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A COMPUTER SIMULATION OF DIETARY COMPETITION AMONG SEVEN CONSUMERS IN THE GREAT SMOKY MOUNTAINS NATIONAL PARK

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ABSTRACT

Interactive feeding among a group of vertebrates in the Great Smoky Mountains National Park was simulated. Consumer density, biomass production, consumer consumption rates, and seasonal food habits of adults of each species were calculated using field or literature values.

The consumers included the European wild hog, black bear, raccoon, wild turkey, white-tailed deer, three sciurid species, and several rodents. The sciurids and rodents were considered as two respective canonical groups making a total of seven consumer groups. Values of requisite parameters were allowed to vary randomly.

Simulations were run for five years at one-half month intervals with a four-year comparison period. The European wild hog did not compete with the other consumers even when their population was doubled. The sciurids were the major competitors. The black bear was the consumer best able to cope with the vicissitudes of life in the Park; however, all consumers gave evidence of being able to usually find enough to eat by relying on alternate foods.

INTRODUCTION

The European wild hog *(Sus scrofa)* was introduced into the Southern Appalachians in the early 1900's and it was established in the Great Smoky Mountains National Park (GSMNP or Park) by the 1950's (Tennessee Game and Fish Commission 1972). The success of this exotic species has raised fears that it might out-compete the native species in the Park for food, possibly extirpating some.

A simulation model was developed to determine the flow of plant and animal biomass through, and the dietary interaction of, selected vertebrates in the Park. It was hoped that this model would yield insight into the impact of the wild hog on native species. Such models are rare in published literature.

Walters and Bunnell (1971) developed a computer model designed to facilitate land use and big game population management decisions. Their model simulated interactions involving plant produc-

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tion, plant succession, wildlife habitat, food selection, and population dynamics of big game herds. Harris and Francis (1972) modeled interactive feeding among herbivores in an African grasslands community. The model allowed for control of birth rates, death rates, production rates, and competitive shifts in the diet by simulating changes in food quality and quantity. Gilbert (1973) developed a model which utilized seasonal food habits, consumption rates, densities, and plant productivity to simulate interactive feeding among a group of consumers in a Colorado grasslands community.

METHODS

Gilbert's (1973) model was modified and used in this study. Biomass flows are defined in much the same way as the original version of the model (i.e. by using seasonal food habits, consumption rates, population densities, and productivity). The major changes involved adding a random number generator and deleting various wastage flows. The model is data dependent for the Park; thus, the values for the intensity of biomass flows can be adjusted to simulate not only average conditions but conditions of stress (i.e. food shortages, high population densities, etc.)

Description of Study Area

The GSMNP is a 2048 square kilometer area located along the Tennessee-North Carolina border. It includes parts of Haywood and Swain counties in North Carolina and parts of Cocke, Sevier, and Blount counties in Tennessee. U. S. Highway 441 bisects the Park in a northwest-southeast direction and the Appalachian Trail bisects it in a southwest-northeast direction.

The GSMNP is located in the Southern Appalachians. Elevations range from 271 meters where Abrams Creek flows into Chilhowee Lake to 2025 meters atop Clingman's Dome. Narrow ridges, steep-sloped V-shaped valleys, and numerous streams typify the area.

Shanks (1954a) described the climate of the Park as quite variable but characterized generally by cool wet conditions. The lowlands are warmer and drier than the upper elevations. There is an average drop in temperature of 1.23°C for every 305 meters increase in elevation.

Precipitation ranges from 127 cm/year at Park Headquarters (elevation 445 m) to approximately 229 cm/year atop the higher peaks. In general, precipitation increases rapidly with altitude, being 50 percent greater around 1500 m elevation than in the valleys 1000 m below.

Shanks (1954b) lumped the complex vegetative patterns into seven physiognomic types; (i) cove hardwood forests, (ii) closed oak forests, (iii) hemlock forests, (iv) northern hardwood forests, (v) grassy balds, (vi) open oak and pine stands; heath balds, and (vii) spruce-fir forests. These seven types occur in distinct elevational and topographical positions and have relatively distinct associations of important species.

The study area encompassed a 50,588 ha segment of the Park. This section constituted approximately one-quarter of the total Park area and lay south of U. S. Highway 441 and west of the state line. This area is not typical of the rest of the Park, for it includes Cades Cove, a 1012 ha area devoted primarily to pasture. About 1600 head of cattle and a few horses are raised there.

Model Components

The consumers included the European wild hog, black bear *(Ursus americanus)*, white-tailed deer *(Odocoileus virginianus)*, wild turkey *(Meleagris gallapavo)*, gray squirrel *(Sciurus carolinensis)*, eastern chipmunk *(Tamias striatus)*, northern red squirrel *(Tamiasciurus hudsonicus)*, raccoon *(Procyon lotor)*, and various small rodents *(Peromyscus* spp., and *Napaeozapus insignis)*. The rodents and sciurids were placed into two separate canonical classifications to simplify the model. The selection of these species for inclusion in the model was based on their potential for competing for food resources.

The literature provided information on the seasonal food habits of the above consumers. Whenever possible, dietary studies from the Southern Appalachians were utilized. If more than one source was used to determine a seasonal diet, then that diet was computed as a weighted average based on sample size.

The sources used to determine the seasonal diets of the consumers were: wild turkey — Korschgen (1967); raccoon — Schoonover and Marshall (1951), Baker et al. (1945), and Johnson (1970); white-tailed deer — Harlow and Hooper (1971); black bear — Beeman (1971); and the wild hog — Scott (1973).

Information on food habits was not available for all species included in the two canonical groupings. The diet of the canonical sciurid was assumed to be the diet of the gray squirrel based on a study by

Dudderar (1967), since no food habits studies on chipmunk and northern red squirrel were found in which results were expressed on a percentage volume basis. (The modelling required that a combination of foods not make up more than 100 percent of the diet.) Layne (1954) and Graybill (1970) furnished information on northern red squirrel and chipmunk diets respectively indicating their diets were similar to the gray squirrel's diet. It is unrealistic to have the red squirrel and chipmunk diets equal to that of the gray squirrel, but it was assumed justifiable since no attempt was being made to investigate the competitive interactions among these sciurids. The intent was to analyze how these sciurids as a canonical group affected the other species with which they coexisted.

J. O. Whittaker (1963, 1966) reported on the summer food habits of *Peromyscus maniculatus* and *P. leucopus* in New York and Indiana, and Martin et al. (1951) presented general information on the diet of *P. leucopus*. Information on the food habits of small mammals in the Park was presented by Linzey and Linzey (1973). Their results were reported on a percent frequency of occurrence basis which was of no value for the purposes of the model but did provide an idea of what small mammals consume in the Park. Enough information was available from these studies to compute realistic dietary percentages for mast, fungi, and blackberry.

The diets were varied during simulation by including monthly threshold values for each dietary item in the model. The contribution any item made to a consumer's diet fluctuated between zero and this maximum threshold value as food availability changed. The threshold values either came from sources used to compute the diets or from Martin et al. (1951), whichever had the highest value. The European wild hog was the exception to this, and the threshold values for this consumer's diet were taken from Scott (1973) or Henry and Conley (1972), whichever had the highest values.

Densities were varied randomly, assuming a normal distribution, between the minimum and maximum values found in the literature (Table 1). The black bear's density was kept stable because it is believed that they have a stable population in the Park (Pelton, personal communication). The two squirrels and the chipmunk were varied independently of each other.

Comsumption rates in kg dry weight per ha were derived from the literature (Table 1) and kept constant with the exception of the black bear and chipmunk. The chipmunk diet was reduced 85 percent in the winter (Graves, 1971). Bacon (personal communication) found the consumption rate of penned bears increased from late March to Fall. They consumed 32.7 kg dry weight per individual per month in March and in September they consumed 98.1 kg. Assuming this increase was linear, a linear interpolation routine was used to find the consumption rates for April through August. The rates of consumption in October and early November were assumed equal to the rate in September, and the consumption rate was set to zero from mid-November to mid-March to account for the dormant period.

Table 1. Literature Sources for Density and Consumption Rate Values Used in Model.

Consumer	*Density Sources*	*Consumption Rate Sources*
Squirrels	Barkalow *et al.* (1970) Uhlig (1957), Layne (1954), and Kemp and Keith (1970)	Short and Duke (1971)
Chipmunk	Yerger (1953)	(see text)
Canonical Rodent	Mohr (1947 and Terman (1968)	Gilbert (1973)
Wild Turkey	Mosby (1967)	Goodrum *et al.* (1971)
Raccoon	Johnson (1970) and Steuwer (1943)	Knoxville Municipal Zoo
White-tailed Deer	Pelton (personal com.)	Goodrum *et al.* (1971)
Wild Hog	Tenn. Game & Fish Commission (1972)	Conley (personal com.)
Black Bear	Pelton (personal com.)	Bacon (personal com.)

Table 2. Literature sources for net annual production data for foods utilized by consumers.

Foods	*Source(s)*
Honeysuckle *(Lonicera japonica)*	Moore and Strode (1966)
Grasses *(Gramineae)*	R. H. Whittaker (1963, 1966)
Fungi *(Agaricaceae, Boletaceae)*	N/A[a]
Rhododendron *(Rhododendron* spp.)	R. H. Whittaker (1961, 1962, 1963, and 1966)
Mountain Laurel *(Kalmia latifolia)*	R. H. Whittaker (1962, 1963, and 1966)
Wintergreen *(Gaultheria procumbens)*	R. H. Whittaker (1963)
Galax *(Galax aphylla)*	R. H. Whittaker (1963, 1966)
Blueberry Browse *(Vaccinium* spp.)	R. H. Whittaker (1962, 1963, and 1966)
Sheep Sorrel *(Rumex acetosella)*	R. H. Whittaker (1966)
Mast *(Quercus* spp., *Carya* spp., *Aesculus octandra)*	Conley (PC)[b]
Animal	N/A
Garbage	N/A
Roots	Harris *et al.* (1973)
Cherry Fruits *(Prunus* spp.)	Graybill (1970)
Dogwood Fruits *(Cornus florida)*	R. H. Whittaker (1966)
Yellow Poplar Fruits *(Liriodendron tulipifera)*	R. H. Whittaker (1966)
Red Maple Seeds *(Acer rubrum)*	R. H. Whittaker (1966)
Squawroot Fruits *(Conopholis americana)*	N/A
Squawroot Forage	N/A
Apple Fruits *(Malus* spp.)	N/A
Juneberry *(Amelanchier* spp.)	R. H. Whittaker (1966)
Mayapple Fruits *(Podophyllum peltatum)*	R. H. Whittaker (1966)
Yellow Poplar Browse *(Liriodendron tulipifera)*	R. H. Whittaker (1966)
Red Maple Browse *(Acer rubrum)*	R. H. Whittaker (1966)
Oak Browse *(Quercus* spp.)	R. H. Whittaker (1966)
Wild Grape Fruits *(Vitis* spp.)	R. H. Whittaker (1966) and Graybill (1970)
Persimmon *(Diospyros virginiana)*	N/A
Blackberry Fruits *(Rubus* spp.)	R. H. Whittaker (1962, 1963, 1966)
Blueberry Fruits *(Vaccinium* spp.)	R. H. Whittaker (1962, 1963, 1966)
Huckleberry Fruits *(Gaylussacia* spp.)	R. H. Whittaker (1962, 1963, 1966)

Literature sources were available giving annual net production values to kilograms dry weight per hectare for most foods included in the model (Table 2). Where literature sources were lacking reasonable estimates were made. Fungi was the only dietary item of potential competitive importance for which data were lacking. The value of 10 kg dry weight per hectare is probably high but not unreasonable (Clebsch, personal communication). The other foods for which production data were lacking were either not a source of competition (e.g. *Conopholis americanas)* or were known to be present in such small amounts in the Park as to be unimportant in the diet (e.g. garbage).

The production figures were varied annually through use of the random number generator. Browse was varied within 25 percent of the mean, fruits within 50 percent, and mast was allowed to vary between the maximum and minimum values recorded in the study above. The 25 percent and 50 percent values were reasonable estimates of annual variation in production (Clebsch, personal communication).

Consumers were assumed to waste 50 percent as much as they ate and only 75 percent of the biomass available for consumption was assumed to be edible.

The food species were grouped together into seasonal orders and fed into the biomass pool at the appropriate time every simulated year. For example, mast was fed in and renewed every September, deciduous browse and grasses were fed in during the spring, and various fruits during the summer. Those species which were present only a few months every year (e.g. summer berries) were zeroed out at the appropriate time. These seasonal orders were realistic (Clebsch, personal communication).

Model Implementation

The model was implemented on the SIMCOMP 2.1 programming system (Gustafson and Innis 1973). SIMCOMP was chosen because it has the capability of defining 300 flows among 99 state variables, consolidated declaration of parameters permitting communications among subprograms, graphical and tabular output, and it allows the user to define any functions and subroutines needed.

A box and arrow diagram (Figs. 1 and 2) aided in the initial formalization of the model. The symbols used follow Forrester (1971) and Weins and Innis (1974). The solid arrows indicate flows of biomass and the dashed arrows indicate flows of information. The circles function as input variables and the five-sided figures are control variables. The valve shaped symbol represents a rate control. The activity blocks are not Forrester symbols but were necessary to depict the working of the model in as concise a form as possible.

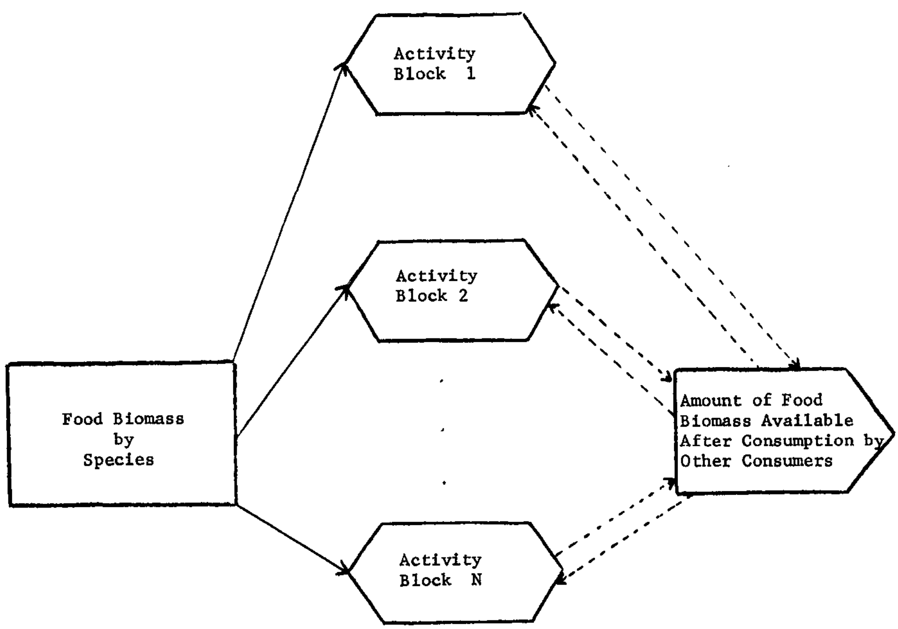

Figure 1. Box and arrow diagram showing flow of biomass to consumers. Each activity block represents one consumer.

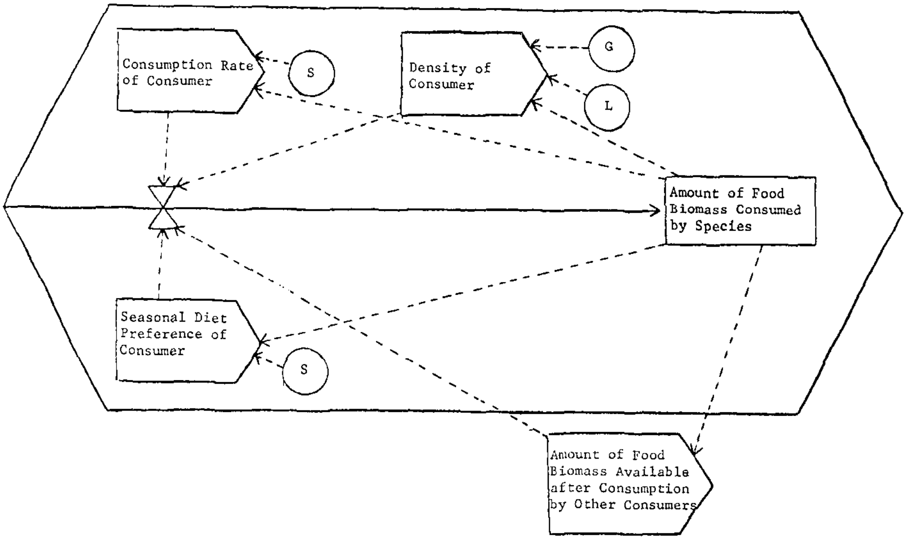

Figure 2. Expansion of activity block from Fig. 1. The flow of biomas into one consumer and the parameters controlling the rate of flow are shown. (S-Season; G-Gain; L-Loss)

The flow chart in Fig. 3 is a schematic representation of how the simulation program functioned. If there was insufficient biomass of a particular food item to satisfy the diet of a consumer, then the percentages the other foods comprised in the diet were redistributed. A Spearman's rank correlation was then performed on the rank of the foods in the redistributed diet versus the rank in the original diet. In addition, the percentages the food comprised in the original diet were subtracted from the percentages those foods comprised in the redistributed diet and all changes (both increases and decreases respectively) greater than 3 percent were accounted for. Three percent was chosen because Gilbert (1973) determined that it allowed for some variation in the diets while remaining sensitive to significant changes. Increases mean that a food was abundant and decreases imply that a food was scarce.

Simulation Period and Timestep

Biomass flows were simulated for 5 years. The first month of a simulated year was assumed to be September because this simplified the manner in which the production values were updated annually. The entire annual net production of a food item was fed into the biomas pool the first month in which that item became available. The consumers were then assumed to feed from this biomass until they had consumed all of it or until it was no longer seasonally available, at which time any remaining biomass of that particular item was removed from the model. In those cases where a food item was assumed to be present for the entire year, the food was never removed except by overconsumption. All foods were renewed every twelve months, though at different times, throughout the year. Those food items which were available for consumption in the late summer-early fall period overlapped the ending and beginning of a simulated year. Rather than guessing how much biomass of these foods was available the first September, no biomass of any given food item was made available the first year until the season of production of that food item was reached. The start of the second year was chosen as the start of the actual feeding period and biomass flows and dietary changes were analyzed for the latter four years of the five year simulation. In all simulations run, the first year was kept the same to provide a common starting point for comparison purposes.

The model was conceptualized on a monthly basis, but a monthly timestep was found to be unsatisfactory for simulation (Gilbert, 1973). Gilbert tried several different time intervals and determined that a two-week simulation timestep represented his feeding regime more precisely. A two-week timestep was chosen for this study.

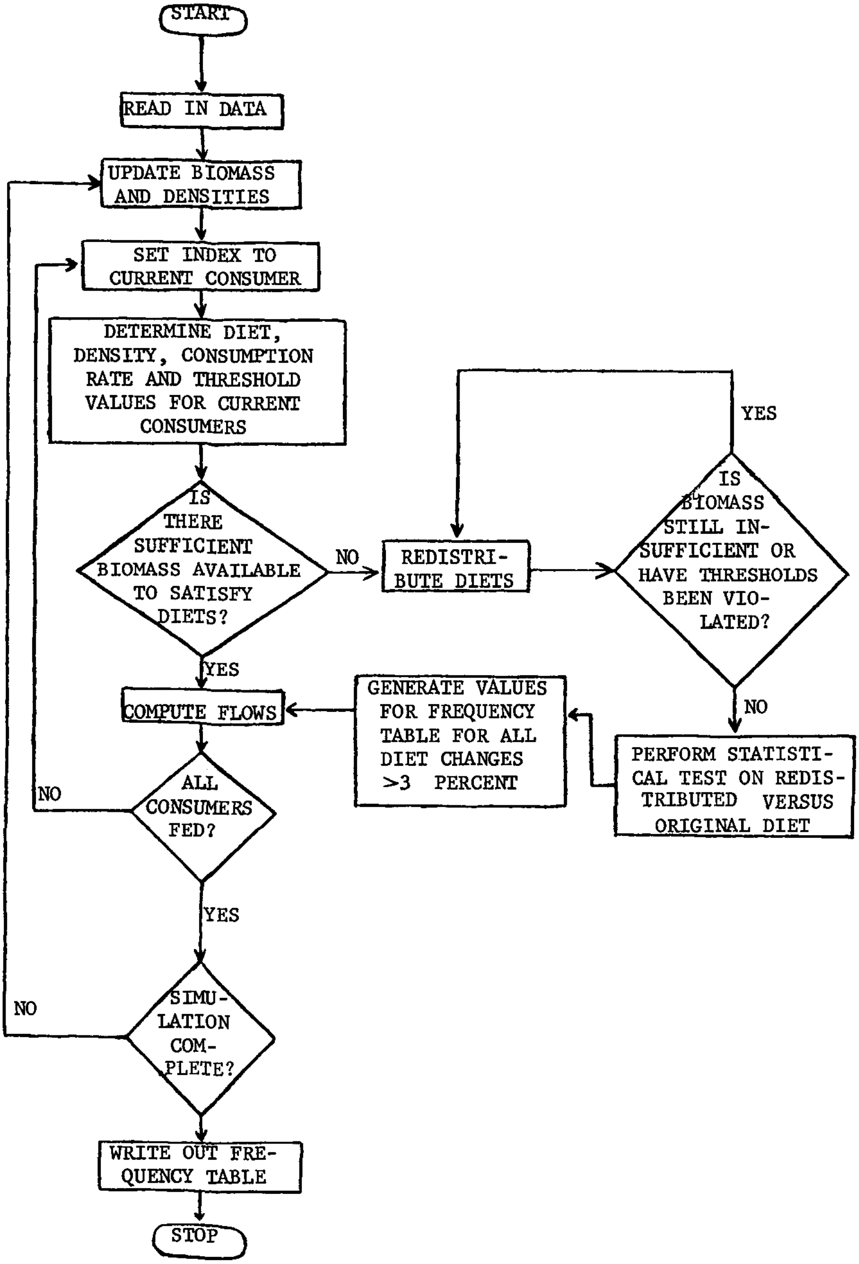

Figure 3. Flowchart of computer program of dietary competition in the Great Smoky Mountains National Park.

It was not possible to simulate a feeding regime in which the consumers fed simultaneously from the available biomass. Instead, a consecutive feeding order was established, and an investigation made into whether different feeding orders yielded different results was needed. The original feeding order was wild turkey, European wild hog, black bear, sciurids, white-tailed deer, canonical rodent, and raccoon. To determine if feeding the consumers in different orders affected the output of the model significantly, four simulations with the original feeding order and three randomly chosen orders were run. No significant differences were found and the original order was kept for all subsequent simulations.

A series of simulations was run to assess the impact of the European wild hog and the sciurids on the Park ecosystem. In the first simulation all food production and consumer density values were chosen randomly. In subsequent simulations wild hog density and sciurid density values were manipulated. High hog densities were simulated by doubling the randomly chosen hog numbers, and low hog densities were simulated by assuming no hogs were present in the Park. High sciurid densities (37 sciurids/ha) were simulated by assuming they were present at the maximum allowable density for the second and third year of the four year comparison period. Low sciurid densities (1.5 sciurids/ha) were simulated similarly. Those runs in which all food production values were determined randomly were considered to be simulations of "average" food availability conditions.

It is not unknown in the Southern Appalachians to have two consecutive poor mast years preceded by and followed by good to excellent years. Since mast is a crucial dietary component of all consumers' diets in the model a series of simulations was run to investigate the hog and sciurid impact on other consumers under these simulated conditions of mast availability. The first simulation of this set varied mast experimentally with all other food production values and all density values varied randomly. A good mast crop (100 kg/ha), two poor mast crops (17 kg/ha), and an excellent mast crop (120 kg/ha) were simulated in the manner described. High and low hog and sciurid densities under these mast conditions were then simulated in the manner described.

Table 3. Frequency of changes in diets of consumers at different simulated wild hog densities. Changes in wild hog diet are not included. Values are from simulation in which production and density values were varied randomly.

	Normal Hogs		*No Hogs*		*Hogs 2× Normal*	
Food Species	*Increase*	*Decrease*	*Increase*	*Decrease*	*Increase*	*Decrease*
Grasses and Sedges	76	0	74	0	77	0
Fungi	17	144	17	144	17	144
Rhododendron	15	0	15	0	15	0
Mountain Laurel	16	0	15	0	16	0
Galax	16	0	16	0	16	0
Mast	124	198	127	194	122	205
Animal	111	0	109	0	113	0
Roots	18	0	18	0	18	0
Cherry	0	20	0	20	0	20
Yellow Poplar Fruits	0	16	0	16	0	16
Red Maple Seeds	0	20	0	20	0	20
Squawroot Forage	0	15	0	15	0	15
Apple	0	23	0	23	0	23
Juneberry	0	23	0	23	0	23
Mayapple	0	23	0	23	0	23
Yellow Poplar Browse	0	20	0	20	0	20
Wild Grape	0	118	0	118	0	118
Persimmon	0	55	0	55	0	55
Blackberry	0	16	0	16	0	16
Blueberry	16	0	16	0	16	0
Huckleberry	0	8	0	8	0	8
TOTAL	409	699	407	695	410	706

RESULTS

Manipulating Wild Hog Density

Simulations in which wild hog density were experimentally manipulated showed that the total number of increases in the diets of the consumers greater than 3 percent was roughly equal (Table 3). In the simulation where all density and production values were varied randomly the number of increases was 407 and when hog density was doubled the number of increases was 410.

The number of increases exhibited by foods on an individual basis was also roughly equal. Mast showed the greatest difference between simulations with 124 increases for average hog densities, 127 for no hogs, and 122 for doubled hog densities. The number of increases in mast decreased as hog density rose. Grasses and sedges, rhododendron, mountain laurel, galax, and animal foods all showed differences between simulations with the general trend being for the number of increases for these foods to increase as hog density rose. The other foods showed no difference.

The number of decreases in the diets did not differ much regardless of simulated hog density (Table 3). The number of decreases shown in Table 3 is for six consumers with the wild hog excluded. This was done to allow direct comparison within Table 4.

Mast showed 198 decreases under average conditions, 194 when no hogs were present, and 205 when hog density was doubled. The number of decreases for the other foods did not change with changing hog density.

The amount of mast biomass consumed by black bear and white-tailed deer did not change in response to changing hog density (Figs. 4-6). Regardless of hog density the black bear always consumed a maximum of about 0.2 kg/ha and the deer consumed a maximum of about .4 kg/ha. The number of significant changes as determined by Spearman's rank correlation analysis were always roughly equal (around 75) regardless of hog density.

Manipulating Sciurid Density

The sciurids consumed large amounts of mast necessitating many changes in the diets of the other consumers (Table 4). The total number of increases in the diet greater than 3 percent occurring under low sciurid densities (1.5 sciurids/ha) was lower than those occurring under high sciurid densities (37 sciurids/ha). When all production values were chosen randomly there was a total of 381 decreases under low sciurid densities, and 435 increases in the simulation of high sciurid densities. In the simulation in which mast was experimentally manipulated there were 373 increases under low sciurid densities and 400 increases under high sciurid densities. There were 669 decreases and 903 decreases respectively for the simulations of low and high sciurid density and average production values, and 657 and 843 decreases respectively for the simulations of low and high sciurid density with mast experimentally manipulated (Table 4).

Many foods were affected by the change in sciurid density with mast, fungi, grasses and sedges, and animal foods being affected the most. The general trend was for mast and fungi consumption to decrease as sciurid density increased and the consumption of other foods listed above to increase as sciurid density increased. Mast consumption by all consumers was particularly affected by the change in sciurid density. A total of 181 decreases in mast consumption greater than 3 percent occurred when low sciurid densities and average production values were simulated versus 326 decreases in mast consumption under the same production values and high sciurid densities.

DISCUSSION

Mast is the key food in the diets of the consumers and is the focal point for any dietary competition which might occur. Matschke (1964) has reported on the importance of mast for the reproductive success of the wild hog, and Scott (1973) and Henry and Conley (1972) have shown the importance of mast in the hog's diet. Black bears use mast in the fall to help lay down the layer of fat required for their winter dormancy. Mast is vital for the growth and reproductive performance of white-tailed deer (Harlow and Tyson 1959), and wild turkey, raccoon, and sciurids are extremely dependent on this source of food as verified by the food habits studies conducted on them. Although quantitative examination of rodent food habits has yet to be done on a large scale seasonal basis in the South, the importance of mast to various rodents is evident. Hamilton (1941) reported finding nearly 2 liters of nuts (beech) stored by a pair of *Peromyscus*. Wildlife managers have long accepted the importance of mast to such species as deer, turkey, and squirrels (Goodrum et al. 1971 and Shaw 1971).

In the model, mast was abundant from September to November but sometimes remained abundant until December. The length of time was dependent on the size of the mast crop, but even in excellent years (120 kg/ha) mast was not abundant enough to satisfy the demands of the consumers on

Table 4. Frequency of changes in diets of consumers under different simulated sciurid densities.

	Normal Simulation				*Mast Experimentally Manipulated*			
	Low Sciurid		*High Sciurid*		*Low Sciurid*		*High Sciurid*	
Food Species	*Increase*	*Decrease*	*Increase*	*Decrease*	*Increase*	*Decrease*	*Increase*	*Decrease*
Grasses and Sedges	67	0	96	0	65	0	80	0
Fungi	17	97	16	178	15	94	10	178
Rhododendron	13	0	16	0	11	0	15	0
Mountain Laurel	11	0	22	0	9	0	15	0
Galax	11	0	22	0	9	0	15	0
Mast	132	181	88	326	139	169	114	266
Animal	97	0	134	0	92	0	114	0
Roots	17	0	24	0	16	0	18	0
Cherry	0	20	0	20	0	20	0	20
Yellow Poplar Fruits	0	16	0	16	0	16	0	16
Red Maple Seeds	1	15	0	23	2	18	0	23
Squawroot Forage	0	15	0	15	0	15	0	15
Apple	0	46	0	46	0	46	0	46
Juneberry	0	23	0	23	0	23	0	23
Mayapple	0	23	0	23	0	23	0	23
Yellow Poplar Browse	0	20	0	20	0	20	0	20
Wild Grape	0	118	0	118	0	118	0	118
Persimmon	0	55	0	55	0	55	0	55
Blackberry	0	16	0	16	0	16	0	16
Blueberry	15	8	17	8	15	8	19	8
Huckleberry	0	16	0	16	0	16	0	16
TOTAL	381	669	435	903	373	657	400	843

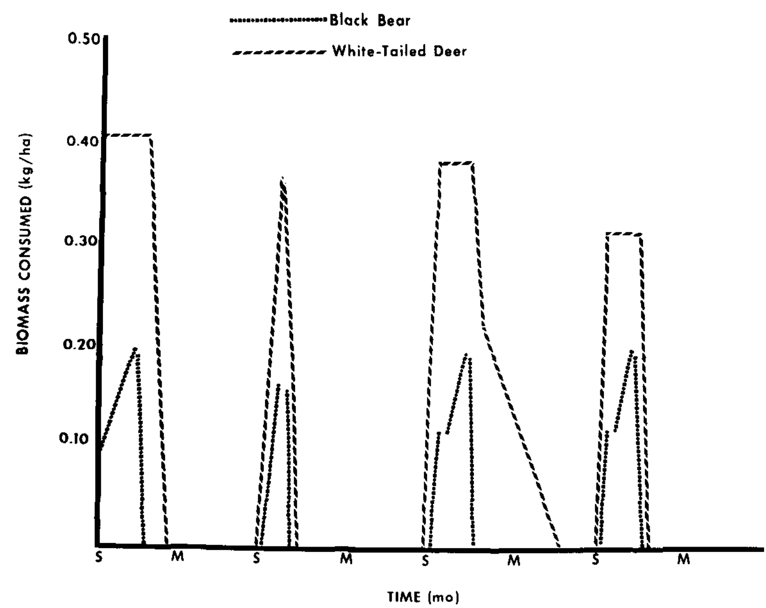

Figure 4. Flow of mast through black bear and white-tailed deer. Hog density was set to zero. (S-September, M-March)

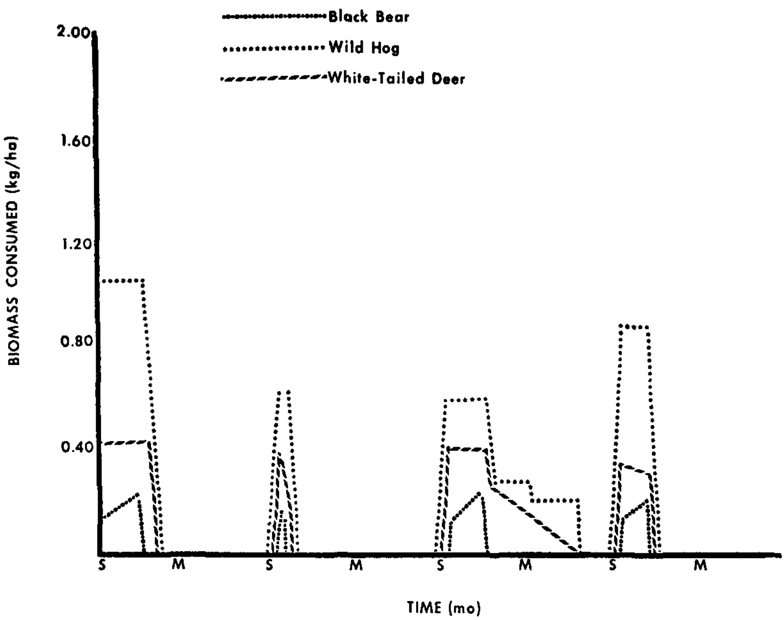

Figure 5. Flow of mast through black bear, wild hog, and white-tailed deer. Hog density was twice normal. (S-September, M-March)

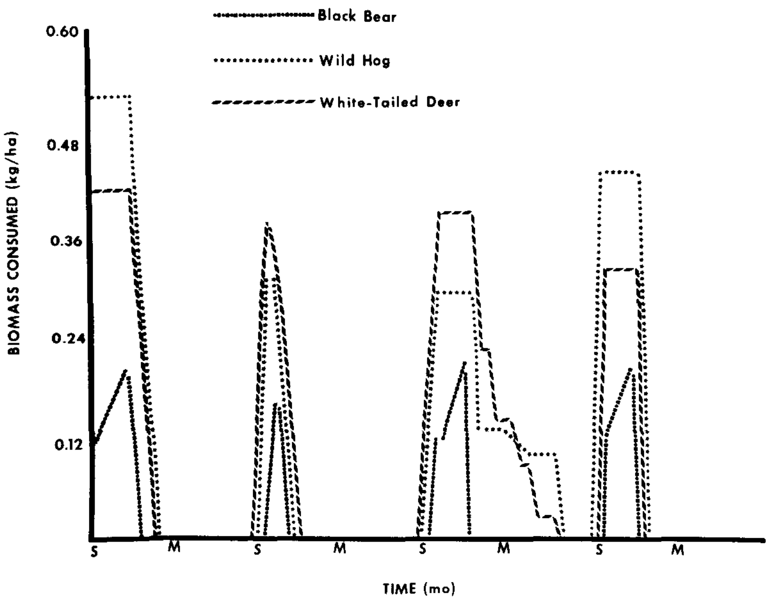

Figure 6. Flow of mast through black bear, wild hog, and white-tailed deer. All production and density values chosen randomly. (S-September, M-March)

an annual basis. The scarcity of mast resulted in dietary shifts to compensate for the shortages. Most consumers compensated, or attempted to compensate, by turning to alternate foods.

The results of simulations in which hog density was experimentally manipulated indicate the hog is not an important competitor for food. The number of increases and decreases greater than 3 percent, the number of significant dietary changes as determined by analysis of Spearman's rank correlation coefficient, and the biomass consumed by the other consumers remained roughly the same regardless of hog density.

High sciurid densities were detrimental to the other consumers, and sciurids proved to be the key to competition in the Park. The sciurids clearly consumed most of the mast in the model, but their effect may have been overestimated. The model failed to account for arboreal feeding possibly resulting in greater sciurid competition than possibly exists. The mast estimates used were corrected for arboreal feeding, and squirrels are known to get part of their mast requirements in this manner. Even though this placed more stress on the Park ecosystem than may actually exist, it does not invalidate the conclusions. If less stress is being applied by the sciurids, then more food is available. If the wild hog is not a factor in the model under conditions of abnormal stress it surely is not a factor under conditions of less stress. In addition, another assumption may have served to offset the increased sciurid competition in the model. No estimates were available on the amount of mast stored by sciurids and rodents. It was assumed that none was stored and it is probable that this assumption offsets the assumptions of no arboreal feeding, although how much is not known.

The black bear was harmed the least by sciurid competition, and the white-tailed deer the most, with raccoon, turkey, and hog all being affected equally as shown by the differences in the number of decreases occurring in the diets greater than 3 percent.

This model has solved no problems nor settled any issues. It has been the first attempt to investigate interactive feeding in the Great Smoky Mountains National Park. Currently, a great deal of work is being done by many people in the development of a management plan for the Park. The management of wildlife is an important component of that plan. If wildlife is to be managed wisely then those factors which significantly affect it must be known. This model has been a crude attempt to do that, and the results indicate that this way of viewing interactive feeding in the Park has promise as a management tool. The model has indicated gaps in knowledge, gaps that must be filled if wildlife in the Park is to be managed in a manner which will provide the greatest benefit to citizens and wildlife.

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