

Afforestation of the Scottish Highlands: The History and the Ecological Repercussions Highlands Under Siege: The Afforestation of Scotland and its Ecological Repercussions

One of the greatest rural land use changes in Britain has been the creation of large expanses of new forests or afforestation. While processes of afforestation have gone on throughout Britain a large proportion of the effort has been concentrated in Scotland. Tompkins (1989) writes that in 1975 after the forestry headquarters was moved to Edinburgh it was confirmed that forestry became "mainly a Scottish affair." At the beginning of the twentieth century, Scotland, like most of Britain, had largely been deforested. In 1905, Scotland consisted of only 4.5 percent forested land compared to 17 percent in 2000 (Forestry Commission, 2001). Since the early 1900's processes of afforestation have continued through to the twenty-first century despite changes in afforestation objectives, political, economic, and social climates. The following paper will discuss how large-scale afforestation in Scotland was able to maintain its momentum throughout the past eighty years and into the future and the ecological consequences that have accompanied it but have only recently begun to receive attention.

Before we can adequately discuss the history of afforestation it is necessary to discuss the structure and organization of forestry within Scotland and greater Britain. The Forestry Commission was created in 1919, after the First World War, during a time when forest cover in Britain was at its lowest. Much of Britain had been deforested in order to fuel the war effort. The Commission was created in reaction to the fact that Britain and Ireland, at the time, were the least forested countries in Europe and were almost solely dependent on timber imports for their wood supply (Mackay, 1994). The goal of the Forestry Commission was to establish strategic wood reserves in order to decrease reliance on imports in case of another war. The Commission had two main roles. It was to function as a 'forestry enterprise', which would acquire, plant and manage forested lands. Its second function was to serve as a 'forestry authority' that would administer policy instruments such as planting grants and felling licenses (Mather, 1993). The Forestry Commission was given cross-boarder public authority over all of Great Britain (including Ireland) and the legal status of a government department. It was the first state-controlled production industry (Tompkins, 1989). The powers and duties of the Forestry Commission were stated in the Forestry Act passed on August 19th, 1919. The ultimate goal of the Commission was to plant 2 million hectares of "well-managed, productive woodlands" by the turn of the century. It was estimated that 800 000ha could be obtained by restocking existing forests and the remaining 1.2 million ha would be obtained through afforestation of bare lands (Healey, 2002). The creation and structural organization would serve to shape the nature and distribution of forested lands in Britain and Scotland in particular.

The expansion of afforestation in Britain has almost exclusively been confined to uplands. Much of these uplands, especially in England and Wales were considered unsuitable for planting due to elevation, incline, infertile soil and high wind exposure (Table. 1). Therefore, planting was further restricted to only the sub-montane zone (a maximum of 500m above sea level) above which it became infeasible to plant due to harsh environmental conditions (Tompkins, 1989).

% Plantable upland Area	England	Scotland	Wales
	20%	34%	28%

Table 1: Shows the percent plantable area in the UK's uplands (Tsouvalis, 2000).

Afforestation was relegated to the uplands mainly to avoid competition with agricultural land uses, as food production was viewed as more important than forestry; and to minimize conflict with farmers (Tompkins, 1989). Furthermore, as the Forestry Commission began to acquire land, it could only afford to purchase cheap, marginal, upland areas that were dedicated mainly as grazing lands. In order to reduce the costs of forestry, the Commission also had to

carry out land acquisition at a large-scale to reduce unit costs, and the only place where inexpensive land was held in large unit ownership was in the uplands. Because Scotland had the greatest plantable land availability (34%) (Table 1); it became the obvious emphasis of the afforestation program (Tsouvalis, 2000). Afforestation in England and Wales, peaked in the 1950's and continued to press on through the 1960's, but soon after began to decline. This was partially due to high prices of land and public opposition to conifer plantations (Tompkins, 1989). The people of England were especially opposed to afforestation with conifer plantations, as their traditional landscape consisted of scattered broadleaved woodlands amongst a rolling open landscape. Finally, in 1988, the Secretary of State for the Environment announced that large-scale afforestation projects would no longer be permitted in the English highlands (Tsouvalis, 2000). Scotland became the center for the afforestation industry. However, this was not because it wanted to be there but rather because it less contentious to continue with afforestation concentrated in Scotland than to try to deal with the public opposition to afforestation in England and in Wales (Tompkins, 1989).

Afforestation was made even more appealing, especially in Scotland, by the introduction of a series of grant schemes and tax avoidance programs administered by the Forestry Commission in order to encourage continued afforestation. In 1947 a 'Dedication Scheme' was introduced to encourage landowners to enter into formal legal agreements with the Forestry Commission to dedicate part of their lands to forestry for use in timber production in exchange for grant aid (Tsouvalis, 2000). Tax concessions were also offered by the Forestry Commission in exchange for legal agreement by landowners to conduct forestry on part of their land. This tax concession was the driving force for afforestation in Scotland throughout the mid-20th Century (Tsouvalis, 2000). Forestry was normally taxed under income tax Schedule B. Under Schedule B, no taxes were levied on income received from timber sales, or on any grant money received for forestry from the Forestry Commission. Moreover, landowners had the option of being assessed under Schedule D. Under Schedule D loans taken to buy land for forestry were interest free. Any capital spent on forestry building (i.e. road and fence building) could also be offset against other income at a rate of 4 percent per year under Schedule D (Tompkins, 1989). The benefits of these tax concessions attracted many investors to forestry (i.e. Pension funds, corporations, new afforestation companies). The tax concessions had provided a tax loophole. First, investors would take advantage of the system by having, the money invested to purchase land for afforestation, assessed under Schedule D. Then the ownership of the land would be transferred to a spouse or child once it reached the productive stage and was reassessed under Schedule B. This was done in order to avoid paying tax on the profits that might come out of the forest once it reach the productive stage (Tsouvalis, 2000). Investors were not really interested in forestry or rural development rather they were seeking a means of tax avoidance on income they had generated elsewhere (Tsouvalis, 2000). Finally, the 1980 House of Commons Public Accounts Committee felt that forestry subsidies should not be "left to the fortuitous consequences of the exploitation of a tax loophole" (Tompkins, 1989). In 1988, the income tax advantages of tax concessions were discontinued (Mather, 1993). A new Woodland Grant Scheme was introduced which offered more grant aide; however, this scheme was not as financially appealing to investors as the tax concession and the end result was a drop in planting rates (Mather, 1993).

Changes in economic, social and political climates were not significant enough to totally halt afforestation of Scottish uplands so planting pressed onward. Annual planting rates have fluctuated throughout the afforestation process. The original target rates for Britain were 20 000 to 25 000ha per year. In March 1986, the annual planting target was increased to 30 000ha per year, and further increased a year later to 33 000ha per year (Tompkins, 1989). Table 2 shows Scotland's share of the new plantings taking place in Britain over the years.

Years	Forestry Commission	Private Sector
1950	48%	NA
1960	58%	NA

1971 81% 74%
 1980 90% 83%
 1990 99% 80%

Table 2 : Scotland's share of new plantings in Britain (Mather, 1993)
 From these figures it is clear that afforestation became "mainly a Scottish affair" beginning especially in the 1970's through to the 1990's where virtually all of the afforestation being done in Britain is taking place in Scotland. Much of this afforestation has been conducted in the Scottish highlands (Healey, 2002).

Not only did planting rates fluctuate throughout the process of afforestation, but so did the ratio of conifers to broadleaves planted. The native vegetation in Scotland was composed mainly of mixed oakwoods in lowland areas, pine dominated the highland regions and birch was found in the far north (Mather, 1993). Figure 1 shows the shift in species choice between the 1950's to the 1990's. The planting of other or exotic conifers increased dramatically from the 1950's through to the 1980's. Only beginning in the 1990's has there been a rise in the planting of broadleaved species.

Figure 1: Shows the shift in species choice between the 1950's to 1990's (Forestry Commission, 1998)

Species	Forestry Commission (%)	Private Sector (%)	Total Area (ha)
Conifers	99	80	765 633
Scots Pine	12	24	144 371
Lodgepole Pine	17	61	103 924
Sitka Spruce	52	31	364 601
Norway Spruce	7	6	54 707
Jap/Hybrid Larch	7	6	52 146
Broadleaves	12	0	76 567
Oak	14	1	16 551
Beech	<1	3	10 496
Birch	<1	4	16 647

Table 3: Scottish forested land area by species and ownership. Based on Forestry Commission census 1980 (Mather, 1993).

An account of the history of the British Forestry Commission makes reference to the major species planted in the afforestation process. Paradoxically, the Forestry Commission started out by planting the upland areas using the only native timber producing conifer- the Scots Pine (*Pinus sylvestris*). The species was widely used for its tolerance of harsh soil and site conditions. The Scots pine fairs relatively well compared to other softwoods on less fertile heather moors, which characterized the upland environment along with acid bogs (Healey, 2002). However, from the figures in Table 3 it is clear that the forestry commission decreased its use of the native conifer in favor of exotic varieties that were faster growing. The exotic, Sitka spruce (*Picea sitchensis*), was the overwhelming species of choice for afforestation of Scotland's highlands both in the public and private sectors (table 3). Approximately, 10 000ha of Sitka spruce were planted annually by the Forestry Commission throughout Britain (Mather, 1993). This exotic conifer owed its popularity to its ability to tolerate acid peats and heathy vegetation and for its ability to resist damage from exposure experienced at high elevations (Healey, 2002). Lodgepole pine (*Pinus contorta*) was another exotic species used in the afforestation of the Scottish uplands. It was planted extensively on poorer sites; however, it was less widely used compared with Sitka spruce due to its susceptibility to pest outbreaks (Mather, 1993). Other exotic conifers such as Japanese and Hybrid larch were also used in the planting of hillsides but to a much lesser extent. Hybrid larch, in particular, could not be planted extensively due to limited seed availability (Healey, 2002). Norway spruce was not used very much in afforestation although it is fast growing and a useful timber species. This is because it was much more sensitive than Sitka spruce and could not tolerate acid conditions or severe exposure both of which are prevalent in the highlands (Healey, 2002). Broadleaves were rarely planted by the Forestry Commission and

only slightly more so by the private sector (Table 3). This was because throughout most of the afforestation process timber production was the primary focus and broadleaves are typically much slower growing than conifer species. A recent trend towards the planting of more broadleaves illustrated in Fig. 1 reflects a significant underlying change in the objectives of afforestation. More recently, the focus on timber production has decreased in favor of trying to restore some of Scotland's natural heritage.

The landscape of the Scottish highlands is harsh, consisting mostly of heather moor and acid bogs. Afforestation of these areas typically involved drainage of peatlands and deep ploughing (60-90cm) (Tsouvalis, 2000). Trees would be planted in the upturned mounds of soil created by ploughing. Planting of trees was closely spaced (1.8 – 2.4 meters) and each site was planted to full stocking (Tsouvalis, 2000). Sites were fully stocked in order to reduce exposure and damage from windthrow. Application of herbicides, pesticides, fertilizers and phosphates was done via aerial sweeps (Mather, 1993). At the end of the first rotation, trees were harvested using the clear-cut method and the site was replanted once the area had been cleared (Tsouvalis, 2000). The following section will describe the ecological impacts of afforestation on the Scottish highlands as a result of the species planted, planting location and planting methods used.

The striking change to the Scottish rural landscape created through afforestation could not be achieved without leaving a, perhaps, irreversible mark on the natural environment. The process of afforestation has severely altered the hydrology of the highland ecosystem and that affects part of the watershed further downstream in lowland areas. As ploughing and draining of upland soils takes place during the process of afforestation, the rate of run-off tends to increase. Streams and rivers fed by headwater areas undergoing afforestation have experienced more irregular water flows. Flows tend to peak during a rainfall event due to run-off from uplands but quickly dissipate leaving lower than normal base flows in downstream areas (Tompkins, 1989). Furthermore, the amount of exposed soil and peat caused by ploughing results in increased sediment deposition in streams and lakes (Tompkins, 1989). A study by Robinson and Blyth (1982), as cited by (Tompkins, 1989), found that during drainage operations, the sediment loaded into streams was 50 times their original levels. Moreover, it took several years for the sediment loading to decrease to only 4 times the original amount of sediment loading experienced by downstream areas. Increased sediment loading destroys the spawning grounds of fish (Tompkins, 1989). Conifer plantations have also been shown to pollute watercourses. Conifer foliage has the ability to trap atmospheric pollutants on their leaves such as those in acid rain. As the needles fall to the ground and are washed by a rainfall event, these pollutants are washed into the streams. The headwaters of the Severn and Wye rivers have shown a 14 fold increase in acidity (Newson, 1985). Increased levels of acidity in waters adversely affect fish populations such as salmon and sea trout (Tompkins, 1989). In the river Fleet in Galloway, which is heavily forested, salmon populations were reported to have been reduced by one third and sea trout catches were drastically reduced within a decade (Tompkins, 1989). Finally, it is inevitable that the levels nitrogen, potassium and phosphorous in fertilizers used in conifer plantation forestry will enter watercourses and their concentrations will increase. This may result in eutrophication problems further downstream. Pesticides that are also used will make their way into streams contaminating them further.

Afforestation has also destroyed a lot of the peatland communities of the Scottish highlands. Draining of peatlands cause disappearance of wetland species such as sundew, butterwort and bog bean. Those that survive are quickly eliminated once plantations reach the thicket stage where they shade out ground vegetation (IPCC, 2001). It has been found that even after a clear-cut the original ground vegetation does not return rather species adapted to human disturbance move in such as brambles, foxgloves and rosebay willowherb (Tompkins, 1989). This is the result of the hydrology of peatlands being so severely altered by forestry practices. Native peatland bird assemblages have also been adversely affected by afforestation, although different species are affected to different degrees. Peatland birds tend to disappear as soon as plantation forests reach the thicket stage 10-15yrs when all semblance of the

former peatland habitat is destroyed (IPCC, 2001). In fragmented areas where plantations that are adjacent to residual peatlands, the plantation forest tends to attract predators such as foxes, carrion and hooded crows. Although these animals require a woodland habitat they rely on ground outside forests (e.g. adjacent boglands) for food. As a result, waterfowl, which use bog pools for nesting, and other moorland bird species are severely affected by this increased predation (IPCC, 2001)

Afforestation represents one of the most significant rural land use changes in Scotland's. The above discussion it is clear that afforestation within Scotland especially in the highlands has become so ingrained in the Scottish psyche that despite changes in political, social and economic factors, afforestation has maintained its momentum for over eighty years and it will most likely continue on well into the future. However, afforestation has not come without ecological repercussions to both the physical and natural Scottish environment. It has only been recently that such environmental repercussions have come to the forefront. The question is will past forestry practices continue into the 21st century or will Scotland and Greater Britain take responsibility for their actions and begin to bear the true costs of trying to reclaim their forests?

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