Forestry in a treeless land 2009

Thröstur Eysteinsson
Division Chief, National Forests

SKÓGRÆKT RÍKISINS

Iceland Forest Service, Miðvangi 2-4, IS-700 Egilsstaðir, Iceland throstur@skogur.is
(Updated from an article originally published in Lustgarden 2004)

Among the first things that visitors to Iceland usually notice are that it is not as warm as where they came from and there is a lack of forests in the landscape. Logically, they connect these two facts and come to the conclusion that Iceland is too cold for forests. This impression is often reinforced when they see the "forests" of low-growing and crooked native birch. However, over a century of forestry activity has proven that this is not the case, that it is past land-use and not climate that explains the treeless landscape. In fact, forests grow as well in Iceland as they do in parts of the world where forestry is a major industry.

Forest history

Fossil evidence indicates that Iceland was forested to a considerable extent during the mid to late Tertiary (5-15 million years ago), with tree genera including S*equoia, Magnolia, Sassafras, Glyptostrobus* and many others, indicating that the climate was warm-temperate. Beech (*Fagus sp.*) forests seem to have been very common. By the late Pliocene, shortly before the onset of Pleistocene glaciations, coniferous forests predominated including *Pinus, Picea, Abies, Larix, Betula* and *Alnus,* indicative of a boreal climate.

With succeeding glaciations, the Icelandic flora became ever more species-poor. *Pinus* survived (or was able to return after) the first few glacial periods up to about 1.1 million years ago and fossil evidence of *Alnus* is found during interglacials to about 500,000 years ago. The only forest forming tree species to survive/return to the present interglacial is downy birch (*Betula pubescens*). Other native tree species found in Icelandic forests are rowan (*Sorbus aucuparia*), which is uncommon, and the extremely rare aspen (*Populus tremula*) found in only 7 locations, along with tea-leaved willow (*Salix phylicifolia*), which sometimes reaches tree size but is usually a shrub.

At the time of human settlement about 1140 years ago, birch forest and woodland covered 25-40% of Iceland's land area. The relatively tall (to 15 m) birch forests of sheltered valleys graded to birch and willow scrub toward the coast, on exposed sites and wetland areas and to willow tundra at high elevations.

As in agrarian societies everywhere, the settlers began by cutting down the forests and burning scrubland to create fields and grazing land. Sheep were important as a source of wool from the outset, but by 1300 they had become a staple source of food for Icelanders as well. At the same time, the Catholic Church (also the political power at the time) started obtaining woodland remnants, a clear indication that they had become a rare and valuable resource. Continued sheep grazing prevented regeneration of the birchwoods after cutting and the area of woodland declined steadily. A cooling climate is sometimes cited as a possible cause for woodland decline, but birch regenerates by stump sprouts at quite low temperatures. Cooling temperatures might

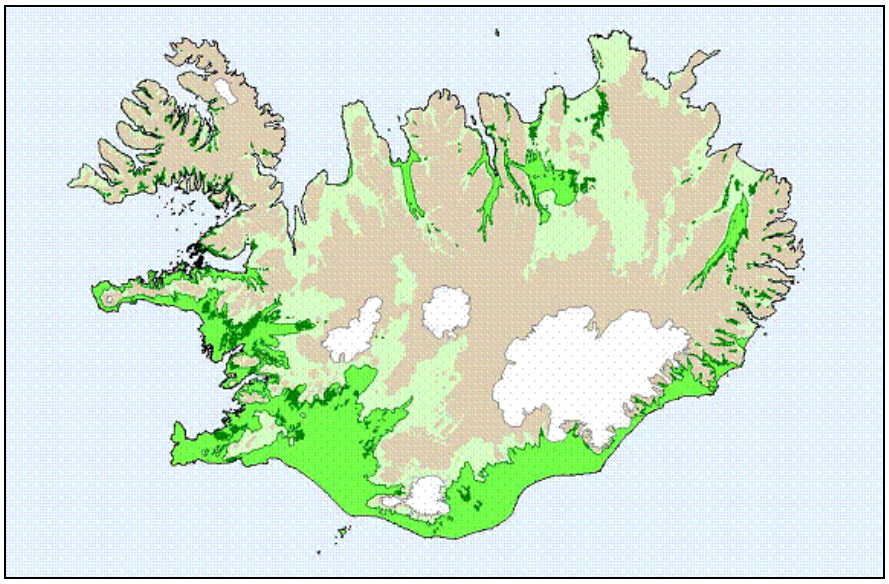
have lowered tree line elevation, but they do not explain deforestation of the lowlands.

The birchwoods were important as a source of fuelwood, building material and livestock fodder, but the most important forest product was charcoal, needed to smelt iron and make iron tools. The need for charcoal was alleviated in the latter half of the 19th century, when steel tools and farming implements began to be imported. However, wood was used for fuel until as late as 1940, both for cooking and heating the new wood frame and concrete houses, which were colder than the sod homes that Icelanders lived in before. Thus, deforestation did not end in Iceland until the middle of the 20th century.

Charcoal making in Skaftafell around 1950.

The extent of Icelandic birchwoods probably reached a post-glacial minimum of less than 1% cover around 1950. Even though economic, technical and agricultural development alleviated the need to utilise birch for fuel or fodder by the mid 20th century, increases in sheep numbers and high levels of summer grazing continue to prevent natural extension of woodlands outside of protected areas to this day.

Today, birchwoods are not economically important as a source of wood or fodder. Some birch forests are popular recreation areas and birchwoods are now recognised as being important form an ecological perspective as remnants of an ecosystem that once covered much of Iceland and as the source of organisms to colonise new woodlands where birch is being used in afforestation, thereby reclaiming that ecosystem.



Map showing the current birchwoods (dark green) and areas with mean summer temperatures of at least 9°C (middle green) and 7.6°C (light green), which is thought to be the pre-settlement limit of birch woodlands.

Forestry

Organised forestry is considered to have started in Iceland in 1899 with the planting of the "Pine Stand" at Thingvellir. Three Danes; merchant marine captain Carl H. Ryder who perceived the problems inherent in having no forest resource, forestry professor Carl V. Prytz who provided expertise and Christian E. Flensborg, a young forester who did most of the work, were instrumental in initiating forestry efforts in Iceland and lobbying the parliament to adopt a forestry and soil conservation act. It was adopted in 1907 and the Iceland Forest Service (IFS) was established in 1908.

After an early phase of experiments with exotic tree species, forestry efforts largely focussed on protecting birch forest remnants during the first half of the 20th century, with several forest areas being acquired by the IFS for that purpose. They, along with more recently acquired afforestation areas and experimental forests comprise the National Forest system today.

Since about 1950, emphasis has been on afforestation through planting trees. Planting by forestry societies and the IFS increased greatly during the 1950's, reaching over 1.5 million seedlings per year during 1960-'62. The principal species planted were exotic conifers: *Picea abies, Picea sitchensis, Pinus sylvestris, Pinus contorta* and *Larix sibirica*. Planting declined after 1963 and remained at 500,000 to 1 million seedlings annually from 1963 to 1989. The period from 1950 to 1990 was a time when a great deal of experience was gained through experimenting with different exotic species and provenances.

Afforestation through planting has increased again since 1990 to over 6 million seedlings annually since 2005, which corresponds to an increase in planted area of 1000-1500 ha per year. Planting of native birch has been increasing proportionate to the total, comprising as much as 30% of seedlings planted in some years. *Larix sukaczewii (syn. L. sibirica var. sukaczewii)* is planted to roughly the same extent as native birch and *Picea sitchensis* has recently gained a similar status.

Species	**Seedlings planted 2007**	**% of total**
Larix sukaczewii	1,530,000	24.8%
Picea sitchensis	1,379,000	22.3%
Betula pubescens	1,368,000	22.2%
Pinus contorta	777,000	12.6%
Populus trichocarpa	332,000	5.4%
*Salix spp.**	160,000	2.6%
Picea engelmannii	149,000	2.4%
Sorbus aucuparia	89,000	1.5%
Betula pendula	85,000	1.4%
Alnus sinuata	68,000	1.1%
Picea glauca	60,000	1%
Other species	174,000	2,7%

Afforestation planting in Iceland by species in 2007. * Willow species include *Salix alaxensis, S. lanata, S. phylicifolia, S. hookeriana, S. borealis, S. caprea* and several others. Source: Icelandic Forestry 2007.

The IFS planted roughly half the trees planted in Iceland up to 1990, mostly on Forest Service lands. With the exception of some early direct seeding trials, this included practically no native birch since most IFS enclosures were established around remnants of birchwoods where natural regeneration was usually sufficient. For example, the area of birch cover in Hallormsstadur National Forest increased by 130 ha from 1906 to 1995 without a single birch tree being planted and in spite of 200 ha being converted to conifer forest. The total extension of birch within the enclosure was around 330 ha in 90 years, or an average of 3.7 ha per year, more than doubling the original forest area.

The other half of trees planted up to 1990 was planted by forestry societies, which were mostly involved in afforestation of treeless land. Since 1990, forestry societies have been the main actors in the Land Reclamation Forest project, a co-operative project between the Icelandic Forestry Association (an umbrella organisation for the local forestry societies), the Forest Service, the Soil Conservation Service (both state agencies) and the Ministry of Environment, within which about 1 million seedlings are planted annually. The aim is to afforest eroded or degraded land and 40-75% of seedlings planted annually have been native birch even though it is not always the most effective tree species at reclaiming degraded or eroded land.

From its limited beginnings in 1970, state supported afforestation on farms has become the main channel for afforestation activity in Iceland, comprising about 80% of the afforestation effort today. Originally, only farms located within the best areas for afforestation were eligible to participate and the only goal was establishment of plantations for wood production. Since the mid 1990's, state support for farm afforestation has spread to all parts of Iceland and afforestation goals have become variable resulting in increased use of native birch and other species not grown for wood production.

In recent years, there has also been increased recognition that forestry entails more that afforestation by tree planting. As plantations get older and a growing number of them are becoming noticeable in the landscape, it has become obvious to most that a forest resource is developing in Iceland; still small but growing in area at a rate of about 20% per decade. The trees are growing well too, with current annual increments for larch, spruce, pine and poplar often ranging between 10 and 20 m^3/ha/year on good sites.

Hallormsstaður National Forest.

Forestry Legislation

Laws pertaining to forestry reflect the fact that forests form a very small part if the Icelandic landscape, the main policy points being that existing forests should be protected and afforestation of treeless land is encouraged. To this end, the IFS also has a mandate to educate and advise the public in forestry matters, which requires research. These goals have been in effect since the first Forestry Act of 1907. The goal of increasing forest cover through afforestation is re-affirmed in the Regional Afforestation Projects Act of 2006, where for the first time a concrete goal of 5% forest and woodland cover of lowlands is set.

In recent years, checks have been put into place regarding certain aspects of forestry through the Environmental Impact Assessment Act and a regulation regarding use of exotic plant species. These legal instruments are the results of EU directives; in other words not the result of a perceived need within Iceland to put checks on forestry. Because of the costs involved, the Environmental Impact Assessment Act effectively puts a ceiling of 200 ha on the size of afforestation areas and prevents or at least discourages afforestation within protected areas.

Sitka spruce in Haukadalur National Forest

The forestry sector

The Icelandic forestry sector went through major administrative changes in 2007. The IFS, along with funding to the Icelandic Forestry Association and a new project called Hekluskógar, were moved from the Ministry of Agriculture to the Ministry of Environment, while the Regional Afforestation Projects as well as partial control over IFS research funding remained in the Ministry of Agriculture (which became the Ministry of Fisheries and Agriculture). The full effects of these changes have yet to come to light, but splitting the small forestry sector between two ministries has not simplified administration (the stated aim of the changes).

The IFS

The Iceland Forest Service (IFS) was established according to the forestry and soil conservation act of 1907. It is the state forestry authority in Iceland and is under the Ministry of Environment. The IFS manages over 40 national forests throughout

Iceland, totalling about 7000 ha or 5% of Icelandic forests and woodlands. The majority of forest and woodland area within the national forests is protected native birch woodland, but there are also cultivated forests of various species, experimental forests, arboreta and outdoor recreation areas including 4 campgrounds. The national forests employ a full-time staff of around 30 people.

Until recently, the IFS was the main producer of tree seedlings in Iceland, as between 1950 and 1990 the main emphasis of the IFS was on afforestation through planting. Tree planting has now become a minor part of IFS activities and seedling production has been privatised.

Iceland Forest Research, located at Mógilsá near Reykjavik, is the research division of the IFS. Traditionally, species and provenance trials have been the mainstay of forest research in Iceland and they are still important. In recent years however, ecology has become an increasingly important field of study with a wide range of topics being looked at, including carbon and nutrient cycles, establishment problems, insect pests and pathogens and the effects of afforestation on plant and animal communities. Forest inventory has also increased in importance, not the least due to the need for knowledge about carbon stocks and sequestration. Other recent research topics include growth and yield studies, climatic mapping and historical and social aspects of forestry. For the majority of research projects, emphasis is placed on them being directly applicable to forest management planning and practice. Iceland Forest Research has a professional staff of 15.

Forestry extension and education is another function of the IFS. As an example, over 20 primary schools have become Forest Schools through a project headed by the IFS to integrate aspects of forests and forestry into all parts of the school curriculum. Each of these schools has adopted a forest stand within walking distance of the school that serves as an extra "classroom".

A Rowan in an Icelandic birch forest

Forestry Societies

The Icelandic Forestry Association (IFA) was formed in 1930 and is an umbrella organisation for 57 local forestry societies. These are non-governmental volunteer organisations of people interested in afforestation. Their efforts are mostly

concentrated around towns and villages, but some own quite large tracts of forest land and some of the oldest cultivated forests originally grown on treeless land belong to forestry societies.

Besides the Land Reclamation Forests program mentioned earlier, local forestry societies are mostly concerned with managing older forests and woodlands for outdoor recreation, some grow Christmas trees and some have small tree nurseries.

The IFA publishes the journal *Icelandic Forestry*, which comes out in two volumes annually. It is the main forestry publication in Iceland and contains a mix of scientific papers and more general articles. They also offer short courses in forestry related subjects, an annual lecture series and forests walks aimed at increasing public knowledge of and interest in forestry. The IFA has roughly 7000 members, or about 2.5% of the Icelandic population, making it by far the largest environmental NGO in Iceland.

Regional Afforestation Projects

Starting with Héraðsskógar in 1991, five Regional Afforestation Projects (RAPs) have now been established to cover all of Iceland. They are "mini-agencies" under the Ministry of Fisheries and Agriculture but and their function is to manage the state grants scheme for afforestation on farms, each in its own region of the country. This includes making contracts with landowners, afforestation planning, co-ordinating seedling production and distribution, education and extension (usually in co-operation with the IFS and the Agricultural University) and distributing the grants.

Each farm afforestation grant covers 97% of establishment costs, including fencing, roads, site preparation, planting and the first thinning. It is the individual landowner who owns the resulting forest stands and bears all legal responsibility. The landowners also usually do the planting, thereby receiving part of the grant as compensation for work. A forest-farmer afforesting a large tract of land can earn what amounts to as much as 2-3 months wages per year.

The five RAPs were responsible for roughly 80% of planting in Iceland in 2007. Around 700 farms currently participate in afforestation and/or establishing shelterbelts and there is a waiting list to join. This is a total of over ¼ of Icelandic farms.

An example of farm afforestation

The Forest Owners Association
The Icelandic Forest Owners Association (FOA) was formed in 1998 as a union to represent the views and concerns of forest owners. It has a membership of over 700, consisting mostly of forest owners participating in the RAPs. As a young organisation, it is still in the process of defining itself. The FOA has a volunteer board of directors, a very small budget, one part-time employee and no permanent headquarters. A significant part of the board's efforts to date have been in lobbying for increased funding for forestry.

Forestry education at the Agricultural University of Iceland
The Agricultural University of Iceland, with its main campus at Hvanneyri in West Iceland, started a forestry degree programme in 2004. This marked the first time that university level education in forestry was offered in Iceland and was a milestone for Icelandic forestry. The first foresters with an Icelandic BSc in forestry graduated in spring 2007 and the first MSc degree was awarded in autumn of 2008.

Soil Conservation Service
The Soil Conservation Service (SCS) is the sister organisation to the IFS. It works to prevent soil erosion and revegetate eroded land. In recent years, use of woody plants in land reclamation has increased, especially native birch and willows.

Hekluskógar (Hekla forests)
A very large area north, west and south of the volcano Hekla consists mostly of desertified land at fairly low elevation. It was wooded for the most part at the time of settlement, but the forests were felled and grazing along with blowing volcanic ash caused severe erosion. Volcanic ash is not only a problem immediately after an eruption, in an open landscape it is blown back and forth for years and can be the source of dust storms for decades. In the shelter of a forest however, the ash quickly settles, is not blown around and does not cause erosion.

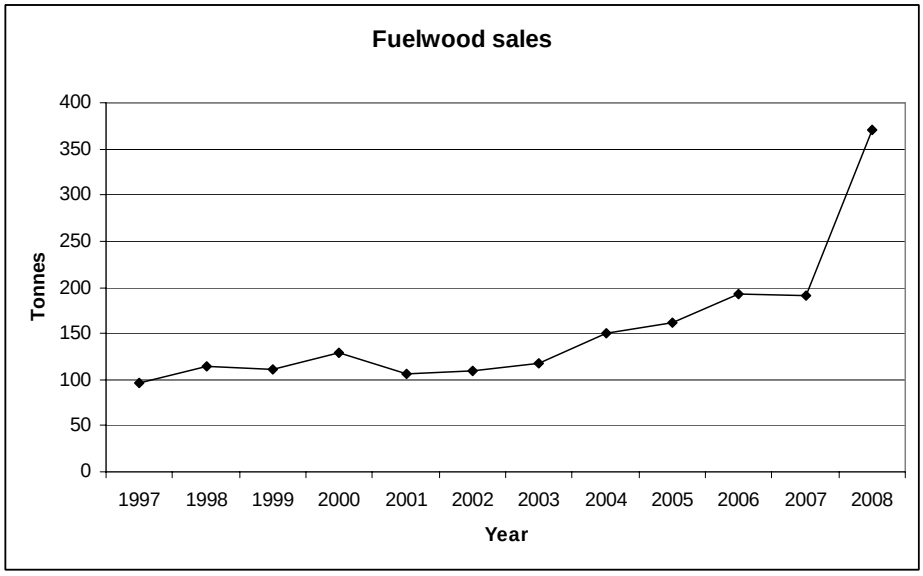
An ambitious effort to reclaim forest and woodland around Hekla was initiated in 2005. The aim is to afforest up to 100,000 hectares of land, primarily with native birch, in the hope of reducing disturbance from future eruptions of Hekla. The Hekluskógar project is a joint effort of the Soil Conservation Service and the Forest Service with participation of the Agricultural University, Suðurlandsskógar regional afforestation project, local forestry societies and land owners.


Planting can often be done mechanically in the Hekluskógar project.

Forest industry?

Icelanders use the same amount of forest products as other nations with a comparable standard of living, but they are almost all imported due to Iceland's very small forest resource. However, the market for fuelwood never quite disappeared and there are niche markets that can be supplied with wood from selection felling in the largest birch forests and thinning in plantations. Examples include:

- Birch fireplace logs
- Birch and pine fuelwood mostly used by pizzerias
- Larch fenceposts
- Birch, larch and other species for handicrafts
- Larch, birch and spruce sawn wood in small quantities for special projects
- Spruce poles for fish drying racks
- Spruce and pine shavings for bedding for livestock.
- Wood chips used in footpaths, as mulch, etc.



Sale of fuelwood from the Iceland Forest Service has been increasing, mostly due to an increase in the number of pizzerias with wood-fired ovens.

It is perhaps inappropriate to use the term forest industry in Iceland, but there are several small businesses that use wood from Icelandic forests in their production. As the forest resource grows and more wood from thinnings in plantations becomes available, these businesses and others will be able to rely on domestic sources of wood rather than imports. As this is being written (January 2009), the importance of domestic wood sources has recently become abundantly clear, since bank failures have made importing wood difficult for the time being and the fall of the Króna means that imported wood will be very expensive for some time to come.

Splitting birch fireplace logs in Vaglaskógur National Forest

Afforestation objectives and afforestation planning

In general, Icelandic afforestation is planned and cultivated forests managed with multiple-use objectives. These objectives can best be described based on the four principle functions of forests: ecological (ecosystem processes, habitats, wildlife), economic (wood production, non-wood products), protective (soil and water conservation, shelter, sequestering CO_2) and social (recreation, spiritual).

In forest planning and management, greater emphasis is often placed on one or two of these functions and less emphasis on others, without ignoring them entirely however. Within the RAPs, the majority of afforestation plans to date emphasize timber production as a primary goal within areas where timber production is possible, the main timber species being *Larix sukaczewii, Picea sitchensis, Pinus contorta* and *Populus trichocarpa*. In peripheral areas, emphasis is on protective functions and in some cases ecological restoration, where the main species is native *Betula pubescens*, or on establishing shelterbelts, mostly with willows. A few plans have been drawn up emphasizing wildlife value, improved grazing for livestock and outdoor recreation as well.

Outdoor recreation is an increasingly important service provided by forests.

The Iceland Forest Service has put forth a set of guidelines to afforestation planners. Some points from these guidelines are:

- Tree species planted should be selected based primarily on site conditions and the goals of afforestation on that site.
- Planting of exotics within natural woodlands is discouraged. Instead planting should be directed toward treeless land to increase the total forest area.
- Wetlands should not be drained for afforestation.
- Care should be taken to avoid planting on sites of special value. These include sites where rare species have been found or rare habitat types, archaeological sites, special landscape features and much-visited sites with scenic vistas.
- Planting species mixtures rather than monocultures is recommended.
- Forest edges should be designed specifically so that the cultivated forest blends as well as possible into the landscape.

A combination of protective and social functions is the aim of Land Reclamation Forests. Since they are mostly close to population centres, these forests will become outdoor recreation areas. In fact, two forest areas originally cultivated on treeless land in the 1950's and 60's, one near Reykjavik and the other near Akureyri, annually receive over 400,000 visits, well over the entire population of Iceland.

The management goal for the majority of national forests (IFS lands) is simply protection of native forest and woodland ecosystems. Outdoor recreation, timber production, ecosystem restoration and research are also main goals in some IFS lands, whereas erosion control and reclamation are the main aims on land managed by the SCS.

There are no forests managed only for carbon sequestration nor are there any plans for afforestation specifically for that purpose. However, carbon sequestration can be one of the management objectives of multiple-use cultivated forests.

Norway spruce planted in the shelter of Russian larch

So how is it going?

Over a century of forestry activity in Iceland has yielded several positive results and developments. We prevented the destruction of the last remnants of natural forests. We gained experience in forest management and cultivation of a number of tree species. We gained scientifically based knowledge of the best provenances to use and where to plant them. We have a great deal of knowledge and experience with afforestation of treeless land. We are beginning to develop a real multiple-use forest resource. Without a doubt, the most important outcome is that there has been a change in attitude of the Icelandic people. A century ago, most Icelanders had never seen a tree. Fifty years ago, few Icelanders believed that trees of any size to speak of could grow in Iceland. Planting trees was the harmless hobby of a few eccentrics, but forests for timber production were out of the question. Today, forestry for timber production, land reclamation and amenity is being carried out by thousands of people all over Iceland.

The good growth of several tree species has probably been most important in changing people's attitude towards forestry. The native *Betula pubescens* generally grows slowly, rarely reaching more than 13 m in height and the mean annual increment is almost always well below 1 m^3/ha/yr. Based on this, it is no wonder that people did not consider forestry to be a realistic possibility in Iceland. Several exotic species planted in the 1950s and earlier, including *Picea abies, P. engelmannii, P. glauca, Pinus cembra, Abies lasiocarpa, Betula pendula, Larix decidua* and *Pseudotsuga menziesii* are reasonably well adapted to Icelandic conditions and will all grow to be much larger than the native birch. The tallest trees of all these species are between 17 and 21 m in height and they will all grow to well over 20 m in the coming years. With the exception of *Pseudotsuga menziesii*, they are all used to a limited extent in Icelandic forestry, but are not among the major species because of their relatively slow growth or limited experience with them.

The major species used in forestry are, in addition to the native *Betula pubescens*, *Larix sukaczewii, Picea sitchensis, Pinus contorta* and *Populus trichocarpa*. They have all reached at least 20 m in height and show mean annual increments ranging from 5 to 15 m^3/ha/yr. The tallest tree in Iceland is a 24.5 m *Populus trichocarpa* (at left), followed closely by *Picea sitchensis* at 23 m and *Larix sukaczewii* at 22 m. Based on growth curves, *Larix sukaczewii* and *Pinus contorta* will certainly reach 25 m height on good sites by age 100 years and *Picea sitchensis* and *Populus trichocarpa* at least 30m.

However, 100 years of forestry have not resulted in much extension of forest area. The native birch woodlands have expanded through natural regeneration within fenced areas but there has been little or no expansion in areas not specifically protected from grazing. Thus, natural expansion of birchwoods has been very limited and will continue to be so as long as the tradition of uncontrolled sheep grazing continues.

For several reasons, planting has not resulted in large land areas being afforested either, compared to the area of potential forest land in Iceland. Up to the mid 1980s, land was not available for afforestation because of competition by other land use, especially grazing. Forest establishment is expensive and few individuals have the financial resources to invest in afforesting large amounts of land. Planting by forestry societies was always constrained by lack of money as was planting by the IFS. State afforestation grants were first offered in the early 1970s but were extremely limited until the 1990s. Due to these constraints, afforestation of relatively large areas has only started within the last 20 years.

The fact remains that Iceland has a very small population (320,000) compared to the area of the country (103,000 km^2, of which at least 30,000 km^2 can potentially be afforested). For this reason alone, afforestation through planting, as a proportion of

total land area, will proceed slowly. Total afforestation planting has been 1000-1500 ha per year during the last 15 years. At that rate, it will take 50 years to plant trees on 1% of Iceland's land area. The RAPs are facing a 20% budget cut and the Hekluskógar project 50% in 2009 due to the financial crisis. This will certainly lead to a reduced rate of afforestation that may last for several years, depending on how long the depression lasts.

The future

Aspects that the forestry sector has some control over, such as planting trees, could possibly lead to a doubling of forest and woodland area of Iceland within the next half century, although that is by no means certain. However, other factors are likely to have greater and more far-reaching effects. Land-use change, specifically a decline in sheep farming, is likely to result in increased natural regeneration and extension of birchwoods to areas that have been treeless for centuries. Climate change (global warming) could conceivably lead to far greater changes. A warmer climate would allow both natural extension of woodland and afforestation through planting to reach areas at higher elevations than has been possible previously, expanding the potential forest area and allowing us to reclaim large areas of eroded land to woodland.

The future if Icelandic forestry is bright. The main obstacle, the psycological one, has been overcome. In comparison, financial and technical obstacals are easy to deal with.

Principal references

Blöndal, S. and Gunnarsson, S.B. 1999. Íslandsskógar (Iceland's Forests) Reykjavik: Mál og Mynd: 267 pp.

Grímsson, Friðgeir, Thomas Denk, and Leifur A. Símonarson. 2007. "Middle Miocene floras of Iceland — the early colonization of an island?." *Review of Palaeobotany & Palynology* 144, no. 3/4: 181-219.

Gunnarsson, E. 2008. Skógræktarárið 2007; (Forestry in 2007). Icelandic Forestry 2008 vol. 2: 98-101.

Halldórsson, G. (ed.). 2006. Skógarbók Grænni Skóga. (Thr forest book for Greener Forests). Agricultural University of Iceland. 248 pp.

Snorrason, A. and S.F. Einarsson. 2002. Land capability for forestry in Iceland. Icelandic Forest Research report no. 14/2002, 68 pp.

Thorarinsson. Th. 1974. Þjóðin lifði en skógurinn dó (The nation lived but the forest died). Icelandic Forestry 1974: 16-27.