

Distribution of Oaks (*Quercus spp.*) in forests of Palisades-Kepler Park, Linn County, Iowa.

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Introduction

Palisades-Kepler State Park is an 840-acre state game refuge consisting of river bluffs, hardwood trees and an abundance of wildlife that lies along the Cedar River. In 1969, a Palisades Plant Study was done by Terry Cairns on the west side of the Cedar River above the park. He investigated factors affecting plant and plant community development on opposing north-south slopes. He compared the interrelationship of environmental and biotic factors that affected plant communities, populations and succession on opposing north and south-facing slopes.

Cairns reported *Q. alba* was twice as dominant on the south slope while there was a low population of *Q. rubra* which would have reduced competition for *Q. alba* in the forest canopy.¹ He proposed that *A. saccharum* could eventually surpass the *Q. rubra* and share dominance with basswood because *A. saccharum* was more shade tolerant than *Q. rubra*. Recent studies have shown that *Acer spp* expansion patterns across both moisture and slope gradients increase direct competition with oak and favors shade-tolerant species.² *Q. alba* is expected to be evenly distributed and have larger stems while *A. saccharum* is expected to be aggregated and have smaller stems.³ Abrams found that *Q. alba* was dominant on xeric sites with *Q. velutina*, dominant with *Q. rubra* on mesic sites, and it was also absent from ravines dominated by *A. saccharum*.⁴

Given the data from 1969, we extended the study to the park that was already established to investigate the phenomenon of decreasing *Q. alba* recruitment in the turn of the 20th century in the U.S. We are especially concerned about the rapid decline in *Quercus spp* because they play a very important role in the forest ecosystem. Acorns are arguably the most important food source for birds and mammals and they provide vital habitat for maintaining biodiversity.⁵ Oak distribution has been studied and reported for each *Quercus spp* (*Q. alba*, *Q. rubra*, and *Q. velutina*) and we hypothesize that *Q. alba* will be dominant in the south-facing slopes and ridge tops. The goals of this study were to determine the species composition and ecological succession of *Q. alba* in Palisades-Kepler State Park.

METHODS

121 plots with a total of 706 trees were sampled between 06/08/17 to 8/10/17 at Palisades Kepler state park.

Field Data Collection

- 7m radius circular plots, selected by randomizing points on ArcGIS (ArcMap)
- Garmin GPS receiver: to reach randomized plot point
- ProMark 120 GPS receiver: to record GPS raw file
- Ashtech L1 GPS/GLONASS Survey Antenna: to record GPS raw file
- True Pulse 360B Laser Rangefinder: to measure range and azimuth
- Forestry Suppliers Inc. DBH tapes: to measure tree diameter
- Keson 100m fiberglass measuring tape
- Soil probes

Data analyses

- ArcGIS (ArcMap): contour and DEM layers used to extract and clip aspect, slope and elevation of plot centers
- GNSS Solutions: post-process collected GPS files
- Minitab 17 Statistical Software: ANOVA statistical analysis
- Microsoft Excel: data storage and summaries

RESULTS



Figure 1. Location map of Palisades-Kepler State Park

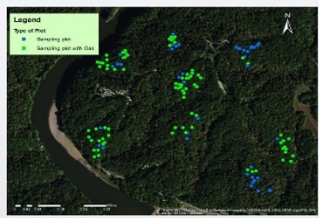


Figure 2. Total sampled plots

Table 1. Index for Tree species abbreviation

ACSAC	Acer saccharum
CAOVA	Carya ovata
FRAME	Carya remota
FRAME	Fraxinus americana
FRPEN	Fraxinus pennsylvanica
PRSER	Pinus serotina
QUALB	Quercus alba
QURUB	Quercus rubra
QVELV	Quercus velutina
TIAME	Tilia americana
ULAME	Ulmus americana
ULCRA	Ulmus crassifolia
ULRUB	Ulmus rubra

Table 3. Mean and standard deviation of the topographical features (aspect, slope and elevation) for plots

Tree Species	Frequency (# of plots)	Aspect, °		Slope, %		Elevation, m	
		Mean	SD	Mean	SD	Mean	SD
A. saccharum (Absent)	116	188.67	88.48	23.6	11.52	246.96	18.279
Q. alba (Absent)	64	185.7	96.9	23.33	11.54	247.66	8.34
Q. alba (Present)	59	199.33	72.69	23.96	11.67	246.53	11.43
Q. rubra (Absent)	86	185.63	81.22	23.74	11.79	247.83	10.74
Q. rubra (Present)	37	205.4	89.4	24.03	10.79	245.46	6.46

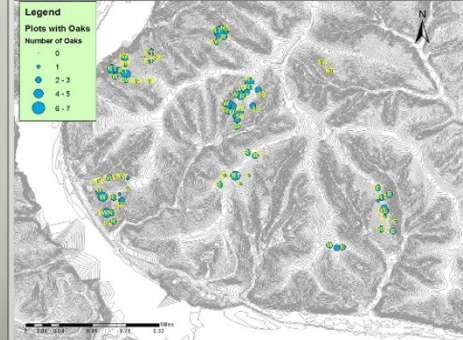


Figure 3. 3D map constructed from TIN raster extracted from contour map.

Table 4. Cardinal direction preference of each tree species of interest

Position of plot	Total trees (# of trees)		Total oaks (# of trees)		Total acorns (# of trees)		Total basal area (per plot)	
	Total trees	Total oaks	Total acorns	QUALB	QURUB	ACSAC	QUALB	QURUB
N	257	41	20	57	17	115	1.29	0.43
NE	122	2	0	0	0	10	0.06	0.00
E	53	9	12	4	4	23	0.69	0.44
SE	63	12	18	12	4	41	1.21	0.33
S	4	1	0	1	1	2	0.00	1.00
SW	92	16	15	5	10	40	0.31	0.63
W	66	15	28	26	4	56	1.46	0.27
NW	54	10	12	6	6	32	0.60	0.60

Table 5. Species composition of Palisades-Kepler State Park

Species	Number of trees	Total BA, cm sq	Relative Frequency	Relative BA	Mean DBH/cm
ACSAC	389	203775.991	52.28628895	28.76095110	29.69
QUALB	152	22505.150	17.28045294	31.76372199	46.37
QURUB	71	23760.467	30.25665721	3.57796261	17.36
QVELV	47	14654.518	6.637223798	20.6862167	60.1
TIAME	34	36288.513	4.813894021	5.321762112	33.15
CAOVA	18	15765.22	2.649350711	1.223103764	30.36
FRAME	17	27240.996	2.407193211	8.85081213	40.15
FRPEN	13	13638.191	1.841359773	1.504882077	34.47
PRSER	5	5814.534	0.78121297	0.023481997	38.62
ULAME	4	3031.344	0.566572338	0.427985148	30.55
QVELV	2	3114.932	0.281288119	6.419644444	42
ULCRA	2	795.781	0.281288119	0.112126561	22.5
CATOM	1	456.1818197	0.181818182	0.064181818	24.1
Unknown	1	1367.852709	0.181818182	0.4611684	64.5
Total:	706	708516.1746			

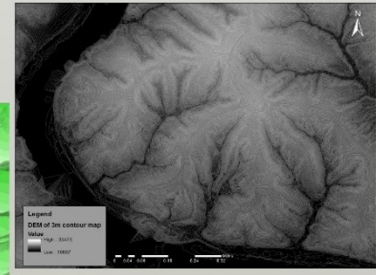


Figure 4. Contour Map with 3 meter intervals. Symbols proportional to # of Oaks

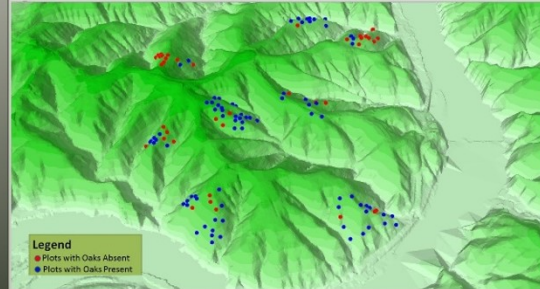


Figure 5. DEM Map constructed from 3m interval contour map. Variation in elevation represented by a graduated color ramp.

CONCLUSIONS

- Figure 2 and 3 visually indicated that there might be a topographical preference for Oak species.
- There is no apparent spatial pattern in topographical preference for any of the species of interest (ACSAC, QUALB and QURUB).
- QUALB is observed to be found more in the west plots followed by ridge tops and east plots. QURUB is observed to be found more in the south plots followed by southwestern and northwestern plots.
- Table 4 shows ACSAC is observed to be found to be the most in north plots, but the values seem to show the range of ACSAC to be the greatest, meaning that they could be found in almost all the cardinal ranges.
- Table 5 shows ACSAC has the highest relative frequency, 52.27, followed by QUALB, 17.28. QUALB has the highest relative basal area, 31.76, followed by ACSAC, 28.76.
- Although ACSAC is more abundant than QUALB, there are larger QUALB trees than ACSAC, which could mean that the ACSAC trees might be the younger secondary-canopy species on the rise for canopy dominance.

FUTURE WORK

- Addition and analysis of soil series layers with the GIS map, along with topographical features, to create a site index.⁶
- Record environmental factors (sunlight, light intensity, rainfall and wind) in the plots three times a day.
- Investigate tree composition in the forestland in private ownership around the Palisades-Kepler State Park.

REFERENCES

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