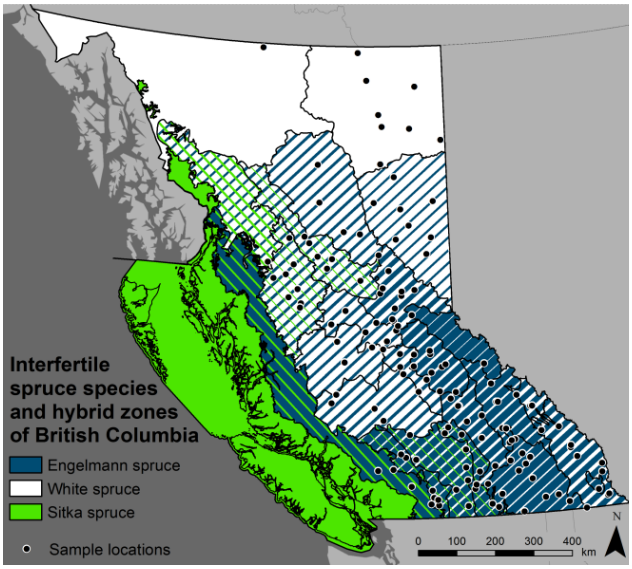
Spruce hybridization in British Columbia

British Columbia is home to three interfertile species of spruce; Sitka (*Picea sitchensis*), white (*Picea glauca*), and Engelmann (*Picea engelmannii*). Each has different ecological requirements, and wood qualities. For example, Sitka spruce has very low tolerance for freezing while white spruce is very frost-hardy. White-Sitka hybrids, present throughout the Nass and Skeena river systems, can tolerate conditions anywhere along that spectrum. Likewise, the cool, dry conditions of the Central Plateau are a perfect compromise between Engelmann spruce's cool, wet habitats in the subalpine and white spruce's cold, dry boreal habitat. As such, white-Engelmann hybrids, collectively referred to as "interior spruce (Sx)", are present throughout much of the interior (see figure).

Following the recession of the ice sheet covering most of BC at the end of the last ice age, spruce rapidly recolonized the landscape and began hybridizing. While hybridization is common among similar species around the world, most hybrid zones consist of first-generation hybrids that may not be well-suited to their environments. In contrast, the spruce hybrids present in BC are the product of many generations of hybridization, allowing time for natural selection to favour hybrid trees that best survive and reproduce. They are able to draw from traits that evolved separately in both parent species and to thrive in new environments where either parent would quickly die off. This includes many regions of the Chilcotin Plateau that are too warm for white spruce and too dry for Engelmann. This flexibility has allowed the white-Engelmann hybrid zone to be widespread and stable for thousands of years.

While early researchers noted that pure species and hybrids could be differentiated based on cone morphology, these methods don't allow determination of the degree of hybridization. This has historically been troublesome for seedling nursery managers, as a seedlot that is 20% Engelmann and 80% white spruce will have different growing requirements than one that is 80% Engelmann and 20% white, yet these species may be indistinguishable in the field. Recent advancements in molecular genetics have allowed us to determine the boundaries of hybrid zones and to accurately categorize hybrids. For example, genetic data from the AdapTree project[1] has helped us determine that relatively few populations of pure Engelmann spruce exist in BC, and that some white spruces as far north as Fort St. John aren't so white after all (see figure).



Map of hybridization among Sitka, white, and Engelmann spruce species in British Columbia. Relative stripe widths illustrate the average proportion of each species represented in hybrids. Pure Sitka spruce is found in coastal BC and pure white spruce occurs only in northern BC.

White (?) spruce cone. *(photo S. Aitken)*

[1] AdapTree is co-led by Dr. Sally Aitken (UBC) and Dr. Andreas Hamann (U. Alberta)

The easy crossability and huge range of traits among spruces in BC has given breeders an exceptional amount of genetic variation to work with, allowing the spruce breeding program to achieve high genetic gain for both growth and weevil resistance. New molecular tools will help breeders understand specific hybrids and select the best trees for seed orchards and seed production. This is particularly relevant for climate-based seed transfer policies currently being developed, as a broad range of hybrids will form the populations used for reforestation in future growing conditions. The hybrids of BC have allowed a constant spruce presence throughout every climate BC has faced since the last glaciation, and they will continue to support the productivity of BC's forests well into the future.

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