All photos: Mark Nason

Slate waste and green waste meet

New techniques recover wildlife habitats

Experimental plots at Blaenau Ffestiniog, December 2005

Slate and other mineral wastes cover large areas of the country where mining has been, and often continues to be, a landscape-shaping industry. How do you soften and re-vegetate some of these tips? Sterile and expensive reclamation projects involving bulldozers and topsoil are being replaced by schemes based on aiding natural processes, through ecological research, and... compost! **MARK NASON** *reports.*

Slate dominates the cultural and visual landscape in many parts of north Wales and quarrying drove the development of communities and culture, particularly in Bethesda, Blaenau Ffestiniog and Llanberis. It has been estimated that 98% of slate extracted from the ground ends up as waste and although new equipment and techniques are lowering this figure, the mineral waste legacy of north Wales' 200-year industrial heritage remains. In Gwynedd alone, there are an estimated 730 million tonnes of slate quarry waste, with a further 6 million tonnes produced every year. Attitudes to this integral part of the Welsh landscape differ enormously; some visitors to north Wales speak of derelict and active quarries as a blot on the landscape, but many local people feel that their environment would be 'naked without them'.

Slate quarries have even inspired art and poetry by the people who have visited them. One such tourist, Alfred Lord Tennyson wrote:

He spoke; and, high above, I heard them blast
The steep slate-quarry, and the great echo flap
And buffet round the hills, from bluff to bluff.

The Golden Year, 1846

Lichen is an early coloniser

Pogonatum urnigerum urn haircap

Slate has been quarried since Roman times, but until the mid 1700s quarries were shallow and usually worked by individuals for their own needs. The oldest tips of significant size are between 150 and 200 years old and consist of large blocks and waste from cutting sheds, cut entirely by hand and often transported by mine cart to be tipped from the end of finger-like projections of slate waste known as Pen Clips. It is these tips that present the greatest challenge to colonising vegetation, as there is no soil to provide nutrients; despite high rainfall, plants that establish in small patches of fine material are prone to summer drought.

Ecologically, these blocky waste tips are extremely interesting since their colonisation by plants mimics processes of primary succession, where vegetation first establishes on bare land, for example following the retreat of glaciers or the cooling of volcanic lava. Arguably it is worth preserving blocky slate waste simply to study these processes. Among the first colonisers of the surface of the rocks of both natural block scree and blocky slate quarry waste are slow-growing lichens such as *Parmelia glabratula*, *Lecanora campestris*, and *Buellia aethalea* (that largely lack common names!) and woolly hair moss *Racomitrium lanuginosum*, which is also very tolerant of drought. Where there is an accumulation of moisture-retaining fine material, other mosses such as urn haircap *Pogonatum urnigerum* and ferns, most notably parsley fern *Cryptogramma crispa*, are among the first colonisers.

At Penrhyn quarry we have noticed that the small seeds of wood sage *Teucrium scorodonia*, silver and downy birch *Betula pendula* and *B. pubescens*, and grey willow *Salix cinerea* often germinate directly in pockets of moist moss. Although summer drought may mean that their seedlings only survive for one or two years, during their brief life they shed leaves that will rot down amongst the slates and begin the long, slow process of soil formation. The colonisation of plants with bird-dispersed seeds is generally much slower but they can be found under established birches and willows, and scattered oaks are seen on many older tips. Heathland plants are generally restricted to places where the waste slate has been compacted into a less porous substrate, e.g. on the bed of old tramways.

In some cases it is desirable to intervene and try to accelerate the slow colonisation of slate quarry waste by plants, for example to restore connectivity between patches of heather moorland severed by quarry expansion. Historically, planning permission to expand existing quarries was granted without requiring restoration to a beneficial after-use. Now, planning applications require environmental impact assessment and most are granted only if restoration is planned. With financial help from the European Commission under the Life-Environment programme, the University of Wales, Bangor, has been studying how best to restore slate quarry waste to habitats of conservation value. In a six-year partnership with Alfred McAlpine Slate Ltd., we have set up trial sites in Penryhn Quarry (Bethesda) and in Ffestiniog Quarry (Blaenau Ffestiniog). Alfred McAlpine Slate Ltd. is committed to restoration and remodelling landscapes that are affected by quarrying and has budgeted £3.5 million over the next 25 years for this purpose.

It is not always easy deciding what habitat to restore slate quarry waste to. For this reason we have surveyed adjacent plant communities in Blaenau Ffestiniog and Bethesda and sought extensive advice from many regulatory bodies and conservation agencies, most notably the Countryside Council for Wales. One thing is clear: industrial features within slate quarries should be retained for their heritage value. Slate quarries contain rare examples of Victorian engineering, such as water balances and inclines, and old buildings are sometimes occupied by scarce birds such as peregrine falcon *Falco peregrinus* and chough *Pyrrhocorax pyrrhocorax*. Bats, including the rare lesser horsehoe bat *Rhinolophus hipposideros* may occupy derelict quarry buildings or caves within slate quarries. A variety of objectives for quarry restoration might be considered, among them biodiversity conservation, landscape aesthetics, amenity and recreation. Potential future developments (i.e. re-working of quarry waste for secondary aggregates) should also be borne in mind. What is appropriate and practically achievable at a particular site depends on many factors including altitude and climate, neighbouring vegetation and the availability of soil-forming materials.

Finding the right compost

Using composts created from household and commercial wastes as a substitute soil in quarry


The plots in summer 2006


Producing compost in pods

restoration schemes has the potential to address many pressing environmental issues, and avoid environmental problems associated with imported topsoil. Biodegradable waste in landfill sites decomposes without oxygen; the result of this anaerobic decay is that carbon once contained in living organic matter is released to the atmosphere as methane. Methane is a potent greenhouse gas with a global warming potential some 20 times that of carbon dioxide. Composting organic wastes does not produce methane and the finished compost can be used to add nutrient- and water-holding organic matter to bare quarry waste tips without introducing weed seeds.

Behold this compost! Behold it well…!
It grows such sweet things out of such corruptions…
Walt Whitman (1819-1892), This Compost

However there is a problem with using composts to try and create, or re-create, Welsh upland habitats, particularly heather moorland, on bare slate quarry waste. Compost has a neutral to slightly alkaline pH and in comparison with Welsh upland acidic soils it is very fertile. For example, amounts of the essential plant nutrient phosphorus can be 200 times greater in compost than in heathland soil. In general, fertile soils favour the fastest growing species, so preventing the co-existence of a large number of species, and there is a danger that spreading fertile composts will result in species-poor grassland.

We have been composting a variety of household and industrial wastes according to recipes designed to produce compost suitable for biodiverse target habitats. We chose to use portable in-vessel composters (the EcoPOD© system) to allow us to control the composting process with a high degree of precision without producing leachate and unpleasant smells. Composting is a fascinating process. During the first few weeks, large numbers of bacteria and fungi consume 'labile' compounds, such as sugars and amino acids, contained in the organic matter being composted. During this feeding frenzy so much energy is released by their break-down that the temperature of the compost increases to 65°C or above. The high temperatures sanitise and sterilise the compost by killing weed seeds and potentially harmful bacteria such as *E. coli* and Salmonella. When the supply of labile compounds declines, the compost cools and white rot (basidiomycete fungi) continue the slow degradation of compounds such as lignin, which may take as long as 5,000 years to be broken down completely. As the compost cools, its texture and colour change and after approximately three months the finished compost resembles soil.

We have composted about 10 different mixtures of organic and mineral wastes at our trial sites in Blaenau Ffestiniog and Deeside. These include green waste, tertiary treated sewage sludge (biosolids), de-inking paper pulp (a by-product of recycling paper) and fine grain slate mineral fines. Green waste and biosolids contain large amounts of essential plant nutrients such as nitrogen, phosphorus, potassium and calcium. Paper pulp and mineral fines do not contain nutrients and are used to dilute the nutrients in compost whilst increasing water-holding capacity and improving physical structure. We are demonstrating that by carefully mixing these wastes, the characteristics of compost can be matched to target species and habitats.

Our finished composts have been spread on bare slate waste according to a robust experimental design. This allows us to assess the performance of different mixtures before deciding which might be suitable for restoring large areas of quarry waste. At Blaenau Ffestiniog, our experimental plots are

Heather seedling

clearly visible from the A470 over the Crimea Pass as it descends into the town from the north. The plots have a patchwork-like appearance and it is clear that some composts are supporting lots of vegetation whilst others look bare. The green plots are covered with lush growth of our target upland grasses, common bent *Agrostis capillaris* and sheep's fescue *Festuca ovina* and from the road it might be concluded that this compost has performed best. On closer inspection, however, you can see that the bare plots support patchy grass cover together with heather *Calluna vulgaris* seedlings, which have not become established on the fertile, grass-covered plots. Our recommendation would be that, in order to encourage initial establishment of heather, the fertility of compost must be kept low.

Having tested different mixtures of waste materials, our next step is to restore larger areas to demonstrate the validity of our techniques. Over the next few months we will be spreading our customized compost over approximately 0.5 ha of bare slate quarry waste and seeding the slope with a mixture of native upland grasses and heather. We know that the grasses will grow, but not flourish, on the infertile compost. We will monitor the site carefully and watch for the heather seedlings that will germinate early next autumn. In the process of creating our compost we have stopped several thousand tonnes of organic wastes from going to landfill sites and instead used them to create a safe, ecologically appropriate resource for slate quarry restoration.

Further reading
http://www.bangor.ac.uk/ies/TWIRLS/TWIRLS_home.htm
http://www.amslate.com/amslate_home/about.asp
http://www.llechicymru.info

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Birch seedling in *Racomitrium lanuginosum* hair moss

O Wastraff i Werddon

Diwydiant gwastraffus iawn yw chwarela. Amcangyfrifir bod 730 miliwn tunnell o wastraff llechi yng Ngwynedd yn unig. Mae nifer o'r tomennydd yn bentyrrau sylweddol o flociau craig a luchiwyd dros ymylon 'clipiau' chwarel. Mae'r hynaf yn eu plith yn 150-200 mlwydd oed. Dim ond yn araf iawn y bydd llystyfiant yn ailsefydlu ar y tomennydd hyn - er y gall coed bedw a helyg, yn y pen draw, dyfu yn y pocedi o fwsogl llaith sy'n datblygu rhwng y creigiau. Weithiau, mae angen cyflymu'r broses hon, ac mae amodau caniatâd cynllunio yn gofyn yn gynyddol am asesiad ecolegol a chynlluniau ar gyfer gwaith adfer tirlun. Rhaid cofio bod angen cyflawni sawl amcan wrth adfer olion chwarela - cadw nodweddion hanesyddol yn y tirlun, gwarchod cynefinoedd i fywyd gwyllt fel ystlumod ac adar, a chynnal cyfleoedd hamddena hefyd. Drwy gymysgu gwahanol fathau o wastraff domestig, mae Prifysgol Bangor wedi creu compost mwy asidaidd ei natur a fydd yn helpu llystyfiant nodweddiadol i ailsefydlu'n gynt ar domennydd llechi. Os bydd y dechneg yn llwyddiannus, bydd y Brifysgol wedi arbed tunelli o wastraff rhag mynd i safleoedd tirlenwi ac wedi ei ddefnyddio, yn lle hynny, i greu deunydd diogel a defnyddiol ar gyfer adfer rhai o'n tirluniau diwydiannol.