

2023 Mast Survey Report

Kentucky Department of Fish and Wildlife Resources

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Introduction

Our Agency

The Kentucky Department of Fish and Wildlife Resources (KDFWR) is an agency of the Kentucky Tourism, Arts & Heritage Cabinet. KDFWR is overseen by a commission of members nominated by Kentucky's sportsmen and women from 9 districts across the state and appointed by the Governor. KDFWR employs about 400 full-time staff, including conservation officers, wildlife and fisheries biologists, conservation educators, and specialists in information technology, public relations, and administrative services. KDFWR receives no money from the state's General Fund; rather, the agency is funded through the sale of hunting and fishing licenses, boating registration fees, and federal grants based on the number of hunting and fishing licenses sold in the state.

KDFWR's Wildlife Division is responsible for the conservation and management of wildlife populations in the state to provide opportunity for hunting and viewing wildlife. Each year, KDFWR staff and partners from other agencies, universities, and non-governmental organizations conduct a mast survey in an effort to summarize mast conditions and shed light on population and harvest trends of various wildlife species. The Grouse & Turkey Program and Small Game Program coordinate the survey and prepared this report of survey findings.

Importance of Mast to Wildlife

Mast refers to the fruit of woody vegetation, many types of which provide important foods for wildlife. "Hard mast" includes acorns, hickory nuts, beechnuts, walnuts, and hazelnuts, all of which are available to wildlife beginning in late summer through fall and winter. "Soft mast" includes the many types of soft fruits produced from late spring through the summer and early fall, such as serviceberries, wild plums, wild grapes, dogwood berries, and persimmons.

Both hard and soft mast are important for Kentucky's wildlife throughout the year, but fall and winter hard mast production is of primary concern for wildlife managers because of the great influence this food resource exerts on the movements, body condition, and thus population dynamics of many forest-dwelling wildlife species. Thus, the KDFWR Mast Survey focuses on surveying oak, hickory, and American beech trees.

Deer, bears, wild turkeys, ruffed grouse, squirrels, small mammals, and other species depend on nutritious hard mast to bulk up before winter and for sustenance during winter when few other foods are available. Research has shown that in years when acorn crops are large enough to be available in March and April, female ruffed grouse enter the nesting season in better condition. The same may be true for other species. Animal movement in fall and winter is related to the availability of high-energy hard mast foods. In years when little to no mast is available from oaks, hickories, or beech trees, wildlife may move more often and/or greater distances in search of limited food supplies. Higher rates of movement may lead to more encounters with wildlife, some positive (deer and turkeys using fields to a greater degree in search of waste grains) and some negative (bear nuisance activity may be higher).

Mast production may be highly variable year to year, especially among the many oak species in our forests. Harsh spring weather may hinder flowering and pollination, reducing the fall mast crop. However, weather does not explain all the variability in mast production and all factors influencing a given year’s mast crop are unknown. Variability in production is buffered to some degree by having different hard mast species present in a forest stand, and most forests in Kentucky have multiple oak and hickory species. Some have walnuts and beech, as well.

Methods

Since 1982, KDFWR has conducted a statewide mast production survey of important producers of wildlife foods. The KDFWR Mast Survey evaluates 4 broad groups of trees of importance to Kentucky wildlife: red oaks, white oaks, hickories, and beech. By monitoring mast production annually, we can detect trends in wildlife food availability in our forests any given year. We may also compare these metrics to the number of animals harvested or observed in a given year to determine the relationship between mast and wildlife.

Past Method

Beginning in 1982 the Mast Survey took the form of a survey card sent out to area biologists for completion on 3 separate areas in their respective regions. The survey card had 4 categories for each tree and shrub group: Heavy, Moderate, Light, and None. These subjective categories reflected the surveyor’s personal evaluation of the amount of hard or soft mast occurring on each group of trees and shrubs in September and October (Figure 1). The trends observed from these data cannot be assimilated in the current survey method, but are valuable metrics in a historical context (Figure 2).

ANNUAL MAST SURVEY CARD		G-PR(44)		
County _____	Observer _____	Year <u>2005</u>		
	Heavy	Moderate	Light	None
The Hickories				
The Red Oaks				
The White Oaks				
Black Walnut				
American Beech				
Flowering Dogwood				
Other				

Figure 1. Old survey card method for mast assessment across Kentucky 1982 – 2006.

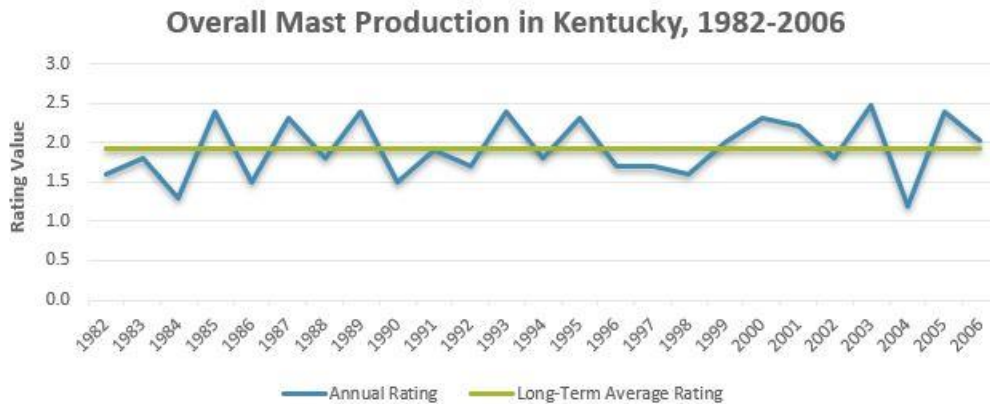


Figure 2. Mast Survey results, 1982-2006.

Ratings are mast production index values averaged annually across all trees surveyed. Species survey included various white oak, red oak, and hickory species, American beech, black walnut, and flowering dogwood.

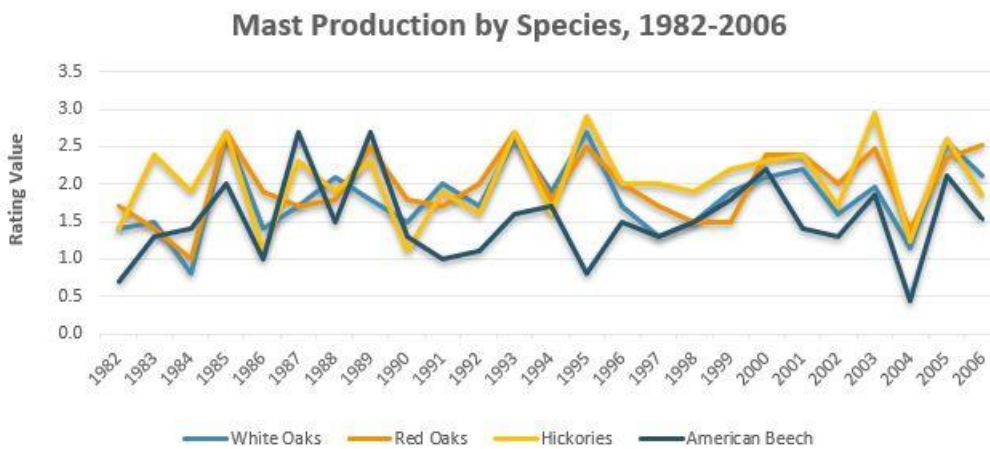


Figure 2b. Mast Survey results by species group, 1982-2006. Ratings are mast production index values averaged annually across all trees surveyed within each of 4 groups: white oak species, red oak species, hickory species, and American beech.

Current Method

Beginning in 2007 the Mast Survey changed to a more quantitative method of data collection. This change was motivated by the formation of a coordinated hard mast survey by several eastern states in 2007 based on recent research. The goal was to allow comparison of mast conditions regionally (Figure 3).

The current method requires individuals to scan the crown of each survey tree for 30 seconds and estimate the percentage of the crown bearing mast. This percentage, abbreviated as “PCA” (the “A” originally meant “acorns” but here denotes “any” mast) is quantitative, which is

preferable to the old qualitative method. To alleviate concern that PCA is still subjective, we reclassify the PCA ratings more broadly based on presence or absence of any mast, abbreviated as “PBA”. We group PBA ratings into categories: failure (0-20% PBA), poor (21-40% PBA), average (41-60% PBA), good (61-80% PBA), and bumper (81-100% PBA).

WHITE OAK MAST SURVEY SITES 2016

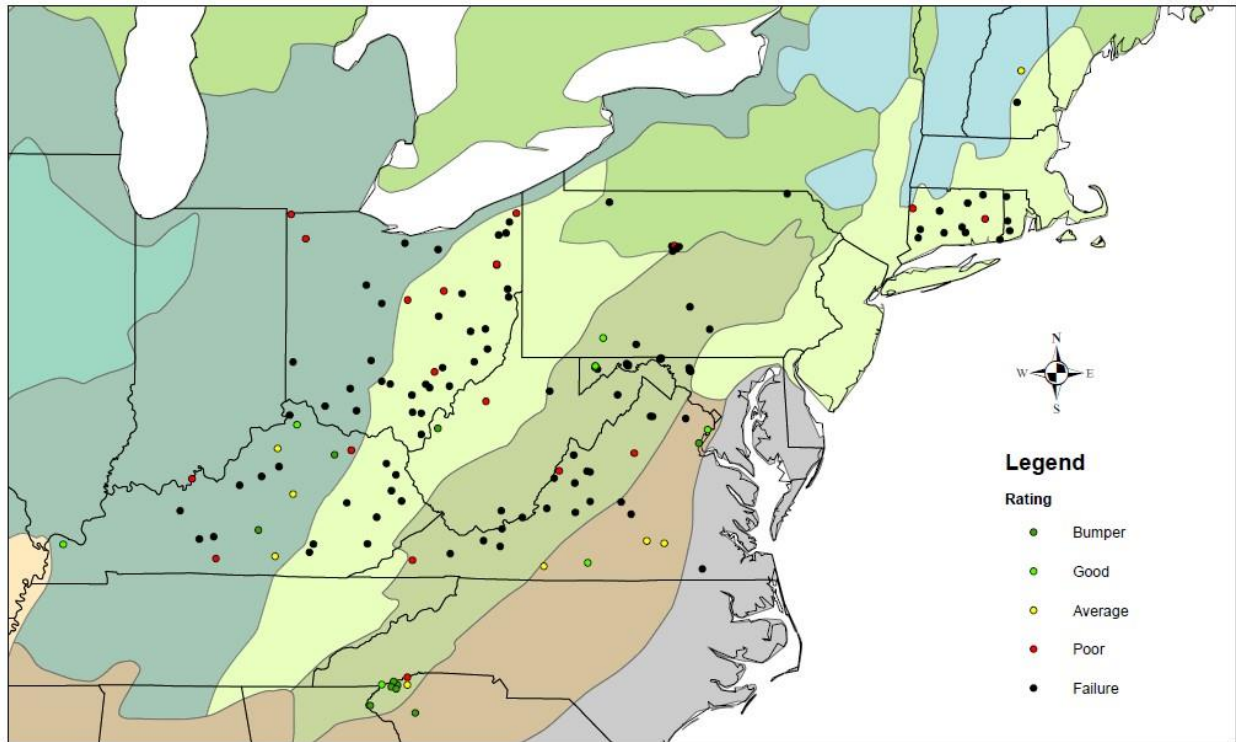


Figure 3. White oak mast survey locations for the regional mast survey consortium, 2016.

Surveyors

The Mast Survey in Kentucky takes place across the state. The number of surveys conducted each year has varied but typically has included about 25 individual survey routes. Most routes include 100 trees per route, with 25 each in the white oak group, red oak group, hickory group, and American beech. Historically, KDFWR biologists completed surveys but the list of surveyors now includes volunteers from other natural resource agencies, universities, and non-governmental organizations.

Results and Discussion

In 2023, surveys were completed along 34 individual routes in 31 counties (Figure 4). A total of 2,760 individual trees were sampled, including 783 white oak trees, 786 red oak trees, 786 hickory trees, and 405 American beech trees (Table 1).

Figure 4. Mast survey sites, 2023. Regional division based on U.S. Forest Service ecological and forest type classifications (<https://www.fs.fed.us/land/pubs/ecoregions/intro.html>, https://data.fs.usda.gov/geodata/rastergateway/forest_type/).

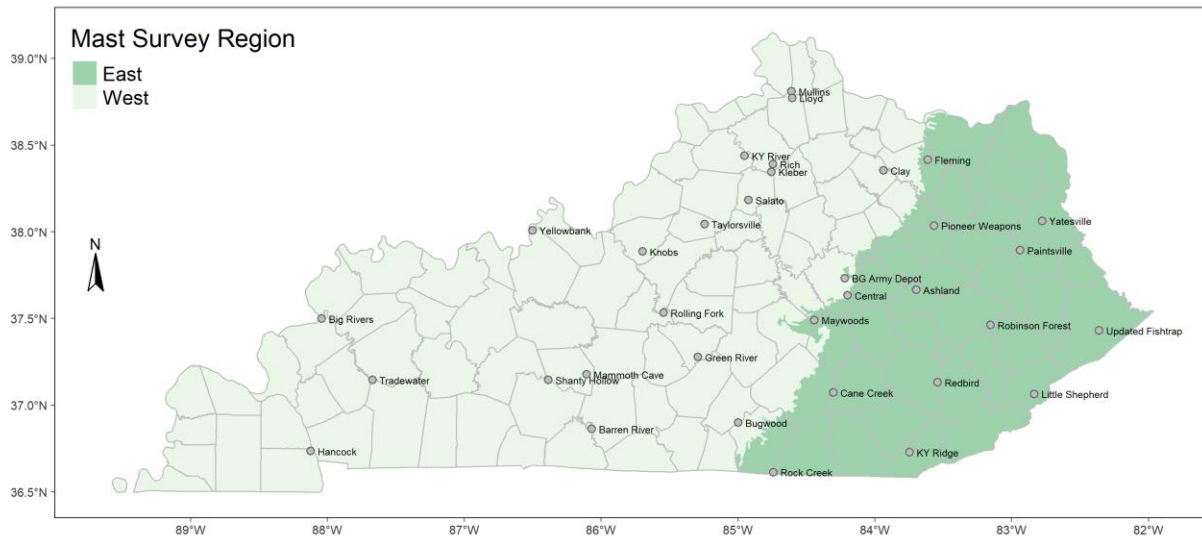


Table 1. Mast survey results overall, 2023 This table provides quantitative and qualitative measures of masting. Region indicates how data are summarized. Tree Group refers to broad categories into which various tree species are grouped. Trees Surveyed is the number of individual trees surveyed across all routes. PCA is the percentage of a tree’s crown bearing mast averaged across all survey trees. PBA is the percentage of survey trees bearing any mast and is derived from PCA. Rating is the PBA value categorized into classes: “Failure” = 0 to 20%, “Poor” = 21 to 40%, “Average” = 41 to 60%, “Good” = 61 to 80%, “Bumper” = 81 to 100%.

Region	Tree Group	Trees Surveyed	PCA (median ± IQR*) ^a	PBA	Rating
Statewide	White Oak	783	5 (0-15)	52	Average
	Red Oak	786	20 (0-60)	71	Good
	Hickory	786	2.525 (0-15)	50	Average
	Beech	405	30 (0-60)	71	Good
East	White Oak	327	0 (0-10)	41	Average
	Red Oak	293	5 (0-30)	56	Average
	Hickory	309	0.05 (0-15)	50	Average
	Beech	245	25 (0-60)	64	Good
West	White Oak	456	5 (0-20)	60	Average

Region	Tree Group	Trees Surveyed	PCA (median \pm IQR*) ^a	PBA	Rating
	Red Oak	493	30 (5-65)	80	Good
	Hickory	477	5 (0-15)	50	Average
	Beech	160	35 (13.75-70)	82	Bumper

^a Median is used like an average to show a middle PCA values (i.e., 50th percentile); interquartile range (IQR) is used to show average variation around the median (i.e., middle of the data between the 25th and 75th percentiles)

Across the state, mast production rated Average for white oaks, Good for red oaks, Average for hickories, and Good for beech (Figure 5, Figure 6). At eastern sites, mast production rated Average for white oaks, Average for red oaks, Average for hickories, and Good for beech. At western sites, mast production rated Average for white oaks, Good for red oaks, Average for hickories, and Bumper for beech.

Figure 5. Percentage of trees bearing mast (PBA), 2023. This bar plot shows the distribution of PBA values when sampled trees are grouped by species group and survey region. PBA is presence or absence of mast derived from estimates of the percentage of tree crown area bearing mast (PCA; see Figure 9).

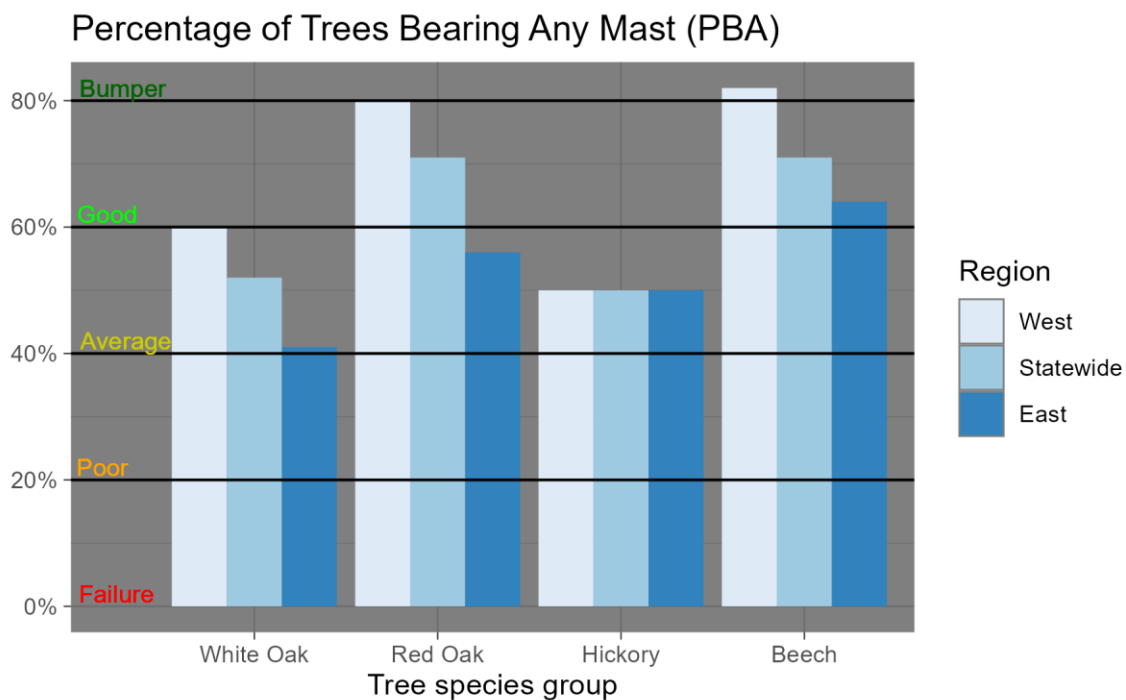
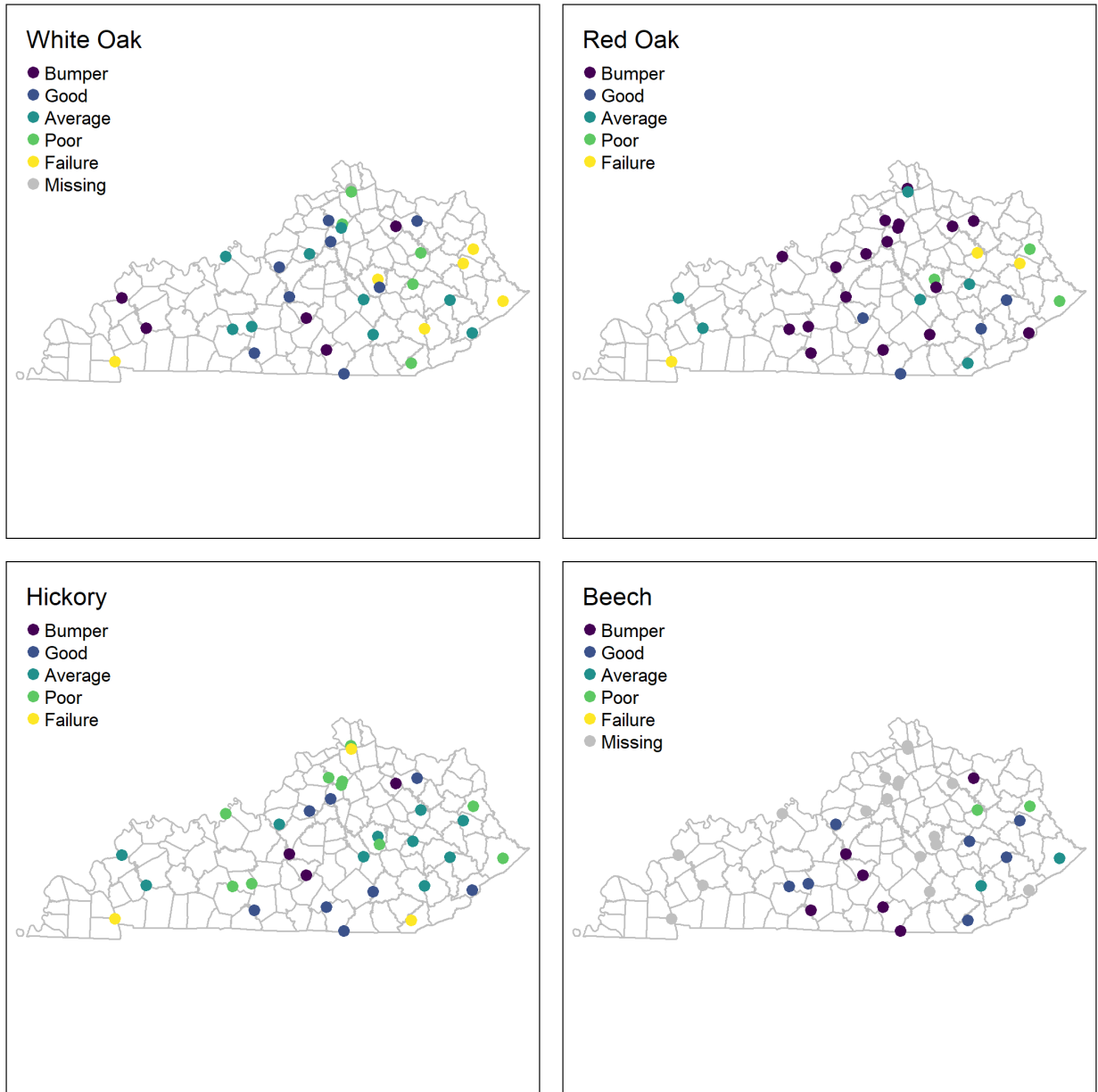


Figure 6. Mast survey ratings by site for tree species groups, 2023. Ratings categorize the percentage of trees bearing any mast (PBA). At each site, “Failure” = 0 to 20%, “Poor” = 21 to 40%, “Average” = 41 to 60%, “Good” = 61 to 80%, “Bumper” = 81 to 100%. White Oak, Red Oak, Hickory, and Beech are 4 broad groupings of the various mast-producing tree species surveyed. Not all tree group were surveyed at each site.



White oak acorn crops were good to bumper at 55% of survey sites in western Kentucky but were rated that highly at only 15% of eastern sites. Similarly, red oak acorn crops were good to bumper at 76% of western sites but at only 46% of eastern sites (Tables 2 and 3). Hickory nut

crops were good to bumper at 33% of western sites and 31% of eastern sites. Beechnut crops were good to bumper at 100% of western sites and 60% of eastern sites.

Table 2. Mast ratings by tree group, 2023. This table provides the number (and percentage) of survey routes in each of 5 mast rating categories for each of 4 tree species groups. Region indicates how data are summarized. Tree Group refers to broad categories into which various tree species are grouped. Trees Surveyed is the number of individual trees surveyed across all routes. PBA Rating refers to categories for the percentage of trees bearing any mast: “Failure” = 0 to 20%, “Poor” = 21 to 40%, “Average” = 41 to 60%, “Good” = 61 to 80%, “Bumper” = 81 to 100%. White Oak, Red Oak, Hickory, and Beech are broad categories into which various tree species are grouped.

Region	PBA Rating	White Oak	Red Oak	Hickory	Beech
Statewide	Bumper	5 (15%)	18 (53%)	3 (9%)	6 (35%)
	Good	8 (24%)	4 (12%)	8 (24%)	7 (41%)
	Average	9 (27%)	6 (18%)	10 (29%)	2 (12%)
	Poor	5 (15%)	3 (9%)	10 (29%)	2 (12%)
	Failure	6 (18%)	3 (9%)	3 (9%)	0 (0%)
East	Bumper	0 (0%)	3 (23%)	0 (0%)	2 (20%)
	Good	2 (15%)	3 (23%)	4 (31%)	4 (40%)
	Average	4 (31%)	3 (23%)	6 (46%)	2 (20%)
	Poor	3 (23%)	2 (15%)	2 (15%)	2 (20%)
	Failure	4 (31%)	2 (15%)	1 (8%)	0 (0%)
West	Bumper	5 (25%)	15 (71%)	3 (14%)	4 (57%)
	Good	6 (30%)	1 (5%)	4 (19%)	3 (43%)
	Average	5 (25%)	3 (14%)	4 (19%)	0 (0%)
	Poor	2 (10%)	1 (5%)	8 (38%)	0 (0%)
	Failure	2 (10%)	1 (5%)	2 (10%)	0 (0%)

Table 3. Mast ratings by survey site, 2023. This table provides mast ratings for every site surveyed. Sites are ordered alphabetically within regions. PBA Rating refers to categories for the percentage of trees bearing any mast: “Failure” = 0 to 20%, “Poor” = 21 to 40%, “Average” = 41 to 60%, “Good” = 61 to 80%, “Bumper” = 81 to 100%. White Oak, Red Oak, Hickory, and Beech are broad categories into which various tree species are grouped. Blanks indicate that a tree group was not surveyed at a site.

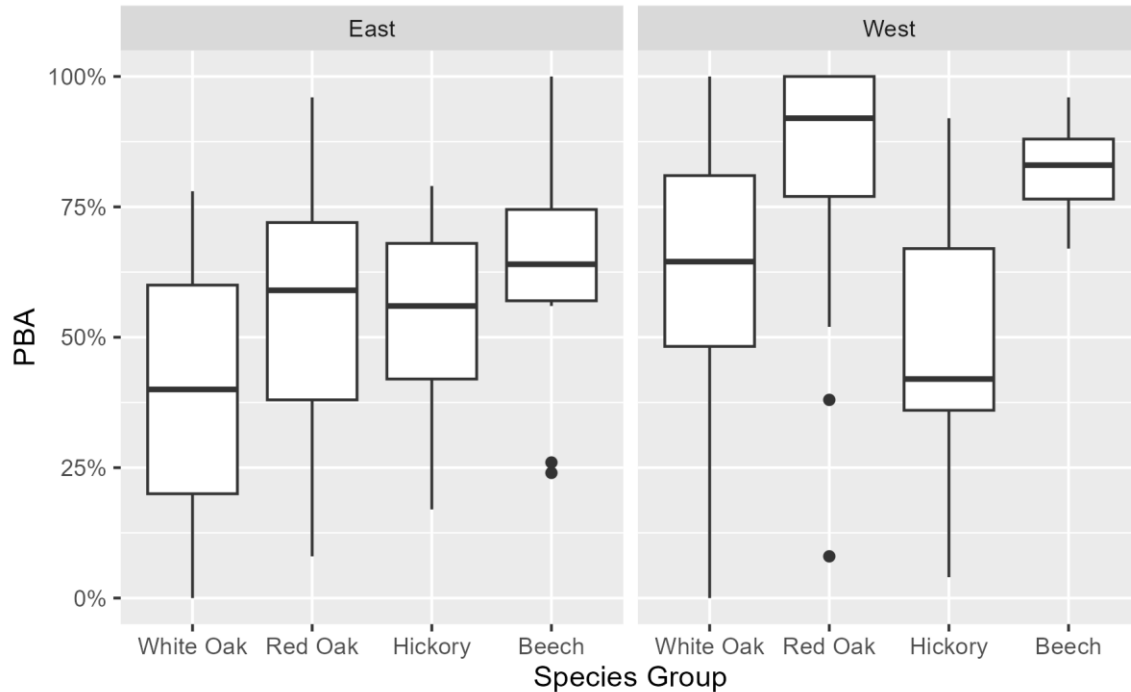
		Mast Rating (% of trees bearing mast)			
Region	Site	White Oak	Red Oak	Hickory	Beech
East	Ashland	Poor	Average	Average	Good
	Cane Creek	Average	Bumper	Good	
	Fleming	Good	Bumper	Good	Bumper
	KY Ridge	Poor	Average	Failure	Good
	Little Shepherd	Average	Bumper	Good	
	Maywoods	Average	Average	Average	
	Paintsville	Failure	Failure	Average	Good
	Pioneer Weapons	Poor	Failure	Average	Poor
	Redbird	Failure	Good	Average	Average
	Robinson Forest	Average	Good	Average	Good
	Rock Creek	Good	Good	Good	Bumper
	Fishtrap	Failure	Poor	Poor	Average
Yatesville	Failure	Poor	Poor	Poor	
West	Barren River	Good	Bumper	Good	Bumper
	Big Rivers	Bumper	Average	Average	
	BG Army Depot	Failure	Poor	Average	
	Bugwood	Bumper	Bumper	Good	Bumper
	Central	Good	Bumper	Poor	
	Clay	Bumper	Bumper	Bumper	

Mast Rating (% of trees bearing mast)					
Region	Site	White Oak	Red Oak	Hickory	Beech
	KY River	Good	Bumper	Poor	
	Green River	Bumper	Good	Bumper	Bumper
	Hancock	Failure	Failure	Failure	
	Salato	Good	Bumper	Good	
	Kleber	Average	Bumper	Poor	
	Knobs	Good	Bumper	Average	Good
	Lloyd	Poor	Average	Failure	
	Mammoth Cave	Average	Bumper	Poor	Good
	Mullins		Bumper	Poor	
	Rich	Poor	Bumper	Poor	
	Rolling Fork	Good	Bumper	Bumper	Bumper
	Shanty Hollow	Average	Bumper	Poor	Good
	Taylorville	Average	Bumper	Good	
	Tradewater	Bumper	Average	Average	
	Yellowbank	Average	Bumper	Poor	

As is typical, mast production was variable among sites (Table 3, Figure 6, Figure 7). As an example of how two nearby sites can vary, white oak mast rated as Failure at Blue Grass Army Depot but as Good at nearby Central Kentucky WMA, both in Madison County. In contrast, red oak rated as Bumper at Barren River Lake WMA, which is much farther west than Cane Creek WMA in the east. Still, based on the inter-quartile range (i.e., the width of boxes in Figure 7), variability about PBA values actually was similar between western and eastern sites this year, meaning we can have fairly high confidence in the PBA values themselves.

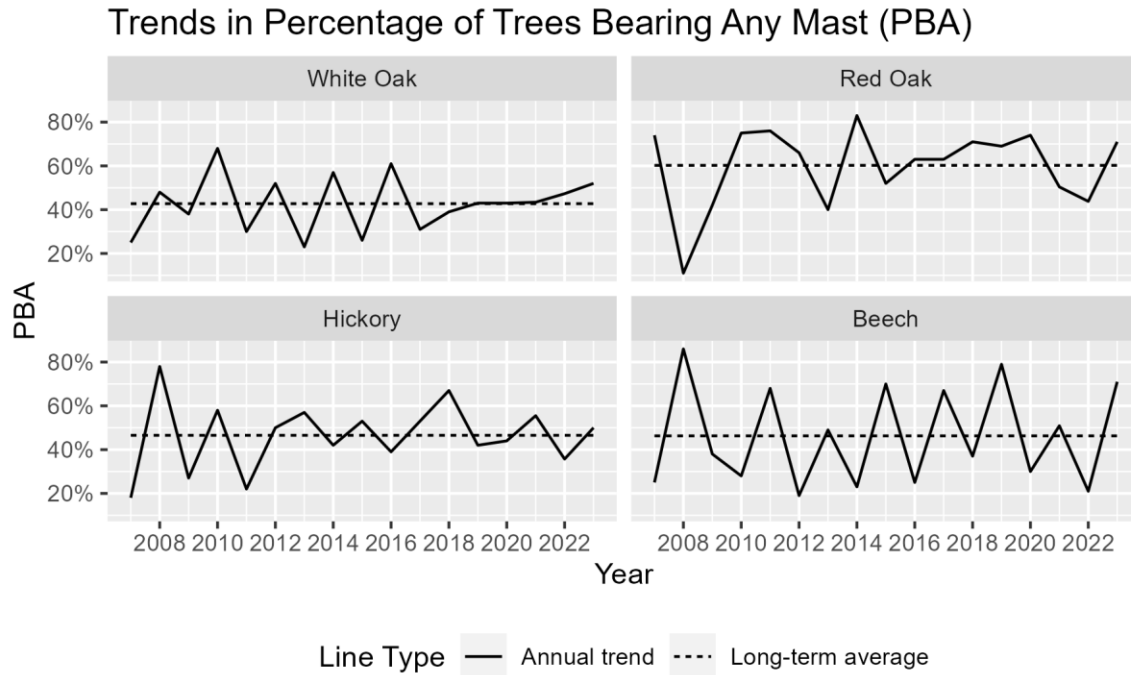
Figure 7. Variation in percentage of trees bearing mast (PBA), 2023

Distribution of PBA values summarized by tree species group and site. The horizontal line inside each box represents median PBA (50% of values across all sites in the region are below this value). The lower bound of each box is 25th percentile (25% of values below this value). The upper bound is the 75th percentile (75% of values below this value). The “whiskers” show maximum and minimum values, excluding outliers. Outliers, represented by individual dots, are 1.5 times greater than the upper quartile or lower than the lower quartile.



Long-term trends in PBA show substantial fluctuations year-to-year at the statewide level (Figure 8). White oak PBA increased slightly but mostly has been stable since rebounding to the long-term average in 2018. Red oak PBA was low the past two years but increased sharply this year. Hickory increased modestly back to the long-term average. Beech increased sharply to its highest level since 2019. Causes of variability in mast production are not well understood, particularly at local levels.

Figure 8. Trends in percentage of trees bearing mast (PBA) by species group, 2007-2023. PBA is presence or absence of mast derived from estimates of the percentage of tree crown area bearing mast (PCA). NOTE: Values for beech should be interpreted with caution because a high proportion of beechnuts tend to be unsound, and we do not routinely assess soundness by floating the nuts.



So far we have reported on PBA, a presence-absence metric. In terms of PBA, a white oak tree with 1 acorn rates the same as another white oak tree with 1,000 acorns, despite the large difference in acorn abundance (i.e., PCA) between trees. Trees commonly have low PCA values and PCA can be highly variable. Both conditions were observed this year (Figure 9, Figure 10). PBA and PCA are not related linearly in a 1-to-1 relationship (Figure 11). PBA tends to be higher at a given PCA, so slight changes in PCA can bump the PBA rating to a higher category (Figure 11A). At statewide and regional levels, the PBA-PCA relationship varies somewhat by tree group (Figure 11B). And across sites, the median and variance for PCA (5%, 25%) are much lower than for PBA (60%, 44%).

Figure 9. Percentage of tree crown area bearing mast (PCA) statewide and in each survey region, 2023. In this plot, points are median PCA values (50% all trees are below this value) and the error bars are the interquartile range (middle 50% of the data, with 25% above and below the median, respectively).

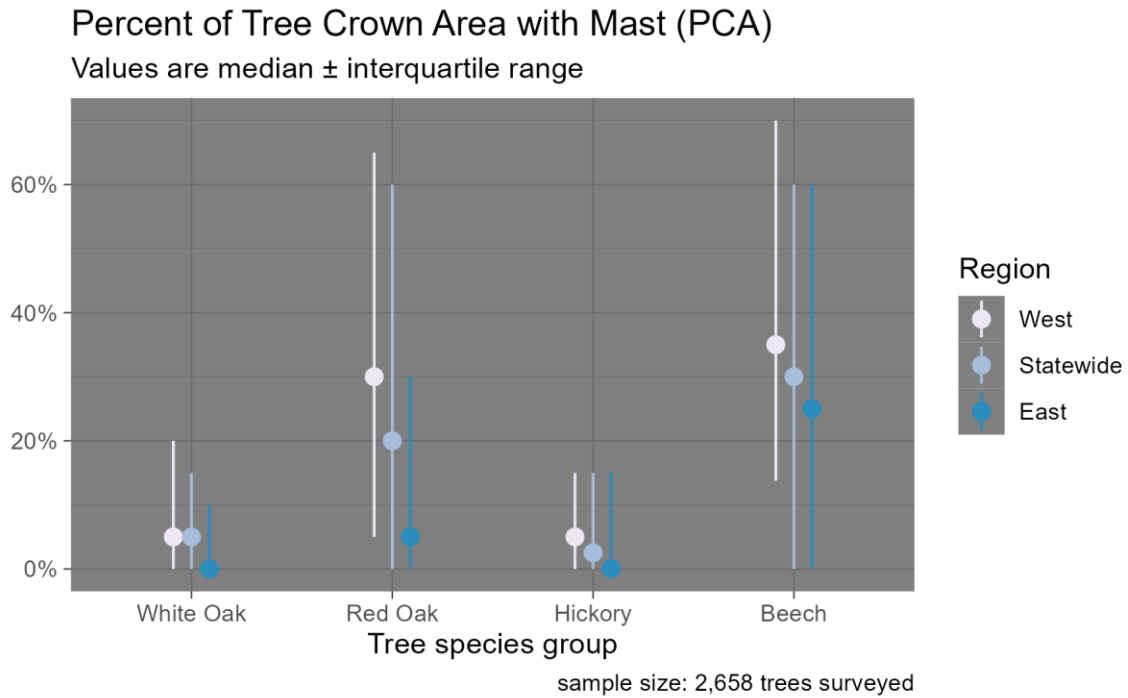


Figure 10. Percentage of tree crown area bearing mast (PCA) by site, 2023. Plots show the distribution of PCA values among individual trees at each survey site. Tree species group are abbreviated (W = white oak, R = red oak, H = hickory, B = beech).

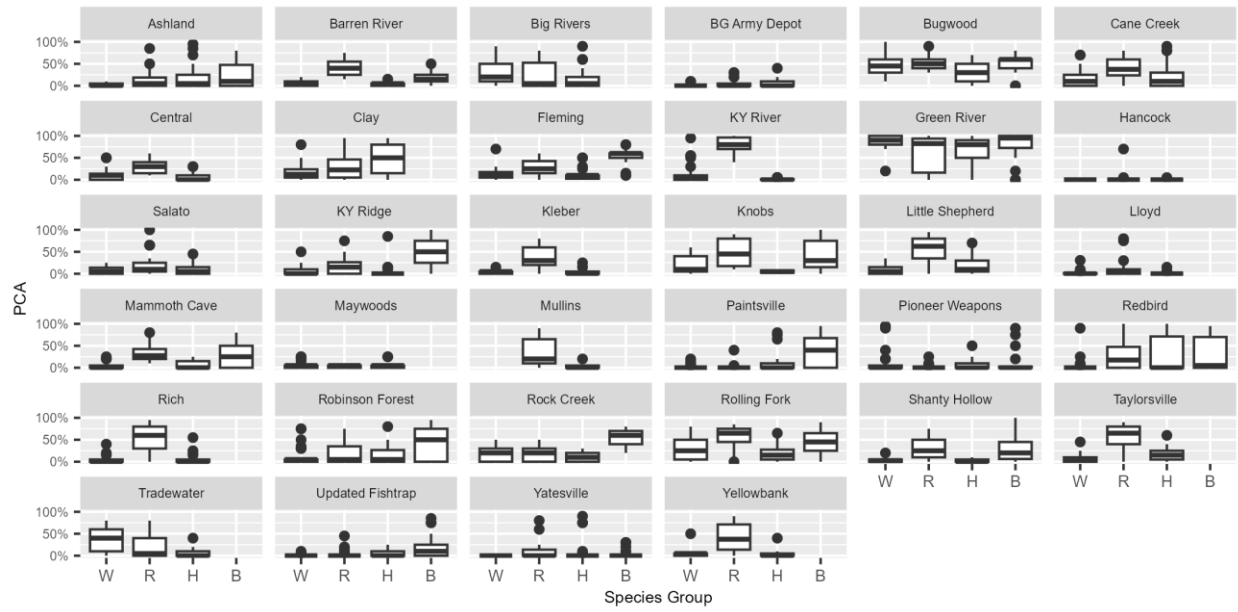
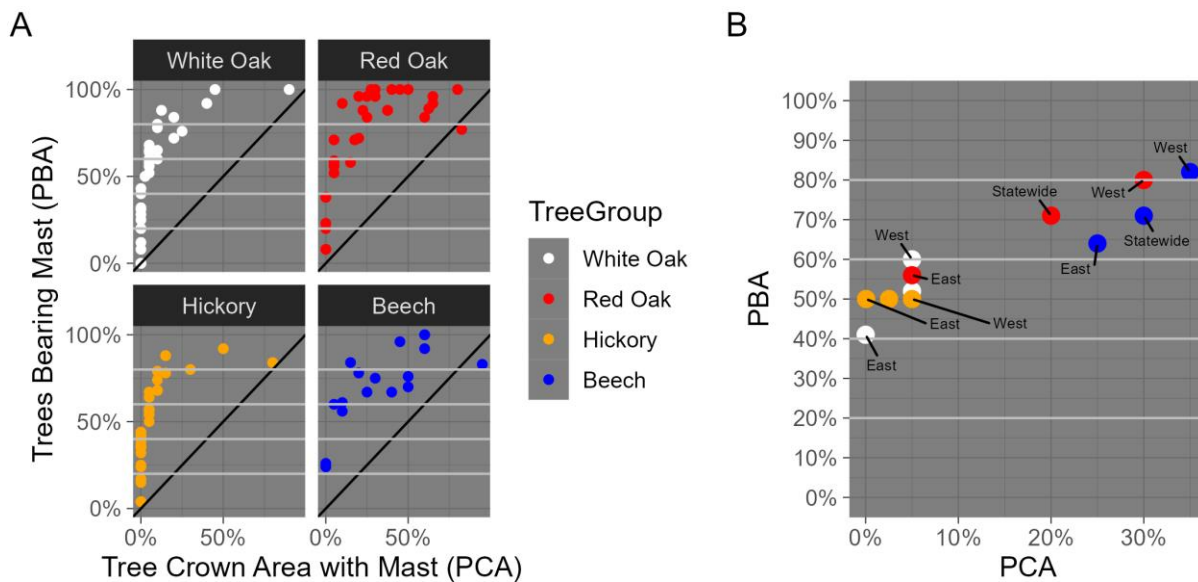


Figure 11. Relationship of PCA and PBA, 2023. Plot A shows the correlation of PCA values with PBA values by tree group for each survey site. Each dot is a site and colors represent tree species groups. The black diagonal line in each subplot is a reference for what would be a perfectly linear relationship; however, for each tree group, the relationship is not linear, with PBA values being higher for a given PCA level. Plot B shows the PCA-PBA correlation summarized statewide and regionally. Colors represent tree groups and dots are statewide or regionally summarized values of PCA and PBA. For (A) and (B), the white horizontal lines denote the PBA ratings described above (“Failure” = 0 to 20%, “Poor” = 21 to 40%, “Average” = 41 to 60%, “Good” = 61 to 80%, “Bumper” = 81 to 100%).



In summary, this year masting was better than last year, being average to good overall across the Commonwealth. However, hunters should expect variation from place to place and scout for productive trees in the areas they hunt. Deer, turkeys, bears, squirrels, grouse, and other animals will be keyed in to those resources.

Acknowledgments

Survey coordinators Cody Rhoden and Zak Danks thank Trey Prather for data management and the many KDFWR staff, partners, and volunteers who battled bugs, briars, and poison ivy to collect mast data for this year’s survey.

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