北海道北部の冷温帯森林流域におけるリターフォールと養分動態の空間分布
Landscape patterns of overstory litterfall and related nutrient fluxes in a cool-temperate forest watershed in northern Hokkaido, Japan

Xu Xiao-niu [1, 2] and Hideaki Shibata[2]

(1) Department of Forest Science, College of Forestry and Landscape Architecture, Anhui Agricultural University, Hefei, Anhui, 230036, P. R. China
(2) Field Science Center for Northern Biosphere, Hokkaido University, Nayoro, Hokkaido 096-0071, Japan

Within a forested watershed at the Uryu Experimental Forest of Hokkaido University in northern Hokkaido, overstory litterfall and related nutrient fluxes were measured at different landscape zones over two years. The wetland zone covered with *Picea glehnii* pure stand. The riparian zone was deciduous broad-leaved stand dominated by *Alnus hirsuta* and *Salix* spp., while the mixture of deciduous broadleaf and evergreen conifer dominated by *Betula platyphylla*, *Quercus crispula* and *Abies sachalinensis* distributed on the upland zone. Annual litterfall averaged 1444, 5122, and 4123 kg·hm−2·a−1 in the wetland, riparian and upland zones, respectively. Litterfall production peaked in September–October, and foliage litter contributed the greatest amount (73.4%–87.6 %) of the annual total litterfall. Concentrations of nutrients analyzed in foliage litter of the dominant species showed a similar seasonal variation over the year except for N in P. glehnii and A. hirsuta. The nutrient fluxes for all elements analyzed were greatest on riparian zone and lowest in wetland zone. Nutrient fluxes via litterfall followed the decreasing sequence: N (11–129 kg·hm−2·a−1) > Ca (9–69) > K (5–20) > Mg (3–15) > P (0.4–4.7) for all stands. Significant differences were found in litterfall production and nutrient fluxes among the different landscape components. There existed significant differences in soil chemistry between the different landscape zones. The consistently low soil C:N ratios at the riparian zone might be due to the higher-quality litter inputs (largely N-fixing alder).

Table 1. Characteristics of forest types studied in Dorogawa watershed in Hokkaido, Japan

Forest type	Topography and soil	Forest structure	Major tree species
Spruce pure forest (U-1)	Wetland, peat soil; peat deposit about 2.5 m; water table near but not above the surface in growing season and waterlogged during snow-melt.	Canopy height 15-20 m, Mean DBH 24.7 cm (range 10-57 cm), density 400 # hm^{-2}, Basal Area (BA) 25 $m^2 \cdot hm^{-2}$; few small trees (DBH < 10 cm);	*Picea glehnii*;
Alder-willow young forest (U-2, U-3)	Flat riparian wetland never waterlogged; alluvial sediments, loamy sand, over 100 cm deep.	Canopy height 12-15 m; Mean DBH 15.8 cm (range 10-28 cm), density 1000 # hm^{-2}, BA 20 $m^2 \cdot hm^{-2}$; few small trees	*Alnus hirsute* *Salix sachalinensis* *Salix per-susu*
Broadleaf-confer mixed forest			
U-4	Lower slope, sandy loam, 70-100 cm; well drainage;	Canopy height 15-25 m, Mean DBH 30.6 cm (range 10-64 cm), density 300-400 # hm^{-2}, BA 43 $m^2 \cdot hm^{-2}$; few small trees (DBH < 10 cm).	*Quercus crispula* *Abies sachalinensis* *Betula platyphylla*
U-5	Middle slope, fine sandy loam, over 100 cm; well drainage;		
U-6	Flat ridge, silt loam, over 100 cm; well drainage;	Canopy height 15-25 m, DBH 10-80 cm, density 300 # hm^{-2}, BA 30 $m^2 \cdot hm^{-2}$; old-growth with few small trees.	*Quercus crispula* *Betula platyphylla* *Abies sachalinensis*

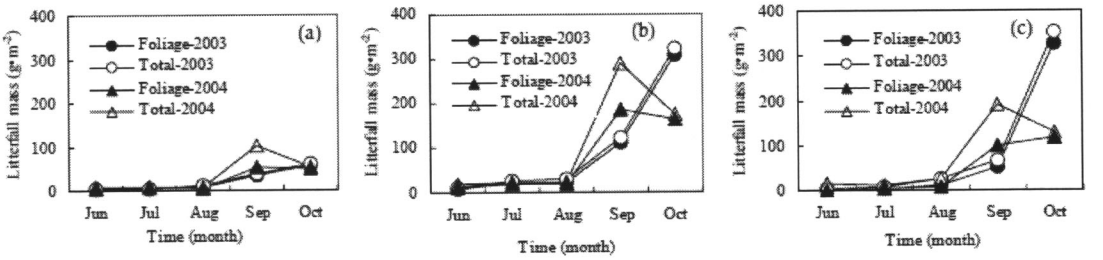

Fig.1 Seasonal change of litterfall in each site
(a) Wetland (U-1), (b) Riparian (U-2 and U-3), (c) Upland (U-4, 5 and 6)

Table 2. Mean nutrient concentration (mg g-1) in foliage litter for dominant tree species in each site.

Species	Site	C	N	P	K	Ca	Mg
Picea glehnii	U-1	527 (6.15)	7.56 (1.30)	0.85 (0.41)	2.76 (1.81)	7.24 (1.16)	1.63 (0.81)
Alnus hirsuta	U-2	539 (8.36)a	28.73 (3.74)a	1.03 (0.24)a	3.54 (1.73)a	13.86 (1.29)a	2.55 (0.19)a
	U-3	528 (8.63)a	28.02 (4.46)a	1.19 (0.49)a	3.91 (1.28)a	14.12 (1.38)a	2.94 (0.38)b
Salix spp.	U-2	515 (9.12)a	22.60 (4.99)a	1.34 (0.32)a	5.55 (1.01)a	13.99 (2.15)a	2.77 (0.19)a
	U-3	508 (4.99)a	22.41 (6.52)a	1.12 (0.44)a	4.13 (0.43)b	15.49 (2.16)b	2.29 (0.20)b
Abies sachalinensis	U-4	542 (7.87)a	8.65 (2.47)a	0.66 (0.21)a	4.68 (1.11)a	12.06 (2.08)a	2.02 (0.36)a
	U-5	536 (8.67)a	8.45 (2.83)a	0.68 (0.09)a	3.61 (0.84)b	13.16 (1.88)b	1.04 (0.09)b
	U-6	537 (9.89)a	7.88 (1.89)a	0.61 (0.26)a	2.28 (0.49)c	14.99 (2.25)c	1.03 (0.09)b
Acer mono	U-4	499 (6.61)a	11.61 (1.84)a	0.89(0.18)a	3.69 (1.35)a	11.91 (2.86)a	2.39 (0.58)a
	U-5	491 (5.33)a	9.90 (2.08)b	0.61 (0.13)b	3.71 (0.25)a	15.31 (1.95)b	2.55 (0.42)a
Betula spp.	U-4	508 98.23)a	17.96 (3.24)a	1.19 (0.15)a	5.96 (1.43)a	9.85 (2.08)a	3.46 (0.89)a
	U-5	506 (6.03)a	16.03 (2.63)b	0.70 (0.09)b	4.14 (0.63)b	13.95 (1.13)b	3.17 (0.15)a
	U-6	521 (8.67)b	13.38 (2.55)c	0.53 (0.13)c	2.53 (0.39)c	13.03 (1.22)b	3.06 (0.13)a
Quercus crispula	U-4	493 (6.56)a	12.43 (2.08)a	0.75 (0.10)a	4.01 (0.53)a	9.38 (1.47)a	2.57 (0.31)a
	U-5	5.04 (7.87)ab	13.24 (2.84)a	0.51 (0.12)b	4.09 (1.13)a	12.03 (2.28)b	2.09 (0.32)b
	U-6	513 (5.50)b	9.80 (2.82)b	0.42 (0.09)b	2.59 (0.54)b	12.72 (2.21)b	1.99 (0.22)b

Note: Means for the same species followed by the same letter in the same column indicate insignificant differences ($P < 0.05$).
Salix spp. indicate *S. sachalinensis* Fr. Schm. and *S. pet-susu* Kimura; *Betula* spp. indicate *B. ptyphylla* var. *japanica* Hara and *B. ermanii* Cham.;

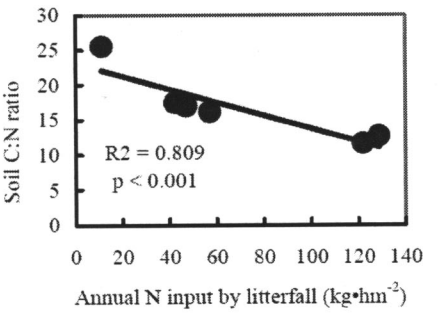

Fig. 2 Relationship between soil CN ratio (0-10 cm) and annual nitrogen input by litterfall in different site.

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