

## INTERNAL REPORT 17

### NUTRIENT TURNOVER IN FOREST FLOORS OF INTERIOR ALASKA

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#### ABSTRACT

In this study, we examined the loss of selected chemical elements, mass, and energy from decomposing quaking aspen (Populus tremuloides Michx.), paper birch (Betula papyrifera Marsh.), and alder (Alnus crispa subsp. sinuata (Regel) Hult.) in upland aspen and birch stands near Fairbanks, Alaska. The following summary of the work, much of which was conducted before funding of the present project, will appear this year as a short paper in Ecology. The paper is included as part of this report because it describes experimental site locations and field and laboratory methods used in conducting this study. After the paper was prepared, additional sets of samples were collected, which extended the duration of the study to 1,325 days. Regression analysis has now been conducted on all parameters originally discussed in the project proposal. These results, with the exception of those for Fe, Mn, Zn, and ash are summarized in Table 1. Further examination of data for the later constituents is necessary before submitting these results. The equations relating energy loss to weight loss have also been extended to include data from the 1,325-day samples. Graphical presentation of this data will be available shortly.

Studies of nutrient, mass, and energy loss from foliage of fertilized birch and aspen and unfertilized black spruce (Picea mariana (Mill) B.S.P.) and unfertilized white spruce (Picea glauca (Moench) Voss) are continuing, and results of these experiments will be available in the near future. A graduate student research project has been initiated (other funding) on the effect of different intensities of thinning in a 70-year-old white spruce forest on cellulose decomposition and decay and nutrient loss from white spruce forest litter. This information will also be available soon.

The completed data set (1,325 days) for all constituents measured is described with the asymptotic, exponential decay equation:  $y = a + be^{-\lambda x}$ . The asymptotic form was employed because, although nutrient contents and mass of the organic matter could theoretically go to zero, inputs to the organic matter of various constituents are continually occurring. Although the mass and nutrient content of the organic matter may be continually decreasing, the input of various constituents maintains their measured level at some higher point. Until these inputs can be measured, the asymptotic equation form seems most realistic.

Highest correlation coefficients and lowest standard errors for the estimated parameters were generally obtained for weight, energy, N, and K (Table 1). Largest errors were generally encountered for Ca and Mg. Half-times, calculated on the basis of  $\lambda$  determined in regression analysis, are summarized in Table 3. These figures showed that loss of mass and energy is more rapid from aspen and

birch than from alder. Most rapid nutrient loss was obtained for N in aspen (63 days). Potassium showed consistently the shortest half-times for all species of foliage (range from 131 days to 144 days, Table 1). Longest half-times for base elements was encountered in birch foliage (Table 3). This condition may reflect the relatively base-rich (Ca, K, Mg) condition of aspen forest floors compared with birch forest floors (Van Cleve and Noonan 1971) and the initial base status of the foliage (Table 4). Aspen foliage had a considerably higher Ca content than either birch or alder foliage.

Shorter half-times generally were not encountered for alder foliage placed in the aspen forest compared with alder foliage placed in the birch forest. The change in concentration of such additional constituents as carbohydrates, fats, and lignin must be considered in future studies to obtain a clearer picture of factors related to nutrient loss in the forest floor.

Differences in half-times for mass and energy between data obtained for 763 days and 1,325 days may reflect the extended period of the completed study on decomposition. In addition, the earlier data were calculated on the basis of amount of component lost, but data from the completed study were expressed on amount of component that remained in the organic matter.

The rate of change in mass and energy in decomposing foliage examined in the present study represents changes that occur in material freshly deposited on the forest floor and, with time, as it is incorporated into the F and H layers. The asymptote of the regression equations may represent a steady state concentration of the particular component in the forest floor.

Additional equations were developed relating weight loss to energy loss (Table 2). These are highly significant linear functions. I hope that future studies will establish the relation between short-term forest floor respiration rates and loss of energy and weight.

#### LITERATURE CITED

- VAN CLEVE, K. 1971. Energy and weight loss functions for decomposing foliage in birch and aspen forests in interior Alaska. In Press, Ecology.
- VAN CLEVE, K. and L. L. NOONAN. 1971. Physical and chemical properties of the forest floor in birch and aspen stands in interior Alaska. Soil Sci. Soc. Amer. Proc. 35(2):356-360.

TABLE 1. Summary of Regression Analysis for Mass, Energy and Nutrient Loss From Tree Foliage

Species	Function	r	Std Error A	Std Error B	Std Error $\lambda$
Aspen	weight remaining $y = 3.90 + 5.42e^{-.0034x}$	0.99	0.13	0.18	0.0002
	energy remaining $y = 19615.9 + 26071.5e^{-.0030x}$	0.99	591.7	755.3	0.00018
	N remaining $y = 0.16 + 0.44e^{-.011x}$	0.99	0.0069	0.014	0.0017
	P remaining $y = 0.0046 + 0.015e^{-.0012x}$	0.81	0.0049	0.0044	0.00071
	K remaining $y = 0.0059 + 0.063e^{-.0053x}$	0.98	0.0015	0.0026	0.00045
	Ca remaining $y = 5.33 \times 10^{-8} + 0.43e^{-.00019x}$	0.84	15.75	15.69	0.0061
	Mg remaining $y = 0.0074 + 0.014e^{-.0022x}$	0.77	0.0025	0.0026	0.00091
Birch	weight remaining $y = 3.15 + 6.28e^{-.0028x}$	0.99	0.17	0.21	0.0020
	energy remaining $y = 16243.5 + 31303.7e^{-.0026x}$	0.99	651.4	764.2	0.00014
	N remaining $y = 0.084 + 0.119e^{-.0017x}$	0.97	0.0083	0.0078	0.00026
	P remaining $y = 0.0074 + 0.024e^{-.0046x}$	0.94	0.0011	0.0018	0.00068
	K remaining $y = 0.0040 + 0.070e^{-.0048x}$	0.97	0.0022	0.0037	0.00050
	Ca remaining $y = 0.0065 + 0.10e^{8.6 \times 10^{-5}x}$	-0.75	3.05	3.05	0.00055
	Mg remaining $y = 1.57 \times 10^{-4} + 0.066e^{-.00029x}$	0.80	1.10	1.09	0.0058

TABLE 1. Continued

Species	Function	r	Std Error A	Std Error B	Std Error $\lambda$
Alder in Aspen	weight remaining $y = 3.23 + 6.15e^{-.0024x}$	0.99	0.14	0.16	0.00014
	energy remaining $y = 16214.2 + 29707.8e^{-.0023x}$	0.99	955.6	1049.1	0.00018
	N remaining $y = 0.06 + 0.18e^{-.00076x}$	0.91	0.064	0.060	0.00043
	P remaining $y = 1.11 \times 10^{-8} + 0.920e^{-.00048x}$	0.74	0.040	0.039	0.0013
	K remaining $y = 0.0071 + 0.058e^{-.0052x}$	0.97	0.0016	0.0028	0.00052
	Ca remaining $y = 4.71 \times 10^{-8} + 0.60e^{-.00013x}$	0.92	41.50	41.44	0.0052
	Mg remaining $y = 4.65 \times 10^{-8} + 0.037e^{-.0013x}$	0.93	0.0063	0.0056	0.00042
Alder in Birch	weight remaining $y = 2.52 + 6.76e^{-.0020x}$	0.98	0.34	0.34	0.00023
	energy remaining $y = 11836.67 + 33938.6e^{-.0018x}$	0.97	2143.7	2048.0	0.00025
	N remaining $y = 0.00088 + 0.24e^{-.00063x}$	0.88	0.13	0.12	0.00050
	P remaining $y = 0.0039 + 0.012e^{-.0013x}$	0.83	0.0032	0.0029	0.00066
	K remaining $y = 0.0050 + 0.060e^{-.0051x}$	0.98	0.0015	0.0025	0.00044
	Ca remaining $y = 3.81 \times 10^{-8} + 0.57e^{-.00016x}$	0.93	30.5	30.5	0.0057
	Mg remaining $y = 0.0024 + 0.032e^{-.0014x}$	0.90	0.0056	0.0051	0.00048

TABLE 2. Summary of Regression Analysis Energy Remaining vs. Weight Remaining.\*

<u>Species</u>	<u>Function</u>	<u>r</u>	<u>S<sub>y·x</sub></u>
Birch	$y = 0.18 + 0.49x$	1.00	0.07
Aspen	$y = 0.25 + 0.47x$	0.99	0.08
Alder in Birch	$y = 0.14 + 0.48x$	0.99	0.12
Alder in Aspen	$y = 0.12 + 0.48x$	0.99	0.09

\*y = Energy remaining, kilocalories.  
x = Weight remaining, grams.

TABLE 3. Half Times for Loss of Mass and Chemical Components From Organic Matter.\* (Days)

<u>Species</u>	<u>Mass</u>	<u>Energy</u>	<u>N</u>	<u>P</u>	<u>K</u>	<u>Ca</u>	<u>Mg</u>
Aspen	203.8	231.0	63.0	575.5	130.8	3647.4	315.0
Birch	247.5	266.5	407.6	150.7	144.4	8058.1	2389.7
Alder in Birch	346.5	385.0	1100.0	533.1	135.9	4331.3	495.0
Alder in Aspen	288.8	301.3	911.8	1443.8	133.3	5330.8	533.1

\*calculated for  $\lambda$  based on mass of chemical constituents remaining in sample.

TABLE 4. Initial Chemical Content of Foliage Used in Decomposition Studies.

<u>Species</u>	<u>Energy*</u>	<u>N</u>	<u>P</u>	<u>K</u>	<u>Ca</u>	<u>Mg</u>
Aspen	4.90	0.20	0.019	0.069	0.187	0.022
Birch	4.78	0.20	0.032	0.074	0.111	0.031
Alder	4.59	0.22	0.016	0.065	0.147	0.034

\*Kilocalories.