Eadha Enterprises

ASPEN PROJECT

Research into Phytoremediation and Biomass

Aspen in Phytoremediation

Eadha Enterprises are working to conserve the rare and enigmatic native aspen and its unique assemblage of biodiversity. Aspen is not only rare itself but is also associated with a wide range of rare flora and fauna. There has been a recent upsurge in interest in this species not only in terms of its biodiversity value but also its potential economic uses including timber, and biomass. Phytoremediation trials using willow have been undertaken in the UK, however no current research has been undertaken using native aspen. However, aspen has been used successfully for this purpose in North America and eastern Europe where it is considered to be the ideal species for remediation. Aspen represent optimal plants for absorption, accumulation, storage, and degradation of environmental pollutants such as heavy metals, mercury, PCBs, nitrates, pesticide and herbicide residues, aromatics, wood preservatives, explosives and other waste products.

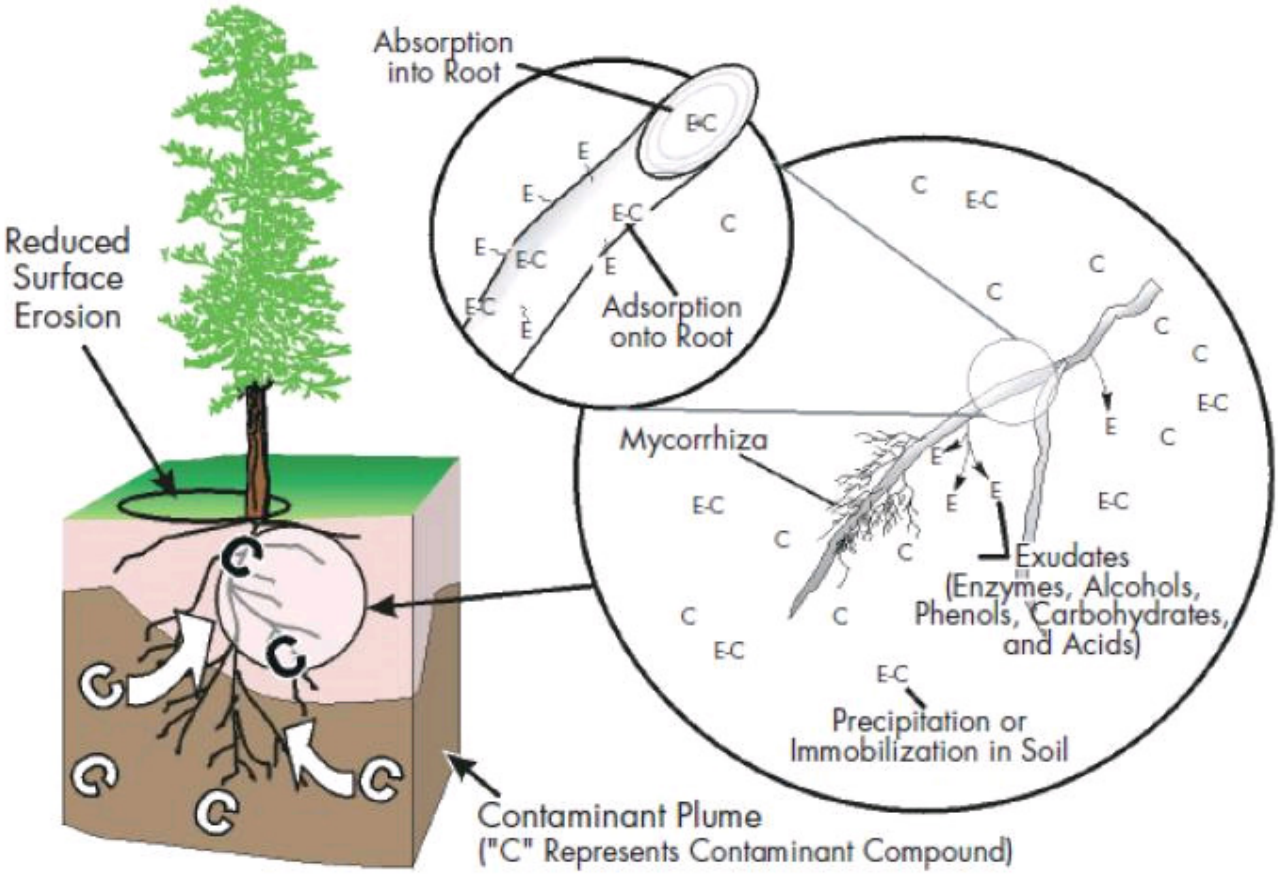
Extract from "Ecology, Conservation and Management of Aspen, A Literature Review, Neil Mackenzie, Scottish Native Woods, 2010

"Most forest tree species return between 50% and 80% of their annual nutrient uptake to the soil but aspen retains over half of its uptake and is particularly efficient at retaining calcium, sulphur and zinc, thereby limiting loss by leaching and improving soil fertility. The ability to absorb zinc and other trace elements allows aspen to survive on the spoil heaps of mining operations and assist in the reclamation of post-mining landscapes, for example lignite mines in Germany, opencast oil shale quarries in Estonia and many sites laid bare by coal spoil, heavy metal and smelter pollution in North America (Cripps, 2003; Pastor, 1990; Tullus et al, 2008). In North America aspen has been found to naturally colonise large areas of polluted industrial sites and to tolerate soils with low pH, low fertility and heavy metal content. The ability to sucker is also an advantage for rapidly extending across new areas of bare ground. Some aspen forests have developed diverse habitats and thrived for over 70 years on mine tailings near smelter sites. Aspen has a mutualistic relationship with a small group of mycorrhizal fungi from the genera Laccaria, Inocybe, Paxillus and Scleroderma which help to increase phosphorus uptake and ameliorate soil conditions and may be essential for aspen to establish in contaminated soils (Cripps, 2003). Beneficial mycorrihiza such as Laccaria laccata have been recorded with aspen and other Populus species on uranium tailings and the spoil heaps of old arsenic mines in England (Benson et al, 1980)."

Aspen can reduce hotspots of certain contaminants to safe levels of long time frames. However, notwithstanding the hyperaccumulation properties of aspen, increasingly the process of phytostabilisation rather than phytoextraction is being regarded as the more viable option. Rather than focussing on the removal of contaminants from the soil, phytostabilization is all about locking them safely up within the soil, through accumulation and adsorption within the root zone. This process lowers the leachability of contaminants which effectively can reduce risks to the environment and human health to within safe limits. Theoretically this process can be effective as soon as the roots have sufficiently spread. In the interim, plants such as Reed Canary Grass can be planted to provide some immediate stability to the surface soils and act as a nurse crop for subsequent tree establishment. There has been limited research into phytostabilization in the UK and none involving aspen. Eadha Enterprises are therefore seeking sites and partners to develop some pilot projects including the following:

- **Contaminated Land Remediation**
- **Temporary Greening**
- **Nitrate buffer zones**
- **Soft cap for landfills**

PHYTOSTABILIZATION



Aspen Clones

Eadha Enterprises is taking a clonal forestry approach to tree production. Clones are tested and selected for superior growth qualities. Eadha Enterprises now holds the national collection of aspen clones amounting to 180 different clones from the full geographical and topographical range across Scotland. This represents a unique resource on which to base research and development of phytotechnologies and other forestry related applications. Each clone has evolved as a genetically unique specimen with unique growth characteristics and tolerances to different physical conditions.

Eadha Enterprises are developing projects in Scotland to trial native aspen in different environments and under different conditions, and to explore how systems can be designed to integrate productive woodland with other community and amenity uses. Eadha Enterprises are working with Local Authorities to develop Species Action Plans (SAPs) for aspen focussing on local clones present in areas as part of their Local Biodiversity Action Plans (LBAPs). We have developed SAPs for Renfrewshire, Inverclyde and East Renfrewshire.

We are developing a network of arboreta in the west of Scotland to showcase these clones and these trees will also be used to provide propagation material. We are developing a dedicated nursery in Renfrewshire to grow aspen during 2012 and this will also provide a project hub and training and education facility. In the longer term we are exploring the option of developing a lab to undertake micropropagation using plant tissue culture methods.

Biomass Research and Trials

Short rotation forestry (SRF) has the potential to make a useful contribution to renewable fuels According to the Forestry Commission, however, there is little current knowledge of SRF in the UK. This knowledge gap is recognised in the *Scottish Forestry Strategy* (2007), the *Scottish Government Woodfuel Taskforce Report* (2008) and the FCS *Climate Change Action Plan* (2008 - 2010*).* All three publications indicate the need for SRF research. In the UK the establishment of energy crops is significantly behind Europe and has focused largely on willow in a short rotation coppice (SRC) system. Research by FR indicates that native aspen can outperform SRC willow over a 50 year period.

Eadha Enterprises proposes to undertake growth trials using native aspen, researching new methods and approaches to propagation, planting and establishment. In the longer term, Eadha Enterprises proposes to undertake breeding programmes to develop new super-vigorous clones. This is also critical in conserving the genetic robustness of the species as a whole. Our work builds on research undertaken by Forest Research in the UK and various trials across Europe.

Over and above its fast growth potential, the unique characteristic of aspen which sets it apart from other trees and which can lead to superior productivity in successive rotations, is its ability to sucker profusely. Suckering can be viewed as a response mechanism and is promoted by coppicing. Trials in Germany have indicated that where a crop of aspen is planted at 4167 stems per hectare (2.0m x 1.2m spacing), a yield in the region of 70t dry biomass per hectare can be achieved at the first 10 year rotation. Following harvesting, as much as 187,000 stems can regenerate which naturally reduces to about 40,000 stems after 5 years through competition. On average two shoots develop from the rootstocks and three from suckers from each plant potentially producing significantly more biomass in subsequent rotations.

Eadha Enterprises have developed a model of a sustainable and ecologically sound SRF system using native aspen to maximise both biodiversity and productive potential. Eadha Enterprises has experience developing SRF trials, for example our Growing Green Energy Project in East Ayrshire. This project involved the establishment of a 3Ha trial plantation of aspen on a former opencast site with negligible topsoil with no soil amendment. So far the results appear encouraging with good survival rates. We will be monitoring tree growth over a 5 year period.

Soil Amendments

Eadha Enterprises has been investigating the use of soil amendments in a phytoremediation scenario. In particular biochar would appear to have the greatest potential. Biochar can be produced from any organic material, including woody biomass and is a useful way to recycle wastes. Research suggests that biochar affects microbial populations and soil biogeochemistry. Both biochar and mycorrhizal associations are potentially important in various ecosystem services provided by soils, contributing to sustainable plant production, ecosystem restoration, and soil carbon sequestration and hence mitigation of global climate change. In an urban and contaminated land setting, biochar can also have a significant impact on the mobility and fate of residual pollutants in the soil. Biochar can therefore benefit tree establishment and growth and also contaminant stabilisation.

There has been a recent surge in interest in biochar with extensive research and trials being undertaken by many universities including the UK Biochar Research Centre (UKBRC) at Edinburgh University. Eadha Enterprises has also been working with Strathclyde University to run some trials on aspen biochar. Biochar production itself can produce some useful bi-products including biogas and can lend itself to integrated heat and power systems.

Another soil amendment is gypsum which is available in the industrial waste stream. Potentially gypsum can offset some of the negative effects of biochar (increase in pH) and used together could create a highly effective amendment. Eadha Enterprises is looking to undertake some field trials using biochar and gypsum.