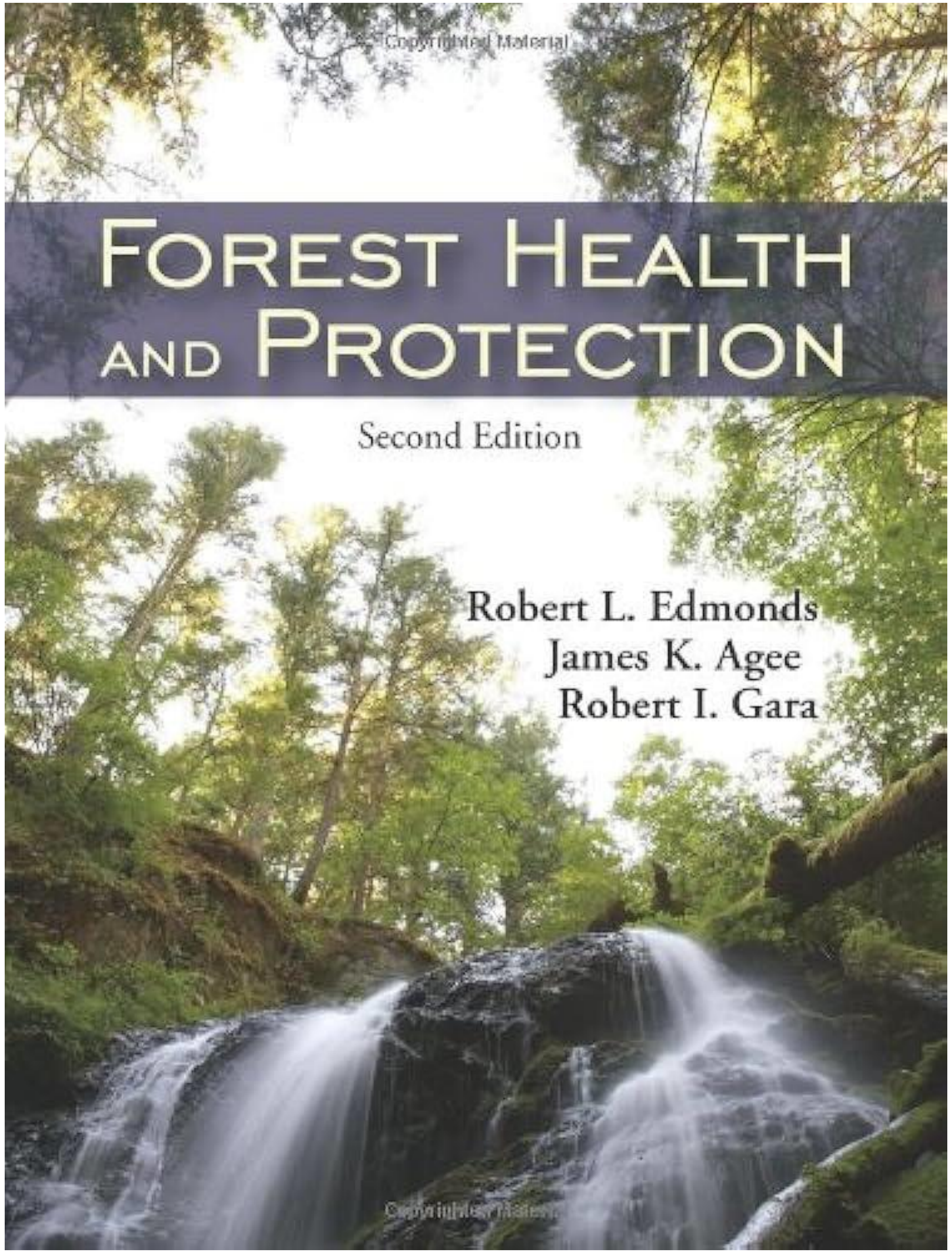

Course in Forest Protection
Master of Science Level
2023-2024

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Wind and Forest Health

- ✓ Wind is a weather phenomenon that is largely out of the control of the forest manager.
- ✓ Although wind is an uncontrollable physical process, its effects in terms of damage by snapping trees or blowing them over depend on the species composition, density, and size of the trees, characteristics that can be managed.
- ✓ In addition to its direct effects, wind has synergistic interactions with itself and other forest disturbances, For example: wind throw may begin a pattern of subsequent wind susceptibility for residual trees in the stand.
- ✓ If wind injures trees, other disturbances such as bark beetle epidemics may begin.
- ✓ Wind is also a major vector of spread for many insects and biological disease agents.

Wind as a Physical Process

- ✓ Wind can be described as simply gentle, brisk, or strong, but a more accurate weather scale is the Beaufort scale. Categories of breezes, gales, storms, and hurricanes are recognized, with attendant ranges of wind speeds.
- ✓ Winds represent natures attempt to equalize pressure differentials around the earth due to unequal heating between the equator and the poles, and between land and water surfaces.
- ✓ Because these processes repeat on an annual basis, there is some predictability to the general wind patterns in any region, although topography will create substantial sub regional variation.

Table the Scale of Wind Velocity

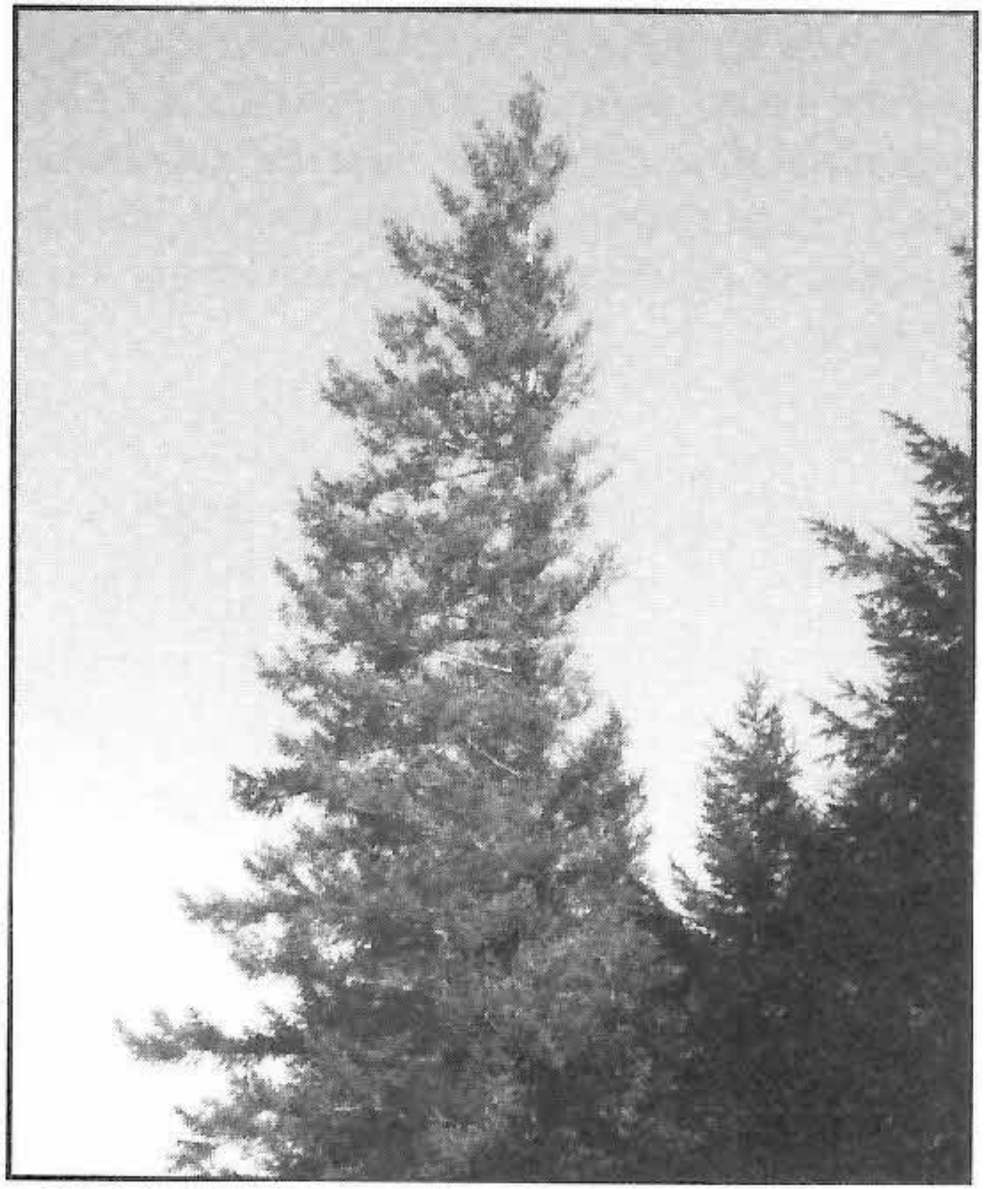
Number and Beaufort description	Wind speed	
	kph (km/hr)	mph (mi/hr)
1 Calm	0	0
2 Light air	1-5	1-3
3 Light breeze	5-12	4-7
4 Gentle breeze	12-19	8-12
5 Moderate breeze	19-29	13-18
6 Fresh breeze	30-39	19-24
7 Strong breeze	40-50	25-31
8 Moderate gale	51-61	32-38
9 Fresh gale	62-74	39-46
10 Strong gale	75-87	47-54
11 Whole gale	88-101	55-63
12 Storm	102-116	64-72
13 Hurricane	>117	>72

Wind Effects on Trees

- ✓ The ecological effect of "wind" often will incorporate extra loading of mass on the tree crown from ice and snow.
- ✓ Normal storm winds can then have a more catastrophic impact on the stand.
- ✓ The discussion of wind snap and windthrow implicitly incorporates the additional impacts that various forms of precipitation may have on susceptibility of tree crowns and boles to breakage.

Crown Morphology

- ✓ **Flagging** is the most obvious morphological effect of wind on tree crowns .
- ✓ On the windward side of the tree, foliage is repeatedly killed by winds that desiccate the needles.
- ✓ In summer this may be due to excessive transpiration and associated foliar moisture deficits.
- ✓ In winter, where soils become very cold, root uptake and movement of water will be restricted, and similar foliar moisture deficits may occur.
- ✓ Foliage can be abraded by soil or ice particles, and near the coast salt spray carried by wind can have a toxic effect on windward foliage of some tree species, while preventing other species from establishing at all.
- ✓ In species with limber branches, winds can "train" the branches by permanently bending them away from the wind over a period of years.
- ✓ Prevailing winds can be reconstructed from the patterns of flagged trees using the direction of branch growth .
- ✓ Flagging is most pronounced on isolated trees or those on the windward edge of stands; more protected trees seldom exhibit flagging .



Figure

A wind-flagged tree, with the damaging winds coming from the right and causing mortality of needles on a regular basis on the windward side of the tree.

Stem and Root Shape

- ✓ Conifers and angiosperms react differently to wind coming from a fairly constant direction.
- ✓ Conifers will develop compression wood on the lee side of the stem, enlarged annual rings that will help the tree remain upright against the tendency to compress the wood in that direction.
- ✓ Angiosperms react quite differently, developing tension wood on the windward side of the stem, resisting the tension.
- ✓ Compression and tension wood, both also known as reaction wood, are not solely related to the presence of constant winds, but where such winds occur this response is common and results in elliptical stem shapes with the long axis in the direction of the wind.
- ✓ Roots on trees exposed to wind will develop asymmetrical shapes, with growth allocated to the top and bottom at the expense of growth to the side, due to the same effect on localized growth caused by ethylene.
- ✓ Root grafting also can improve wind firmness. The effective root mass of the tree is extended by the physical bonding with roots of other trees, although these grafts can act as vectors for biological agents that cause root diseases.

Wind snap (Stem Breakage) and Windthrow (Uprooting)

- ✓ Stem breakage and uprooting are more severe effects of wind than those mentioned above and are most significant in terms of a forest health perspective.
- ✓ The wind speed, timing of gusts, and duration of wind are clearly initiating factors in wind snap and wind throw.
- ✓ In addition to the strength of the wind, there are several factors associated with the probability that a tree may break or be uprooted.
- ✓ Species characteristics, stand age and structure, and degree of decay all play important roles in evaluating the probability of severe wind damage.
- ✓ Crown area provides resistance to wind flow and acts as a "sail," increasing the ability of wind to push over the tree. Species with flexible or low-density crowns, or deciduous species out of leaf, will have less of a sail effect and may suffer only minor top damage, while other species are blown over.
- ✓ Trees with large crowns also may have well-developed buttresses or root systems, so they may be stronger than trees with thinner crowns that may not be as well supported.

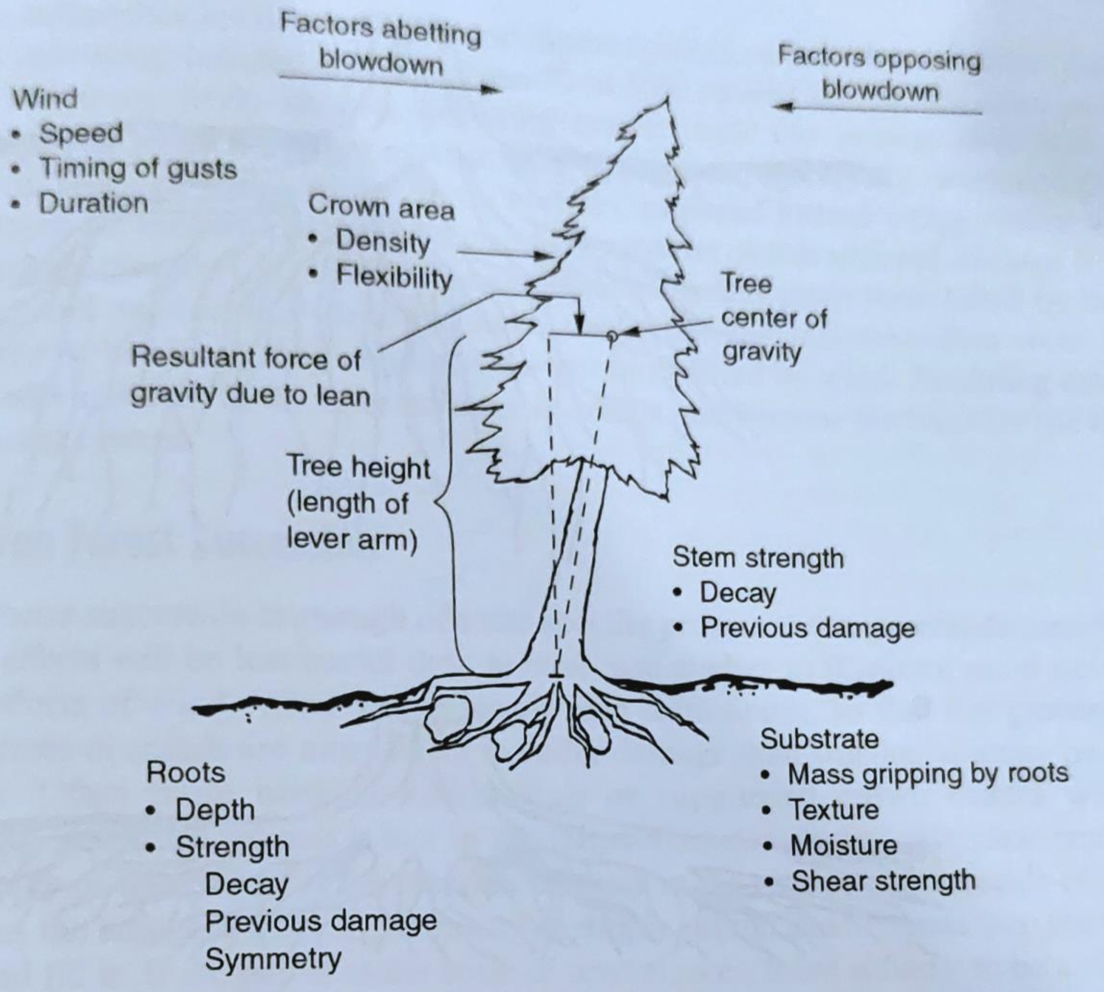


Figure 7.4
Factors affecting tree stability. (Source: From Harris 1989)

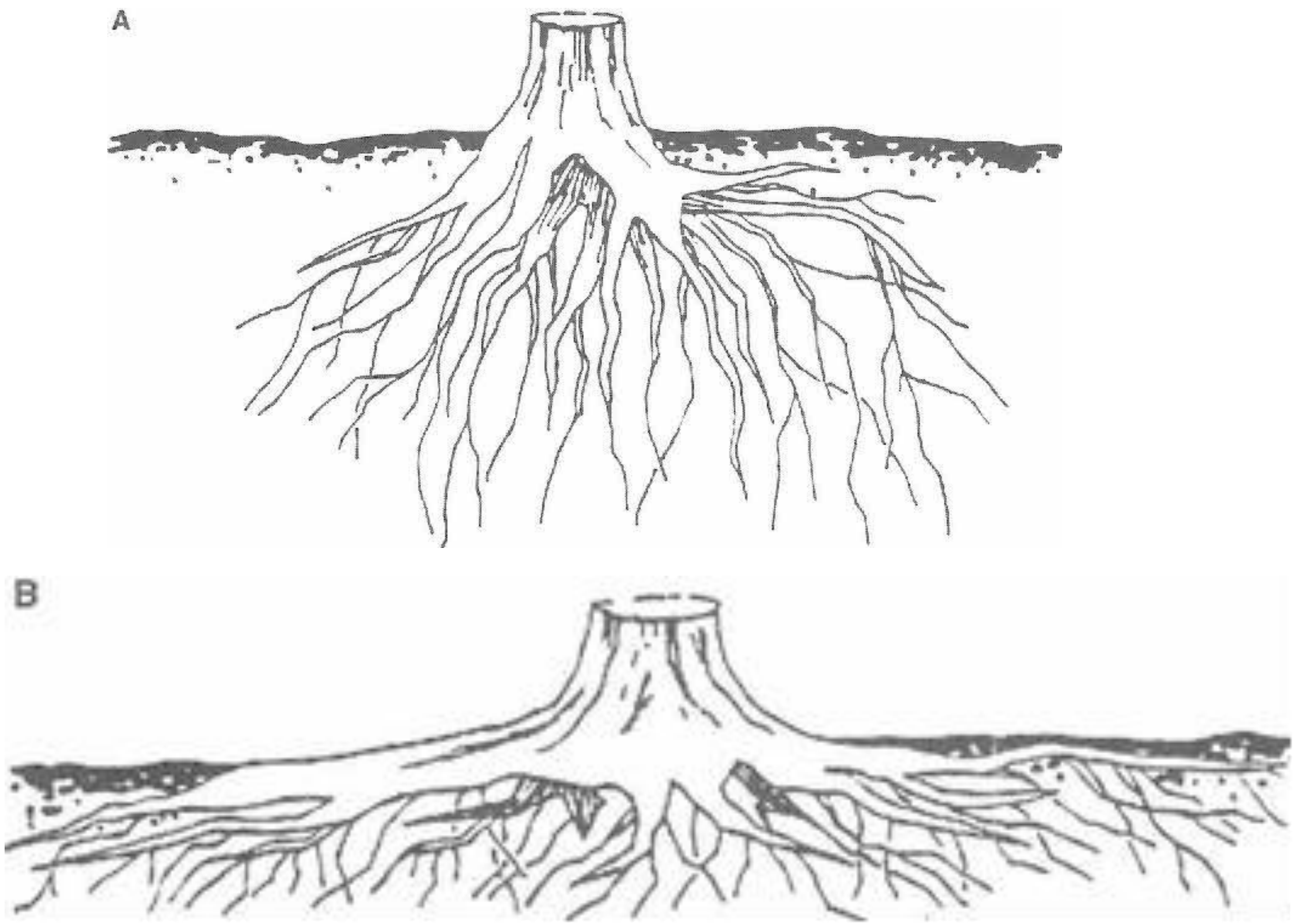


Figure
Typical rooting habit of Sitka spruce on two soils. A: Predominately vertical rooting on deep soils; B: Wide, shallow rooting on poorly drained soils.

Forest Management Strategies

Shelterbelts

- ✓ Trees are not only affected by wind but also have a large effect on wind.
- ✓ shelterbelts, or bands of trees oriented per-pendicular to prevailing winds, have long been used to decrease winds to the lee side of the barrier.
- ✓ Narrow shelterbelts tend to be more effective than wide barriers.
- ✓ The distance over which wind speed drops is proportional to the height of narrow barriers.
- ✓ At a lee distance five times the barrier height, wind speed is only one-third of the free wind speed, and at 10 tree heights it is about 50%, becoming 80% and more after 20 tree heights .
- ✓ Shelterbelts are commonly used to protect agricultural crops from desiccating or otherwise damaging wind.

Site Preparation and Planting

- ✓ Site preparation and planting are normally not times when wind hazard is expected to be significant.
- ✓ On some sites where spaced furrow plowing is used to prepare sites on gley soils, the planting of trees on the raised rows between furrows can prevent adequate anchoring by roots, as they do not spread across the exposed hardpan in the furrows.
- ✓ Whole rows of trees may later be windthrown.
- ✓ Shallow plowing is advised on such sites.
- ✓ Initial spacing of trees is not a wind throw concern, as they are too small to be blown over soon after planting.
- ✓ However, control of tree density is important to allow individual trees to develop anchoring root systems.

Thinning

- The effect of thinning on wind damage potential is therefore complex.
- If the initial stand has very high tree densities and little crown stratification, all the trees in the stand are likely to have little windthrow resistance.
- The stand may not as yet have suffered significant wind damage because of the energy dampening effect of closely spaced crowns on one another.
- Thinning of these stands will increase sway in the residual stems, and significant loss from wind may be expected until residual crowns fill in the space.
- If root disease is present, losses from windthrow will be even greater.
- Several entries, each of which takes a small proportion of the total density, may be the safest way to build wind firmness in the residual trees.

- ✓ Low thinnings, where trees of subordinate crown classes are removed, will leave codominant and dominant trees that have large crowns but are likely to have well-developed root systems.
- ✓ Wind damage is likely to be minimal in low thinnings.
- ✓ Crown thinnings remove a range of crown classes and may expose at least some trees with poorly developed root systems near locations where dominant trees were removed.
- ✓ Selection thinnings remove the largest size classes of trees and often leave stems that have poorly developed root systems and have experienced little wind stress.
- ✓ In multispecies stands, these intermediate to suppressed trees are generally of shade-tolerant species and are more likely to have root or butt rots.
- ✓ Mechanical thinnings are most common in even-aged plantations, and create linear gaps that may tend to funnel wind or expose an entire line of residual trees at once.