



Impact Note - CFS Atlantic - Making a difference

Natural hybridization of red and black spruce

Although it is widely held that red spruce (*Picea rubens* Sarg.) and black spruce (*P. mariana* (Mill.) B.S.P.) frequently hybridize, published estimates of hybridization have ranged from extensive to minor. John Major, a research scientist with Natural Resources Canada - Canadian Forest Service's Atlantic Forestry Centre (CFS-AFC), has shown that the production of hybrids is much lower than many might expect (Major et al. 2005).

Major and colleagues are studying the adaptive ecology and natural hybridization of red and black spruce in an effort to better inform the conservation, restoration, and improvement programs for red spruce, a species in decline within the Acadian Forest Region.

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The question of spruce hybridization is of more than academic interest. Red spruce is in decline, and was named a "species of concern" in 1997 by the New Brunswick Gene Conservation Working Group. One of eastern North America's most shade-tolerant and long-lived conifers, red spruce historically formed a significant and economically important component of the Acadian Forest Region. Past and current silvicultural practices have favored early successional species such as black spruce, which can outcompete red spruce seedlings in the relatively dry, exposed environment and increased light conditions that occur after forest harvesting. Together with air pollution and climate variability, this harvesting impact has reduced the range of red spruce to less than one-fifth of its historic extent. In some areas, particularly in the western part of its range, red spruce has been reduced to small, isolated populations.

Extensive hybridization would put further pressure on the ability of red spruce to maintain its identity in the forest. As hybrids cross back with their parent species, genes from one parent species enter natural populations of the other species. This process, called "introgression," could dilute the genetic adaptations of red spruce, making it less competitive within its normal habitat.

Major and his colleagues have demonstrated that there is a significant barrier to the development of red-black hybrid seed. In controlled pollinations, between-species crosses produced seed at a rate less than one-sixth that of within-species crosses. Such low rates of seed set in controlled crosses where there is no pollen competition from the other species suggest that, under natural pollination conditions, even lower levels of viable hybrid seed may be expected. A significant level of hybrid seed would likely only occur if the supply

Natural hybridization . . .

of red spruce pollen were overwhelmed by black spruce pollen—a situation that might occur under some current silvicultural practices.

Hybrid trees grow at rates not very different from the average of parental species—another finding by Major, and one that counters earlier suggestions that red–black hybrids are much less vigorous. This means that, in habitats where red spruce is marginally adapted to grow (such as cutovers), it will face competition from both black and hybrid spruces.

Do hybrids occur? Yes, but not to the extent once thought, because of the strong barriers to cross-

ability. The low rate of hybrid seed production is clearly important in maintaining the separation of the species. In addition, ecological separation based on adaptive differences (for example, shade tolerance) further reduces rates of hybridization. Ongoing research into how red and black spruce are adapted to their particular ecological niches, and into the mechanisms that keep them genetically distinct, will allow foresters to better manage both of these important forest species.

Reference: Major, J.E., Mosseler, A., Johnsen, K.H., Rajora, O.P., Barsi, D.C., Kim, K. -H., Park, J.-M., and Campbell, M. 2005. Reproductive barriers and hybridity in two spruces, Picea rubens and Picea mariana, sympatric in eastern North America. Canadian Journal of Botany 83: 163–175.



Left to right: John Major, Moira Campbell, and Alex Mosseler performing controlled crosses. (Image on front page shows mature red spruce.)

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