

# Part 4: Shelterwood & Structures



Alexander Robertson

Diversity in form, function and biodiversity is the key to a pleasant and effective all-season shelterwood structure



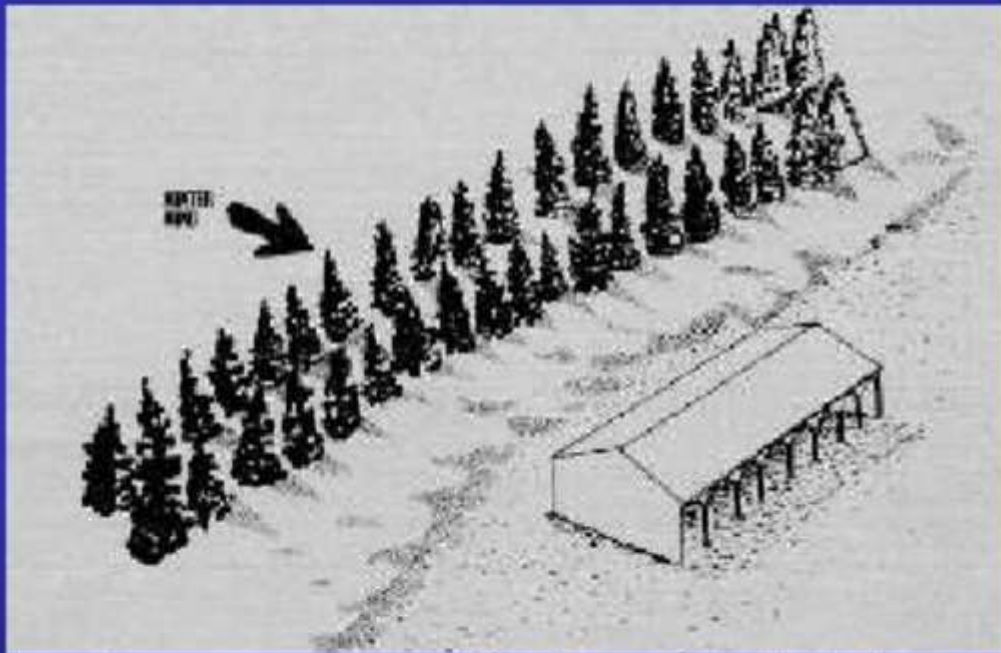
Alexander Robertson



Shelterbelts in straight lines have been the conventional wisdom the world over – but do they work?



Double and triple lines of 'feathered' trees which trap snow are a little better than a single line – but only if it takes into account variations and degrees of turbulence generated by micro-scale wind directions and wind speed



Iowa Department of Agriculture





Miniature fortresses intended to protect trees from children and their toys. In this open landscape they also improve the micro - heat balance which helps young saplings get established more quickly.



One fence helps control snow & sand drifting but only for short distance, and only until snow (or sand) builds up to about 2/3 of the fence height. Double and even triple fences work even better in slowing drifting over a longer distance and for a longer period.





The white picket fence fits well below the colorful arrangement of street trees in Conception Bay, Newfoundland. However, being mostly deciduous, the trees only provide shelter in summer. Picket fences (*left*) are more effective in reducing drifting snow (and/or sand) than the more common rail fences.





# These attractive fences are aerodynamically excellent for reducing uncomfortable leeward turbulence

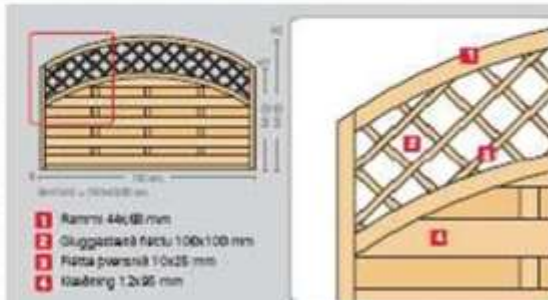
## HÚSASMÍÐJAN

### Skjólgrindir

Bogform í skjólgrindum gefur þeim lítla ka og undirstikar vel samspil gróðurs og grindar. Bogformið vitar einnig til náttúruka á borð við dökkreyfingar og skýja. Með því að nýta þá kosti sem náttúran (bogforminu) er auðvelt að aðlagja grindir að gróinu, einkum í nýjum gróum þar sem gróur er vaxandi og fyllir að sér lívleika.

Með þessu formi er einnig auðvelt að samana háar og lágar grindir, einkum í minna ákrofum gróum.

Gagnvæn áhrif og nýttar festingar eru í öllum skjólgrindum sem Húsasmíðjan seldur.



### Dæmi um samsetningu



Bæturseti af inngangi í Salsvötn þvö.



Meðalíni fyrir upp.





## The wind problem at the Arts & Culture Centre, St. John's, Newfoundland



Here's why edge trees should never be pruned. In the graph note that air-flow is drawn through a car port by the suction of the upper main stream wind flow is almost triple that of the least windy part under the shelterbelt.





Reynifell is reminiscent of the Scottish *run-rig* system where the *out-fields* on the mountains and lava plain were used for rough grazing, while the *in-fields* (*inbye*) have turf walls to protect the hay fields from grazing and perhaps serve as allotments for individual families and low shelter for sheep in stormy winter weather.



In 1776, when the Danish King's decreed that dykes be built to protect hay fields from grazing, many of the sand farmers refused to obey; and for those who did mostly built walls of turf rather than stone.





This remarkable Icelandic heritage wall that shelters a fine garden on Skólavörðustigur in Réykjavík was built by a lady who was the minister at Hallgrímskirk. It's rough top subdues lee turbulence.





An industrial strength shelter wall that has the height and roughness elements to shelter an industrial compound from mountain gales. The well-spaced boulders helps to reduce leeward turbulence.





This elaborate sheep fank was built at Réttarnes in 1609 and was last used for sheep in 1979. Although it was not built for shelter *per se* (except for lambing) it demonstrates a high-degree of skillful stone work that has survived earthquakes. These days it used by horse riders as an overnight coral.





One of the reasons the walls at Réttarnes have stood up for so long is because they are mostly double-walled with a tightly-packed hearting (*bottom right*) much like Scottish 'dykes'





The Skeið walls built in 1881 and refurbished in 1981 is a remarkable example of beauty and precision. The hearting (*visible on the right*) suggests a similarity to Scottish Galloway 'dyke'





The Skreið wall has become an icon wall in the landscape architecture of public and private spaces throughout Iceland. Although the wall provides low shelter and restricts snow drifting, in many cases they are built strictly for ornamentation and property boundaries.



Laugardal, Reykjavik



Borganess



John Cleveley's painting of Skálhóltsstaður and Dómkirkjan in 1772. Note that most of the buildings and their doors (at least the kirk's door) are located on the sheltered side of the hill. We know this because Bláfell is the prominent hill in the background. The landform in the middle are sand dunes which appear to be sparsely vegetated.





In contrast to Galtalækur's well-managed and extensive grasslands, vast areas of degraded land, where only small grassy islands (called rofabarðs) show that several metres of topsoil have been eroded away by the combination of removal of forest cover and over-grazing which exposed the landscape to massive erosion by wind, water and frost-heaving







It is hard to imagine this was a heavily wooded area 150-200 years ago. The pasture in the foreground is fertile enough to winter 100 or so sheep. The cottage on the left boasts the only (planted) birch trees, otherwise the hills are bereft of vegetation except for a rofarbarð on the extreme right. This landscape needs help!

Remnants of the once extensive birch forest cling to the ridge, while some effort is being made to restore grassland on the desert probably for grazing and perhaps for trees

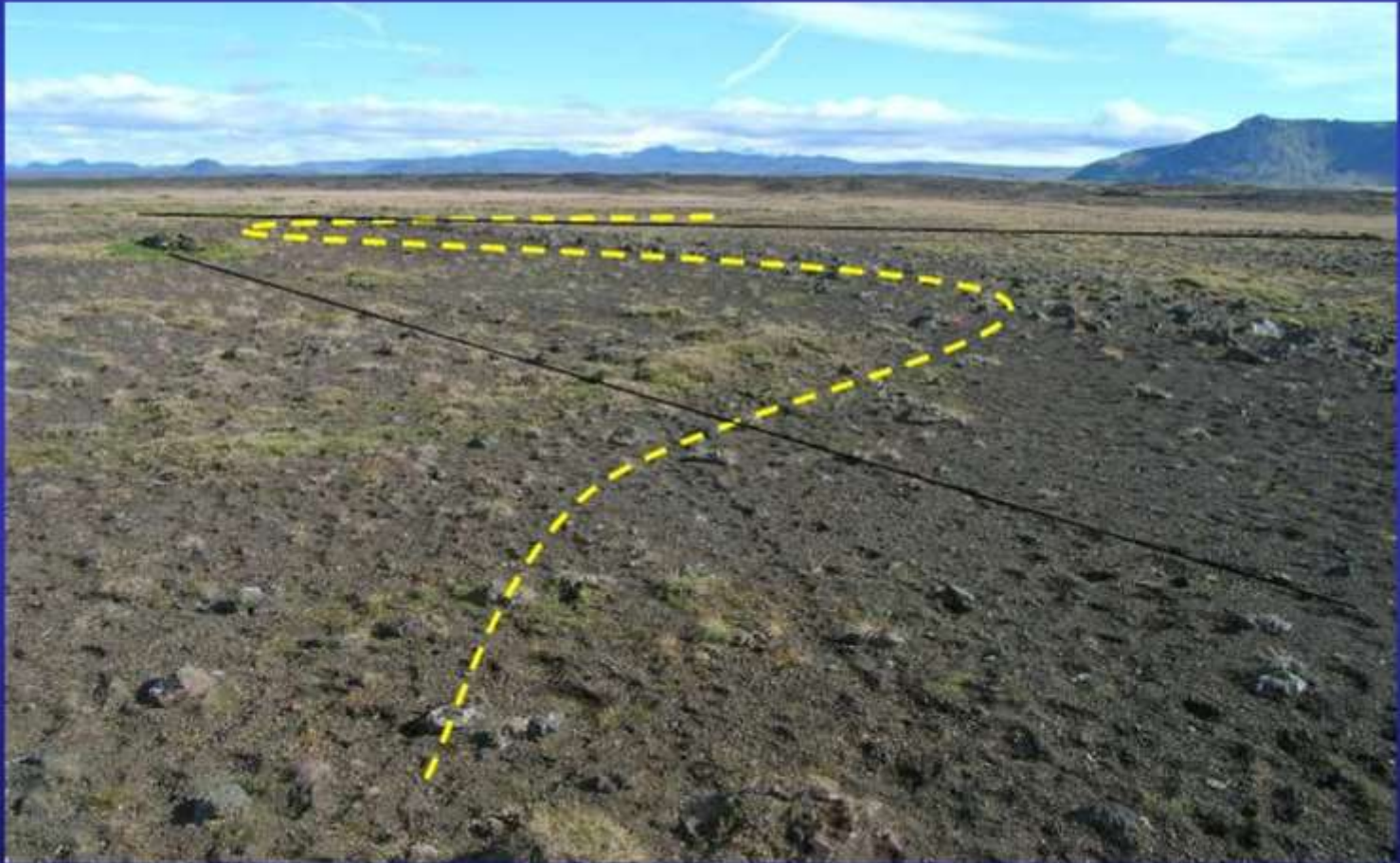


This historic map shows where lake Reyðarvatn close Keldur which was filled in with sand during the worst years of sand drifting in the late 19th century when the farm was also inundated by sand. The farm was reclaimed by sheer hard work and determination. But there is no visible trace of where the lake was, although it is still shown on most modern



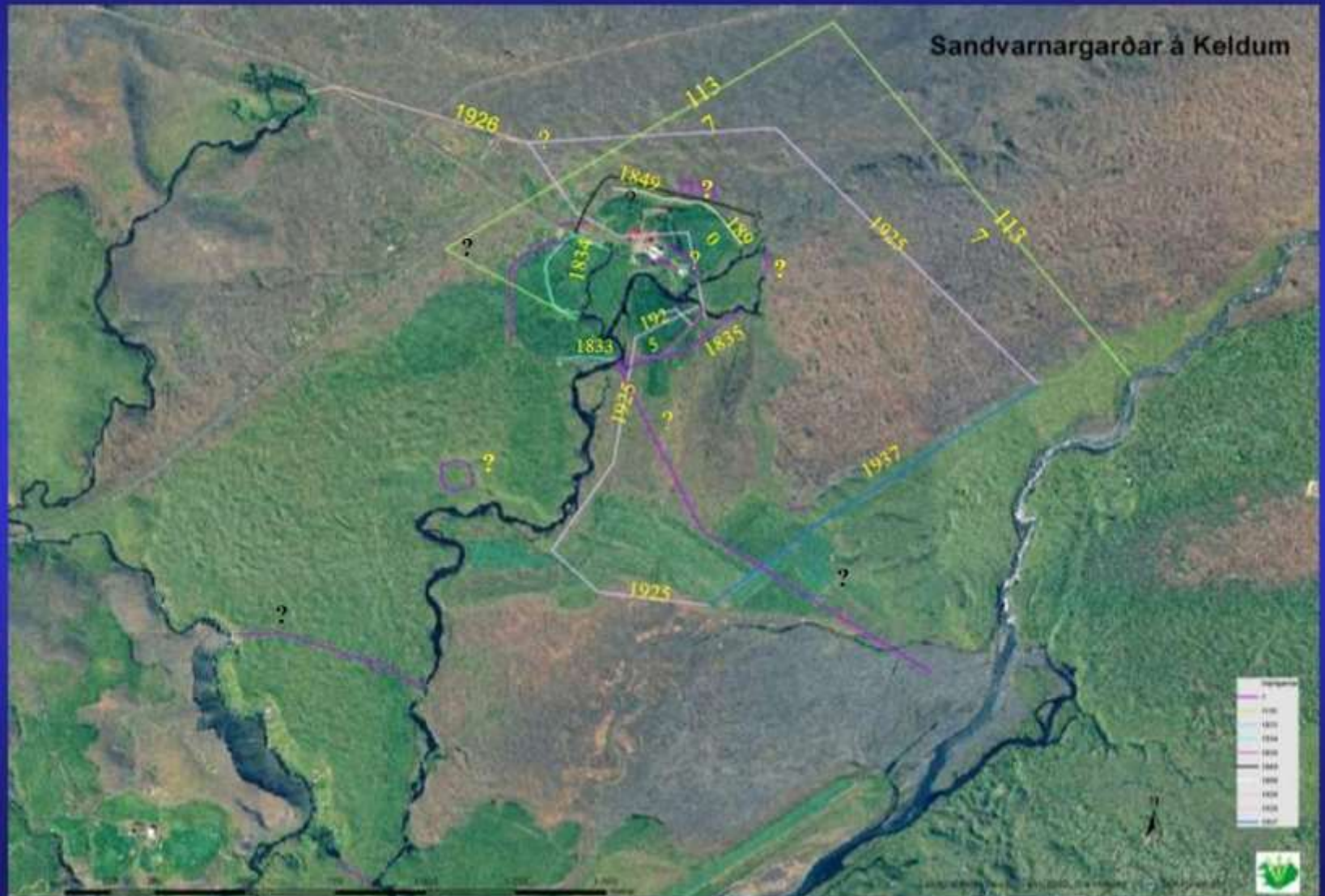


The scattered remains of a 6 km wall around Keldur that was built about 1137 AD to protect the barley fields from grazing. Over the centuries, farm and construction machinery has displaced the rocks (yellow) considerably away from the original transect. Much of the 15,000 ha farm was destroyed by sand in the 19th century. However, much of it is being restored to grassland and elsewhere to forest by Skúli Lýðsson and his family.





The sand farm of Keldur showing the dates when the walls were built; a few to combat sand drifting and some to exclude livestock to enable grassland restoration as well as to anchor conservation fences.







Lava stone walls with a typical offset 'dog-leg' gate built in 1890 by Skúli Guðmundsson to combat sand drifting at Keldur and also provide shelter for livestock.





A relatively new fence anchored into a stone wall built c1834 (*top left*), The south west meadow of Keldur is a fine example of productive grassland with a high carrying capacity for livestock. An ancient stone wall is visible across the centre just beyond the sheep (*top right*). Bottom photos show remnants of a wall of unknown age – probably early 19<sup>th</sup> century





The remains of a 1926 fence installed by Soil Conservation Service on top of a stone wall that was earlier built by the farmer in an effort to combat the sand demons at Keldur. The grasslands are still in the process of being restored but are presently good enough for a few livestock. Off the photo to the left, the family spends their spare time planting trees on large tracts of land at the rate of about 160,000 tree seedlings annually.





The two low walls at Galtalækur are part of a series of about 10 built in 1920-30's to stop severe sand drifting (desert creep). Progressing from NE-SW it took 2 year to complete a single wall. **Had these series of walls not been built** the erosion would have continued for many kilometers southward. Looking east to Bjölfell (*top*), north to Burfell (*bottom right*), and south to Hella (*bottom right*) it is gratifying indeed to see that the hard work in building these walls has paid off in terms of very productive grasslands for farming.



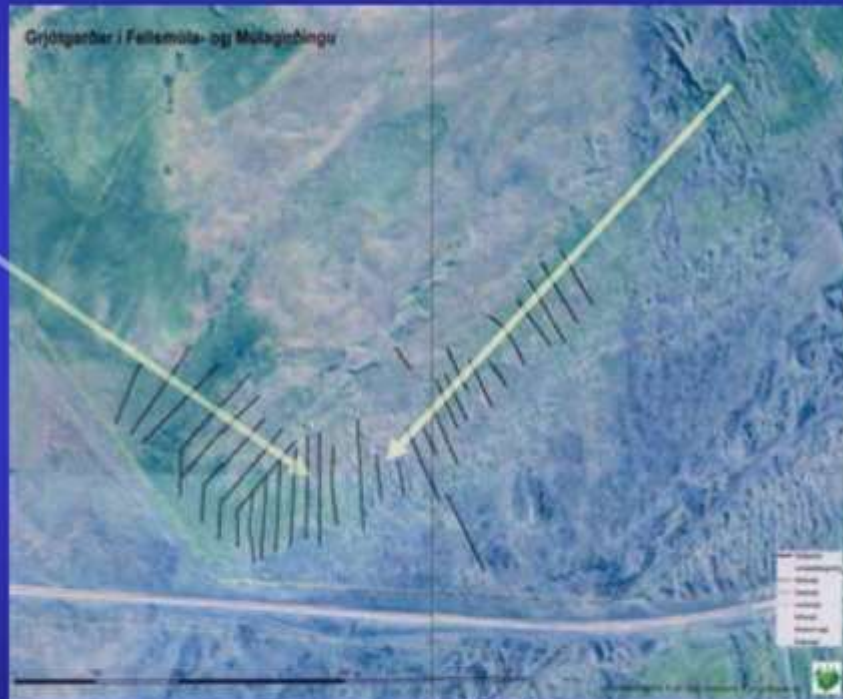


In 1907-8 a series of about 50 stone walls were built by the Soil Conservation Service across the sand flat between Vörðufell and route 31 (i.e., from Skeið to Steintegar) on the marshy areas of Eldvatn, Varða, Kálfá and Holmsá the east side of the dual farms Reykholl – Reykahlið. The result was a successful restoration of fertile grasslands.





The Soil Conservation Service built series of lava stone walls in many districts to arrest sand drifting deserts and reclaim them to grasslands. The arrows in the photos show prevailing directions of sand drifting.





These walls at Bolholt were built between 1926-28 by the Soil Conservation Service. The walls reduce saltation\* (desert creep) and provide just enough shelter for lyme grass to become establish and start the process for later vegetation succession.



Anne Bau

**\*Saltation:** when sand is transported by wind in a bouncing like motion, suspends them in the air for a short period of time and then fall to the surface. The impact of the falling grains dislodges additional sand that is sent down wind



More examples of the Soil Conservation's stone walls at Gunnarsholt built in the 1940's – most of them very successful in trapping sand. Several small woodlands in the distance have been established on grassland reclaimed from the desert



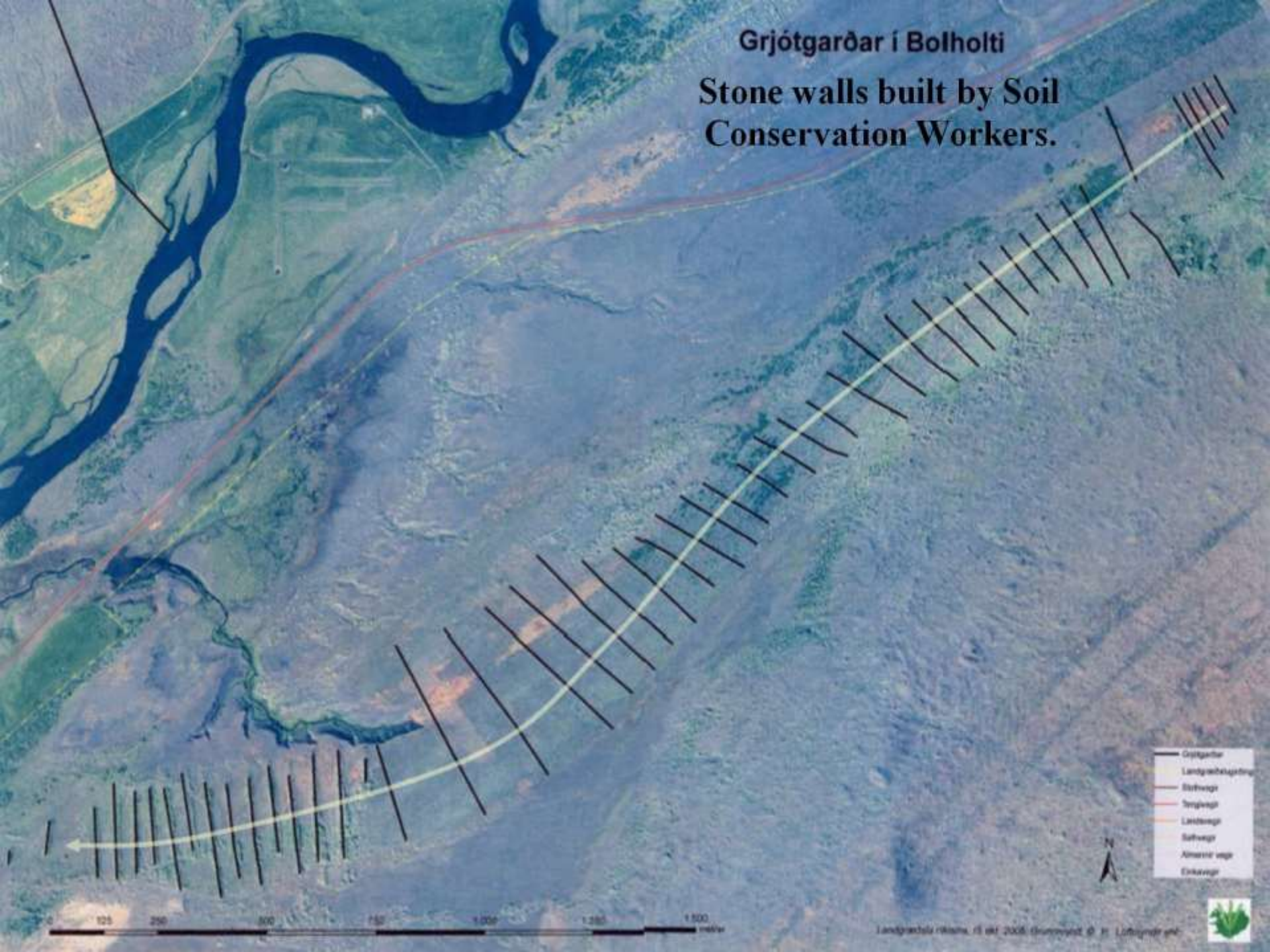


# Grjótgarðar í Gunnarsholti og nágrenni





**Grjótgarðar í Bolholti**  
**Stone walls built by Soil**  
**Conservation Workers.**



- Grjótgarðar
- Landgræðsluskipting
- Eitthvegi
- Tengivegi
- Landvegur
- Súlfvegi
- Almennir vegir
- Eitthvegi



0 125 250 500 750 1000 1250 1500 metrar





Underneath the ridge of sand is one of the Soil Conservation's stone walls at Gunnarsholt which demonstrates their utility in slowing sand drift enough to allow seeded and fertilized grass and spruce and poplar woodlands to plantation to flourish.





For a century, the Iceland Soil Conservation Service and its collaborators have successfully undertaken the Herculean task of combating the sand demons (sand storms). In the foreground are a series of both wood and stone walls built about 1945 near Boholt north of Gunnarsholt, to reduce sand transport by Görtler-like vortices and conserve moisture. The low wooden walls were built of two rows of 1 x 6 inch planks which substituted for stone walls. Between the walls, *Lymus arenarius*, Lyme grass seed was ploughed in by a horse plough and, with time, airborne material accumulated into the plant growth and organic material increased as did water retention. To-day, the walls are hidden by *Salix* and fescue grasses as well as a thriving mixed-species tree plantations.

A patch of  
2800 yr old  
white pumice  
from Hekla



A series of stone and wood walls at the long abandoned farm of Bolholt





The pieces of wood are traces of one of the many wooden walls at bolholt. Though only 12 inches tall they were high enough to slow down desert creep to allow grasses and herbs to grow and, as we can see, a healthy new forest with a good growth rate. The walls and vegetation restoration is the work of Soil Conservervation Service and the tree planting is the work of Rangæingá Skógræktarfélag. It is now officially a forest reserve.





A few of the series of stone walls at Gunnarsholt built to inhibit sand drifting (i.e, saltation) from the northeast.

Not so obvious is scouring of sand by less frequent winds from the east. The drifting process was inhibited enough to allow for colonization of moss, grass, heath and a few patches of birch and willow.







Alexander Robertson



Anne Bau

Heybaggar Leirdalur 4831 1/11/2002

Where there are no rocks for walls, hay bales make a good substitute since they retain moisture and thereby rapidly build up fertile humus for naturally regenerated plants. Leguminous plants are often seeded into the bales



The soil Conservation Service also experimented with hay bales as a substitute for stone walls, and planting trees & shrubs helps to establish lush grasslands





Drifting sand has obliterated a landscape that was once a fertile grassland on deep peat. On the left is a deep ditch to trap sand to slow down the drifting but in places has obviously been overloaded.



Fences tend to become overburdened and ineffective.



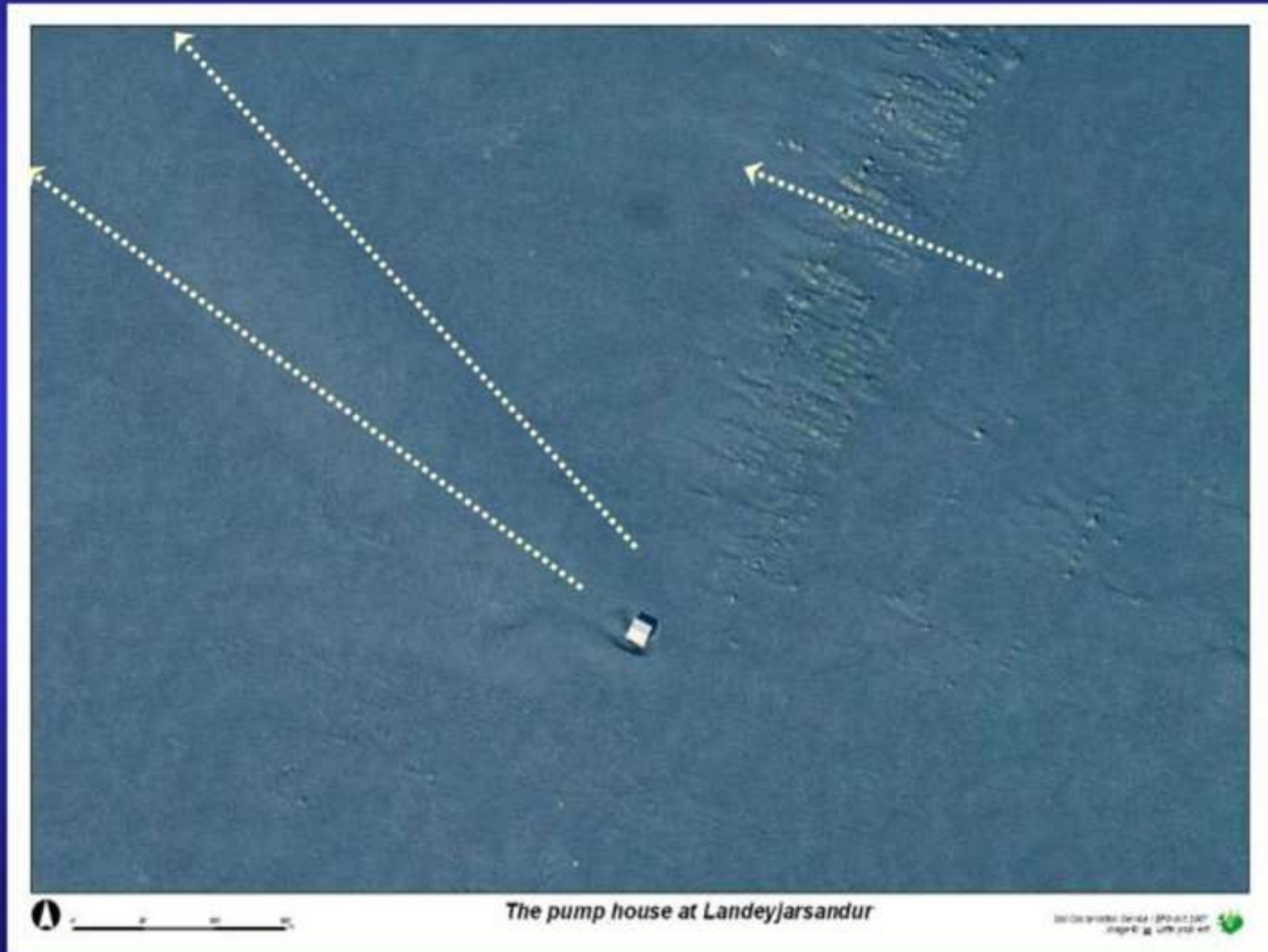
As with many wooden barriers more sand may be deposited on the 'sheltered' side.



This low wall allowed lyme grass to get established on the peaty soils.



This aerial photo of Landeyjasandur illustrates the combination of von Karman and Görtler (longitudinal spiral) vortices as efficient mechanisms for shifting large volumes of sand from around isolated structures such as the pump house and a series of fences and dunes. The pump house supplies water to the Westman Islands



Strong winds and shifting sands close to pumphouse on Landeyjasandur have easily over-burdened the fence. The hills in the background are the Westman Islands





Instead of walls of turf, stone and wood, spreading old hay is an effective way to stabilize the drifting sand on Landeyjasandur – especially if the hay were to contain a sizeable amount of viable grass seed



An example of the successful greening of Landeyjasandur





Dunes seeded with grass provide a sheltered niche for native biota to naturally regenerate the desert first with mosses followed by herbs, willow and birch seedlings



Selsund



Landeyjasandur

Within two or three years or so, the Soil Conservation Service has covered much of Landeyjasandur with very productive grasslands which more or less eliminated the serious problem of wind-blown dust. During the same period a new harbour for the a Westman Island Ferry was built. As we can see from the the harbour is occasionally filled in by sand from the beautifully braided river.





Alaska lupine conserves moisture and provides the primary ecosystem and protection from wind and erosion to promote the establishment and fast-growth of native birch. In the background is Mt. Hekla and in the middle eroded lands that once carried birch forest and later fertile pastures.



## Paradise Regained –Absolutely!

The lush grassland of the headquarters of the Soil Conservation Service have been reclaimed. There is even a 4 km strip of barley which was unthinkable 20 years ago.



Lamdgræslá ríkisins



Reclaiming the desert is community effort involving the Keldur and many other farmers who work closely with the Soil Conservation service at Gunnarsholt. The dark green section is an experimental poplar plantation for scientific research.



Gunnarsholt is famous for its transformation from desert to fertile grasslands. It is due in part to an extensive network of fast-growing and well-structured and ideally oriented manicured shelterbelts (right) and a young experimental poplar plantation.





On the right is one of Gunnarsholt's many well manicured willow-poplar shelter belts. On the left is the edge of 14 ha experimental poplar plantation that is the subject for several post-graduate degrees and to date about 45 research projects. Below are photos of the plantation thinnings that were left on the ground and have started sprouting healthy shoots – not what was planned but could be potentially useful in some circumstances.



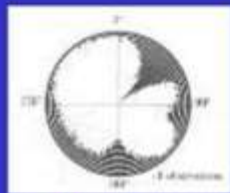


Lush grassland and manicured shelterbelts at Gunnarsholt dominate a landscape which only a few decades ago was virtually lifeless desert.





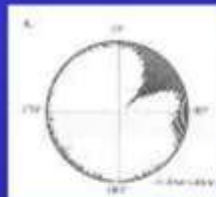
Part of the 80 km of compact shelterbelts (yellow lines) at Gunnarsholt. The slightly angular alignment of the shelterbelt system with respect the principle direction of severest winds is ideal because it deflects them rather than tackle them head on. Regular maintenance, such as hedge-trimming and replacement, is essential to prolongs the durability and effectiveness of the shelterbelts.



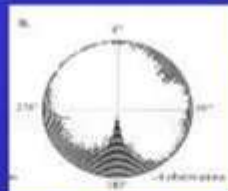
> 2 m s<sup>-1</sup>



> 10 m s<sup>-1</sup>



'dry' winds  
Rh < 75%



'wet' winds  
Rh > 85%



In many parts of Iceland the work of the farmers with support from the Soil Conservation Service and Iceland Forestry Association have transformed vast areas of desert to magnificent farms, forests and woodland parks.





Iceland's volcanic deserts and/or eroded lands are rapidly being reclaimed to grasslands, barley, vegetable crops and pleasant woodlands.







Some of the finest shelterbelts in Iceland are in plant nurseries, arboreta and public gardens.

The shelter hedges in Hallormstaðir (top) rely on willows which need regular maintenance. Whereas, the author's research tree nursery at Pasadena, Newfoundland (bottom) relied

mostly on retaining a mixture of naturally regenerated trees and shrubs between fields, plus in-planting with stock produced by the nursery.

Both nurseries are partly bounded by fields and woods which make them even more sheltered as well as attractive places to visit and work in.





Fast-growing poplar shelter belts are essential for profitable potato crops in Iceland. In 1983, the organic farmer started planting shelterbelts - mostly of poplar in double rows in which the gap between them serve as a foot paths for public recreation (and thereby attracting potential customers). In recent years he began planting mixed-species shelterbelts.



Is this a shelter wood or a fashion statement? It is probably both and very common in the borders of Scotland and was the sort of pattern advocated by the well known Scottish shelterbelt expert J.M. Caborn. Ironically, the places where sheep find shelter from a blizzard around this formation (*which is fenced to protect the trees*) is also the place where hazardous deep snow drifts develop. Around the village are examples of a community broadleaf/conifer shelterwood.





This Japanese larch border was planted to protect more valuable timber species within the enclosure from fire. Larch was chosen because it grows much faster throughout its juvenile stage and has the advantage of ensuring the grass under them greens up early (a natural fire retardant) well before the fire season. For additional protection weeds are removed from a 2 m strip around the perimeter by grubbing with a mattock.





In Spring and fall, a Norway spruce forest would be in danger of ground fire were it not protected by a fine, open stand of larch under which the grass is more or less too green to burn.



Alexander Robertson



Not too many decades in the future, perhaps the deserts of Rangárvellir below the active volcano Mt. Hekla will resemble the mixed forest landscape around the ancient extinct volcano of Ben Lomond in Scotland.





Clear cutting and replanting part of a forest in Duchray, Queen Elizabeth Forest Park east of the snow-capped Ben Lomond. Incredibly it took only 50 years to transform the worn-out hill pasture to such a fine forest. The inset is a sample of logs from the plantation that were stacked by the roadside when the both pictures were taken. Asymmetric tree rings on the stumps indicate this area has a moderate, persistent wind.





A monoculture of white spruce (*left*) is not as productive nor aesthetic as the **'Avalon mixed broadleaf/conifer shelter wood system'**. The spruce is 2 years younger than the shelter wood due to a forest fire that destroyed the first spruce plantation and the natural forest surrounding it. The fire did not burn the shelter wood because of its fire-retardant mainly deciduous species mixture, which allows an understory of herbs to green up early.



Neatly trimmed willow hedges and birch stands are common in Iceland. However, it is important to manage the hedges with regular maintenance to keep them vigorous as at Stykkishólmur (*top*) and only in sheltered locations prune the understory of trees.





Small trees and tall shrubs make a fine combination and provide an attractive and effective shelter in Akranes. The shrubs provide low shelter without spoiling views to and from the street





The oldest larch shelterbelt in Iceland at Stóra Sandfell, East Iceland provides welcome shelter in summer; not so much in winter.







Change in the growth of a two-tiered windbreak from 1985 to 2007 at Hvammur, Skorradalur, west Iceland with Alaska poplar and a native Iceland willow (*Salix phyllicifolia*)



The hedge has become shorter and effectively redundant

A variety of shelterbelts and small shelterwoods which need to be enlarged to meet the needs of this fast-growing agricultural university and village of Hvannery. For example the long walk from the new School (*with horse-shoe patterns*) to the old school (*beside the church*) is exposed to cold and often wet winds. Parking areas are prone to snow drifts.





The view from the ground floor of the student apartments is much admired. But winds from the mountains can be bone-chilling. Experience at Hvanneyri shows that roughening the 'fetch' with low shelter woods a little higher than the fence will provide shelter without spoiling the view.



An tall shelterwood would conceal the beautiful landmarks of Hvanneyri. On the other hand, the cemetery shares a world-wide custom, insofar that it is the dear departed who enjoy the blessings of a shelterwood.





## Shelterwoods (*top*) and traditional linear shelterbelts at Hvanneyri



In the leafless stage the willow shelterbelt (top left) is ineffective. The double canopy of a denser low hedge and small trees by the parking lot would be an improvement, but are only ornamental. A mixture of conifers and broadleaves in a series of three iconic horse-shoe patterns (*bottom left*) are excellent all-season shelterbelts (for unknown reasons, conifers died out in the 'horse-shoe' in the foreground).





Most shelterbelts at Hvanneyri follow ditches and gardens - except for a few small woods along the path from the old to the new school. The horse shoe shape (*bottom left*), designed by Landscape Architect, professor Auður Sveinsdóttir, is an appropriate signature for an institution well-known for its horse breeding. The prominent spruce/birch/willow shelterbelt (*bottom centre*) protects a high-yielding vegetable garden. However most of the recreation areas are exposed to strong winds from the east and north.





A heritage garden with a shelterbelt that does not screen magnificent vistas of mountains or the fertile coastal plain and estuary. The busts are of former Rectors who strongly advocated farm shelterbelt programs.





During infrequent gales from the south, redirection and convergence is accentuated by low escarpments, knolls and buildings which causes violent gusts strong enough to tilt and, in couple of cases, almost uproot rowan trees in the garden and along the buildings





Because many residents travel frequently in summer, while, during the other seasons, they tend to make more visits to the neighbourhood ‘winter park’. And yet, quite often, gardens and shelterwoods are designed with summer in mind. However, Borganes Park is well structured for all-season enjoyment





These photos of Borganes park illustrates how 'head-room' drops in the winter garden under the weight of snow and/or icing. So some adjustment in species selection and/or maintenance routines is adviseable.



Mosfellsbær's attractive community shelterwood is a popular style (top). Somewhere in a hollow across the lava to the Blue Lagoon (bottom left) is a fine little spinney planted by the volunteer members of Skógrækterfélag Suðernesja which provides a welcome stroll in the woods – a rare privilege for their parents 20-30 years ago.





## Einar Gunnarsson's grand poplar-lined alleys in Mosfellsbær



A neat combination of municipal street trees and mixed shelterwood of neighboring properties while in the opposite direction there is an ample well maintained green strip and a clear view of the mountains (*Oh! how Icelanders love their mountains*)



More of Einar Gunnarsson's and the resident's fine work (*top*). In this case Einar has combine berms with standard's (pruned trees). The trees are obviously intended for aesthetics since it is obvious from tree flagging that the winds are from right-left. Below is a sketch for better use of berms in shelterbelt.







The lush and diverse treescape in the beautiful town of Mosfellsbæ combines standard and feathered trees and shrubs that maintains a comfortable, year round micro-climate.

The formal grand ally of poplars lining the long driveway to the fine farm/mansion built for Gunnar Gunnarsson one of Iceland's most famous writers. It is now the Institute of Gunnar Gunnarsson, a cultural and educational centre at Skriðuklaustur.





Professional Engineer Ágúst Háldánsson's 20 year-old forest at HEIÐAHVAMMUR, Mosfellsbæ which he planted, is a dynamic, complex mosaic of vegetation structures with combinations of natural and planted ecological successions that evolved from eroded pastures and riverbanks.





A pleasant and very effective shelterbelt around curved streets for 'traffic calming' and aesthetics at Laugardal's famous park and sports complex





Reykjavik spared no expense in blending a variety of 'hard' landscape embellishments with 'soft' green space with a diversity of well maintained shelterwoods and a botanical garden.





The Laugardal Recreational Complex with its fine botanical garden, arenas and other sports complexes and an artificial lake set among diverse shelterwoods





In many parts of Iceland, trees can grow as fast as anywhere in the boreal region; such as this young larch stand planted by the Borgarfjörður Forestry Association. So there is lots of potential for shelterbelts on many of the vast barren lands across Iceland.





Hákon Bjarnarsson (*left*) and Sigurður Blöndal discuss the merits of a beautiful 47 year-old Siberian larch wood at Hallormsstað Forest; likewise Þórarinn Benediks, Lady Jean Balfour (who has a large estate in Scotland) Sigurður Sigursveinsson while his wife Kristíne admires the diversity of the diverse ground flora provided by the light and airy canopy of the larch.





Mixed shelter belts across the golf course in Seljlandsdalur near Ísafjörður. Whatever one's opinion about the obvious anthropogenic influence on this landscape, it is prime recreational and cottage area and requires appropriate plantation geometry to blend with the geodiversity





The attractive school plantation at Skógafoss serves to dampen the chill of a downslope wind and is typical of many school plantations in Iceland. The buildings in the foreground were moved and renovated as part of Skógar Folk Museum – the life-long creation of a very dedicated man.





Jón Sveinbjörnsson (bottom left) with Einar Gunnarsson of Skógræktarfélag Íslands. Jón (*on the left of the big spruce*) is a distinguished professor of theology and continues to expand his forest grove and maintain the legacy of his father Sveinbjörn Jónsson 1894-1979, Advocate to the Supreme Court, and an Administrator with Skógræktarfélag Reykjavíkur from its foundation until 1978. Jón's shelterwoods (*right*) tend to be an attractive mixture of native and exotic species in irregular patterns and with ample open spaces





The cold grip of winter accentuates the darksome geometry of Haukadalsskógur. However, in summer, or when there is no snow in winter (*a common feature of winters in Iceland*) the straight edges are not noticeable since the colors blend well with the heath and the forest is mostly out-of-view from the main tourist attractions around the Geysir.



Skorradalur in the less photogenic dimming light of a cold, cloudy afternoon. Nevertheless a mixture of tree species and variable patterns is not quite so darksome or boring as a blanket of spruce with straight edges or as a grey, treeless winter landscape would be.





# Government House Grounds



Government House was built in 1831 under the guidance of Sir Thomas Cochrane, Governor of Newfoundland, on a site known as the 'barrens' which was one of the windiest sites in one of the windiest places in the world. The 21 acre grounds have a touch of the genteel landscape of an English manor house and in summer is very sheltered - mainly by stately European beech trees



An opening in the 160 years old European beech shelter wood planted at Government House provides shelter in summer but virtually none in winter.





The 'paddock' among the beech, bass & maple shelterwood provides a nice perspective of St. Thomas Church





Magnificent European beech shelter woods at Government house provide a nice colonial setting and comfortable weather in summer, but are a drafty and occasionally dangerous in winter.

