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Seasonal Mast Availability for Wildlife in the Piedmont Region of Georgia

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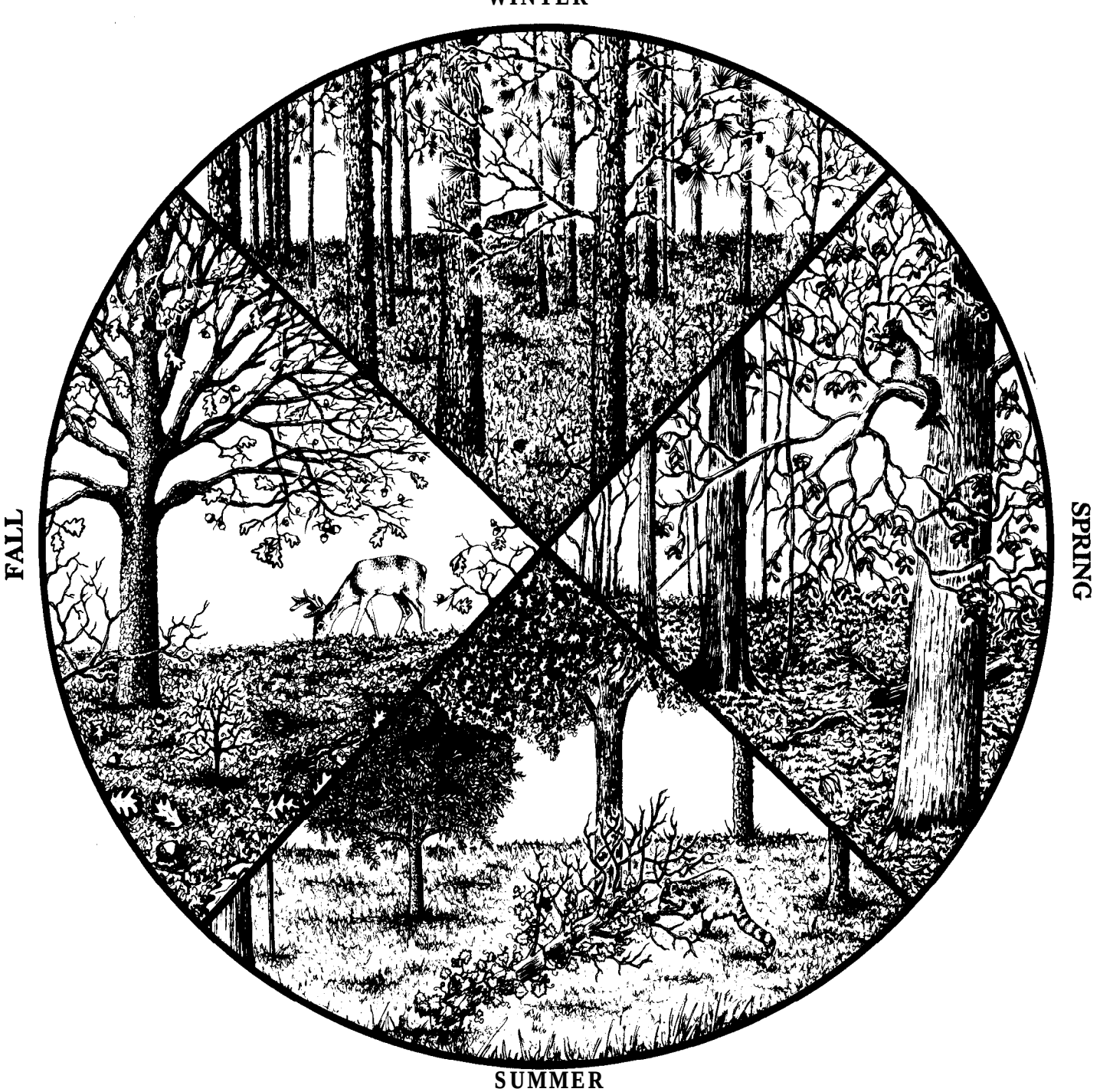

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ABSTRACT

We measured mast production by traditional and buffer species for 2 years on the Piedmont National Wildlife Refuge in Georgia. Our objectives were to determine how these two types varied on a seasonal, annual, and habitat basis. Mast from buffer species was more frequent and diverse than that from traditional mast producers. Our findings suggest that although traditional mast species are important, buffer species may play an equally important seasonal role in maintaining annual diversity.

Keywords: Buffer species, oak, Southeast, traditional.

Introduction

Availability of mast in specific seasons is important to many wildlife species. Janzen (1971) defined mast fruiting as the periodic synchronous production of large seed crops by trees. Huntley (1990) described mast species as woody species that produce fruits that are not wind disseminated. Hard mast is fruit with a dry or hard exterior; soft mast is fruit with a soft or fleshy exterior. Traditionally, however, discussion of mast has included only heavy-seeded hard mast, such as acorns (*Quercus* spp. L.)' and hickory nuts (*Caryu* spp. Nuttall), and relatively large soft fruits, such as persimmon (*Diospyros virginiana* L.), black cherry (*Prunus serotina* Ehrhart), and dogwood (*Cornus florida* L.). Seeds and fruits from other woody species like pines (*Pinus* spp. L.), sweetgum (*Liquidambar styraciflua* L.), poison ivy (*Rhus radicans* L.), and Virginia creeper (*Parthenocissus quinquefolia* L.) have often been ignored. The term "buffer" has been used in connection with these species (Huntley 1990) because their mast is believed to decrease the adverse effects of poor crops of traditional mast species like oaks and hickories.

Mast is important food for many wildlife species. Many studies have shown the importance of oaks and hickories to game animals, such as deer (*Odocoileus* spp. Rafinesque),[2] squirrels (*Sciurus* spp. L.), wild turkeys (*Meleagris gallopavo* Vieillot),[3] and bobwhite quail (*Colinus virginianus* L.) (Goodrum and others 197 1, Kirkpatrick 1990, Kurzejeski 1990, Martin and others 1961, Nixon and Hansen 1987, Nixon and others 1975, Pelton 1990, Wentworth and others 1990). Huntley (1990), however, argued that the combination of all other mast-producing species is of equal or greater importance than oak to both game and nongame wildlife. This conclusion was reached because oak and hickory mast is usually available only in fall and winter, and annual yields vary widely.

The mast-producing species in a habitat depend on the characteristics of the habitat and past land-use patterns. Mast production and availability are influenced by the ages and sixes of plants, the season, inherent fruiting ability, canopy coverage, age of stand, competition, climate, and stem density (Stransky and Halls 1980). Many studies show that acorn yields vary considerably from tree to tree, species to species, and year to year (Cypert and Webster 1948, Downs and McQuilkin 1944, Goodrum and others 1971, USDA 1980). Nixon and others (1980) and Sork (1983) reported large tree-to-tree and annual variations in mast yields of hickories. Little information has been published on the seasonal availability of hard mast among habitat types.

Pew studies have been conducted on soft mast production. Lay (1959) found flowering dogwood and blueberry hawthorn (*Crataegus brachyacantha* Engelm.) to be consistent producers during a 4-year study in Texas. Of the 50 mast species present in slash pine (*Pinus elliottii* Engelm.) plantations 1 to 30 years old in southeastern Georgia, 8 species produced abundant fruit, 11 minor amounts, and 31 none (Johnson and Landers 1978). Gallberry (*Ilex glabra* Aiton) and blackberry (*Rubus* spp. L.) were the most abundant mast producers, representing 71 and 15 percent of the total mast yield, respectively. In contrast, blackberry (*R. argutus* Link) accounted for 91 percent of the total mast production in 1- to g-year-old loblolly pine (*P. taeda* L.) stands in Mississippi (Campo and Hurst 1980). Little is known about seasonal soft mast production and periodicity in mature forest types.

We measured the production of traditional and buffer mast for 2 years on the Piedmont National Wildlife Refuge in Georgia. Our objectives were to determine how these two types varied on a seasonal, annual, and habitat basis.

[1] Botanical nomenclature follows Radford and others (1968).

[2] Mammalian nomenclature follows Honacki and others (1982).

[3] Ornithological nomenclature follows Sprunt and Chamberlain (1970).

Study Description

The Piedmont National Wildlife Refuge (PNWR) is approximately 40 km north of Macon in Jasper County, Georgia. The rolling hills of the PNWR are typical of the Piedmont Plateau. The PNWR was established in 1939 to demonstrate that depleted land could be restored and support viable populations of native wildlife. At that time, the land was severely eroded and the soils were depleted by over 100 years of cotton farming. Today, much of the 14,000-ha PNWR is covered by pine and mixed pine/hardwood forests. Loblolly pine seeded naturally onto the area. Hardwoods occupied small sheltered upland valleys and creek bottoms. The forested stands of the PNWR are actively managed to maintain populations of deer, wild turkey, red-cockaded woodpeckers (*Picoides borealis* Vieillot), and other game and nongame species.

Upland soil series include Gwinnett, Hiwassee, and Wilkes with textures ranging from sandy loam to sandy clay loam. Bottomland soils are Chewacla and Wehadkee with textures from tine sandy loam.[4]

Twenty-two permanent transects, 50 m apart and 400 to 900 m long, were established. Reference points were placed at 50-m intervals along each transect. Six mast traps were randomly placed on each transect line. Each mast trap was located 10 m from its assigned reference point in a randomly selected cardinal direction (N. ,E.,S. ,W.). Hard and soft mast were collected in 0.00004-ha circular basket traps (modified design of Thompson and McGinnes 1963). The bottom of the trap was mesh window screen attached to a wire (9 gauge) hoop (228.6 cm circumference) to form a basket-shaped structure. This "basket" was secured on three wooden stakes, 1 m above the ground, and covered with 2.54-cm-mesh poultry wire. Trap placement was intended to reduce seed predation, but it also excluded mast from low-growing species, such as blueberry (*Vaccinium* spp. L.). Mast traps were checked monthly, and the presence of fruits was recorded by species. No attempt was made to quantify mast found in traps.

Stand boundaries were delineated using aerial photographs and ground reconnaissance. On a 10- by 40-m plot in each stand, d.b.h and species of codominant and dominant stems were recorded. On a 5- by 20-m plot, d.b.h and species of midstory stems > 2.5 cm in d.b.h and > 1.4 m in height were recorded. Habitat types were assigned based on overstory basal area (USDA Forest Service 1988). Individual stands were assigned to one of four habitat types:

	Basal area (Percent)
1. Pine	> 69 pine
2. Pine/hardwood	51-69 pine
3. Hardwood/pine	5 l-69 hardwood
4. Hardwood	> 69 hardwood

Stands were further classified, based on slope position. Stands in top and upper-mid positions were classified as "upland, " and stands in bottomland and lower-mid slopes were classified as "bottom." Because the numbers of pine/hardwood and hardwood/pine stands were low, these two classes were combined into a mixed pine/hardwood habitat type. Accordingly, each of the 132 mast traps was assigned to one of five habitat types: (1) upland pine, (2) upland mixed pine/hardwood, (3) bottom pine, (4) bottom mixed pine/hardwood, or (5) bottom hardwood.

In these habitat types the dominant overstory species were: loblolly pine in upland pine; loblolly pine, sweetgum, and white oak (Q. *alba* L.) in upland mixed pine/hardwood; loblolly pine and sweetgum in bottom pine; and swamp chestnut *oak (Q. michauxii* Nuttall), willow oak (Q. *phellos* L.), sweetgum, scarlet oak (Q. *coccinea* Muenchh.), and shagbark hickory (C. *ovata* (Miller) K. Koch) in bottom mixed pine/hardwood. Habitat characteristics, overstory stems/ha, midstory stems/ha, and basal area are presented in table 1.

Mast items were categorized as traditional or buffer, hard or soft, winged or nonwinged seeds, and vine fruit. Comparisons of mast availability among seasons, years, and habitat types were based on the relative frequency of mast items. Relative frequency of mast item M_i =

[4] Personal communication. 1992. Harold McMichael, soil conservation technician, USDA, Soil Conservation Service, 206 S. Mulberry St., Jackson, GA 30233.

(frequency of M_i/total frequency of all mast items M, through M_n) x 100. Winter, spring, summer, and fall seasons included the calendar months January-March, April-June, July-September, and October-December, respectively. In each habitat type, occurrences of mast items from traditional and buffer species were compared by season and year. An index of mast availability was calculated by summing the number of traps containing individual mast items, M_1 through M_n, by mast type, traditional or buffer, habitat type, season, and year. For example, if a habitat type contained 10 mast traps and mast item M, was found in 8 traps, mast item M_2 in 2 traps, and mast item M_3 in 1 trap, the mast availability index would equal 8 + 2 + 1 = 11. Numbers of mast items recorded in different habitats were adjusted for unequal numbers of mast traps.

Results

Scientific names, fruiting seasons, and frequencies of substantial yields for the 25 mast species sampled are presented in table 2.

Availability of mast, based on relative frequency, varied by season and habitat. Buffer species pine, yellow-poplar, and elm were among the 3 most common mast items in 35, 27, and 10, respectively, of the 40 season/year/habitat type categories (tables 3-6). Traditional species dogwood, oak, and muscadine were among the 3 most frequently recorded mast items in 11, 6, and 2, respectively, of the 40 season/year/habitat type categories (tables 3-6). Buffer species were the most common mast item in 36 of 40 season/year/habitat type categories, compared with traditional mast items which were most frequent in only 4 categories; pine was the most frequent mast in 26 of 40 categories, while oak was most common in only 2 categories (tables 3-6).

Annual availabilities of elm and sweetgum differed markedly. Elm mast, which was virtually absent during 1989, was one of the three most common mast items available in all habitats during the winter of 1990 (table 3). Sweetgum mast, which was common in all habitats during the fall of 1989, was not common in the fall of 1990 (table 6). In the habitats where their mast was found, dogwood and oak were consistent producers during 1989 and 1990 (tables 3,5,6). Although seasonal availability of pine and yellow-poplar (*Liriodendron tulipifera* L.) mast were similar, annual trends differed (fig. 1). Pine mast availability was moderate in the

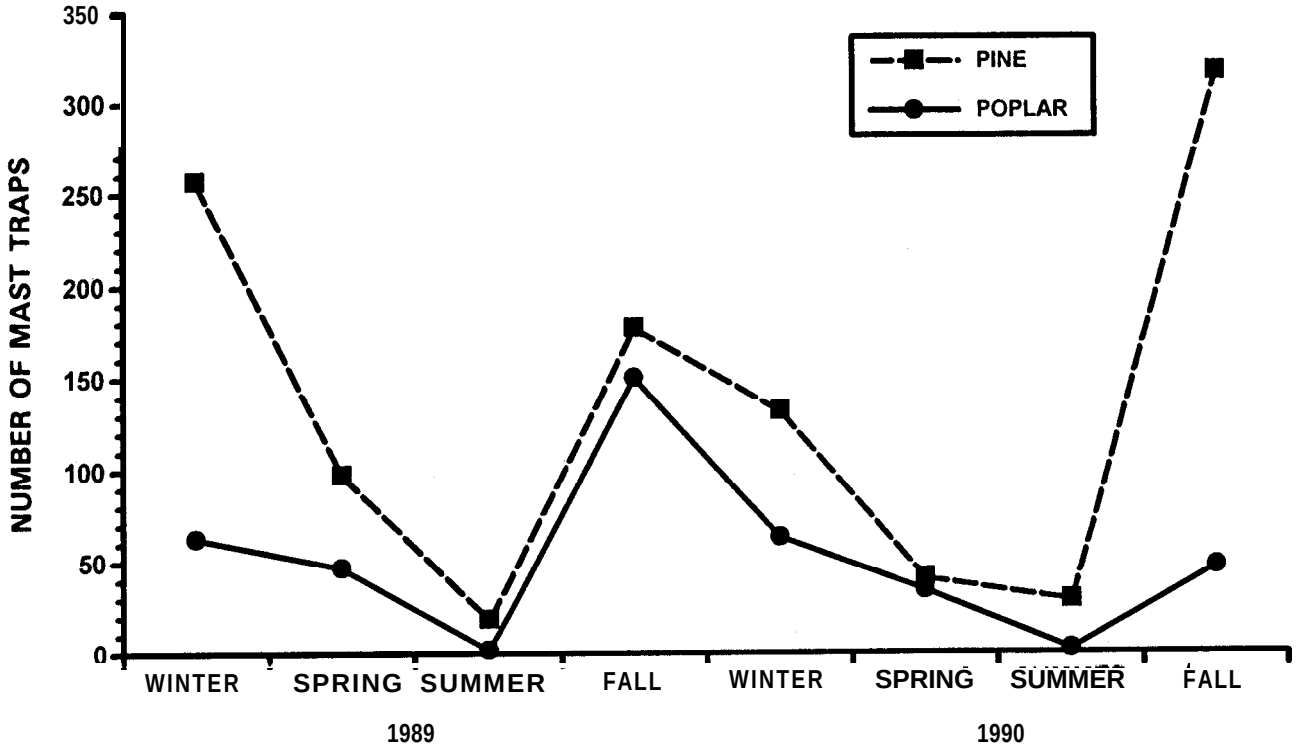

Figure l-Seasonal availability of loblolly pine and yellow-poplar on the Piedmont National Wildlife Refuge, Georgia.

winter of 1989, poor in fall/winter of 1989/1990, and high during the fall of 1990. Yellow-poplar showed the reverse trend with high production during the winter of 1989 and fall/winter of 198911990, compared with low availability in the fall of 1990 (table 7).

Across habitat types, species of available mast varied by season. The most frequent winter mast items included pine, yellow-poplar, elm, and dogwood (table 3); the most common spring mast items were pine, yellow-poplar, elm, maple, and sycamore (table 4); the most common summer mast items were pine, dogwood, oak, muscadine, and cherry (table 5); and the most common fall mast items were pine, yellow-poplar, oak, dogwood, and sweetgum (table 6). Traditional mast species occurred primarily during summer and fall, while buffer species were available throughout the year.

Mast availability varied among habitat types (tables 3-6). Most frequent mast items in upland habitats included pine, yellow-poplar, elm, dogwood, and sweetgum. In bottom pine and bottom mixed pine/hardwood habitats, pine, yellow-poplar, elm, dogwood, sweetgum, oak, and cherry were the most common. Most frequent mast items in the bottom hardwood type were yellow-poplar, oak, muscadine, pine, and maple. Traditional mast species occurred more frequently in bottom habitats than in uplands. Traditional species accounted for 1 or more of the 3 most common mast items in 46 percent (11 of 24) of the season/year/habitat type categories in bottom habitats compared with 38 percent (6 of 16) in the upland habitats.

The number of individual mast species present, or mast richness, was generally lower in spring and summer than in fall and winter (table 8). Mast richness in spring and summer was quite similar between years. In contrast, mast richness in winter and fall varied considerably (table 8). Within seasons, mast richness was generally higher in bottom types than in upland habitats, and bottom hardwood habitats contained the highest mast richness (table 8). Buffer species richness within season was higher in 32 of 40 season/year/habitat categories than traditional mast richness (table 8). Four of the five categories where traditional mast richness was higher occurred in upland mixed pine/hardwood and bottom pine types during the summer (table 8).

Mast availability index was least in summer, intermediate in spring, and greatest in fall and winter. Annual variation (percent) in the mast availability index during summer ranged from 0 in bottom pine to 106 in upland pine, from 18 in upland mixed pine/hardwood to 91 in bottom hardwood during spring, from 11 in upland pine to 43 in bottom hardwood during fall, and from 7 in upland mixed pine/hardwood to 52 in bottom hardwood during winter (table 9). While the mast availability index during fall and winter remained relatively constant in upland habitats, bottom types showed higher fluctuations-bottom hardwood had a 43-percent decrease in fall and a 52-percent increase in winter. Bottom types had higher mast availability indices within seasons than did upland habitats; bottom hardwood had the highest, except in the spring of 1989 (table 9). The buffer species mast availability index was greater in 36 of 40 season/year/habitat type categories than the traditional mast availability index (table 9). The traditional mast availability index was higher in upland mixed pine/hardwood, bottom pine, and bottom hardwood during the summer.

Discussion

Mast richness and abundance are functions of site conditions, weather, and past land use. Such environmental constraints limit potential mast-producing trees, shrubs, and vines. Once mast-producing species are established, their inherent yield and periodicity will determine mast abundance in a habitat. The fruiting patterns of the species that are present also influence seasonal mast abundance. We found mast richness to be generally lower in spring and summer and higher during fall and winter. This would be expected because only 3 of the 24 mast species present are known to fruit predominantly in spring and only 5 during the summer; in contrast, 10 are known to fruit in winter and 21 during the fall. Mast richness was higher in bottom habitats than upland types. Because loblolly pine is the single most dominant pine species in all habitats, the presence of hardwood species has a significant effect on mast richness. Although the numbers of overstory hardwood stems/ha decreased from bottom to upland habitats, a strong midstory hardwood presence remained in all habitats. However, the midstory hardwoods in the upland types were small and their likely contribution to mast richness was minimal.

Fire strongly influences species composition on the PNWR. One purpose of prescribed fire is understory hardwood control. Most stands are burned in winter at 3- to 4-year intervals. Particularly in the uplands, burning limits the presence of large vines, shrubs, and midstory hardwoods. Midstory species maple, black cherry, and dogwood do not begin to bear fruit until 4, 5, and 6 years of age, respectively (USDA Forest Service 1974). Of the mast items sampled on the PNWR, 15 of 24 were produced by midstory hardwoods or vines. Although many of these species do not produce large mast crops, most are believed to be fairly consistent producers. Either through constructed barriers, topography, or moisture conditions, bottom habitats on the PNWR are more protected from the effects of fire. As a result, mast-producing hardwoods, shrubs, and vines are more prevalent in bottom midstories.

In an area on the Piedmont of North Carolina where fire had been excluded, the differences in species composition between uplands and bottoms were less distinct than those we observed at the PNWR (Oosting 1942). In the absence of fire, there was greater overlap in species composition among upland pine, bottom pine, and bottom hardwood habitats. Johnson and Landers (1978) found that mast yields from huckleberry (*Gaylussacia* spp. HBK) and blueberry responded positively in frequently (< 5 yr) burned areas, while other species were less fire resistant and failed to attain mast-producing size. In addition to mast species richness, improved site quality in bottom types, including better soils, less drought, and limited fire, may increase the yields of some species in these habitats (USDA 1980).

Mast from buffer species was found to be more common and diverse than that from traditional mast producers. The species producing the most common buffer mast items were pine, yellow-poplar, elm, ash, and maple; the most common traditional mast items were from dogwood, black cherry, oak, and blackgum. Traditional mast was produced primarily in late summer and fall, while buffer mast was more common throughout the year. During summer-a season of low mast production-black cherry, dogwood, and oak contributed significantly to the availability of mast. Among oak, hickory, black walnut (*Juglans nigra* L.), and beech (*Fagus grandifolia* Ehrhart)-the traditional hard mast species occurring on the study area-only oak mast was recorded in our mast traps. Availability of oak mast on the PNWR was relatively low in all habitats except the bottom hardwood type. Our estimate may be less than was actually available due to arboreal seed predators, which may consume 11 to 13 percent of the acorns before they fall (Cypert and Webster 1948, Kearby and others 1986). Seed predation of varying degrees also occurs in other mast-producing species, but its occurrence is not well documented. In contrast to oak mast, traditional soft mast was available in several seasons and habitat types.

The term “buffer” has been used to describe species whose crops may compensate for low yields from traditional mast species like oaks and hickories. Huntley (1990) suggested that the term “buffer” is inappropriate. Although he agreed that they serve a compensatory role, he recognized that non-oak mast production is of primary importance to many wildlife species even where acorns

are available. The importance of oak mast to wildlife has been well documented (McGee 1990). Acorns are consumed by 30 southeastern wildlife species (Martin and others 1961). In comparison, buffer species such as pine, yellow-poplar, and sweetgum are reportedly used by 22, 8, and 10 species, respectively. However, the relationship between mast richness and wildlife use is not exact. Each wildlife species may use several mast items during a particular season, depending on availability and individual preferences. Therefore, overlap is likely. For example, of the 30 southeastern wildlife species known to consume oak mast, 15 have been found to also consume pine mast. Additional information quantifying mast production and species specific use is needed.

Our findings suggest that although traditional mast species such as oak, dogwood, and black cherry are important, buffer species such as pine, yellow-poplar, elm, and maple may play equally important seasonal roles in maintaining the diversity of fauna found on the PNWR. Although "buffer" may be an accurate term for certain seasons or during periods of high mast yield by traditional species, our results demonstrate the importance of buffer species in annual mast production. The diets of wildlife species include numerous mast items. Both traditional and buffer mast are common foods. Harlow and Van Lear (1990) suggested that increases in mast diversity should be accompanied by increased wildlife diversity. Empirical data to support this hypothesis are unavailable, however.

To maximize the benefit to wildlife and to minimize variations in mast availability, we suggest promoting both traditional and buffer mast species in conjunction with maintaining species diversity. We would promote only species endemic to habitats. This type of management would allow buffer species to provide mast during seasons when traditional mast species are not fruiting. During traditional mast seasons, buffer species would compensate when traditional mast crops fail. In addition, they would add variety to wildlife diets.

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TABLES

Table 1—Stand characteristics of habitat types sampled on the Piedmont National Wildlife Refuge, Georgia

Habitat type	N	Over-story (stems/ha)				Midstory (stems/ha)				Basal area[a] (m^2/ha)			
		Pine		Hardwood		Pine		Hardwood		Overstory		Midstory	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Upland pine	22	115.9	56.5	10.2	16.7	331.8	891.4	763.6	829.5	12.1	4.9	7.8	8.2
Upland mixed pine/hardwood	6	95.8	40.5	79.2	43.1	1550.0	2379.7	2166.7	1153.5	10.5	6.5	14.8	6.4
Bottom pine	5	260.0	185.9	25.0	25.0	200.0	158.1	1260.0	602.5	22.0	4.5	9.0	3.4
Bottom mixed pine/hardwood	3	58.3	14.4	58.3	14.4	33.3	57.7	1700.0	1652.3	16.7	8.4	19.2	2.6
Bottom hardwood	7	7.1	18.9	175.0	79.1	0.0	0.0	1414.0	715.1	21.6	10.9	11.6	4.3

N = number of stands in sample; SD = standard deviation.

[a] Pine and hardwood combined.

Table 2—Scientific names, mast type, fruiting seasons, and periodicity of mast species sampled on the Piedmont National Wildlife Refuge, Georgia (USDA Forest Service 1974)

Common name	Scientific name	Mast types	Fruiting season	Periodicity[a]
Ash	*Fraxinus* spp. L.	Buffer-WS	Fall/winter	3-5 yr
Black cherry	*Prunus serotina* Ehrhart	Trad-soft	Summer/fall	Annual
Blackgum	*Nyssa sylvatica* L.	Trad-soft	Fall	N/A
Dogwood	*Cornus florida* L.	Trad-soft	Fall/winter	l-2 yr
Elm	*Ulmus* spp. L.	Buffer-WS	Winter/spring	2-3 yr
Hackberry	*Celtis occidentalis* L.	Trad-soft	Fall	Annual
Hawthorn	*Crataegus* spp. L.	Buffer-NW	Fall	N/A
Japanese honeysuckle	*Lonicera japonica* Thunberg	Buffer-vine	Fall/winter	N/A
Hornbeam	*Ostrya virginiana* (Miller) K. Koch	Buffer-NW	Fall	N/A
Ironwood	*Carpinus caroliniana* Walter	Buffer-NW	Fall	3-5 yr
Maple	*Acer* spp. L.	Buffer-WS	Spring	Annual[b]
Muscadine	*Vitis rotundifolia* Michaux	Trad-soft	Summer/fall	N/A
Oak	*Quercus* spp. L.	Trad-hard	Fall/winter	Variable
Pine	*Pinus* spp. L.	Buffer-WS	Fall	3-13 yr
Poison ivy	*Rhus radicans* L.	Buffer-vine	Fall/winter	N/A
Possumhaw holly	*Ilex decidua* Walter	Buffer-NW	Fall/winter	N/A
Smilax	*Smilax* spp. L.	Buffer-vine	Fall/winter	N/A
Supplejack	*Berchemia scandens* (Hill) K. Koch	Buffer-vine	Summer/fall	N/A
Sweetgum	*Liquidambar styraciflua* L.	Buffer-WS	Fall	2-3 yr
Sycamore	*Platanus occidentalis* L.	Buffer-WS	Spring	l-2 yr
Trumphet vine	*Campsis radicans* L.	Buffer-vine	Summer/fall	N/A
Virginia creeper	*Parthenocissus quinquefolia* L.	Buffer-vine	Summer/fall	Annual
Winged sumac	*Rhus copallina* L.	Buffer-NW	Fall/winter	Annual
Yellow-poplar	*Liriodendron tulipifera* L.	Buffer-WS	Fall/winter	Annual

WS = winged seed; Trad = traditional;
N/A = no information available; NW = nonwinged seed.

[a] Period between good mast crops.

[b] For red maple (A. *rubrum*).

Table 3—Relative frequency of winter mast items by habitat typo on the Piedmont National Wildlife Refuge, Georgia

	Upland Dine		Upland mixed Dine/hardwood		Bottom Dine		Bottom mixed Dine/hardwood		Bottom hardwood	
Mast item	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990
Blackgum	**0.5**	NP	NP	NP	**NP**	NP	**NP**	NP	NP	**NP**
Dogwood	3.1	2.2	NP	3.1	7.2	1.3	10.8	5.0	3.3	1.1
Elm	**NP**	17.7	NP	25.0	NP	23.4	NP	27.5	1.6	17.6
Hackbarry	0.5	NP	NP	NP	1.4	NP	NP	NP	5.0	NP
Honeysuckle	NP	0.5	NP	3.1	NP	3.9	2.7	NP	3.3	2.2
Hornbeam	NP	NP	NP	NP	NP	NP	2.7	5.0	NP	NP
Ironwood	NP	NP	NP	**NP**	NP	1.3	NP	NP	NP	4.4
Maple	NP	5.4	NP	3.1	NP	5.2	NP	7.5	3.3	15.4
Oak	NP	NP	NP	NP	NP	NP	NP	NP	NP	6.6
Pine	80.6	47.8	80.0	37.5	63.8	23.4	54.1	17.5	25.0	6.6
Poison ivy	NP	1.6	3.3	**NP**	1.4	1.3	2.7	5.0	18.3	6.6
Possumhaw	NP	1.6	NP	NP	1.4	1.3	NP	5.0	NP	2.2
Smilax	1.0	3.2	3.3	3.1	NP	3.9	2.7	2.5	NP	NP
Supplejack	NP	NP	NP	NP	NP	NP	NP	NP	3.3	1.1
Sweetgum	0.5	5.9	3.3	9.4	1.4	13.0	5.4	17.5	3.3	8.8
Sycamore	NP	1.1	NP	NP	NP	NP	NP	NP	11.7	7.7
Trumphet vine	NP	NP	NP	NP	NP	NP	NP	NP	1.6	NP
Winged sumac	NP	NP	NP	**NP**	NP	NP	NP	NP	1.6	3.3
Yellow-poplar	13.6	12.4	10.0	15.6	23.2	22.1	18.9	1.5	18.3	16.5

NP = not present in sample.

Table O-Relative frequency of spring mast items found by habitat type on the Piedmont National Wildlife Refuge, Georgia

	Upland Dine		Upland mixed Dine/hardwood		Bottom Dine		Bottom mixed Dine/hardwood		Bottom hardwood	
Mast item	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990
Ash	NP	NP	NP	NP	NP	5.0	6.3	6.7	NP	4.5
Blackgum	NP	1.5	NP	NP	NP	NP	NP	NP	NP	NP
Black cherry	NP	NP	NP	NP	3.8	10.0	NP	NP	**NP**	NP
Dogwood	1.0	NP	NP	NP	NP	NP	NP	NP	NP	NP
Elm	1.0	26.2	NP	23.1	NP	20.0	NP	33.3	NP	25.0
Maple	NP	3.1	NP	15.4	NP	15.0	12.5	33.3	4.3	20.5
Pine	69.1	47.7	63.6	30.8	46.2	15.0	50.0	6.7	17.4	4.5
Possumhaw	NP	NP	**NP**	NP	NP	NP	NP	NP	4.3	NP
Smilax	NP	NP	NP	NP	NP	NP	6.3	NP	NP	NP
Sweetgum	NP	1.5	NP	NP	NP	NP	NP	6.7	NP	**NP**
Sycamore	5.2	NP	18.2	15.4	**7.7**	5.0	NP	NP	30.4	15.9
Winged sumac	NP	NP	NP	NP	NP	NP	NP	NP	13.0	4.5
Yellow-poplar	23.7	20.0	18.2	15.4	42.3	30.0	25.0	13.3	30.4	25.0

NP = not present in sample.

Table 5—Relative frequency of summer **mast** items **found by** habitat type on the **Piedmont National** Wildlife **Refuge, Georgia**

	Upland Dine		Upland mixed Dine/hardwood		Bottom Dine		Bottom mixed Dine/hardwood		Bottom hardwood	
Mast item	1989	1990	1989	1990	1969	1990	1989	1990	1989	1990
Ash	NP	NP	NP	NP	NP	18.2	20.0	28.6	4.8	15.8
Blackgum	6.3	15.2	NP	14.3	NP	9.1	NP	14.3	NP	10.5
Black cherry	NP	3.0	25.0	14.3	18.2	18.2	NP	NP	NP	NP
Dogwood	6.3	6.1	25.0	28.6	18.2	NP	NP	28.6	4.0	5.3
Hornbeam	NP	NP	NP	NP	NP	NP	NP	14.3	NP	UP
Huscadine	NP	NP	NP	NP	36.4	NP	NP	NP	23.8	NP
Oak	NP	NP	NP	14.3	NP	18.2	NP	NP	33.3	42.1
Pine	75.0	66.7	50.0	28.6	27.3	36.4	40.0	14.3	4.8	10.5
Poison ivy	NP	3.0	NP	NP	NP	NP	20.0	NP	4.0	5.3
Possumhaw	NP	NP	NP	NP	NP	NP	NP	NP	14.3	NP
Smilax	NP	NP	NP	NP	NP	NP	20.0	NP	NP	NP
Winged sumac	NP	NP	NP	HP	NP	NP	NP	NP	4.8	NP
Yellow-poplar	12.5	6.1	NP	NP	NP	NP	NP	NP	4.8	10.5

NP = not present in sample.

Table 6—Relative frequency of fall **mast items found by habitat type on the Piedmont National Wildlife** Refuge, **Georgia**

	Upland Dine		Upland mixed pine/hardwood		Bottom Dine		Bottom mixed pine/hardwood		Bottom hardwood	
Mast item	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990
Ash	0.4	NP	NP	NP	NP	1.4	8.3	13.9	1.7	6.2
Blackgum	0.4	1.8	NP	NP	1.0	1.4	NP	NP	NP	2.5
Dogwood	5.4	2.8	9.1	la.4	10.6	9.6	14.6	8.3	6.0	8.6
Hackberry	NP	NP	NP	NP	NP	NP	NP	NP	0.8	NP
Hawthorn	0.4	NP	NP	NP	NP	NP	4.2	NP	NP	NP
Honeysuckle	0.4	NP	2.3	NP	1.9	1.4	2.1	NP	1.7	NP
Hornbeam	0.8	NP	NP	NP	NP	NP	a.3	NP	NP	NP
Ironwood	NP	NP	NP	NP	NP	NP	NP	NP	4.3	NP
Maple	NP	NP	NP	NP	2.9	NP	NP	NP	0.8	NP
Huscadine	NP	NP	NP	NP	1.0	NP	NP	NP	2.6	NP
Oak	NP	0.5	4.5	2.0	NP	2.7	2.1	2.8	19.8	27.2
Pine	50.6	83.9	25.0	75.5	24.0	63.0	18.8	63.9	8.6	35.8
Poison ivy	NP	NP	NP	NP	3.8	1.4	NP	2.8	6.0	2.5
Possumhaw	0.4	NP	NP	NP	NP	NP	NP	NP	3.4	NP
Smilax	2.5	NP	2.3	NP	3.8	NP	2.1	NP	NP	UP
Supplejack	NP	NP	NP	NP	NP	NP	NP	NP	NP	1.2
Sweetgum	8.7	NP	27.3	2.0	18.3	NP	18.8	2.8	16.4	NP
Sycamore	NP	NP	NP	NP	NP	NP	NP	NP	NP	1.2
Trumphet vine	NP	NP	2.3	NP	NP	NP	NP	NP	0.8	2.5
Virginia creeper	NP	NP	NP	NP	1.0	NP	NP	NP	2.6	1.2
Winged sumac	NP	NP	NP	NP	NP	NP	NP	NP	2.6	3.7
Yellow-poplar	29.0	11.1	27.3	2.0	31.7	19.2	20.8	5.6	21.6	7.4

NP = not present in sample.

Table 7—Number of mast traps containing pine and yellow-poplar seeds by year, season, and habitat type on the Piedmont National Wildlife Refuge, Georgia

Year and season	Upland pine	Upland mixed pine/hardwood	Bottom pine	Bottom mixed pine/hardwood	Bottom hardwood
			PINE		
1989					
Winter	154	24	44	20	15
Spring	67	7	12	8	4
Summer	12	2	3	2	0
Fall	122	11	25	9	10
1990					
Winter	**89**	12	18	7	6
Spring	31	4	3	1	2
Summer	22	2	4	1	0
Fall	182	37	46	23	29
			YELLOW-POPLAR		
1989					
Winter	26	3	16	**7**	11
Spring	23	2	11	**4**	7
Summer	2	0	0	0	0
Fall	70	12	33	10	25
1990					
Winter	23	5	17	3	15
Spring	13	2	6	2	11
Summer	2	0	0	0	0
Fall	24	1	14	2	6

Tab10 8—Number of different mast items in each habitat type by season and year on the Piedmont National Wildlife Refuge, Georgia

Year and season	Upland Dine		Upland mixed Dine/hardwood		Bottom Dine		Bottom mixed Dine/h ardwood		Bottom hardwood	
	Traditional	Buffer	Traditional	Buffer	Traditional	Buffer	Traditional	Buffer	Traditional	Buffer
1989										
Winter	3	4	0	5	2	5	1	7	2	11
Spring	1	4	0	3	1	3	0	5	0	6
Summer	2	2	2	1	3	1	0	4	3	6
Fall	2	9	2	5	3	8	2	8	4	12
1990										
Winter	1	10	1	7	1	10	1	9	2	12
Spring	1	5	0	5	1	6	0	6	0	7
Sumner	3	3	4	1	3	2	2	3	3	4
Fall	3	2	2	3	3	5	2	5	3	9

Table 9—Index of seasonal mast availability by habitat type and year on tha Piedmont National Wildlife Refuge, Georgia[a]

Year and season	Upland Dine		Upland mixed Dine/hardwood		Bottom Dine		Bottom mixed Dine/hardwood		Bottom hardwood	
	Traditional	Buffer	Traditional	Buffer	Traditional	Buffer	Traditional	Buffer	Traditional	Buffer
1989										
Winter	7.0	184.0	0.0	125.3	22.4	235.4	28.4	234.3	23.7	260.3
Spring	1.0	96.0	0.0	45.9	3.7	93.4	0.0	113.6	0.0	108.9
Sumner	2.0	14.0	8.4	8.4	29.9	11.2	0.0	35.5	61.5	37.9
Fall	14.0	226.0	25.1	158.7	40.6	340.1	56.8	284.0	160.9	388.1
1990										
Winter	4.0	181.0	4.2	129.5	3.7	284.0	14.2	269.8	33.1	397.6
Spring	1.0	64.0	0.0	54.3	7.5	67.3	0.0	106.5	0.0	208.3
Sumner	8.0	25.0	20.9	8.4	18.7	22.4	21.3	28.4	52.1	33.1
Fall	11.0	206.0	41.8	162.9	37.4	235.4	28.4	221.2	146.7	236.1

[a] Estimate calculated by summing the number of mast traps containing individual mast items M_1 through M_n, by habitat type, season, and year. For example, if a habitat type contains 10 mast traps, and mast item M_1 is found in 8 of the traps, mast item M_2 in 2 traps, and mast item M_3 in 1 trap, the estimated mast availability would be 8 + 2 + 1 = 11. Numbers of mast items recorded in different habitats were adjusted for unequal numbers of mast traps.

Edwards, John W.; Guynn, David C., Jr.; Loeb, Susan C. 1993.
Seasonal mast availability for wildlife in the Piedmont Region of Georgia. Res. Pap. SE-287. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 13 pp.

We measured mast production by traditional and buffer species for 2 years on the Piedmont National Wildlife Refuge in Georgia. Our objectives were to determine how these two types varied on a seasonal, annual, and habitat basis. Mast from buffer species was more frequent and diverse than that from traditional mast producers. Our findings suggest that although traditional mast species are important, buffer species may play an equally important seasonal role in maintaining annual diversity.

Keywords: Buffer species, oak, Southeast, traditional.

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