Litter decomposition in British Columbia forests: Influences of forestry activities

CINDY PRESCOTT* AND LEANDRA BLEVINS†

INTRODUCTION

The decomposition of litter and subsequent release of nutrients in plant-available forms is an essential process in the functioning of forest ecosystems. Temperature, moisture, and litter chemistry control decomposition rates through their influences on the activity of soil organisms. Forestry activities that influence the microclimate or nature of the litter can alter decomposition rates.

There are several commonly held beliefs about rates of litter decomposition. Using a suite of field experiments across the province, we tested the applicability of these "well-known facts" to decomposition in British Columbia forests. We asked the following questions:

1. Is decomposition slower in cold (northern and high-elevation) forests?
2. Is decomposition faster in clearcuts than in forests?
3. Does broadleaf litter decompose faster than needle litter?
4. Is decomposition faster in N-fertilized forests?

MATERIALS AND METHODS

Litterbags were used in all experiments. A known dry weight of litter was enclosed in a mesh bag and the weight remaining was measured annually for 3–5 years.

Question 1: Decomposition Rates in Biogeoclimatic Zones

Rates of decomposition of standard litter substrates (lodgepole pine needle litter, trembling aspen leaf litter, and forest floor material) were measured at 26 sites in nine biogeoclimatic zones across the province. Seven bags of each substrate were collected from each site annually for 4 years (pine and forest floor) or 3 years (aspen), and the dry weight of material remaining in each bag was measured.

Question 2: Decomposition Rates in Forests and Clearcuts

Experiments were established at 14 sites in seven biogeoclimatic zones across the province. Litterbags containing pine needle litter, aspen leaf litter, and forest floor material were installed in a forest and in an adjacent clearcut. Seven bags of each material were collected from each location annually, and the dry mass of material remaining in the forests and clearcuts were compared.

Citation —

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Question 3: Decomposition Rates of Broadleaf and Needle Litter

Foliar litter of 14 tree species (lodgepole pine, western white pine, ponderosa pine, western hemlock, western larch, Engelmann spruce, subalpine fir, western redcedar, Douglas-fir, amabilis fir, trembling aspen, black cottonwood, red alder, and vine maple) were collected at sites across the province. Mass loss of leaf litter of each species was measured for 5 years at the University of British Columbia Research Forest near Maple Ridge, B.C.

Decomposition of aspen leaf litter and spruce needle litter (both pure and mixed) was compared for 5 years at four sites near Dawson Creek, B.C. The decomposition of red alder leaf litter and Douglas-fir needle litter (both pure and mixed) was compared for 3 years in three pure plots of Douglas-fir and of red alder at the University of British Columbia Research Forest near Maple Ridge, B.C.

Question 4: Decomposition Rates in Fertilized Forests

Rates of decomposition were measured in control and N-fertilized plots of trembling aspen near Chetwynd, B.C. and coastal Douglas-fir near Seattle, Washington.

RESULTS AND DISCUSSION

Question 1: Decomposition Rates in Biogeoclimatic Zones

Mass loss of lodgepole pine needle litter after 4 years was greatest in the Coastal Western Hemlock (CWH) and Interior Cedar–Hemlock (ICH) zones and least in the Ponderosa Pine (PP) followed by the Boreal White and Black Spruce (BWBS) zone. The other five zones (Mountain Hemlock [MH], Coastal Douglas-fir [CDF], Interior Douglas-fir [IDF], Sub-Boreal Spruce [SBS], and Engelmann Spruce–Subalpine Fir [ESSF]) had intermediate rates of decomposition. In aspen leaf litter, mass loss after 3 years was greatest in the CWH followed by the MH zone. The slowest decomposition of aspen was in the PP, followed by the BWBS and IDF zones. Forest floor material decomposed slowly without much differentiation among the zones. These results indicate that within the range of climates in the province, decomposition is most affected by moisture.

Question 2: Decomposition Rates in Forests and Clearcuts

Mass loss of pine needles was slower, or the same, in clearcuts after 3 years. Mass loss of aspen leaf litter varied widely among sites with no consistent differences between clearcuts and forested sites.

Question 3: Decomposition Rates of Broadleaf and Needle Litter

Only leaf litter of vine maple decomposed faster than needle litter. Broadleaf litter lost mass faster during the first year, but then more slowly, such that mass loss was similar after 3 years. In the mixture experiments, aspen lost mass faster during the first year and then more slowly than spruce, so differences were small after 3 years. Alder leaf litter decomposed faster than Douglas-fir during the first 6 months, but no differences were evident after 1 year. There was no evidence in either experiment that mixing with broadleaf litter hastened decomposition of the needle litter.

Question 4: Decomposition Rates in Fertilized Forests

For both Douglas-fir and aspen, litter from N-fertilized and control plots decomposed at the same rate, as did litter incubated in fertilized and control plots.

In conclusion, our studies in British Columbia forests suggest that:

1. Decomposition in provincial forests is more closely related to moisture than temperature.
2. Decomposition is no faster in clearcuts than in forests.
3. Broadleaf litter does not decompose faster than needle litter after the first year.
4. Fertilization does not increase decomposition rates.

Decomposition rates are determined by a few very fundamental factors, so the effects of forest management activities can only be predicted by assessing, on a site-specific basis, how the activity will affect each of these factors. Generalizations about the effects of forest opening, fertilization, or species mixtures are inappropriate. These findings are contrary to several commonly held beliefs about decomposition rates and demonstrate the need for research conducted in British Columbia to support forest management decisions.

AUTHORS

* ***Correspondence to:*** **Cindy E. Prescott**, Department of Forest Sciences, University of British Columbia, 3041-2424 Main Mall, Vancouver, BC V6T 1Z4.

E-mail: cpres@interchg.ubc.ca

† Department of Forest Sciences, University of British Columbia