aimed at reducing water pollution and improving riparian habitat.**

## Constraints on woodland planting

Another important consideration was whether woodland was appropriate for a given location. This required an assessment of a range of possible constraints (Figure 9), including:

- Areas designated for their special landscape character. All of the catchment lay within the Lake District National Park, placing restrictions on the location, scale and type of new woodland planting.
- Sites designated for their special conservation interest as an open habitat, e.g. SSSIs, NNRs, SPAs and SACs. A large part of the catchment of Bassenthwaite Lake is a candidate Special Area of Conservation on the basis of the high ecological value of the predominantly upland grassland and heath vegetation (Lake District High Fells). This occupies some 66% of the area classed as being highly vulnerable to erosion. A further 7% of the latter area is designated as non-woodland SSSIs. However, there could be significant scope for riparian woodland along upland valleys/ghylls.
- Existing woodland, which occupied 12% of the catchment. It is notable that only 1% of the high soil erosion vulnerability class is under woodland. Similarly, only 12% of the river length identified as highly vulnerable to bank erosion is occupied by riparian woodland.
- High ground above the natural tree line (29% of catchment >450 m), although there may still be a role for a dwarf tree cover such as juniper and some riparian trees/scrub woodland.
- Areas of Common Land, except for juniper and riparian woodland.
- Sites of special archaeological interest, e.g. Scheduled Ancient Monuments.
- Riparian areas where access is required for river maintenance and flood management.

**Figure 9 Distribution of potential constraints to woodland planting.**



## Identification of where new woodland could best aid sediment control

The end result was the identification of the following opportunities for woodland planting to assist sediment control:

- 95 ha of land below 450 m with a high vulnerability to erosion, mainly comprising two areas in the central and southern part of the catchment (Figure 10) with some potential for woodland extension.
- 37 km of river length with a high vulnerability to bank erosion (Figure 10). Assuming that buffer zones of 10, 20 and 40 m width would be appropriate for protecting the banks of first, second and third order stream channels, respectively, this presented a total area of 223 ha of land that would benefit from the planting of riparian woodland. There was a low potential to build on existing riparian woodland.

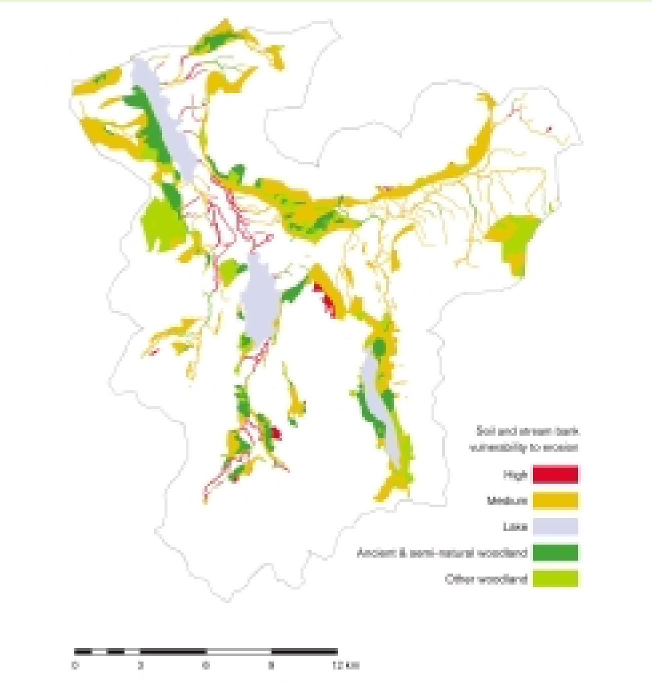



**Figure 10** **Opportunities for woodland planting to aid sediment control.**

- 3184 ha of land below 450 m with a medium vulnerability to erosion, mainly distributed throughout the steeper sloping sections of the catchment. Significant core areas of woodland were already present, providing good potential for woodland extension.
- 89 km of river length with a medium vulnerability to bank erosion, equating to a total area of 220 ha of potential riparian woodland. Some opportunities to build on existing riparian woodland.
- The restoration and expansion of wet woodland/floodplain woodland within and adjacent to the SSSI at the southern end of Bassenthwaite Lake.

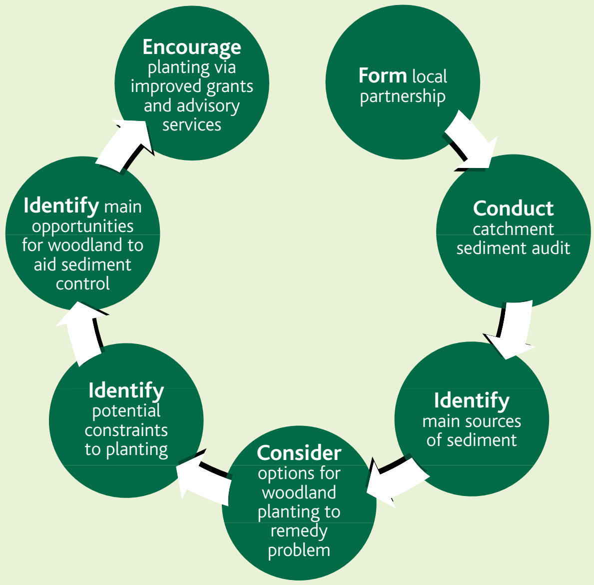



**Figure 11** **Flow chart summarising steps in approach to evaluating how woodland could be used to aid sediment control.**

## Planning and implementation

The Forestry Commission is now working with the Bassenthwaite Lake Partnership and other stakeholders to realise these opportunities (Figure 11). A key need is to improve the synergy between woodland and agricultural grants as well as advisory services. The establishment of demonstration woodlands is being considered as a way of communicating to local landowners the advantages for sediment control and conserving the soil resource. It is hoped that a programme of monitoring can now be put in place to allow the financial benefits to be quantified. This information could then be used to justify increasing grant levels for new planting in the most effective locations. Further information and guidance on using woodland to assist sediment control can be obtained from the local office of the Forestry Commission: see website: **www.forestry.gov.uk/northwestengland**

## Further reading


Boorman, D.B., Hollis, J.M. and Lilly, A. (1995). *Hydrology of soil types*. Institute of Hydrology Report No.126. IoH, Wallingford.

Forestry Commission (1998). *Forests and soil conservation guidelines*. Forestry Commission, Edinburgh.

Forestry Commission (2003). *Forests & water guidelines*. 4th edn. Forestry Commission, Edinburgh.

Harrod, T.R. (1998). A systematic approach to national budgets of phosphorus loss through soil erosion and surface run-off. Final Report on MAFF Project NT1014, SSLRC Project JF3818.

McHugh, M., Wood, G., Walling, D., Morgan, R., Zhang, Y., Anthony, S. and Hutchins, M. (2002). Prediction of sediment delivery to water courses from land: Phase II. R & D Technical Report No P2-209. EA, Bristol.

Orr, H.G. (2003). Bassenthwaite Lake Geomorphological Assessment: Phase 1. Unpublished Lancaster University project report to the EA.

Orr, H.G., Davies, G., Quinton, J. and Newson, M.D. (2004). Bassenthwaite Lake Geomorphological Assessment: Phase 2. Unpublished Lancaster University project report to the EA.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