

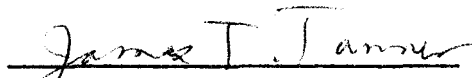
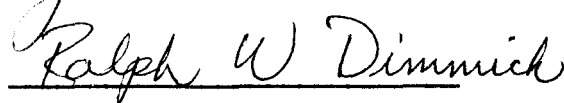
August 10, 1971

To the Graduate Council:

I am submitting herewith a thesis written by Larry Eugene Beeman entitled "Seasonal Food Habits of the Black Bear (Ursus americanus) in the Smoky Mountains of Tennessee and North Carolina." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Wildlife Management.


Major Professor

We have read this thesis and
recommend its acceptance:

Accepted for the Council:


Vice Chancellor for
Graduate Studies and Research

SEASONAL FOOD HABITS OF THE BLACK BEAR (URSUS AMERICANUS) IN THE
SMOKY MOUNTAINS OF TENNESSEE AND NORTH CAROLINA

A Thesis
Presented to
the Graduate Council of
The University of Tennessee

In Partial Fulfillment
of the Requirements for the Degree
Master of Science

by
Larry Eugene Beeman

August 1971

ACKNOWLEDGMENTS

I am grateful to Dr. Michael R. Pelton, Assistant Professor of Forestry, The University of Tennessee, who served as director of research.

I would like to express my appreciation to Dr. Ralph W. Dimmick, Associate Professor of Forestry, and Dr. James T. Tanner, Professor of Zoology, who served on my committee. Appreciation is extended to the Great Smoky Mountains National Park and the North Carolina Wildlife Resource Commission for cooperation in collecting field data. Also, gratitude is expressed to the wildlife graduate students of the Forestry Department whose aid in the field was helpful.

The University of Tennessee is thanked for generous support of field and lab work. Facilities for this study were provided by the Department of Forestry, The University of Tennessee. Significant financial support was provided by McIntire-Stennis funds.

ABSTRACT

This study was conducted on the Tennessee side of the Great Smoky Mountains National Park and game management areas in North Carolina. Information on seasonal food habits of the black bear (Ursus americanus) was obtained through analyses of scat and stomachs collected during 1969 and 1970.

In the Great Smoky Mountains National Park herbaceous species were the most common food items in the spring. When berries of shrub species matured, bears ate large quantities of Rubus sp., Vaccinium sp., and Gaylussacia sp. A saprophyte, Conopholis americana, was also an important food item during the summer and early fall seasons. Fruits of Prunus serotina, Fagus grandifolia, and Quercus sp. became the dominant foods of bears in the early and late fall seasons.

Although black bears are omnivores, animal foods were not consumed in great quantities. Colonial insects were frequently found but in small amounts. Mammals are even less important and are probably eaten only as carrion.

Scat and stomach samples collected in North Carolina from wildlife management areas (in similar Southern Appalachian terrain) revealed similar results as samples from the Great Smoky Mountains National Park. Samples of stomach contents collected in North Carolina and scat remains from the Great Smoky Mountains National Park were also similar in food content.

Results of analyses of six cub scat indicate food habits of cubs were similar to older bears.

A direct relationship was found between garbage consumption by bears and increased camping and picnicing in the Great Smoky Mountains National Park.

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CHAPTER I

INTRODUCTION

Food habits of the black bear have been studied in various sections of the United States and Canada. Some of the early endeavors were in Oregon and California (Bailey, 1923), Anticosti Island (Newsom, 1937), New York (Shadel, 1941), Ontario (Bigelow, 1922), and Florida (Hamilton, 1941). Bray and Barnes (1967) collected several scat in Yellowstone National Park and analyzed these as percent garbage and natural food. One of the first quantitative analyses of scat was carried out by Murie (1937) using 64 droppings from Yellowstone National Park. Another early analytical study was conducted in Virginia (Cottam, Nelson, and Clark, 1939). Other quantitative studies were in Colorado (Gilbert, 1951), Pennsylvania (Bennett, English, and Watts, 1943), and Florida (Harlow, 1961).

The first extensive study was conducted on the Kenai Peninsula when 250 scat were analyzed (Chatelain, 1950). This study included collections from May through September and grasses and berries were the important food items. Hatler (1967) analyzed 23 stomachs, 16 intestinal tracts, and 44 scat from interior Alaska and found horsetail (Equisetum sp.) important during the fall. Results in Maine (analyzing 108 stomachs and 377 scat) found grasses and sedges the major food items in the spring, insects and apples (Malus sp.) important in the summer, and carrion and beechnuts (Fagus grandifolia) dominant in the fall. The most extensive

study to date was a quantitative analysis of 819 scat collected in the Whitefish area of Montana (Tisch, 1961). Grasses were the most important spring foods, various forbs ranked first in the summer, berries and pine-nuts were the main constituent of the fall diet, and mountain ash (Sorbus sp.) was the major late fall food.

Virtually no food habits study has ever been conducted in the Southern Appalachian Region on black bears. Komarek and Komarek (1938) stated that bears in the Great Smoky Mountains National Park are known to eat blackberries (Rubus sp.), huckleberries (Gaylussacia sp.), blueberries (Vaccinium sp.), acorns (Quercus sp.), chestnuts (Castanea dentata), beechnuts (Fagus grandifolia), grapes (Vitis sp.), herbs, grasses, yellowjackets, carrion, and garbage.

This study deals with the seasonal food habits of the black bear (Ursus americanus) in the Great Smoky Mountains National Park in Tennessee and adjacent game management areas in North Carolina. Field collections were carried out during June, September, and October of 1969, and from April 1 to December 9, 1970. The major objectives of the study were:

1. To determine seasonal food habits of the black bear.
2. To determine the relationship between seasonal feeding activity and vegetation types present in the Park.
3. To determine the significance of garbage in the food habits of the black bear.

CHAPTER II

DESCRIPTION OF STUDY AREA

Geography

The Great Smoky Mountains National Park (hereafter called GSMNP) is located along the common border of North Carolina and Tennessee. This area includes Blount, Sevier, and Cocke counties in Tennessee and Swain and Haywood counties in North Carolina (Figure 1). The GSMNP boundary surrounds 800 square miles of mountainous terrain. One trans-mountain road bisecting the Park and another paralleling the northern boundary just inside the Park are the only major roads. Over 600 miles of horse and foot trails wind through the GSMNP. Field investigations were conducted primarily on the Tennessee side which includes 375 square miles.

Collections were also made from six wildlife management areas located near the GSMNP in North Carolina. These management areas are located in parts of the following counties: Buncombe, McDowell, Clay, Transylvania, Caldwell, Madison, Graham, Yancey, and Johnson.

Topography

The GSMNP is a part of the Blue Ridge Province. Elevation ranges from 888 feet to 6,642 feet; the highest summits rise more than 5,000 feet above valleys. Valleys are cut deep into the mountain mass and have steep slopes and narrow flats. The slopes form most of the mountain area. Over 600 miles of streams dissect the Park and drain into the

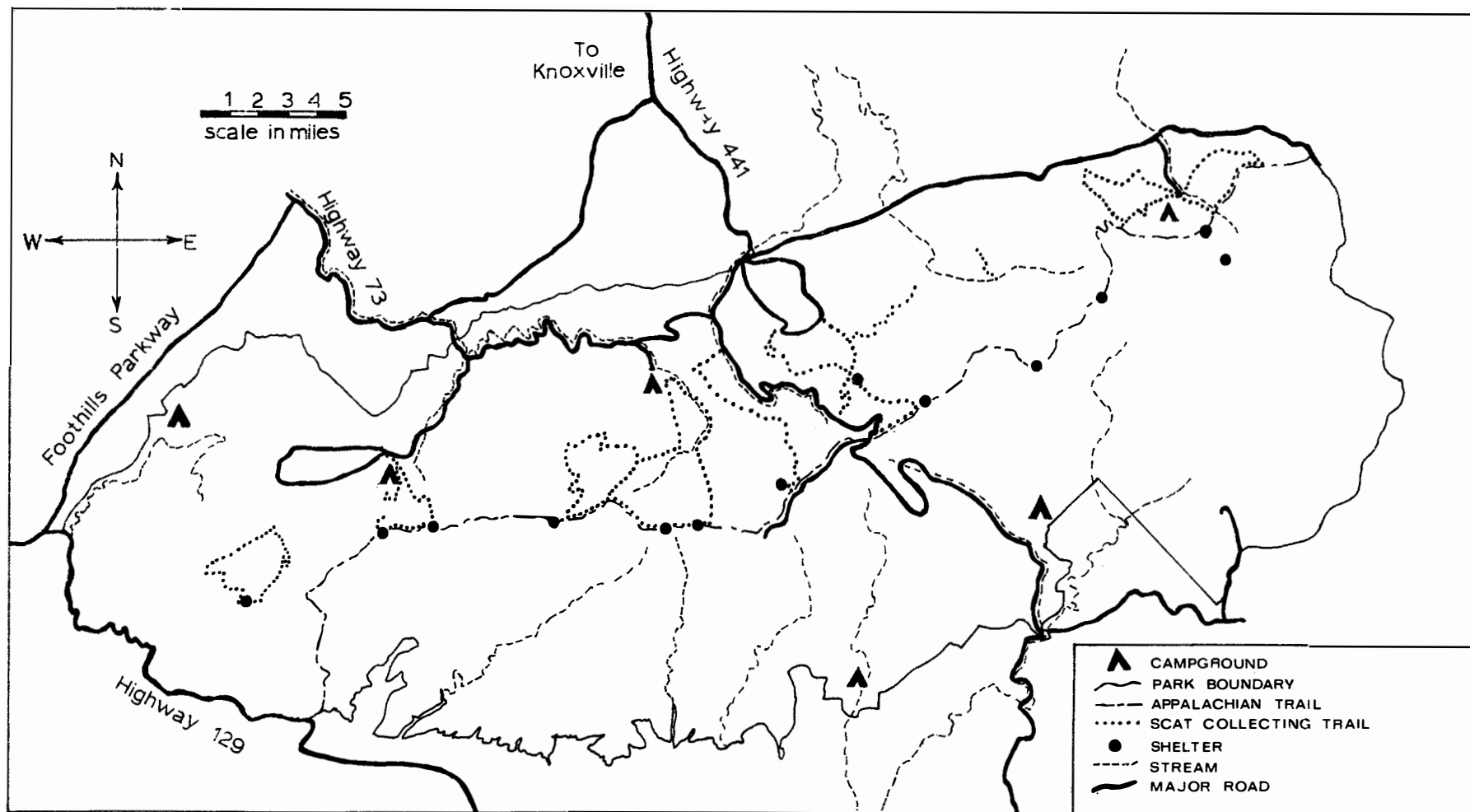


Figure 1. Map of study area, the Great Smoky Mountains National Park located in Tennessee and North Carolina.

Oconaluftee and Tuckasegee Rivers in North Carolina and Little Pigeon and Little Tennessee Rivers in Tennessee. The management areas in North Carolina have topography similar to the GSMNP.

Climate

A humid climate with marked local climatic variation occurs due to the geographical location and high relief of the study area. Mean temperatures decrease with elevation at an average of 2.43°F per 1,000 feet, so that high elevations average 10 to 15°F cooler than the base of the mountains. Annual precipitation values range from 45 to 55 inches in the lower valleys (Gatlinburg and Elkmont, Tennessee) to more than 85 to 95 inches at high elevations. Weather data collected inside the study area from Gatlinburg (elevation 1,500 feet) and Newfound Gap (elevation 4,950 feet) are given in Tables 1 and 2.

Description of Vegetation

Classification of the vegetation patterns in the GSMNP has been attempted by several taxonomists. Whittaker (1956) used 15 associations to describe the vegetation. Shanks (1954) and Cain (1935) described the vegetation of the GSMNP with six associations. These six associations are broad physiognomic types that are characterized by conspicuous species, occupy obviously different sites, and have marked differences in minor vegetation. Cain's and Shank's classification is closely followed below to describe the GSMNP.

Scat and stomachs were also collected outside the GSMNP from ten counties in North Carolina. These ten counties are located in the

TABLE 1

TEMPERATURE DATA FROM GATLINBURG AND NEWFOUND GAP, TENNESSEE

Month	Temperature in °F ^a				
	Gatlinburg (1500 ft)			Newfound Gap (4950 ft) ^b	
	1923 to 1967 Mo. Av.	1969	1970	1969	1970
January	39.3	34.4	28.5	25.5	19.7
February	41.9	36.7	36.5	24.5	25.1
March	47.8	39.0	45.3	24.0	32.0
April	56.8	56.7	56.1	42.6	42.2
May	64.8	62.3	63.9	49.0	48.8
June	72.0	70.5	68.9	59.2	54.3
July	73.6	74.3	72.5	59.9	57.0
August	73.7	70.4	71.8	54.3	56.3
September	68.9	65.3	71.2	50.4	55.1
October	57.9	55.5	58.6	44.6	46.4
November	46.7	42.3	44.0	32.9	31.5
December	40.2	34.6	42.2	24.7	34.4
Maximum Temperature		88.2	87.9	79.0	75.0
Minimum Temperature		1.0	4.0	-10.0	-8.0

^aFrom records of the Great Smoky Mountains National Park.

^bLong term data unavailable.

TABLE 2

PRECIPITATION DATA FROM GATLINBURG AND NEWFOUND GAP, TENNESSEE

Month	Precipitation in Inches ^a				
	Gatlinburg (1500 ft)			Newfound Gap (4950 ft) ^b	
	1923 to 1967 Mo. Av.	1969	1970	1969	1970
January	4.84	2.29	2.86	6.39	4.25
February	4.76	5.82	2.83	9.69	5.21
March	5.32	5.42	3.04	8.51	7.59
April	4.50	3.51	7.32	7.53	9.37
May	4.50	3.10	3.70	5.91	4.31
June	5.20	7.75	4.34	8.78	8.72
July	5.66	5.29	5.21	8.60	8.61
August	5.29	4.21	3.44	10.07	10.68
September	2.98	2.57	5.35	3.53	3.46
October	3.12	2.11	2.06	3.17	11.67
November	3.42	3.22	2.48	6.44	4.21
December	4.46	5.12	4.05	10.39	7.70
Annual	54.05	50.41	46.68	89.01	85.78

^aFrom the records of the Great Smoky Mountains National Park.

^bLong term data unavailable.

Southern Appalachian Mountains and have similar vegetation patterns as those found in the GSMNP.

The Eastern Deciduous Forest in the GSMNP includes 421,745 acres or about 83 percent of the total area (Anon., 1969). There are five associations located in the Eastern Deciduous Forest: cove hardwood hemlock, northern hardwood, closed oak, and open oak and pine. Spruce-fir is the sixth forest association (Shanks, 1954). The accompanying diagram depicts the general topographical and altitudinal position of each broad vegetation type (Figure 2). Effective moisture and soil depth are correlated with topographical position, while temperature and length of growing season are correlated with altitude.

The cove hardwood forest association includes 67,350 acres in sheltered, deep-soiled drainages below 4,500 feet (Anon., 1969). On the North Carolina side, which has a general south facing exposure, the cove forests are narrow and finger up each drainage. On the Tennessee side, with a general north exposure, the cove forests often broaden out, occasionally extending over ridge crests, and to much higher elevations. Seven tree species make up 80 to 90 percent of the cove forest canopy (Table 3) (Shanks, 1954).

The 7,696 acres of hemlock forest association is restricted to sheltered topography along steams below 3,000 feet, but occurs also on the more exposed slopes and ridges to 4,500 feet (Anon., 1969). Eastern hemlock (Tsuga canadensis) stands appear on sites that are less mesic than those of the cove forests, whether on open valley flats or slopes above the valleys at high elevations (Shanks, 1954). The most

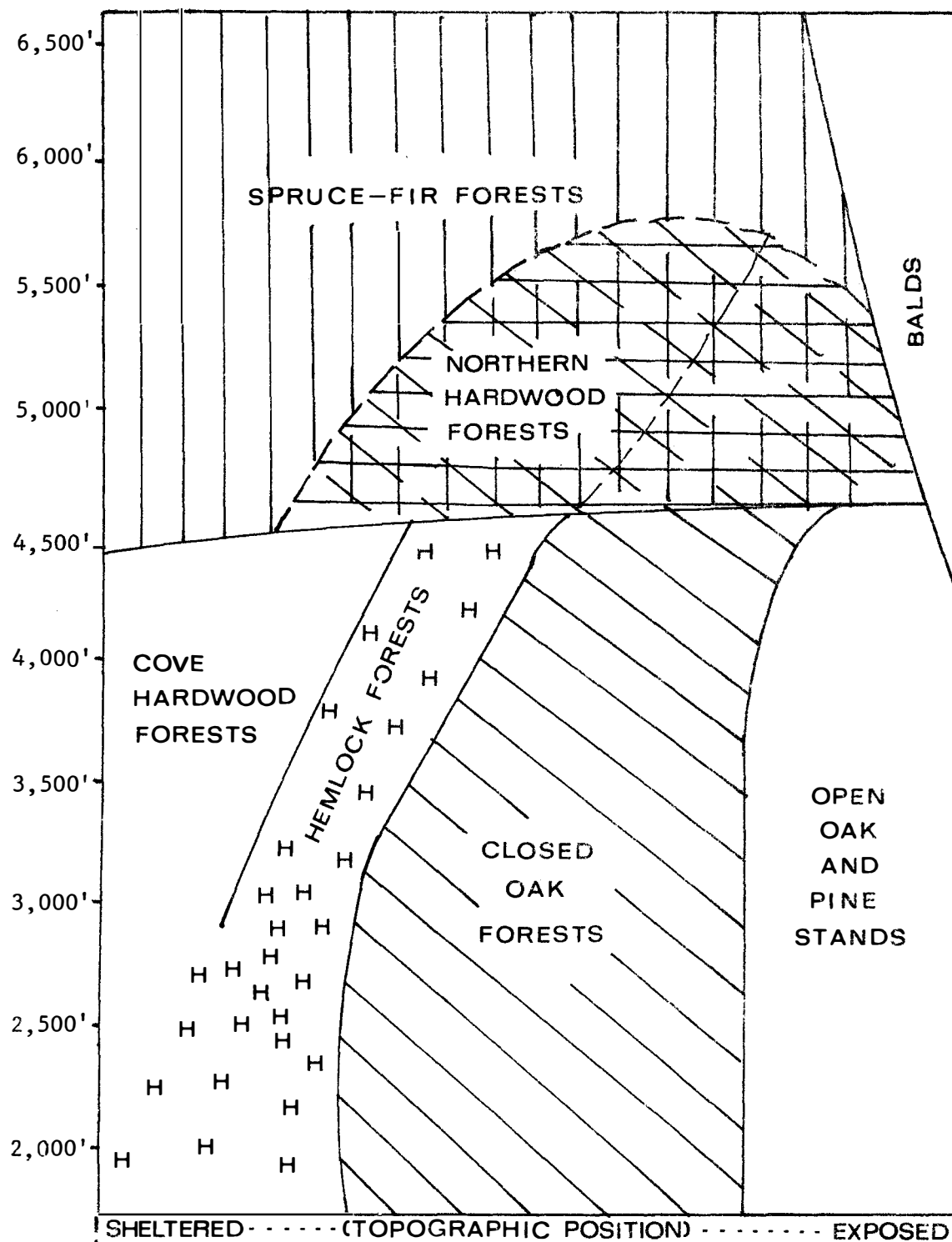


Figure 2. Vegetation pattern of the Great Smoky Mountains based on pattern diagrams by R. H. Whittaker, 1952.

TABLE 3

FOREST ASSOCIATIONS AND THEIR IMPORTANT TREE SPECIES IN THE
GREAT SMOKY MOUNTAINS NATIONAL PARK

Forest Association Type	Important Species
Cove hardwood	Eastern hemlock (<u>Tsuga canadensis</u>) Silverbell (<u>Halesia monticola</u>) Yellow buckeye (<u>Aesculus octandra</u>) Sugar maple (<u>Acer saccharum</u>) Yellow birch (<u>Betula alleghaniensis</u>) Tulip poplar (<u>Liriodendron tulipifera</u>) Beech (<u>Fagus grandifolia</u>)
Hemlock	Eastern hemlock Yellow birch Silverbell Fraser magnolia (<u>Magnolia fraseri</u>) Rhododendron (<u>Rhododendron maximum</u> and <u>R. catawbiense</u>) Mountain laurel (<u>Kalmia latifolia</u>)
Northern hardwood	Beech Yellow birch Yellow buckeye Sugar maple Mountain maple (<u>A. spicatum</u>)
Closed oak	White oak (<u>Quercus alba</u>) Chestnut oak (<u>Q. prinus</u>) Northern red oak (<u>Q. rubra</u>) Black oak (<u>Q. velutina</u>) Pignut hickory (<u>Carya glabra</u>) Mockernut hickory (<u>C. tomentosa</u>) Sourwood (<u>Oxydendrum arboreum</u>) Black locust (<u>Robinia pseudoacacia</u>)
Open oak	Scarlet oak (<u>Quercus coccinea</u>) Sassafras (<u>Sassafras albidum</u>) Pitch pine (<u>Pinus rigida</u>) Table mountain pine (<u>P. pungens</u>)
Spruce-fir	Red spruce (<u>Picea rubens</u>) Fraser fir (<u>Abies fraseri</u>)

Source: R. E. Shanks, "Reference list of native plants in the Great Smoky Mountains." Botany Dept., The University of Tennessee, 1954. (Mimeographed.)

important associates of hemlock are listed in Table 3.

The northern hardwood forest association is found on mesic sites and occurs above 4,500 feet, especially in cove heads and gaps. The forest covers 70,921 acres inside the GSMNP. Stands of beech (Fagus grandifolia) or yellow birch (Betula alleghaniensis) and buckeye (Aesculus octandra) occur at higher elevations (Anon., 1969). Other tree species are listed in Table 3.

The closed oak forest association grows at low and middle elevations on intermediate and dry slopes. Species of oaks (Quercus) and hickories (Carya) are common. Other important species are given in Table 3 (Shanks, 1954).

The open oak and pine stands are forest associations of dry exposed slopes and ridges on rocky soils. The tree canopy is not continuous, although a tall shrub layer dominated by mountain laurel (Kalmia latifolia) is abundant. Tree growth is scrubby in comparison to the trees of the more mesic and deeper soils (Anon., 1969).

The spruce-fir forest association covers 35,491 acres. The floral characteristics of this association resemble the floral characteristics of the Canadian zone (Anon., 1969). The lower limits of this forest are dominated by red spruce (Picea rubens), the middle by a combination of red spruce and Fraser fir (Abies fraseri), and the upper elevation--above 6,000 feet--by Fraser fir. Other associated plants are listed in Table 3, page 10 (Shanks, 1954).

Grassy balds are also found in the GSMNP. Their maintenance has been the subject of wide speculation for years. Serviceberry

(Amelanchier laevis) is the most common tree invader while blueberries (Vaccinium) are common shrub invaders (Anon., 1969).

CHAPTER III

PROCEDURES

Black Bear Scat Collection

Routes for collecting scat were selected during June and September, 1969. Due to the difficulty of covering the entire Park, trails were limited to the Tennessee side and the Appalachian Trail. This included half of the Park or approximately 275,000 acres. All of the foot trails and many of the abandoned logging roads were investigated and permanent trails selected. An attempt was made to choose trails systematically distributed on the Tennessee side of the Park that covered the various vegetative associations and different altitudes. An effort was also made to investigate areas around camping shelters in the back country where bears tend to concentrate. A total of nine foot trails ranging from 13 to 24 miles and accumulatively including 159.1 miles were selected as permanent scat collecting routes. These foot trails included 34.2 miles above 5,000 feet, 43.2 miles between 3,000 and 4,000 feet, 36.6 miles between 2,000 and 3,000 feet, and 1.5 miles below 2,000 feet.

Scat was collected during June, September, and October in 1969 and between April 1 and December 9 in 1970. Most trails were covered at two-week intervals. Scat was not aged more accurately than the two-week rotation in which trails were covered due to the following:

- (1) variable weather, especially heavy rains;
- (2) different plant

overstories affected deterioration of scat by the amount of exposure to the weather; and (3) judgement of several different people.

Areas surrounding ten shelter cabins located along the mountain ridge top were investigated for scat at two-week intervals. The only open garbage pit in the GSMNP, located at Mt. LeConte, was checked every two weeks. Scat found off the pre-determined routes were collected if it appeared to have been recently deposited. Campgrounds and picnic areas were the main areas for scat collected off the foot trails. Also, 35 scat were collected from four North Carolina wildlife management areas. Although these were off the study area, they came from Southern Appalachian terrain adjacent and similar to the Great Smoky Mountains National Park.

Baiting to attract bears for collection of feces proved to be a successful technique. Burlap was soaked in sardine oil and tied in a tree. Visitation to the baited sites by a bear was confirmed by the burlap being torn down or completely absent. After one or two weeks, the baited area appeared to become a part of the bear's daily visitations and droppings were located in the vicinity of the baited area. This method obviously introduced some artificiality, but served the purpose of attracting bears for feces deposition.

Black Bear Stomach Collection

Four black bear stomachs from the GSMNP and 53 from wildlife management areas in North Carolina were collected for food analysis. The four stomachs from the GSMNP were obtained from a bear killed by

an automobile (yearling), a poached bear (adult male), a bear overdosed with drugs (adult male), a "troublesome" bear shot by a ranger (adult male). Stomachs from North Carolina were collected by personnel of the North Carolina Wildlife Resource Commission from hunter kills in four of their wildlife management areas. All four areas were located in the Southern Appalachian mountain terrain similar to the GSMNP.

Preservation of Scat

It was noted that fresh droppings deteriorate rapidly. Maggots (Diptera larvae) and scavenger beetles (Silphidae) entered fecal material and fed upon food remnants. To preserve droppings it was necessary to freeze them soon after collection. A 10 percent formalin solution was used to preserve scat when refrigeration was not immediately available.

Scat Analysis

Frozen scat was put in a flask of water for two to three hours. The soaked feces was washed through a series of sieve screens with a stream of tap water. The three sizes of sieves (screen openings of 2 mm, 1 mm, and 0.25 mm) aided in sorting food items.

A sample of the saturated feces was placed in a Petri dish of water. Macroscopic examination of fecal contents was accomplished by spreading material to approximately one-quarter inch in depth. Berries, most seeds and insects, and mast could usually be identified without the aid of magnification. Examination with a binocular scope was continued until all food items were located. Samples of unidentified

material were preserved in 10 percent formalin for later identification. After becoming familiar with food items eaten by black bears, each scat required approximately 20 minutes for analysis.

Measurement of scat and stomach contents by volume were listed in five ocular estimates: 75 to 100 percent, 50 to < 75 percent, 25 to < 50 percent, 1 to < 25 percent, and trace. The above is very similar to the method used by Clark (1957) for analysis of Kodiak bear feces and Tisch (1961) for black bear feces. Precise volumetric measurements were not taken for the following reasons: (1) feces could not be collected in their entirety; (2) weather conditions and differential exposure to weather greatly affected volume prior to collecting; (3) other animals feeding upon feces altered volume prior to collecting; (4) relative amounts of food items in scat may not be a indication of food initially consumed; and (5) the time required to separate food remains in scat was considered to be impractical.

A seed manual by Martin and Barkley (1961) was the major guide used to identify seeds. Reference collections were maintained for seeds not found in this manual. Gray's Manual of Botany (Fernald, 1950) along with the aid of Dr. A. J. Sharp of The University of Tennessee were the main sources used for identifying plant leaves and stems. Mammal hairs were identified using a reference collection. A key to the dorsal guard hairs of California mammals was used as a supplement for identifying mammal hair (Mayer, 1952).

Herbs in feces were difficult to identify. The GSMNP has one of the richest floral displays and includes over 1,000 herbaceous

species. Even with the aid of an experienced botanist many herbaceous plants could not be specifically identified.

The seeds of Vaccinium, Rubus, Gaylussacia, and Quercus were the major food items identified only to the genus. Stupka (1964) listed 16 species of Rubus, 14 species of Vaccinium, two species of Gaylussacia, and 10 species of Quercus in the (GSMNP.) Any attempt to classify these four groups beyond the genus taxon by using seeds alone would be difficult.

Volume Index and Frequency Index Percent

The volume index for a given food item was determined by assigning an index number for that item in all scat and/or stomachs. Index numbers were assigned according to the following classification:

75 to 100 percent of volume	= 4
50 < 75 percent of volume	= 3
25 < 50 percent of volume	= 2
1 < 25 percent of volume	= 1
Trace	= 0

The volume index percent (hereafter called VIP) was determined by dividing the volume index number for a specific food item by the total volume index value for that season. The VIP is an expression that permits volume consumption of food items to be compared within and between seasons. The frequency index by itself can be misleading in delineating the amount of a food item actually consumed. A better evaluation of a food items importance can be made by presenting each food

item with a frequency and a volume index percent.

The frequency index percent (hereafter called FIP) is simply frequency of occurrence. This percent is calculated by dividing the number of scat collected during a particular season into the number of scat in which a food item appeared.

Utility of Scat as a Food Habits Technique

The identity of food items in this study relied heavily upon scat analysis for determining the food habits of black bears. Hatler (1967) found green plant material appeared little changed in either form or volume as it passed through a bear's digestive system. Hatler also found animal material underwent the biggest volume change in a bear's digestive tract. However, identity of animal material is seldom lost as resistant materials (exoskeleton, hair, claws, teeth, etc.) will not be digested. In conclusion, Hatler stated the following:

I feel that a good collection of scats can justifiably serve as a base for nearly any bear food habit study. If a study is oriented toward determination of basic food habit patterns, scats alone may be adequate.

CHAPTER IV

RESULTS AND DISCUSSION

A. ANALYSES OF SCAT AND STOMACHS COLLECTED FROM BEARS IN THE GREAT SMOKY MOUNTAINS NATIONAL PARK

A summary of the various classes of black bear food items is presented in Tables 4 and 5 and Figure 3. A generalized breakdown of food items illustrates black bears depend mostly on vegetative material (VIP = 83). Insects comprised most of the animal food source of bears (VIP = 7). During the period of heavy visitation by tourists to the GSMNP bears were attracted to garbage (VIP = 6).

Plant foods consumed by bears were divided into two categories: leaves and stems and fruits and seeds. Bears relied heavily on fruits and seeds as their main source of food (VIP = 66). When fruits became available in the summer, the bear's diet changed from herbs to eating the maturing fruits. Numerous species of fruiting plants and their wide distribution of fruiting times gave the black bear a variety of well distributed (spatially and seasonally) food items during the summer and early fall.

Insects occurred frequently in all seasons and were the only major animal food item consumed by black bears. Hatler (1967) found that detection of insect larvae and eggs in scat usually is difficult. Therefore, insect forms may be more important than analysis of scat demonstrates. Immature beetles (Coleoptera) were identified on only

TABLE 4

FREQUENCY OF OCCURRENCE OF FOOD ITEMS IDENTIFIED IN 667 SCAT AND
4 STOMACHS COLLECTED IN THE GREAT SMOKY MOUNTAINS
NATIONAL PARK IN 1969 AND 1970

Items Identified	Percent of Frequency							
	<u>Spring</u>		<u>Summer</u>	<u>Early Fall</u>		<u>Late Fall</u>		Totals
	1969	1970	1970	1969	1970	1969	1970	
	(24) ^a	(87)	(283)	(174)	(66)	(11)	(26)	(671)
<u>Plant Remains</u>								
Leaves and stems	79	84	27	18	22	45	4	33
Fruits and seeds	33	12	75	93	89	90	88	71
Total plants	91	98	94	98	94	100	100	95
<u>Animal Remains</u>								
Insects	25	15	31	59	55	27	58	46
Mammals	4	--	2	3	2	--	--	2
Other	--	--	2	--	1	--	--	1
Total animal	29	15	35	61	57	27	58	48
<u>Miscellaneous</u>								
Garbage	8	8	26	20	12	18	8	20

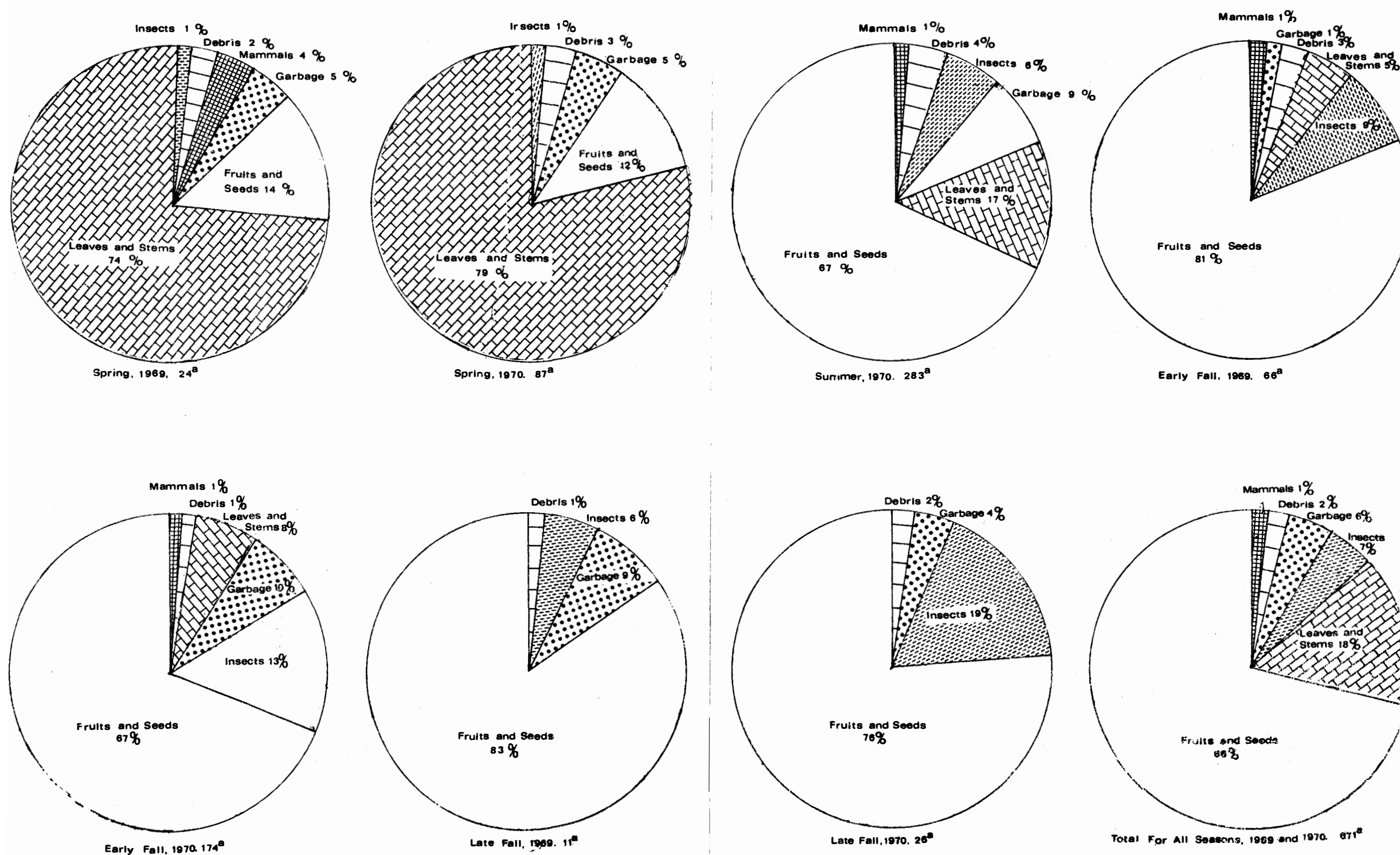
^aNumber in parentheses represents number of scat and stomachs collected.

TABLE 5

VOLUME INDEX PERCENT OF FOOD ITEMS IDENTIFIED IN 667 SCAT AND
4 STOMACHS COLLECTED IN THE GREAT SMOKY MOUNTAINS
NATIONAL PARK IN 1969 AND 1970

Items Identified	Volume Index							Totals (671)
	<u>Spring</u>		<u>Summer</u>	<u>Early Fall</u>		<u>Late Fall</u>		
	1969 (24) ^a	1970 (87)	1970 (283)	1969 (66)	1970 (174)	1969 (11)	1970 (26)	
<u>Plant Remains</u>								
Leaves and stems	74	79+	17	5	8	--	--	18
Fruits and seeds	14	12	62	81	67	83	76	66
Total plants	88	92	79	86	85	83	76	84
<u>Animal Remains</u>								
Insects	1	1	6	9	13	6	19	7
Mammals	4	--	1	1	1	--	--	1
Other	--	--	1	1	1	--	--	1
Total animal	5	1	7	10	14	6	19	8
<u>Miscellaneous</u>								
Garbage	5	4	9	1	10	9	4	6
Other (debris, wood)	2	3	4	3	1	1	2	2

^aNumber in parentheses represents number of scat and stomachs collected.



^aNumber of scat in that season.

Figure 3. Volume and distribution of black bear food classes by season, year, and a total.

five occasions, probably reflecting the difficulty of identifying larvae and eggs in scat. Beetles and wasps were the insects most commonly eaten by black bears in the GSMNP.

Most studies show insects are the major animal food consumed by black bears. Murie (1937) found insects occasionally can become a major food item of black bears. In a year of cricket and grasshopper abundance in Yellowstone National Park, Murie found 58 of 64 black bear droppings were entirely of these insects. Results (listed below) from other areas in North America were similar to the results in the GSMNP (VIP = 8). On the Kenai Peninsula insect foods increased from a frequency of 20.6 percent in spring to 40.3 percent in the summer. In West Virginia 25 percent of bear stomachs in the late fall contained insect remains (Cottam et al., 1939). Tisch (1961) identified insects in 45.3 percent of bear feces in Montana.

Black bears in the GSMNP utilized mammals as a food item infrequently. Carrion beetles (Silphidae) were found in scat with most mammal remains thus indicating the likelihood of mammals being consumed as carrion. Many mammals are abundant in the GSMNP meaning availability of mammals to bears is likely not a limiting factor as a food source. A large deer herd is located in the western end of the GSMNP. In addition, over 1,000 beef cattle roam this same area. No scat containing deer or cattle remains were collected in the western end of the GSMNP. Studies in Maine (Spencer, 1966), Colorado (Gilbert, 1951), Pennsylvania (Chatelain, 1950), Florida (Harlow, 1961), and Montana (Tisch, 1961) all found black bears do not depend upon mammals as an important food item.

Spring Food Habits

A total of 110 scat and one stomach were collected during the spring (emergence from hibernation through June 30) (Tables 6 and 7). Black bears fed mainly on stems and leaves of herbaceous plants during the spring. The consumption of grasses (Gramineae) by bears (VIP = 32) was higher in 1969. During 1970 grasses (VIP = 22) were still an important food item for bears but were second to unidentified herbs (VIP = 38). The major source of grasses is most likely on grassy balds and along trails. The forest canopy is reduced or absent in these areas allowing grasses to grow abundantly. In addition to balds, there are a few other openings in the GSMNP where grasses are found. These openings are limited in number and are probably insignificant to the black bear as a source for grass. Grasses are also found along roadsides, but are likely not important to the bear as a food source. Many sightings of bears along roadsides were recorded and not one instance of grazing was observed. The availability of food and garbage from GSMNP visitors appears to be the reason bears visit roadsides.

Most black bear food habit studies indicate that grasses are an important spring food. On the Kenai Peninsula, Chatelain (1950) found grass in 89.5 percent of the black bear's scat. In Maine grasses were identified in 36.6 percent of the scat (Spencer, 1966). Grasses comprised 33 and 27 percent (two years) by volume in Alaska (Hatler, 1967). Other studies in which grasses were a food item of the black bear include Colorado (Gilbert, 1951), West Virginia (Cottam et al., 1939), Yellowstone National Park (Murie, 1937), and Florida (Harlow, 1961).

TABLE 6

VOLUME AND OCCURRENCE OF FOOD IN 24 SCAT COLLECTED FROM THE GREAT
SMOKY MOUNTAINS NATIONAL PARK, SPRING (HIBERNATION EMERGENCE
TO JUNE 30), 1969

Food Item	Volume Percent Category					Vol. Index	Freq. Index
	100-75	75-50	50-25	25-1	Trace		
<u>Plant Remains</u>							
Mainly leaves and stems							
Gramineae	10	-	-	-	1	32	46
Unidentified herbs	7	-	-	-	-	28	29
<u>Conopholis americana</u>	2	-	-	-	-	8	8
<u>Amaranthus blitoides</u>	-	-	-	1	1	1	8
<u>Quercus</u> sp. (buds)	-	-	-	1	-	1	1
Mainly fruits and seeds							
<u>Amelanchier</u> sp.	2	-	-	-	-	8	8
<u>Rubus</u> sp.	1	-	-	-	-	4	4
<u>Vaccinium</u> sp.	-	-	-	2	-	2	8
<u>Malus</u> sp.	-	-	-	-	1	-	1
<u>Animal Remains</u>							
Coleoptera	-	-	-	1	6	1	33
<u>Marmota monax</u> ^a	1	-	-	-	-	4	4
<u>Miscellaneous</u>							
Garbage	1	-	-	1	-	5	8
Wood	-	-	-	1	3	1	16
Debris	-	-	-	1	3	1	16

^aHair.

TABLE 7

VOLUME AND OCCURRENCE OF FOOD IN 86 SCAT AND 1 STOMACH COLLECTED
FROM THE GREAT SMOKY MOUNTAINS NATIONAL PARK, SPRING
(EMERGENCE TO JUNE 30), 1970

Food Item	Volume Percent Category					Vol. Index	Freq. Index
	100-75	75-50	50-25	25-1	Trace		
<u>Plant Remains</u>							
Mainly leaves and stems							
Gramineae	19	1	1	-	-	22	24
Unidentified herbs	35	-	-	-	-	38	41
<u>Ranunculus</u> sp.	3	-	-	-	-	1	2
<u>Amaranthus blitoides</u>	3	-	-	-	-	3	3
<u>Anemone quinquefolia</u>	2	-	-	-	-	2	2
<u>Sanguinaria canadensis</u>	2	-	-	-	-	2	2
<u>Eupatorium</u> sp.	2	-	-	-	-	2	2
<u>Galium</u> sp.	2	-	-	-	-	2	2
<u>Goodyera pubescens</u>	1	-	-	-	-	1	1
<u>Aster</u> sp.	1	-	-	-	-	1	1
<u>Tsuga canadensis</u>	-	-	-	-	2	-	2
<u>Quercus</u> sp.	-	-	-	1	-	< 1	1
Mainly fruits and seeds							
<u>Conopholis americana</u>	10	-	2	-	-	12	14
<u>Vaccinium</u> sp.	-	-	-	1	-	< 1	1
<u>Animal Remains</u>							
Coleoptera	-	-	1	3	6	1	13
Formicidae	-	-	-	2	2	1	5
<u>Miscellaneous</u>							
Garbage	2	1	-	4	-	4	8
Wood	-	1	-	4	3	2	9
Debris	-	-	-	1	-	< 1	1

Few fruits of plants are available to black bears during the spring in the GSMNP. In 1969 serviceberry (Amelanchier sp.) was the most important fruit to bears (VIP = 8). In 1970 a saprophyte, squawroot (Conopholis americanus), was the major fruit consumed. Squawroot is not previously mentioned in the literature as a food item for black bears. However, local residents in the Southern Appalachian region were aware that this is a bear food, as evinced by its local appellations, "bear potato" and "bear cabbage." Squawroot grows on roots of several kinds of trees and is especially abundant on dead roots of oaks (Stupka, 1964).

Animal matter constituted only a very small proportion of the spring foods of the black bear. Bears ate only small quantities of beetles and wasps (VIP = 1). Hair from a woodchuck (Marmota monax) was the only other animal remain identified.

Summer Food Habits

Food items found in 281 scat and 2 stomachs for this season are listed in Table 8. During this season herbaceous stems and leaves were eaten less than in the spring (VIP = 17). As fruits matured at lower elevations bears consumed large quantities of blueberries (Vaccinium sp.), huckleberries (Gaylussacia sp.), and blackberries (Rubus sp.). The three above genera composed 39 percent of the summer food volume (VIP = 13 for each genus). Bears continued to feed upon squawroot; it was the most important food item consumed during the summer (VIP = 17).

TABLE 8

VOLUME AND OCCURRENCE OF FOOD IN 281 SCAT AND 2 STOMACHS COLLECTED
FROM THE GREAT SMOKY MOUNTAINS NATIONAL PARK, SUMMER
(JULY 1 TO AUGUST 30), 1970

Food Item	Volume Percent Category					Vol.	Freq.
	100-75	75-50	50-25	25-1	Trace	Index	Index
<u>Plant Remains</u>							
Mainly leaves and stems							
<u>Gramineae</u>	12	1	2	2	-	5	7
Unidentified herbs	15	2	3	4	-	5	7
<u>Ranunculus</u> sp.	4	2	3	6	6	2	7
<u>Galium</u> sp.	1	-	-	1	4	1	2
<u>Aster</u> sp.	3	-	-	-	-	1	1
<u>Amaranthus blitoides</u>	3	-	-	-	-	1	1
<u>Verbena alternifolia</u>	2	-	-	-	-	1	1
<u>Goodyera pubescens</u>	2	-	-	-	-	1	1
<u>Oenothera biennis</u>	1	-	-	-	-	< 1	< 1
<u>Sanguinaria canadensis</u>	1	-	-	-	-	< 1	< 1
<u>Mimosa</u> sp.	1	-	-	-	-	< 1	< 1
<u>Eupatorium</u> sp.	1	1	-	-	-	1	1
<u>Picea rubens</u>	-	-	-	-	1	-	< 1
<u>Pinus rigida</u>	-	-	-	1	-	< 1	< 1
<u>Aronia arbutifolia</u>	-	1	-	-	-	< 1	< 1
<u>Tsuga canadensis</u>	-	-	-	2	1	< 1	1
<u>Brassica arvensis</u>	-	-	-	-	1	-	< 1
Mainly fruits and seeds							
<u>Vaccinium</u> sp.	24	7	11	4	10	13	34
<u>Rubus</u> sp.	27	10	8	13	5	13	25
<u>Conopholis americana</u>	55	3	2	3	2	17	26
<u>Gaylussacia</u> sp.	38	5	7	6	-	13	20
<u>Prunus pennsylvanica</u>	2	1	2	3	-	1	2
<u>Amelanchier</u> sp.	2	-	2	4	2	1	3
<u>Sorbus americana</u>	2	-	-	1	-	1	2
<u>Ribes</u> sp.	2	-	-	-	-	1	1
<u>Nyssa sylvatica</u>	1	1	-	-	-	1	1
<u>Carya</u> sp.	1	1	1	1	-	1	1
<u>Quercus</u> sp.	-	-	2	1	-	< 1	1
<u>Malus</u> sp.	-	-	-	1	2	< 1	1
<u>Betula lenta</u>	-	-	-	-	2	-	< 1
<u>Prunus serotina</u>	-	-	-	2	2	< 1	1

TABLE 8 (continued)

Food Item	Volume Percent Category					Vol.	Freq.
	100-75	75-50	50-25	25-1	Trace	Index	Index
<u>Animal Remains</u>							
Coleoptera	3	-	3	34	29	4	29
Vespidae	1	-	2	10	-	1	5
Formicidae	-	-	-	4	2	< 1	2
Bombidae	-	-	1	6	-	1	2
<u>Marmota monax</u> ^a	1	-	-	-	-	< 1	< 1
<u>Procyon lotor</u> ^a	-	-	-	1	-	< 1	< 1
<u>Didelphis marsupialis</u> ^a	-	-	-	2	-	< 1	< 1
<u>Mephitis mephitis</u> ^a	-	-	-	1	-	< 1	< 1
<u>Sorex</u> sp.	-	-	-	1	-	< 1	< 1
Symphyla (centipedes)	-	-	-	-	1	-	< 1
Crustacea (crayfish)	-	-	-	4	-	< 1	1
<u>Miscellaneous</u>							
Garbage	12	8	13	30	9	9	26
Wood	7	2	2	4	-	3	5
Debris	-	-	-	1	-	< 1	< 1

^a Hair.^b Hair and bones.

Blueberries and blackberries are important bear food items in other parts of North America. Hatler (1967) found black bears fed almost entirely on Vaccinium sp. during the spring. In Montana Tisch (1961) found blueberries to be an important bear food item in the fall (94.3 percent frequency). Blueberries and blackberries are important foods of the black bear also in Pennsylvania (Bennett et al., 1943), Maine (Spencer, 1966), and West Virginia (Cottam et al., 1939). In most studies Vaccinium sp. was eaten more by bears and Rubus sp. eaten less than was found in the GSMNP.

The black bear ate insects in greater quantities in this season (VIP = 6) than during the spring. Most of the above increase was a larger consumption of beetles by bears. However, wasps and bees were also occasionally eaten. Bears also ate more mammals in the summer. Hair and bones of woodchuck, raccoon (Procyon lotor), opossum (Didelphis marsupialis), skunk (Mephitis mephitis), and a small insectivore (probably Sorex sp.) were found.

As increased numbers of people used the campgrounds, trail shelters, and picnic areas, bears consumed more garbage (VIP = 9). The increased availability of garbage also was expressed by the frequency (FIP = 26) that bears ate garbage.

Early Fall Food Habits

Analyses of 239 scat and one stomach collected in this period are presented in Tables 9 and 10. Bears depended highly on the fruits of black cherry (Prunus serotina) in 1969 (VIP = 60). During 1970

TABLE 9

VOLUME AND OCCURRENCE OF FOOD IN 66 SCAT COLLECTED FROM THE GREAT SMOKY
MOUNTAINS NATIONAL PARK, EARLY FALL (SEPTEMBER 1
TO OCTOBER 15), 1969

Food Item	Volume Percent Category					Vol.	Freq.
	100-75	75-50	50-25	25-1	Trace	Index	Index
<u>Plant Remains</u>							
Mainly leaves and stems							
<u>Galium</u> sp.	-	-	-	1	2	< 1	4
<u>Gramineae</u>	1	1	-	1	2	3	8
<u>Ranunculus</u> sp.	1	-	-	1	-	2	3
<u>Parthenocissus</u>							
<u>quinquefolia</u>	-	-	1	-	-	1	2
<u>Aralia</u> sp.	-	-	-	-	1	-	2
Mainly fruits and seeds							
<u>Prunus serotina</u>	43	6	1	1	-	60	77
<u>Quercus</u> sp.	3	-	1	2	1	5	11
<u>Amelanchier</u> sp.	1	1	-	3	-	3	8
<u>Prunus virginiana</u>	2	-	-	1	-	3	5
<u>Prunus pennsylvanica</u>	1	-	1	-	-	2	3
<u>Carya</u> sp.	1	-	-	1	-	2	3
<u>Fagus grandifolia</u>	-	1	1	-	-	2	3
<u>Gaylussacia</u> sp.	-	-	-	1	-	< 1	2
<u>Vaccinium</u> sp.	-	-	-	-	1	-	2
<u>Amaranthus blitoides</u>	1	-	-	-	-	1	2
<u>Lindera benzoin</u>	-	-	1	-	-	1	2
<u>Rubus</u> sp.	-	2	-	2	6	2	12
<u>Animal Remains</u>							
<u>Coleoptera</u>	-	1	-	9	15	4	38
<u>Vespidae</u>	1	-	3	4	1	4	14
<u>Formicidae</u>	-	-	-	4	-	1	12
<u>Hemiptera</u>	-	-	-	-	1	-	2
<u>Sciurus carolinensis</u> ^a	-	-	-	1	-	< 1	2
<u>Cricetidae</u> ^b	-	-	-	1	-	< 1	2
<u>Gastropoda</u> (snail)	-	-	-	-	1	-	2
<u>Miscellaneous</u>							
<u>Garbage</u>	-	-	-	2	6	< 1	12
<u>Debris</u>	-	2	-	2	8	2	15
<u>Wood</u>	-	-	1	1	-	1	3

^aHair.

^bHair and bones.

TABLE 10

VOLUME AND OCCURRENCE OF FOOD IN 173 SCAT AND 1 STOMACH COLLECTED
FROM THE GREAT SMOKY MOUNTAINS NATIONAL PARK, EARLY FALL
(SEPTEMBER 1 TO OCTOBER 15), 1970

Food Item	Volume Percent Category					Vol. Index	Freq. Index
	100-75	75-50	50-25	25-1	Trace		
<u>Plant Remains</u>							
Mainly leaves and stems							
Gramineae	1	4	4	13	-	4	13
Ranunculus sp.	-	-	2	4	2	1	5
Unidentified herbs	2	2	2	4	-	2	6
<u>Tsuga canadensis</u>	-	-	-	1	1	< 1	1
<u>Morus florida</u>	1	-	-	-	-	< 1	1
<u>Cornus alterifolia</u>	-	-	-	1	-	< 1	1
<u>Lindera benzoin</u>	-	-	1	-	-	< 1	1
<u>Ilex opaca</u>	-	-	1	-	-	< 1	1
<u>Myrica</u> sp.	-	-	-	-	2	-	1
<u>Galium</u> sp.	-	-	-	1	-	< 1	1
<u>Malus</u> sp.	-	-	-	1	2	< 1	2
<u>Sassafras albidum</u>	-	-	-	-	1	-	1
Mainly fruits and seeds							
<u>Rubus</u> sp.	32	10	7	11	3	21	35
<u>Quercus</u> sp.	19	5	4	5	3	12	19
<u>Fagus grandifolia</u>	18	1	-	1	1	9	12
<u>Vaccinium</u> sp.	1	7	2	12	3	5	13
<u>Nyssa sylvatica</u>	3	1	2	3	3	3	5
<u>Vitis</u> sp.	4	-	2	4	3	3	8
<u>Gaylussacia</u> sp.	4	3	3	5	1	4	8
<u>Conopholis americana</u>	4	-	-	-	-	2	2
<u>Prunus serotina</u>	6	1	2	1	1	4	6
<u>Prunus pennsylvanica</u>	6	-	-	1	1	3	4
<u>Carya</u> sp.	-	1	2	1	1	1	2
<u>Amelanchier</u> sp.	1	-	-	1	-	1	1
<u>Ilex opaca</u>	-	-	1	3	1	1	2
<u>Malus</u> sp.	1	-	-	2	-	1	2
<u>Lonicera</u> sp.	-	-	-	-	2	< 1	1
<u>Phytolacca americana</u>	-	-	-	1	-	< 1	1
<u>Diospyros virginiana</u>	-	-	-	-	1	< 1	1

TABLE 10 (continued)

Food Item	Volume Percent Category					Vol.	Freq.
	100-75	75-50	50-25	25-1	Trace	Index	Index
<u>Animal Remains</u>							
Coleoptera	1	-	9	50	28	8	51
Vespidae	4	3	1	2	-	3	6
Bombidae	-	-	1	7	-	1	4
Formicidae	-	-	2	4	-	1	2
Diptera	-	-	-	1	-	< 1	1
<u>Ursus americana</u> ^a	1	-	-	-	-	< 1	1
Crustacea (crayfish)	-	-	-	1	1	< 1	1
<u>Didelphis marsupialis</u> ^a	-	-	-	1	-	< 1	1
Cricetidae ^b	-	-	-	1	-	< 1	1
Unidentified hair	-	-	-	1	-	< 1	1
<u>Miscellaneous</u>							
Garbage	9	8	4	10	10	10	20
Wood	1	1	1	1	-	1	2
Debris	-	-	-	-	10	-	6

^a Hair.

^b Hair and bones.

black cherry was not an important food item to black bears (VIP = 4). Black cherry is fairly common in the GSMNP occurring from the lowest altitudes to 5,300 feet. It is listed as a common species in the hemlock forests, cove hardwood, and the northern hardwoods (Shanks, 1954).

The fruits of Prunus in its native habitat are an important food item for black bears. Shadel (1941) in New York stated that bears do considerable damage by bending and breaking limbs and tops of choke-cherry (P. virginiana) and pin cherry (P. pennsylvanica) in search of drupes. In Pennsylvania cherries comprised 52.7 percent by volume of the black bear's summer food (Bennett et al., 1943). During the summer in Maine wild cherry comprised 85 percent of the black bear's food (Spencer, 1966).

Bears consumed large quantities of blackberries (Rubus sp.) (VIP = 35) and blueberries (Vaccinium sp.) (VIP = 13) in 1970. Also, bears began to eat acorns (VIP = 19) and beechnuts (VIP = 12). Several other fruits were eaten early in the season but were absent from the bear's diet by October.

Beetles were still the major animal food eaten by bears (VIP = 4, 1969; VIP = 8, 1970). The peak consumption for the year of insects was during early fall but declined in early October. The cooler weather during this month at higher elevations may have reduced insect availability. Four (different) mammals were eaten by bears--black bear, opossum, red squirrel (Tamiasciurus hudsonicus) and a cricetid rodent.

Hair from Ursus americanus was one of the four mammal remains found in the fall scat collection. This hair could have been from

grooming or from cannibalism. The quantity of hair present suggested cannibalism. Tisch (1961) found one scat with black bear hair. He suggested this was possibly from grooming. Bray and Barnes (1967) documented cannibalism on two occasions. They observed an adult feeding on the remains of a previously killed bear, and on another occasion, two seven-month-old cubs were observed feeding on the carcass of their mother less than five hours after she was killed. Gilbert (1951) reported cannibalism by black bears in Colorado.

Bears fed abundantly on garbage in 1970 (VIP = 10). The VIP of 10 indicated early fall had the highest consumption of garbage than any season during the study period. In 1969 garbage was eaten less by bears (VIP = 1). The numbers of park visitors camping, picnicing, and hiking were approximately equal these two years. Therefore, garbage was probably available in nearly the same quantities. The difference was likely due to the obvious increase of bear activity that was noted in campgrounds and picnic areas during 1970. For example, four bears were trapped in the Cades Cove campground during 1969 while 28 bears were trapped in this area during 1970.

Late Fall Food Habits

A total of 37 scat was collected during late fall (Tables 11 and 12). In 1969 the food habits of the black bear did not change from early fall. Black cherry was still the major food item (VIP = 42) in 1969 while bears fed heavily on acorns (VIP = 41) and beechnuts (VIP = 19) in 1970.

TABLE 11

VOLUME AND OCCURRENCE OF FOOD IN 11 SCAT COLLECTED FROM THE GREAT
SMOKY MOUNTAINS NATIONAL PARK, LATE FALL
(OCTOBER 16 TO HIBERNATION), 1969

Food Item	Volume Percent Category					Vol. Index	Freq. Index
	100-75	75-50	50-25	25-1	Trace		
<u>Plant Remains</u>							
Mainly leaves and stems							
<u>Ranunculus</u> sp.	-	-	1	1	1	6	18
Mainly fruits and seeds							
<u>Prunus serotina</u>	5	-	1	-	-	42	55
<u>Quercus</u> sp.	2	-	-	-	-	15	18
<u>Carya</u> sp.	1	-	-	-	-	8	9
<u>Rubus</u> sp.	-	-	1	1	-	6	18
<u>Prunus virginiana</u>	1	-	-	-	-	8	9
<u>Galium</u> sp.	-	-	-	-	1	-	9
<u>Animal Remains</u>							
Coleoptera	-	-	1	1	2	6	36
<u>Miscellaneous</u>							
Garbage	1	-	-	1	-	9	18
Debris	-	-	-	1	3	1	36

TABLE 12

VOLUME AND OCCURRENCE OF FOOD IN 26 SCAT COLLECTED FROM THE GREAT
SMOKY MOUNTAINS NATIONAL PARK, LATE FALL (OCTOBER 16
TO HIBERNATION), 1970

Food Item	Volume Percent Category					Vol. Index	Freq. Index
	100-75	75-50	50-25	25-1	Trace		
<u>Plant Remains</u>							
Mainly fruits and seeds							
<u>Quercus</u> sp.	12	-	2	1	-	41	58
<u>Fagus grandifolia</u>	4	2	-	-	-	19	23
<u>Nyssa sylvatica</u>	1	-	-	-	-	3	4
<u>Gaylussacia</u> sp.	1	-	-	-	-	3	4
<u>Ilex opaca</u>	1	-	-	-	-	3	4
<u>Vitis</u> sp.	1	-	-	-	-	3	4
<u>Rubus</u> sp.	-	-	-	1	2	1	12
<u>Carya</u> sp.	-	-	-	1	-	1	4
<u>Malus</u> sp.	-	-	-	1	-	1	4
<u>Vaccinium</u> sp.	-	-	-	1	-	1	4
<u>Ranunculus</u> sp.	-	-	-	-	1	-	4
<u>Conopholis americana</u>	-	-	-	-	2	-	8
<u>Animal Remains</u>							
Coleoptera	-	-	-	10	2	8	46
Vespidae	3	-	-	2	-	11	19
<u>Miscellaneous</u>							
Garbage	-	1	1	-	-	4	8
Debris	-	-	-	-	4	-	15
Wood	-	-	-	2	-	2	8

In eastern United States acorns are staple foods of black bears and are consumed in large quantities during the fall and early winter. Acorns were important foods in Maine (Spencer, 1966), Pennsylvania (Bennett et al., 1943), Florida (Harlow, 1961), and West Virginia (Cottam et al., 1939). Black bears were observed eating acorns in oak trees as well as on the ground. One observation was made in which a sow and two cubs remained in a tree eating acorns for 20 minutes before discovering they were being watched. Of the ten species of oak in the GSMNP, white oak (Quercus alba) and red oak (Q. rubra) are probably the most important mast producers for bears. White oak is more abundant than red oak in both the closed oak and open oak and pine associations (Shanks, 1954).

Although not as abundant as acorns, beechnuts were also an important late fall food. The bear's diet included 29 percent beechnuts in Maine during the fall (Spencer, 1966). In Pennsylvania during the winter bears consumed 36.3 percent beechnuts (Bennett et al., 1943).

Acorns might be considered the most critical food item for black bears in the GSMNP. Acorns are palatable to the black bear and have a chemical composition of nearly 20 percent fat (King and McClure, 1944). Most of the fat reserves of the bears are added during the fall when acorns are the important food. Bray and Barnes (1967) reported bears in Colorado averaged a weight increment of 1.16 lb/day during the fall; one adult male gained 162 pounds during the summer and fall.

Acorns (plus hickory nuts and sometimes beechnuts) are the only plentiful foods available during the time of a bear's greatest food

demand. During the spring and summer seasons a large variety of other foods are available to bears in the GSMNP. A failure of one or two food items in these seasons is not critical because of the large number of other food sources available. A failure of oaks to produce acorns apparently causes bears to move more than during a year of a good mast crop. In 1968 when acorns were not available to bears in large quantities, a substantial number of bears were reported outside the Park boundary. The Tennessee Game and Fish Commission reported that a larger than normal number of bears were killed in the vicinity just outside the GSMNP (personal communication, Larry E. Safley, biologist, Tennessee Game and Fish Commission).

Although the total effect of this mast failure was not documented, some indexes indicated the population declined substantially. For example, trapping data from the Cades Cove picnic area indicated the population was reduced following acorn unavailability. Twenty-eight bears were trapped in 1968. In 1969, following the low mast availability, only four bears were trapped. The next year, 1970, 18 bears were trapped in this same area. The last year mentioned (1970) followed a good mast year with an apparent increase in the bear population.

How a lack of food in the fall reduces a black bear population is not known. The obvious possibility is starvation of the adult bears. However, the effect on reproduction is very likely a factor. Implantation of embryos is thought to take place in the winter (December). It is possible the lack of food in 1968 affected implantation and thus lowered the cub crop in 1969. Another possibility is the young embryos

being reabsorbed during the winter or the sow unable to produce enough milk to feed the young after birth. In 1969 only one female was observed with a cub. Stuart Free (1969) observed reproductive synchrony in black bears in New York state. Although he did not correlate this to any cause and effect, a lack of fall food was a likely possibility. Matschke (1964) noted the European wild boar has a complete cessation of reproduction during a oak mast failure. In summary, whatever the cause, oak mast appears to have a substantial effect on a black bear population.

B. ANALYSES OF SCAT AND STOMACHS COLLECTED FROM BEARS
IN NORTH CAROLINA

Results from 53 stomachs and 35 scat collected in North Carolina are given in Tables 13 and 14. The black bear's diet was mostly plant material (VIP = 83). Fruits and seeds comprised the bulk of plant foods, especially in the early and late fall seasons.

The only significant animal constituent consumed by bears was insects. Insects were eaten mostly in the summer and became less important during the later seasons. Mammal remains were occasionally found but accounted for only a small fraction of the black bear's diet.

Garbage was a food item for bears but was not as abundant as in the GSMNP (VIP = 6). Although dump sites were present on some of the North Carolina wildlife management areas, the dumps are not accessible (due to distance) to many bears. In the GSMNP, numerous garbage depots allow most bears to be within six miles of a garbage source.

TABLE 13

FREQUENCY OF OCCURRENCE OF FOOD ITEMS IDENTIFIED IN 53 STOMACHS AND
35 SCAT COLLECTED IN THE NORTH CAROLINA SOUTHERN
APPALACHIAN AREA IN 1969 AND 1970

Items Identified	Summer (15) ^a	Early Fall (35)	Fall (38)	Totals (88)
<u>Plant Remains</u>				
Leaves and stems	8	11	21	15
Fruits and seeds	87	80	95	82
Total plants	87	91	100	97
<u>Animal Remains</u>				
Insects	53	34	18	31
Mammals	13	3	--	3
Other	--	--	--	--
Total animal	66	37	18	34
<u>Miscellaneous</u>				
Garbage	20	11	8	11

^aNumber in parentheses represents number of scat and stomachs collected.

TABLE 14

VOLUME INDEX PERCENT OF FOOD ITEMS IDENTIFIED IN 53 STOMACHS AND
35 SCAT IN THE SOUTHERN APPALACHIAN AREA OF NORTH CAROLINA
IN 1969 AND 1970

Items Identified	Summer (15) ^a	Early Fall (35)	Fall (38)	Totals (88)
<u>Plant Remains</u>				
Leaves and stems	--	3	7	4
Fruits and seeds	55	75	88	75
Total plant	55	78	95	79
<u>Animal Remains</u>				
Insects	22	11	3	10
Mammals	7	3	--	2
Other	--	--	--	--
Other animal	29	14	3	12
<u>Miscellaneous</u>				
Garbage	11	8	2	6
Other (debris, wood)	5	2	--	2

^aNumber in parentheses represents number of scat and stomachs collected.

Summer Food Habits

Results of the 15 scat collected during this season are presented in Table 15. Conopholis americana was the most important food item eaten by bears (VIP = 43). Squawroot was also the most important summer food of bears in the GSMNP. Nyssa sylvatica (blackgum), Rubus sp., and Malus sp. were the other food items consumed by bears during this season.

As was found in the GSMNP, beetles was the major animal food consumed by bears (VIP = 8 and FIP = 40). However, wasps (VIP = 8) and ants (VIP = 7) were also important food items of the black bear. Two mammals, Didelphis marsupialis and a cricetid rodent, were the other animal food items eaten by bears.

Garbage was the other major food item (VIP = 11). Bears ate more garbage during the summer than any other season.

Early Fall Food Habits

A total of 20 scat and 15 stomachs were collected in early fall (Table 16). Acorns and hickory nuts were the main food items eaten by bears (a collective VIP of 40). Conopholis americana was also a major food item of bears during the early fall (VIP = 14).

Wasps were the major animal food eaten by bears (VIP = 7). Beetles and ants were also eaten but were not an important food item to the bear during the early fall. Domestic hog (Sus scrofa) hair was found in one stomach.

TABLE 15

VOLUME AND OCCURRENCE OF FOOD IN 15 SCAT COLLECTED FROM THE SOUTHERN
 APPALACHIAN AREA IN NORTH CAROLINA, SUMMER
 (JULY 1 TO AUGUST 30), 1970

Food Item	Volume Percent Category					Vol. Index	Freq. Index
	100-75	75-50	50-25	25-1	Trace		
<u>Plant Remains</u>							
Mainly fruits and seeds							
<u>Conopholis americana</u>	8	-	-	1	-	43	60
<u>Malus</u> sp.	-	-	-	1	-	1	7
<u>Nyssa sylvatica</u>	-	-	2	1	1	7	27
<u>Rubus</u> sp.	-	1	-	-	-	4	7
<u>Animal Remains</u>							
Coleoptera	1	-	-	2	3	8	40
Vespidae	1	-	1	-	-	8	13
Formicidae	-	1	-	1	-	7	13
Cricetidae ^a	1	-	-	-	-	5	7
<u>Didelphis marsupialis</u> ^b	-	-	-	1	-	1	7
<u>Miscellaneous</u>							
Garbage	1	1	-	1	-	11	20
Debris (wood)	1	-	-	-	-	5	7

^aHair and bones.

^bHair.

TABLE 16

VOLUME AND OCCURRENCE OF FOOD IN 20 SCAT AND 15 STOMACHS COLLECTED
FROM THE SOUTHERN APPALACHIAN AREA IN NORTH CAROLINA,
EARLY FALL (SEPTEMBER 1 TO OCTOBER 15),
1969 AND 1970

Food Item	Volume Percent Category					Vol.	Freq.
	100-75	75-50	50-25	25-1	Trace	Index	Index
<u>Plant Remains</u>							
Mainly leaves and stems							
Gramineae	-	-	-	1	-	1	3
Unidentified herbs	1	-	-	-	2	3	9
Mainly fruits and seeds							
<u>Quercus</u> sp.	7	1	-	2	1	23	31
<u>Carya</u> sp.	6	-	-	-	-	17	17
<u>Conopholis americana</u>	5	-	-	-	-	14	14
<u>Vitis</u> sp.	3	-	-	-	-	8	9
<u>Malus</u> sp.	-	3	1	-	-	7	11
<u>Amaranthus</u> sp.	-	-	-	-	1	-	3
<u>Fagus grandifolia</u>	2	-	-	-	-	6	6
<u>Nyssa sylvatica</u>	-	1	-	-	2	2	9
<u>Animal Remains</u>							
Vespidae	1	-	3	-	-	7	11
Coleoptera	-	-	-	-	4	-	11
Formicidae	-	-	-	2	1	1	9
Diptera (larvae)	-	-	-	-	1	-	3
<u>Sus scrofa</u> ^a	1	-	-	-	-	3	3
<u>Miscellaneous</u>							
Garbage	2	1	1	-	-	12	11
Debris (wood, rocks)	-	-	1	1	-	3	6

^aHair.

Garbage was still consumed by bears during the early fall (VIP = 8). Eight scat were collected at a dump site located on a management area and possibly biased the results. Four of the eight scat collected at the dump contained garbage and accounted for all the garbage identified during the early fall.

Late Fall Food Habits

A listing of the late fall food habits based on examination of 38 stomachs is presented in Table 17. The diet of the black bear was not abruptly changed from early to late fall. Carya sp. (VIP = 35) and Quercus sp. (VIP = 39) were staple food items of the black bear.

Animals and garbage were not major foods consumed during the late fall. Insects were the only animals eaten by bears (VIP = 3). The cooler weather of the late fall probably reduced the availability of insects. Garbage was found in only three stomachs (VIP = 2).

C. ANALYSIS OF CUB SCAT COLLECTED IN THE GREAT SMOKY MOUNTAINS NATIONAL PARK

Six scat from black bear cubs were examined (Table 18). (VIP and FIP were not calculated since the sample size was small.) Cubs relied heavily on herbs as their major food source in the spring. Garbage, insects, and berries were the main foods during the summer and fall. This sample indicated that the cub's (6 to 9 months old) food habits are similar to yearling and adult bears.

TABLE 17

VOLUME AND OCCURRENCE OF FOOD IN 38 STOMACHS COLLECTED FROM THE
SOUTHERN APPALACHIAN AREA IN NORTH CAROLINA, LATE FALL
(OCTOBER 16 TO JANUARY 7), 1969 AND 1970

Food Item	Volume Percent Category					Vol. Index	Freq. Index
	100-75	75-50	50-25	25-1	Trace		
<u>Plant Remains</u>							
Mainly leaves and stems							
Unidentified herbs	1	-	2	2	2	7	18
Mainly fruits and seeds							
<u>Carya</u> sp.	13	1	-	1	1	35	42
<u>Quercus</u> sp.	10	-	-	-	2	29	32
<u>Malus</u> sp.	4	-	-	-	3	12	18
<u>Fagus grandifolia</u>	1	1	-	-	-	5	5
<u>Vitis</u> sp.	2	-	-	-	-	5	5
<u>Tsuga canadensis</u>	-	-	-	1	-	1	3
<u>Nyssa sylvatica</u>	-	-	-	-	1	-	3
<u>Ilex opaca</u>	-	-	-	-	1	-	3
<u>Rosa</u> sp.	-	-	-	-	1	-	3
<u>Animal Remains</u>							
Coleoptera	-	-	-	1	5	1	16
Orthoptera ^a	-	-	-	2	-	1	5
Vespidae	-	-	-	1	-	1	3
<u>Miscellaneous</u>							
Garbage	-	-	-	3	-	2	8
Debris (wood, rocks)	-	-	-	-	5	-	11

^aGrasshoppers.

TABLE 18
FOODS IDENTIFIED IN 6 CUB SCAT COLLECTED IN THE GREAT
SMOKY MOUNTAINS NATIONAL PARK, 1970

Date ^a	Food Item	Percent Volume Index				
		100-75	75-50	50-25	25-1	Trace
6-27-70	Unidentified herbs	1	-	-	-	-
7-11-70	<u>Conopholis americana</u>	1	-	-	-	-
7-13-70	<u>Vaccinium</u> sp.	1	-	-	-	-
	Coleoptera	-	-	-	-	1
	Hymenoptera	-	-	-	-	1
7-25-70	<u>Aster</u> sp.	1	-	-	-	-
8-10-70	Garbage	-	-	1	-	-
	Coleoptera	-	-	1	-	-
	Vespidae	-	-	-	1	-
8-22-70	<u>Rubus</u> sp.	1	-	-	-	-
	<u>Tsuga canadensis</u>	-	-	-	1	-
	Garbage	-	-	-	-	1

^a Each date represents a separate scat.

D. COMPARISON OF STOMACH AND SCAT ANALYSES

Analyses of late fall bear scat (Tables 10 and 11, pages 32 and 36, respectively) and late fall bear stomachs (Table 17, page 47) were compared. Fifteen different food items were identified from the stomach contents. Thirteen of these food items were identified in the scat remains. The high content of hickory nuts (Carya sp.) in the stomachs and its low content in scat remains was the only marked difference. The appearance and volume of hickory nuts is probably not altered significantly in a bear's digestive tract. Therefore, the difference of hickory nut quantity is most likely explained by a greater availability of hickories in the area where the stomachs were collected.

Insects were found in approximately equal quantities in both scat and stomachs (Tables 10, 11, and 17, pages 32, 36, and 47, respectively). This comparison was made in the late fall when insect larvae and eggs are not abundant. These immature insect forms are more abundant during the summer and early fall. Therefore, a better evaluation of the change in volume of insects in the digestive tract of a black bear could be made between scat and stomachs collected during the summer.

In summary, the results of stomach and scat samples were similar. The utility of using scat as a food habit technique of black bears in the fall is supported by this study. A more complete evaluation would require stomach and scat samples collected during all seasons of the year.

E. SIGNIFICANCE OF GARBAGE

In the GSMNP black bears ate garbage frequently (FIP = 20) but not in large quantities (VIP = 6). Since bears depend on people for their garbage source, garbage consumption varied directly with the peak seasons of camping and picnicing (July and August).

Two studies analyzed scat from campgrounds in an attempt to evaluate the importance of this artificial source of food. Bears in Colorado apparently subsisted more on garbage as a food source than bears in the GSMNP. Bray and Barnes (1967) report that 44.4 percent of scat they examined was composed of more than 50 percent garbage. These authors reported on another study conducted in Yellowstone National Park by Murie (1944) in which scat from campgrounds were 10.48 percent garbage. Murie's results were similar to the results of my study.

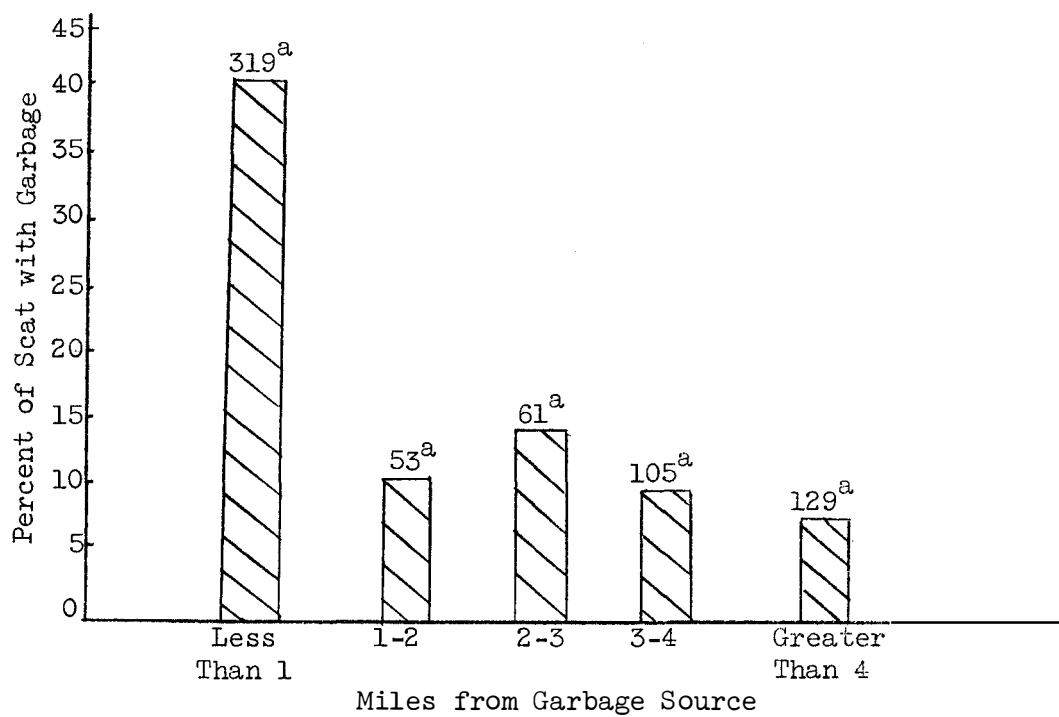
A comparison of scat with garbage and scat without garbage in relation to distance from a garbage source (picnic area, campground, road, trail shelter, or dump) is presented in Table 19 and Figure 4. A trend toward lower frequency of garbage in scat can be noted as distance from a garbage source increases. Slightly more than 41 percent of scat collected more than one mile from a garbage source contained garbage, while 7.8 percent of scat collected less than four miles from a garbage source contained garbage.

All portions of the study in the GSMNP were within six miles of a potential garbage source. On five occasions garbage was found

TABLE 19
 RELATIONSHIP BETWEEN GARBAGE IN SCAT AND DISTANCE FROM
 NEAREST GARBAGE SOURCE IN THE GREAT SMOKY
 MOUNTAINS NATIONAL PARK^a

	Miles from Garbage Source				
	Less Than 1	1-2	2-3	3-4	Greater Than 4
Scat with garbage	131	6	9	10	10
Scat without garbage	188	47	52	95	119
Total scat	319	53	61	105	129
Percent garbage for each category	41.1	11.3	14.8	9.5	7.8

^aAnalyses from a total of 667 scat.



^aNumber of scat collected in each distance interval.

Figure 4. Relationship between garbage in scat and distance from the nearest garbage source in the Great Smoky Mountains National Park.

in scat greater than five miles from a garbage source. The bears either had obtained garbage from a back country hiker or had moved more than five miles during the time required for food to traverse the digestive tract. The above suggested there are no areas on the Tennessee side of the GSMNP which are not frequented by bears which use garbage as a source of food.

CHAPTER V

SUMMARY

A food habit study of the black bear (Ursus americanus) was conducted in the Great Smoky Mountains National Park and adjacent wildlife management areas from June 1969 to December 1970. The major objectives were: to determine seasonal food habits of the black bear; to determine the relationship of seasonal feeding activity to vegetation types present in the Park; and to determine the significance of garbage in the black bear's food habits.

The 800 square miles of mountainous terrain varies from an elevation of 888 to 6,642 feet. Description of the GSMNP was based primarily on the six vegetative associations described by Shanks* (1954) and Cain (1935). Six wildlife management areas in North Carolina are outside the GSMNP but located in similar terrain as the Park.

Nine permanent trails were selected and cleared of bear scat at two-week intervals. Scat were collected off trails, in two campgrounds, and one dump. Four stomach samples and 667 scat were collected from these locations. In addition, 53 stomachs and 35 scat were collected and analyzed from North Carolina wildlife management areas.

Results were presented by frequency of occurrence and an ocular estimate of volume. A volume index percent was calculated so volumes of different food items could be compared.

Scat were grouped into four temporal periods: spring (emergence from hibernation through June 30), summer (July 1 through August 30),

early fall (September 1 through October 15), and late fall (October 16 until snow accumulation inhibited scat collection).

Gramineae and unidentified herbs formed the bulk of spring foods. Amelanchier sp. in 1969 and Conopholis americana in 1970 were the only major seeds identified. Coleoptera and garbage were the other two major food items.

With the maturation of berries, bears started eating Rubus sp., Vaccinium sp., and Gaylussacia sp. Conopolis americana was the fourth most abundant food. Garbage, Gramineae, unidentified herbs, and Coleoptera were the other major foods.

In 1969, fruits of Prunus serotina were the dominant black bear food item in the early fall. In 1970, Rubus sp., Quercus sp., Fagus grandiolia, Coleoptera, and garbage were the top five foods. Fruits of Prunus serotina were only identified in 6 percent of the 1970 scat.

Fruits of Prunus serotina were also the major late fall item in 1969 and Quercus sp. ranked second. In 1970, Quercus sp. and Fagus grandifolia accounted for over half of the black bear diet.

Results of stomachs and scat collected from North Carolina were similar to results found in the Great Smoky Mountains National Park. The only major difference was the abundance of Carya sp. identified in 38 stomachs collected in late fall.

Plant remains were identified in 95 percent of the 671 scat and stomachs from the GSMNP, insects in 46 percent, ~~mammals~~ in 2 percent, and garbage in 20 percent.

Six cub droppings were collected and analyzed. Results indicate that cub food habits closely parallel those of older bears.

Thirty-eight late fall stomachs from North Carolina were compared to 37 late fall scat collected in the GSMNP to test the utility of using scat as a black bear food habits technique. The results suggest scat is a satisfactory technique.

Scat collected in campgrounds and picnic areas has a volume index of 11.2 percent for garbage. Scat less than four miles from a garbage source have a higher frequency of garbage than scat greater than four miles. Since garbage was found in scat collected from the farthest point of a garbage source, a truly "wild" group of black bears may not exist in the Park.

CHAPTER VI

RECOMMENDATIONS

Due to the large study area, the mountainous terrain, the complex vegetational pattern, and insufficient time, this study failed to provide an adequate evaluation of some phases of black bear food habits in the Great Smoky Mountains National Park. For a more complete summary of food habits future research should include the following investigations.

1. Collection of larger sample sizes of scat are needed in the spring and late fall seasons to determine more accurately the importance of various foods during these periods.

2. Fruit production indexes should be determined for Rubus sp., Vaccinium sp., Gaylussacia sp., Conopholis americana, Fagus grandifolia, Quercus sp., and Prunus serotina and compared to food utilization by black bears.

3. A study should be conducted to determine the effects of vegetation succession on availability of food items for the black bear.

4. An intensive study of bear movement in relation to the availability of natural and artificial food sources should be undertaken.

5. A larger sample of stomachs from all seasons is needed to evaluate the utility of scat as a food habit technique for black bears.

6. Further investigations should be carried out to determine any correlation between population density and fluctuation in food abundance (especially fall).

7. Because of the importance of mast as a food source for many wildlife species in the GSMNP, an intensive study needs to be undertaken to evaluate the extent of this indirect competition between black bears and other wildlife species.

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VITA

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