Sitka spruce (*Picea sitchensis*)

Sitka spruce is a maritime species, growing along the outer coast from Cape Mendocino in northern California to the Aleutian Island chain of Alaska. Within this range it seldom strays very far from salt water. A tolerance for salt spray combined with a wood that has among the highest known strength/weight ratios allows it to thrive in the outer coastal environment (Figure 59). The species achieves its best growth in western Washington, where it is found further from the sea than anywhere else in its range (Figure 60).

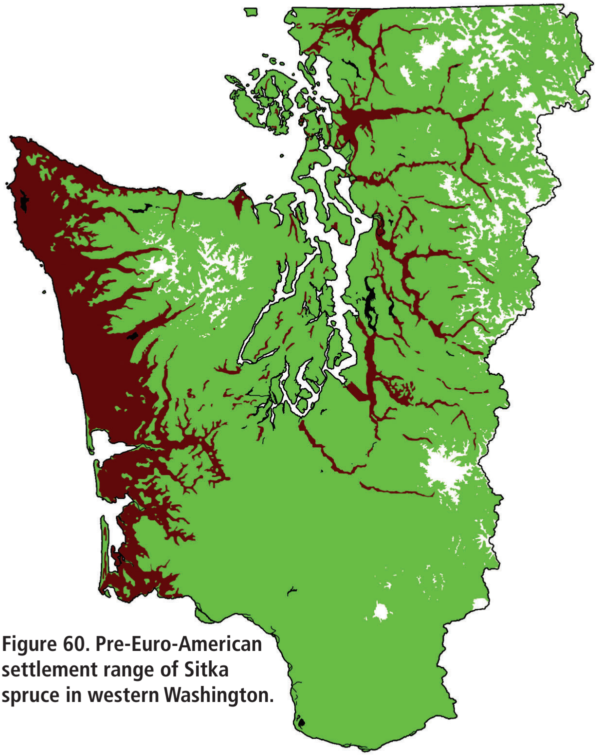

Figure 60. Pre-Euro-American settlement range of Sitka spruce in western Washington.

Of the major tree species found in western Washington, Sitka spruce is the most restricted tree to low elevations. It can be found away from the coastal environment only along the floodplains of large, ocean-flowing rivers (Figure 61). The combination of medium shade tolerance and its preference for well watered, productive soils allows it to grow as far as 80 km from saltwater. It is so restricted to these productive, coastal sites that its presence is the basis for identifying one of our major forest zones (Figure 3). Forests within the Sitka spruce zone have some of the highest forest productivities reported for the planet (Figure 62). As a site-sensitive species, Sitka spruce is unable to establish in poor or dry environments — as illustrated by its absence from the slope forests adjacent to the river floodplains of the Cascade and Olympic Mountains.

Along with Douglas fir, Sitka spruce is the other giant member of the pine family. The tallest and largest known trees are nearly the same size for both species (Douglas fir: 99.4 m, 349 m^3; Sitka spruce: 96.6 m, 337 m^3) The largest known diameter Sitka spruce (539 cm) is the largest recorded for any member of the pine family. It is odd that Sitka spruce and Douglas fir can be so similar in so many ways, yet could not be more different in others.

Early growth patterns

Perhaps the greatest difference between these two species is their seeding characteristics. While of similar size, the seed requirements of each species are completely different. The mineral soil of sand or ash preferred by Douglas fir is a poor seed bed for spruce. It instead prefers elevated organic substrates such as logs or stumps. In the moist, coastal environments where it grows, the forest floor is often a dense carpet of bryophytes and other plants. The thickness and competition these provide presents a difficult obstacle for the tiny seed to overcome. A log, however, especially one freshly fallen, provides a wonderful organic substrate that is (at least temporarily) free from this competition (Figure 63). Lines of trees are often visible in some of these coastal forests where competition on the forest floor is high (Figure 64). As the trees mature they form what is known as a ***forest colonnade*** (Figure 65).

Figure 59. Left: Windswept Sitka spruce trees adorn the outer coast from northern California to the Aleutian Islands of Alaska. **Right: Trees along the ocean front often develop strange forms** as a result of nearly constant exposure to high winds, even inside the protection of a forest.

Figure 61. Large floodplains in western Washington provide ideal conditions for Sitka spruce to dominate, such as on the South Fork Hoh River on the Olympic Peninsula.

Figure 62. Rainforests dominated by Sitka spruce and western hemlock have some of the highest growth rates known — often producing record-sized trees in just two or three centuries.

Figure 63. Several groups of spruce seedlings can be seen colonizing wood in this grassy glade in the rain forest.

Figure 64. Young Sitka spruce trees growing in lines reveal that they started their lives on a log.

Figure 65. A forest colonnade. Mature trees in a row with interwoven roots is sometimes the only evidence of the former location of a nurse-log.

Life is precarious for a seedling that starts on an elevated substrate. The bark of a decaying log may slough off, taking the young plants with it. If the log decays quickly, the young seedling might not be able to get roots into the ground in time to support its own weight. To survive, the tree must ultimately be able to support its own weight and the roots that were in the log will become stems when the log disappears (Figure 66). If the log or stump on which the young spruce started its life was very large, huge buttresses may be the only evidence centuries later of the tree's origin (Figure 67).

Since Sitka spruce is a site sensitive species, variation in growth rates between trees is far less pronounced than for Douglas fir. Consequently, size and age are more closely correlated for Sitka spruce. This relationship holds true only for height and total volume, however, not for the diameter at breast height (DBH). Buttresses are highly variable and exhibit a considerable influence on DBH, depending on the size of the stump or log on which the spruce germinated. In older stands, measuring the DBH of a Sitka spruce amounts to nothing more than measuring buttress

Figure 66. If a spruce started on a very large log, the resulting tree can often have a bizarrely shaped root system.

Figure 67. The Quinault Lake Spruce. The huge buttresses found on trees such as this indicate that they started life on a very large stump or log.

roots, a measurement with limited usefulness. As an extreme example, how do you measure the DBH on the Quinault Lake Spruce (Figure 68)?

Patterns in mature trees

Many of the clues used to determine the age or successional stage of a Douglas fir do not apply to Sitka spruce. The textural patterns of the bark, for example, do not change much over time. The bark flakes that develop on trees during their first century of life continue, relatively unchanged, throughout the remainder of their life (Figure 69).

The pattern of epicormic branching in mature trees is also not as consistent as for Douglas fir. While Sitka spruce is every bit as capable as Douglas fir in producing epicormic branches, it often does not need to. Two primary reasons account for this: Sitka spruce is slightly more shade-tolerant than Douglas fir; and often grows in less dense stands. The loss of original branches and the lifting of the crown during the biomass accumulation/competitive exclusion phase is a major pattern in densely-stocked Douglas fir stands; such a patten is often less of a factor in many Sitka spruce stands. This is particularly true in the floodplain forests where spruce is often growing up through an alder canopy, rather than a dense stand of other spruces. Since alders are leafless for half of the year, some of the spruces will keep many of their original branches and thus maintain deeper crowns (Figure 70).

Even in the older Sitka spruce/western hemlock stands growing on floodplains, stand densities are much lower than their Douglas fir/western hemlock counterparts. This may be due in part to a shared dominance with bigleaf maple, and to a lesser degree, alder and cottonwood. Moreover, heavy grazing by deer and elk is common in many spruce floodplain forests and influences understory vegetation and seedling recruitment. Chronic, small-scale disturbances created by wind and/or flooding are common, as are the shorter life-spans of most of the tree species.

The strength of Sitka spruce wood makes it common for trees to live well into their third century with the simple architecture of their youth (Figure 71). By then, most of their height growth has been completed. Wind, decay, and the exposure to the elements begin to take their toll, creating the individuality seen in old spruce crowns (Figure 72).

Longevity and death

The pattern of slowed height growth in older stands is common to both Sitka spruce and Douglas fir. While the ultimate height and size of Sitka spruce and Douglas fir are similar, Sitka spruce achieves these dimensions in about half the time. This is advantageous for

Figure 68. The Quinault Lake Spruce. The red line indicates where DBH would be measured. How useful is such a measurement?

Figure 69. Bark characteristics do not change much with Sitka spruce. The left photo shows small trees near the coast that have similar bark flakes to the 450 cm tree in the right photo.

the spruce, since its lifespan is about half that of Douglas fir. On productive sites, a Sitka spruce has never been successfully aged to over 400 years, making it one of the shortest-lived of all western conifers. This may seem strange considering it is one of the largest trees in North America. Individual trees, such as the Quinault Lake Spruce, certainly live slightly beyond this but they cannot be aged by non-destructive methods. Even if cut, their centers would likely be rotten and hollow. Sitka spruce, like Douglas fir, is susceptible to velvet top fungus. Giant spruces are frequently killed by this disease after only 250-350 years (Figure 73). Trees that have their tops broken during storm events will also begin to decay from the top down, often breaking off in sections (Figure 74).

Figure 70. Changes in crown form in Sitka spruce over time. Note that despite a few epicormic branches in the lower crown, trees retain a simple architecture for the first two centuries. Decay puts an upper limit on longevity.

Figure 71. Upper canopy of a 250+ year-old spruce stand in Olympic National Park. Many of the trees still retain the branch structures of young trees.

Figure 72. Upper crown profiles of several 300+ year-old spruces. The simple growth pattern of youth is still detectable in a few trees, but their individuality and idiosyncrasies become apparent.

Figure 73. Death by velvet top fungus. The two classic cases are the fallen trunk, full of rot, with a small root wad (left), or the splintered stump, with sapwood still intact (right).

Figure 74. The rotten top of a 400+ year-old spruce snapped off in a violent winter storm, only to impale itself in the ground a full 20 m away from its base.