VOL. I DECEMBER, 1947 No. 22

BLACK ROCK FOREST PAPERS

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ON OBTAINING NATURAL HARDWOOD REGENERATION

By

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SINCE the autumn of 1927 some 20 experimental improvement cuttings of various types have been established on this Forest. During this period the question "are we using the methods which will induce the maximum amount of natural regeneration" has constantly loomed large. To obtain a moderately reliable measure of the success achieved in this effort called for considerable patience since occasional spot checks showed clearly that accurate data could be gathered only after a fairly long interval. Hence 19 years were let pass before a thorough tally was initiated.

The previous history of this Forest has been set forth in some detail in several of the earlier publications [1, 2, 3]. Up to about 1920 the area suffered from lengthy and continuous over-exploitation and frequent fires, resulting in a too-abundant hardwood sprout population with many of the sprouts showing butt-rot, so our primary objective has been to replace these sickly sprouts with thrifty seedlings. The majority of our operations thus far have been cleanings of one sort or another.

Since a wholly satisfactory concept of our local climax associations has not yet been clearly formulated our cutting policy has been governed largely perforce by the commercial value and the growth rate of the principal species—white oak, white ash, red oak, chestnut oak and hemlock.

The field work for this paper was completed in 1946. A preliminary cursory examination of the various operations indicated the possibility of gathering data sufficiently adequate for an initial evaluation of the success thus far obtained in stimulating seedling reproduction.

While there were a few areas where it had not been feasible to leave untreated controls, customary control methods were used. A series of transects were run through the several cuttings and the adjacent uncut control areas, the lines being so located as to sample the variations in altitude and aspect of each cutting. Stocked quadrat counts were made, using the milacre as a unit. Where each milacre plot occurred in a cutting, a similar plot was established in the adjacent control at approximately identical altitude and aspect. This procedure yielded paired samples for statistical analysis later on.

Each transect line and each plot was numbered, and the number, species and age of all seedlings found on each plot were recorded. The plots were classified by stocking as follows:

Bare . . . . No seedlings
Understocked . . . . 1-2 seedlings per plot
Adequately stocked . . . . 3-6 seedlings per plot
Overstocked . . . . 7 and over seedlings per plot

Experience to date indicates that a minimum of 3000 seedlings per acre is necessary to guarantee a fully stocked stand at maturity. Omitting non-productive portions such as swamps and alpine areas, this survey sampled some 30-40% of the potentially productive part of the Forest. Table 1 below summarizes the degrees of stocking found by percent of plots tallied.

Some further study revealed the existence of an interesting correlation between the age of a plot (i.e., the number of growing seasons elapsed since the cutting) and the percent of plots showing adequate stocking. It was noted that of the older plots (those averaging 13 years) 49% show adequate stocking against 40% for the younger samples. In this analysis, the correlation coefficient was 0.611, with 16 degrees of freedom.

These field counts support in substantial fashion the belief that this is primarily a hardwood section with the oaks predominating and carrying, in addition, a not-to-be-lightly-disregarded amount of hemlock on the sites commonly associated with this species. It has been put forth [1, 2,] that before exploitation and burning began here this Forest supported the same species which are now present, but in markedly different numerical representation. It is felt that this hypothesis is still tenable. Certainly the tract supports today, and as an obviously direct consequence of previous abuse, a disagreeably high array of both weed species and sprouts which may be a notch or two above the weed classification, yet are low in the scale of commercial values.

TABLE 1

Density of Stocking

	Age of Seedlings (Years)	*Bare %*	*Inadequate %*	*Adequate %*	*Over-stocked %*
All cuttings	5-16	12	28	40	20
Uncut control areas	* 50-60	14	40	31	15

* Estimated average age of overwood in uncut areas sampled.

[1] Tryon, H. H. (1930) The Black Rock Forest. Black Rock Forest Bulletin I.
[2] Scholz, H. F. (1931) Physical Properties of the Cove Soils of the Black Rock Forest. Black Rock Forest Bulletin II.
[3] Raup, H. M. (1938) Botanical Studies in the Black Rock Forest. Black Rock Forest Bulletin VII.

[1] Tryon, H. H. (1939) Ten Year Progress Report. Black Rock Forest Bulletin X.
[2] Tryon, H. H. (1943) Practical Forestry in the Hudson Highlands. Black Rock Forest Bulletin XIII.

TABLE 2

Stocking by Species

	Red-Oak	*Chestnut Oak*	*Hemlock*	*Red Maple*	*White Oak*	*Basswood*	*White Ash*	*Sugar Maple*	*Hickory*
				In Cuttings					
Frequency of Occurrence	1	2	3	4	5	6	7	8	9
Per cent of Composition	72.1	14.1	4.6	3.3	2.6	1.4	0.9	1.0	.01
				In Controls					
Frequency of Occurrence	1	2	3	4	5	8	—	6	7
Per cent of Composition	53.2	27.9	8.4	3.8	3.8	0.7	—	1.2	1.0

Turning now to the stocking by species as revealed by this study, red and chestnut oak proved to be the numerical leaders in both cut and uncut areas—another bit of evidence that this is primarily oak country. Table 2 below gives both the principal species in their order of occurrence and the stand composition by species percent.

For example, red oak was the leading species in both areas, forming, in the cuttings, 72.1% of the stand, and making but 53.2% in the controls. Or take the case of sugar maple which stood 8th in order of occurrence and made up 1% of the reproduction in the cuttings, while in the controls it ranked 6th and formed 1.2 of the total stand. Here one may with propriety observe that our cutting practices have apparently operated both to increase the number of red oak seedlings in the cuttings by some 35% over what was found in the untreated controls, and also to decrease the number of chestnut oak seedlings (an inferior commercial species) by about 50%. This is a pleasing discovery.

At this point, owing to the somewhat complicated nature of our mixed hardwood stands and owing also in part to the wide spread in the commercial value of our various species it seems wise to set up three classes of species based on their utilization value. While any such classification is subject to change, for the present these are as follows:

Group 1—Chief Merchantable Species...Red Oak, White Oak, Chestnut Oak

Group 2—Other Merchantable Species..White Ash, Hemlock

Group 3—Cordwood Species....Sugar Maple, Red Maple, Hickory, etc.

These groups have been arranged in tabular form in Table 3. The letters in the boxes are purely arbitrary designations for purposes of comparison.

A statistical dissection of the tallies revealed that not only is the amount of seedling oak reproduction considerably larger in the cuttings, but the analysis also brings out that the seedling population of the "merchantable species" (Group A) is significantly greater than is the seedling population in either the "other merchantable species" (Group B) or the "cordwood species" (Group C). No such difference was discovered to exist between the seedling reproduction of Groups B and C. Clearly, there appears to be considerable statistical evidence that in the cuttings the merchantable species reproduction (Group A) is numerically much stronger than is the same group in the controls. As might be expected, the longer the time interval following the cuttings the better will be the seedling stocking.

All of the foregoing comparisons and conclusions were performed and arrived at by the usual methods of

TABLE 3

	Merchantable Group	*Other Merchantable Species*	*Cordwood species*
Area	*Red Oak, White Oak, Chestnut Oak*	*White Ash, Hemlock*	*Sugar Maple, Red Maple, Hickory, Basswood, etc.*
In Cuttings...	A	B	C
In Controls...	D	E	F

statistical analysis. The relationship between the age of the cutting and the adequacy of seedling stocking proved to be nonlinear.

Employing the customary regression calculation, it appears that the cutting practices now in effect here will produce adequate regeneration of the better merchantable species in about 16 years following a cleaning operation. This can properly be regarded as a start towards something clear and definite in the way of a cutting cycle. It is, we believe, the first proven bit of hard, quantitative, applied operating data to emerge from the Hudson Highlands.

So, as our acquaintance with this region becomes more intimate, our cutting practices should become increasingly efficient as regards the coaxing in of desirable natural regeneration. It is felt that we are, at last, on the road to practical results. It is now clear that good regeneration may be confidently expected in about 16 years following a cutting; and we believe that as our silvical knowledge ripens, this interval may be perceptibly shortened. Perhaps it is a digression, but it seems fitting to mention here that plans are afoot to provide for the introduction here of oak strains from other areas. This Forest would undoubtedly benefit by such genetic improvement.

Discussion

It should be here repeated that nearly all of our cuttings to date have been in the nature of a cleaning. We are dealing with an abused and somewhat run-down forest and our primary objectives are:

a. to reduce the number of weed trees.

b. to reduce the number of stems of sprout origin.

c. to increase the number of seedlings of merchantable species.

Other goals are of course in view, but these three are the immediate and pressing aims, and the foregoing repetition should make it clear that it is largely coincidental that many of the cleaning operations to date have reacted as reproduction cuttings. Only rarely have these operations been severe, with 4 to 6 cords of fuelwood per acre making the average harvest. All this gives one to feel that we are approximately on the right track in our treatments thus far.

Continuing further, 8 out of the 10 areas sampled in this study show a markedly greater percent of adequate stocking than do the adjacent controls. If, however, the degree of stocking comparison be made on a year to year basis it is clearly shown that the cut areas are carrying a distinctly higher degree of adequate stocking at 12 years of age and thereafter than is shown for the younger cutting operations. If this comparison be accurate, then some 80% of the plots examined are either adequately stocked—or overstocked. Areas carrying no seedlings can probably be re-stocked either by more intensive treatment, or as a last resort they could be planted. It should be noted that a certain percent of these unstocked areas are either very stony or ledgy and will doubtless lack any plants whatever for some time to come. It is estimated that of the 6% "bare" plots (see Table 1), 5/6 of these can be regenerated either naturally or artifically, for on 94% of the cut areas sampled the natural seedling reproduction has become established. And similarly, the 25% of the plots showing an understocked condition is associated chiefly with the younger cuttings (Table 1). Hence, on recalling the pleasant correlation found to obtain between the degree of stocking and the number of seasons elapsed since the cutting was completed, it appears a logical assumption that probably many of these areas now found to be understocked will show adequate stocking at some later date—presumably when about 16 years have passed following the cutting.

The percentage composition of the seedling reproduction varied somewhat from that of the overwood with red and chestnut oak leading the procession in both cases, but, as noted above, with red oak sharply increased and chestnut oak markedly decreased in the treated portions. Together these two species make up some 86% and 81% respectively of all the seedling reproduction found on both the cut and uncut areas. Not a surprising discovery for an oak region.

The lower representation of chestnut oak seedlings in the cuttings could have been caused by the current policy of marking this species rather severely in view of the prevailing and rather severe infestation with golden oak scale and shoestring fungus, which policy has of course reduced the potential source of seed.

Considerably more hemlock seedlings were found in the controls. Evidence is not lacking to support the belief that the opening up of the cut areas, followed by the usual parching effect may be the primary cause of this difference.

The other species occurred in about the same proportions on both areas. While white oak, white ash and hemlock appear in comparatively small numbers in the sampled areas, these are highly valuable species, they thrive well on proper sites, and their reproduction should be fostered so far as possible.

Beech, the birches, red and sugar maple, hickory, basswood, black gum and the like can be here regarded only as good cordwood species and should be managed as such. Silviculturally, these can be utilized for a part of their life span as trainers to aid in producing knot-free boles amongst the more valuable concomitant species; and they can furthermore be relied on to help in maintaining the local climate in somewhat stable condition.

The three chief oaks—red, white and chestnut—are present as seedling reproduction in significantly greater numbers than are the species listed in Groups B and C (see p. 137). This agrees with Raup (loc. cit.) who stated that the reproduction on uncut areas did not differ significantly from the composition of the parent overwood. Whether this relationship will persist under managed conditions is a question for future determination, for the time interval elapsed thus far has been by no means long enough to serve as a basis for even an approach to anything in the way of final conclusions.

Transect No. 6 (Ctg. 4a) showed more seedlings in the control than in the cutting. The latter evidently suffered from too severe a treatment as is now amply evidenced by the luxuriant growth of laurel blanketing the area and greatly reducing the amount of sunlight reaching the forest floor. This heavy shading, combined with the root-competition put forward by the laurel could have sharply reduced the desired seedling reproduction. Transect 5 (Ctg. 14e) where similar conditions were found is a comparatively recent operation (1940-41) on a warm south slope. Here the marking was obviously much too severe, for the cut area was promptly preempted by unusually dense clones of white oak. Again it was a case of too much low shade plus too sharp a reduction in the number of seed trees left. Since it was a south exposure, laurel was a negligible factor.

Transects Nos. 8 and 9 (Ctgs. 5a and 7a) showed no significant difference in seedling population on both cut and uncut portions. No wholly satisfactory answer to this has been worked out, but it is felt that the chief cause lies in the fact, as revealed by the case histories, that these two operations were of a very moderate nature —a treatment of such light severity that the main canopy was opened but very little, effecting no marked subsequent change in the climatic and other factors governing germination and growth.

The foregoing analysis and discussion throw no light on the chance of survival of the seedling reproduction found on the plots. So it is recommended that these areas be periodically scrutinized and carefully re-checked at 5-year intervals. To illustrate the danger attendant on placing one's trust in a single set of tallies of growing plants, a check count made here in 1939 on sugar maple showed a large array of vigorous seedlings which have since died out. A project of this type calls for careful and systematic re-counts over a period, we estimate, of not less than 15 years.

Conclusions

Below are such tentative conclusions as we have been permitted to deduce. These are set forth in all humility in the face of the always complicated and frequently confusing ramifications of biological matters.

1. Reproduction in the cut areas is in general significantly greater numerically than in the controls.
2. The existing cutting practices appear to have been fairly successful as regards obtaining adequate natural regeneration though the figures indicate clearly that these practices are still some distance from 100% efficiency.
3. Red oak and chestnut oak are the chief species represented in the seedling reproduction found.
4. The compositon of the seedling reproduction varies from that of the parent overwood in that the former includes a considerably higher number of red oak plants and a much lower number of chestnut oaks.
5. A highly significant correlation exists between the amount of seedling reproduction found and the time interval elapsed since the cuttings were completed. In general, the 16th year following a cutting should see adequate stocking of the cut areas. As the cutting practice improves, and as the entire Forest becomes increasingly benign to timber production, it seems likely that this interval may be shortened.
6. Today (1947) it is estimated that some 46% of the uncut area of this tract is adequately stocked.
7. There exists substantial evidence that overcutting has occasionally occurred. In a few instances this has resulted in either vigorous clones or abnormally rampant laurel growth, either one of which has cast shade sufficiently heavy to reduce the desired seedling population. (Ctgs. 4a & 14e).
8. Conversely, there are two areas (Ctgs. 5a & 7a), portions whereof revealed no significant difference in seedling reproduction in either cuttings or controls, owing in the main to the cutting having been rather on the cautious side.