The Ecophysiological Basis for Regeneration Silviculture of Boreal *Picea glauca*

The Problem

Regeneration of *Picea glauca* in boreal mixedwood forests poses major challenges for silviculturists in the western boreal forest of Canada. Competition from other vegetation and cold, wet soils are key environmental factors hindering regeneration. Partial canopy retention and mechanical site preparation (e.g., scalping, mixing and mounding) can been used to modify microenvironments and suppress competing vegetation.

The Approach

Eco-physiological investigations seek to connect the seedling response to the microenvironmental factors that silvicultural practices create. This helps to provide explanations for results, so that we understand why we have succeeded, and to propose rational alternatives to try where failures have occurred.

Methods

As part of the Ecosystem Management Emulating Natural Disturbance (EMEND) experiment, we studied *Picea glauca* regeneration in poplar-dominated and spruce-dominated forest types at three harvest residuals (clearcut, 50% and 75%), with mechanical site preparation (scalped, mixed, mounded and undisturbed control).

Microclimate measurements included light, air and soil temperatures and soil moisture. Height, root collar diameter and photosynthesis of planted seedlings were measured.

20% retention in a spruce-dominated stand

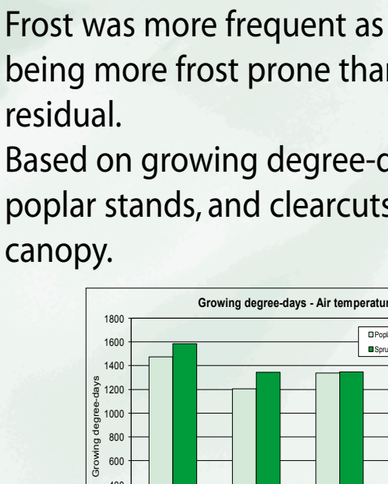
70% retention in a poplar-dominated stand

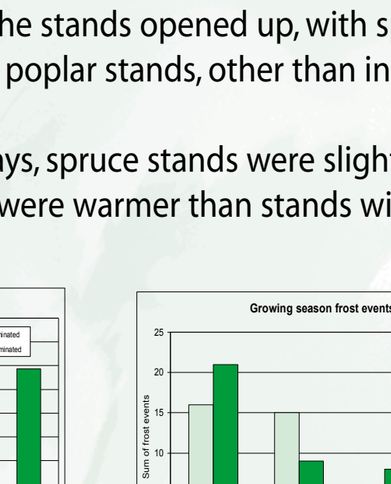
Residual Canopy Effect on Atmospheric Microenvironment

- Frost was more frequent as the stands opened up, with spruce stands being more frost prone than poplar stands, other than in the 50% residual.
- Based on growing degree-days, spruce stands were slightly warmer than poplar stands, and clearcuts were warmer than stands with residual canopy.

Residual Canopy Effect on Soil Microenvironment

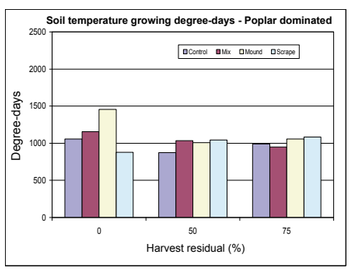
- Soil temperatures reflect air temperatures; however, they are buffered by the heat capacity of the soil and by the insulating forest floor.
- Clearcut soils are warmer than those under canopies.
- Soils under poplar are consistently warmer than those under spruce, probably due to the wetter soils and thick moss layer of the spruce stands.

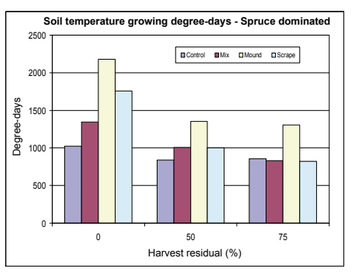




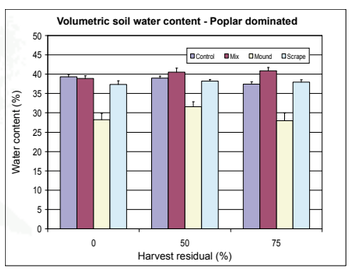
Site Preparation Effect on Soil Microenvironment

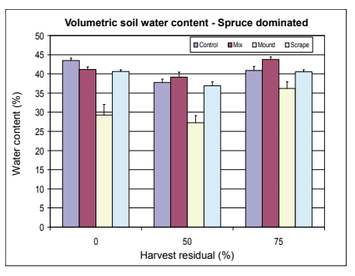
- Soil growing degree-days differed little among site preparation treatments or residual in poplar stands, except that mounds in the clearcut were warmer than in the other treatments.
- In the spruce stands, mounds were also warmest. All site preparation was warmer in spruce clearcuts, which were more exposed than the swiftly regenerating poplar clearcuts.
- Poplar stands were drier than spruce stands. Mounds were consistently drier than other treatments, which did not differ much from one another.





Placing sensors in a mound

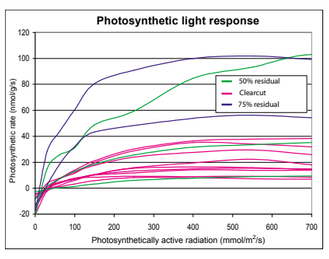


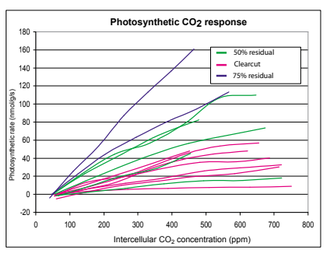


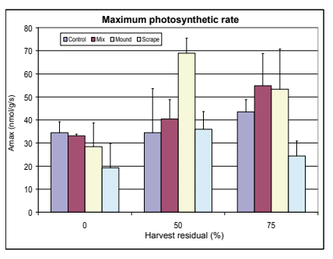
Field photosynthesis measurements

Microenvironment Effects on Seedling Physiology

- Changes in photosynthetic rate in reponse to light and to CO_2 suggest physiological acclimation to open vs. shaded environments.
- Maximum photosynthetic rate was highest in seedlings planted in mounds, and lowest on seedlings planted in scrapes.
- Amax was higher under partial canopies than in clearcuts.







Seedling Growth

- Seedlings were taller in partial cut stands than in clearcuts and taller in stands dominated by poplar than by spruce.
- Diameter growth was greatest under the 50% residual and greater under poplar than under spruce.
- The largest seedlings grew on mounds in spruce stands but on both mounds and mixed microsites under poplar.

Conclusions

- Canopy retention decreases competition and moderates the temperature regime. Shading improves photosynthetic efficiency and growth of seedlings.
- The warmer, drier microsite of mounds provides the best growth conditions for white spruce in the boreal forest.
- Mixed microsites also support good seedling growth in the poplar-dominated stands.
- *Picea glauca* seedlings tolerate wide ranges of light, temperature and moisture, making them adaptable to many regeneration methods.

Authors

Jim Stewart, Travis Jones, Rick Hurdle, and Derek Sidders

Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre, 5320 - 122 St., Edmonton, Alberta, Canada T6H 3S5.

jstewart@nrcan.gc.ca 780-435-7224
tjones@nrcan.gc.ca 780-435-7362
rhurdle@nrcan.gc.ca 780-435-7263
dsidders@nrcan.gc.ca 780-435-7355

Natural Resources Canada
Ressources naturelles Canada

Canada