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Drought Response in William L. Hutcheson Memorial Forest, 1957

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When many trees, of many species, showed brown and dry leaves on some or all of their branches by September 1, 1957 in Hutcheson Forest, it seemed an opportune time to record the effect of droughtiness on individuals, species, and on the forest as a whole.

The forest is controlled by a grid system providing sections of 100 meters on each side. A reconnaisance was made, trees were noted, the d.b.h. and the location of those trees with apparent top injury was recorded, in September-October 1957. In 1958 the reconnaisance was repeated between July 31 and September 5. At this time an estimate of the degree of injury (leafless branches) was attempted. It appeared possible to separate this injury from dead branches of earlier years. The purpose of the second survey was to: 1. determine the possibility of relocating the trees, 2. increase the accuracy of the data since the 1957 survey ran into autumn coloration as a confusing factor, 3. check upon the possibility that the trees might have escaped into early dormancy and survived, at least to some extent, the drought effects, and 4. ascertain, on the other hand, if drought injury had occurred in 1957 which was not expressed or at least not recognized in the appearance of the foliage at the time of that reconnaisance. Some further checking was done in August of 1959. An attempt was made to assemble any pertinent records of the environment of the forest during 1957 and to make pertinent comparisons.

1. All but two of the trees were relocated, out of a total of 188.

2. As was expected, the number of trees injured or killed proved to be greater when checked in 1958 than was recorded in 1957, but the increase was even more than expected. It also appeared that in some instances the injury had not been as serious as it appeared in 1957. Subsequent observation has corroborated this in some cases, but in others the apparent recovery or survival was a failure. For instance, the largest *Q. alba* in the forest (location 195 × 290) was recorded as killed in 1957. All of its leaves were brown and

appeared dried on the tree. In 1958, however, it put out leafy shoots along the trunk and most of the branches. This was very gratifying, but also misleading because there have been no leaves in 1959 or 1960, and a fairly large branch has already broken off.

3. The question of dormancy was not resolved. It appeared that in some cases buds had been far enough developed to survive and the tree had not suffered otherwise to the extent that the buds failed to function normally in 1958. For instance, on section A8 a 22.4" *Acer rubrum* was noted October 13, 1957 as "apparently done for"; but on September 5, 1958, "top has 40% of expected foliage" and in 1959, "recuperating". On section B8, October 13, 1957, "10.0" *A. rubrum* is drought killed". In 1958 it was found that "top 25% is O.K.". And in 1959 "recovery goes on". On section C2 a 2.2" *Fagus grandifolia* had prematurely brown leaves and appeared dead on October 13, 1957, but in 1958 it had "small leaves on every branch, but they are few". In 1959 it was estimated to have 30% normal leaf crop though some twigs were bare and indeed whole branches on the north side. On section D2 a 5.4" *Cornus* was noted October 9, 1957, "has leaves brown. Dead?" But on June 27, 1958 this was reconsidered as "the *Cornus* appears to have been alive and well. It is in full leaf . . .". In other instances it appears that the normally set buds did not survive to function in 1958 or that some other factor prohibited their function, as witness the 74 trees now dead, and the many trees with dead branches. In addition there is the situation of adventitious buds becoming active though normally set buds failed, as on the big white oak.

4. There was more actual drought injury, as recorded in 1958, than was apparent in 1957. The confusion of autumn coloration no doubt accounted for part of the difference, but it also appears that permanent damage had occurred in trees where the leaves did not get noticeably brown. The number of branches without leaves in 1958 was very much larger than appeared likely in 1957.

The distribution of injured and killed trees through the forest is indicated by sections on the map Fig. 1, adapted from Monk (1956). The distribution of injured and killed trees by species is indicated in Table 1. These figures must be interpreted with little comparative significance since the species that occur in greater abundance show higher numbers in the table, but this certainly does not represent a ratio of occurance or of injury. The New Brunswick station in the state network for precipitation records is located east of the forest at approximately eight miles distance. Data for this station with the long term mean, are presented in Table 2. Soil moisture and wilting point records for the Forest in 1957 constitute Table 3 (Balloni 1957).

Summer droughtiness to some degree is usual in Central New Jersey and irrigation of hoed crops is a commonly accepted practice. Droughtiness has been observed in Hutcheson Forest during several seasons of the past decade. It has been manifested by wilting and drying (brittle) of the leaves of *Viburnum acerifolium* and of *Cornus florida*, particularly at the forest edge. During one season the drought was severe enough so that the *V. acerifolium* in one area frequently showed all leaves dried, brittle, and soon brown. No quantitative data were taken, but selected plants were kept under observation. It was found that the tops died, but the root system did not die because new shoots appeared the next season and persisted.

Summer droughtiness was to be expected in 1957. During the winter and spring U. S. Dept. of Commerce, Weather Bureau records show only April had precipitation at or above normal, May produced only 24.06% of the expected rainfall, June 57.18%, and July 30.82%. The drought effect of reduced precipitation is probably greater than the percentages imply because interception at the various levels in the Forest remained the same, likewise reevaporation, so that the amount reaching the level of root systems in the soil must have been very small indeed. By mid-July, wilting, yellowing, brittleness of leaves could be found. It was noticed that *Lindera* showed more response than usual, more in fact than *Viburnum acerifolium*. In other words, the prolonged water deficit was making itself felt more noticeably in the normally (at least seasonably) wetter parts of the forest, see *Q. palustris*, Table 1. Soil samples from the A horizon in the forest on

July 3 (Institute of Field Biology, class data) ranged from 17.2% to 28.5% moisture on dry weight basis with the average 21.54%. A replicated series averaged 19.9%. On July 11 another sampling showed 16.4% moisture. See Table 3 for further data. Balloni (1957) noticed that the increased moisture in the A_0 layer in mid-September was not accompanied by an equally large increase below. Buell, Buell, Small and Monk (1960) found the trees unable to recover until December.

It is realized that trees die from causes other than drought, even in dry years, but there has never been a year in the more than a decade of continuous observation when so many trees died as in 1957, except the hurricane damage of 1950, 1954, and 1955. Another factor should be recorded, however, in this regard. The Forest is generally infested with the root-rot fungus, *Armillaria mellea*. 1956 was a particularly favorable year for the fungus, as indicated by mushroom production. While it is possible to observe leafless branches in the tree tops, it is not possible to record the degree of root system injury as a result of drought, fungus, or both. It seems reasonable to suppose that such injury occurred and that this contributed to the increased evidence of injury that was observed in 1958.

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TABLE 1. *Tree species damaged and killed, Hutcheson Forest 1957 and 1958.*

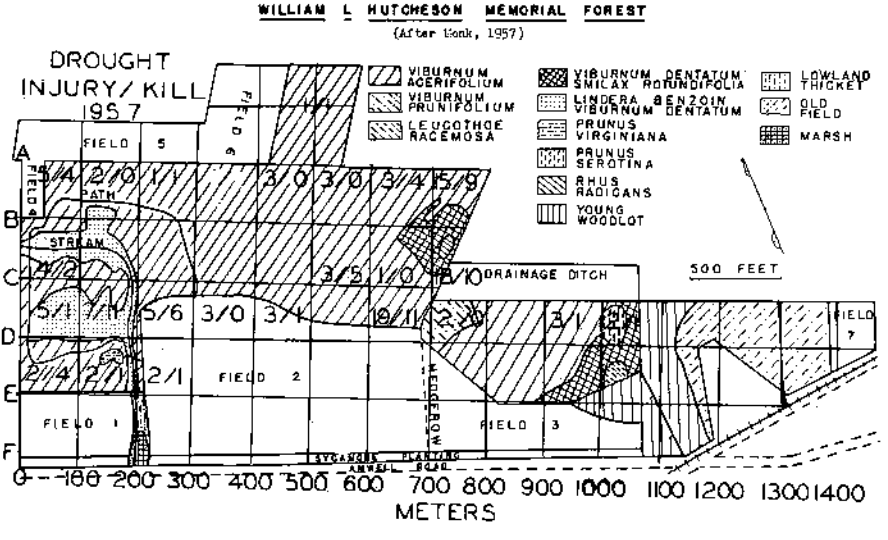
Species		Number Damaged	Number Killed
A. rubrum	Red maple	22	10
A. saccharum	Sugar maple	2	0
Carya ovalis	Red hickory	0	1
C. ovata	Shagbark hickory	0	2
Cornus florida	Dogwood	14	24
Fagus americana	Beech	3	0
Fraxinus americana	White ash	1	2
Nyssa sylvatica	Black gum	2	0
Carpinus caroliniana	Blue beech	1	0
Prunus sp.	Cherry	5	3
P. avium	Sweet cherry	10	0
P. serotina	Sour cherry	1	2
Q. sp.	Oak	1	2
Q. alba	White oak	12	10
Q. bicolor	Swamp white oak	3	1
Q. coccinea	Scarlet oak	2	1
Q. palustris	Pin oak	10	7
Q. rubra	Red oak	7	1
Q. velutina	Black oak	17	4
Ulmus americana	American elm	1	4

TABLE 2. *Monthly precipitation in inches, 1956–1958, and long term mean (1931–1955), New Brunswick, N. J.*

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1956	2.22	5.09	3.31	3.23	2.84	3.15	3.93	4.67	3.19	3.50	4.33	4.12	43.58
1957	2.02	2.51	2.98	5.66	0.96	2.19	1.31	3.66	2.32	2.03	3.92	5.71	35.27
1958	5.46	4.10	4.53	5.97	4.09	2.99	5.86	3.27	3.28	6.26	2.33	1.67	49.81
Mean	3.38	2.60	3.86	3.34	3.99	3.83	4.25	4.78	4.19	3.12	3.63	3.06	44.03

TABLE 3. *Soil moisture content at various depths in upland forest on dates given, 1957 (Balloni, 1957)*

Depth	July 30	August 4	August 17	August 31	September 14	September 27	Wilting Point
ao	22%	54%	33.6%	26%	83%	75%	—
0	22	54	33.6	26	83	75	9.6
3	9.6	28	12.5	12	16.3	1.5	9.6
6	8.1	8.3	11.3	11.7	15.6	12.0	7.7
9	7.1	7.8	9.3	10.2	14.2	10.5	7.6
12	6.1	7.9	8.6	9.2	11.3	10.0	7.4
15	6.7	8.1	8.1	8.1	8.6	11.0	8.6
18	8.6	9.2	10.2	8.7	11.5	13.4	9.6
21	8.9	12.0	10.7	8.4	12.5	14.2	10.9
24	9.7	12.3	11.3	8.7	11.4	12.8	10.1
27	9.3	10.8	10.3	12.4	10.4	10.7	8.5
30	8.2	13.0	9.3	10.0	9.3	5.6	7.2
33	8.5	13.8	8.3	7.5	8.1	8.0	8.1
36	9.1	14.4	8.4	7.1	8.1	10.0	8.7



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