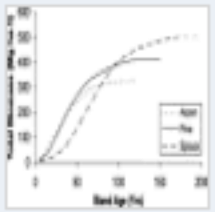

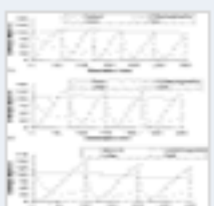

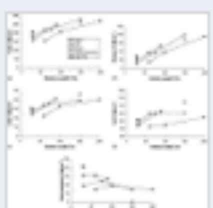

Abstract

The effect of alternative harvesting practices on long-term ecosystem productivity and carbon sequestration was investigated with the ecosystem simulation model, FORECAST. Three tree species, white spruce (*Picea glauca*), trembling aspen (*Populus tremuloides*), and lodgepole pine (*Pinus contorta* var. *latifolia*), were each used in combination with different rotation lengths. An additional run was conducted to investigate the effect of nitrogen addition to aspen. Results were also compared with a natural disturbance scenario in which a mixedwood stand composed of all three species was subjected to a catastrophic wildfire, on a 150-year fire cycle. All simulations included an understory grass competitor, *Calamagrostis canadensis*, and the total simulation length for each scenario was 300 years.

Carbon stored in soil represented a large, relatively stable pool and showed only minor long-term responses to harvesting activities. Tree biomass and litter pools, in contrast, fluctuated widely in concert with the harvest cycle. *Calamagrostis* was relatively unimportant as a carbon pool.

Total ecosystem carbon increased with rotation length regardless of species, and this was attributable largely to changes in the live biomass pool. A 150-year pine, and a 200-year spruce rotation, were the only scenarios in which average total carbon storage exceeded that in the natural disturbance scenario. For equivalent rotation lengths, total carbon storage was the greatest in aspen, followed by pine and spruce, respectively. Application of nitrogen fertilizer to aspen increased average total carbon storage by 9%. This increase was attributable primarily to the storage in wood products and live biomass pools.

The proportion of total carbon stored in the soil pool decreased as harvest frequency declined (i.e., at longer rotation lengths), while the proportion stored in litter pools was roughly equivalent among all scenarios. However, there was a consistent decline in soil carbon across the 300-year simulation period for managed stands. The natural disturbance scenario, in contrast, showed an increase in soil carbon over the same period.

Species-specific biomass accumulation rates (an index of ecosystem productivity) were maximal in the shortest rotations for aspen, but in mid-length rotations for pine and spruce. Short rotation scenarios showed a marked drop in site productivity over subsequent rotations. The application of nitrogen fertilizer reduced the relative drop in site productivity for aspen.

Our results suggest a trade-off between ecosystem storage capacity and timber production. By selecting the appropriate tree species and rotation length, however, it is possible to either balance these competing demands, or favour one value versus the other.

Keywords

Carbon sequestration; Ecosystem-level modelling; Forest management; FORECAST