# WOODY VEGETATION AS FOOD ITEMS FOR SOUTH CAROLINA COASTAL PLAIN BEAVER[a]

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*Abstract:* Feeding strategies of the beaver (*Castor canadensis*) were investigated on the Savannah River Plant in the Upper Coastal Plain region of South Carolina. Three beaver colonies, comprising 4 ponds, were selected. Feeding by beavers upon woody vegetation was monitored monthly. Sweetgum (*Liquidambar styraciflua*) was the most important woody species for the beaver. Stems 2.5 - 5.0 cm diameter stump high and stems located within the water were preferentially selected. Selection of woody vegetation decreased during spring and summer months and increased during winter months. One pond was deserted apparently because of a shortage of preferred food items within the normal foraging area.

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The beaver presently occurs in 28 of 46 counties in South Carolina (Woodward et al. 1976). Although these beaver produce suitable habitat for many wildlife species, they also conflict directly with the economic interests of man. Inundation of land and resulting destruction of timber and agricultural crops are major problems of beaver habitation. In 1974 alone, damage to timber and domestic crops exceeded benefits by more than 225 thousand dollars.

Woodward et al. (1976) and Woodward (1977) studied the biology and economic impact of beaver in South Carolina; however, with the exception of status, this research was restricted to the Piedmont region. Extensive research from other regions of the state is needed to provide a basis for assessment of beaver - man interactions and for formulation and implementation of a beaver management program. Therefore, the objective of this study was to determine the feeding strategies of beaver upon woody vegetation in the Upper Coastal Plain of South Carolina.

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## MATERIALS AND METHODS

The study was conducted on the Savannah River Plant (SRP), a 750 $km^2$ reservation, occupying portions of Aiken, Allendale and Barnwell Counties of South Carolina. Three beaver colonies were selected according to the following criteria: (1) accessibility, (2) representativeness of pond types, (3) evidence of feeding activity and (4) habitation.

Colony A consisted of 2 adjacent ponds containing approximately 5 beavers. The older pond (A1) was a 0.8 ha artificial impoundment with a mean depth of 1.3 m. The water level was controlled by a man-made dam utilizing an overflow structure. Very little

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woody vegetation was present within the water; however, herbaceous aquatic vegetation was abundant during the summer.

The second pond (A2), constructed by the beaver during the third month of the study, was located 30 m upstream from pond A1. This pond was 0.4 ha in size and had a mean depth of 0.6 m. The vegetation within the water was largely bottomland hardwoods. In contrast to pond A1, very little aquatic vegetation was present.

Colony B consisted of 1 pond (B) encompassing an area of 1.5 ha. The water was impounded to a mean depth of 0.8 m by a beaver dam constructed 3 months prior to the study. The population consisted of 2 beavers that had apparently emigrated from older ponds some distance downstream. The vegetation consisted of large bottomland hardwoods located within the water. Again, there had been little development of aquatic vegetation.

Colony C consisted of 1 pond (C) which was 1.5 ha in size. The water was impounded to a mean depth of 0.6 m by a rather extensive beaver dam. Observations of annual rings of live trees within the water indicated that this pond was approximately 10 years old. Almost all woody vegetation, with the exception of certain water tolerant species, was dead. Development of aquatic vegetation was extensive in this pond.

Feeding activity at the selected colonies appeared to be evenly distributed within the water and within 10 m of the water's edge; therefore, a 100% sample of woody plant species was taken for each pond. In order to avoid confounding of data, the stumps of all stems previously utilized were painted during the last week of July 1976. During the first week of each month from September 1976 to August 1977 ponds were sampled and feeding activity was recorded. Data collected during the first week of each month represented feeding that had occurred during the previous month; therefore data of this study included August 1976 through July 1977. Species, diameter at stump height (dsh), distance from the water and type of selection (cut, girdled or barked) were recorded for each stem selected greater than 2.5 cm dsh. Each selected stem sampled was marked to avoid sampling a second time. For the purposes of this study it was assumed that girdling or barking of a tree represented feeding upon that tree.

During August 1977 the remaining (nonselected) stems in the water and within 10m of the water's edge were measured and recorded. The addition of the selected and nonselected stems yielded the total number of stems by species at the beginning of the study period.

The stems present at each pond site were stratified by species, dsh (2.5 cm classes) (Table 1) and distance from the water (1 m intervals) (Table 2). Because selection had not occurred in every distance class, it was necessary to determine for each pond a selection area in which the beaver had actively fed. The selection area was composed of the stems in distance class 0 plus each consecutive distance class in which at least 2% of the total selection had occurred (Fig. 1). This selection area technique reduced the number of available stems greatly, yet reduced the number of selected stems by a small quantity. Thus, only those stems within the selection area were used for analysis of species, size class and distance class selection. A value index (VI) was computed following Chabreck (1958) for each species size class and distance class. The VI was calculated by multiplying the percentage of total stems in each class by the percentage selection of stems in each class. An importance rating (IR) was assigned to each class based upon the magnitude of the VI. A VI of 501-10,000 received an IR of high, a VI of 101-500 received an IR of moderate and a VI of 1-100 received an IR of low.

Chi square goodness of fit tests (Roscoe 1975) were used to determine if feeding upon species, size classes and distance classes was random or nonrandom.

If feeding was determined to be nonrandom, a chi square value (one variable goodness of fit test; Roscoe 1975) was calculated for each species, size and distance class. If a particular species, size class and/or distance class was selected significantly more than

TABLE 1. Size classes and their respective class intervals for stems measured at beaver ponds on the SRP, September 1976 to August 1977.

| Size Class | DSH[a] (cm) | DSH[a] (in) |
|---|---|---|
| 1 | 2.5- 5.0 | 1- 2 |
| 2 | 5.1- 7.5 | 2- 3 |
| 3 | 7.6-10.1 | 3- 4 |
| 4 | 10.2-12.6 | 4- 5 |
| 5 | 12.7-15.1 | 5- 6 |
| 6 | 15.2-17.7 | 6- 7 |
| 7 | 17.8-20.2 | 7- 8 |
| 8 | 20.3-22.8 | 8- 9 |
| 9 | 22.9-25.3 | 9-10 |
| 10 | 25.4-27.8 | 10-11 |
| 11 | 26.9-30.4 | 11-12 |
| 12 | 30.5-32.9 | 12-13 |
| 13 | 33.0-35.5 | 13-14 |
| 14 | 35.6-37.9 | 14-15 |
| 15 | 38.0-40.5 | 15-16 |
| 16 | 40.6-43.1 | 16.17 |
| 17 | 43.2-45.6 | 17-18 |
| 18 | 45.7-48.2 | 18-19 |
| 19 | 48.3-50.7 | 19-20 |
| 20 | 50.8+ | 20+ |

[a]Diameter Stump Height

TABLE 2. Distance classes and their location for stems measured at beaver ponds on SRP.

| Distance Class | Distance from the Water Increments (m) |
|---|---|
| 0 | Within the Water |
| 1 | 0-1 |
| 2 | 1-2 |
| 3 | 2-3 |
| 4 | 3-4 |
| 5 | 4-5 |
| 6 | 5-6 |
| 7 | 6-7 |
| 8 | 7-8 |
| 9 | 8-9 |
| 10 | 9-10 |

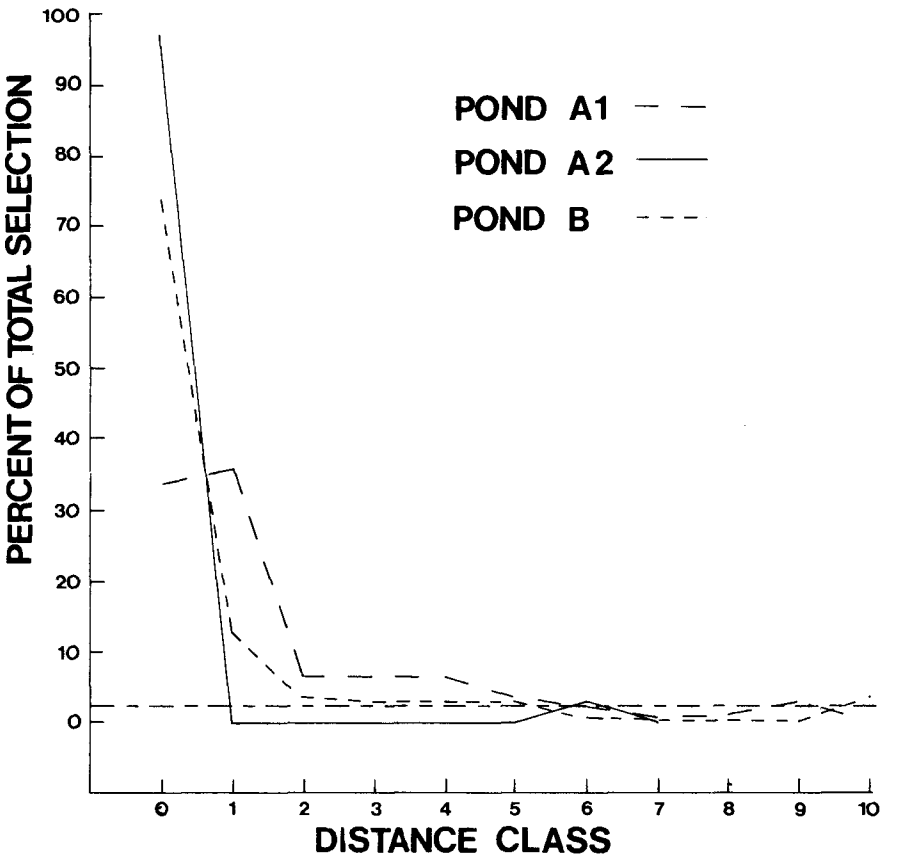


Fig. 1. Percent of total stem selection by distance class at three beaver ponds located on the Savannah River Plant, August 1976 to July 1977. Horizontal dashed line represents the two percent cutoff level for determination of selection area.

expected, it was interpreted to mean beaver preferred that class over other classes. All significance mentioned in this text indicates significance at the 1% level.

## RESULTS

### Monthly Selection

The cutting of woody vegetation rose sharply during the winter months at colony A. (Fig. 2). The lowest monthly total occurred in May when only 7 stems were cut. November and January had the highest totals with 66 and 62 stems, respectively.

Colony B also showed an increase in cutting of woody vegetation although not as distinct as in colony A. The highest occurred in December when 16 stems were cut and the lowest occurred in June and August when 8 stems were cut.

### Species Selection

Pond A1-25 plant species were observed within distance classes 0-6 at pond A1 (Table 3). Eleven (44%) of these were selected by beaver. Sweetgum (*Liquidambar styraciflua*), water oak (*Quercus nigra*), speckled alder (*Alnus serrulata*) and red maple (*Acer rubrum*)

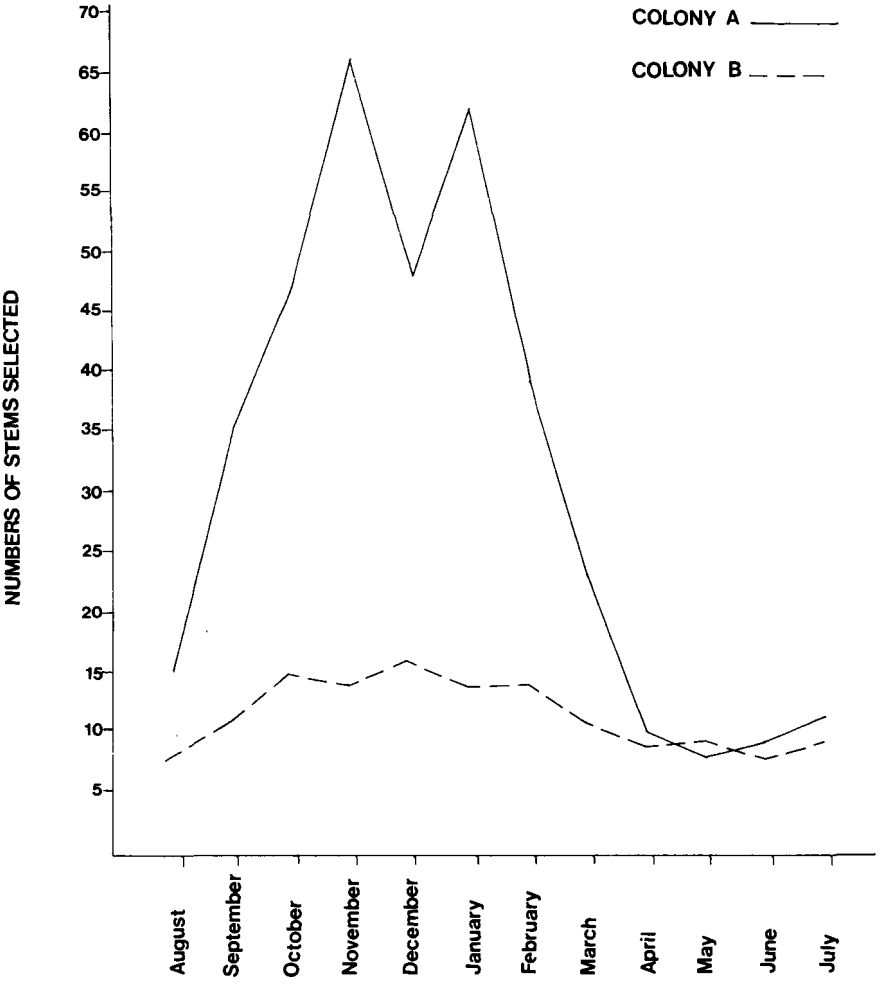


Fig. 2. Montly selection of woody stems at two beaver colonies on the Savannah River Plant from August 1976 to July 1977.

comprised 77.3% of available stems and accounted for 81.7% of those selected. Sweetgum was the most important species present with a VI of 1205. Water oak, speckled alder, red maple, wax myrtle (*Myrica cerifera*) and loblolly pine (*Pinus taeda*) were of moderate importance with VI's ranging from 124-410. Remaining species yielded low or no VI's. Selection of stems among species by beaver at pond A1 was nonrandom. Sweetgum was used more than expected while water oak, black willow (*Salix nigra*) and black cherry (*Prunus serotina*) were utilized less than expected.

Pond A2-16 species were present within distance class 0 at pond A2. Ten of these species (62.5%) were selected. Sweetgum and red maple were the most important species with VI's of 1233 and 790, respectively. Sweet bay (*Magnolia virginiana*) was the only species of moderate importance (VI = 230). Plant species selection at pond A2 was also nonrandom. Red maple was the only species which was selected more than expected. The "other species" class which was selected more than expected, was due to the high percent

TABLE 3. Value indices and importance ratings for woody species selected by beaver at three ponds on the SRP, August 1976 to July 1977.

| Common Name | Pond A1 | | Pond A2 | | Pond B | |
|---|---|---|---|---|---|---|
| | Value Index[a] | Importance Rating[b] | Value Index | Importance Rating | Value Index | Importance Rating |
| Sweetgum | 1205 | High | 1233 | High | 636 | High |
| Red Maple | 273 | Moderate | 790 | High | - | - |
| Water Oak | 410 | Moderate | - | - | - | - |
| Speckled Alder | 323 | Moderate | - | - | 200 | Moderate |
| Wax Myrtle | 174 | Moderate | - | - | - | - |
| Loblolly Pine | 124 | Moderate | - | - | - | - |
| Sweet Bay | - | - | 230 | Moderate | 400 | Moderate |
| Water Ash | - | - | - | - | 327 | Moderate |
| Black Gum | - | - | - | - | 309 | Moderate |
| Flowering Dogwood | - | - | - | - | 109 | Moderate |

[a]Value Index (VI): % of total stems available times % of stems selected per class (Chabreck 1958).
[b]Importance Rating: high = 501+; moderate = 101-400; low = 1-100.

selection of the following species which had a low stem availability: sweet bay, holly (*Ilex opaca*), flowering dogwood (*Cornus florida*) and magnolia (*Magnolia grandiflora*).

Pond B-A value index of 636 for sweetgum indicated that this species was the most important species at pond B. Of 19 plant species present at this pond, 15 (78.9%) were selected. Sweet bay, water ash (*Fraxinus caroliniana*), black gum (*Nyssa sylvatica*), speckled alder and flowering dogwood were of moderate importance with VI's ranging from 109-400. Remaining species were of little or no importance. Plant species selection at pond B was nonrandom with sweetgum selected more than expected and holly selected less than expected. Selection of remaining species was random.

Size Class Selection

Pond A1-Size classes 1-4 comprised 68.4% of the available stems and 74.8% of the selected stems at pond A1. The stems in size class 1 were the most important with a VI of 1118 (Table 4). The stems in size classes 2-6 were of moderate importance (137 to 447) with the remaining size classes (7-20) of little or no importance to beaver. The chi square goodness of fit test revealed that the use of size classes at pond A1 was nonrandom. Stems in size class 1 were selected more than expected and those in size class 4 were selected less than expected. Selection among the remaining size classes was random.

Pond A2-At pond A2 stems in size class 1 were the most important with a VI of 1522. Size classes 2, 3, 5 and 7 were of moderate importance with VI's ranging from 116 to 289. Remaining size classes were of little or no importance to the beaver. Feeding among size classes at pond A2 was also nonrandom. As found for pond A1, the stems in size class 1 were used more than expected. Stems in size classes 3 and 4 were selected less than expected while feeding among the remaining size classes was random.

Pond B-At pond B also, size class 1 was the most important size class for the beaver (VI = 709). Size classes 2, 3, 4, 5, 11, 14 and 20 were of moderate importance. Unlike

TABLE 4. Size classes, value indices and importance ratings for stems selected by beaver at three ponds on the SRP, August 1976 to July 1977.

| Size Class | DSH[a] (cm) | Pond A1 | | Pond A2 | | Pond B | |
|---|---|---|---|---|---|---|---|
| | | Value Index[b] | Importance Rating[c] | Value Index | Importance Rating | Value Index | Importance Rating |
| 1 | 2.5- 5.0 | 1118 | High | 1522 | High | 709 | High |
| 2 | 5.1- 7.5 | 447 | Mod. | 289 | Mod. | 418 | Mod. |
| 3 | 7.6-10.1 | 311 | Mod. | 135 | Mod. | 127 | Mod. |
| 4 | 10.2-12.6 | 149 | Mod. | - | - | 109 | Mod. |
| 5 | 12.7-15.1 | 161 | Mod. | 116 | Mod. | 218 | Mod. |
| 6 | 15.2-17.7 | 137 | Mod. | - | - | - | - |
| 7 | 17.8-20.2 | - | - | 116 | Mod. | 127 | Mod. |
| 11 | 28.0-30.5 | - | - | - | - | 109 | Mod. |
| 14 | 35.7-38.1 | - | - | - | - | 109 | Mod. |

[a]Diameter Stump Height.
[b]Value Index (VI): % of total stems available x% of stems selected per class (Chabreck 1958).
Importance rating: high = 501+; moderate = 101-500; low = 1-100.

ponds A1 and A2, there was no evidence of nonrandom selection of size classes by beaver at pond B. Thus, no evidence of preferential size class selection was found.

Distance Class Selection

Pond A1-Distance classes 0 and 1 comprised 58.3% of availability and 67.6% of selection at pond A1. These distance classes were the most important with VI's of 966 and 981 respectively (Table 5). Distance classes 2, 3, 4 and 5 were of moderate importance. Selection among distance classes was nonrandom. Stems in distance class 0 were selected more than expected. Selection of stems in distance classes 1, 2, 3 and 4 was random while selection of stems in distance classes 5 and 6 was less than expected.

Pond A2-Selection of stems in various distance classes at pond A2 was also nonrandom. The selection area consisted of distance class 0 because only 3 stems at the pond were selected outside the water.

Pond B-At pond B distance class 0 was the most important (VI = 1875) with distance class 1 being of moderate importance. Feeding among distance classes at pond B was nonrandom. Stems in distance class 0 were selected more than expected while feeding upon stems in remaining distance classes was random.

Pond C-Sampling of feeding activity at pond C was initiated in September, 1976. However, in mid-October the beaver abandoned the pond. No data on availability was taken at this pond; however, an analysis of species, size and distance class selection was conducted. Sweetgum, water oak (*Quercus nigra*) and black gum comprised 88.7% of the total selection. Only 5 species were selected during the 3 months. Sizes classes 1, 2, 3 and 5 comprised 66.1% of the selection while larger size classes comprised very little of the total selection.

Unlike the other ponds, feeding at pond C occurred throughout distance classes 0-10 with the greatest amount of feeding (66.2%) occurring in distance classes 5-10.

TABLE 5. Distance classes, value indices and importance ratings for stems selected by beaver at three ponds on the SRP, August 1976 to July 1977.

| Distance Class | Distance from Water (m) | Pond A1 | | Pond B | |
|---|---|---|---|---|---|
| | | Value Index[a] | Importance Rating[b] | Value Index | Importance Rating |
| 0 | Within the Water | 966 | High | 1875 | High |
| 1 | 0-1 | 966 | High | 327 | Mod. |
| 2 | 1-2 | 199 | Mod. | - | - |
| 3 | 2-3 | 199 | Mod. | - | - |
| 4 | 3-4 | 195 | Mod. | - | - |
| 5 | 4-5 | 112 | Mod. | - | - |

[a]Value Index (VI): % of total stems available times % of stems selected per class (Chabreck 1958).
[b]Importance Rating: high = 501+; moderate = 101-500; low = 1-100.

## DISCUSSION

### Monthly Selection

Brenner (1962), Northcott (1971) and Woodward (1977) all reported beaver feed mainly upon woody vegetation during winter months and feed upon herbaceous vegetation when available (usually during summer months). Results of this study indicate that seasonal feeding patterns of beaver in the Upper Coastal Plain region of South Carolina are similar to the above. Cutting of woody vegetation was lowest during spring and summer when herbaceous species were present and greatest during winter when herbaceous species were absent.

The shift to woody vegetation in winter was much greater at colony A than colony B. This was probably due to the number of beaver and the amount of herbaceous food material present.

### Species Selection

Sweetgum was found to be the most important woody species for beaver. Beaver preferred sweetgum over other species at pond A1 and B while red maple was preferred at pond A2. Although sweetgum was not preferred at pond A2, its numerical abundance resulted in the highest VI of all plant species found at this pond.

The value of sweetgum found in this study concurs with other reports of the feeding habits of beaver in the southern U.S. (Chabreck 1957, Parrish 1960, Woodward 1977). Red maple was the only other species receiving a high IR; however, this was for only 1 pond.

Plant species of moderate importance varied between ponds. Sweet bay and speckled alder received moderate ratings at 2 ponds and water oak, wax myrtle, loblolly pine, water ash, black gum and dogwood received moderate ratings in only 1 of 3 ponds studied.

Chabreck (1957) and Woodward (1977) reported that pine (*Pinus* spp.) was an important food item for beaver. In this study, pine comprised only 4.3% of available stems at pond A1 and was not present at ponds A2 and B. Most beaver ponds in the Coastal Plain of South Carolina occur along second or third order streams characterized by wide flood plains. Such areas support water tolerant hardwoods rather than pines. A few pines may occur on drier elevated sites within the flood plains. Thus, for most Coastal

Plain beaver pond sites, pines usually do not occur within the foraging areas of beaver. In the Piedmont region, however, stream flood plains are narrow and pines are likely to be found within foraging areas.

### Size Class Selection

At ponds A1, A2 and B. stems in size class 1 were the most important stems for beaver while size classes 2 and 3 were of secondary importance. At ponds A1 and A2 beaver selected stems in class 1 over other stems. The use of smaller size classes is probably related to numerical abundance and palatability. Preference of smaller stems and their resulting importance to beaver has also been reported by Shadle et al. (1943), Bradt (1947) and Nixon and Ely (1969).

### Distance Class Selection

The selection of stems in various distance classes was nonrandom (at all 3 ponds). Stems located within the water (distance class 0) were the most important and preferred stems. Stems located near the water (distance class 1-3) were selected randomly while those farther from the water (distance classes 4-6) were selected less than expected.

The only difference between the feeding habits of beaver at the 3 ponds was the distance travelled to obtain food. Pond A1 had the largest selection area (distance classes 0-6). This pond was the oldest of the 3 ponds and had very little woody vegetation located in the water. Pond B, 3 months old at the start of this study, had a selection area which consisted of distance classes 0-5. The lack of small stems in the water and abundant cover adjacent to this pond may have influenced the beaver to feed at greater distances from the water. In contrast at pond A2, beaver fed primarily in distance class 0. It appears, from these data, that beaver at a young pond fed primarily within the water. As the pond ages, feeding moves farther away from the water's edge.

### Pond C

To elucidate possible causes for the desertion of pond C, this pond was compared to the other ponds in the study. The 3 most selected species at pond C were water oak (33.9%), blackgum (29.0%) and sweetgum (25.8%). Two of these (water oak and blackgum) were not preferred food items at the other ponds. In addition, water oak was selected significantly less than expected at ponds A1 and A2. The selection of stems in various size classes at pond C was similar to the selection of size classes at ponds A1, A2 and B. Size classes 1, 2 and 3 comprised 51.6% of the total selection.

The major difference in feeding patterns at pond C was the distance travelled from the water to obtain food. Feeding in distance classes 5-10 comprised 66.2% of the total selection. Only 12.9% of the selection occurred within the water. At ponds A1, A2 and B feeding within the water comprised 35.3, 100.00 and 76.9% of the total selection, respectively. Very little feeding took place farther than 5 m from the water's edge at ponds A1, A2 and B.

Although no data on availability were collected at pond C, it appears the beaver at pond C abandoned the site because of a shortage of preferred food within a reasonable distance from the water's edge. Warren (1932) reported a colony of beaver he observed abandoned a pond after 12 years; however, he reported an abundance of food was present when the pond was abandoned. Both Lawrence (1952) and Warren (1932) reported that beaver may abandon and later reoccupy pond sites, however, neither offered any reason for the desertion and reoccupation.

## CONCLUSIONS

Based on the results of these data it appears that sweetgum, especially during winter months, comprises the bulk of the beaver's diet. This is due to (1) relative abundance of

the species and (2) the preference beaver exhibited for the species. In addition stems in smaller size classes and stems within or very near the water are the most important and preferred food items. The authors assumed, for the purposes of this study, that food items were selected by species, size and distance class independently. These assumptions were appropriate prior to the use of the univariate analysis used to describe preference. Jenkins (1975) used a multidimensional technique to describe the interaction of various parameters including species, size and distance classes. It is clearly understood that some degree of interaction occurs; however, both techniques fall short of the most important ecological question. The real question that should be addressed is not whether food items are preferred or are more important but why are some items preferred and others not.

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