

**WESTERN NORTH CAROLINA  
HARD AND SOFT MAST  
SURVEY REPORT  
37<sup>th</sup> Year**

**FALL 2019**



**North Carolina Wildlife Resources Commission**

**Compiled and written by:  
Colleen Olfenbuttel  
Black Bear and Furbearer Biologist  
November 2019**



© 2008 Arbor Day Foundation

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 Region 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 2019 hard mast survey was conducted by WRC Land and Water Access staff, WRC Wildlife Management Division Private Lands staff, Carl Sandburg Home National Historic Site staff, and South Mountains State Park staff on 13 routes in western North Carolina. A total of 1,442 trees were sampled including 569 from the white oak group, 685 from the red oak group, 143 hickories, 40 beeches, and 3 walnuts. Other trees sampled were dead trees (n=28). Combining all groups of species, mast was rated as fair, with an overall index of 2.63, which is an improvement from last year's mast crop index (1.58; Table 1). Since 1983, North Carolina has experienced 23 years out of 37 years in which the hard mast index was rated as fair. Including only the oak species, mast production rated as fair (2.45; Table 1).

White oak production rated as poor (1.97), but above both the long-term average (1.86) and last year's index (0.94; Table 1). When the white oak group is separated by species, chestnut oak production rated as poor (1.21) and white oak production rated as fair (2.85; Table 2). Red oak production rated as fair (2.84) and slightly above the long-term average (2.83; Table 1) for the species. Separated by species, black oak, scarlet oak, and northern red oak rated as fair (2.71, 3.13, and 2.76, respectively; Table 2). Hickory production rated as fair (3.35) and above the long-term average (2.37) for the species (Table 1). Beech production (5.54) was good and above the long-term average (4.09; 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). Nine areas surveyed had white oak productivity rated as poor, while the Standing Indian (Macon County) and Cold Mountain (Haywood County) routes had fair white oak productivity and the Fires Creek (Clay County) and Nantahala (Macon County) had good white oak productivity (Table 3; Figure 1). Red oak production varied even more so by area than

white oak productivity. Red oak productivity rated as poor in 6 areas, rated as fair in 4 areas, and rated as good in 3 areas (Table 3; Figure 2). Red oak productivity ranked highest at the upper elevations (4,000 to 5,000+ feet) and was fair at mid-elevations (2,000 and 3,900 feet; Table 4). White oak productivity ranked highest from 4,000 to 4,900 feet (3.37) and was lowest above 5,000 feet, followed by mid-elevations (2,000 and 3,900 feet; Table 4).

### **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 survey has remained consistent throughout this period including the current year. Summer soft mast surveys have been 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 survey every other year. Because of the new schedule, the summer soft mast survey will be conducted in odd years. The previous survey was conducted in 2017 (Table 5 and 6) and the next survey was conducted during the summer of 2019.

This year's three of four summer soft mast species surveyed (blueberry, huckleberry, 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 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 2019 fall soft mast survey is conducted in conjunction with the hard mast survey. Overall, soft mast production was slightly above the production observed in 2018, but pokeberry, cherry, and grapes were all below long-term averages for those species (Table 7; Figure 3). Cherry and blackgum rated as poor, while grape and pokeberry produced fair crops (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-third year since 1983 in which the overall hard mast index was fair. The fall hard mast index was higher in 2019 than in 2018, and slightly higher than long-term averages. White oak productivity was poor in most areas, except for Macon and Clay counties, while red oak productivity was fair, but much more variable by county compared to white oak (Table 1; Figures 1 and 2). Surrounding states, including Georgia and South Carolina, reported that both soft and hard mast production was better than in 2018, with most states reporting fair hard mast. Georgia reported white oak and red oak productivity was fair (3.2 and 2.7, respectively). South Carolina reported white oak was fair (2.8), while red oak was good (4.7). The overall trend in hard mast production shows a very slight declining trend since surveys were initiated in 1983 (Figure 4).

## **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, 1983-2019.

<b>Year</b>	<b>White Oak</b>	<b>Red Oak</b>	<b>All Oaks</b>	<b>Hickory</b>	<b>Beech</b>	<b>Total</b>
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
<b>Average</b>	<b>1.86</b>	<b>2.83</b>	<b>2.31</b>	<b>2.37</b>	<b>4.09</b>	<b>2.48</b>

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, 2019.

<b>Grouping</b>	<b>Species</b>	<b>Index</b>	<b>Number of Trees Sampled</b>
Hickories	MH, PH, SH, GH <sup>1</sup>	3.35	143
Beech	Beech	5.54	40
Red Oaks	Black Oak	2.71	30
	Northern Red Oak	2.76	482
	Scarlet Oak	3.13	168
White Oaks	Chestnut Oak	1.21	309
	White Oak	2.85	260

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

<sup>1</sup>MH,SH, PH, GH: Mockernut Hickory, Pignut Hickory, Shagbark Hickory

Table 3. Hard Mast Survey Results by Area, 2019.

<b>County</b>	<b>Area</b>	<b>White Oak</b>	<b>Red Oak</b>	<b>All Oaks</b>
Transylvania	Avery Creek	0.8	1.6	1.2
Haywood	Cold Mountain	2.1	2.3	2.2
Avery & Caldwell	Edgemont	1.1	1.5	1.3
Clay	Fires Creek	5.2	6.2	5.7
Haywood	Harmon Den	1.1	1.6	1.3
Henderson	Carl Sandberg	0.4	0.4	0.4
Burke & McDowell	Linville Mtn.	1.7	1.8	1.8
Macon	Nantahala	4.7	3.5	4.0
Mitchell	Poplar	1.1	1.3	1.2
Graham	Santeetlah	1.9	4.2	3.2
Haywood	Sherwood	1.0	3.3	2.7
Burke	South Mountains	0.8	2.3	1.4
Macon	Standing Indian	2.8	4.5	3.8

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

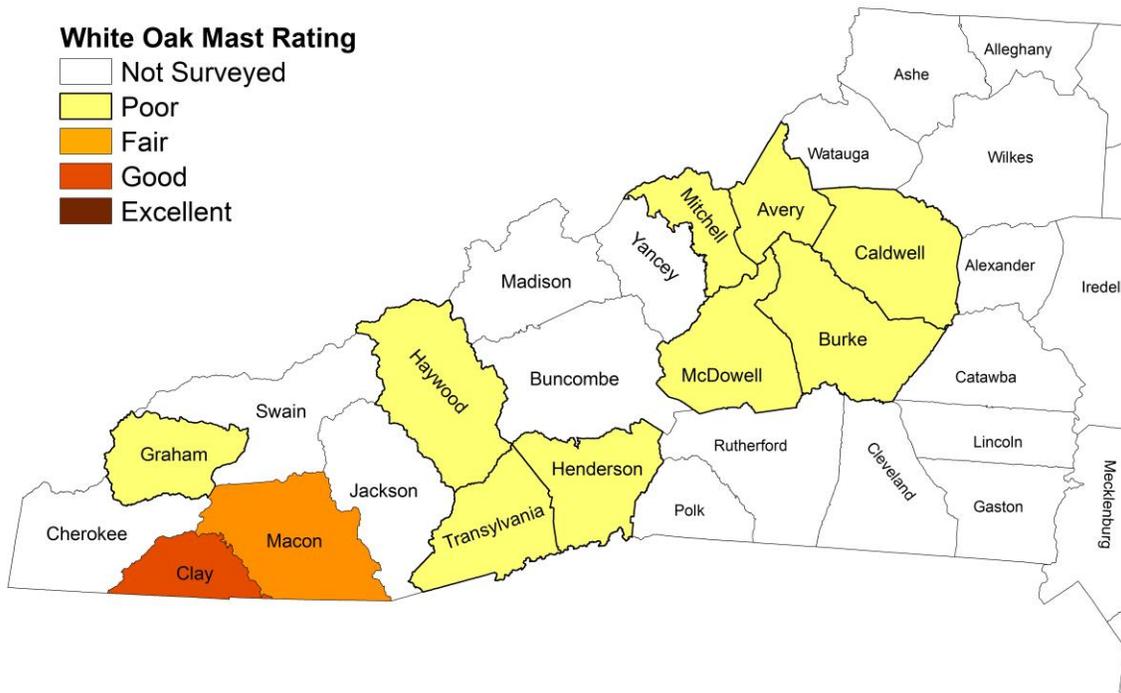


Figure 1. White Oak Index by County in western North Carolina, 2019.

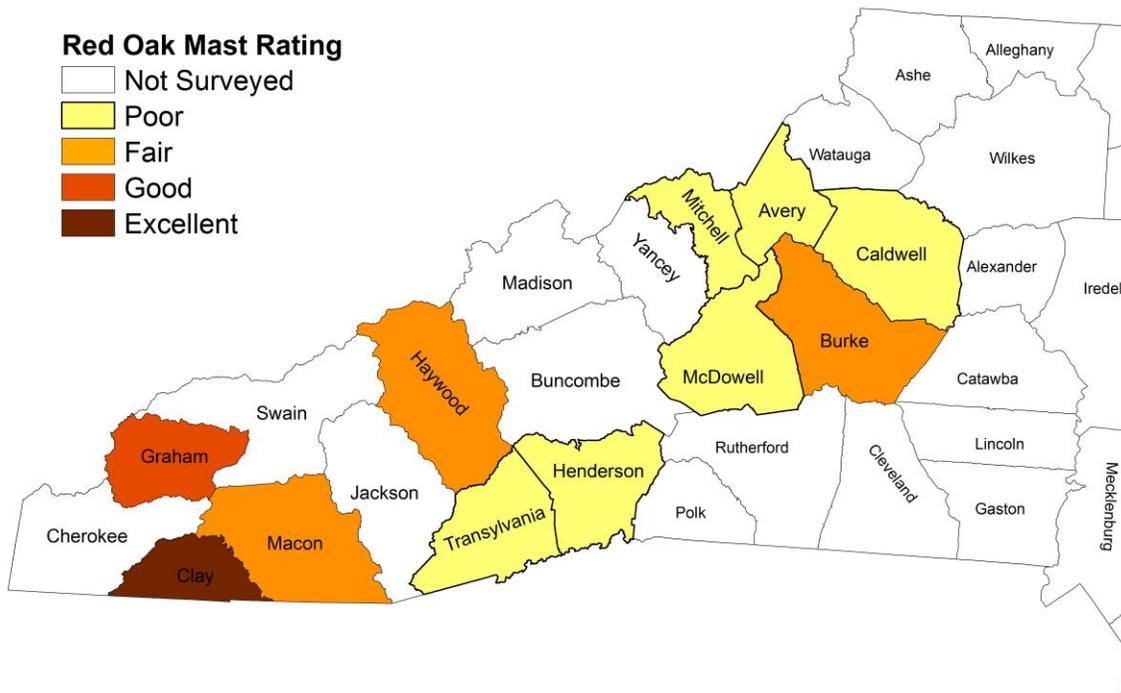


Figure 2. Red Oak Index by County in western North Carolina, 2019.

Table 4. Hard Mast Survey Results by Elevation, 2019.

<b>Elevation (ft.)</b>	<b>Red Oak</b>	<b>White Oak</b>
<1900	4.32	2.56
2000-2900	2.45	1.77
3000-3900	2.13	1.67
4000-4900	4.36	3.37
5000+	5.14	1.36

---

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, 1993-2019<sup>1</sup>.

<b>Year</b>	<b>Blueberry</b>	<b>Huckleberry</b>	<b>Blackberry</b>	<b>Pokeberry</b>
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
<b>Average</b>	<b>2.16</b>	<b>2.07</b>	<b>3.35</b>	<b>1.54</b>

<sup>1</sup> After 2005, summer soft mast surveys are conducted every two years.

Table 6. Mountain Summer Soft Mast Survey Results by Area, 2019.

<b>Area</b>	<b>Blueberry</b>	<b>Huckleberry</b>	<b>Blackberry</b>	<b>Pokeberry</b>
Daniel Boone	1.00	0.50	4.25	0.75
Fires Creek/Santeetlah	1.60	1.00	1.60	1.60
Flattop	0.00	0.00	6.00	0.00
Harmon Den Area	3.67	4.00	1.67	1.33
Mt. Mitchell	0.67	0.33	5.67	1.33
Pisgah Area	2.40	2.20	2.60	1.20
Rich Mountain	2.50	2.00	2.50	0.50
Standing Indian	1.00	1.50	0.50	0.50
T. Chatham	1.50	1.00	2.25	1.50
Cheoah	1.00	1.00	1.50	1.50
South Mountains	0.00	1.00	1.00	0.00
Highlands	0.00	0.00	4.00	0.00
Gorges State Park	6.00	6.00	2.00	1.00
Lake James State Park	3.00	2.00	2.00	2.00
Sandy Mush	2.00	2.00	9.00	6.00
Green River	0.00	1.00	9.00	0.00
<b>Average</b>	<b>1.65</b>	<b>1.60</b>	<b>3.47</b>	<b>1.20</b>

NA<sup>1</sup>=No summer soft mast data provided for this route.

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, 1993-2019.

<b>Year</b>	<b>Pokeberry</b>	<b>Cherry</b>	<b>Grapes</b>	<b>Blackgum</b>
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
<b>Average</b>	<b>2.55</b>	<b>2.59</b>	<b>2.96</b>	<b>1.53</b>

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

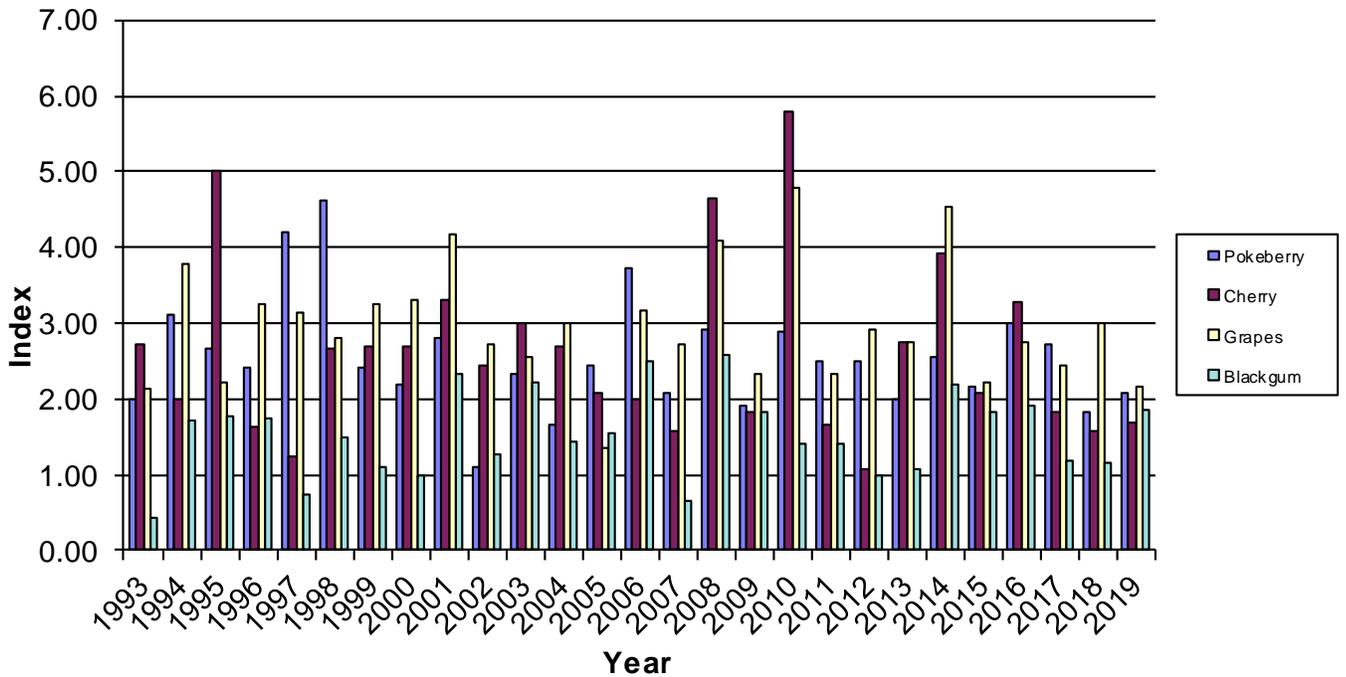


Figure 3. Results of Mountain Fall Soft Mast Surveys by species, 1993-2019.

Table 8. Local Results of Mountain Fall Soft Mast Surveys, 2019.

County	Area	Pokeberry	Cherry	Grapes	Blackgum
Transylvania	Avery Creek	1	2	2	2
Haywood	Cold Mountain	1	0	0	2
Avery & Caldwell	Edgemont	0	0	0	0
Clay	Fires Creek	2	0	2	4
Haywood	Harmon Den	1	6	3	1
Burke & McDowell	Linville Mtn.	4	4	2	2
Macon	Nantahala	4	0	2	6
Mitchell	Poplar	4	0	3	1
Graham	Santeetlah	2	2	4	0
Haywood	Sherwood	2	1	4	0
Burke	South Mountains	0	3	2	1
Macon	Standing Indian	4	2	3	4
<b>Average:</b>		<b>2.08</b>	<b>1.69</b>	<b>2.15</b>	<b>1.85</b>

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

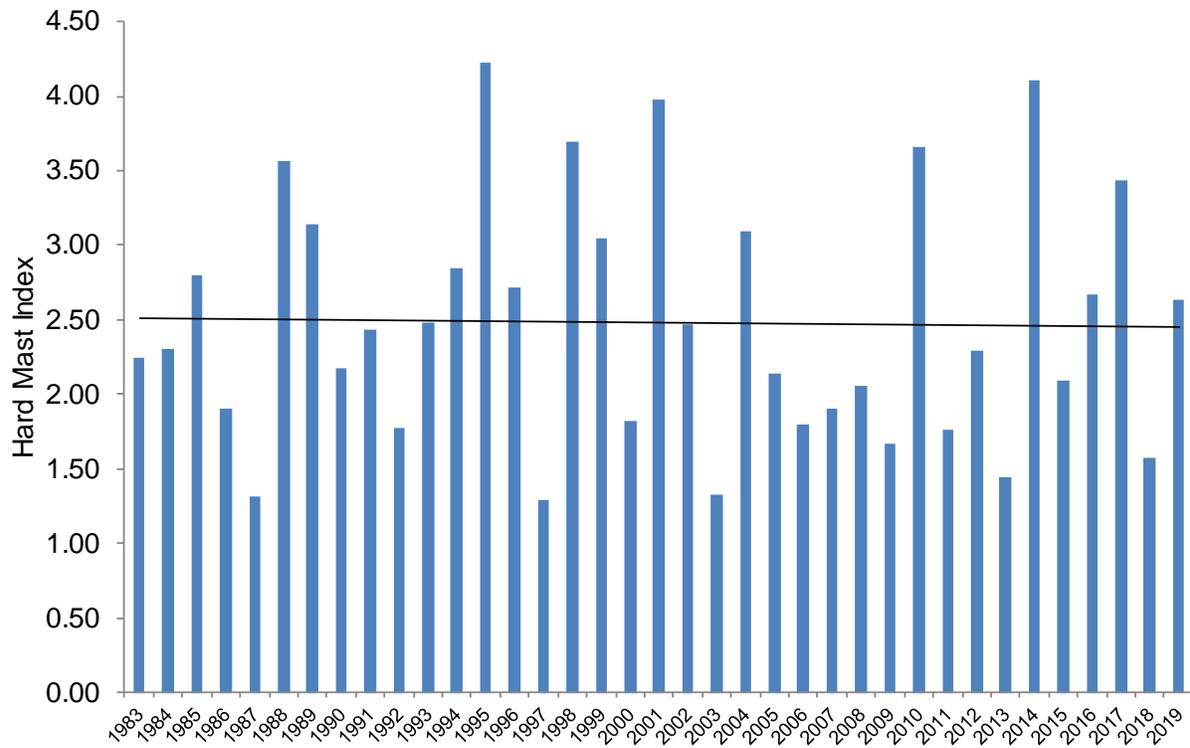


Figure 4. Annual hard mast index in western North Carolina, 1983 through 2019.