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Pin Oak Acorn Production On Normal and Flooded Areas

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Pin Oak Acorn Production On Normal and Flooded Areas

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Pin oak (*Quercus palustris* Muenchh.), a common tree species on wet, heavy soils in the central states, is useful for timber products and its acorns are an important source of wildlife food (McDermott and Minckler 1961; Minckler 1957). In 1956 a series of experimental plots was established through the cooperative efforts of four public agencies** to study the effects of flooding and other stand treatments on pin oak acorn production, growth, and regeneration. Results on acorn production and regeneration after four years were reported by Minckler and McDermott (1960). This paper reports the approximate amounts and variability of pin oak acorn production after nine years of acorn collections, and discusses some of the elements that affect the size and quality of the acorn crops.

THE STUDY AREAS

To improve duck habitat, 500 acres of the Mingo Swamp in southeastern Missouri have been flooded artificially every winter for the last nine years. In order to study the effect of this flooding on acorn production and on growth and regeneration, study plots were located on this area and on an undisturbed area 200 acres in size and three miles away. The undisturbed or "normal" area flooded one to four times a year for two to 10 days at a time. On the artificially flooded area water stood 1 to 3 feet deep from November to March or April.

Even-aged pin oak and willow oak (*Quercus phellos* L.) 25 to 35 years old occupied both areas in 1956. The average basal area per acre for trees 5 inches and larger was 82 square feet. Dominant and codominant trees were 62 to 67 feet tall and the site index was about 80. On the normal area about 20 percent of the trees were willow oak while on the flooded area the stands were virtually pure pin oak. Except for species composition, no important differences appeared between the stands on the normal and flooded areas.

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**The cooperators are the University of Missouri, the Missouri Conservation Commission, the U.S. Fish and Wildlife Service, and the U.S. Forest Service, Central States Forest Experiment Station.

Fig. 1—A row of basket seed traps on a flooded pin oak plot. In this photograph the flooding is shallower than usual.

METHODS OF STUDY

Thirty-six half-acre plots were established—18 in the normal area and 18 in the flooded area. One-third of the plots were thinned to 40 square feet of basal area per acre, one-third to 60 square feet, and the remaining third left unthinned as checks (87 square feet of basal area). On half of all the plots, large trees (larger than 10 inches d.b.h.) predominated; on the other half, small trees (5 to 10 inches d.b.h.) predominated.

Twenty-five bushel-basket seed traps were spaced equally in each of the 36 plots, making a total of 900 seed traps (Fig.1). Traps were screened to reduce pilferage by birds and animals. To prevent acorns from bouncing out of the basket when a direct hit was made on a screen wire, the 1-inch-mesh wire screen was fastened about halfway down in the basket. Acorns were collected from 1956 through 1964.

The acorns† were inspected and cut open where required to classify them as follows:

1. Well developed, sound, and undamaged.
2. Well developed and sound, but damaged by animals, birds, or mechanical means.
3. Well developed, but weevil (*Curculio* spp.) infested.
4. Underdeveloped or deformed.

†Mostly pin oak but willow oak acorns were not separated in the data. The few overcup oak (*Quercus lyrata* Walt.) acorns were not counted.

RESULTS OF THE STUDY

The estimated annual production of sound, well-developed acorns for the nine years ranged from less than 1,000 to more than 200,000 per acre (Table 1). There were six good or moderately good years and three poor years (Fig. 2). One possible cause of the yearly variation in acorn production may be differences in precipitation. The acorn production pattern followed closely the yearly and summer precipitation totals at a local weather station (Fig. 3). Whether or not there is a causal relationship will require additional study.

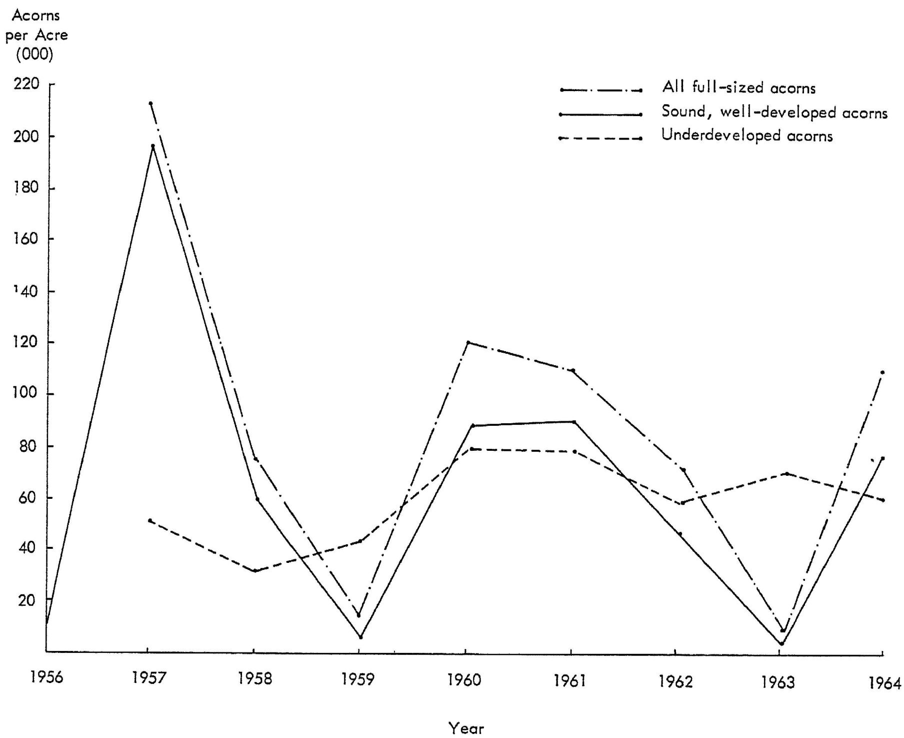


Fig. 2—Number of acorns produced per acre by years (normal and flooded areas combined).

TABLE 1--AVERAGE PRODUCTION OF ACORNS IN PIN OAK STANDS BY YEAR AND ACORN CLASS
(Thousands of Acorns per Acre)

Year	Normal Area			Flooded Area			Rating of Year
	Sound, Well-developed Acorns	All Full-sized Acorns	Under-developed Acorns	Sound, Well-developed Acorns	All Full-sized Acorns	Under-developed Acorns	
1956*	8	--	--	0.4	--	--	Poor
1957	188	218	58	201	208	46	Very good
1958	24	43	32	96	109	32	Moderate
1959	2	7	66	13	23	22	Poor
1960	125	172	120	51	68	37	Good
1961	95	120	102	88	99	56	Good
1962	42	80	82	50	65	38	Moderate
1963	5	14	98	6	9	43	Poor
1964**	81	135	75	64	82	41	Good
Means	63	99	79	63	83	39	

* Underdeveloped and insect-infested acorns not separated in 1965.
** Stands received the second thinning treatment before the 1964 growing season.

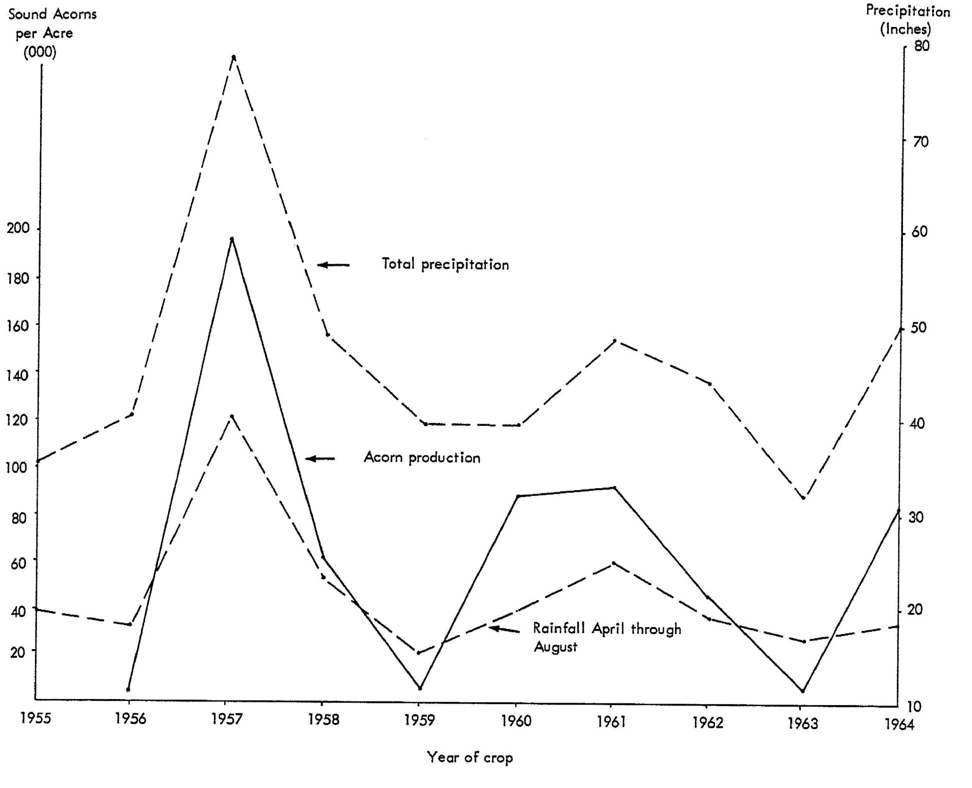


Fig. 3—Production of sound acorns related to precipitation by years.

Effects of Density and Structure on Acorn Production

During the first two good seed years after thinning, 1957 and 1958, the high-density stands produced more sound, well-developed acorns than the low-density stands (Table 2; Fig. 4). However, in 1960, 1961, and 1962, the low-density stands (residual stocking 40 square feet basal area in 1956) produced as many or more acorns than the high-density stands. Five years after thinning, tree crowns in heavily thinned stands had expanded rapidly (Minckler 1964) because of better lighting and less root competition, and probably, as a result, became better acorn producers.

Stands with large trees produced more acorns than stands with small trees at all densities regardless of the time since thinning (Table 2; Fig. 5).

Because of the variability of data from plot to plot within years, statistical tests do not indicate strong relationships in most cases. However, our interpretation of an analysis of variance for individual selected years accepts the above trends as real.

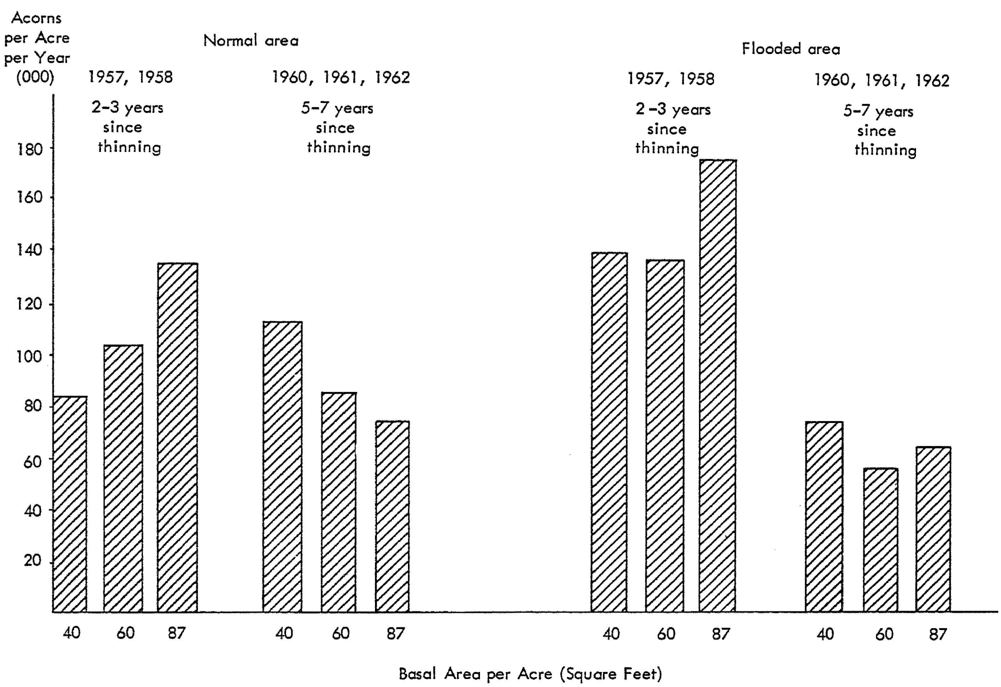
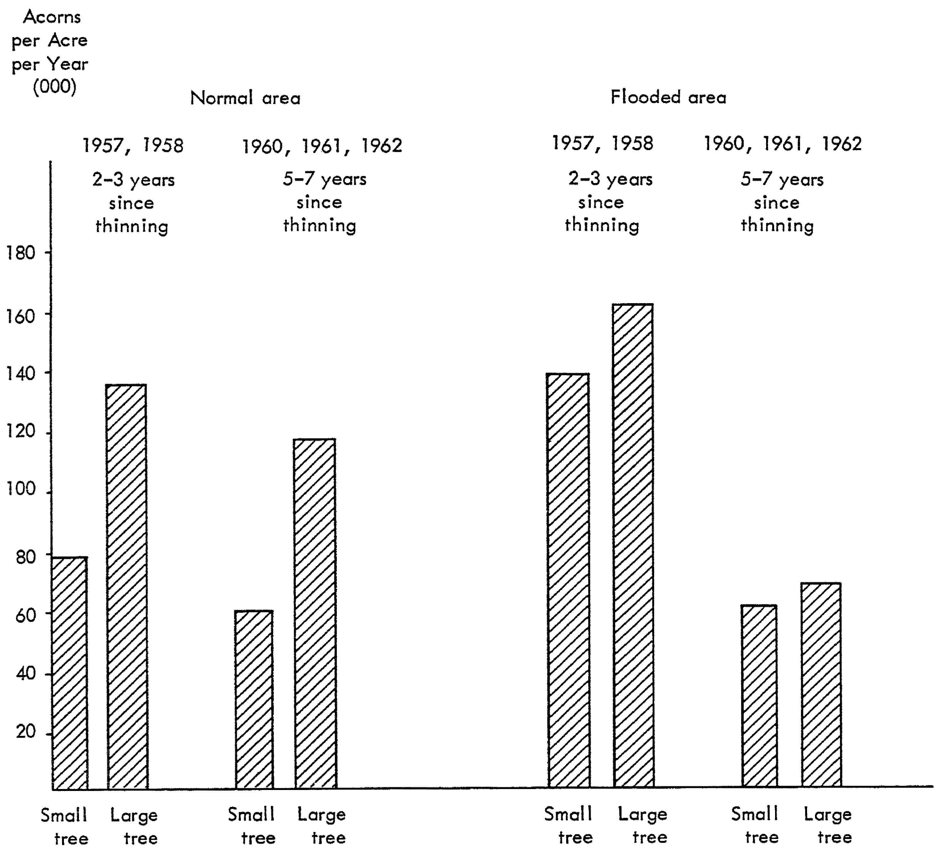


Fig. 4—Production of sound, well-developed acorns during good seed years related to stand stocking and period of time since thinning.

TABLE 2 --PRODUCTION OF SOUND, WELL-DEVELOPED ACORNS BY STOCKING AND YEAR
(Thousands of Acorns per Acre

Stocking of residual stands	Year 1956	1957	1958	1959	1960	1961	1962	1963	1964
					Normal Area				
Low stocking									
Small tree	4.2	109	7	2.5	143	67	41	4.1	78
Big tree	15.0	183	29	1.9	235	119	59	5.5	143
Medium stocking									
Small tree	7.2	122	29	3.3	43	82	32	2.5	50
Big tree	15.0	227	30	1.9	171	121	35	7.4	98
High stocking									
Small tree	4.3	168	30	2.2	45	49	29	6.3	26
Big tree	9.0	316	22	1.4	116	134	57	6.1	93
					Flooded Area				
Low stocking									
Small tree	0.0	184	133	13	53	88	49	4.4	44
Big tree	.3	146	89	8	112	91	45	5.2	84
Medium stocking									
Small tree	.3	144	41	9	35	76	47	4.7	56
Big tree	.8	282	72	9	35	99	34	3.6	54
High stocking									
Small tree	.2	216	104	16	33	87	60	5.8	71
Big tree	.8	232	140	21	43	88	65	9.7	76

* Each mean based on 75 seed traps in three plot replications.



Fig' 5—Production of sound, well-developed acorns during good seed years related to size of trees and time since thinning.

Condition of Acorns

Weevil infestations of acorns varied greatly from year to year (Table 3). On the normal area 41 percent of all full-sized acorns were infested. On the flooded area 25 percent were infested (Minckler and McDermott 1960).

There was a close relation between the total number of full-sized acorns and the percentage of insect-infested acorns (Fig. 6). The larger the acorn crop, the smaller was the percentage of insect infestation. The percentage of infestation dropped rapidly as production went up to about 150,000 acorns per acre and then tended to level off. The percent infestation on the normal area was consistently higher than that on the flooded area.

TABLE 3--NUMBER OF FULL-SIZED AND INSECT-INFESTED ACORNS
(Thousands of Acorns per Acre)

Year*	Normal area			Flooded area		
	Total full-sized acorns	Insect-infested		Total full-sized acorns	Insect-infested	
	Number	Number	Percent**	Number	Number	Percent**
1957	218	30	14	208	6	3
1958	43	19	44	109	13	12
1959	7	5	69	23	10	44
1960	172	46	27	68	17	25
1961	120	23	21	99	11	11
1962	80	38	48	65	15	23
1963	14	8	62	9	4	50
1964	135	53	39	82	18	22
Means	99	28	41	83	12	24

* This type of data not available in 1956.
** Based on actual, not rounded, data.

There were fewer underdeveloped than full-sized acorns in good seed years but many more in poor years (Table 4; Fig. 2). The normal area produced an average of 79,000 underdeveloped acorns and 99,000 full-sized acorns per acre per year. The flooded area produced an average of 39,000 underdeveloped acorns and 83,000 full-sized acorns.

The normal area generally produced more full-sized acorns and more underdeveloped acorns than the flooded area, but because of heavier infestation on the normal area both areas produced about the same number of sound acorns. Apparently, climatic and/or physiological factors affecting yearly acorn production acted essentially the same on both the normal and flooded areas.

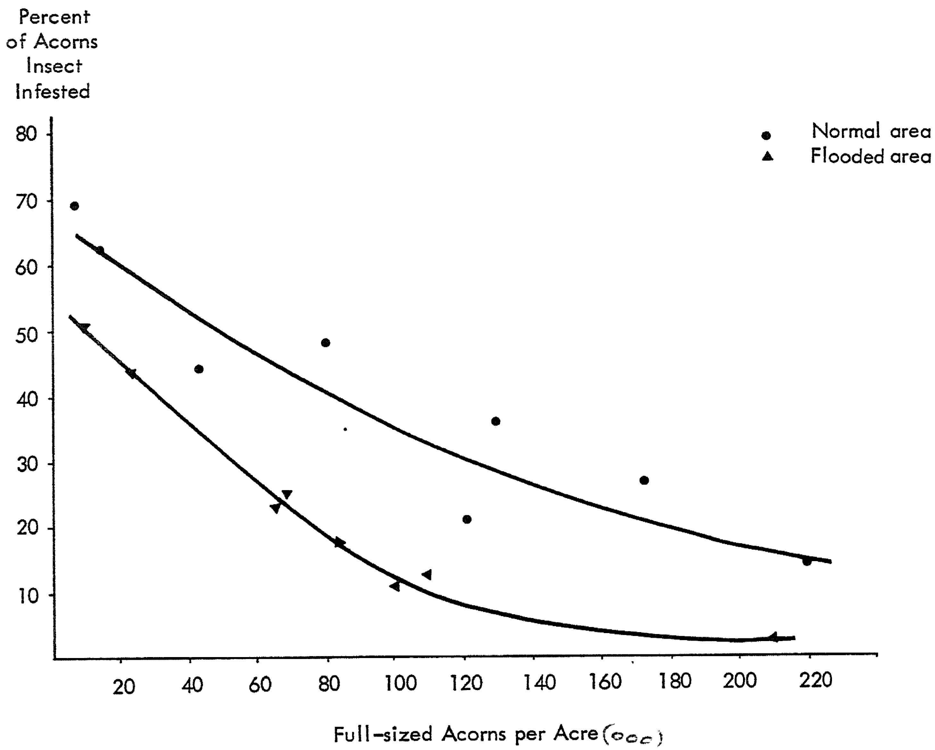


Fig. 6—Relation between number of full-sized acorns and percent infested by insects (all plots by years). (Curves fitted by least squares.)

TABLE 4--NUMBER OF UNDERDEVELOPED ACORNS PER ACRE AND RATIO TO FULL-SIZED ACORNS BY YEAR

Year*	Normal Area		Flooded Area	
	Number of Underdeveloped Acorns; Units of 1,000	Ratio Underdeveloped to Full-sized Acorns	Number of Underdeveloped Acorns; Units of 1,000	Ratio Underdeveloped to Full-sized
1957	58	0.27	46	0.22
1958	32	.74	32	.29
1959	66	9.43	22	.96
1960	120	.70	37	.54
1961	102	.85	56	.57
1962	82	1.02	38	.58
1963	98	7.00	43	4.78
1964	75	.55	41	.50

* This type of data not available in 1956.

INTERPRETATION OF RESULTS

During the good acorn-crop years, in stands 25 to 35 years of age, about 100,000 sound, well-developed acorns per acre can be expected. This amount may double in some years. In poor crop years the number of sound acorns per acre may be less than 1,000.

The annual variability is not affected by stand density, stand structure, or flooding. There appears to be an association between total summer rainfall during the year of crop maturity and the total crop of full-sized acorns. However, further work will be required to verify this relationship. Other weather factors that may affect acorn crops are low temperatures and unusual rainfall conditions at the time of flowering and pollination. In addition, physiological factors such as stored food may play a part in size of crops.

In good seed years there are probably too many full-sized acorns for weevils to infest. The number that survive the winter is usually limited and, consequently, only a small percentage of the acorns are infested. In poor seed years, the weevils infest nearly all the full-sized acorns.

Pin oak stands produce abundant acorns at ages well below 30 years and with heavy early thinning, acorns could be produced much sooner. Lowering stand density to 40 square feet of basal area did not decrease acorn production and stands with larger trees generally produced more acorns. Moreover, growth was not reduced in low-density stands (Minckler, 1964). Therefore, it is possible to grow piling or logs on short rotations at low densities and maintain maximum acorn production for wildlife. Trees can be pruned to increase quality of saw logs (Minckler and Krajicek, 1963).

During the nine-year period the area that was flooded each fall for duck feeding produced about the same number of sound acorns as the normal area. The 500-acre green-tree reservoir used in this study has been a success up to this time. To detect any long-term effects of flooding, the study will be continued.

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