J. Field Ornithol., 62(3):325–334

DIETS OF LESSER SCAUP BREEDING IN MANITOBA

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Abstract.—Diets and food preferences of Lesser Scaup (*Aythya affinis*) breeding in southwestern Manitoba were analyzed. Overall diets differed among reproductive stages, but were similar for paired males ($n = 23$) and paired females ($n = 29$). Mollusks were consumed in greater quantities during rapid ovarian follicle growth and laying than in other reproductive stages. Insects, amphipods, leeches and seeds comprised the majority of diets throughout the reproductive cycle. Lesser Scaup preferred seeds over other foods prior to rapid follicle growth and during laying. Amphipods and trichopteran larvae, the most abundant foods available, were the least preferred foods during these stages. Mollusks also were a preferred food during egg-laying. Availability of amphipods may be a key factor influencing large-scale habitat selection by breeding Lesser Scaup. Wetland management practices that promote macro-invertebrates (especially amphipods) and seed-producing aquatic plants should be emphasized in conservation programs for this species.

DIETA DE INDIVIDUOS DE *AYTHYA AFFINIS* QUE SE ESTÁN REPRODUCIENDO

Sinopsis.—Analizamos la dieta y preferencias alimenticias de individuos del pato *Aythya affinis,* que se reprodujeron en el suroeste de Manitoba. En general la dieta varió entre las diferentes etapas de la reproducción, pero resultó ser similar para machos ($n = 23$) y hembras ($n = 29$) apareados. Durante las etapas de rápido crecimiento de los folículos y puesta, se consumió mayor cantidad de moluscos, que en otras de las etapas de la reproducción. Los moluscos fueron el alimento preferido en la etapa de puesta. La mayoría de la dieta durante el ciclo reproductivo consistió de insectos, anfípodos, sanguijuelas y semillas. Las aves prefirieron semillas, sobre otros artículos alimenticios, previo a las etapas de crecimiento rápido de los folículos y de puesta. Durante estas etapas, los anfípodos y las larvas de tricópteros aunque resultaron ser los alimentos más abundantes, fueron los menos preferidos por los patos. La disponibilidad de anfípodos, podría ser factor clave en la selección de hábitats de parte de estos patos para reproducirse. Las prácticas de manejo que promuevan la producción de macro-invertebrados (particularmente anfípodos) y de plantas acuáticas que produzcan semillas, debe ser enfatizado en programas para la conservación de la especie.

Food resources on breeding areas often are critical for successful reproduction by prairie-nesting ducks. In some species, females accumulate

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energy and nutrient reserves after arrival in spring that subsequently are used during egg-laying and incubation (Afton and Paulus 1991, Alisauskas and Ankney 1991). Clutch formation requires a high daily commitment of energy and nutrients (e.g., Walsberg 1983) because females lay energy-rich eggs (Carey et al. 1980) at a rate of 1/d in most species (Bellrose 1976). Consequently, females feed extensively during this period, and may alter their diets to provide specific nutrients for egg formation (Krapu and Reinecke 1991, Swanson and Duebbert 1989).

Foods consumed by adult Lesser Scaup (*Aythya affinis*; hereafter scaup) during the breeding season have been described (Bartonek and Hickey 1969, Bartonek and Murdy 1970, Dirschl 1969, Munro 1941, Rogers and Korschgen 1966). None of these studies examined diets in relation to reproductive status, and only Bartonek and Murdy (1970) compared foods consumed with their availability in the environment. Here we examine diets of scaup in relation to sex, reproductive status, site-specific food abundance and energy/nutrient requirements for reproduction.

STUDY AREA AND METHODS

We collected actively feeding pairs (Swanson and Bartonek 1970) from April to July, 1977–1980 near Erickson, Manitoba (50°30′N, 99°55′W). Collections were initiated each year only after marked residents arrived (Afton 1984, 1985) and unmarked migrants departed to ensure that specimens represented birds breeding in the area. Hammell (1973), Rogers (1964) and Sunde and Barica (1975) have described the study area in detail.

Contents of the upper digestive tract were removed immediately after collection and preserved in 10% formalin. We combined esophageal and proventricular contents for analysis to maximize sample size (Sugden 1973). Three Ekman dredge (225 cm^2/grab) and three net-sweep (927.7 cm^2/sweep) samples were taken at each feeding site. Dredge samples were washed in a bucket fitted with a brass wire cloth bottom (30 mesh openings/2.5 cm, 0.5-mm aperture). Net sweeps were taken by placing a long-handled net (20 mesh openings/2.5 cm, 1-mm aperture) on the bottom and then rapidly sweeping in an arc up to the water surface. We combined net and dredge samples (on a per unit surface area basis) for comparisons of diets and site-specific food abundance because scaup consumed pelagic and benthic organisms. Food items and habitat samples were sorted, identified, dried at 50–70 C for 24 h, and weighed to the nearest 0.0001 g. Data were summarized as percent occurrence (Swanson et al. 1974) and aggregate percent dry weight (Prevett et al. 1979).

For analysis, we assigned females to various stages of the reproductive cycle (Afton and Ankney 1991): (1) pre-Rapid Follicle Growth (pre-RFG; dry weight of largest ovarian follicle <0.2 g), (2) Rapid Follicle Growth (RFG; largest follicle ≥ 0.2 g), (3) Laying (in RFG with one or more postovulated follicles) and (4) Incubation. Paired males were classified according to reproductive stages of their mates.

We used multivariate analysis of variance (MANOVA) to assess differences in overall diets (aggregate percent dry weights) among reproductive stages and between sexes (PROC GLM, SAS Institute 1987). Major food taxa were used as response variables in the MANOVA (see Table 1). Our sample sizes were too small for tests of annual variation in diets; thus, we pooled data over years (see also Rogers and Korschgen 1966). F-values reported from MANOVA were determined using Wilks' criterion. We used univariate analysis of variance (ANOVA) of each major food taxa to further examine diet differences following a significant overall MANOVA (Barker and Barker 1984). Angular transformations were applied to percent values to more closely meet assumptions of normality (Sokal and Rohlf 1969:386). We compared preferences among foods based on mean differences between ranks of components by usage and availability (Johnson 1980).

RESULTS

We determined diet composition for 23 paired male and 29 paired female scaup collected on 29 different wetlands (Table 1). Overall diets differed among reproductive stages ($F = 2.12$; df = 18, 111; $P = 0.0094$), but were similar for males and females ($F = 0.70$; df = 6, 39; $P = 0.65$). The sex-by-stage interaction also was not significant ($F = 1.49$; df = 18, 111; $P = 0.11$).

The significant difference detected with MANOVA apparently was due to differential consumption of mollusks ($F = 3.04$; df = 3, 48; $P = 0.0378$) and leeches ($F = 2.74$; df = 3, 48; $P = 0.0532$) among reproductive stages. Scaup consumed more mollusks during RFG and laying than in other reproductive stages (Table 1). Fewer leeches were consumed during RFG than in other reproductive stages (Table 1). Consumption of other major food taxa did not differ ($P > 0.19$) among reproductive stages.

Our sample sizes were adequate to examine site-specific food preferences for only pre-RFG and laying stages (Table 2). Scaup exhibited significant food preferences during pre-RFG ($F = 10.30$; df = 10, 11; $P = 0.0003$) and laying ($F = 11.50$; df = 10, 7; $P = 0.002$). In both stages, seeds were preferred over other foods (Table 2). Amphipods and trichopteran larvae, the most abundant foods available (Table 3), were the least preferred foods during these stages (Table 2). Mollusks were more preferred during laying than during pre-RFG (Table 2).

DISCUSSION

Sexual differences in diets have been documented for many prairie-nesting ducks during egg-laying, when females consume large quantities of invertebrates to satisfy protein demands (Krapu and Reinecke 1991, Swanson and Duebbert 1989). In contrast, our results and those of Bartonek and Murdy (1970) indicate that diets of breeding scaup do not differ between sexes. Correspondingly, diets of male and female scaup generally are similar during migration and winter in the Mississippi Flyway (Afton et al. 1991).

We believe that there are at least two explanations for lack of sexual

TABLE 1. Foods consumed by reproductive stage for Lesser Scaup (sexes combined) breeding near Erickson, Manitoba, 1977–1980.

Food	% occurrence				Aggregate %			
	PRE[a] (n = 21)	RFG (n = 9)	LAY (n = 17)	INC (n = 5)	PRE (n = 21)	RFG (n = 9)	LAY (n = 17)	INC (n = 5)
Total animal	100	89	88	100	96.9	83.9	85.4	86.7
Insecta[b]	81	67	82	80	50.2	46.6	34.6	30.8
Odonata	29	56	24	60	9.6	4.8	3.7	23.5
Anisoptera (dragonflies)	5	11	6	20	3.9	2.7	2.6	7.6
Zygoptera (damselflies)	29	44	24	60	5.7	2.0	1.1	15.9
Diptera	38	67	53	20	20.7	32.0	12.7	tr[c]
Chaoborinae (phantom midges)	10	22	18	20	1.7	1.1	1.8	tr
Chironomidae (midges)	38	67	47	0	18.8	30.9	10.9	0
Heleidae (biting midges)	5	11	0	0	tr	0.1	0	0
Tabanidae (horseflies)	5	0	0	0	0.1	0	0	0
Coleoptera	29	56	35	40	0.6	5.8	3.0	0.8
Dytiscidae (predaceous diving beetles)	29	56	35	40	0.6	4.9	3.0	0.8
Gyrinidae (whirligig beetles)	0	11	0	0	0	0.4	0	0
Haliplidae (crawling water beetles)	0	11	0	0	0	0.5	0	0
Hemiptera (water boatmen)	19	22	18	0	4.9	0.8	0.3	0
Ephemeroptera (mayflies)	10	11	24	20	0.5	0.1	2.2	tr
Trichoptera (caddis flies)	43	33	53	60	14.1	3.1	12.7	6.5
Amphipoda (scuds)[b]	48	44	59	80	28.9	28.7	22.7	15.0
Gammarus spp.	48	44	59	40	28.9	28.7	22.5	13.0
Hyallela spp.	0	0	6	40	0	0	0.2	1.9
Mollusks[b]	5	33	53	20	0.3	6.6	5.6	0.1
Gastropoda (snails)	5	33	29	0	0.3	3.2	2.7	0
Pelecypoda (fingernail clams)	0	11	29	20	0	3.4	2.9	0.1
Hirudinea (leeches)[b]	43	22	71	80	17.4	1.7	19.1	40.8
Other animal[b,d]	5	22	18	20	0.1	0.3	3.5	tr

TABLE 1. Continued.

Food	% occurrence				Aggregate %			
	PRE[a] (n = 21)	RFG (n = 9)	LAY (n = 17)	INC (n = 5)	PRE (n = 21)	RFG (n = 9)	LAY (n = 17)	INC (n = 5)
Total plant	33	67	65	100	3.1	16.1	14.6	13.3
Seeds[b]	33	67	65	100	3.1	16.1	14.6	13.3
Amaranthus spp. (pigweed)	0	0	6	40	0	0	tr	0.3
Carex spp. (sedge)	5	0	12	20	0.2	0	0.1	tr
Ceratophyllum spp. (coontail)	0	0	0	20	0	0	0	0.1
Glyceria spp. (mannagrass)	0	11	6	20	0	0.4	0.1	tr
Libiatae (mints)	0	0	6	0	0	0	0.3	0
Myriophyllum spp. (watermilfoil)	10	0	6	60	0.8	0	5.1	8.3
Polygonum spp. (smartweed)	5	0	12	20	0.2	0	3.5	2.4
Potamogeton spp. (pondweed)	5	11	0	40	0.1	tr	0	0.2
Scirpus spp. (bulrush)	19	67	53	80	1.8	14.3	5.4	1.6
Sparganium spp. (burreed)	0	0	12	20	0	0	0.2	0.3
Unknown seeds (fragments)	5	11	0	20	tr	1.3	0	tr

[a] PRE = pre-Rapid Follicle Growth, RFG = Rapid Follicle Growth, LAY = Laying, INC = Incubation.
[b] Category used as response variable in MANOVA.
[c] tr = values less than 0.05.
[d] Includes Cladocera, fish, Ranidae tadpoles, Aranea, Hydracarininae, and Nematomorpha.

TABLE 2. Food preferences by reproductive stage for Lesser Scaup (sexes combined) breeding near Erickson, Manitoba, 1977–1980.

Stage	Preference rank[a]										
	1	2	3	4	5	6	7	8	9	10	11
PRE[b] (n = 21)	SEE[c]	EPH	OTH	ODO	COL	MOL	DIP	LEE	HEM	TRI	AMP
LAY (n = 17)	SEE	MOL	EPH	DIP	OTH	COL	HEM	LEE	ODO	TRI	AMP

[a] Rank 1 = most preferred.
[b] PRE = pre-Rapid Follicle Growth, LAY = Laying.
[c] SEE = seeds, EPH = Ephemeroptera, OTH = other animal, ODO = Odonata, COL = Coleoptera, MOL = mollusks, DIP = Diptera, LEE = leeches, HEM = Hemiptera, TRI = Trichoptera, and AMP = Amphipoda; foods underscored with the same line are statistically similar ($P > 0.05$).

TABLE 3. Food abundance by reproductive stage at Lesser Scaup collection sites near Erickson, Manitoba, 1977–1980.[a]

Food	% occurrence				Aggregate %			
	PRE[b] (n = 21)	RFG (n = 9)	LAY (n = 17)	INC (n = 5)	PRE (n = 21)	RFG (n = 9)	LAY (n = 17)	INC (n = 5)
Total animal	100	100	100	100	99.7	99.6	99.6	91.0
Insecta	100	100	100	100	35.9	45.2	23.3	17.7
Odonata (dragonflies, damselflies)	57	56	100	60	3.0	3.9	2.0	6.4
Diptera (flies, midges)	90	67	100	60	12.8	6.5	2.8	2.8
Coleoptera (beetles)	81	100	100	100	2.4	0.8	1.6	1.9
Hemiptera (water boatmen)	90	67	100	100	1.7	1.3	1.3	0.7
Ephemeroptera (mayflies)	43	11	29	20	0.6	tr[c]	0.5	0.3
Trichoptera (caddis flies)	86	100	100	60	15.3	32.6	15.1	5.8
Amphipoda (scuds)	90	67	88	100	45.5	30.2	43.2	53.3
Mollusks	48	44	53	100	6.4	10.7	8.6	4.6
Gastropoda (snails)	48	44	41	100	5.9	10.5	7.8	4.6
Pelecypoda (fingernail clams)	29	11	18	0	0.5	0.3	0.7	0
Hirudinea (leeches)	86	78	100	100	9.9	12.9	14.8	14.9
Other animal[d]	38	11	53	60	2.0	0.6	9.8	0.5
Total plant	57	33	41	80	0.3	0.4	0.4	9.0
Seeds	57	33	41	40	0.3	0.4	0.4	8.9
Tubers	10	0	29	40	tr	0	0.1	0.2

[a] Net and dredge samples combined—see methods.
[b] PRE = pre-Rapid Follicle Growth, RFG = Rapid Follicle Growth, LAY = Laying, INC = Incubation.
[c] tr = values less than 0.05.
[d] Includes Cladocera, fish, Ranidae tadpoles, Aranea, Hydracarininae, and Nematomorpha.

differences in diets of breeding scaup. Firstly, diets of scaup are comprised primarily of aquatic invertebrates throughout the year (Afton and Ankney 1991). Other prairie-nesting ducks are omnivorous, with plant material predominating in the non-breeding season and more animal material consumed during nesting (Alisauskas and Ankney 1991). As carnivorous species (e.g., scaup) have a diet inherently high in protein, females have no need to switch to a "more proteinaceous" diet during egg-laying. Secondly, forced copulations are frequent in scaup, and paired males spend considerable time in mate-guarding behavior, apparently to protect their genetic paternity (Afton 1985). Consequently, paired males usually are in close contact with their mates and thus feed in the same areas.

Diets of prairie-nesting ducks are influenced by a variety of factors, including energy/nutrient requirements and varying food availability (Alisauskas and Ankney 1991, Krapu and Reinecke 1991). Female scaup accumulate protein reserves while on breeding areas before and during laying, and then utilize these reserves to support partially their metabolism during incubation (Afton and Ankney 1991). Protein storage by females and their complete reliance on exogenous protein to meet requirements of egg production (Afton and Ankney 1991) were facilitated by the high proportion of animal foods consumed (Table 1), and high densities of aquatic invertebrates in the breeding habitats of these ducks (Table 3).

Females store small amounts of lipids while on breeding areas before laying, and subsequently utilize considerable amounts of lipid reserves during egg formation (Afton and Ankney 1991). Despite this strong reliance on endogenous lipids, lipids derived from the diet contribute importantly to egg production. Scaup preferred seeds, despite their relatively low abundance at foraging sites (Table 3), and seeds comprised 3–16% of diets throughout the breeding season (Table 1). Consumption of carbohydrate-rich seeds (Krapu 1979, Woodin and Swanson 1989) by scaup may be advantageous in meeting daily energy expenditures of both sexes and energetic costs of egg production by females.

Females also accumulate mineral reserves while on breeding areas before laying (Afton and Ankney 1991). These reserves decline during laying, accounting for the shell of one egg in an average 10-egg clutch (Afton 1984). Consequently, we expected that females would consume foods with a high mineral content during egg production (cf. Krapu 1979). Our findings, that scaup selected and increased their consumption of mollusks just before and/or during laying, were consistent with this argument.

Several studies, conducted throughout the breeding range of scaup, have documented that amphipods are principal foods of adults during the breeding season (Bartonek and Hickey 1969, Bartonek and Murdy 1970, Dirschl 1969, Munro 1941, Rogers and Korschgen 1966). Similarly, we found that breeding scaup consumed large quantities of amphipods. Amphipods also are a primary food of young scaup on breeding areas (Austin 1983, Bartonek and Hickey 1969, Bartonek and Murdy 1970, Sugden 1973) and migrant scaup during spring and fall in the upper Midwest

(Afton et al. 1991). Consequently, we hypothesize that availability of amphipods is a key factor influencing selection of breeding habitats by scaup (i.e., first-order selection of Johnson 1980). Our findings, that amphipods were least preferred of the major food taxa, appears contradictory to this hypothesis. Our preference analysis, however, was concerned with procurement of food items from those available at specific foraging sites (i.e., fourth-order selection), and consequently does not preclude that amphipods are important in large-scale habitat selection by scaup (see Johnson 1980:69). Finally, we recommend that conservation programs for breeding scaup include wetland management practices that promote macro-invertebrates (especially amphipods) and seed-producing aquatic plants.

ACKNOWLEDGMENTS

We are greatly indebted to Marlene Afton and several Webster Fellows for initial washing and sorting of habitat samples. We thank Bruce Batt, Richard Crawford, Todd Eberhardt and Rod Sayler for administrative assistance in allowing us to complete this study. Richard Pace, III made valuable suggestions regarding the statistical analysis, and Dave Ankney, Jane Austin, Ron Bielefeld, Fred Bryan, Bob Chabreck, Bobby Cox, Bob Hamilton, Bill Hohman, Roger Lake, Mike Peters and Mike Zicus provided helpful comments on the manuscript. We gratefully acknowledge the following for financially and logistically supporting one or more aspects of the research and manuscript preparation: Alumni Association, Department of Biology, Institute for Ecological Studies, and Sigma Xi chapter of the University of North Dakota; James Ford Bell Sr. Memorial Fellowship Fund and North American Wildlife Foundation through the Delta Waterfowl and Wetlands Research Station; Canadian Wildlife Service; Minnesota Department of Natural Resources; U.S. Fish and Wildlife Service through the Louisiana Cooperative Fish and Wildlife Research Unit; and School of Forestry, Wildlife and Fisheries at Louisiana State University.

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Received 27 Jul. 1990; accepted 23 Oct. 1990.