Natural oak regeneration after clearcutting on the Hoosier National Forest

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Project overview

We examined 32 clearcut sites on the Tell City Ranger District of the Hoosier National Forest (HNF) (Figure 1) to examine the regeneration of oak (*Quercus* spp.) in relation to site variables; this study is a follow-up to work done in 1987 by Fischer et al.

Oaks play a very important role in the Central Hardwood Forest Region (CHFR) historically, ecologically and commercially (Figure 2). Even-aged silviculture has been deemed the most suitable method for oak regeneration in the CHFR (Roach and Gingrich, 1968); however, many studies have observed that oaks are being replaced by less desirable hardwood species (Heiligman et al, 1985; Hilt, 1985; Fischer et al, 1987; Wright et al, 1998; Shostak et al, 2002). Mesic sites are most often dominated by maples (*Acer* spp.), yellow-poplar (*Liriodendron tulipifera*), white ash (*Fraxinus americana*) and various other less desirable species, while oak species have better success on the more xeric sites.

Methods

The sites ranged in age from 22-35 years and were 5.4 to 49.9 acres in size, while distributed across a variety of landscapes (Figure 3). A total of 572 permanent plots were established to evaluate species composition change on clearcut sites over time (Figure 4). Aspect, slope percent, elevation, stoniness, slope position and average canopy height were determined at plot centers. A 209 x 209 foot grid was generated over the stand and sample plots were established at grid intersections, for a resultant sampling intensity of 1 plot per acre. Regeneration sampling consisted of recording all trees < 1 inch diameter at breast height (DBH) by species in a 0.01 acre plot. Individual tree data in a 0.10 acre plot included species, DBH, crown classification (suppressed, intermediate, or dominant), estimates of merchantable volume, and estimation of origin (sprout vs. seed, Figure 5) for all trees with a DBH > 1 inch. If a measured tree hosted any grapevines, all were tallied and vine diameter recorded.

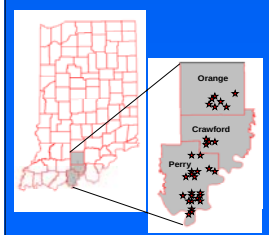

Figure 1. Location of the 32 stands in the Tell City District of the Hoosier National Forest.

Figure 2. Example of a mature oak.

Figure 3. Typical sampled stand.

Results

The mean stand density across all 32 stands was 792 trees per acre (Table 1). Oaks comprise approximately 10% (84 TPA) of all trees within sampled stands, and approximately 23% (43 TPA) of all dominant trees.

Approximately 34% of all dominant oaks originated from stump sprouts (Figure 6), making them more competitive to occupy a dominant position within the canopy. In 1987, only 31% of oaks were in the dominant class compared to 55% today (Figure 7).

Figure 4. Tree tally plot layout.

Figure 5. Chestnut oak (*Q. prinus*) originated from seed (left) and from stump sprouts (right).

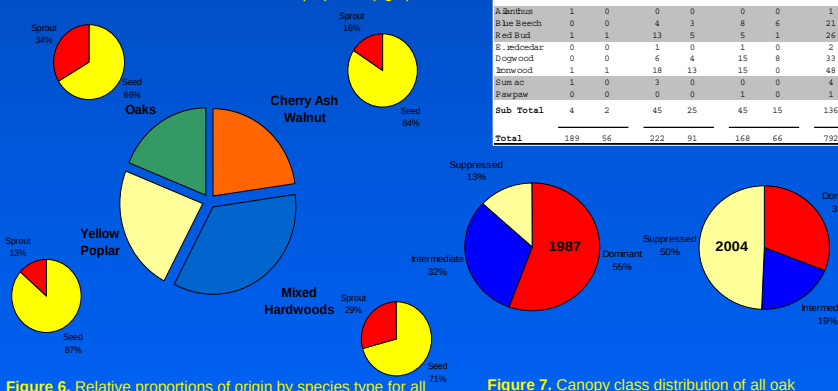

Figure 6. Relative proportions of origin by species type for all dominant trees sampled in the Tell City Ranger District for the 2004 measurement period.

Figure 7. Canopy class distribution of all oak species in the 32 sampled stands of the Tell City Ranger District for 1987 and 2004 measurement periods.

Table 1. Mean species per acre values by crown class and origin for 32 sampled stands in the Tell City Ranger District during 2004 measurement period.

Species	Dominant		Intermediate		Suppressed		Total
	Seed	Sprout	Seed	Sprout	Seed	Sprout	
White Ash	13	5	23	3	11	1	56
Bl Cherry	34	4	14	1	1	0	54
Black Oak	6	1	3	0	1	0	11
Bl Walnut	1	0	0	0	0	0	1
Y. Poplar	50	8	9	2	3	0	72
Chest. Oak	4	4	2	1	1	0	12
Ching. Oak	1	0	2	0	1	0	4
N. Red Oak	8	4	5	1	2	0	20
Scarlet Oak	2	1	1	0	0	0	4
White Oak	9	5	9	2	6	0	31
Sub Total	128	32	68	10	26	1	265
Am. Beech	1	0	7	1	15	2	26
Aspen	3	0	0	0	0	0	3
Buckeye	0	0	0	0	1	0	1
Am. Elm	1	0	2	0	2	0	5
Red Elm	9	2	10	1	5	0	27
Other Elm	1	0	2	0	3	0	6
Bl Gum	1	0	5	3	8	3	20
Sweet Gum	1	0	1	0	0	0	2
Bit. Hick.	1	0	1	0	0	0	2
Pignut Hick.	2	1	4	1	3	0	11
Shag. Hick.	1	0	1	0	1	0	3
Black Locust	2	0	1	0	0	0	3
Red Maple	6	7	8	7	4	3	35
Sugar Maple	14	9	44	41	53	42	203
Mulberry	0	0	1	0	0	0	1
Persimmon	1	0	1	0	0	0	2
Sassafras	11	2	20	2	2	0	37
Sycamore	2	1	1	0	0	0	4
Sub Total	57	22	109	56	97	50	391
Ailanthus	1	0	0	0	0	0	1
Blue Beech	0	0	4	3	8	6	21
Red Bud	1	1	13	5	5	1	26
E. redcedar	0	0	1	0	1	0	2
Dogwood	0	0	6	4	15	8	33
Ironwood	1	1	18	13	15	0	48
Sumac	1	0	3	0	0	0	4
Pawpaw	0	0	0	0	1	0	1
Sub Total	4	2	45	25	45	15	136
Total	189	56	222	91	168	66	792

Table 2. Stand composition of dominant oaks prior to harvest and during 1987 and 2004 samplings for 32 sampled stands in the Tell City Ranger District.

Stand	Pre-Harvest*		1987**		2004	
	Dominant oaks					
	TPA	of dominant trees	TPA	of dominant trees	TPA	of dominant trees
1	3	32%	49	2%	37	6%
2	9	51%	52	6%	11	27%
3	23	82%	156	6%	32	17%
4	46	77%	76	11%	51	33%
5	13	19%	55	2%	50	21%
6	19	88%	238	12%	76	32%
7	13	79%	169	11%	61	25%
8	45	87%	176	11%	111	70%
9	53	79%	29	4%	11	5%
10	26	74%	157	19%	73	44%
11	43	52%	0	0%	1	1%
12	24	54%	85	3%	64	23%
13	75	72%	95	4%	16	7%
14	62	96%	197	9%	80	28%
15	21	58%	184	12%	89	48%
16	40	58%	43	3%	33	17%
17	14	69%	77	6%	34	17%
18	85	92%	480	25%	65	38%
19	12	50%	66	9%	45	24%
20	10	32%	289	11%	51	25%
21	36	57%	48	2%	19	10%
22	62	82%	64	3%	31	13%
23	42	78%	200	7%	57	27%
24	69	88%	300	16%	54	46%
25	17	43%	43	6%	38	28%
26	1	13%	40	3%	21	9%
27	14	35%	179	4%	44	13%
28	18	49%	40	5%	2	16%
29	12	36%	48	4%	22	2%
30	30	69%	134	9%	51	33%
31	13	67%	10	1%	9	4%
32	19	51%	52	4%	49	25%
Stand Avg.	**30**	**61%**	**120**	**7%**	**43**	**23%**

*Pre-havest composition estimated from timber volume removed and assuming 150 bd.ft. per tree
**1987 composition adapted from Fischer et al (1987)

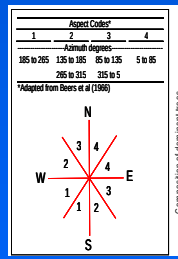

Figure 8. Aspect transformation codes.

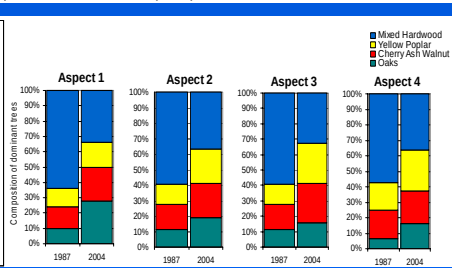

Figure 9. Dominant species composition by aspect and measurement period for 32 sampled stands in the Tell City Ranger District.

Today, a greater density (TPA) of dominant oaks exist in approximately 70% of sampled stands compared to pre-harvest levels, while some stands show very little oak regeneration (Table 2). The 1987 data showed only slight differences in oak dominance relative to aspect code (Figure 8). Oaks have made the most significant gains on the more xeric sites (codes 1 & 2), now comprising almost 30% of dominant trees.

Conclusions

- Preliminary results show that oaks have successfully regenerated to pre-harvest levels in approximately 70% of sampled stands. A previous study on these sites indicated a significantly reduced oak component shortly after harvest (Fischer et al, 1987).
- This delayed response of oak to gain a dominant position in the canopy is in agreement with findings of Sander and Graney (1992).
- Site aspect proved to be a modest partial indicator of future stand conditions as previously reported by Jenkins and Parker (1998).

Future directions

We will conduct a more thorough investigation of the influence of site and age on the changes in oak composition over time. From that information we hope to better identify suitable variables to characterize the potential for natural oak regeneration across various sites. We will also examine the potential for oak-dominated sites to naturally regenerate to their pre-harvest Ecological Landtype Phases (ELTP) designations, as defined by Van Kley et al. (1994), within the HNF.

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