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FOODS OF DUCKS WINTERING IN COASTAL SOUTH CAROLINA, 1965-1967¹

By JAMES A. KERWIN² and LLOYD G. WEBB³

ABSTRACT

During the wintering seasons of 1965-1967, 706 waterfowl gizzards were collected and subsequent food habit studies were made. The collections represented 14 species of waterfowl (9 species of dabblers and 5 species of divers). Six hundred and five collections constituted the dabbling duck sample and 101 gizzards represented the diving duck sample. The most important foods consumed were from fresh and slightly brackish water habitats. Seeds of marsh plants and vegetative fragments and

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seeds of pondweeds were the primary foods consumed. Animal foods in the diet were not considered important. The most important food consumed by volume by dabbling ducks was *Najas guadalupensis*. The most important food consumed by volume by diving ducks was *Brasenia schreberi*. The plant most frequently used by dabblers was *Scirpus validus*, while the plant most frequently used by diving ducks was *Brasenia schreberi*.

Food habit studies are of utmost importance in relating waterfowl utilization to various habitat types in aquatic ecosystems. They document the important food plants and animals and provide an understanding of the role of higher vertebrates within the trophic structure of the aquatic ecosystem (e. g. fresh water, estuarine, and marine). Although at times food habit studies are criticized, they are essential if we are to understand the functional processes of ecosystems.

Previous studies of the food habits of waterfowl in South Carolina have been generally confined to local areas, or limited to a few analyses. Some of these studies are as follows. One hundred and fourteen duck stomachs from South Carolina were examined for the comprehensive report by Martin and Uhler (1939). An intensive study of 244 ducks, including 12 species, was conducted near Georgetown by Brock Conrad (1965). Twenty-five crops and 243 gizzards were examined and their contents were identified. McGilvrey (1966 a and b) published data concerning the fall food habits of dabbling ducks from Lake Marion and the area around Santee National Wildlife Refuge.

Coastal South Carolina is extremely important for wintering waterfowl of the Atlantic Flyway. In the waterfowl survey of January 1968, South Carolina had 366,400 ducks, 15,800 gease, 100 brant, and 61,300 coots; they comprised 13.4 percent of the total population of wintering waterfowl in the Atlantic Flyway (Martinson *et al.*, 1968). Comparable wintering populations occurred during the years of this study, 1965-1967.

The objective of this study was to document the relative importance of foods for the major species of ducks utilizing the coastal, aquatic habitats of South Carolina. The resulting information could be used as a basis for studies having a more functional nature.

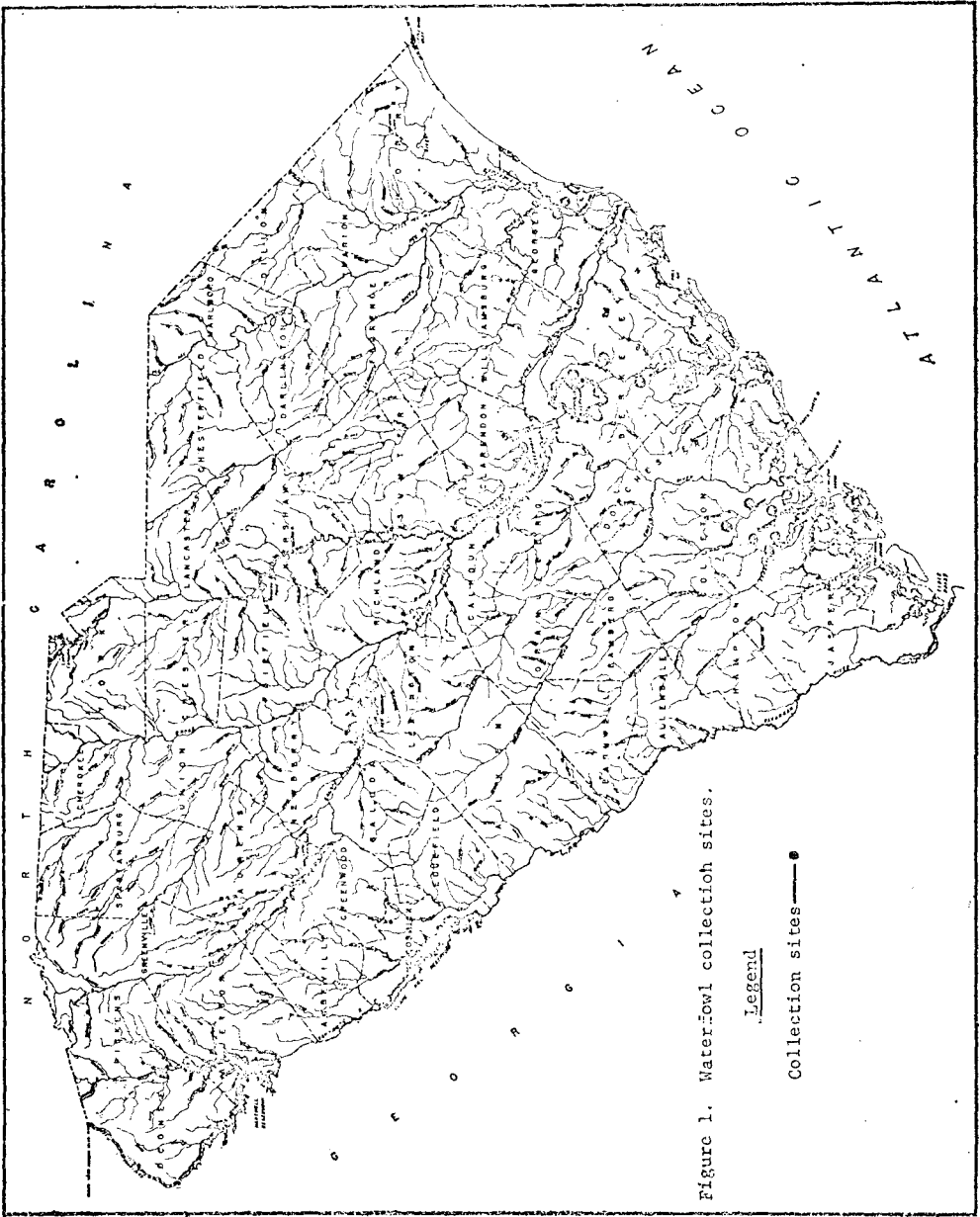
DESCRIPTION OF THE AREA

The coastal plain of South Carolina comprises three major drainage systems. The first includes the Combahee, Ashepoo, and Edisto Rivers. The southern parts of Jasper and Colleton Counties, as well as the western part of Charleston County, are included in the lower portion of this drainage area. The second drainage system includes the Santee and Cooper Rivers, along with Lake Moultrie and Lake Marion. It encompasses upper Charleston County, all of Berkeley County, and parts of Georgetown and Williamsburg Counties adjoining the Santee River. The third major drainage system consists of the Black, Pee Dee, and Waccamaw Rivers. It includes the eastern parts of Georgetown and Williamsburg Counties, and part of Horry County. Waterfowl gizzard collection sites within these drainage systems are illustrated in Figure 1.

Sixteen major types of wetlands occur in South Carolina (U. S. Fish and Wildlife Service, Office of River Basin Studies, 1954). The most extensive types are: (1) seasonally flooded basins or flats; (2) open, inland, fresh water; (3) wooded swamps; (4) deep, fresh, coastal marshes; (5) regularly flooded salt marshes; and (6) bays and sounds. The deep, fresh, coastal marshes, consisting primarily of giant cutgrass marshes and cutgrass communities, are the most important waterfowl areas in South Carolina (op. cit.).

MATERIALS AND METHODS

A total of 706 gizzards, including 605 from dabbling ducks (Anatinae) and 101 from diving ducks (Aythiinae), were collected by personnel of



the South Carolina Wildlife Resources Department and were analyzed by the senior author (Table 1). Nine species of dabblers and five species of divers were represented.

TABLE 1. Duck gizzards examined (1965-1967).

Species	Number
Dabblers-Subfamily Anatinae	605
Mallard (<i>Anas platyrhynchos</i> Linnaeus)	80
Black duck (<i>A. rubripes</i> Brewster)	63
Gadwall (<i>A. strepera</i> Linnaeus)	60
Pintail (<i>A. acuta</i> Linnaeus)	118
Green-winged teal (<i>A. carolinensis</i> Gmelin)	37
Blue-winged teal (<i>A. discors</i> Linnaeus)	54
American widgeon (<i>Mareca americana</i> Gmelin)	11
Shoveler (<i>Spatula clupeata</i> Linnaeus)	42
Wood duck (<i>Aix sponsa</i> Linnaeus)	134
Divers-Subfamily Aythyinae	101
Ring-necked duck (<i>Aythya collaris</i> Donovan)	78
*Canvasback (<i>A. valisimera</i> Wilson)	5
*Black head (mixed ringneck and scaup)	2
Scaups (<i>Aythya marila</i> Linnaeus and <i>A. affinis</i> Eyton)	15
*Ruddy duck (<i>Oxyura jamaicensis</i> Gmelin)	1
Total ducks	706

* Not included in this study due to small sample.

The total volume of the contents of each gizzard was determined to the nearest 0.1 cubic centimeter by volumetric displacement. The contents were then preserved in labeled vials containing 70 percent ETOH.

Food items were sorted in a petri dish, and visual estimates were made of the percent composition of each plant or animal food. With the aid of a binocular microscope, food items were identified to genus and, when possible, to species. References used to identify plant material included: Fassett (1957), Fernald (1950), Martin (1951 and 1954), Martin and Barkley (1961), Martin and Uhler (1939), Prescott (1954), and Small (1933). Animal items were identified with the aid of the texts by Barnes (1963), Borrer and DeLong (1960), and Pennak (1953).

RESULTS

The volumes and frequencies of foods taken by species of ducks are given in Tables 3-13. The food habits of dabbling ducks are summarized in Table 2. Tabular presentation of the food habits of diving ducks other than scaup and ringnecks was not included because the sample sizes were extremely small. The discussion of the data presented herein is limited since the tables showing the major food items consumed are self explanatory. The scientific classification of major plant foods, along with acceptable common names, are presented in Appendix Table 1.

In terms of volume, the three most important plant foods for 605 dabbling ducks were: *Najas guadalupensis* (8.5 percent), *Scirpus robustus* (5.4 percent), and *Quercus palustris* (5.2 percent) (Table 2). In contrast, plant foods most frequently consumed were: *Scirpus validus* (236 times), *Myrica cerifera* (171 times), *Eleocharis equisetoides* (156 times), *Polygonum hydropiperoides* (132 times), *Cyperus odoratus* (105 times), and *Scirpus robustus* (100 times).

The major foods of individual species of dabbling ducks are shown in Tables 3-11. The species of dabblers studied, with sample sizes shown in parentheses, were: Mallard (80), blacks (63), gadwalls (60), baldpates (118), pintails (37), green-winged teals (54), blue-winged teals (17), shovelers (42), and wood ducks (134).

Twelve species of plants comprised 94.42 percent by volume of the foods consumed by the 15 scaup examined. Eighteen other plant species, unidentified plant material and animal matter made up the remainder of the foods found in the gizzards (Table 12).

TABLE 2. Plant food items in 605 gizzards of dabbling ducks.

Food Item	Total Volume (cc)	Times Taken	Percent Volume
<i>Najas guadalupensis</i>	70.92	76	8.49
<i>Scirpus validus</i>	56.09	236	6.71
<i>Polygonum hydropiperoides</i>	48.68	132	5.82
<i>Scirpus robustus</i>	44.70	100	5.35
<i>Quercus palustris</i>	43.36	16	5.19
<i>Zea mays</i>	40.93	9	4.90
Unidentified fragments	36.73	130	4.40
<i>Eleocharis equisetoides</i>	34.55	156	4.13
<i>Polygonum sagittatum</i>	30.80	58	3.69
<i>Panicum dichotomiflorum</i>	29.82	75	3.57
<i>Ruppia maritima</i>	29.44	78	3.52
<i>Cyperus odoratus</i>	24.03	105	2.88
<i>Potamogeton pusillus</i>	20.47	39	2.45
<i>Pontederia cordata</i>	20.17	16	2.41
<i>Polygonum punctatum</i>	18.96	38	2.27
<i>Peltandra virginica</i>	18.91	36	2.26
<i>Rhynchospora corniculata</i>	17.58	85	2.10
<i>Echinochloa walteri</i>	15.52	71	1.86
<i>Myrica cerifera</i>	15.43	171	1.85
<i>Proserpinaca palustris</i>	13.35	55	1.60
<i>Polygonum arifolium</i>	13.00	35	1.56
<i>Nyssa sylvatica</i>	12.70	28	1.52
<i>Aneilema keisak</i>	12.53	43	1.50
<i>Panicum verrucosum</i>	11.24	5	1.34
<i>Panicum lindheimeri type</i>	8.52	37	1.02
Total plant *			

* Comprised by plant food items which consisted of at least 1.0 percent of the total volume. Grit not included.

TABLE 3. Winter foods of 80 mallards, 1965-66.

Food Item	Percent Frequency	Percent Volume
Plant:		
<i>Polygonum hydropiperoides</i>	30.00	17.30
<i>Polygonum sagittatum</i>	23.75	13.74
<i>Scirpus robustus</i>	23.75	10.15
<i>Cyperus odoratus</i>	18.75	6.69
<i>Zea mays</i>	2.50	4.46
<i>Panicum dichotomiflorum</i>	10.00	4.17
<i>Eleocharis equisetoides</i>	33.75	3.96
<i>Najas guadalupensis</i>	7.50	3.42
<i>Scirpus validus</i>	35.00	3.16
<i>Paspalum boscianum</i>	3.75	2.89
Unidentified fragments	22.50	2.88
<i>Brasenia schreberi</i>	8.75	1.81
<i>Echinochloa walteri</i>	12.50	1.81
<i>Sagittaria latifolia</i>	1.25	1.26
<i>Polygonum pennsylvanicum</i>	11.25	1.25
<i>Polygonum arifolium</i>	10.00	1.23
<i>Myrica cerifera</i>	41.25	1.17
<i>Aneilema keisak</i>	12.50	1.09
<i>Pontederia cordata</i>	6.50	1.07
<i>Spartina alterniflora</i>	1.25	1.05
<i>Nyssa biflora</i>	5.00	1.00
<i>Potamogeton pectinatus</i>	1.25	1.00
Other species	*(61)	11.58
Total plant	100.00	98.14
Animal:		
Total animal	28.75	1.86
Total Food		** 58.19
Grit		** 41.81

* Number of other food items, each comprising less than one percent.

** Percent volume of the total content.

TABLE 4. Winter foods of 63 black ducks, 1965-66.

Food Item	Frequency Percent	Volume Percent
Plant:		
<i>Pontederia cordata</i>	14.29	13.10
<i>Eleocharis equisetoides</i>	36.51	10.48
Unidentified fragments	19.05	6.21
<i>Polygonum hydropiperoides</i>	20.63	6.07
<i>Scirpus robustus</i>	31.75	6.04
<i>Polygonum punctatum</i>	11.11	5.71
<i>Myrica cerifera</i>	66.67	4.86
<i>Polygonum sagittatum</i>	20.63	4.80
<i>Polygonum arifolium</i>	14.29	4.70
<i>Scirpus validus</i>	42.86	3.97
<i>Cyperus odoratus</i>	17.46	3.60
<i>Ruppia maritima</i>	15.87	3.05
<i>Potamogeton pusillus</i>	7.94	2.85
<i>Aneilema keisak</i>	14.29	2.83
<i>Nymphaea odorata</i>	4.76	2.55
<i>Echinochloa walteri</i>	12.70	2.02
<i>Nyssa biflora</i>	4.76	1.90
<i>Distichlis spicata</i>	3.17	1.26
<i>Spartina alterniflora</i>	3.17	1.13
<i>Eleocharis parvula</i>	11.11	1.10
<i>Tridens flava</i>	1.59	1.02
<i>Eleocharis palustris</i>	2.22	1.00
<i>Suaeda depressa</i>	3.17	1.00
Other species	*(58)	7.15
Total plant	100.00	98.40
Animal:		
Total animal	41.27	1.60
Total Food		** 67.70
Grit		** 32.30

* Number of other food items, each comprising less than one percent.

** Percent volume of the total content.

TABLE 5. Winter foods of 60 gadwalls, 1965-66.

Food Item	Percent Frequency	Percent Volume
Plant:		
<i>Scirpus validus</i>	31.67	14.26
<i>Najas guadalupensis</i>	25.00	12.74
Unidentified fragments	25.33	9.04
<i>Potamogeton pusillus</i>	20.00	8.93
Chlorophyta	6.67	8.67
<i>Panicum dichotomiflorum</i>	8.33	6.47
<i>Panicum verrucosum</i>	3.33	6.43
<i>Hypericum perforatum</i>	3.33	5.62
<i>Polygonum punctatum</i>	3.33	3.48
<i>Echinochloa walteri</i>	10.00	2.29
Gramineae, unidentified	3.33	2.03
<i>Polygonum hydropiperoides</i>	8.33	1.92
<i>Nitella</i> sp.	3.33	1.90
<i>Scirpus robustus</i>	3.33	1.88
<i>Lemna</i> sp.	11.67	1.43
<i>Ruppia maritima</i>	6.67	1.30
<i>Myrica cerifera</i>	8.33	1.22
Other species	*(24)	7.96
Total plant	100.00	97.57
Animal:		
Amphipoda	3.33	1.06
Other	*(6)	1.37
Total animal	21.67	2.43
Total food		** 43.44
Grit		** 56.56

* Number of other food items, each comprising less than one percent.

** Percent volume of the total content.

TABLE 6. Winter foods of 118 baldpates, 1965-66.

Food Item	Percent Frequency	Percent Volume
Plant:		
<i>Najas guadalupensis</i>	44.92	36.51
<i>Ruppia maritima</i>	26.27	12.17
<i>Potamogeton pusillus</i>	10.17	5.62
<i>Panicum lindheimeri</i>	7.63	4.87
<i>Scirpus validus</i>	29.66	4.85
<i>Polygonum hydropiperoides</i>	11.02	3.99
<i>Panicum verrucosum</i>	2.54	3.81
<i>Echinochloa walteri</i>	10.17	3.53
Unidentified fragments	15.25	3.00
<i>Cyperus odoratus</i>	7.63	2.77
<i>Polygonum punctatum</i>	4.24	2.65
<i>Panicum agrostoides</i>	4.24	2.56
<i>Rhynchospora corniculata</i>	6.78	1.36
<i>Panicum capillare</i>	1.69	1.33
<i>Eleocharis parvula</i>	7.63	1.28
<i>Scirpus robustus</i>	5.93	1.20
<i>Hypericum perforatum</i>	1.69	1.16
Gramineae, unidentified	4.24	1.13
<i>Brasenia schreberi</i>	2.54	1.04
Other species	*(45)	4.70
Total plant	100.00	99.53
Animal:		
Total animal	28.81	0.47
Total Food		** 46.29
Grit		** 53.71

* Number of other food items, each comprising less than one percent.

** Percent volume of the total content.

TABLE 7. Winter foods of 37 pintails, 1965-66.

Food Item	Percent Frequency	Percent Volume
Plant:		
<i>Scirpus robustus</i>	54.05	31.59
<i>Tridens flava</i>	18.92	8.44
<i>Ruppia maritima</i>	37.84	8.28
<i>Suaeda depressa</i>	27.03	4.60
<i>Eleocharis parvula</i>	21.62	4.46
<i>Panicum dichotomiflorum</i>	24.32	3.84
<i>Cyperus odoratus</i>	40.54	3.79
<i>Echinochloa walteri</i>	32.43	3.52
<i>Polygonum hydropiperoides</i>	13.51	3.52
<i>Chara</i> sp.	2.70	3.45
<i>Scirpus validus</i>	27.03	2.41
Unidentified fragments	18.92	2.37
<i>Panicum lindheimeri</i>	16.22	2.21
<i>Myrica cerifera</i>	48.65	2.02
<i>Eleocharis equisetoides</i>	27.03	1.68
<i>Eleocharis palustris</i>	10.81	1.56
<i>Brasenia schreberi</i>	3.11	1.15
Cyperaceae, unidentified	3.11	1.06
<i>Najas guadalupensis</i>	2.70	1.03
<i>Scirpus olneyi</i>	8.11	1.01
Other species	*(39)	5.41
Total plant	100.00	97.38
Animal:		
Corixidae	16.22	2.11
Other species	** (7)	0.51
Total animal	45.95	2.62
Total Food		** 56.36
Grit		** 43.64

* Number of other food items, each comprising less than one percent.

** Percent volume of the total content.

TABLE 8. Winter foods of 54 green-winged teal, 1965-66.

Food Item	Percent Frequency	Percent Volume
Plant:		
<i>Panicum dichotomiflorum</i>	38.89	24.96
<i>Scirpus validus</i>	51.85	9.62
<i>Polygonum hydropiperoides</i>	51.85	8.65
<i>Scirpus robustus</i>	29.63	7.21
<i>Cyperus odoratus</i>	35.19	5.77
<i>Echinochloa walteri</i>	31.48	4.81
<i>Ranunculus pennsylvanicus</i>	11.11	4.25
<i>Aneilema keisak</i>	12.96	3.41
<i>Cyperus esculentus</i>	5.56	3.33
<i>Polygonum sagittatum</i>	7.41	2.68
<i>Digitaria sanguinalis</i>	5.56	2.64
<i>Zea mays</i>	1.85	2.12
<i>Paspalum boscianum</i>	12.96	2.08
<i>Eleocharis palustris</i>	31.48	1.96
<i>Jussiaea leptocarpa</i>	5.56	1.60
<i>Polygonum punctatum</i>	5.56	1.52
Unidentified fragments	14.81	1.20
<i>Chara</i> sp.	3.70	1.12
<i>Paspalum</i> sp.	1.85	1.12
Other species	** (52)	8.95
Total plant	100.00	99.00
Animal:		
Total animal	57.41	1.00
Total Food		** 66.65
Grit		** 33.35

* Number of other food items, each comprising less than one percent.

** Percent volume of the total content.

TABLE 9. Winter foods of 17 blue-winged teal, 1965-67.

Food Item	Percent Frequency	Percent Volume
Plant:		
<i>Zea mays</i>	17.65	18.45
<i>Aneilema keisak</i>	29.41	10.82
<i>Eleocharis equisetoides</i>	47.06	8.45
<i>Polygonum hydropiperoides</i>	41.18	8.14
<i>Cyperus odoratus</i>	58.82	7.32
<i>Scirpus robustus</i>	23.53	6.70
<i>Ranunculus pennsylvanicus</i>	29.41	5.57
<i>Polygonum sagittatum</i>	5.88	4.64
<i>Scirpus validus</i>	47.06	4.23
<i>Panicum dichotomiflorum</i>	17.65	3.71
<i>Ceratophyllum demersum</i>	5.88	2.89
<i>Eleocharis quadrangulata</i>	41.18	2.78
<i>Rhynchospora corniculata</i>	5.88	2.58
<i>Cephalanthus occidentalis</i>	5.88	1.55
<i>Decodon verticillatus</i>	5.88	1.55
<i>Carex comosa</i>	11.72	1.44
<i>Eleocharis palustris</i>	29.41	1.44
<i>Ruppia maritima</i>	17.65	1.44
<i>Panicum</i> sp.	23.53	1.13
Other species	*(30)	4.55
Total plant	100.00	99.38
Animal:		
Total animal	64.71	0.62
Total Food	100.00	** 63.73
Grit		** 36.27

* Number of other food items, each comprising less than one percent.

** Percent volume of the total content.

TABLE 10. Winter foods of 42 shovelers, 1965-67.

Food Item	Percent Frequency	Percent Volume
Plant:		
<i>Panicum dichotomiflorum</i>	35.71	28.83
<i>Aneilema keisak</i>	11.90	10.60
<i>Scirpus validus</i>	52.38	9.00
<i>Eleocharis quadrangulata</i>	19.05	7.00
<i>Scirpus robustus</i>	26.19	6.64
<i>Ruppia maritima</i>	9.52	3.34
<i>Alisma</i> sp.	4.76	3.27
<i>Polygonum arifolium</i>	14.29	2.75
<i>Ranunculus pennsylvanicus</i>	19.05	2.65
<i>Cyperus odoratus</i>	30.95	2.23
<i>Polygonum hydropiperoides</i>	40.48	2.09
<i>Rhynchospora corniculata</i>	9.52	1.90
<i>Cephalanthus occidentalis</i>	4.76	1.57
Convolvulaceae, unidentified	7.14	1.57
<i>Cyperus</i> sp.	9.52	1.44
<i>Scirpus americanus</i>	16.67	1.24
Gramineae, unidentified	11.90	1.05
<i>Panicum agrostoides</i>	11.90	1.05
Other species	*(37)	7.59
Total plant	100.00	95.81
Animal:		
Gastropoda	4.76	1.57
Amphipoda	11.90	1.34
Other species	*(9)	1.28
Total animal	57.14	4.19
Total Food		** 52.28
Grit		** 47.72

* Number of other food items, each comprising less than one percent.

** Percent volume of the total content.

TABLE 11. Winter foods of 134 wood ducks, 1965-67.

Food Item	Percent Frequency	Percent Volume
Plant:		
<i>Quercus palustris</i>	11.94	19.88
<i>Zea mays</i>	4.47	15.61
<i>Scirpus validus</i>	44.03	9.08
<i>Peltandra virginica</i>	26.12	8.51
<i>Rhynchospora corniculata</i>	41.79	6.42
<i>Eleocharis equisetoides</i>	34.33	4.99
<i>Proserpinaca palustris</i>	28.36	4.87
Unidentified fragments	29.85	4.60
<i>Nyssa biflora</i>	14.18	3.71
<i>Myrica cerifera</i>	29.85	2.16
<i>Plantago</i> sp.	11.19	1.94
<i>Carex comosa</i>	26.12	1.82
<i>Polygonum arifolium</i>	5.24	1.64
<i>Pinus taeda</i>	7.46	1.26
<i>Polygonum hydropiperoides</i>	14.93	1.21
<i>Eleocharis quadrangulata</i>	12.69	1.17
<i>Polygonum punctatum</i>	10.45	1.16
<i>Polygonum sagittatum</i>	10.45	1.00
Other species	*(72)	8.43
Total plant	100.00	99.46
Animal:		
Total animal	20.90	0.54
Total Food		** 66.73
Grit		** 33.27

* Number of other food items, each comprising less than one percent.

** Percent volume of the total content.

TABLE 12. Winter foods of 15 scaups, 1965-67.

Food Item	Percent Frequency	Percent Volume
Plant:		
<i>Panicum dichotomiflorum</i>	26.67	17.40
<i>Polygonum hydropiperoides</i>	73.33	13.54
<i>Eleocharis quadrangulata</i>	40.00	13.35
<i>Aneilema keisak</i>	33.33	9.76
<i>Scirpus validus</i>	46.67	7.45
<i>Polygonum pennsylvanicum</i>	46.67	6.94
<i>Scirpus robustus</i>	26.67	6.56
<i>Polygonum arifolium</i>	20.00	6.52
<i>Panicum agrostoides</i>	33.33	5.40
<i>Eleocharis equisetoides</i>	46.67	3.94
Unidentified fragments	20.00	2.82
<i>Potamogeton pusillus</i>	13.33	2.35
<i>Myrica cerifera</i>	46.67	1.31
Other species	*(18)	1.82
Total plant	100.00	99.16
Animal:		
Total animal	20.00	0.84
Total Food		** 85.83
Grit		** 14.17

* Number of other food items, each comprising less than one percent.

** Percent volume of the total content.

TABLE 13. Winter foods of 78 ring-necked ducks, 1965-67.

Food Item	Percent Frequency	Percent Volume
Plant:		
<i>Brasenia schreberi</i>	51.28	28.40
<i>Scirpus robustus</i>	5.13	6.94
<i>Polygonum hydropiperoides</i>	20.51	6.92
<i>Polygonum arifolium</i>	10.26	6.55
<i>Eleocharis equisetoides</i>	55.13	5.21
<i>Eleocharis quadrangulata</i>	29.49	5.21
<i>Nitella</i> sp.	15.38	4.93
<i>Nymphaea odorata</i>	24.36	4.78
Unidentified fragments	17.95	3.59
<i>Scirpus validus</i>	37.18	3.32
<i>Panicum dichotomiflorum</i>	15.38	3.26
<i>Najas guadalupensis</i>	11.54	2.99
<i>Paspalum boscianum</i>	5.13	2.45
<i>Polygonum punctatum</i>	6.41	2.18
<i>Chara</i> sp.	12.82	2.02
<i>Panicum agrostoides</i>	10.26	1.92
<i>Echinochloa walteri</i>	10.26	1.38
<i>Polygonum sagittatum</i>	14.10	1.29
<i>Aneilema keisak</i>	7.69	1.13
Other species	*(61)	5.48
Total plant	100.00	99.95
Animal:		
Total animal		0.05
Total Food		** 67.69
Grit		** 32.31

* Number of other food items, each comprising less than one percent.

** Percent volume of the total content.

Approximately 90.8 percent of the foods by volume found in 78 ring-necked ducks represented 18 species of plants. The remaining 9.2 percent was made up of animal matter, unidentified plant fragments and 61 other plant species that were consumed in minute quantities (Table 13).

DISCUSSION AND CONCLUSIONS

Assuming that collection of gizzards was representative of the major habitats, the fresh and slightly brackish-water marshes are the most important feeding areas for most dabbling ducks wintering in South Carolina. These findings are similar to those reported by Conrad (1965), McGilvrey (1966 a and b), and Martin and Uhler (1939). Few birds contained remains of brackish or salt water plants and animals. In contrast, the estuarine littoral zone and salt marsh areas are very important to many waterfowl in New England (Norton, 1909; Lynch, 1939; Cottam *et al.*, 1944; Addy, 1945; Mendall, 1949; Siegler, 1950; Coulter, 1955; and Hartman, 1963), as well as along the middle-Atlantic Bight (Quay and Critcher, 1962; Stewart, 1962; and Sincock and Kerwin, 1969 a and b). Estuarine areas are also important feeding and wintering grounds for waterfowl in some areas along the Gulf Coast (Singleton, 1951; Dillon, 1957; Kimble and Ensminger, 1959; Glasgow and Bardwell, 1962; and Cronan and Halla, 1968).

Fresh and slightly brackish marsh habitats were not only more important than high salinity estuarine areas in South Carolina, but they were also more important than agricultural areas. Cereal grains were not generally significant in the diets of most dabbling ducks; however, corn was the most important food for blue-winged teal and an important food item for mallards and wood ducks. Corn or other agricultural crops were not important food items for the other six species of dabblers studied. Apparently, the marsh habitats in South Carolina are productive enough that the current wintering waterfowl populations do not exceed the carrying capacity. Such is not the case in some areas along the middle-Atlantic Bight. There, the carrying capacity may be insufficient to winter the migratory fowl; or the marshes, although productive, may not be interspersed enough with open water to provide feeding habitat. The latter situation occurs in Back Bay, Virginia, and Currituck Sound, North Carolina (Sincock *et al.*, 1969). Further south, many dabbling waterfowl frequent the ricefields and rice-marsh transition areas (Dillon, 1957 and 1959, and Harmon *et al.*, 1960).

South Carolina's wetlands serve primarily as a wintering ground for dabbling ducks. In 1968 only 12.5 percent of 366,400 ducks that wintered in the State were diving ducks (Martinson *et al.*, 1968). There is a paucity of information concerning the food habits of diving ducks in South Carolina, and steps should be taken to obtain adequate samples for analysis. During this study, animal foods were not important to many diving ducks in South Carolina; whereas, in some waterfowl wintering areas, they are extremely important (Cottam, 1933 and 1939; Cronan, 1957; Harmon, 1962; Rogers and Korschgen, 1966; and Cronan and Halla, 1968).

APPENDIX

APPENDIX TABLE 1. Checklist of plant food items, South Carolina food habits study, 1965-67.*

Family	Scientific Name	Common Name
Chlorophyta	Chlorophyta	Green algae
Characeae	Characeae	Muskgrass Family
Characeae	<i>Nitella</i> sp.	Nitella
Characeae	<i>Chara</i> sp.	Muskgrass
Pinaceae	<i>Pinus</i> sp.	Pine
Pinaceae	<i>P. taeda</i> L.	Loblolly pine
Pinaceae	<i>Juniperus virginiana</i> L.	Red cedar
Typhaceae	<i>Typha</i> sp.	Cat-tail flag
Typhaceae	<i>T. domingensis</i> Pers.	Cat-tail flag
Sparganiaceae	<i>Sparganium eurycarpum</i> type	Bur-reed
Sparganiaceae	<i>S. americanum</i> Nutt.	Bur-reed
Zosteraceae	<i>Potamogeton</i> sp.	Pondweed
Zosteraceae	<i>P. pectinatus</i> L.	Sago pondweed
Zosteraceae	<i>P. pusillus</i> L.	Pondweed
Zosteraceae	<i>P. perfoliatus</i> L.	Claspingleaf pondweed
Zosteraceae	<i>Ruppia maritima</i> L.	Ditch-grass
Najadaceae	<i>Najas</i> sp.	Naiad
Najadaceae	<i>N. guadalupensis</i> (Spreng.) Magnus	Southern Naiad
Alismataceae	<i>Alisma</i> sp.	Water-plantain
Alismataceae	<i>Sagittaria</i> sp.	Swamp-potato
Alismataceae	<i>S. subulata</i> (L.) Buchenau	Dwarf arrowhead
Alismataceae	<i>S. platyphylla</i> (Engelm.) J. G. Sm.	Arrowhead
Alismataceae	<i>S. latifolia</i> Willd.	Duck-potato
Hydrocharitaceae	<i>Anacharis</i> (<i>Elodea</i>) <i>canadensis</i> Michx.	Waterweed
Hydrocharitaceae	<i>Vallisneria americana</i> Michx.	Wild-celery
Gramineae	Gramineae	Grass Family
Gramineae	<i>Triodia</i> (<i>Tridens</i>) <i>flava</i> (L.) Smyth	Tall red-top
Gramineae	<i>Distichlis spicata</i> (L.) Greene	Spike-grass
Gramineae	<i>Spartina alterniflora</i> Loisel	Salt-water cord-grass
Gramineae	<i>S. patens</i> (Ait.) Muhl.	Salt-meadow grass

Family	Scientific Name	Common Name
Gramineae	<i>Oryza sativa</i> L.	Rice
Gramineae	<i>Leptochloa fascicularis</i> (Lam.) Gray	Sprangletop
Gramineae	<i>Zizaniopsis miliacea</i> (Michx.) Doll. & Aschers	Water-millet
Gramineae	<i>Zizania aquatica</i> L.	Wild rice
Gramineae	<i>Digitaria ischaemum</i> (Schreb.) Muhl.	Small crab-grass
Gramineae	<i>D. sanguinalis</i> (L.) Scop.	Crab-grass
Gramineae	<i>Paspalum</i> sp.	Paspalum
Gramineae	<i>P. laeve</i> Michx.	Paspalum
Gramineae	<i>P. boscianum</i> Flugge	Bull-grass
Gramineae	<i>Panicum</i> sp.	Panic-grass
Gramineae	<i>P. verrucosum</i> Muhl.	Panic-grass
Gramineae	<i>P. dichotomiflorum</i> Michx.	Fall panicum
Gramineae	<i>P. capillare</i> type	Panic-grass
Gramineae	<i>P. agrostoides</i> Spreng.	Panicum
Gramineae	<i>P. lindheimeri</i> type	Panicum
Gramineae	<i>Echinochloa colonum</i> (L.) Link	Millet
Gramineae	<i>E. walteri</i> (Pursh) Nash	Wild millet
Gramineae	<i>Setaria</i> sp.	Bristly foxtail
Gramineae	<i>S. (lutescens) glauca</i> (L.) Beauv.	Foxtail
Gramineae	<i>S. viridis</i> (L.) Beauv.	Green foxtail
Gramineae	<i>Andropogon</i> sp.	Beardgrass
Gramineae	<i>A. scoparius</i> Michx.	Broom-beardgrass
Gramineae	<i>Zea mays</i> L.	Maize (corn)
Cyperaceae	Cyperaceae	Sedge Family
Cyperaceae	<i>Cyperus</i> sp.	Sedge
Cyperaceae	<i>C. compressus</i> L.	Cyperus
Cyperaceae	<i>C. erythrorhizos</i> type	Cyperus
Cyperaceae	<i>C. odoratus</i> L.	Chufa
Cyperaceae	<i>C. esculentus sativus</i> Boeckl.	Cyperus
Cyperaceae	<i>C. strigosus</i> L.	Cyperus
Cyperaceae	<i>C. schweinitzii</i> type	Cyperus
Cyperaceae	<i>Dulichium arundinaceum</i> (L.) Britt.	Three-way sedge
Cyperaceae	<i>Eleocharis</i> sp.	Spike-rush
Cyperaceae	<i>E. equisetoides</i> (Eill.) Torr.	Jointed spikerush

Cyperaceae	<i>E. cellulosa</i> type	Gulf-coast spikerush
Cyperaceae	<i>E. quadrangulata</i> (Michx.) R. & S.	Squarestem spikerush
Cyperaceae	<i>E. parvula</i> (R. & S.) Lind	Dwarf spikerush
Cyperaceae	<i>E. obtusa</i> (Willd.) Schultes	Spike-rush
Cyperaceae	<i>E. ovata</i> (Roth) R. & S.	Common spikerush
Cyperaceae	<i>E. palustris</i> (L.) R. & S.	Fimbristylis
Cyperaceae	<i>Fimbristylis</i> sp.	Bulrush
Cyperaceae	<i>Scirpus</i> sp.	Three-square
Cyperaceae	<i>S. americanus</i> Pers.	Olney's Three-square
Cyperaceae	<i>S. obneqi</i> Gray	Soft-stem bulrush
Cyperaceae	<i>S. validus</i> Vahl.	Southern bulrush
Cyperaceae	<i>S. californicus</i> (Meyer) Britton	Saltmarsh bulrush
Cyperaceae	<i>S. robustus</i> Pursh	Beak-rush
Cyperaceae	<i>Rhynchospora</i> sp.	Horned-rush
Cyperaceae	<i>R. corniculata</i> (Lam.) Gray	Beak-rush
Cyperaceae	<i>R. capitellata</i> type	Saw-grass
Cyperaceae	<i>Cladium jamaicense</i> Crantz	Sedge
Cyperaceae	<i>Carex</i> sp.	Sedge
Cyperaceae	<i>C. aquatilis</i> Wahlenb.	Sedge
Cyperaceae	<i>C. comosa</i> type	Arrow-arum
Araceae	<i>Peltandra virginica</i> (L.) Schott & Endl.	Duckweed Family
Lemnaceae	Lemnaceae, unidentified	Duckweed
Lemnaceae	<i>Lemna minor</i> L.	Dayflower
Commelinaceae	<i>Commelina virginica</i> L.	Aneilema
Commelinaceae	<i>Aneilema leiscak</i> Hassk.	Pickrelweed
Pontederiaceae	<i>Pontederia cordata</i> L.	Water-hyacinth
Pontederiaceae	<i>Eichornia crassipes</i> (Mart.) Solms	Neederush
Juncaceae	<i>Juncus roemerianus</i> Scheele	Bayberry
Myricaceae	<i>Myrica pennsylvanica</i> type	Wax-myrtle
Myricaceae	<i>M. cerifera</i> L.	American hornbeam
Corylaceae	<i>Carpinus caroliniana</i> Walt.	Oak
Fagaceae	<i>Quercus</i> sp.	Pin-oak
Fagaceae	<i>Q. palustris</i> Muenchh.	Mulberry
Moraceae	<i>Morus</i> sp.	Dock
Polygonaceae	<i>Rumex</i> sp.	Smartweed
Polygonaceae	<i>Polygonum</i> sp.	

Family	Scientific Name	Common Name
Polygonaceae	<i>P. amphibium</i> L.	Water-smartweed
Polygonaceae	<i>P. densiflorum</i> Meisn.	Smartweed
Polygonaceae	<i>P. pennsylvanicum</i>	Pinkweed
Polygonaceae	<i>P. persicaria</i> L.	Ladysthumb
Polygonaceae	<i>P. punctatum</i> Eil.	Dotted Smartweed
Polygonaceae	<i>P. hydroperoides</i> Michx.	Swamp smartweed
Polygonaceae	<i>P. sagittatum</i> L.	Tearthumb
Polygonaceae	<i>P. arifolium</i> L.	Tearthumb
Polygonaceae	<i>P. dumetorum</i> type	Smartweed
Chenopodiaceae	<i>Suaeda</i> sp.	Glasswort
Chenopodiaceae	<i>Suaeda depressa</i> (Pursh) S. Wats.	Sea-blite
Ceratophyllaceae	<i>Ceratophyllum demersum</i> L.	Hornwort
Nymphaeaceae	<i>Nymphaea odorata</i> Ait.	Fragrant water-lily
Nymphaeaceae	<i>Brasenia schreberi</i> Gmel.	Water-shield
Ranunculaceae	<i>Ranunculus</i> sp.	Buttercup
Ranunculaceae	<i>R. abortivus</i> type	Buttercup
Ranunculaceae	<i>R. pennsylvanicus</i> type	Bristly crowfoot
Magnolia Family	Magnoliaceae	Magnoliaceae
Magnoliaceae	<i>Liriodendron tulipifera</i> L.	Tulip-poplar
Cruciferae	<i>Sisymbrium altissimum</i> L.	Tumble-mustard
Rosaceae	<i>Rubus</i> sp.	Bramble
Rosaceae	<i>R. odoratus</i> L.	Thimbleberry
Rosaceae	<i>R. occidentalis</i> L.	Black raspberry
Rosaceae	<i>Rosa palustris</i> Marsh.	Swamp rose
Leguminosae	Leguminosae	Pulse Family
Leguminosae	<i>Chamaecrista nictitans</i> L.	Wild sensitive plant
Leguminosae	<i>Trifolium repens</i> type	White clover
Leguminosae	<i>T. hybridum</i> type	Alsike clover
Leguminosae	<i>Melilotus</i> sp.	Sweet clover
Leguminosae	<i>Sesbania macrocarpa</i> Muhl.	Sesbania
Leguminosae	<i>Amphicarpa bracteata</i> (L.) Fern.	Hog-peanut
Euphorbiaceae	<i>Stillingia aquatica</i> L.	Queen's root
Anacardiaceae	<i>Toxicodendron (Rhus) radicans</i> L.	Poison ivy
Aquifoliaceae	<i>Ilex</i> sp.	Holly

Aquifoliaceae
 Aquifoliaceae
 Aquifoliaceae
 Celastraceae
 Rhamnaceae
 Malvaceae
 Malvaceae
 Guttiferae
 Lythraceae
 Nyssaceae
 Onagraceae
 Onagraceae
 Haloragaceae
 Haloragaceae
 Haloragaceae
 Haloragaceae
 Cornaceae
 Cornaceae
 Cornaceae
 Ericaceae
 Oleaceae
 Oleaceae
 Oleaceae
 Gentianaceae
 Convolvulaceae
 Convolvulaceae
 Convolvulaceae
 Convolvulaceae
 Boraginaceae
 Verbenaceae
 Labiatae
 Solanaceae
 Solanaceae
 Plantaginaceae
 Rubiaceae
 Rubiaceae
 Compositae
 Compositae
 Compositae
 Compositae

I. opaca Ait.
I. decidua Walt.
I. verticillata (L.) Gray
Celastrus scandens L.
Berchemia scandens (Hill) K. Koch
 Malvaceae
Sida spinosa L.
Hypericum perforatum L.
Decodon verticillatus (L.) Eill.
Nyssa sylvatica (Walt.) Sarg.
Jussiaea decurrens (Walt.) DC.
J. leptocarpa Nutt.
Myriophyllum spicatum L.
M. scabratum Michx.
Proserpinaca palustris L.
Cornus sp.
C. florida L.
C. amomum Mill
Gaultheria procumbens L.
Fraginus sp.
F. americana L.
Forestiera acuminata (Michx.) Poir.
Nymphoides sp.
 Convolvulaceae
Ipomoea sp.
I. lacunosa L.
Cuscuta sp.
Heliotropium sp.
Lippia nodiflora (L.) Michx.
Monarda punctata L.
Solanum sp.
Physalis sp.
Plantago sp.
Gallium sp.
Cephalanthus occidentalis L.
 Compositae
Iva frutescens L.
Bidens sp.
 Unidentified Vegetation

American holly
 Possum-haw
 Winterberry
 Climbing bittersweet
 Supple-jack
 Mallow Family
 Prickly mallow
 Common St. John's wort
 Water-willow
 Black gum
 Water-primrose
 Water-primrose
 Water-milfoil
 Water-milfoil
 Marmalad-weed
 Dogwood
 Flowering dogwood
 Red willow
 Teaberry
 Teaberry
 Ash
 White ash
 Swamp-privet
 Floating-heart
 Morning glory Family
 Morning glory
 Morning glory
 Dodder
 Heliotrope
 Lippia
 Dotted mint
 Nightshade
 Ground-cherry
 Plantain
 Bedstraw
 Buttonbush
 Composite Family
 Marsh-elder
 Bur-marigold
 Umid. seeds and plant matter

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AN EVALUATION OF RECOVERY DATA FROM ARTIFICIALLY SEEDED LEAD SHOT ON CATAHOULA LAKE, LASALLE PARISH, LOUISIANA

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ABSTRACT

Paired plots, seeded with four sizes of lead shot, were established at three locations in an effort to better understand the lead shot problem associated with waterfowl using Catahoula Lake. Half of the plots were treated with a known number of shot in the fall of 1965 and the remainder were similarly treated in the spring of 1966. Soil samples were to be taken in October every two years.

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