United States
Department of
Agriculture

Forest Service

Research
Paper NE-475

1981

Effect of Deer Browsing on Timber Production in Allegheny Hardwood Forests of Northwestern Pennsylvania

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MANUSCRIPT RECEIVED FOR PUBLICATION
22 SEPTEMBER 1980

Abstract

Regeneration surveys in fenced and unfenced portions of thirteen 9- to 22-year-old clearcuts on the Allegheny Plateau of Northwestern Pennsylvania show that deer browsing has resulted in (a) inadequate stocking of tree species, (b) delay in establishment, and (c) less valuable species composition. Ninety-two percent of the fenced areas, but only 38 percent of the unfenced areas, are considered satisfactorily stocked. The value of timber production lost as a result of browsing during the regeneration period is estimated to average $1,075 per acre.

Browsing of tree seedlings by white-tailed deer in heavily-forested regions of the Allegheny Plateau in Pennsylvania seriously interferes with tree regeneration. As a result, establishment of a new stand following harvest cutting is often delayed and sometimes prevented entirely. Even where regeneration does occur, timber yields may be diminished by shifts in species composition, reduced stocking, or extended rotations.

The effects of deer on regeneration establishment, species composition, and density have been abundantly documented. A summary of many of these articles is available,[1] and a history of the problem has been published (Marquis 1975). However, information on the value of timber production lost due to browsing is scarce. Records on the long-term development of stands damaged by deer have not been available to permit calculations of yield losses, and data have not been available to estimate the proportion of stands affected.

Although good data remain limited, a series of deer exclosures created in clearcuts on the Allegheny National Forest 9 to 22 years ago now provide records on stand development over a long enough period for crude estimates to be made on ultimate timber yields of the fenced and unfenced stands. This is a report on those stands and the projected losses resulting from deer browsing.

[1] Marquis, David A., and Ronnie Brenneman. The impact of deer on forest vegetation in Pennsylvania. USDA For. Serv. Gen. Tech. Rep., Broomall, Pa. (in preparation).

Study Methods

During the 1950's and 1960's Allegheny National Forest personnel installed a series of deer exclosures in various stands throughout the four-county area included within the Forest boundary in northwestern Pennsylvania. Most of the exclosures were located in recently cutover areas. In 1971 and 1977, vegetation surveys were made on plots both inside and outside 13 of the exclosures. The three oldest clearcuts had also been surveyed in 1960. All fences in the 13 areas had been erected shortly after clearcutting of the second-growth Allegheny hardwood stand that previously occupied the site (Table 1).

A cluster of nine sample plots was located inside and another cluster outside of each exclosure. The sample plots were arranged in three rows of three plots each, with 40 feet between plots. The cluster outside of the exclosure was located in an area as similar as possible to that inside the fence, based on topography, drainage, and residual stand density. The center plot of the outside cluster was located at least 100 feet from the fence to avoid atypical conditions that sometimes exist in the heavily traveled zone near the fence.

The nine sample plots used in each stand in this study would not provide an adequate sample on which to evaluate regeneration on an entire clearcut, but were considered satisfactory here because the total area evaluated was limited to the 1/2-acre inside or the similar area outside the deer exclosure.

Table 1.—Exclosures surveyed

Stand No.	Sale area	Cutting complete	Fence built	Fence height	Acres exclosed	Acres clearcut
101	Railroad Run	1966	1966	6′	0.5	3
102	North Branch Sugar Run	1965	1966	6′	0.5	30
103	Hemlock Run	1966	1966	6′	0.5	39
104	Wolf Run	1969	1969	8′	8.0	15
105	Slide Run No. 2	1963	1963	8′	0.5	35
106	Long Hollow	1965	1966	8′	0.5	26
107	Lower Morrison	1965	1966	8′	0.5	16
108	Fork Run	1966	1966	8′	0.5	28
109	Farnsworth	1965	1966	8′	0.5	16
110	Kinzua Trail	1965	1966	8′	0.5	2
113	Chappel Fork	1957	1957	8′	1.0	3
114	Cherry Grove	1957	1957	8′	1.2	3
120	Silver Creek	1956	1957	8′	1.0	3

Sample plots were circular, with a radius of 6 feet. The number of stems was recorded by species and height classes in all the inventories, and the exact height of the tallest individual of each important species was recorded in 1971. Percentage of ground area covered by six major groups of herbaceous ground-cover plants was also recorded. During the 1977 survey, a 100 percent tally was made of all trees 0.5 inch dbh or larger, by species and diameter class, on the four oldest areas. Data from the 1960 and 1971 surveys were published (Marquis 1974, Jordan 1967).

The Student's t-test for paired observations was used to make statistical comparisons between fenced and unfenced plots. Several species groups are mentioned throughout the data tabulations that follow. Preferred species are those preferred for timber production; they include black cherry, sugar maple, red maple, yellow-poplar, cucumber tree, and red oak. Other commercial species include beech, yellow birch, black birch, other oaks, hickory, aspen, and hemlock. Noncommercial species include pin cherry and striped maple.

Deer populations in the four-county area of the Allegheny National Forest during the time that these clearcuts were made are not precisely known. Estimates made by the Pennsylvania Game Commission in 1980 place the current pre-hunting-season population at 28 to 30 deer per square mile. Records of antlered deer harvest indicate that deer populations during the mid-1950's and mid-1960's—when the study stands were clearcut—were approximately the same as now (about 25 deer per square mile). Deer populations rose to between 36 and 39 deer per square mile during the early 1970's, but the cuttings were made much earlier.

Results and Discussion

Tree regeneration

The total number of stems of regeneration present 9 to 22 years after clearcutting did not differ significantly between fenced and unfenced areas. However, there were important differences in species composition and large differences in the number of stems that had grown above 5 feet in height (Table 2).

Table 2.—Average number of stems 9 to 22 years after clearcutting (1977), in thousands per acre

Species	All stems		Stems over 5 feet	
	Fenced	Unfenced	Fenced	Unfenced
Black cherry	7.5	6.5	3.4[a]	0.8
Sugar maple	0.7	0.6	0.3	0.2
Red maple	2.0	1.5	0.4*	0.1
White ash	0.4	0.4	0.1	0.1
Total preferred species	10.7	9.1	4.2[a]	1.2
Beech	1.0	1.7	0.5*	1.0
Birch	0.9	1.2	0.6	0.6
Total other commerical species	2.0[a]	3.0	1.1	1.6
Striped maple	0.4	1.3	0.1	0.5
Pin cherry	0.8	0.1	0.7*	0.0
Total noncommercial species	2.2	4.3	1.1	1.2
TOTAL ALL SPECIES	16.2	16.8	6.8	4.0

[a] Differences between fenced and unfenced areas statistically significant at 0.10 level.
* Differences between fenced and unfenced areas statistically significant at 0.05 level.

The preferred species had been dramatically reduced by browsing outside the fences. There were over three times as many preferred stems over 5 feet tall inside the exclosures as outside. Noncommercial pin cherry was also affected; it was nearly eliminated by browsing in the unfenced areas.

Conversely, less desirable beech and noncommercial striped maple were favored by preferential browsing on the other species. There were about twice as many stems of these species in the unfenced plots as in the exclosures.

The total number of stems over 5 feet tall in the fenced plots was 150 percent of that in the unfenced ones. However, there were still 1,200 stems per acre of preferred species over 5 feet tall in the unfenced plots—on the average. If evenly distributed, that would be enough stems to establish desirable new stands. To evaluate the impact of deer in delaying or preventing establishment, we needed to determine how many of the clearcuts were adequately stocked.

Current guidelines for evaluation of regeneration stocking after clearcutting require that 70 percent of the 6-foot radius plots in a stand contain at least two stems over 5 feet in height. The terminals of such stems are considered tall enough to escape further browsing (although occasionally damage does occur on stems taller than 5 feet, especially where the stem is isolated and other adjacent browse is scarce). For stands that have not yet achieved this level of stocking (usually because they are too young), the potential for success is assessed by calculating the average of (a) the proportion of plots that are stocked with 5 stems over 3 feet tall and (b) the proportion of plots that are stocked with 25 stems total. All of the above stocking criteria are calculated for preferred species alone, and for the commercial species together.

During the first 5 years or so after clearcutting, regeneration is small and the percentage of plots stocked with 2 stems over 5 feet is still increasing. At this time, the percentage of plots stocked with 5 stems over 3 feet and 25 stems total is ususally higher, and indicates how much the stocking of stems over 5 feet is likely to increase in the future. However, after 5 to 10 years, as the canopy in portions of the stand closes and crowding reduces the total number of stems, the proportion of plots with 5 stems over 3 feet and 25 stems total decreases, and drops below the proportion of plots stocked with 2 stems over 5 feet. Between 5 and 15 years, the total number of stems over 5 feet tall also begins to decline (Fig. 1), and this indicates that further improvement in stocking is unlikely. Those plots not stocked at this time are usually dominated by noncommercial species or are open; in either case, stocking is usually fixed.

Figure 1.—Change in regeneration with stand age. Dashed line indicates expected trend—no data collected during that period.

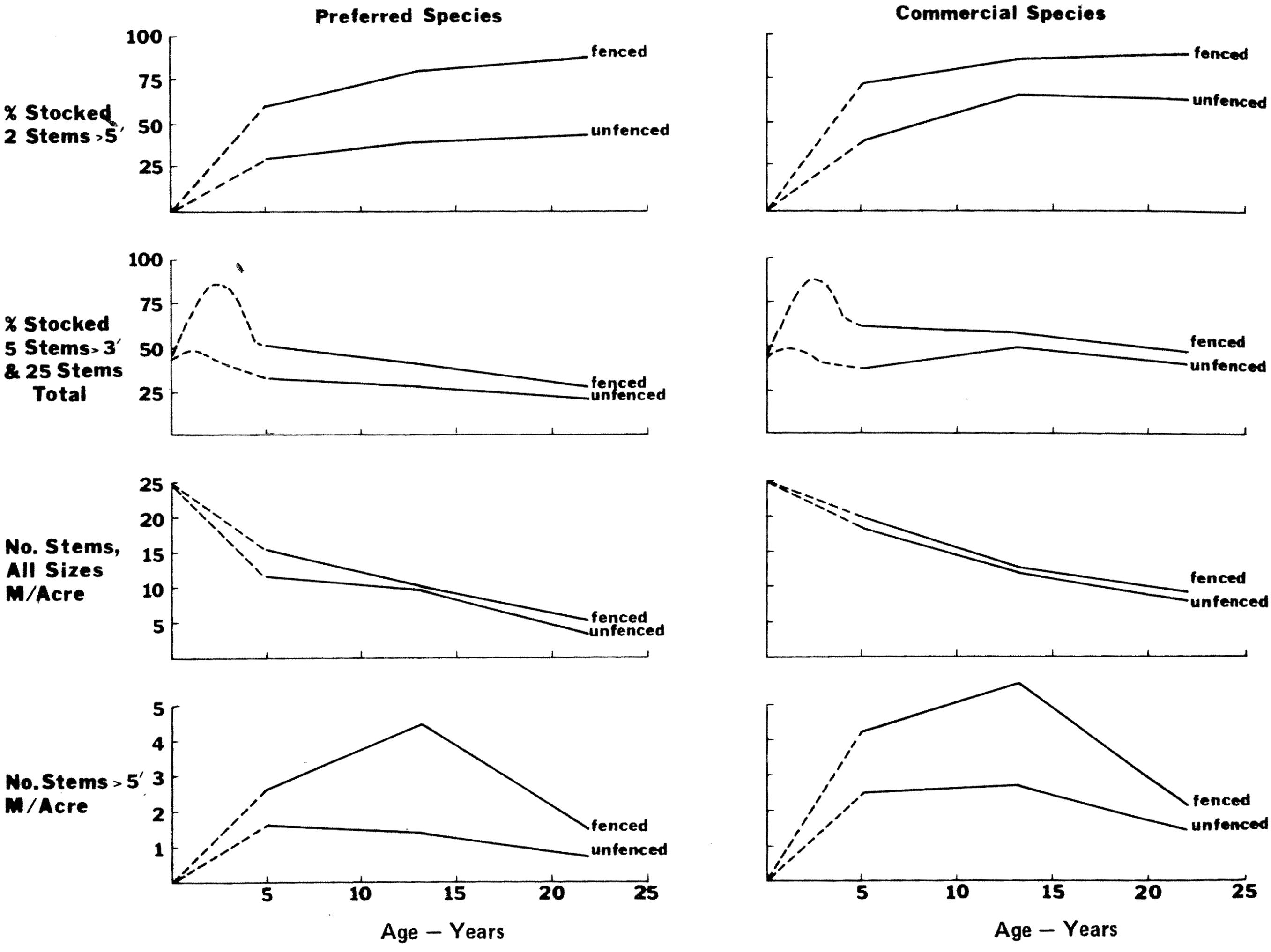

Table 3.—Percentage of plots stocked to given levels with preferred and commercial species 9 to 22 years after clearcutting (1977)

Stand no.	Fenced				Unfenced			
	Two stems over 5 feet		Five stems over 3 feet and 25 total		Two stems over 5 feet		Five stems over 3 feet and 25 total	
	Preferred species	Commercial species	Preferred species	Commercial species	Preferred species	Commercial species	Preferred species	Commercial species
101	78	89	39	72	56	89	56	78
102	22	22	11	11	0	22	0	6
103	56	67	22	22	0	22	0	11
104	100	100	94	100	44	44	78	84
105	67	78	44	56	0	0	0	0
106	67	89	39	66	89	100	34	56
107	56	100	16	66	0	100	0	44
108	89	100	16	66	11	78	11	78
109	100	100	44	72	67	100	28	61
110	100	100	72	84	100	100	94	100
113	89	89	22	28	100	100	50	62
114	78	89	44	56	22	44	16	38
120	78	89	22	56	8	46	0	27

In the 9- to 22-year-old clearcuts, nearly all stands have reached the condition where further improvement in stocking is unlikely. Only one stand, the unfenced portion of stand 104, has potential for significantly improved stocking (Table 3). Thus, estimates of the impact of deer browsing on regeneration in these clearcuts can be made with reasonable assurance that the stocking observed now will not change appreciably in the future.

Table 3 shows that stocking of preferred species and of all commercial species is dramatically higher in the fenced plots. Less than one-third of the clearcuts where deer were able to browse are staisfactorily stocked with preferred species, whereas most stands are staisfactorily stocked inside the exclosures (Table 4).

Table 4.—Percentage of clearcuts satisfactorily stocked with two stems over 5 feet[a]

Species	Fenced	Unfenced
Preferred	77	31
Commercial	92	54

[a] Although 70 percent is usually considered the minimum for acceptable stocking, 67 percent was accepted in this study. This is equivalent to 6 of 9 plots—7 of 9 plots (78 percent) would have been unnecessarily restrictive.

Differences between fenced and unfenced areas statistically significant at 0.05 level.

Although only four of the 13 clearcuts were old enough to have formed a closed stand (with a few trees as large as 10 to 11 inches dbh and average stand diameter for all four stands of 2.5 inches), they provided a means of comparing stocking estimates from the regeneration surveys with traditional stand data used in silvicultural operations.

Stocking values from the 100 percent tallies are remarkably well correlated with stocking values for commercial species from the regeneration surveys (Table 5). The number of stems and basal area in preferred species (100 percent tally) are also very closely related to the stocking of preferred species (regeneration tally).

The effects of browsing on ultimate species composition are reemphasized by these stand data. Note that the basal area in preferred species is nearly three times higher in the five stands with 70 to 100 percent regeneration stocking (four of which were fenced) than in the three stands of lower stocking (all of which are unfenced). Conversely, the basal area of less desirable beech, birch, and hemlock is three times lower. The most extreme effect is on pin cherry—25 square feet of basal area versus only 1 square foot. Pin cherry is diminished drastically by preferential browsing in all of the unfenced stands, probably because it is a fast-growing species that is succulent and attractive to deer and it grows above the other vegetation quickly where it is naturally singled out. A common observation is that the presence of large amounts of pin cherry (or *Rubus*) indicates that browsing pressure is not severe and that desirable regeneration will probably emerge.

Table 5 also shows that browsing in an area of very high regeneration potential can actually be beneficial. Stand 113 is such a stand—it contained about 70,000 stems per acre of preferred species at 4 years of age, far more than any other stand (the average was 16,000 and the second best stand had 40,000). In stand 113, there were far too many seedlings present for deer to prevent the establishment of a new stand. But browsing has drastically reduced the very dense stocking of pin cherry from 45 square feet of basal area in the fenced stand to 9 square feet in the unfenced one. The dense pin cherry in the fenced area adversely affected preferred species —leaving only 33 square feet of preferred species as opposed to 81 square feet in the unfenced area. These differences will probably decrease as the pin cherry begins to die out and previously suppressed stems of other species grow into the 1-inch class. But deer browsing in this unusual case will probably result in higher proportions of black cherry in the unfenced stand and slightly better early growth.

Average stand diameter is slightly greater where browsing has occurred. Presumably the lower overall stocking and lack of overtopping pin cherry permit those few trees that escaped deer in the unfenced areas to grow faster than the larger number of stems that are subject to more severe competition in the fenced areas. However, this slightly larger stand diameter cannot offset the poor stocking and scarcity of preferred species in most unfenced areas. Furthermore, data on average height show that the preferred species averaged 9.2 feet in the fenced areas in 1971 versus only 5.7 feet in the unfenced areas (Marquis 1974)—a good indicator that overall stand development had been delayed by browsing.

From preceding data on all 13 stands, it is apparent that excessive deer browsing can have three major effects on the establishment of tree regeneration: (a) inadequate stocking of commercial tree species; (b) delay in establishment, which in-

Table 5.—Comparison of stocking as estimated from regeneration plots versus 100 percent tallies by dbh class—four oldest clearcuts, 1977

		Regeneration plots		100 percent tally									
		Two stems over 5 feet				No. trees/acre		Basal area					
Percent stocking	Stand no.	Preferred	Commercial	Stocking[a]	Average stand diameter	All	Preferred	All	CAPs[b]	Red maple	All Preferred	Beech Birch Hemlock	Pin cherry
		Percent			Inches			Sq. ft./acre					
70-100	105F	67	78	79	1.9	3,060	2,180	63	19	18	37	3	23
	113F	89	89	86	2.7	2,024	1,428	78	20	13	33	1	45
	113UF	100	100	84	3.0	1,892	1,664	92	56	25	81	2	9
	114F	78	89	79	2.3	2,313	1,244	67	16	17	33	18	15
	120F	78	89	86	2.1	2,828	964	69	13	2	15	19	34
	Average	82	89	83	2.4	2,423	1,496	74	25	15	40	9	25
50-70	None												
30-50	114UF	22	44	68	3.0	2,312	280	61	8	15	23	34	1
	112UF	8	46	66	2.8	1,424	196	59	10	1	11	45	3
0-30	105UF	0	0	10	—	108	36	9	0	7	7	2	0
	Average	10	30	48	2.9	932	171	43	6	8	14	27	1

[a] Roach, 1977.
[b] CAPs are black cherry, white ash, and yellow-poplar (nearly all cherry in these stands).

creases the time required to grow trees to merchantable size; and (c) less valuable species composition. Each of these effects may occur in varying degrees.

To provide a measure of the overall impact of deer browsing on Allegheny hardwood timber production, I used the stocking information in Table 3 to estimate the final stocking and species composition and the amount of increase in rotation age for fenced and unfenced portions of the 13 clearcuts.

Without deer browsing, regeneration would become established within 10 years after cutting, so I did not assign a delay in establishment to any stand stocked with at least two commercial stems over 5 feet tall on at least 67 percent of the plots by age 10. Stands not stocked at 10 years of age but stocked at 20 years of age were assigned a 10-year delay. Stands not stocked at the last tally, but showing potential for improvement in stocking (as evidenced by more plots stocked with 5 stems over 3 feet tall and 25 stems total than currently stocked with 2 stems over 5 feet tall) were assigned an additional 10-year delay. In these plots with potential for improvement, final stand stocking was assumed equal to the average proportion of plots now stocked with 5 commercial stems over 3 feet and 25 commercial stems total, and the final percentage of preferred species was assumed to be the same as the percentage of plots that now contain them.

Stands showing no potential for improvement in stocking were assigned final stand stocking equal to the proportion of plots stocked with two commercial stems over 5 feet tall, and final percentage of preferred species was assumed to be the same as the percentage of plots that now contain them. No additional delay in establishment was assigned to stands that did not exhibit potential for improvement.

For example, unfenced stand 104 is only 44 percent stocked at age 9, but shows potential for improvement as evidenced by the larger proportion of plots with 5 stems over 3 feet and 25 stems total. So, it is assigned a 10-year delay in establishment on the assumption that stocking will improve during the next 10-year period. Final stand stocking is estimated to be 84 percent—the average proportion of plots now stocked with 5 commercial stems over 3 feet and 25 commercial stems total. Of the 84 percent of plots thus stocked, 78 percent are also stocked with preferred species; so preferred species composition of the final stand is estimated as 78/84 or 93 percent preferred species. Unfenced stand 114 is also only 44 percent stocked at age 21, but shows no potential for improvement. So, final stand stocking is estimated at 44 percent, and final preferred species composition is estimated by the relative proportion of these plots also stocked with preferred species (22/44 or 50 percent). No delay in establishment is assigned this stand. It has not improved in stocking since age 10 and shows no potential for future improvement. It was "established" within the first 10 years after cutting at an unsatisfactory level. Estimates for all stands are shown in Table 6.

Table 6.—Estimated final preferred species composition, stocking, and delay in establishment

	Fenced			Unfenced		
Stand no.	Preferred species	Stand stocking	Delay	Preferred species	Stand stocking	Delay
	Percent		*Years*	*Percent*		*Years*
101	88	89	0	63	89	0
102	100	22	0	0	22	0
103	84	67	0	0	22	0
104	100	100	0	93	84	10
105	86	78	0	0	0	—
106	75	89	0	89	100	0
107	56	100	0	0	100	0
108	89	100	0	14	78	0
109	100	100	0	67	100	0
110	100	100	0	100	100	0
113	100	89	0	100	100	0
114	88	89	0	50	44	0
120	88	89	0	17	46	0

If areas that regenerate with at least 50 percent preferred species, establish without delay, and achieve at least 67 percent stocking are considered satisfactory, then 92 percent of the fenced areas but only 38 percent of the unfenced areas have regenerated successfully. Of the 62 percent of the stands that failed to regenerate outside the fence, 87 percent regenerated successfully inside the fence. Thus, deer browsing was directly responsible for 87 percent of the failures.

Since browsing can damage advanced seedlings before cutting, and the fences in this study were not erected until after cutting, the failure of regeneration in the one fenced area (stand 102) may also be due, at least in part, to deer browsing. On the other hand, we have now learned that the proportions of failures can be greatly reduced by restricting clearcutting to areas that have abundant advance regeneration and by encouraging the establishment of additional advance seedlings through shelterwood cutting (Marquis and others 1975). Such measures require additional expenditures and cannot be applied on some areas, but will reduce the number of failures if applied where appropriate.

Ground cover vegetation

Deer browsing has affected ground cover vegetation as well as tree regeneration. During the first 10 years after cutting, there was considerably more *Rubus* in the fenced areas than the unfenced ones. *Rubus*, like pin cherry, is browsed preferentially by deer, and often nearly eliminated. As the stands aged and canopies closed, the amount of *Rubus* declined in all stands. But in spite of the greater crown closure on the fenced plots, considerably more *Rubus* remains there than in areas subject to browsing (Table 7).

Fern coverage, on the other hand, was not appreciably different between the fenced and unfenced areas in the early years after cutting (1971), but large differences developed. As the crown canopy closed in the fenced areas, the amount of fern there declined. But in the unfenced areas, both fern and grass increased because browsing continued to prevent crown closure and *Rubus* was reduced (Table 7).

Data from other studies, where fences were erected in clearcuts that had previously failed to regenerate, show that protection from browsing even 10 years after cutting quickly results in the reemergence of *Rubus* and suppression of ferns and grass (Marquis and Grisez 1978). Thus, fern and grass appear to expand primarily in areas where browsing or other factors have prevented the development of tree seedlings and *Rubus* that would normally occupy the site. The abundance of fern and grass on the Allegheny Plateau and the difficulties in obtaining seedling regeneration in the presence of these plants (Horsley 1977a, 1977b) may therefore be an indirect effect of deer browsing.

Table 7.—Percentage of plots with more than 30 pe cent ground cover

Ground cover	1971		1977*	
	Fenced	Unfenced	Fenced	Unfen
Rubus	57[a]	39	32*	8
Ferns	23	20	21[a]	36
Grass, sedge	6	20	4*	23

*Differences between fenced and unfenced areas statistica significant at 0.05 level.

[a] Differences between fenced and unfenced areas statistica significant at 0.10 level.

Value of Timber Production Lost Due to Deer

In order to make a crude estimate of the effect of deer browsing on timber production, I developed a multiple regression equation to estimate timber value at maturity (assumed to be 80 years) as a function of species compositior Stand table data from 33 Allegheny hardwood stands rang in age from 55 to 80 years were projected to a common ag of 80 years with a computer stand growth simulator at the Forestry Sciences Laboratory, Warren, Pennsylvania. Boar foot and cubic-foot volumes for these stands were calculat from local volume tables. Stand values (stumpage) were est mated from information on average grade distribution (Err and Marquis 1979), with stand value computations followi the techniques described by Debald and Mendel (1976). Then, multiple regressions were fitted to the data to predic stand value from species composition and other stand variables.

To estimate stand value, I found that both the percentage of black cherry and the percentage of other preferred species had to be included in the regression. Furthermore, the average diameter of these species groups was important, and it varied due to past cutting practices and other factors. Since had no way to predict these variables from the regeneratior data in this study, I fixed these variables as follows: (a) I assumed that two-thirds of the preferred species were black cherry and one-third were other preferred species, and (b) I set the average black cherry diameter at 18 inches and the average diameter of other species at 12 inches. These diameter values are well within the normal range expected at ma turity, and the high proportion of black cherry in the preferred species is consistent with the dominance of black che ry in most third-growth regeneration.

The end result was an equation that permitted me to estimate mature stand value as a function of the percentage of preferred species in the regeneration. Although this equation is a gross oversimplification and could be in considerable error for any individual stand, it does provide a means of making an educated guess at stand value. Since the same equation was used for both fenced and unfenced areas, the result should at least reflect relative differences.

The curvilinear equation is:

$$Y = 40.964 - 6.323X + 0.72624X^2 - 0.0037266X^3$$

where

Y = stand value in dollars per acre, at age 80, where black cherry average diameter is 18 inches and other species (excluding saplings) average 12 inches in diameter.

X = percentage of final basal area in preferred species. Assume that two-thirds of this is black cherry and the balance is sugar and red maple.

This equation is used to calculate values for each fenced and unfenced stand with the proportion of preferred species shown in Table 6. These values were then reduced in direct proportion to the amount of understocking or delay in establishment, also shown in Table 6. For example, stands with 89 percent stocking were reduced in value by 11 percent; stands with a delay of 10 years in establishment were reduced in value by 13 percent (10 years of 80-year rotation). All values are shown in Table 8.

On the basis of these estimates, the average stumpage value of the fenced stands is expected to be $2,177 per acre at maturity, while the value of unfenced stands is expected to be only $1,102 per acre. This represents an average loss of $1,075 per acre for all stands clearcut. If you assume that all stands under even-age management will be harvested and regenerated over an 80-year rotation, the value from timber production would average about $27 per acre per year, while losses from deer damage would amount over $13 per acre per year across the entire Allegheny Plateau. These, of course, are stumpage values. Values of sawed lumber, veneer, furniture, or paneling manufactured from this timber would be several times greater.

The reader is again cautioned that these values are only crude estimates. Furthermore, it is not intended that you use these figures to argue the relative value of timber or deer. Both are extremely important resources and both can be obtained from the same forest area if properly managed. But these estimates illustrate that timber losses due to high deer populations in northern Pennsylvania are very large. Much of this loss could be avoided by a reduction in deer population—and that reduction might be achieved with only a minor impact on Pennsylvania's deer hunting resource.

Table 8. Estimated stand values at 80 years of age, in dollars per acre

Stand no.	Fenced			Unfenced		
	Fully stocked	Reduced for stocking	Reduced for delay	Fully stocked	Reduced for stocking	Reduced for delay
101	2,569	2,286	2,286	1,593	1,417	1,417
102	2,944	648	648	41	9	9
103	2,425	1,625	1,625	41	9	9
104	2,944	2,944	2,944	2,737	2,299	2,000
105	2,498	1,948	1,948	41	0	0
106	2,080	1,851	1,851	2,604	2,604	2,604
107	1,310	1,310	1,310	41	41	41
108	2,604	2,604	2,604	85	66	66
109	2,944	2,944	2,944	1,757	1,757	1,757
110	2,944	2,944	2,944	2,944	2,944	2,944
113	2,944	2,620	2,620	2,944	2,944	2,944
114	2,569	2,286	2,286	1,075	473	473
120	2,569	2,286	2,286	125	58	58
Average			2,177			1,102

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Scientific Names of Trees Mentioned in This Report

Common name	*Scientific name*
Sugar maple	*Acer saccharum* Marsh
Red maple	*Acer rubrum* L.
Striped maple	*Acer pensylvanicum* L.
Yellow birch	*Betula alleghaniensis* Britton
Black birch	*Betula lenta* L.
Hickory	*Carya* spp.
Beech	*Fagus gradifolia* Ehrh.
White ash	*Fraxinus americana* L.
Yellow-poplar	*Liriodendron tulipifera* L.
Cucumber-tree	*Magnolia acuminata* L.
Aspen	*Populus gradidentata* Michx. or *Populus tremuloides* Michx.
Black cherry	*Prunus serotina* Ehrh.
Pin cherry	*Prunus pensylvanica* L.
Red oak	*Quercus rubra* L.
Eastern hemlock	*Tsuga canadensis* (L.) Carr.

☆U.S. GOVERNMENT PRINTING OFFICE: 1981-703-011/54