Patterns of black spruce stand development at north-facing slope in Caribou-Poker Creek, Interior Alaska

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Upland black spruce distribution is limited on the north-facing slope. The north-facing slope, on which mature black spruce stands dominate, is accompanied by underlying permafrost. We selected a ca. two-kilometer long toposequence along the northeast-facing broad ridge topography in Caribou Poker Creek Research Watershed, CPCRW. Eleven survey points were selected along the slope. We examined the relationship between active layer depth in growing period and forest biomass regime. Deeper active layer depth was detected in the upper position of the slope. The shallowest active layer depth was recorded at the lower slope position of north-facing slope. All stands were covered with thick moss-lichen layer, with ranging from 20 to 35 cm thickness. Larger aboveground biomass C accumulation occurred at upper position of the slope. The smallest value of C accumulation in plant biomass was 4.5 Mg C ha\(^{-1}\). Carbon accumulation in aboveground biomass at the upper position is nearly ten times larger than that of the lower position of the slope.

Study sites

Caribou Poker Creek Research Watershed
65N-148W, ca. 50km NE of Fairbanks.

Black spruce (Picea mariana) dominant. Around 1920 forest fire regeneration. Dominant on the N – NE facing slope.

Mean Annual Temperature: \(-3.3^\circ C\)
Annual Precipitation: ca. 280 mm
Soil: Gelisol (USDA)
Cryosol (FAO-ISRIC)
Derived from metamorphosed schist and sedimentary rock fragment.
No glacier ice sheet in the Pleistocene. Discontinuous permafrost region.
Prevaling on the north-facing slope.

Methods

Tree biomass and Carbon storage:
11 quadrates of 10 × 10m and 3 intensive research plots along the slope.
DBH and H (tree height) census.
Using allometry equation of black spruce at Poker Flat (Noguchi et al. 2012).
Assuming that C content in biomass is 500 g/kg.
Active layer depth
Soil profile survey, and penetration tests were conducted. Forest floor thickness and active layer depth were recorded.

Results and Discussion

Temperature regime at mineral soil (0cm)

Soil depth (cm)
Nc value (no. of hits/10-cm penetration)

Soil Profile N-6

Soil Profile N-5

Soil Profile N-2

Soil Profile N-0

Active layer depth and biomass relationship along the slope

Black spruce forests in discontinuous permafrost region of Caribou Poker Creek, Interior Alaska.

Stand Average
Max. (crest flat) D\(_{1,3}\): 8.5 cm H: 9.3 m w: 32.1 kg
Min. (lower slope) D\(_{1,3}\): 2.8 cm H: 2.7 m w: 3.1 kg

Forest stands on the deeper active layer accumulated much biomass. Forests on shallower active layer and/or water-logged sites had less biomass.

Sectional area growth rates at upper slope stand (N1) since 1920 fire.