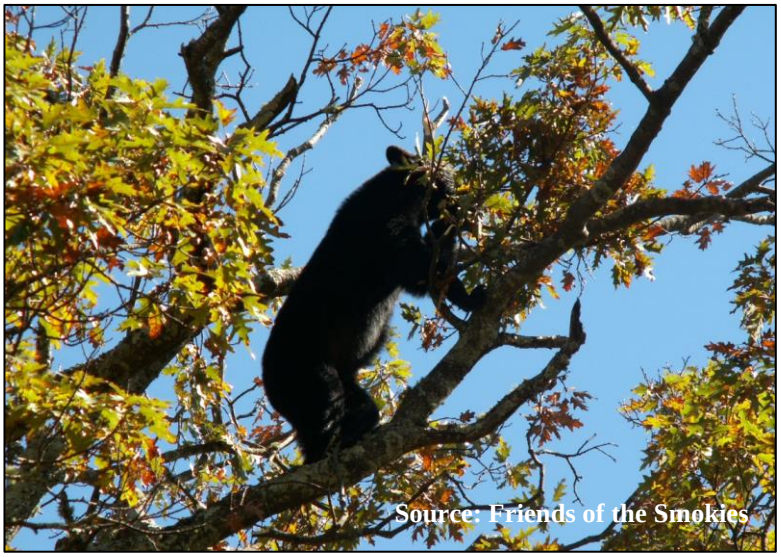
WESTERN NORTH CAROLINA HARD AND SOFT MAST SURVEY REPORT
39th Year

FALL 2021

North Carolina Wildlife Resources Commission

Compiled and written by:
Colleen Olfenbuttel
Black Bear and Furbearer Biologist
November 2021



Source: Friends of the Smokies

Funding for the hard and soft mast survey was partially provided through a Pittman-Robertson Wildlife Restoration Grant. The Federal Aid in Wildlife Restoration Act, popularly known as the Pittman-Robertson Act, was approved by Congress on September 2, 1937, and began functioning July 1, 1938. The purpose of this Act was to provide funding for the selection, restoration, rehabilitation and improvement of wildlife habitat, wildlife management research, and the distribution of information produced by the projects. The Act was amended October 23, 1970, to include funding for hunter training programs and the development, operation and maintenance of public target ranges.

Funds are derived from an 11 percent Federal excise tax on sporting arms, ammunition, and archery equipment, and a 10 percent tax on handguns. These funds are collected from the manufacturers by the Department of the Treasury and are apportioned each year to the States and Territorial areas (except Puerto Rico) by the Department of the Interior on the basis of formulas set forth in the Act. Funds for hunter education and target ranges are derived from one-half of the tax on handguns and archery equipment.

Each state's apportionment is determined by a formula which considers the total area of the state and the number of licensed hunters in the state. The program is a cost-reimbursement program, where the state covers the full amount of an approved project then applies for reimbursement through Federal Aid for up to 75 percent of the project expenses. The state must provide at least 25 percent of the project costs from a non-federal source.

Introduction

North Carolina Wildlife Resources Commission (NCWRC) personnel have surveyed hard mast in the Mountain Bear Management Unit (MBMU) of North Carolina since 1983. From 1983-2005, North Carolina's hard mast surveys were conducted and reported using a method developed by Whitehead (1969) with slight modifications (Wentworth et al. 1992). This same protocol was used in whole or part by Georgia and Tennessee for many years and was adopted by South Carolina in the 1990's. In an effort to reduce costs and manpower commitments, while maintaining quality data and standard methodology among neighboring states, the member states of the Southern Appalachian Black Bear Study Group (SABBSG, Georgia, North Carolina, South Carolina, and Tennessee) have long searched for an improved technique for monitoring hard mast surveys. Beginning with the 2006 survey, we are using a new protocol and formula for determining mast indices (Greenberg and Warburton 2007). The new protocol only requires simple calculation of percent crown with acorns in the field. In order to maintain consistency with the old technique, the new technique uses statistically verified equations to convert mast index values to numbers previously used with the Whitehead (1969) method. Hard mast results reported in this document utilize the techniques described in Greenberg and Warburton (2007) and are described using the scale used by our agency since 1983. Due to small sample sizes, results will no longer be reported for individual routes for hickory and beech, but overall values for these species will be reported. Sample sizes are sufficient to allow the reporting of values for both the white oak and red oak groups by route.

Hard Mast Overall Results

The 2021 hard mast survey was conducted by WRC Land and Water Access staff, WRC Wildlife Management Division Operations staff, and Carl Sandberg Home National Historic Site staff on 12 routes in western North Carolina. South Mountains State Park staff were unable to conduct the surveys in their area this year. A total of 1,391 trees were sampled including 546 from the white oak group, 674 from the red oak group, 133 hickories, 36 beeches, and 2 walnuts. Of these, 53 trees were reported dead or logged. Combining all groups of species, mast was rated as fair, with an overall index of 2.55, which is a slight increase from last year's mast crop index (2.47; Table 1). Since 1983, North Carolina has experienced 25 years out of 39 years in which the hard mast index was rated as fair. Including only the oak species, mast production rated as fair (2.47; Table 1).

White oak production rated as fair (2.58) and above both the long-term average (1.87) and last year's index (1.42; Table 1). When the white oak group is separated by species, chestnut oak (2.24) and white oak (2.99) production both rated as fair (Table 2). Red oak production rated as fair (2.38) and below the long-term average (2.83) and last year's index (3.23; Table 1) for the species. Separated by species, black oak (3.96), northern red oak (2.19), and scarlet oak (2.66) all rated as fair (Table 2). Hickory production rated as fair (3.21) and above the long-term average (2.38) for the species (Table 1). Beech production (2.63) was fair and below the long-term average (4.07; Table 1).

Hard Mast Survey Area Results

As in previous years, hard mast production varied by location and species (Table 3; Figures 1 and 2). Unlike 2019 and 2020, when nine routes surveyed had white oak productivity rated as poor, during 2021 there was more variation in white oak production by route. White oak productivity rated as poor on five routes, rated as fair on five routes, and rated as good on two

routes (Table 3; Figure 1). Fires Creek and Carl Sandberg HHS routes had good white oak productivity (Table 3). Overall, six counties experienced poor white oak productivity, three counties experienced fair white oak productivity, and one county experienced good white oak productivity (Figure 1).

Red oak productivity varied a little bit less by route than white oak productivity. Red oak productivity rated as poor on seven routes, rated as fair on one route, rated as good on three routes, and rated as excellent on one route (Table 3). Overall, seven counties experienced poor red oak productivity, while one county each rated as fair, good, and excellent for red oak productivity (Figure 2).

Unlike previous years, red oak and white oak productivity rated fair across all elevations (<1,900 feet to 5,000+ feet; Table 4). One factor for this was likely the lack of a late spring freeze, that has impacted mast productivity at certain elevations in previous years.

Summer Soft Mast Survey Results

A soft mast survey was implemented during the summer and fall of 1993 to document berry production and abundance. The technique used for evaluating the soft mast has remained consistent throughout this period including the current year. Summer soft mast surveys are conducted in conjunction with the Sardine Bait Station Survey (SBSS). During summer 2006, based on an agreement with the member states of the SABBSG, we did not conduct the SBSS. Review of data from the SBSS indicates that we can obtain long-term bear population trend information by conducting the SBSS every other year. Because of the new schedule, the summer soft mast survey is conducted in odd years. The previous summer soft mast survey was conducted in 2019 (Table 5 and 6) and the next survey was conducted during the summer of 2021.

During the summer of 2021, all four summer soft mast species surveyed (blueberry, huckleberry, blackberry, and pokeberry) were below the long-term averages (Table 5). Blueberry, huckleberry, and pokeberry production rated as poor, while blackberry rated as fair. These are similar results to the 2017 and 2019 summer soft mast survey. Summer soft mast production varied on a local basis with some areas failing to produce any significant fruit of certain species while producing “fair” to “good” crops of others (Table 6).

Fall Soft Mast Survey Results

The 2021 fall soft mast survey is conducted in conjunction with the hard mast survey. Overall, soft mast production was slightly above the production observed in 2020 with all fall mast surveyed (pokeberry, cherry, grapes, and blackgum) above long-term averages for those species (Table 7; Figure 3). Pokeberry, cherry, grape, and blackgum all rated as fair, with cherry approaching good production (Table 7). As observed in previous years, local areas experienced variable production of fall soft mast depending on species and area (Table 8).

Conclusion

This season’s hard mast crop was the twenty-fifth year since 1983 in which the overall hard mast index was fair. The fall hard mast index was slightly higher in 2021 than in 2020, but close to long-term averages and the 2019 hard mast index (Table 1). The white oak index was higher and the red oak index lower than in 2020 (Table 1). Both white oak and red oak productivity declined moving from western to eastern counties within the MBMU, with eastern counties all experiencing poor oak productivity (Figures 1 and 2). Conversely, the far western

counties experienced fair to excellent oak productivity, with one area having excellent red oak production (Figures 1 and 2). Comparing our results with near-by states, Georgia reported that white and red oaks were doing well, while South Carolina had good red oak production (5.5), but fair white oak production (3.5). Virginia reported that both red and white oak productivity were down compared to previous years. While mast surveys are not conducted outside the MBMU, anecdotally, hard mast productivity in the Piedmont region appeared to be fair and lower than the "bumper" crop reported in some Piedmont areas in 2020. The overall trend in hard mast production shows a very slight declining to stable trend since surveys were initiated in 1983 (Figure 4). The 2020 fall soft mast results were similar to that of 2019 which was fair to poor abundance (Table 7; Figure 3).

This report and previous annual mast reports (2003 to present) can be found at: http://www.ncwildlife.org/bear and click on "Surveys and Reports" tab, then the "Hard and Soft Mast Surveys" link.

LITERATURE CITED

Greenberg, C.H., and G.S. Warburton. 2007. A fast and reliable hard mast index from acorn presence-absence tallies. Journal of Wildlife Management 71:1654-1661.

Wentworth, J.M., A.S. Johnson, P.E. Hale, and K.E. Kammermeyer. 1992. Relationship of Acorn abundance and deer herd characteristics in the southern Appalachians. Southern Journal of Applied Forestry 16:5-8.

Whitehead, C.J. 1969. Oak mast yields on wildlife management areas in Tennessee. Tennessee Game and Fish Commission, Nashville, USA.

Table 1. Hard Mast Survey Results for Western North Carolina, 1983-2021.

Year	White Oak	Red Oak	All Oaks	Hickory	Beech	Total
1983	1.43	2.59		1.99	5.51	2.25
1984	1.08	2.73		3.05	4.28	2.30
1985	2.01	3.66		0.80	3.06	2.80
1986	1.32	1.98		2.25	5.22	1.90
1987	1.16	0.56		3.57	5.75	1.31
1988	3.16	4.07		2.04	4.25	3.57
1989	0.43	4.89		2.78	6.44	3.14
1990	1.85	2.62		1.20	1.89	2.17
1991	2.38	1.93		3.75	6.89	2.43
1992	1.07	2.45		0.72	1.17	1.78
1993	0.65	3.58		2.43	4.77	2.48
1994	2.06	3.48		2.02	6.20	2.85
1995	2.80	5.60		2.48	0.36	4.22
1996	3.70	1.99		2.81	4.31	2.72
1997	0.53	1.79		1.17	2.35	1.29
1998	2.26	4.68		3.27	4.70	3.69
1999	3.28	2.76		2.80	6.22	3.05
2000	0.50	2.11		2.73	5.71	1.82
2001	2.83	4.92		2.88	3.97	3.98
2002	1.90	3.01		1.75	3.44	2.47
2003	1.24	0.68		3.58	5.42	1.33
2004	3.99	2.93		1.32	1.65	3.09
2005	0.70	3.11		1.86	4.30	2.14
2006	1.70	1.40	1.50*	3.20	4.10	1.80
2007	3.02	1.19	2.04	0.73	2.71	1.90
2008	1.01	2.40	1.76	3.82	4.34	2.06
2009	0.48	2.47	1.55	1.72	5.58	1.67
2010	3.46	3.97	3.75	3.50	0.87	3.66
2011	1.17	2.22	1.74	1.30	4.96	1.76
2012	1.87	2.68	2.31	2.01	3.14	2.29
2013	1.00	1.43	1.23	2.43	4.45	1.44
2014	4.43	4.36	4.42	2.33	1.23	4.10
2015	1.07	2.65	1.92	2.64	5.77	2.09
2016	2.71	2.60	2.66	2.45	4.08	2.67
2017	2.13	4.42	3.40	3.20	5.69	3.44
2018	0.94	2.14	1.61	1.58	1.11	1.58
2019	1.97	2.84	2.45	3.35	5.54	2.63
2020	1.42	3.23	2.43	2.26	4.67	2.47
2021	2.58	2.38	2.47	3.21	2.63	2.55
Average	**1.87**	**2.83**	**2.33**	**2.38**	**4.07**	**2.48**

Numerical Rating = Crop Quality

0.0 to 2.0 = Poor 2.1 to 4.0 = Fair
4.1 to 6.0 = Good 6.1 to 8.0 = Excellent

* Not reported for prior years.

Table 2. Hard Mast Survey Results by Species, 2021.

Grouping	Species	Index	Number of Trees Sampled
Hickories	MH, PH, SH, GH[1]	3.21	133
Beech	Beech	2.63	36
Red Oaks	Black Oak	3.96	32
	Northern Red Oak	2.19	478
	Scarlet Oak	2.66	161
White Oaks	Chestnut Oak	2.24	295
	White Oak	2.99	251

Numerical Rating = Crop Quality

0.0 to 2.0 = Poor 2.1 to 4.0 = Fair
4.1 to 6.0 = Good 6.1 to 8.0 = Excellent

[1]MH,SH, PH, GH: Mockernut Hickory, Pignut Hickory, Shagbark Hickory

Table 3. Hard Mast Survey Results by Area, 2021.

County	Area	White Oak	Red Oak	All Oaks
Transylvania	Avery Creek	2.2	1.2	1.7
Henderson	Carl Sandberg	4.5	5.0	4.7
Haywood	Cold Mountain	2.3	0.8	1.2
Avery & Caldwell	Edgemont	0.5	0.4	0.4
Clay	Fires Creek	5.8	6.4	6.1
Haywood	Harmon Den	1.4	1.3	1.3
Burke & McDowell	Linville Mtn.	1.6	0.9	1.3
Macon	Nantahala	3.5	5.7	5.0
Mitchell	Poplar	1.5	1.7	1.6
Graham	Santeetlah	3.4	2.9	3.1
Haywood	Sherwood	1.2	1.6	1.5
Burke	South Mountains	N/A	N/A	N/A
Macon	Standing Indian	2.9	5.3	4.3

Numerical Rating = Crop Quality

0.0 to 2.0 = Poor 2.1 to 4.0 = Fair
4.1 to 6.0 = Good 6.1 to 8.0 = Excellent

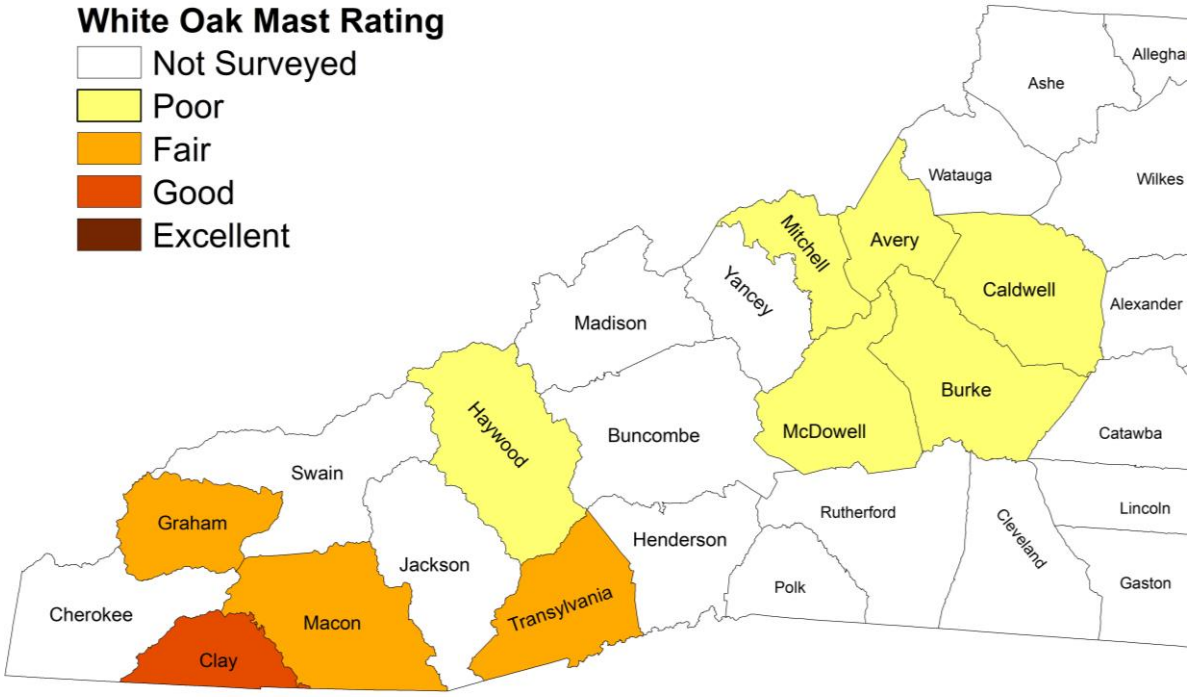


Figure 1. White Oak Index by County in western North Carolina, 2021.

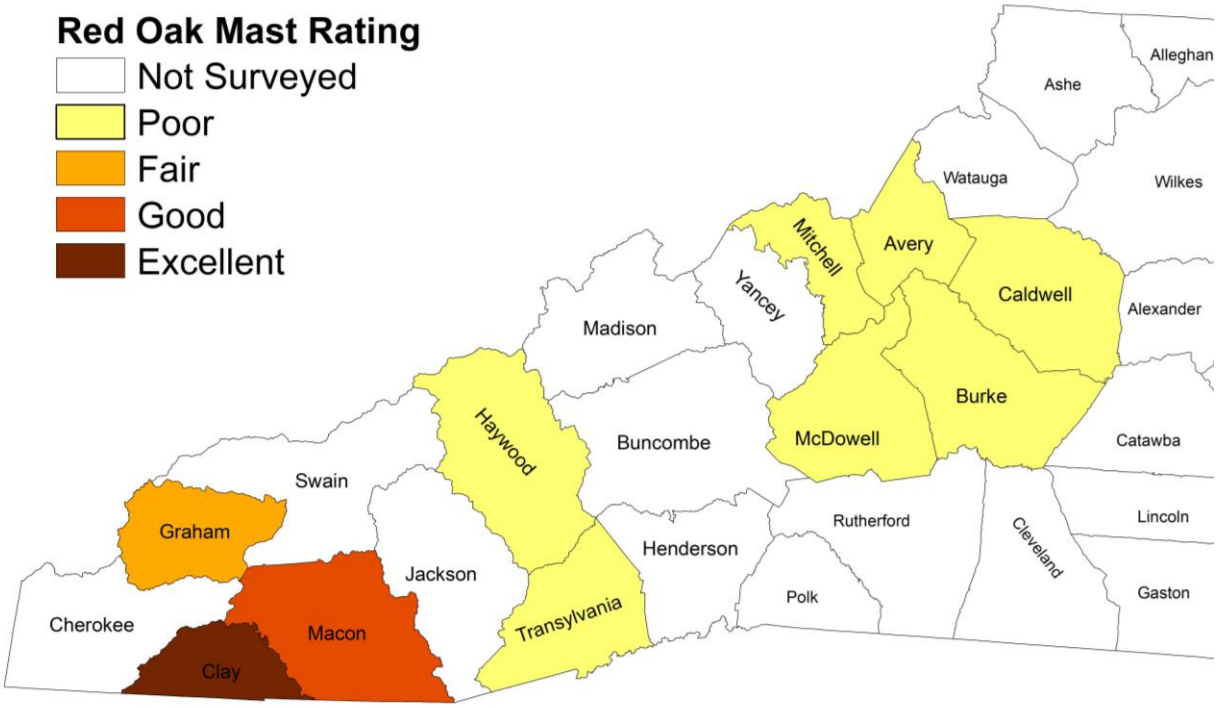


Figure 2. Red Oak Index by County in western North Carolina, 2021.

Table 4. Hard Mast Survey Results by Elevation, 2021.

Elevation (ft.)	Red Oak	White Oak
<1900	2.00	3.31
2000-2900	2.82	2.61
3000-3900	2.12	2.43
4000-4900	2.43	2.85
5000+	3.71	2.34

Numerical Rating = Crop Quality

0.0 to 2.0 = Poor 2.1 to 4.0 = Fair

4.1 to 6.0 = Good 6.1 to 8.0 = Excellent

Table 5. Results of Mountain Summer Soft Mast Surveys, 1993-2021[1].

Year	Blueberry	Huckleberry	Blackberry	Pokeberry
1993	3.24	3.56	3.81	2.44
1994	3.17	3.54	3.53	1.44
1995	1.92	2.46	3.12	1.20
1996	2.02	1.97	3.39	1.51
1997	2.84	2.95	3.78	1.96
1998	1.73	1.09	3.00	2.10
1999	2.72	2.45	2.90	1.78
2000	2.70	2.72	2.99	1.64
2001	2.27	2.73	2.87	0.87
2002	1.87	2.22	3.55	1.32
2003	2.27	2.74	3.20	1.02
2004	1.67	1.61	4.25	1.41
2005	1.57	1.41	4.07	1.48
2007	2.11	1.23	2.48	1.84
2009	2.08	2.06	2.78	1.09
2011	1.69	1.53	3.28	1.37
2013	1.87	1.07	3.73	1.89
2015	2.14	1.38	3.97	2.28
2017	1.64	1.15	2.74	1.04
2019	1.65	1.60	3.47	1.20
2021	1.08	0.72	2.82	1.68
Average	**2.10**	**2.01**	**3.32**	**1.55**

[1] After 2005, summer soft mast surveys are conducted every two years.

Table 6. Mountain Summer Soft Mast Survey Results by Area, 2021.

Area	Blueberry	Huckleberry	Blackberry	Pokeberry
Daniel Boone	1.50	0.00	2.00	1.25
Fires Creek/Santeetlah	1.60	1.00	1.60	1.60
Flattop	0.00	0.00	6.00	2.00
Harmon Den Area	3.67	2.00	1.33	0.67
Mt. Mitchell	1.33	0.67	3.33	0.67
Pisgah Area	1.60	0.60	1.60	0.40
Rich Mountain	2.00	0.50	0.50	0.00
Standing Indian	0.00	0.75	0.25	0.00
T. Chatham	1.50	1.00	1.00	0.75
Cheoah	1.00	1.00	1.50	1.50
South Mountains	0.00	0.00	1.00	0.00
Highlands	0.00	0.00	4.00	2.00
Gorges State Park	1.00	2.00	2.00	2.00
Johns River	0.00	0.00	4.00	4.00
Sandy Mush	2.00	2.00	9.00	6.00
Green River	0.00	0.00	6.00	4.00
Average	**1.08**	**0.72**	**2.82**	**1.68**

Numerical Rating = Crop Quality	
0.0 to 2.0 = Poor	2.1 to 4.0 = Fair
4.1 to 6.0 = Good	6.1 to 9.0 = Excellent

Table 7. Results of Mountain Fall Soft Mast Surveys, 1993-2021.

Year	Pokeberry	Cherry	Grapes	Blackgum
1993	2.00	2.71	2.14	0.43
1994	3.11	2.00	3.78	1.71
1995	2.67	5.00	2.22	1.78
1996	2.40	1.63	3.25	1.75
1997	4.20	1.25	3.14	0.75
1998	4.63	2.67	2.80	1.50
1999	2.40	2.70	3.25	1.10
2000	2.20	2.70	3.30	1.00
2001	2.80	3.30	4.18	2.33
2002	1.10	2.45	2.73	1.27
2003	2.33	3.00	2.55	2.22
2004	1.67	2.70	3.00	1.44
2005	2.45	2.09	1.36	1.55
2006	3.73	2.00	3.17	2.50
2007	2.08	1.58	2.73	0.67
2008	2.91	4.64	4.08	2.58
2009	1.92	1.82	2.33	1.83
2010	2.90	5.80	4.80	1.40
2011	2.50	1.67	2.33	1.42
2012	2.50	1.08	2.92	1.00
2013	2.00	2.75	2.75	1.08
2014	2.55	3.91	4.55	2.18
2015	2.17	2.09	2.23	1.82
2016	3.00	3.27	2.75	1.92
2017	2.73	1.82	2.45	1.18
2018	1.83	1.58	3.00	1.17
2019	2.08	1.69	2.15	1.85
2020	1.83	2.00	2.25	1.50
2021	3.09	4.08	3.92	2.75
Average	**2.54**	**2.62**	**2.97**	**1.58**

Numerical Rating = Crop Quality

0.0 to 2.0 = Poor 2.1 to 4.0 = Fair
4.1 to 6.0 = Good 6.1 to 8.0 = Excellent

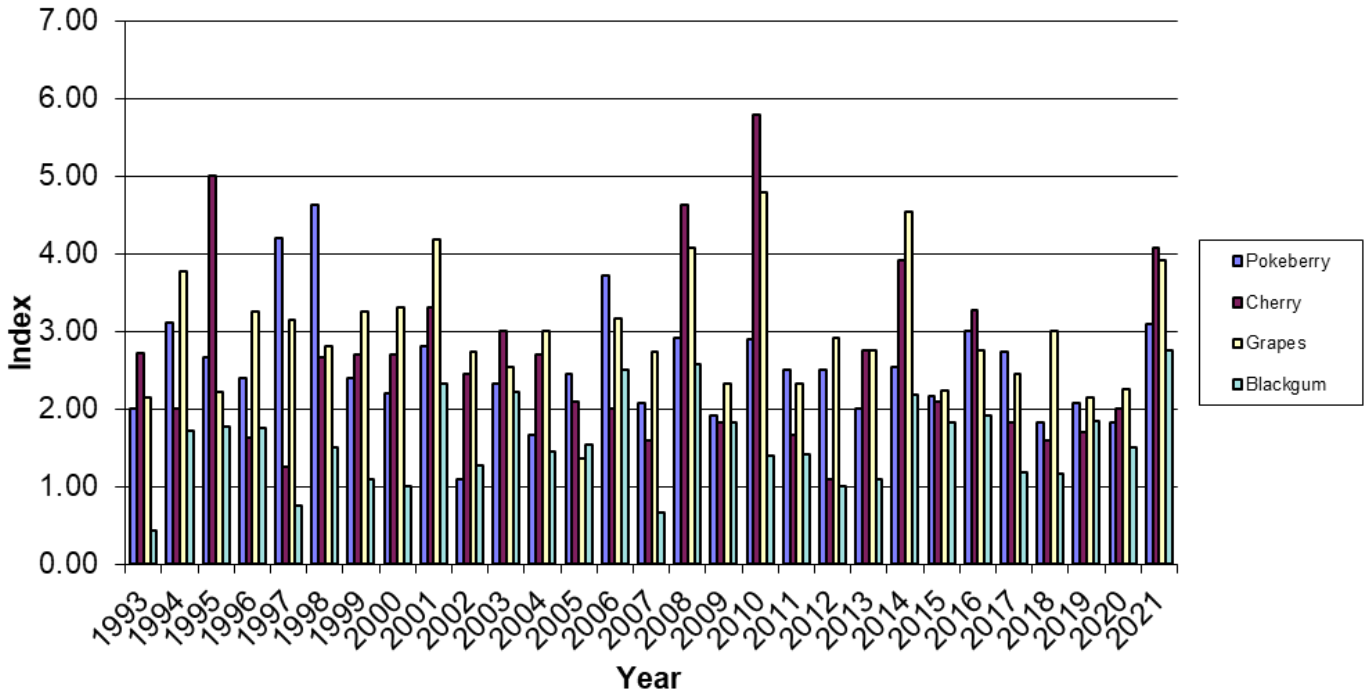


Figure 3. Results of Mountain Fall Soft Mast Surveys by species, 1993-2021.

Table 8. Local Results of Mountain Fall Soft Mast Surveys, 2021.

County	Area	Pokeberry	Cherry	Grapes	Blackgum
Transylvania	Avery Creek	2	2	1	2
Henderson	Carl Sandburg	6	9	1	6
Haywood	Cold Mountain	n/a	2	1	0
Avery & Caldwell	Edgemont	2	0	4	4
Clay	Fires Creek	1	6	9	1
Haywood	Harmon Den	4	4	4	1
Burke & McDowell	Linville Mtn.	1	3	9	6
Macon	Nantahala	4	3	1	2
Mitchell	Poplar	2	4	4	2
Graham	Santeetlah	4	6	6	6
Haywood	Sherwood	4	4	6	1
Burke	South Mountains	n/a	n/a	n/a	n/a
Macon	Standing Indian	4	6	1	2
	Average:	**3.09**	**4.08**	**3.92**	**2.75**

Numerical Rating = Crop Quality	
0.0 to 2.0 = Poor	2.1 to 4.0 = Fair
4.1 to 6.0 = Good	6.1 to 8.0 = Excellent

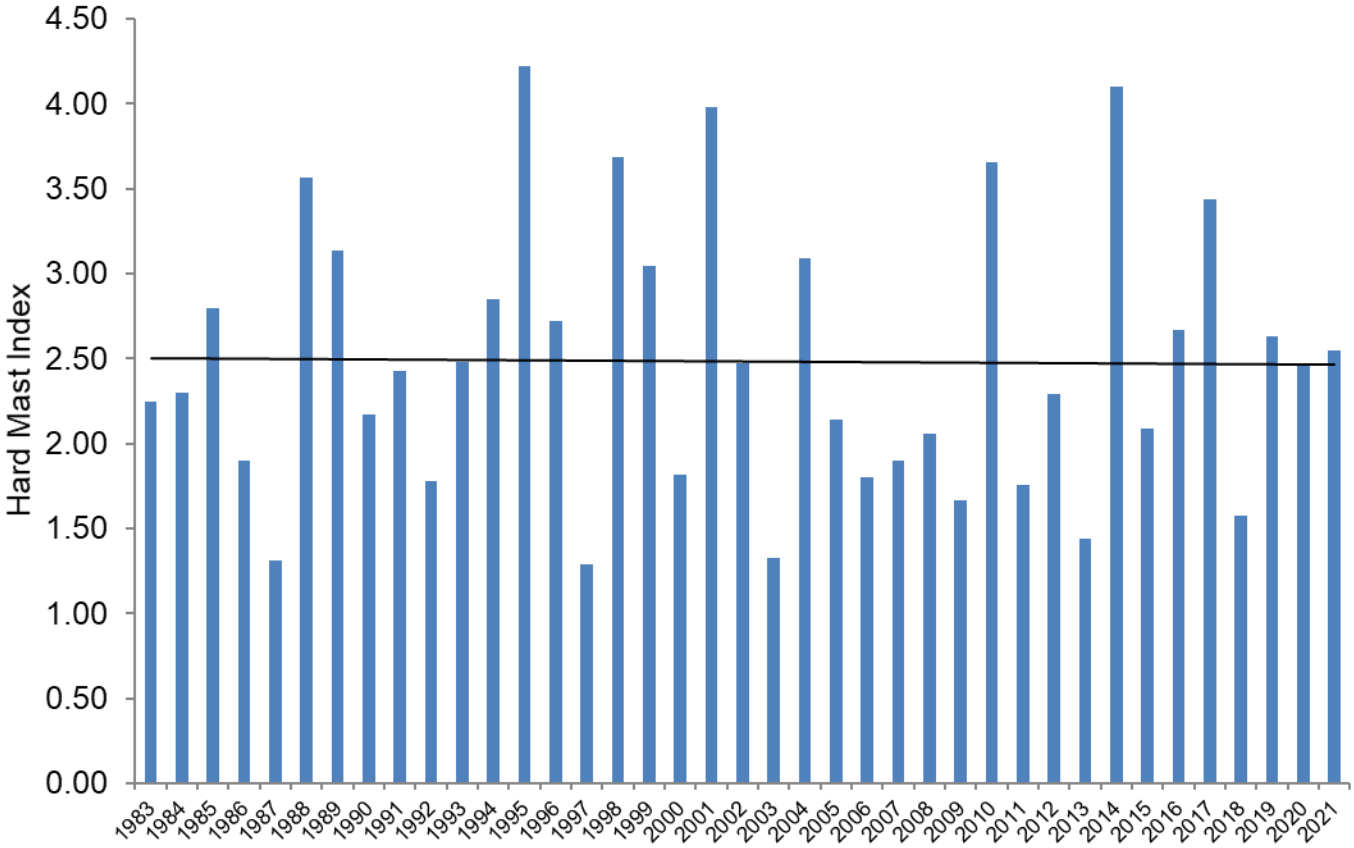


Figure 4. Annual hard mast index in western North Carolina, 1983 through 2021.