

A Story of Woodland

James Fenton January 2015

Do we not all prefer a good story to the truth? Do we not all use science selectively, using only the evidence that supports our prejudices, and finding good reasons why evidence in contradiction to them is flawed? Do we not realise that sometimes our pet theories may be slowing dying a death of a thousand qualifications? i.e. we find reasons why contrary evidence does not apply to our particular case. If, for example, we want to prove that predators control prey numbers we choose an example where this happens, and if we want to prove the opposite likewise we choose the best example.

Let me tell you a story, suitable for children on a long Christmas night ...

Once upon a time, my best beloved, there was a wonderful forest full of God's creatures which cloaked Scotland from head to toe. It was a diverse wood of many different trees, full of nuts and berries and mushrooms for people to eat, people who lived in harmony with the trees, harvesting them selectively so that there would always be wood for fuel and timber for building. The people shared the wood with a host of large animals, animals who kept to themselves but did not harm the trees; some, like the bear and the wolf were fierce and to be avoided, although presenting a challenge to any hunter wanting to show off their prowess; others like the lynx were rarely seen. The deer kept to the forest, hating any areas of open ground to which they were not suited and again were rarely seen because they were kept on their toes by the wolf, who was always out to get them. The blue hares up on the tops of the hills were careful to avoid eating the abundance of shrubs found above the forest itself.

In this harmony of Eden the trees were well-behaved: they ensured there were always enough of their youngsters: children, parents and grand-parents growing together in equal numbers, and they were not racist – they liked to grow with others unrelated to themselves. The great enemy was the rain, always trying to fell the forest by stealth. The rain had tried a hard approach, encouraging the spread of metallic iron in the soil which the soft tree roots could not defeat; and a soft approach, washing out all the plant food and encouraging plants which waterlogged the soil and caused the tree roots to die. But the forest was strong, it was resilient and robust, it recycled its own food and it kept these forces of darkness at bay.

But there came a time when the people, who once saw the forest as their home, out of their own greed turned their faces against it. They cut it down, they burnt it, they destroyed it for their own selfish ends. Industrialists came up from the south with metal of their own to reap the rich rewards which could be had from its destruction. And when the forest was all but gone, it was finished off by the myriad sheep who had replaced the friendly cow, the woolly locusts who could not help themselves in eating the last trees of this once great wood.

And it was we, my best beloved, who brought in the sheep, it was we who cut down the trees, and it was we who destroyed the wolf. We are now reaping the deserts of our actions. The deer have taken over the land, keeping their new sworn enemy (where once it had been their friend), the tree, at bay, and the iron and the peat have taken over the soil, leaving a desolate and devastated landscape in their wake. And so, my child, when you grow up I would like you to take the fiery cross in one hand and a tree in another and restore to this great country of Scotland what should rightfully be there ...

Re. A Woodland Story

The above story is a very good one and it resonates with many: indeed, as a young ecologist I used to believe it. However, over years direct observation of nature began to conflict with what I then knew to be true. For everyone knew it to be true, and most still do, although, in my view, on the flimsiest of evidence – or none at all: we just know it because we know it. However, like all myths it does contain some elements of truth. Let's, then, separate out the truths from the myth – but I do this with some trepidation for no-one likes their cherished beliefs to be challenged ...

1. Once upon a time, my best beloved, there was a wonderful forest full of God's creatures which cloaked Scotland from head to toe.

There is no *a priori* ecological reason why woodland should be the climax vegetation of Scotland: because it is in other parts of the world it does automatically follow that it should be here.

There have certainly been more trees in Scotland in the past as indicated, for example, by the sub-fossil tree stumps under peat in places where there are currently no trees. However research shows that these generally date to 4-5,000 years ago and represent an episode of tree colonisation. Research also indicates, for example, that in areas where there are still relict populations of pine trees, fragmentation of this woodland type began as early as 7,500 years ago (see reference at end). The historian Christopher Smout calls the 'Great of Caledon' a myth 'in every sense of the word.

What is perhaps surprising is the lack of tree remains in peat dating from the past few thousand years. If trees had been common in the landscape we would have expected more incursions of trees onto peatland, particularly in the drier periods of natural climate fluctuations: we know, for example, that today it can be difficult to keep trees from colonising raised bogs if seeding trees are nearby.

If in post-glacial times woods first expanded in extent and then declined, then we would expect the same to have happened to the associated woodland birds and mammals – perhaps even to extinction.

2. It was a diverse wood of many different trees, full of nuts and berries and mushrooms for people to eat, people who lived in harmony with the trees, harvesting them selectively so that there would always be wood for fuel and timber for building.

There is no *a priori* reason why the woods should have been ecologically diverse, whether in trees, shrubs, woodland flora or fauna. Observations today show that most tree species naturally regenerate episodically as even-aged, mono-specific stands. When woods colonise open ground as part of a regeneration cycle, the ground flora is often very species-poor. Because many of the woodlands tended to move around the landscape over time, the concept of 'ancient woodland' is problematical. Only on the richest soils and areas of most temperate climate (for example on Argyll coastal slopes) would there be woods both diverse in tree species and with a rich ground flora. Sessile oaks and Scots pine, with their acid litter, result in a particularly species-poor ground flora.

Woods were a valued resource, so it is probable that over most of history humans tended to conserve them rather than destroy them – so protecting them from natural decline.

3. The people shared the wood with a host of large animals, animals who kept to themselves but did not harm the trees; some, like the bear and the wolf were fierce and to be avoided, although presenting a challenge to any hunter wanting to show off their prowess; others like the lynx were rarely seen.

As woods naturally expanded and declined over thousands of years, it would be expected that the fortunes of obligate woodland animals would do likewise. However it is certain that humans caused extinction of some, such as the wolf, and possibly caused or accelerated the extinction of others. There is no *a priori* reason why large mammals would not harm trees: large herbivores can be

drivers of ecosystem dynamics, such as bison on the American prairies or the range of grazing species on the plains of the Serengeti.

4. The deer kept to the forest, hating any areas of open ground to which they were not suited and again were rarely seen because they were kept on their toes by the wolf, who was always out to get them.

Observations show that red deer have a wide ecological amplitude, surviving in wooded, semi-wooded and unwooded ecosystems. Hence, unlike roe deer, they should not be seen as 'obligate woodland animals'. To what extent the wolf would have affected red deer population size and distribution in Scotland is unknown, as is the past population sizes of red deer: it could be that the killing of deer as a food source kept deer numbers down (and hence encouraged trees), or it could be that, away from settlements, humans had little impact on deer population size.

The population of large herbivores is generally regulated by the ecological carrying capacity of the vegetation, with predators acting as an overlay on top of this. Wolves would have had to eat annually a large percentage of the red deer population to keep their numbers down, although their presence would be likely to locally affect the distribution of deer. In terms of the interaction of wolf/deer/trees, woodland naturally declined over thousands of years even when wolves were present; hence it is unlikely that the reintroduction of the wolf would result in them controlling the red deer population enough to cause significant woodland expansion. However it is possible that the role of lynx might be stronger in controlling roe deer numbers than the wolf in controlling red deer numbers.

5. The blue hares up on the tops of the hills were careful to avoid eating the abundance of shrubs found above the forest itself.

The lack of tree remains at the base of high altitude blanket peat indicates that montane scrub has probably always been rare in Scotland. Unlike, say Norway, Scotland does not have a consistent winter snow cover which would protect high-altitude scrub from grazing. Additionally, Scotland's temperate climate allows relatively high numbers of over-wintering herbivores; and midges, disturbance and better grazing tends to attract deer to the higher hill slopes where scrub would otherwise grow.

Much of the low ground became overlain by peat, with the vegetation providing little grazing value. Any small areas of willow-scrub, with their succulent shoots, would tend to attract both red deer and mountain hares. The acid soils of most Scottish hills would preclude a high diversity of montane scrub species. The willow species perhaps most characteristic of upland Scotland, *Salix aurita*, is still common in the landscape although it only forms dense stands in the absence of grazing.

6. In this harmony of Eden the trees were well-behaved: they ensured there were always enough of their youngsters: children, parents and grand-parents growing together in equal numbers, and they were not racist – they liked to grow with others unrelated to themselves.

Observations today show that most tree species naturally regenerate episodically as even-aged, mono-specific stands, with a tendency to species-poor woods except on the richest soils in the most favourable locations. The most common tree species (downy and silver birch, sessile oak, and Scots pine) tend all to be shade-intolerant, *i.e.* young trees cannot grow under the closed canopy of mature forest. Hence woods would not be expected to have a balanced age-range of trees at a given site. Woodlands could naturally expand, stay the same or decline to extinction depending the balance of factors affecting tree regeneration – see list of factors at the end. There is no *a priori* reason why the woods should have been ecologically diverse, whether in trees, shrubs, woodland flora or fauna.

7. The great enemy was the rain, always trying to fell the forest by stealth. The rain had tried a hard approach, encouraging the spread of metallic iron in the soil which the soft tree roots could not defeat; and a soft approach, washing out all the plant food and encouraging plants which waterlogged the soil and caused the tree roots to die.

Most of Scotland's rock types erode to form nutrient-deficient, acid soils. In a climate where precipitation exceeds evapo-transpiration throughout the year, nutrients are leached out of the soil (podsolization). Over time an impermeable iron-pan develops, preventing further downward drainage of water, leading to waterlogged soils, forming a barrier to root growth and isolating roots from the more nutrient-rich layers below – all detrimental to tree growth and tending to result in peat formation. Additionally, the combination of waterlogged soils and relatively high winter temperatures can cause physiological stress in trees.

8. But the forest was strong, it was resilient and robust, it recycled its own food and it kept these forces of darkness at bay.

Research shows that birch trees can to some extent prevent the above soil processes by re-cycling nutrients from the deeper layers of the soil to the surface layers (through annual leaf fall). Scots pine in contrast tends to accelerate soil acidification. However research suggests that podsolization/iron pan development/peat development was a pretty relentless process over thousands of years. Additionally, the tree species most suited to these acid soils (downy and silver birch, Scots pine, sessile oak) are all shade-intolerant, *i.e.* young trees cannot grow under the closed canopy of mature forest. This is likely to lead to episodes of open ground where soil leaching can take place. Evidence suggests that much of the level ground of Scotland at low altitudes, whether coastal plain, raised beach or glen floor naturally became raised bog rather than woodland.

9. But there came a time when the people, who once saw the forest as their home, out of their own greed turned their faces against it. They cut it down, they burnt it, they destroyed it for their own selfish ends.

Inland Scotland was an inaccessible place until the road-building programme started in the 1700s, with huge tracts of mid to high altitude upland distant from any human population. There could not have been large-scale extraction of timber except along large rivers or lochs where present. If the trees were cut down, the question arises: why did the trees simply not regrow? Soil disturbance from felling results in ideal regeneration conditions, as do occasional fires, and summer-only cattle grazing (the shieling system). The presence of the wolf would have precluded large free-ranging flocks of goat or sheep which might have hindered regeneration.

10. Industrialists came up from the south with metal of their own to reap the rich rewards which could be had from its destruction.

Certainly the development of iron furnaces in the 18th Century needed considerable amounts of wood for charcoal but at, for example, the longest running iron furnace at Bonawe, woods were as extensive at the end of the iron-smelting period as the beginning: the woods must have been sustainably managed for charcoal. Oakwoods are still common in many former iron-working areas such as Loch Maree and Argyll.

11. And when the forest was all but gone, it was finished off by the myriad sheep who had replaced the friendly cow, the woolly locusts who could not help themselves in eating the last trees of this once great wood.

Large-scale sheep farming in the Highlands, which began in the 1700s, could not happen until the wolf had been made extinct. However the woods were largely gone by 1600: hence sheep cannot be held responsible for decline of a 'widespread forest'. Sheep may have caused further decline of some woods locally, but woodland can sometimes be seen expanding in the presence of high sheep numbers. Sheep do not necessarily prevent woodland regeneration, although they will impact on

some trees more than others, their preferences being willows, rowan, broom and gorse rather than birches and pine.

14. And it was we, my best beloved, who brought in the sheep, it was we who cut down the trees, and it was we who destroyed the wolf.

Certainly we brought in sheep but they cannot be held responsible for creating the Highlands' largely open landscape. Likewise there is little evidence that human tree-felling has created the Highland-wide open landscape, although this may have contributed to some local areas being unwooded. We certainly made the wolf extinct, but the wolf as a predator of grazing animals had over the previous 10,000 years failed to prevent woods declining in the landscape. Evidence points to a long-term natural expansion of woodland in the Highlands followed by a long-term natural decline, brought about by a complex array of factors, including climate, soil development, peat development, the nature of the plants themselves and grazing by native herbivores. Natural decline of woodland might have continued if it were not for the modern human intervention: it is possible that future climate change could reverse the natural decline processes or accelerate them – there is uncertainty here.

15. We are now reaping the deserts of our actions.

No, except in and around settlements (inbye land, land below the head dyke), we have inherited in the Highlands one of the most natural vegetation patterns remaining in western Europe. Certainly intensive moorland management for grouse shooting has reduced the naturalness of the locations where it occurs. However these locations would still be moorland without management, and the management itself can increase the overall species diversity (plants and animals). Our open moorland contains globally rare plants such as cross-leaved heath and bog asphodel, and in places is internationally important for its mosses and liverworts. It also encourages Arctic bird species to breed further south than they would otherwise do.

16. The deer have taken over the land, keeping their new sworn enemy (where once it had been their friend), the tree, at bay, and the iron and the peat have taken over the soil, leaving a desolate and devastated landscape in their wake.

The wolf as a predator of grazing animals had over the previous 10,000 years failed to prevent woods declining in the landscape; the generally open landscape is the result of natural processes. Hence, although there is a conservation case for bringing back the wolf to restore the naturalness of the Highland ecosystems, it is unlikely to control red deer numbers enough to allow significant native woodland expansion – bearing in mind the generally poor soil and ground conditions for woodland establishment. It is possible that when humans first colonised Scotland they hunted red deer for food, thus allowing an unnatural expansion of woodland through grazing reduction (although this is speculation).

It has generally been the case in Europe and elsewhere that humans have considerably reduced the populations of large mammals, many to extinction. Hence, in places where a significant populations of large mammals have managed to cling-on, such as red deer in the Highlands, we, not being used to seeing large numbers of animals, instead of saying 'fantastic', say 'there are too many deer'. We do not complain, for example, about the large number of herbivores found on the plains of the Serengeti and which help maintain an open landscape. Large herbivores should be seen as keystone species, driving ecosystem dynamics. If woodland cannot survive their presence, and it cannot over much of the Highlands because of the natural absence of thorny scrub which, in most of temperate Europe, protects regenerating trees (the Frans Vera model), then woodland is likely to be scarce. Additionally, grazing generally increases the species diversity of the ground flora (although excluding some species), maintains soil fertility through enhanced nutrient cycling, and discourages peat development (through eating plant litter which would otherwise form peat).

It does appear to be the case that in recent years the number of red deer has been increasing in some areas; however over the same period there has been a considerable reduction in the number

of sheep so the overall level of grazing may not have changed much. Ultimately the main factor affecting herbivore numbers is food availability.

17. And so, my child, when you grow up I would like you to take the fiery cross in one hand and a tree in another and restore to this great country of Scotland what should rightfully be there ...

Be careful – and be sure what it is you are trying to restore and why. If you are trying to restore natural ecosystems to Scotland, you need to be certain that their currently state is not largely natural. You need to be objective and fully understand the long-term ecological dynamics of the landscape. You must lose your obsession with trees – and see a tree as just one more plant that might or might not be appropriate to the locality. You must not be blinded by ‘diversity’ – expecting to see lots of different species everywhere: there is no reason why ecosystems should be diverse.

If it takes a lot of effort to force your vision on the landscape, then you need to question your vision because the difficulty of implementing it suggests you are working against natural processes. You must beware of damaging the remaining naturalness of the Highlands by your actions, because places where nature is still in charge, and has been for thousands of years, are becoming increasingly rare on this over-crowded and over-managed planet. Taking up the fiery cross can be appealing, but be careful that its emotional appeal does not lead you to places where nature is reluctant to go.

Notes

Extracts from pages 58-9 of: Paterson D, 2011. *The Holocene history of Pinus sylvestris woodland in the Mar Lodge Estate, Cairngorms, Eastern Scotland*. PhD thesis, University of Stirling.

“In core areas [of pinewood], woodland is subject to fragmentation from as early as c. 7500 cal BP; fragmentation is diachronous and is believed to have been earliest in the west ... Human activity is sometimes implicated in woodland fragmentation but is more often cited as reinforcing the effects of a maritime climate preferentially affecting *Pinus* dominated woodlands ... Only in Speyside is human activity thought to initiate disintegration.

“In west Glen Affric, *Pinus* began to decline at c. 4000 cal BP with woodland continuing to fragment until c. 2000 cal BP ... by which time the valley consisted of the ‘apparently monotonous treeless landscape’ seen today.

“Arrival of *Pinus* at Geldie Lodge [Mar Lodge Estate] is undated but occurs before c. 7550 cal BP. Woodland is always more open; *Pinus* is co-dominant with *Betula*, showing affinity with other peripheral areas. *Pinus* woodland fragments at all Mar Lodge sites from c. 3900 cal BP, disappearing from Geldie Lodge by c. 2800 cal BP and White Bridge by c. 1900 cal BP. *Calluna* replaces *Pinus* as the dominant species at all three sites. The disappearance of *Pinus* is thought to relate to regional climatic change toward wetter conditions.”

Factors influencing tree regeneration

- Seed production and fertility
- Seed dispersal (including role of jays/squirrels with oak)
- Soil conditions: nutrient availability (pH), water content, presence of iron-pan
- Competition between seedlings and other plants
- Shading of young trees by taller plants (can encourage mildew on oak seedlings; oak, birch, Scots pine generally shade intolerant)
- Dense litter preventing seedling establishment
- Trampling by large herbivores (creates seed beds)
- Grazing of seedlings/saplings
- Caterpillar grazing (caterpillars falling from oak canopy eat leaves of seedlings)
- Lack of thorny shrubs (protect young trees from grazing)

- Presence of deadwood (as an establishment site for seedlings/preventing grazing)
- Availability of mycorrhizza fungi in the soil
- Air/soil temperature
- Wind exposure
- Late frosts
- Warm & wet winters (tree respiration remains high, but trees stressed owing to roots being in waterlogged/anaerobic conditions)
- Lack of winter snow cover (snow protects trees/shrubs from grazing)
- Presence of winter snow cover (Scots pine in Norway can get attacked by fungi under snow; in Scotland?)
- Disease
- Chance

All these issues are discussed further:

1) Visually in *Towards a New Paradigm for the Ecology of Northern & Western Scotland: A Synthesis of Issues*

2) More scientifically in the 2008 paper *A postulated natural origin for the open landscape of upland Scotland*

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