HARDWOOD BIOMASS AND NET PRIMARY PRODUCTION FOLLOWING CLEARCUTTING IN THE COWEETA BASIN[1/]

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Abstract.--A watershed at the Coweeta Hydrologic Laboratory was clearcut in 1977 as part of an interdisciplinary study of the physical, chemical and biological effects of logging by cable-yarding upon both terrestrial and aquatic components of the hardwood forest ecosystem. This paper compares species composition, leaf area index (LAI), biomass, and net primary production (NPP) across sites and over the first 8 years of regrowth with values for an adjacent, uneven-aged, mixed hardwood forest.

Throughout the study, hardwood stems were sampled to determine diameter/biomass relationships by fitting logarithmic transformed equations for leaf, bole and branch biomass. These were coupled with plot survey data to estimate biomass of woody species, and destructive plot harvesting was used for herbaceous and vine biomass.

The regenerating forest vegetation is characterized by a rapid recovery of leaf area and net primary production in the first three years due to rapid sprout, vine and herbaceous growth. In year 3, mesic site NPP was 5.4 mt/ha/yr, or 62% of the NPP estimated for the uneven-aged mixed hardwood forest, and xeric site NPP was 3.0 mt ha^{-1} yr^{-1}. Although NPP in year 8 was somewhat less on the mesic sites (5.1 mt ha^{-1} yr^{-1}) the xeric sites increased to 4.5 mt ha^{-1} yr^{-1}. In year 3, leaf area indices were 4.2 m^2 m^{-2} and 3.0 m^2 m^{-2} on mesic and xeric sites, respectively, increasing to 4.9 m^2 m^{-2} and 4.3 m^2 m^{-2} in year 8. In comparison, LAI is estimated to range from 5-6 m^2 m^{-2} for the mature hardwood control. Vegetation influences upon nutrient cycling processes are also briefly discussed.

INTRODUCTION

Clearcutting is a prevalent silvicultural practice used to regenerate mixed hardwood forests in the southern Appalachians and to improve stocking in stands degraded by poor selection-cutting practices applied in the past.

Research on clearcutting in southern Appalachian hardwood forests has addressed silvicultural aspects of early regeneration (McGee and Hooper 1970, 1975, Trimble 1973) and subsequent hydrologic responses (Swank and Helvey 1970, Swift and Swank 1981), but there have been additional needs to couple early stand regeneration patterns with nutrient cycling processes to assess forest productivity.

Biogeochemical studies following forest cutting have indicated that there are basic changes in forest floor processes and nutrient uptake patterns by early successional vegetation. Some of these mechanisms have been shown to be important in reducing nutrient losses, although soil leaching of nitrate may still be significant immediately following forest removal in northern hardwood forests (Bormann and Likens 1979, Martin et al. 1985). In southern Appalachian hardwood

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forests, leaching losses of nutrients during early regeneration are relatively low (Johnson and Swank 1973). Nutrient conserving processes have been shown to include rapid immobilization of nutrients in 1-3 year old vegetation (Boring et al. 1981, in press), and changes in decomposition rates and other forest floor processes (Seastedt and Crossley 1981, Abbott and Crossley 1982). Moreover, more recent research has indicated that leaching losses in Appalachian forests may be relatively insignificant in comparison to export of nutrients with practices such as whole tree harvesting (Johnson et al. 1982). Thus, there has been a need to understand the interactions between potential nutrient depletion, rates of nutrient replacement, internal nutrient cycling processes, and stand productivity following both standard and intensive biomass harvesting practices.

Accordingly, a hardwood forested watershed at Coweeta was clearcut in 1977 as part of an interdisciplinary study of the physical, chemical and biological effects of a conventional clearcutting operation upon both terrestrial and aquatic components of the ecosystem. Our objectives have been: 1) to examine differences in forest regeneration trends among former cove, chestnut oak, and xeric scarlet oak-pine sites on the clearcut watershed; 2) to compare species composition, leaf area index (LAI), biomass, and net primary production (NPP), over the first 3 years of regeneration with values for an adjacent, uneven-aged, mixed hardwood forest; 3) to relate productivity and overall regeneration of forest structure to fundamental ecosystem nutrient cycling processes of nutrient uptake, immobilization, and transfers; and 4) to establish a regeneration database for "minimal-impact" conventional logging that may be used for comparison with more intensive harvesting systems. The first two objectives will be addressed here with data from eight years of forest regeneration.

MATERIALS AND METHODS

Study Areas

Watershed 7 (WS7) was the primary site for this study (fig. 1). The catchment has a south-facing aspect, is 59 ha, and ranges in elevation from 720 to 1065 m. Slope ranges from < 20 to 81%.

On the basis of an earlier study (Williams 1954), the watershed was stratified into four plant communities, similar to those identified in recent studies of vegetation classification in the Coweeta Basin (Day, Phillips and Monk, in press). Based upon these previous studies and the delayed completion of site preparation on xeric sites, three sampling strata were identified: 1) a cove hardwood community found at lower elevations and along ravines at intermediate elevations; 2) a chestnut oak community on mesic southeast- and north-facing slopes at intermediate elevations; and 3) a scarlet oak-pine community on xeric southwest and south-facing slopes at intermediate to upper elevations and ridgetops, which combines the two xeric vegetation types from the previous studies.

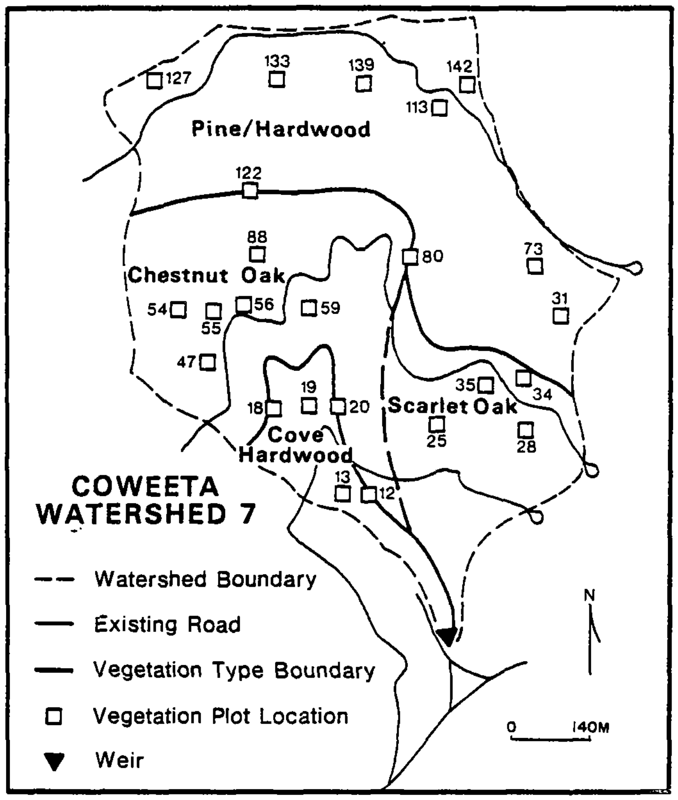

Figure 1. Map of Coweeta WS7, vegetation types, and the vegetation plot locations.

Timber cutting and yarding with a mobile cable system began January 1977 and was completed the following June. Tractor skidding was used on about 9 ha where slopes were less than 20%, and the remainder was yarded with a mobile cable system. Most of the ridgetops and xeric slopes were cut but not logged. The site preparation treatment which was completed in October 1977 consisted of clear-felling all remaining stems ≥ 2.5 cm dbh. This treatment was completed on the xeric portion of the watershed six months later than on the mesic portion.

Comparative data for net primary production (NPP) for an uneven-aged hardwood forest were taken from WS18 (Day and Monk 1977a, b) because these detailed measurements were not made on WS7 prior to clearcutting. Detailed NPP information is available for WS18, a 12.5 ha watershed which primarily differs from WS7 in having a northern aspect. Although species dominance varies among the oaks on these two watersheds, there were no major differences in the overall tree species composition, basal area (25.6 vs. 25.3 m^2 ha^{-1}), density (3044 vs. 3058 stems ha^{-1} > 2.5 cm dbh), and aboveground biomass (139 vs. 130 mt ha^{-1}, Boring 1979).

Forest Composition and Production

Standard dimension analysis techniques coupling regression analysis with sample plot measurements were used to estimate biomass, NPP and leaf area of woody species (Whittaker et al. 1974, Phillips and Saucier 1979). Individual young hardwoods (mostly of sprout origin) were sampled each August from years 1-3 from randomly chosen sample points within the study area to establish regression equations (Boring et al., in press). For years 6 and 8, hardwoods were sampled from adjacent sites in the Nantahala National Forest in addition to the Coweeta Basin. Sample individuals were cut at the ground or at the point of sprout origin on the stump. Diameters were measured at 3 and 40 cm from the base; the 3 cm measurement gave the best fit for slow-growing species, and 40 cm was best for the fast-growing species. All leaves were removed, bagged, dried to a constant weight at 70°C and weighed. Stems and all branches were similarly dried and weighed. Wood weights included all aboveground woody components.

For years 1-3, $\log_{10}$ regression equations based upon pooled 1-3 year-old stem diameters provided the best fits and were selected to predict leaf and wood biomass for eleven species. These equations are reported elsewhere (Boring et al., in press). For the 6-8 year-old trees, similar equations were constructed (table 1).

Prior to clearcutting, the vegetation was inventoried from 142 0.08 ha plots systematically located over WS7. Following clearcutting, 13 of the original plots were randomly selected among mesic sites and sampled for regrowth, including 5 plots in the cove and 8 chestnut oak plots (fig. 1). In 1978, 11 additional plots were also randomly selected in the xeric scarlet oak-pine area. Two quadrats were located in opposite corners of each 0.08 ha plot. Hardwood sprouts and seedlings were sampled in each quadrat with subplots of 7 x 7 m and 3 x 3 m, respectively.

Herbaceous vegetation was destructively sampled in August of each year (ages 1, 2, 3, 6 and 8) from one randomly placed 1 m^2 subplot within each quadrat. Samples were separated by species, or groups of species, and oven-dried to constant weight at 70°C. Total herb NPP was estimated by equating it with August standing crop biomass, since a study in the first year showed that most species attained peak biomass at that time (Boring et al. 1981).

LAI estimates were determined from leaf surface area to dry weight ratios measured on 20-40 leaves for each of 21 woody species (including *Rubus* spp.) in years 1, 3 and 6. These ratios were established by subsampling leaves from several individuals of each species, measuring leaf area with a LI-COR portable leaf area meter (Lambda Instrument Company, Omaha, Nebraska), then drying and weighing the leaves. For herbs, whole plant biomass to leaf surface area ratios were determined for 3 dominant species and a miscellaneous category.

At the end of the growing season, sprout and seedling densities were recorded separately by species and diameter class on each 7 m x 7 m sample plot. For the first year, diameter classes were designated by 0.5 cm increments up to a maximum of 3 cm. For years 2-8, classes were in 1 cm increments up to 14 cm. Aboveground leaf, wood and total biomass (kg ha^{-1}) were determined for each species by multiplying the stem densities for each size class by midpoint biomass values estimated by regression analysis. Wood biomass was separated into branch and bole components in years 6 and 8 only. Summation of the wood and leaf biomass from each size class yielded total biomass per species for each plot. LAI was determined by multiplying the leaf area/dry weight ratios by the leaf biomass for each species.

For comparative estimates of NPP for good, mesic sites versus xeric ridge sites, values for cove and chestnut oak sites were averaged into

Table 1. Regression equations and coefficients of determination (R^2) for predicting leaf, branch, and bole biomass of 6-8 year old open-grown hardwood trees. Y = dry weight biomass (g) and X = diameter (mm).

Species	Leaf Biomass	R^2	Branch Biomass	R^2	Bole Biomass	R^2
Group A (diam. at 40 cm)						
Acer rubrum	$\log_{10}Y = -1.699 + 2.608 \log_{10}X$	.89	$\log_{10}Y = -2.475 + 3.213 \log_{10}X$	.97	$\log_{10}Y = -.943 + 2.567 \log_{10}X$	.97
Liriodendron tulipifera	$\log_{10}Y = -1.111 + 2.161 \log_{10}X$	.98	$\log_{10}Y = -2.092 + 2.808 \log_{10}X$	.97	$\log_{10}Y = -.915 + 2.473 \log_{10}X$	.99
Quercus prinus	$\log_{10}Y = -.528 + 1.898 \log_{10}X$	.95	$\log_{10}Y = -.777 + 2.253 \log_{10}X$	.97	$\log_{10}Y = -.610 + 2.388 \log_{10}X$	.98
Quercus rubra	$\log_{10}Y = -.792 + 2.103 \log_{10}X$	.95	$\log_{10}Y = -1.549 + 2.746 \log_{10}X$	.95	$\log_{10}Y = -.351 + 2.200 \log_{10}X$	.97
Robinia pseudoacacia	$\log_{10}Y = .139 + 1.585 \log_{10}X$	.72	$\log_{10}Y = -.938 + 2.303 \log_{10}X$	.74	$\log_{10}Y = -.489 + 2.335 \log_{10}X$	.96
Group B (diam. at 3 cm)						
Cornus florida	$\log_{10}Y = -.584 + 1.859 \log_{10}X$	.87	$\log_{10}Y = -.734 + 2.165 \log_{10}X$	.81	$\log_{10}Y = -.340 + 2.071 \log_{10}X$	.93
Kalmia latifolia	$\log_{10}Y = -.754 + 1.882 \log_{10}X$	.84	$\log_{10}Y = -1.222 + 2.359 \log_{10}X$	.91	$\log_{10}Y = -.636 + 1.948 \log_{10}X$	.80
Rhododendron maximum	$\log_{10}Y = -.499 + 1.970 \log_{10}X$	.90	$\log_{10}Y = -2.951 + 3.543 \log_{10}X$	.93	$\log_{10}Y = -.445 + 1.893 \log_{10}X$.	.93

"mesic site" values. The NPP was estimated by: 1) equating first-year biomass with NPP; 2) for years 2-8, subtracting the previous year's standing crop of woody biomass and evergreen leaf biomass from current year total biomass, and dividing by the number of years between measurements.

RESULTS AND DISCUSSION

Species Regeneration Patterns

Prior to clearcutting, the highest biomass (166 metric tons ha^{-1}) was in the cove hardwood community, followed by the scarlet oak-pine (133 mt ha^{-1}) and chestnut oak (119 mt ha^{-1}) communities (table 2). These results are not surprising since the site quality of the cove forest was highest, and the scarlet oak-pine sites probably had the least logging activity in the past. Although these biomass figures are for regionally representative stands, they have a complex disturbance history, including high-grade logging and American chestnut (*Castanea dentata*) mortality (Monk and Day, in press). Old-growth cove and chestnut oak forests on similar sites in the Great Smoky Mountains have been estimated to exceed 400 mt ha^{-1} (Whittaker 1966).

Although northern red oak (*Quercus rubra*) and hickories (*Carya* spp.) comprised 36% of the cove forest biomass before clearcutting, in the eighth year of regrowth they decreased to 16% of the woody species biomass, while the formerly dominant yellow-poplar (*Liriodendron tulipifera*) comprised only 5% (table 2). Rosebay rhododendron (*Rhododendron maximum*), flowering dogwood (*Cornus florida*), and northern red oak dominated the regeneration, while vine and herbaceous biomass comprised 47% of the total community biomass through year three (fig. 2). Many of the oaks and hickories in the cove likely originated from seedlings that were established prior to clearcutting (Sander 1972, Trimble 1973). Numerous yellow-poplar seedlings (18,444 ha^{-1}) germinated following clearcutting, in comparison to only 510 sprouts ha^{-1} (table 3). However, by year 8 these were reduced to approximately 7,400 total stems ha^{-1}. Although silver-leaf grape (*Vitis aestivalis* var. *argentifolia*) sprouts were faster growing than seedlings, in the second year the latter were more numerous, with 2244 ha^{-1} vs. 16,222 ha^{-1}.

Prior to clearcutting, oaks and hickories composed 60% of the biomass in the chestnut oak (*Q. prinus*) community, followed by red maple and yellow-poplar (22%, table 2). Following clearcutting, black locust (*Robinia pseudoacacia*), flowering dogwood, yellow-poplar and red maple comprised 53% of the woody regeneration, with oaks and hickories reduced to 12%. Although their biomass was relatively low, many mountain laurel (*Kalmia latifolia*) and *Rhododendron* sprouts were present (table 3). Herbaceous vegetation and blackberries (*Rubus* spp.) comprised 29% of the total biomass in the second year, but were reduced to < 1% by the eighth year.

Except for yellow-poplar and silver-leaf grape, the dominant woody species regenerated primarily from stump or root sprouts. The scarlet oak-pine (*Q. coccinea*/*Pinus rigida*) community was dominated by chestnut oak, scarlet oak, black oak (*Q. velutina*) and mountain laurel, which comprised 64% of the biomass prior to clearcutting (table 2). Afterwards, mountain laurel and red maple were dominant (25%) followed by chestnut oak (12%), black locust (10%), scarlet oak (9%), and American chestnut (7%).

In year 8 following clearcutting, there was little difference in herbaceous biomass between the cove and chestnut oak sites but both were higher than the scarlet oak-pine sites (fig. 2). Blackberries were dominant, ranging from 2026 kg

Table 2. Aboveground biomass for woody species before and 8 years after clearcutting on former cove hardwood, chestnut oak, and scarlet oak-pine sites on WS7. Post-clearcutting data include all stems > 40 cm height, and pre-cut data include all stems ≧ 2.5 cm dbh.

Species	Cove Hardwood				Chestnut Oak				Scarlet Oak-Pine			
	Post-Cut		Pre-Cut		Post-Cut		Pre-Cut		Post-Cut		Pre-Cut	
	t ha^{-1} Biomass	% Biomass	% Biomass	t ha^{-1} Biomass	t ha^{-1} Biomass	% Biomass	% Biomass	t ha^{-1} Biomass	t ha^{-1} Biomass	% Biomass	% Biomass	t ha^{-1} Biomass
Acer rubrum	1.0	8	3	4.3	1.0	5	10	11.7	2.0	12	6	8.4
Betula lenta	1.2	9	9	14.2	.5	2	1	.6	<.1	<1	<1	<.1
Carya spp.	.2	2	16	26.6	.1	1	16	18.9	.4	2	4	5.2
Castanea dentata	0	0	0	0	.3	1	<1	.5	1.1	7	1	1.2
Cornus florida	2.7	20	2	3.1	4.6	21	6	6.5	.5	3	2	2.7
Kalmia latifolia	<.1	<1	<1	.2	.5	2	2	2.5	2.1	13	11	15.2
Liriodendron tulipifera	.6	5	18	29.4	1.7	8	12	13.6	.2	1	3	4.0
Nyssa sylvatica	.2	2	<1	.9	.9	4	2	2.6	.8	5	4	4.9
Quercus coccinea	<.1	<1	1	1.4	.3	1	9	10.5	1.5	9	15	20.2
Quercus prinus	<.1	<1	2	3.9	1.5	7	22	26.6	2.0	12	26	35.1
Quercus rubra	1.9	14	20	34.0	.7	3	4	5.1	<.1	<1	<1	.6
Rhododendron maximum	2.6	20	3	5.3	1.2	6	2	2.5	.7	4	<1	.4
Robinia pseudoacacia	.2	2	0	0	6.2	29	1	.8	1.7	10	2	2.9
Others	2.7	18	26	42.8	2.2	10	14	16.7	3.5	22	26	32.9
TOTAL FOR WOODY SPECIES	13.3	100	100	166.1	21.7	100	100	119.1	16.5	100	100	133.8

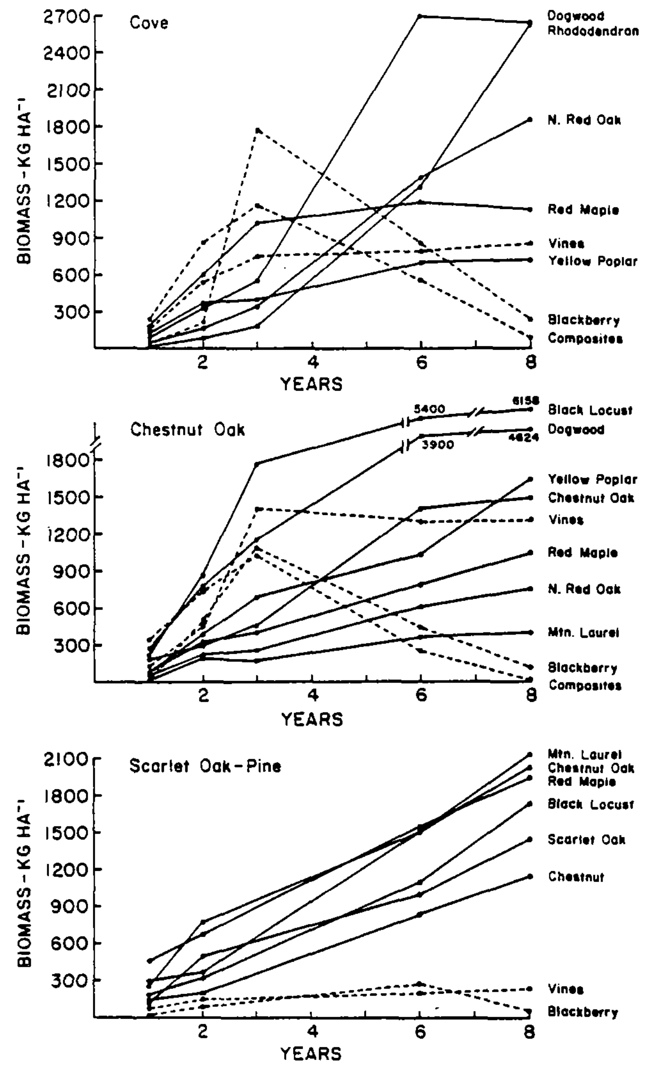

Figure 2. Biomass of dominant species in the three vegetation types over years 1-8 following clearcutting.

ha^{-1} on cove sites to 83 kg ha^{-1} on the scarlet-oak sites.

In year 3, the density of seedlings decreased along the gradient from cove to chestnut oak to scarlet oak-pine communities (table 3). This trend was likely due to lack of seed propagules as well as high mortality resulting from the xeric forest floor microclimate along the south-facing slopes and ridges. High numbers of silver-leaf grape and yellow-poplar seedlings germinated on the rich, moist cove sites, up to 16,222 and 18,444 seedlings ha^{-1}, respectively. The scarlet oak-pine sites were only occupied by 1211 and 1417 seedlings ha^{-1} of the same species.

Woody sprout densities increased from cove to chestnut oak to scarlet oak-pine communities, with an inverse trend observed for seedling density (table 3). Large red oaks and hickories in the cove plots had poor sprouting capabilities (Sander 1972, Johnson 1975, McGee 1978), and sprout biomass was relatively low. The chestnut oak and scarlet oak-pine sites were occupied by species with superior sprouting abilities such as black locust, flowering dogwood, red maple, mountain laurel and blackgum (Nyssa sylvatica). The scarlet oak-pine community lacked the rapid growth that characterizes the tall, dense stands of black locust and dogwood found in cove and chestnut oak communities. However, the scarlet oak-pine community had a higher density of small-diameter individuals, including mountain laurel, red maple, oaks, blackgum, and American chestnut. American chestnut has retained its ability to sprout vigorously, despite the introduction of chestnut blight in the mid 1920s.

Recovery of NPP and LAI

The recovery of aboveground NPP was rapid (fig. 3). The third year NPP on mesic sites was 5.4 mt ha^{-1} yr^{-1} or 62% of the NPP estimated for the uneven-aged mixed hardwood forest on WS18 (Day and Monk 1977a). After clearcutting, NPP on mesic sites was greater than on xeric sites due to rapid sprout growth and an abundance of herbaceous vegetation. The xeric site NPP was 3.0 mt ha^{-1} or 34% of the value for the older, uneven-aged forest on WS18; although sprout density was high, the dominant species was mountain laurel, which is relatively slow growing. By year 8, mesic site NPP was 5.1 mt ha^{-1} yr^{-1}, and xeric site NPP had increased to 4.5 mt ha^{-1} yr^{-1}. Although the NPP on mesic sites increases rapidly, it may not represent an actual "recovery" of NPP. The root systems of the rapidly-growing sprouts were intact to function in water and nutrient uptake, and to provide stored photosynthates and essential elements. The high aboveground production by year 3 was likely attributable to mobilization of these stored root reserves in sprouts, as well as high production from the competing blackberries, vines and herbs. The slowdown in unit area production by year 8 is attributable to the mortality of fast-growing species, and the probable reduction of root reserves in the sprouts.

LAI comparisons with other sites in the Coweeta Basin show a rapid recovery on both the mesic and xeric sites (fig. 3). Including herbaceous leaf area, LAI on mesic sites in year 3 was 4.2 m^2 m^{-2}, or 70% of the estimate for a control mixed hardwood watershed (LAI = 5-6 m^2 m^{-2}; Monk et al., in press). The LAI on xeric sites was 60% of the control in year 2. By year 8, all sites were approximately 85% of baseline LAI values, indicating that forest floor microclimate, and forest watershed evapotranspirational processes have likely also returned near baseline levels.

The patterns of early regeneration in southern Appalachian hardwood forests differ somewhat from those observed in even-aged northern hardwood and Pacific northwest coniferous forests (Marks 1974, Bicknell 1979, Gholz et al. 1985). The prolific hardwood sprout, herb and vine growth shown in this study

Table 3. Stem density by species before and 2 years after clearcutting on former cove hardwood, chestnut oak, and scarlet oak-pine sites on WS7. Post-cut data include all woody stems, and pre-cut data include all stems ≥ 2.5 cm dbh. The % density of post-cut stems includes both seedlings and sprouts.

Species	Cove Hardwood Post-Cut			Cove Hardwood Pre-Cut	Chestnut Oak Post-Cut			Chestnut Oak Pre-Cut	Scarlet Oak-Pine Post-Cut			Scarlet Oak-Pine Pre-Cut
	Sprts/ha	Sdlgs/ha	%Density	%Density	Sprts/ha	Sdlgs/ha	%Density	%Density	Sprts/ha	Sdlgs/ha	%Density	%Density
Acer rubrum	2,876	6,222	12	6	3,172	4,861	7	7	6,956	5,389	13	6
Betula lenta	816	3,000	5	4	765	628	1	<1	0	0	0	<1
Carya spp.	306	1,222	2	4	1,010	278	1	7	1,285	356	2	3
Castanea dentata	0	0	0	0	1,112	0	1	3	1,938	0	2	4
Cornus florida	7,589	111	10	14	17,901	350	16	16	3,029	0	3	4
Kalmia latifolia	0	0	0	2	13,903	139	13	17	40,555	0	42	56
Liriodendron tulipifera	510	18,444	24	5	1,836	6,739	8	6	176	1,211	1	1
Nyssa sylvatica	408	222	<1	1	5,314	767	6	5	5,773	250	6	4
Pinus rigida	0	0	0	0	0	0	0	<1	0	0	0	1
Quercus alba	0	0	0	1	0	0	0	<1	571	406	1	1
Quercus coccinea	0	0	0	<1	316	1,600	2	2	2,009	3,839	6	2
Quercus prinus	0	0	0	2	3,121	417	3	7	3,121	606	4	5
Quercus rubra	1,142	1,444	3	1	979	1,389	2	1	120	656	1	<1
Quercus velutina	0	889	1	<1	13	211	<1	2	65	556	<1	1
Rhododendron maximum	4,488	0	6	46	2,499	139	2	19	1,867	0	2	2
Robinia pseudoacacia	408	444	1	0	2,122	1,322	3	<1	1,275	200	2	1
Vitis aestivalis	2,244	16,222	23	-	2,387	28,000	27	-	1,234	1,417	3	-
Others	7,610	2,832	13	13	4,764	3,412	7	10	9,723	1,967	12	9
TOTALS	28,397	51,052	100	100	61,214	50,252	100	100	79,697	16,853	100	100

results in rapid biomass accretion (in three years, 4.3 - 8.4 mt ha^{-1}). Pacific northwest coniferous forests have profuse herbaceous regrowth, but Douglas-fir seedling establishment and early growth are slow, resulting in aboveground biomass of only 2.6 mt ha^{-1} in year 3

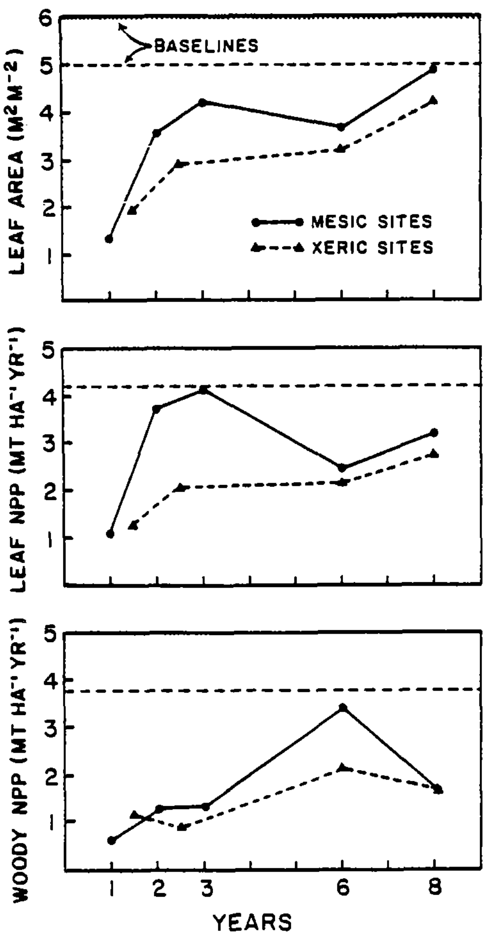

Figure 3. Leaf area, foliar and woody net primary production on the mesic and xeric sites of WS7 for 1-8 years following clearcutting.

(Gholz et al. 1985). Sprouting was less important and regeneration was slower for the first three years in the Hubbard Brook northern hardwood stands. A mixed northern hardwood stand 3 years old had a comparative biomass of 4.7 mt ha^{-1} (Bicknell 1979). After four years, however, pin cherry (*Prunus pensylvanica*) was well established from dormant seeds in the forest floor, resulting in increased accretion rates of biomass and nutrients, especially in dense pin cherry stands (Marks 1974).

Vegetation Influences

Other investigators at Coweeta have found that clearcutting results in first-year forest floor temperatures up to 47°C, severe wetting and drying cycles in forest floor surface horizons, alteration of microarthropod activity in litter (Seastedt and Crossley 1981) and slow first-year decomposition of woody litter, especially on xeric sites (Abbott and Crossley 1982). The return of a high LAI by the third year results in shading, amelioration of the harsh forest floor microclimate and dampening of environmental effects on forest floor biota and their processes. With early canopy closure, there should be a concomitant increase in the decomposition rates of woody and leaf litter. By the sixth year following clearcutting there is a large cumulative amount of decomposition in large woody litter, with decreases in wood density of some species exceeding 50% (Mattson 1985). Woody debris can act as a nutrient sink at least during early phases of decomposition (Abbott and Crossley 1982), and the gradual reduction of this material (as well as dead roots) to humus could partially account for soil organic matter (0-15 cm depth) increases the first few years following clearcutting (Waide et al., in press). The increase in soil organic matter not only increases storage pools of N and P in the soil but should also increase the exchange capacity and the amount of exchangeable nutrients that may be immobilized.

In summary, rapid regeneration has diverse effects upon ecosystem nutrient cycling processes in the southern Appalachians, to include: 1) large amounts of seasonally immobilized nutrients in biomass, and associated high annual nutrient transfers to the forest floor; and 2) early shading and recovery of forest floor temperature and moisture conditions, resulting in the recovery of biological activities which control decomposition, mineralization and the potential mobility of nutrients.

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