



## Refertilising Scotland

*While much has been done to rid our rivers and lochs of artificial fertilisers, the ways in which nutrients from the ocean naturally fertilise the land are still poorly understood, argues Peter Cunningham. By recognising this cycle, we may see a revitalised ecosystem.*

Most people in Scotland live where nutrient levels in nearby soils and streams are higher than they would naturally be. During the 20th century, food production progressed with increasing dependency upon NPK (nitrogen, phosphorus, potassium) fertilisers. Phosphates are also contained in many detergents and other industrial products. Effluents from agricultural land and urban areas over-enriched many rivers and lochs.

One of our greatest government-led achievements for the environment, to date, has been the cleaning-up of eutrophied (excessively fertilised) waters. Salmon have recolonised the Clyde, the Seine and the Rhine, once the greatest wild Atlantic salmon river of them all whose waters were also grossly abused for more than 100 years. We should celebrate.

**Naturally replenishing nutrients**  
I live in the crofting township of Alltgrishan near Gairloch in northwest Scotland. Our land is

Left to right: A solitary Erradale oak; An island of vegetation colonises a massive boulder. All photos: Peter Cunningham.

grazed by livestock, a mix of sheep and cattle. There are deer on the higher ground.

I look out over a garden rich in birdsong, with ash, oak, cherry, rowan, and apple trees, all freshly in leaf. Where planted around houses and protected from wind and grazing animals, trees grow well. On inaccessible ledges along the sea cliffs are some of the other ingredients for biodiverse woodland: aspen, juniper, ivy, holly and willows, together with associated mycorrhiza and a myriad of other micro-organisms. It's bluebell and birds-foot trefoil season, the bumble bees are buzzing. As the sun descends over the Outer Isles, sea pinks, ox-eye daisies and white campion glow against warm Torridonian sandstone.

Before my time here I became fascinated by how natural ecosystems are self-sustaining, and by our failure to understand this. In Thailand I witnessed how easily a rich, productive and biodiverse lowland evergreen rainforest could be destroyed; and how the new grasslands for cattle quickly lost their fertility and even their water supply when the rain-generating mechanism faltered.

In Lao PDR, traditional subsistence villages had learnt from nature and were still adept at fertility management. One village had moved from the riverbank to the middle of their island in the Mekong River. They recognised that by recycling household wastes including the remains of fish from the river into surrounding paddy fields, their children would have more rice and fish to eat.

Then I learnt about the 'salmon forests'. By transporting marine nutrients from distant ocean feeding grounds to spawning streams, pacific salmon can feed an entire forest ecosystem. Native American people have long recognised the importance of the salmon-derived nutrients from the sea, and by tradition return the bones of the salmon they catch to feed the river.

Our world view is distorted by where and when we live. Our gardens may be lush and green; we seldom see other parts of the planet where life remains critically dependent upon the cycling of life-limiting nutrients through the ecosystem. Nitrogen (N) can temporarily limit plant growth in some situations.

However, most floral regions have evolved with plants that together with symbiotic bacteria are able to 'fix' nitrogen from the atmosphere. Our atmosphere is 78% nitrogen. On the African plains, acacia trees feed nitrogen into surrounding grasslands via a wonderful diversity of browsing herbivores, such as giraffe, gazelle and many smaller animals. In South-East Asian tropical forests, there are similar trees and many smaller plants with nitrogen-fixing associations. In Scotland, alder trees grow along riverbanks; bog myrtle grows in wet mildly acidic land; legumes (vetches and clovers) enrich flower meadows.

But phosphorus (P) is different: it is the nutrient that limits biological productivity across much of our planet. Phosphorus availability often limits the growth of nitrogen-fixing plants. Where systems lack phosphorus, very small amounts can make a big difference.

Underlain by hard and insoluble bedrock with equally unyielding glacial deposits, Alltgrishan soils are typically thin and patchy away from the inbye land, and easily smothered by peat-forming moss. As they graze the hill, sheep and cattle crop the scarce phosphorus taken up by the sparse green growth. Phosphorus becomes concentrated in livestock bones and is exported from the township each autumn for sale at Dingwall market. And it seems that that's the way the powers that be think our hill should be managed: as an oligotrophic (nutrient-poor) peatland.

#### Salmon cycle

The hill ground is not uniformly barren. Here and there are little green knolls where birds and mammals perch, eat their meals and defecate. I like to visit these places. They support a richer diversity of plants than the surrounding landscape. Grouse and deer like to browse the phosphorus-rich vegetation. Along the riverbank are similar green patches where otters defecate. For much of the year, when the surrounding vegetation has turned yellow or brown, these places remain vivid green: little nutrient-rich oases in an otherwise barren landscape.

Like the bears of Alaska, otters pull salmon carcasses from Scottish

spawning streams onto the riverbank in autumn, thereby providing a food supply for scavenging fox, badger and many other animals. Bone meal fertilises the riparian corridor, including leguminous plants and alder trees. Some of the nutritious leafy matter falls into the salmon stream and is eaten by the insect larvae that feed the young salmon. In turn, more salmon smolts are produced to go to sea and more adult salmon return to the river, further enriching an otherwise barren hill stream; at least, that is the way I think it is supposed to work...

#### Restoring fertility

Some of Europe's largest brown bears were once found in Scotland. What role did they play in terms of recycling and redistributing nutrients within the landscape? Bears, wolves and lynx were extirpated from our islands many hundreds of years ago. We can only speculate on similarities between temperate maritime northwest Pacific and northwest Atlantic ecosystems. Are the carnivores that defecate bone meal just as vital to the productivity of natural ecosystems as every other link in the cycle?

When our ancestors became the 'bears' of the forest and the 'wolves' of the hill, patterns of nutrient dispersal may have initially resembled those of more natural systems. Then we became increasingly urbanised, plagued by parasites, fearful of our own waste products. As our world has become increasingly sanitised, have we lost sight of our trophic heritage and neglected some of our most important ecological attributes?

To restore forests to parts of Scotland like much of Wester Ross, you first need to restore fertility. In the 1950s, Donald McVean made progress



Top: Myrtle and oak trees. Below: A painting showing the interaction between the river and the land.



A salmon jaw lies on the river bank. Photo: Peter Cunningham.

towards understanding this at Beinn Eighe NNR. See for yourself: take a walk up the Pony Path to his plot, NH 005 621. Contrast soil cover, vegetation and other biota within McVean's fertilised plot with that of the denuded land that surrounds it. Then visit the places where raptors perch, where fox and pine marten defecate. See how blaeberreries and crowberries grow in these places; see how grouse droppings can be found juxtaposed the eagle's pellet that contains their bones.

Now look down to the Kinlochewe River where every autumn otters still remove salmon from the Anancaun (ford of the heads) to be scavenged by foxes and badgers. Imagine a forested valley with bear and wolf, where for every salmon and sea trout removed from the river today, there were ten or one hundred carcasses; where moose and deer grazed the floodplain by

night, returning to defecate on the higher ground by day.

#### Oakwood or lone oak?

On the Bolaven plateau in Lao PDR, Hubert Bahler established the Green Life Association in the 1990s to work with local government agencies and local villagers. The oak forests of the Bolaven Plateau are rich in bird life and edible berries, with beautiful orchids and other epiphytes. When the forests are cleared, soils are quickly leached of nutrients; flammable bracken scrub takes over. Stonechats flit from bush to bush where oak trees once grew. Hubert was trying to fertilise the minds of local people and government officials with the knowledge and understanding of how their forest ecosystem worked; to help them adapt to modern 'development' without destroying something of great value.

As I cycle home from Gairloch, I pass a relict patch of oak woodland. On one side of the road the oak trees grow with hazel and willow scrub on brown soil derived from metadiorite. On the other side there is an isolated oak on its own little green grassy island. Like the acacia trees on the savanna where vultures perch, I sometimes meet a buzzard or crow sitting on this tree providing the nutrients, recycled from sheep carcasses, which the tree needs to survive. Stonechats flit from bush to bush along the roadside nearby.

It is raining heavily. Sheep graze the mossy ground as they have done every day since I came to live here. The hill is denuded and barren. Not so far away there is a lochan where whooper swans feed every winter on lush green aquatic weeds below a hill from where ash from fires lit 'to improve the grazing' is washed into the water. From my window I watch ravens circling. Many lambs have been lost again this year; they say white-tailed eagles have taken them. And only a few

hundred metres away from where I sit, gannets and gulls are feasting on sandeels.

We live in a culturally eutrophied-oligotrophied, polarised nation. There is either too much or too little; rarely just the right amount of nutrient. To restore a healthier balance and revitalise ecosystem complexes of great beauty, you need more than fences and a handful of fertiliser when wee trees are plugged into barren ground. Our country could be naturally more fertile for livestock, wildlife and fisheries if the ecology of phosphorus and trophic linkages were better understood. Everyone should know this, not just scientists and agency experts; we can all enjoy restoring the natural productivity of our country, even more than planting native trees.

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