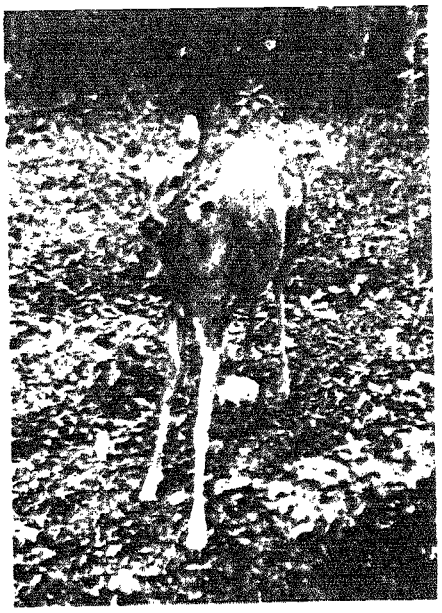

by James S. Jordan

DEER BROWSING IN NORTHERN HARDWOODS AFTER CLEARCUTTING

effect on height, density, and stocking of regeneration of commercial species

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DEER BROWSING

IN NORTHERN HARDWOODS AFTER CLEARCUTTING

Timber & Game

THERE is a close relationship between management of forest land for timber and management for game. This is especially evident in the use of cutting practices that yield both timber and deer browse.

The relationship reaches almost symbiotic proportions in northern hardwoods after clearcutting for stand regeneration. Usually an abundance of woody vegetation — both commercial and noncommercial species — is produced; and much of this can be utilized by deer with no undesirable effect on the composition and growth of the future stand. Under light to moderate browsing, seedlings of commercial species may actually undergo less competition because deer prefer the faster-growing sprouts. And stands of seedling origin are generally thought to be of higher quality than those of sprout origin.

The problem common to both timber management and deer management arises with overbrowsing. In northern hardwoods,

the species most commonly affected are those that are about equally important as sources of both browse and timber: sugar maple, red maple, yellow birch, black cherry, and white ash.

Direct evidence of overbrowsing in these species is a high proportion of browsed twigs, reduced height of stems, and a hedged appearance of seedlings. The low rate of seedling density that often accompanies evidence of overbrowsing, and which is generally presumed to be the result of heavy browsing, is more serious. But this may also be the result of the influence of other factors (poor soil or poor drainage, or plant competition). Thus there is the possibility that factors other than browsing may be implicated in the unsatisfactory conditions that occur.

One of the simplest ways to isolate the influence of deer browsing from other factors is by using deer exclosures. If browsing is heavy, the contrast between protected and unprotected areas may be rather striking within a few years. Such contrasts in vegetation have been reported by Dahlberg and Guettinger (1956), Hosley (1956), Grisez (1959), and Shafer *et al.* (1961). Other examples, mostly unpublished, are commonly encountered throughout the Northeast in areas that have a long history of overbrowsing.

This is a report on the height, density, and stocking of commercial species protected and unprotected from deer browsing for several years on experimental clearcut areas on the Allegheny National Forest in northwestern Pennsylvania. The purpose is not only to describe the effects of browsing but also to examine these effects in relation to recent guides[1] for minimum density and stocking of regeneration in Allegheny hardwoods and also in relation to apparent differences in the capability of the areas to regenerate themselves.

The question of these relationships was not initially a part of the study, so the experimental design did not provide for certain variables that otherwise would have been controlled. Nevertheless the results indicate the complexity of the problem of striking a balance between browse utilization and stand regeneration and establishment.

[1] Tentative guides recently adopted by the Allegheny National Forest as a basis for timber management in Allegheny hardwoods.

Exclosures & Methods

Three exclosures were constructed by Allegheny National Forest personnel in pulpwood and small sawtimber stands that had been clearcut for regeneration of black cherry and associated hardwoods. Each exclosure was about 1 acre in size and was protected from deer browsing by a heavy-gage wire fence 8 to 9 feet high. Adjacent to each exclosure was an unfenced check area of equal size.

The exclosures were installed for administrative study of regeneration after clearcutting and as demonstrations of the impact of deer browsing on vegetation. They were selected for our study because, out of a total of about 10 experimental clearcut areas available, they were the only ones in which exclosures had been erected.

It was assumed that the deer population in the vicinity of each exclosure was about the same and that browsing pressure was heavy. There is abundant evidence that the deer population on the Forest has been out of balance with the food supply for many years.

There were differences among the three clearcuttings in age, and in the period of time with and without protection from deer browsing (table 1). None of the differences exceeded about 1½ years. However, the most important difference — the period of time without protection for the exclosed areas — had little influence because it occurred immediately after cutting and while seedlings were still small, snow-covered in winter, and less vulnerable to browsing.

Milacre plots, located by a completely randomized design, were used in sampling. Stems were counted, by species, in 2-foot height classes of 2, 4, and over 5 feet. The unit of measurement was a single stem. The statistical unit for density was the total number of stems per milacre plot for all commercial species (black cherry, sugar maple, red maple, beech, yellow birch, white ash, and aspen), and for black cherry separately. For determination of stocking rate, a stocked milacre plot was considered to be one that contained at least one stem in the above species categories.

Table 1. — Age, treatment, and period of protection from deer browsing for three areas clearcut for hardwood regeneration, Allegheny National Forest

Location of cutting	Date of cutting	Age of clearing, 1960	Treatment	Period protected	Period unprotected
		Years		*Years*	*Years*
Silver Creek	Winter 1955-56	4½	Fenced Jan. 1958	2½	2
			Unfenced	—	4½
Cherry Grove	Winter 1956-57	3½	Fenced July 1957	3	½
			Unfenced	—	3½
Chappel Fork	Winter 1956-57	3½	Fenced March 1957	3¼	¼
			Unfenced	—	3½

The hypothesis tested at the 5-percent level of significance was that the number of stems per acre and the stocking rate were greater within each fenced area. The "t" test for comparison of two groups of equal size (Snedecor 1956, pp. 87-90) was used to test the hypothesis.

Measurements were also taken on fire cherry; but comparisons in this species, as well as those in any height class for other species, were made only by inspection of the data.

Results & Discussion

The difference in the number of stems for all commercial species (table 2), and for black cherry alone, was not great enough at each location to be significant at the 5-percent level. It may well be that the sample size was too small to detect significant differences in populations with inherently large variation. Subsequent work with seedling regeneration indicated that not less than 40 sample plots are required to estimate means at the 5-percent level. Thus, if it is assumed that the samples in this study gave unbiased estimates of the population differences and variances, then the sample size was too small to judge the differences real.

The negative difference at Chappel Fork (table 2) would nor-

mally be attributed to chance, but it is interesting to speculate that browsing in the unfenced plot may have been selective on sprouts and noncommercial species (fire cherry, shrubs, *Rubus* spp.), thereby reducing competition with the seedlings of commercial species.

The overall stocking rates for commercial species at each location were the same (table 3); for black cherry the only difference — at Cherry Grove — was not significant.

But inspection of the data (table 3) for Silver Creek and Cherry Grove revealed a pattern of a consistently larger number of stems at each height class within the exclosures as compared with those outside. In general, there was also an increase of the magnitude of this difference in each succeeding height class. This was most striking in fire cherry at all locations.

The difference in stocking rates within height classes at each of the two locations followed a pattern somewhat similar to that for density, except for a reversal of the pattern in the 2-foot class for commercial species.

The best explanation for the results found at Silver Creek and Cherry Grove is that deer browsing reduced the height of seedlings, and also the density of seedlings in each height class. The apparent higher rate of stocking in the 2-foot class outside these exclosures could be explained as an accumulation of seedlings

Table 2. — Summary of tests of the difference in mean number of stems of commercial hardwoods protected and unprotected from deer browsing at three locations on the Allegheny National Forest

Exclosure location	Treatment	No. of milacre plots	df	$\bar{X}$ No. Stems	Diff. $\bar{X}_1 - \bar{X}_2$	Calculated t	Tabulated $t_{.05}$
Silver Creek	Fenced	12	11	5.7	3.2	1.09	1.72
	Unfenced	12	11	2.5	—	—	—
Cherry Grove	Fenced	11	10	12.1	9.4	1.41	1.72
	Unfenced	11	10	2.7	—	—	—
Chappel Fork	Fenced	12	11	61.9	—14.6	< 1.0	1.72
	Unfenced	12	11	76.5	—	—	—

Table 3. — Density and stocking rates, by height classes, for hardwood regeneration protected and unprotected from deer browsing after clearcutting, Allegheny National Forest

Location	Stem height class	Commercial spp.		Black cherry		Fire cherry	
		Stems per acre	Stocked plots	Stems per acre	Stocked plots	Stems per acre	Stocked plots
	Feet	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*
				SILVER CREEK			
Fenced	2	3,666	67	2,333	50	500	25
	4	1,583	67	1,500	58	667	42
	5+	417	25	417	25	1,833	67
	2-5+	5,666	83	4,250	75	3,000	75
Unfenced	2	2,417	83	1,667	75	166	17
	4	83	17	83	8	0	0
	5+	0	0	0	0	0	0
	2-5+	2,500	83	1,750	75	166	17
				CHERRY GROVE			
Fenced	2	8,454	72	3,091	27	273	27
	4	2,909	36	1,818	27	636	36
	5+	727	54	273	27	1,364	63
	2-5+	12,090	82	5,182	63	2,273	81
Unfenced	2	2,454	82	364	25	182	9
	4	182	18	0	0	0	0
	5+	91	9	0	0	0	0
	2-5+	2,727	82	364	25	182	9
				CHAPPEL FORK			
Fenced	2	59,417	100	50,000	92	2,000	58
	4	2,000	58	1,000	50	1,500	58
	5+	417	25	167	17	3,417	42
	2-5+	61,834	100	51,167	100	6,917	66
Unfenced	2	75,417	100	68,000	100	83	8
	4	750	25	416	25	0	0
	5+	333	33	250	25	0	0
	2-5+	76,500	100	68,666	100	83	8

that did not grow into the 4-foot class because of browsing. Evidence of this was the very low stocking rates in the 4- and over-5-foot classes.

The overall density and stocking rates for all commercial species and for black cherry at Chappel Fork were the highest among the three areas. Browsing pressure at this location appeared to have no harmful effects on the density and stocking rate.

The density and stocking rates for the browsed plots at Silver Creek and Cherry Grove may also be satisfactory with reference to the Allegheny National Forest management guides. For hardwood regeneration from 5 to 10 years after clearcutting on the Allegheny National Forest, the guides specify a density of at least 5,000 woody stems per acre over 1 foot in height, not less than one-third of which must be commercial species; and 70 percent of the sample plots must be stocked with one or more seedlings of commercial species.

The number of stems per acre at the two locations satisfied an

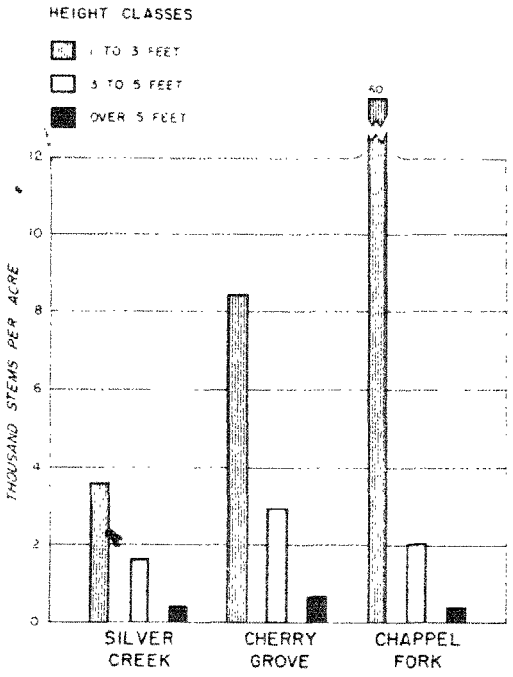

Figure 1. — Density, by height classes, of commercial hardwood regeneration protected from deer browsing on three clearcut areas on the Allegheny National Forest.

important part of these specifications. Whether there was also at least an equal number of noncommercial woody stems was not determined. However, the number of noncommercial stems in clearcut areas generally is greater. And the stocking rates appeared to be satisfactory.

The great difference in the number of seedlings per acre among all locations suggested that there might be inherent differences in the capability of the areas to regenerate themselves. There was a pronounced gradient in the number of stems inside the exclosures (fig. 1), from a low at Silver Creek to a high at Chappel Fork. But this was influenced almost entirely by the density per acre of

Figure 2. — Heavy deer browsing after clearcutting delays the establishment of northern hardwood stands. Open patches like the one in the left foreground were numerous at Silver Creek 10 years after clearcutting.

Figure 3. — The height and density of woody vegetation protected from heavy browsing offers a striking contrast to that in browsed areas. This shows a dense clump of fire cherry after 8 years of protection at Silver Creek.

seedlings in the 2-foot height class. The differences in the next two height classes combined appeared to be unimportant.

Moreover, the rates of stocking in the two height classes were the same (67 percent). This suggested that the number of seedlings per acre in the 4- and over-5-foot height classes was independent of the great variation in density of stems in the 2-foot class, and thus was a better indicator of the capability of these plots (when uninfluenced by deer browsing) to regenerate themselves.

The influence of heavy browsing pressure in the unfenced plots obscured the similarity in density and stocking rates in these two

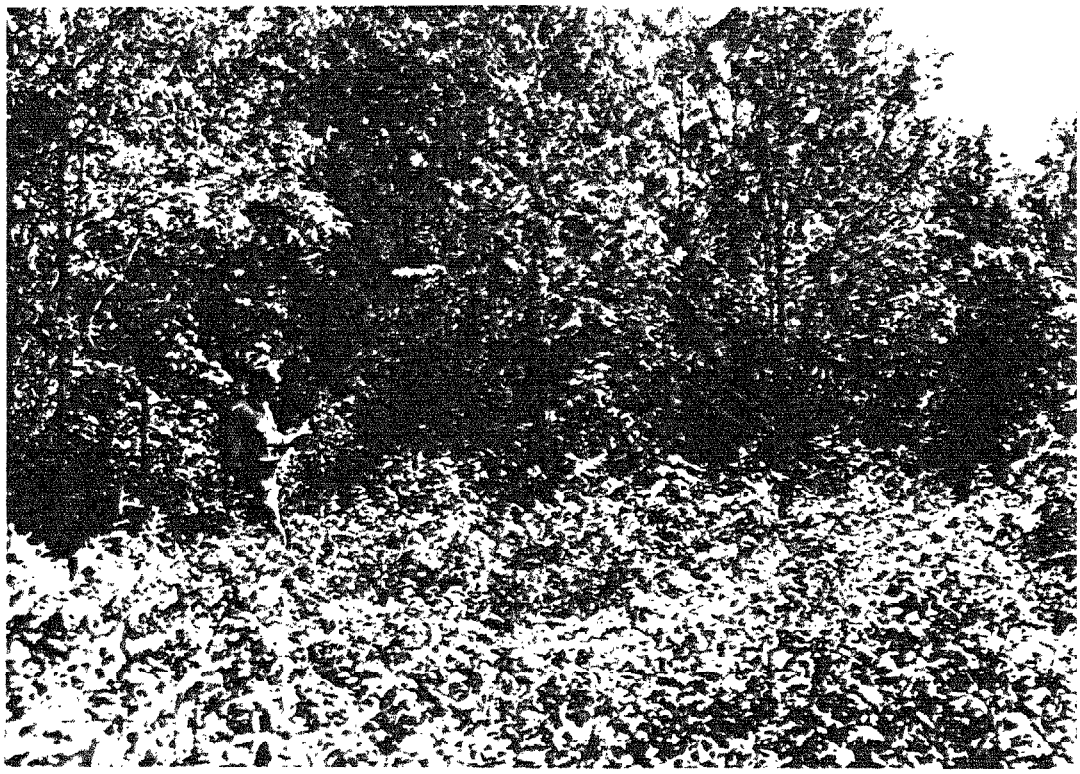

Figure 4. — Although the density of hardwood seedlings may remain high even under heavy browsing, most stems cannot grow out of the reach of deer. The portion of the fenced plot in the background in this view at Chappel Fork contrasts with conditions in the foreground after 9 years of browsing.

height classes. But they may still be a better indicator of the progress of stand establishment than the overall density and stocking rate. The latter values for Silver Creek and Cherry Grove probably are within the requirements of the tentative guides for regeneration, but the comparatively low number of seedlings and the stocking rate for the 4- and over-5-foot height classes indicate that establishment of these stands beyond the reach of deer was at least being delayed by browsing. This may be the case at Chappel Fork as well.

This effect is important for at least two reasons: (1) any delay

in stand establishment adds to the rotation period, and (2) the vulnerability of commercial seedlings to browsing is increased by the length of time the terminals remain within reach of deer. The hazard associated with this is related to the normal sequence of the effects of heavy deer browsing. The first effect is a reduction in the height of seedlings and, with continued browsing, a reduction through mortality in the number of seedlings.

There was also rather uniform evidence from these results that the effect of browsing was selective against seedlings in the 4-foot height class. There were disproportionately fewer seedlings

Figure 5. — Deer prefer sprouts to seedlings, but heavy browsing pressure in clearcut hardwoods for a period of years increasingly favors the faster-growing sprouts. The vigorous sprout clumps in the immediate background in this picture at Chappel Fork have escaped browsing while most of the seedlings are still being held back after 9 years.

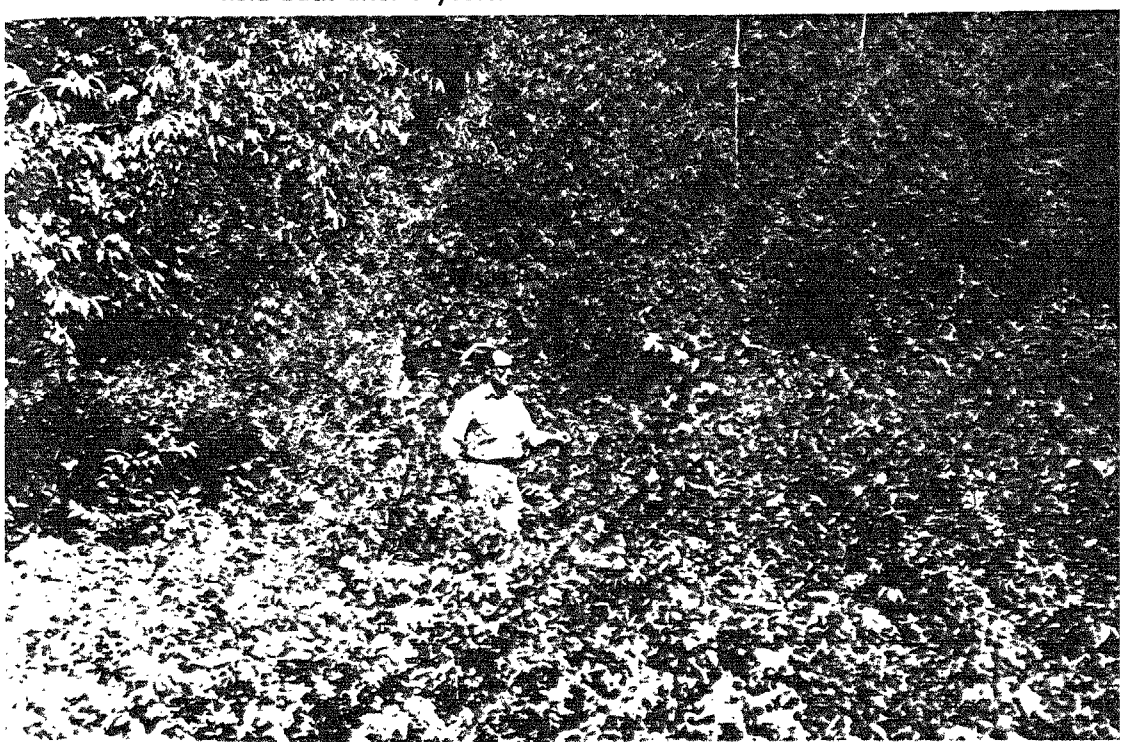

Figure 6. — Successful establishment of northern hardwoods in the Allegheny Plateau means an abundant yield of deer browse and high-quality sawtimber when clearcut at rotation age. The young black cherry shown here is in the poletimber stand adjacent to the Chappel Fork exclosure.

in this class outside of the exclosures at all locations (table 3). This suggests that for these areas under heavy browsing pressure, the density of seedlings in the 4-foot class would yield a more realistic assessment of conditions than the overall number of seedlings per acre. However, no guide is available with which to compare stems per acre in the 4-foot class, nor is there a guide for a minimum stocking rate.

The very low (but probably satisfactory) density of commercial stems for all height classes in the unprotected plots at Silver Creek and Cherry Grove were obviously the result of deer browsing. But this was partly conditioned by the influence of other factors that determined density without browsing; and since this density was not great enough to withstand heavy inroads by deer, both deer browsing and other natural factors are implicated in the low density.

The findings showed that, when subjected to heavy browsing pressure, a density of 5,000 to 12,000 stems of commercial species, and possibly 10,000 to 25,000 stems of all woody species, was not great enough to prevent a delay in stand establishment. There was some evidence that even 60,000 stems per acre of commercial species was not great enough to prevent a delay at Chappel Fork.

From general observations of all areas made 5 years after the study (figs. 2 to 6) it was evident that establishment of the stands was still being delayed by browsing. Numerous patches were found, some large, in which there were no stems of commercial species over 5 feet high.

Conclusions

Several general inferences can be drawn from these results. The most obvious is that heavy browsing in clearcut areas in northern hardwoods can reduce both the height and density of commercial reproduction. The effect seemed to be greatest on stems in the 3- to 5-foot height range, and this carried over to produce an even lower density of stems in the over-5-foot height class.

A satisfactory density and stocking rate for seedling regeneration, determined by current but tentative guides, carries with it no complete assurance that a stand will be established above the height to which deer will browse (4½ to 5 feet). There may at

least be a delay in establishment. This adds to the rotation period and also increases the vulnerability of seedlings to browsing. It seems likely that, the longer the delay, the greater the risk of a further reduction in the density of stems. If this is assumed, then the effect of browsing would be more harmful when seedling density is low to begin with.

The influence of repeated browsing on the growth rate and form of seedlings and the quality of wood produced was not determined, but unpublished results of a study of simulated deer browsing on hardwood seedlings showed that black cherry commonly responds by multiple sprouting from the root collar.

Where browsing pressure is heavy in regeneration stands over 3 years of age, the density and stocking rate of stems above 3 feet in height probably are a better indicator of the progress of stand establishment than if stems under 3 feet are included. Guides for minimum density and stocking rate should be developed for stems above 3 feet in height for areas with large deer populations.

A limited amount of evidence indicates that in seedling stands from 3 to at least 5 years of age, which are not influenced by heavy browsing, the density of stems per acre over 3 feet high is independent of the great variation in those under 3 feet high. The taller stems appear to be a better indicator of the capability of stands to regenerate themselves.

A preference of deer for fire cherry resulted virtually in a biological control of the species.

Literature Cited

Dahlberg, Burton L. and Ralph C. Guettinger.
1956. THE WHITE-TAILED DEER IN WISCONSIN. Wis. Conserv. Dep. Tech. Wildlife Bull. 14. 282 pp., illus.

Grisez, Ted J.
1959. THE HICKORY RUN DEER EXCLOSURE. U. S. Forest Serv. NE. Forest Exp. Sta. Res. Note 87, 4 pp.

Hosley, Neil W.
1956. MANAGEMENT OF THE WHITE-TAILED DEER IN ITS ENVIRONMENT. *In* THE DEER OF NORTH AMERICA. Ed. by Walter P. Taylor, 668 pp., illus. The Stackpole Company, Harrisburg, Pa., and the Wildlife Management Institute, Washington, D. C.

Shafer, E. L., T. J. Grisez, and Ed Sowa.
1961. RESULTS OF DEER EXCLOSURE STUDIES IN NORTHEASTERN PENNSYLVANIA. U. S. Forest Serv. NE. Forest Exp. Sta. Forest Res. Note 121, 7 pp.

Snedecor, George W.
1956. STATISTICAL METHODS. Ed. 5, 354 pp. Iowa State Coll. Press, Ames, Iowa.