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FOODS OF WINTERING DIVING DUCKS IN SOUTH CAROLINA

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An assessment of foods consumed by wintering waterfowl is essential to understand the role wintering habitat plays in the annual cycle of waterfowl. Past research on food habitats of wintering waterfowl in the southeast has dealt mainly with dabblers (Anatini) (Allen 1980, Cely 1979, Glasgow and Bardwell 1962, Hall 1962, Landers et al. 1976, 1977, McGilvrey 1966a,b, Montalbano et al. 1979, Wright 1959) with very little research on wintering diving ducks (Aythyini, Oxyurini) in South Carolina (Conrad 1965, Kerwin and Webb 1972, Montalbano et al. 1979). In addition, most food habit studies in wintering diving ducks have not addressed feeding ecology within and between species. This study examines the winter food habits of three sympatric diving ducks; Ruddy Ducks (*Oxyura jamaicensis*), Ring-necked Ducks (*Aythya collaris*), and Lesser Scaup (*A. affinis*), and differences by sex, season, and species.

STUDY AREA AND METHODS

The study was conducted on Par Pond, a 1130-ha reservoir at the Savannah River Plant, Barnwell County, South Carolina. Par Pond is a wintering area for diving ducks in inland South Carolina with peak densities of more than 1800 Lesser Scaup, 500 Ruddy Ducks, and 1000 Ring-necked Ducks. These three species are the most numerous of the 19 waterfowl species observed on this impoundment. Shallow areas of Par Pond are dominated by sparse stands of cattail (*Typha* spp.), rush (*Juncus* spp.), water lily (*Nymphaea odorata*). Deep water zones are dominated by milfoil (*Myriophyllum* spp.), pondweed (*Potamogeton* spp.), and wild celery (*Valisneria americana*).

Waterfowl were shot and collected weekly from October 1983 through March 1984. South Carolina state and federal permits were obtained for collection. Esophageal and proventriculus contents were immediately preserved in 70% ethanol to impede post-mortem digestion. Gizzards were not used because of bias associated with differential digestion (Swanson and Bartonek 1970). Crop contents were sorted, identified, and volumetrically measured to the nearest 0.1 ml with a graduated cylinder. Thirty clams (*Corbicula fluminea*) were measured (including the largest and smallest) for volume, height, and length (Britton and Fuller 1979). A predictive equation for volume based on height of clams was calculated from these data ($r = 0.98$, $P < 0.01$). All items were partitioned into plant and animal material and identified using criteria from Martin and Barkley (1961) and Pennak (1953). Items were then dried at 60°C for 48 h and weighed to the nearest 1 mg.

Results were summarized by aggregate percent, percent occurrence

TABLE 1. Food items from Ruddy Ducks ($N = 13$) collected during fall and winter 1983–1984 in southwestern South Carolina.

Food items	Percent[a]	% dry wt.[b]	% occurrence[a]
Nymphaea odorata	6.1	7.2	7.7
Eleocharis sp.	15.4	15.4	15.4
Unknown vegetation	11.9	7.9	23.1
Unknown seeds	7.7	7.7	15.4
Total plant food	41.1	38.2	
Diptera			
Chironomidae	57.0	60.8	69.2
Culicidae	0.7	0.7	7.7
Gastropoda			
Helisoma spp.	0.4	0.2	7.7
Odonata			
Anisoptera (Nymphs)	0.8	0.1	7.7
Coleoptera			
Dytiscidae	Tr.[c]	Tr.	7.7
Total animal food	58.9	61.8	

[a] (Swanson et al. 1974).
[b] (Prevett et al. 1979).
[c] <0.1%.

(Swanson et al. 1974), and aggregate percent dry weight (Prevett et al. 1979). A significance level of $P < 0.10$ was used in this field study due to the expected high level of variation. Diet differences among species were assessed with Kruskal-Wallis tests (Hollander and Wolfe 1973: 115–120). Differences by sex and season (Oct.–Dec. 1983 vs. Jan.–Mar. 1984) were examined with Wilcoxon rank sum tests (Hollander and Wolfe 1973:68–75) for Ring-necked Ducks and by season for Lesser Scaup. Sample size precluded further analyses on Lesser Scaup and Ruddy Ducks.

RESULTS

Foods consumed differed ($\chi^2 = 18.3$, df = 2, $P < 0.01$) by weight and volume ($\chi^2 = 18.8$, df = 2, $P < 0.01$) between Ruddy Ducks, Lesser Scaup, and Ring-necked Ducks with the exception of dragonfly nymphs. Midges (Chironomidae) were the most important animal food in the Ruddy Duck diet, comprising 96.8% of the animal matter (Table 1). Spike-rush (*Eleocharis* spp.) seeds and vegetation from unknown plant species made up 66% of plant foods. Items in the Ruddy Duck diet with the greatest dry weight were spike-rush (15.4%) and midges (60.8%). Unknown plant species and midges had the greatest percent occurrence.

Lesser Scaup fed mainly on animal material. Mollusks comprised 94% of the total animal diet; plant material made up only a small proportion

of the Lesser Scaup diet (Table 2). Clams (*Corbicula fluminea* and *Anodenta umbecilles*) and snails (Gastropoda) were the most important food items. Lesser Scaup consumed greater amounts of animal foods during early winter than late ($Z = 1.86$, df = 1, $P = 0.062$).

Plant foods were important in the diet of Ring-necked Ducks (Table 3). The most important plant foods were water lily and spike-rush. Snails were the most important animal food. Ring-necked Duck diets showed variability in consumption of preferred foods, such as water lily seeds, spike-rush, and clams. Ring-necked Ducks consumed fewer clams during late winter (Jan.–Mar.) than during early winter (Oct.–Dec.) ($Z = 1.69$, df = 1, $P = 0.091$). Females consumed more ($Z = -2.71$, df = 1, $P < 0.01$) snails than did males, with the greatest number of snails being eaten during late winter. There were no differences among food items by sex or season for dragonfly nymphs and total seeds ($P > 0.20$).

DISCUSSION

During fall in Iowa, animal food items, primarily mollusks, predominate in the diet of the Ruddy Duck (Thompson 1973). However, Martin et al. (1951:73) reported that Ruddy Ducks consumed approximately 75% plant material consisting mainly of pondweed, wild celery, and bulrush (*Scirpus* spp.). Differences between these diets and our findings may be due to food availability and selectivity, and/or use of gizzards in those studies.

Cottam (1939) concluded that diving ducks (Aythyini), excluding Greater Scaup (*A. marila*), were predominantly vegetarian. However, Bartonek and Hickey (1969) later noted that Lesser Scaup probably maintain a diet high in animal material throughout the year. Animal material made up 98% of esophageal contents in Lesser Scaup collected during summer by Bartonek and Hickey (1969). Harmon (1962) noted that 99.8% of foods consumed during winter off the coast of Louisiana was animal material of which 95.3% was mollusks. Cronan (1957) also found that wintering Lesser Scaup in Connecticut fed mainly on animal food (61.7%). Other investigators have also shown that Lesser Scaup fed mainly on animal food throughout the year (Anderson 1959, Dirschl 1969, McMahan 1970, Rogers and Korschgen 1966, Thompson 1973). Smaller amounts of animal material ingested by Lesser Scaup during late winter were due possibly to large concentrations of scaup depleting specific feeding sites during early winter. In 1983–1984, diving ducks on Par Pond did not severely deplete benthic food resources in general, although clams appear to have declined (Smith, unpubl. data). Another factor may be that Lesser Scaup and Ring-necked Ducks depleted optimal size clams in Par Pond, whereby total biomass would still remain high with low availability.

Ring-necked Ducks consumed a wider variety of food items, especially plant material, than the other species. Thompson (1973) using percent occurrence methods also indicated that plant foods were used more often by Ring-necked Ducks than Lesser Scaup or Canvasbacks (*A. valisiner-*

TABLE 2. Food items from Lesser Scaup ($N = 14$) collected during fall and winter 1983–1984 in southwestern South Carolina.

Food items	Percent[a]	% dry wt.[b]	% occurrence[a]
Eleocharis sp.	Tr.[c]	0.1	7.1
Unknown vegetation	10.7	11.9	25.5
Total plant food	10.7	12.0	
Diptera			
Chironomidae	3.6	2.7	21.4
Gastropoda			
Physella heterostropha	6.6	8.0	28.5
Helisoma spp.	13.3	16.8	28.5
Pelecypoda			
Corbicula fluminea	50.3	45.8	57.1
Anodonta umbecillis	14.0	14.2	14.2
Odonata			
Anisoptera (Nymphs)	1.5	0.5	0.5
Total animal food	89.3	88.0	

[a] (Swanson et al. 1974).
[b] (Prevett et al. 1979).
[c] <0.1%.

ia). Pondweeds and smartweeds (*Polygonum* spp.) occurred in 42% of Ring-necked Ducks in Illinois (Anderson 1959). Kerwin and Webb (1972) discussed the importance of winter plant species in coastal South Carolina. Watershield (*Brasenia schreberi*) occurred most frequently and had the greatest volume in that study. In our study water lily seeds from the same family (Nymphaeaceae) as watershield occurred most frequently and had the greatest volume. Conrad (1965), however, noted that water lily was undesirable and accounted for only 0.5% of total volume. In contrast, Martin et al. (1951:67) stated that during winter, watershield and water lily were consumed at a frequency of 10–25% and 2–5% respectively in the southeast by Ring-necked Ducks.

Thompson (1973) and this study have indicated that gastropods comprise a large proportion of the diet of Ring-necked Ducks whereas Anderson (1959) found only a small proportion. Decreases in volume of animal foods during late winter were demonstrated both by Ring-necked Ducks and Lesser Scaup. In Ring-necked Ducks, the decrease in consumption of clams during late winter seems to correspond with the general trend of decreases in mean number of clams on Par Pond (Smith, unpubl. data). Nilsson (1969) also noted a seasonal change in diet corresponding to faunal changes in Sweden. Female Ring-necked Ducks may meet nutritional needs for future use on the breeding grounds by consuming larger quantities of animal food than males. Interestingly, Hohman (1985) did not find a difference in diets of male and female

TABLE 3. Food items from Ring-necked Ducks (N = 60) collected during fall and winter 1983–1984 in southwestern South Carolina.

	Fall				Winter				Total		
	Male (n = 14)		Female (n = 10)		Male (n = 12)		Female (n = 24)				
Food items	Agg. %[a]	% dry wt.[b]	Agg. %	% dry wt.	Agg. %	% dry wt.	Agg. %	% dry wt.	Agg. %	% dry wt.	% occurrence[a]
Nymphaea odorata	21.8	25.0	45.0	34.4	10.0	16.0	15.0	14.3	21.8	23.5	50.0
Eleocharis spp.	0	0	10.2	24.9	27.9	25.5	11.1	15.2	11.7	15.3	38.3
Eleocharis equisetoides	0	0	Tr.[c]	Tr.	0	0	0.3	0.2	0.1	Tr.	5.0
Hypericum spp.	3.03	3.9	0	0	0	0	0	0	0.5	0.7	1.7
Boehmeria cylindrica	3.03	1.9	0	0	0	0	0	0	0.5	0.3	1.7
Polygonum spp.	3.03	3.3	0	0	0	0	1.4	1.1	1.1	1.1	5.0
Erianthus giganteus	0	0	Tr.	Tr.	0	0	0	0	Tr.	Tr.	1.7
Brasenia schreberi	0.1	0.1	Tr.	1.4	0.3	0.8	0	0	0.1	0.4	8.3
Pinus taeda	0	0	5.0	7.6	0	0	0	0	0.8	1.3	1.7
Pinus spp.	0	0	0	0	0	0	0.5	0.8	0.2	0.3	1.7
Potamogeton spp.	0	0	Tr.	0.5	0	0	Tr.	Tr.	Tr.	0.1	3.3
Myrica cerifera	0	0	0	0	0	0	1.4	0.6	0.5	0.3	1.7
Cyperus spp.	8.7	9.0	0	0	0	0	0	0	1.6	1.6	1.7
Unknown seeds	0	0	5.0	2.4	11.2	11.1	8.3	11.1	6.4	7.0	21.7
Unknown vegetation	31.8	29.3	Tr.	0.1	18.1	14.6	4.2	5.2	11.6	10.5	28.3
Total plant food	71.5	72.5	65.2	71.3	67.5	68.0	42.2	48.5	56.9	62.4	
Diptera											
Unknown	0	0	Tr.	Tr.	0	0	0	0	Tr.	Tr.	3.3
Chironomidae	0.6	Tr.	Tr.	Tr.	11.7	10.6	1.4	0.1	2.9	2.2	15.0
Tabanidae	0	0	0	0	0	0	0	0	0.1	0.1	3.3
Lepidoptera											
Pyralidae	0	0	0	0	0	0	0	0	Tr.	Tr.	1.7

TABLE 3. Continued.

Food items	Fall				Winter				Total		
	Male (n = 14)		Female (n = 10)		Male (n = 12)		Female (n = 24)				
	Agg. %[a]	% dry wt.[b]	Agg. %	% dry wt.	Agg. %	% dry wt.	Agg. %	% dry wt.	Agg. %	% dry wt.	% occurrence[a]
Gastropoda											
Physella heterostropha	9.1	9.1	12.2	11.4	2.1	2.9	6.9	6.2	7.2	6.7	30.0
Helisoma spp.	0.4	0.1	7.3	5.6	6.2	9.0	32.8	34.1	16.0	16.4	35.0
Pelecypoda											
Corbicula fluminea	18.2	18.2	12.2	10.5	0	0	10.1	36.1	9.4	7.5	18.3
Odonata											
Anisoptera (Nymphs)	0.2	Tr.	3.0	1.0	10.4	8.0	5.1	3.7	6.2	3.7	21.7
Coeagriidae	0	0	0	0	0	0	0	0	1.0	Tr.	1.7
Coleoptera											
Unknown	0	0	0	0	2.1	1.6	1.4	1.0	Tr.	0.7	3.3
Dytiscidae	0	0	Tr.	0.1	0	0	Tr.	Tr.	Tr.	Tr.	5.0
Trichoptera											
Phryganeidae	0	0	0	0	0	0	0.3	0.1	0.1	Tr.	1.7
Unknown insect case	0	0	Tr.	Tr.	0	0	0	0	0.1	Tr.	3.3
Unknown insecta	0	0	0	0	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.	3.3
Total animal food	28.5	27.4	34.7	28.6	32.5	32.1	58.0	51.3	43.0	37.3	

[a] (Swanson et al. 1974)—aggregate.
[b] (Prevett et al. 1979)—aggregate.
[c] <0.1%.

Ring-necked Ducks on the breeding ground. With the possible depletion of clams during early winter, females shifted to snails in late winter to meet dietary requirements.

This study indicates that midges made up the majority of animal material in the Ruddy Duck diet. Lesser Scaup preferred animal material, particularly clams and snails, whereas Ring-necked Ducks fed on a variety of plant and animal foods, specifically water lily seeds and mollusks. In comparing food habits of these three species, the Ring-necked Duck has the broadest selection. Ring-necks possibly adapt to environmental conditions more readily than other divers (Aythyini, Oxyurini) in order to maximize fitness (survival, reproduction) (Hohman 1985, Montalbano et al. 1985).

SUMMARY

Foods of wintering Ruddy Ducks, Ring-necked Ducks, and Lesser Scaup were examined on a 1130-ha inland reservoir on the Savannah River Plant in South Carolina. There were differences in food item selection among the three waterfowl species, with the exception of dragonfly nymphs (Odonata). Ring-necked Ducks were generalists, with >55% of the total aggregate percent consisting of plant material. Main plant items consumed were water lily seeds, spike-rush, and unknown vegetative parts. The major animal foods were snails (Gastropoda), making approximately 50% of the animal foods consumed. Female Ring-necked Ducks consumed more snails than did males. Ring-necked Ducks consumed fewer clams during late winter (Jan.–Mar.) than in early winter (Oct.–Dec.). The Ruddy Duck diet consisted of 59% animal foods with midges comprising 97% of the animal volume. Spike-rush and unknown vegetation were the most important plant foods. Animal foods comprised 89% of the Lesser Scaup diet, of which 72% were clams. Lesser Scaup consumed more animal matter during early winter than late.

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NOTES AND NEWS

THE 104th STATED MEETING of The American Ornithologists' Union will be held 18–21 August 1986 at Mississippi State University, Mississippi State, MS. Jerome A. Jackson will chair the Committee on Arrangements.

THE COOPER ORNITHOLOGICAL SOCIETY will hold its 56th annual meeting 8–13 September 1986 at the University of California, Davis. The Committee on Local Arrangements is chaired by Charles Van Riper III, *DES/CPSU, Wickson Hall, Univ. of California, Davis, CA 95616.* The Committee on Scientific Programs is chaired by Daniel Anderson, *Dept. of Wildlife and Fisheries Biology, Briggs Hall, UC Davis, Davis, CA 95616.* Anyone interested in conducting workshops or special symposia should contact one of those individuals. COS members will receive a detailed announcement later. Anyone desiring more information should contact C. Van Riper.

A SYMPOSIUM ON WATERFOWL AND WETLANDS MANAGEMENT in the Coastal Zone of the Atlantic Flyway will be held in Wilmington, Delaware, 16–19 September 1986. Sponsored by Delaware Dept. Natural Resources and Environmental Control. For details write W. R. Whitman, *Wildlife Section, Div. Fish and Wildlife, DNREC, P.O. Box 1401, Wilmington, DE 19903.*

WESTERN BIRD BANDING ASSOCIATION 1986 annual meeting, 10–12 October, Santa Barbara Natural History Museum, Santa Barbara, Calif. The program will highlight banding demonstrations and workshops and will include field trips. Title and abstract of papers should be submitted to David F. DeSante, *Point Reyes Bird Observatory, 4990 Shoreline Highway, Stinson Beach, CA 94970.*

THIRTEENTH ANNUAL NATURAL AREAS CONFERENCE, 21–24 October 1986, Trout Lodge Conference Center near Potosi, southeast Missouri. For information write: *Natural Areas Conference, P.O. Box 180, Jefferson City, MO 65102.*

NATIONAL SYMPOSIUM ON URBAN WILDLIFE, National 4-H Center, Chevy Chase, Maryland, 3–6 November 1986. Theme: Integrating Man and Nature in the Metropolitan Environment. For information, registration and program details write: Lowell W. Adams, *Program Chairman, Urban Wildlife Symposium, National Institute for Urban Wildlife, 10921 Trotting Ridge Way, Columbia, MD 21044.*