

Manipulating Wind in Recreational Forests



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INTRODUCTION

There can be no doubt that communities investing in recreational forests reap the economic benefits of being comfortable, attractive and profitable places to live, work and visit. Most Canadian communities recognize the importance of recreational forests but may have difficulty establishing one because of the climate, and particularly because of wind. In Newfoundland, though, the role of wind in landscape ecology contributes to the beauty and biodiversity its urban forests. In this article,

When designing or modifying recreational forests, we should take an holistic approach and think not so much of blocking the wind, but of capturing its assets.

This article highlights some of the wind effects on in native forests in Newfoundland and some of the successful approaches in designing urban forests that compensate for the vagaries of windiness.



Board walk through the willows along Rennie's River,

RECREATIONAL FORESTS IN NEWFOUNDLAND

Newfoundland's urban forests have more than 1,000 species, varieties and cultivars of native and exotic trees and shrubs – the vast majority produced at nurseries in central Canada and USA and introduced by retail outlets. Having a relatively mild winter climate and pleasant summers, cities within the boreal biome - that vast coniferous forest belt that extends over much of Canada, Alaska, Russia and northern Europe - have as rich a biodiversity as the City of St. John's.

The city's oldest cultivated trees are European beech, planted in the 1850s. At the turn of the century, maples (Norway and sycamore) became the most frequently planted genus, although English elm and linden were fairly popular. The finest stand of cultivated trees in St. John's is undoubtedly at Government House.



Government House has some of the oldest cultivated trees in Newfoundland such as the graceful European beech planted not long after the house was built in 1831. A young girl experiences the joy of climbing a large c150 yr old European beech at her home near Long Pond, St. John's.



The Reid Family, who built the Newfoundland Railway and operated coastal shipping service, had many trees planted on their estates on the north side of the Waterford Valley, which extends south westward from St. John's harbour. Although the Reid's have long since left the valley, other property owners, especially those who acquired the property in the Waterford Valley between 1930-1940, followed the Reid's example of planting ornamental trees so that today the Waterford Valley has a fine urban forest which has literally altered the microclimate climate and extended the growing season in the valley by at least two months; and rubbed the raw edge off winter's windy, cold grip.

During the late 1960s, home owners in new subdivisions could buy a street tree (almost always a maple) from the city Parks Department for \$5.00 which included planting by city crews. Now there's a bargain!. Needless to say, that program was very popular. The survival and growth of the trees was excellent and today, the city is reaping enormous benefits from its 25 year-old urban forest.

We can cultivate a wide variety of trees and shrubs in Newfoundland because we have a relatively mild winter. In fact we rank third as the mildest winter of Canada – Summers are

extremely pleasant since we do not experience intense heat and droughts during the growing season.

But there is no denying the windiness and snow that characterizes eastern Newfoundland in particular. The ranking of St. John's as the snowiest and windiest city in Canada is a little misleading – because the climatic data is derived from a weather station on an extremely exposed location at the airport quite close to sea and not always representative of the weather and climate of the city and neighbouring communities as whole.

MANIPULATING THE WIND

Experiencing as much wind as we do, it is surprising that so little planning and urban development consider its impact not only on people, but also on natural and recreational forests. When a parks or outdoor recreational facility is planned and constructed, little consideration is given to the need for recreational forests. They are only considered as an After thought when park users complain that windy conditions interfere with their activities. Consequently, many treeless parks are under-utilized as people patronize parks beyond their neighbourhood that have recreational forests. This is unfortunate, because of all the climatic variables wind is the most easily controlled. Even in moderately exposed locations it is not particularly difficult to establish a recreational forest.

Controlling the wind, therefore, holds the key to increased use of parks. A judicious selection of trees and shrubs will increase the average temperature in a park by a few degrees and dispense with low wind-chill factors. We can also use trees and shrubs to trap snow and provide better quality and longer-lasting ski trails and toboggan runs, and provide a protective snow blanket for shrubbery. Conversely, we can design recreational forests to channel wind flow to prevent drifting in certain areas. Or, we can shift the wind through an area to provide a cooler, gentler breeze in summer and reduce frost pockets in spring and fall.



Simple dry ice models demonstrates how wind and/or snow behaves and can be manipulated around buildings and with trees and shrubs. A flair for planting biodiversity with dynamic and colourfull changes throughtout the year is great asset.

Wind has little effect on the survival of cultivated trees and shrubs in Newfoundland, providing they are properly planted. However, wind does set the upper limit of tree growth and reduces the longevity of mature trees. The maximum height of urban trees 40-50 years old is 20-22 meters, if grown in sheltered valleys. Also, the growth rate of young saplings can be phenomenal by North American standards. For example, coppiced willows, especially strains of *Salix viminalis*, the famous basket willow cultivated in Britain since Roman times and introduced by earlier settlers from southwest England, regularly grow three metres in a single year, and over five metres in two years in our nursery at Pasadena in western Newfoundland. Such growth rates are comparable to those of similar plantations in the temperate British Isles.

In moderately windy locations, young Japanese and European larch, Norway and Sycamore maples can grow at rates of 0.5-1.0 metre in height per year. Such rapid growth makes it possible to provide shelter within three to five years in an average suburban garden or play areas. By 10 years, the trees will be sufficiently tall and dense to shelter a double tennis court, a small park or most of a baseball park.

In very windy locations, feathered trees are essential. Lilac, though a small tree, white spruce, linden and sycamore can tolerate persistent strong winds and grow to heights reasonable enough to provide good shelter. But, aerodynamically and aesthetically, a better alternative is to mix these trees with an under-planting of deciduous and evergreen shrubs of various sizes, classes and texture.



A panarama of the north side of the author's garden begun in 1971 illustrates an effective and extremely biodiverse shelterbelt. This design extended the growing season by at least 2 months compared to neighboring gardens to allow for productive pear trees and provide a trap for an insulating snow cover to protect a wide range of near-temperate shrubs and perennials that would not normally grow in this climate. Also, sheltered trees, such as the hybrid larch are less deformed and produce viable seed and considerable natural regeneration (which are lifted and given to friends and neighbours). The terraces were carved out of shale and still have a very thin soils. Nevertheless, during the first 10-15 years, the garden had approximately 500 species, varieties and cultivars of woody plants from dwarf willows. Natural competition and judicious thinning has reduce the number to about 125 species, varieties and cultivars.

HOW WIND AFFECTS NATURAL FORESTS

The tallest trees in a forest take the brunt of wind stress. Smaller, usually younger and more supple trees and shrubs are not unduly affected by wind. In spring, summer and fall, shaking by wind disturbs tree roots. If this disturbance is severe, it will inhibit root and shoot growth. In winter, when winds often are laden with ice crystals, they strip off the young shoots and branches that would have sustained healthy growth the following summer



Larch (tamarack) and birch are shaped by summer winds whereas, spruce and fir are develop a compact growth due to winter dessication, and damage from freezing rain and snow loading.

Trees planted along the shores of ponds are especially prone to blasting by wind-driven ice crystals. Trees and shrubs adapt to wind stress by shifting their growth downwards into their boles, lower branches and roots - at the expense of height growth. In so doing, they produce a dense canopy of foliage on thickened, short twigs that becomes streamlined (flagged) in an upwind direction. This enables the trees to survive strong persistent winds and resist uprooting by the fiercest storms. Consequently, extensive wind-throw and stem breakage is not a common problem in Newfoundland forests unless the trees have been weakened by human or other disturbances.

Quite often, when a natural coniferous forest has been disturbed, by road construction for example, the newly exposed trees at the edge of the construction suffer desiccation and tend to die standing rather than be blown down. This is especially true of remnants of a mature or semi-mature natural coniferous forest, consisting mainly of balsam fir, which may have been retained to serve as a recreational forest within, say, a linear park system, or as a backdrop along the street edges. These dead tree strips can progress into the forest at rates of three to ten metres per year until eventually, the entire forest has collapsed. But the good news is that, as the forest dies back, it is replaced by a healthy, copious regeneration of balsam fir saplings mixed with birch and understorey shrubs. We cannot stop the deterioration of a fir forest exposed by disturbance, but we can offset it by opening up the forest's interior and introducing small (patch) cuttings. In doing so, we introduce greater biodiversity, and begin the landscape planting process of native and exotic trees and shrubs within the natural forest, as well as around the edges, well before the entire coniferous forest deteriorates.



On windy sites, a predominance of evergreen trees and shrubs is recommended; whereas, on moderately windy sites, an even mixture of evergreens and deciduous trees and shrubs is sufficient - such Caledonian pine, rowan and weeping birch (right).

STANDARD OR FEATHERED TREES?

STANDARD TREES

In establishing an urban forest a common practice is to plant standards in rows consisting of a single species (usually maples). Standards are balled and burlapped broadleaved saplings 3-5 meters tall with their lower branches pruned off. This type of planting is not satisfactory for windy sites. The top-heavy crown absorbs most of the wind force and acts like a lever, putting enormous strain on the root mass. No amount of guying the standards will compensate for the wind stress on the crown and stem above the guys. Consequently, the trees may take a decade or more, if ever, to begin to grow in a reasonable fashion as their root mass struggles to maintain a grip.



Standard like this row of sycamore (top) have a hard, unproductive life at the top of a ridge where strong winds sweep up from the sports field and running track (left) which reduces growth and a weak root mass and of no shelter or aesthetics value in winter. Whereas, adding a broad, well-maintained hedge provides much better root growth and stability and hence more vigorous tree growth and of course comfort for pedestrians.

Aesthetically, the contortions of wind-pruned standards may appeal to some as an art form - a symbolic icon of defiance against the elements. If the trees do succeed and become "tallish", they will not provide much shelter, since the wind will simply sweep underneath their leafy crowns, causing much discomfort to parks users. **tion.** Its protection enables evergreen trees and to some extent, the young bark of deciduous trees, to draw on moisture reserves below the frost line, enabling them to transpire freely and avoid desiccation (winterburn on evergreens and dieback on hardwoods). If leaf-fall and snow cover have done their job, the hazards of freeze-thaw cycles will be reduced, thus allowing for a great deal of root growth activity to proceed during the spring thaw season, long before humans can sense any growth activity in the tree crowns. How well protected from frost (and grass) and how early and vigorously the fine-root mass develops, very much determine rapid, healthy summer growth, fertility (fruit production), and subsequently, seeds that can be used in both natural and artificial regeneration.



Walking under these standards (having no lower branches), such as the beech grove can be cold and draughty on a cool day, but has a cool pleasant breeze on a hot days. In winter when there are no leaves, there is no shelter . To correct the deficiency, an understory of rhodendrons has been planted which in a few years will provide shelter.whatsoever.By contrast, the young natural forest of fir, spruce, larch, birch and shrubs provides excellent year-round shelter.



FEATHERED TREES

By contrast, feathered trees - i.e., those which have branches all the way to the ground - are much more practical and suited to windy environments. In nature, almost all trees are feathered during the early part of their life cycle.

Feathered trees have certain advantages over standards. First, the branches shade the base of the tree and thus exclude competing vegetation. During excessive summer heat, the lower branches shade and stabilize soil temperatures and conserve soil moisture, all conducive to tree growth.

In the fall, leaf-litter builds up a humus layer that further protects and improves the soil structure and encourages the symbiotic relationships between fine roots and soil microflora and fauna, also conducive to healthy tree growth. In winter, in addition to the leaf litter, the lower branches trap snow that protects fine roots from deep soil frost penetration.

SNOW AND ICE

Snow is beneficial in many ways. As mentioned above, it acts as an insulation blanket that protects plants and eliminates or at least reduces the depth of soil frost that would otherwise damage foliage and fine roots. As a general rule, evergreen trees and shrubs tolerate exceptionally heavy loads snow and ice much better deciduous species. Though birch is flexible and will bend under the weight of heavy ice, it will develop knots and various contortions later in life. Maples, particularly Norway maple, will not bend but snap free of the trunk. Conifers are also damaged (as any tree and shrub would be) but they don't particularly show damage since it is the branches which droop towards the ground and therefore evenly distributes the weight and eventually sheds it when the weather warms up.

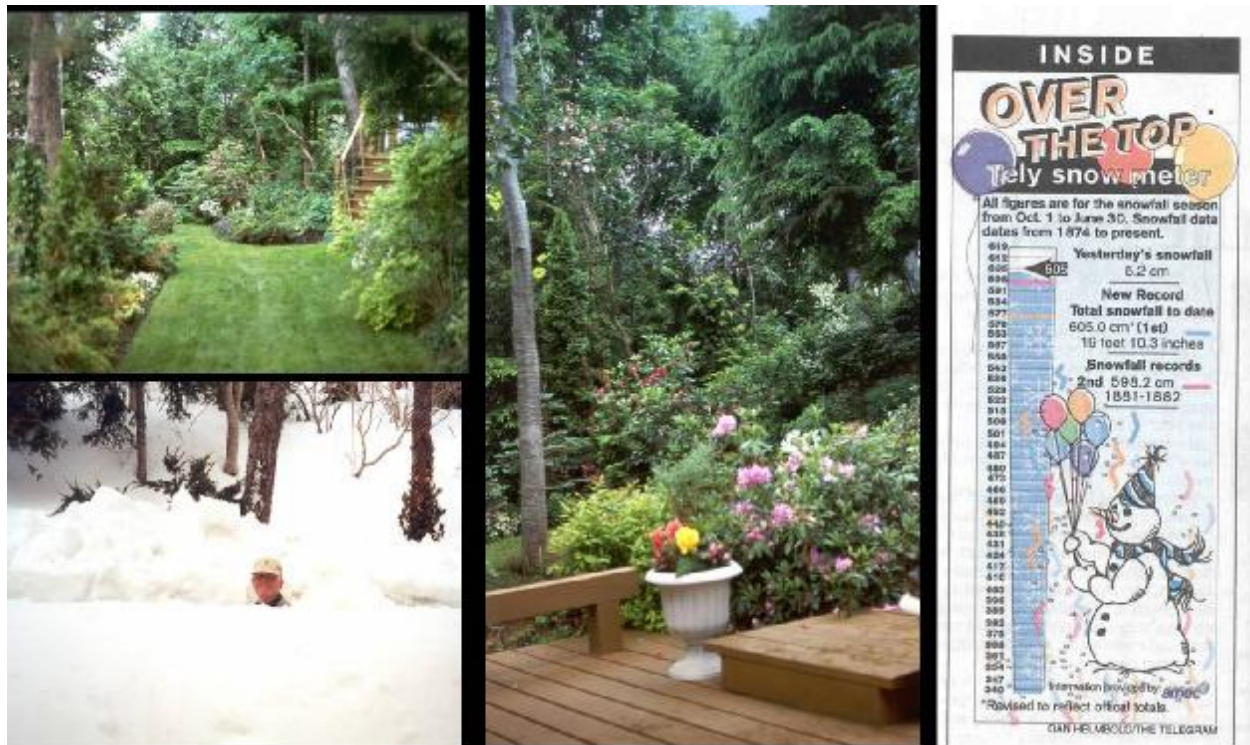


Knowing the characteristics of wind direction goes a long way to effective planning of garden design and plant selection.



Birch that bends under the weight of heavy ice usually recovers after the ice melts. Maple branches are rigid and therefore, being brittle, readily snap off from the trunk when overloaded with ice, such as the branches lying on the snow at bottom of the photo on the right. Evergreen trees and shrubs tend to droop while the trunk remains vertical and therefore are much better adapted to heavy ice and snow loads.

The winter of 2001-02 produced a record snowfall of 6.5 m (more snow fell after the graph below was drawn). For all that, as can be appreciated by the photos of the garden taken the following summer, the exceptionally deep snow had no effect on the garden ; firstly because because the soil didn't freeze and, secondly, the plant selection is moreless immune from breakage.



Rhododendrons and azaleas, spreading junipers and cedars and dwarf spruces are none the worse for wear after spending 4-6 months under several tonnes of snow and ice such as the 'streetbergs' that snow ploughs build up in cul-de-sacs at the top of cul-de-sacs.



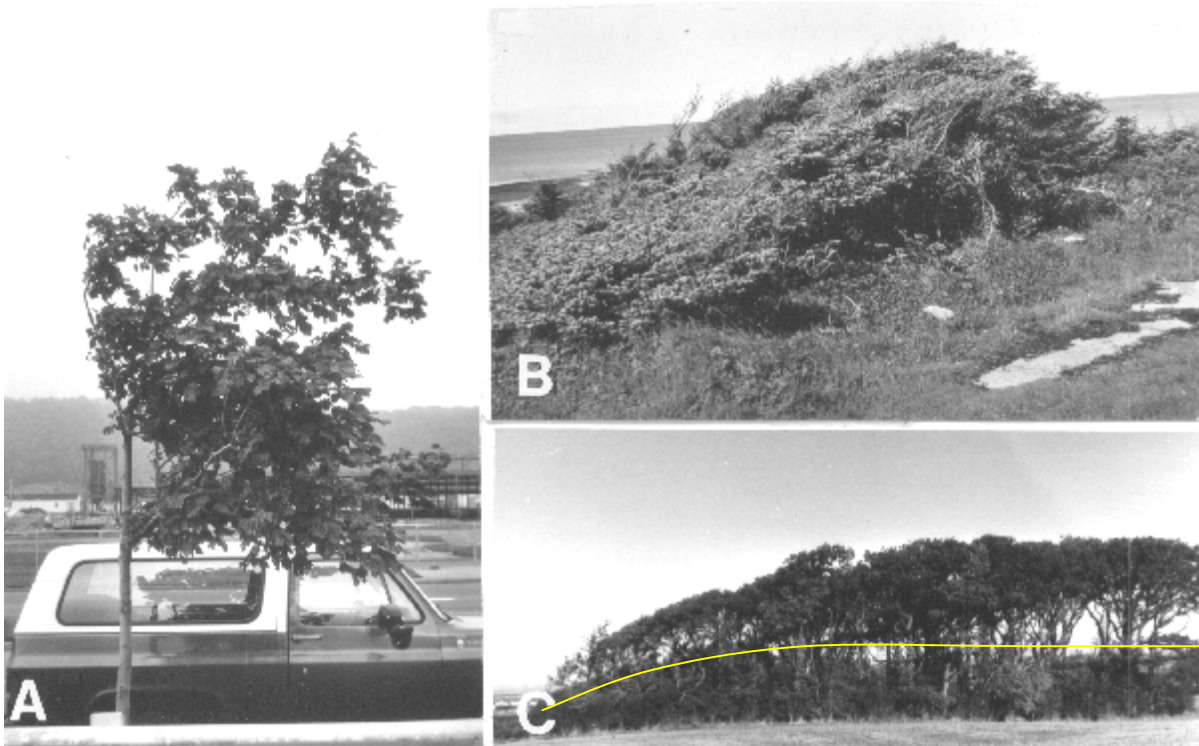
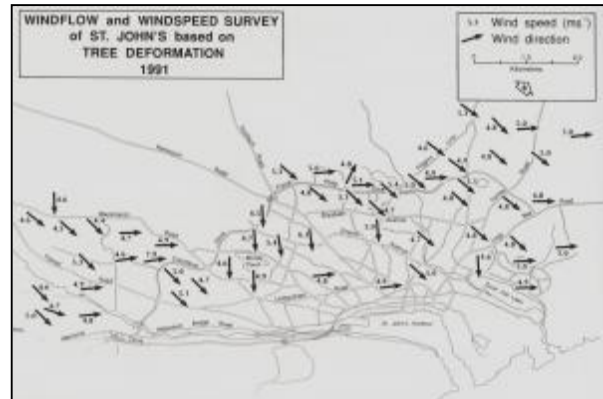
The typical stated of affairs of a new suburban house in St. John's built in 1971 where terraces were chiselled out of bedrock and topped completely barren, plus being in the windiest and snowiest city in Canada would appear to be a daunting challenge for any seasoned gardener. However, as can be seen top-centre, within a few years the site was occupied by a lush garden with hundreds of trees and shrubs which eliminated windiness and took advantage of heavy snow. Top right shows the rhododendrons are still lying flat on the ground having spent Oct-April under a streethere after. The bottom row of photos show the rhododendrons, azaleas and other shrubs and

USING TREES TO MAP WIND FLOW

From a development standpoint, wind exposure in the early stages of a recreational forest is generally the only major climatic problem facing parks managers. So, a first step in planning is to get a sense of regional wind flow patterns that have the greatest affect on trees. This can best be done by preparing a map of the relative effects of wind on existing trees in the neighbourhood. So far as I know, the use of trees as biological indicators of wind flow within a city has only been used in St. John's, although there are many other municipalities across Canada where this would be a very useful technique.

The direction of flagging in tree crowns not only gives us an indication of the principle wind direction that adversely affect tree growth but also wind directions that cause the most discomfort to humans. Therefore, the principal value of tree deformation surveys is to provide a convenient clue as to the best orientation for the main axis of linear parks systems, and leisure and sports facilities and recreational forests within them.

The degree of tree flagging gives an indication of the wind speed that causes tree deformation. Hence, we have a clue about what the composition of the windward side of an urban forest needs to be, and of the limitations on the size of the openings within the forest.



A. a severely flagged sycamore maple in St. John's; B severely windswept balsam fir tuckamore on a western Newfoundland coast; C In this spinney near Bangor, Wales, the wind created a double curve of the Scots pine overstory and the mainly rhododendron understory..

DESIGNING FOR WIND

Almost every article that I have read on the "proper" way to establish windbreaks advises us to plant avenues of trees, sometimes between equal rows of shrubs, oriented perpendicular to the prevailing wind direction. This stereotypical textbook approach is generally physically useless (especially in rough terrain), structurally and ecologically weak, and quite monotonous.

Physically, developing a recreational forest is not so much a question of sheltering recreational facilities from the prevailing winds, but protecting them from the much more offending non-prevailing winds - such as the strong westerlies and cold north-easterlies.

Landscapes with well-developed recreational forests provide shelter in small openings on any side of a hill or plain, regardless of wind direction. To minimize adverse wind effects, outdoor sports parks need to be planned, giving consideration to the wind flow patterns as they relate to the area's topography and recreational forests.

Structurally, a mixture of colourful evergreen and deciduous trees and shrubs with a variety of textures, sizes and shapes make ideal windbreaks since they absorb wind without generating violent gusts on the leeward side. Ecologically, a biodiverse recreational forest is likely to have vegetation succession patterns that are better adapted to the harsh environment, and more resilient to natural and human disturbance. They are also more likely to serve their primary purposes sooner, and in perpetuity.

It is no more costly to develop an aesthetically pleasing recreational forest that has complex shapes, structures and colours, as it is to do one with strict geometric patterns and bland uniformity. In fact, because complex recreational forests are aesthetically superior, they encourage greater use by humans and wildlife alike, have lower maintenance costs over the long term, and can directly and indirectly attract considerable revenues relative to an unappealing recreational forest design.



Modern landscape architecture in Iceland has many examples of how to design for windiness tastefully by blending architecture, culture and biodiversity to provide very effective and hence popular parks. In fact, regardless of the size of the community or park, Iceland has some of the most attractive recreational forests in Europe.

DYNAMICS OF A RECREATIONAL FOREST

The structure of every recreational forest changes on temporal and spatial scales. Hence, they can be maintained in perpetuity as dynamic ecosystems. For quick establishment, the formative years (1 - 10 years) should consist of flowering trees (lilac, mountain ash, crab apple, hawthorn, bartlett pear) and shrubs (potentilla, honeysuckle, spirea, mock orange) that are planted among a wide range of colourful evergreen shrubs. Fast-growing, light demanding trees (larch, birch, sycamore, willow) will provide early shelter.

Between 10-15 years, more durable trees (oak, whitebeam, pine, linden, beech, spruce, eastern hemlock and fir, Douglas fir), will develop faster under the canopy of shade intolerant species (larch, birch, and willows). At this point, the parks manager can take advantage of the new shelter by extending the recreational forest on its most sheltered side over a period of years. On the windward plant standards to create a classical woodland vista of maple, oak, beech, and ash, with islands of feathered trees like spruce, pine, fir, mountain ash, and birch, and border them with colourful and flowering shrubs as the final steps in developing a large recreational forest. Choose evergreen and deciduous trees and shrubs to give a mixture that will display an attractive variety of form, texture, height, density. A well thought out planting scheme should change its character every two-three weeks as it progresses from bud burst through to flowering fruiting, summer and fall leaves and senescence. In the fall and throughout the winter the planting scheme should look just as interesting in winter (if it has threes and shrubs with colourful bark and with or without snow and ice. Naturally, such a well-stock plantation will attract mainly birds and perhaps other wildlife.

