Temporal Changes in Fall and Winter Foods of Canada Geese

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Abstract: We studied fall and winter food habits of Canada geese (*Branta canadensis*) in the Swan Lake Zone of north-central Missouri during the 1980–82 hunting seasons. Gizzards from hunter-killed geese were obtained during 5 periods of each hunting season. Average proportions of native foods, row crops, winter wheat, and other forage were highly variable among and within years. Row crops in the diet ranged from an average of 1.1% to 99.6% by volume, compared to 0.3% to 98.8% for native foods. In general, row crops increased and native foods decreased in average percent volume through the hunting season, except in 1982, when floods during the hunting season likely kept native foods available all season. Winter wheat (*Triticum aestivum*) comprised up to 26.2% average volume. Cold temperatures and snow and ice accumulations increased use of row crops and decreased use of native foods within a season. We recommend that management for Canada geese include providing native foods to ensure that a range of food alternatives is available.

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North American Canada goose populations have increased concurrently with increased management of public wetlands to provide food and refuge and control of goose harvest (Hanson and Smith 1950, Vaught and Kirsch 1966, Crider 1967,

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Bellrose 1978:142). During fall and winter, geese are concentrated primarily on state, provincial, and federal wetland management areas.

Canada geese of the Eastern Prairie Population (EPP) (mostly *B. c. interior*) nest in northern Manitoba, migrate through the upper midwest (Vaught and Kirsch 1966, Bellrose 1978, Malecki et al. 1981), and winter primarily in north-central Missouri (Miss. Flyway Counc. Tech. Sec. 1986). Swan Lake National Wildlife Refuge (NWR) and Fountain Grove Wildlife Area (WA) are the major wintering areas (Humburg et al. 1985). Harvest and habitat management have been largely responsible for an increase in the EPP from <30,000 geese during the late 1940s to >200,000 in 1975 (Miss. Flyway Counc. Tech. Sec. 1986). Peak Canada goose numbers during the years of this study ranged from 123,000 to 164,000 in the Swan Lake area (Mo. Dep. Conserv. unpubl. data).

Row crops and winter wheat are available on most managed public areas. Food produced on public land 1) helps to ensure availability of seasonal food requirements, 2) allows more precise control of goose harvest rates (Vaught and Kirsch 1966), and 3) increases acceptance of geese by private landowners (Miss. Flyway Counc. Tech. Sec. 1986). Geese also obtain waste grain and winter wheat forage from private lands in the Swan Lake area.

Corn (*Zea mays*) is a major component in diets of many geese (Craven and Hunt 1984), and habitat management for Canada geese traditionally includes row crops (mainly corn), green forage, and refuge. Recently, managers have become more concerned about providing for the range of nutritional requirements of geese. Although nutritional requirements of Canada geese are poorly understood, native foods may provide a nutritional alternative or supplement to agricultural foods for nonbreeding waterfowl (see Fredrickson and Taylor 1982), including Canada geese.

Early information on Canada goose diets in Missouri indicated that geese consume large amounts of corn when available but also use native foods to a large extent (Helm 1951; Korschgen 1952, 1955). These native foods typically are the desired results of moist-soil management techniques (Fredrickson and Taylor 1982) and also occur naturally when soil and water conditions are favorable. Geese extensively use these habitats, primarily when inundated, in both managed and natural situations (Austin 1988). Managers using moist-soil techniques often provide native foods for migrating and wintering ducks but rarely consider this habitat management alternative for Canada geese.

Temporal changes in food availability to field-feeding waterfowl affect their diets, habitat use, and movements (Jorde et al. 1983, 1984; Baldassarre and Bolen 1984; Hobaugh 1984; Humburg et al. 1985). Food availability, weather, farming conditions, and hunting pressure likely influence distribution and, hence, food habits of migrating and wintering geese in north-central Missouri (Humburg et al. 1985). Information on temporal variation in diets may aid in developing habitat management plans. Consequently, the objective of this study was to investigate seasonal and year-to-year patterns in diets in Canada geese in the Swan Lake Zone, Missouri.

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Methods

The Swan Lake Zone is a 3,626-km^2 goose management area that includes Swan Lake NWR and Fountain Grove WA. Contents from goose gizzards, collected for a shot ingestion study (Humburg and Babcock 1982), were used in this investigation of the seasonal dynamics of Canada goose food habits. Gizzards from hunter-killed birds were collected from local goose processors and from biological check stations at Swan Lake NWR and Fountain Grove WA during the 1980–82 hunting seasons, which ensured that samples were collected throughout the zone, from both public and private land. Each year, gizzards were collected during 5 periods throughout 70-day hunting seasons, which opened 1 November 1980, 31 October 1981, and 30 October 1982. Each 6-day collection period was separated by 10 days when no gizzards were collected.

Contents were removed from gizzards and oven-dried. Food was separated from grit and shot (Humburg and Babcock 1982). We identified the species of plant and animal foods and measured volumes. Aggregate percent volumes were calculated for each food type. Seeds were identified using a reference collection of Missouri seeds, and green vegetation was identified using macroscopic characteristics, and microscopic characteristics of leaf epidermal tissues. Foods were assigned to 5 general categories: row crops, winter wheat, other forage, native foods, and animal foods. Row crops included corn, sorghum (*Sorghum vulgare*), and soybeans (*Glycine max*). Other forage included foods such as brome grass (*Bromus* spp.) and clover (*Trifolium* spp. and *Melilotus* sp.). Native foods consisted primarily of seeds from species such as smartweed (*Polygonum* spp.), spikerush (*Eleocharis* spp.), and wild millet (*Echinochloa* spp.) but also included the associated tubers, stems, and leaves of these species.

Methods used in this study, specifically, gizzard samples obtained from hunter-killed geese, allowed us to compare results to those from earlier food habits research in the Swan Lake Zone (Helm 1951; Korschgen 1952, 1955). We did not analyze esophageal contents, nor did we collect birds that were observed feeding (Swanson and Bartonek 1970). Post-mortem digestion and differential digestive rates of foods have been cited as biases when only gizzards are used in food habits analyses (Swanson and Bartonek 1970, Sedinger 1986). Hence, various foods could be represented in proportions different from those actually ingested. Soft-bodied invertebrates, a food type most prone to post-mortem and rapid digestion in waterfowl (Swanson and Bartonek 1970), have not been reported in Canada goose food habits studies. Leafy vegetation is among the most easily digested goose foods. Although leaves often appeared relatively undigested in gizzards examined, this food type may have been underrepresented. Despite these potential biases, we believe our results from gizzard analyses provide an index that reflects seasonal and annual

variations in Canada goose food habits because, as a result of large sample sizes, the probability of detecting important foods was greater.

A wide range of weather and crop conditions occurred within and among years. Monthly and annual reports from Swan Lake NWR and Fountain Grove WA provided information on food availability, timing of weather events (floods, droughts, freezes, and snows), and timing of goose movements and use of managed areas.

We used 2-way ANOVAs to test effects of period and year and their interaction on volumetric proportions of each of the 5 food types present in individual gizzards (sample units). These proportions were transformed (arcsin of the square root of the percentage) to minimize departures from normal and homoscedastic distributions.

Results

We identified 172 different foods in 1,132 gizzards during the 3 years of collection. The 10 most important foods by frequency of occurrence were knotweed seeds (*Polygonum pensylvanicum*), sorghum grain, corn, nodding smartweed seeds (*P. lapathifolium*), winter wheat vegetation, blunt spike rush seeds and vegetation (*Eleocharis obtusa*), barnyard grass seeds (*Echinochloa muricata*), acorns, nodding foxtail seeds (*Setaria faberii*), and yellow nutgrass (primarily tubers) (*Cyperus esculentus*). Seven of these 10 were in the native foods category. The 5 most prominent foods by aggregate percent volume were sorghum grain, knotweed seeds, corn, winter wheat vegetation, and barnyard grass seeds. Animal foods comprised $<1\%$ of food items by volume in all periods and, therefore, were excluded from further analyses.

Crop production on Swan Lake NWR and Fountain Grove WA varied among years; combined grain production for the 2 areas was estimated to be 2.1 million kg (81,200 bushels) in 1980, 0.4 million kg in 1981, and 1.0 million kg in 1982. Little wheat forage was available in 1982, when planting was delayed by wet weather. Fall tillage of private crop fields also was affected. Native food production was rated as fair in 1980, poor in 1981, and excellent in 1982; total production at Swan Lake was estimated to range from 159,000 kg to 780,000 kg (Swan Lake NWR and Fountain Grove WA annual reports). Severe cold and snow characterized December and January 1981–82, whereas 1982–83 was extremely mild. Precipitation extremes occurred in 1980 (drought) and 1982 (8 floods during the growing season). Fall and early winter flooding occurred in early November 1981 and 1982 and in early December 1980 and 1982.

Average proportions of native foods, row crops, winter wheat, and other forage in Canada goose diets differed among years, and among periods within years (Table 1). The types of food used among periods within a year also differed among years, as evidenced by the significant year-by-period interaction (Table 1).

Native foods were important in goose diets during November and early December 1980 (Periods 1–3) and declined in importance by late December (Period 4), when the proportion of row crops in the diet increased (Table 1). Agricultural foods (row crops, $\bar{x} = 78\%$, and winter wheat, $\bar{x} = 12\%$) comprised essentially the entire

Table 1. Average percent volume of each food type present in Canada goose gizzards from the Swan Lake Zone, Missouri, by year and period,[a] 1980–82.

Year and Period (*N*)	Native foods[b] $\bar{x}$	Native foods[b] SD	Row crops[b] $\bar{x}$	Row crops[b] SD	Winter wheat[b] $\bar{x}$	Winter wheat[b] SD	Other forage[c] $\bar{x}$	Other forage[c] SD
1980–81								
1 (106)	33.7	41.4	30.4	40.8	16.1	33.5	0.0	0.0
2 (101)	20.0	33.8	47.6	43.6	13.8	31.6	4.4	17.0
3 (99)	33.3	37.0	50.6	40.1	10.8	25.3	2.7	15.7
4 (100)	11.2	22.5	61.1	40.4	20.3	35.1	2.0	11.0
5 (65)	4.8	14.0	77.8	34.2	12.2	29.6	3.8	17.3
1981–82								
1 (99)	94.0	15.2	2.1	0.3	1.2	5.5	0.4	3.8
2 (101)	50.1	36.5	22.2	33.5	17.6	32.9	5.2	19.8
3 (100)	54.0	38.7	19.3	31.2	8.6	24.8	1.7	12.0
4 (95)	20.5	32.2	38.6	43.3	26.2	38.3	2.5	14.1
5 (30)	0.3	1.4	99.6	1.4	0.0	0.0	0.0	0.0
1982–83								
1 (98)	54.7	45.8	12.6	30.9	1.3	9.2	5.9	23.0
2 (60)	49.8	39.3	40.8	41.2	1.6	12.7	1.2	6.8
3 (15)	98.8	2.8	1.1	2.8	0.0	0.0	0.0	0.0
4 (31)	70.7	40.3	12.4	29.4	0.0	0.0	0.0	0.0
15 (32)	49.8	33.4	24.8	32.1	0.0	0.0	6.3	17.9

[a]Gizzards were collected during 5 6-day periods throughout 70-day hunting seasons, which began November 1980, 31 October 1981, and 30 October 1982. Collection periods were separated by 10 days when no gizzards were collected.

[b]$p < 0.001$; Year main effect, Period main effect, and Year X Period interaction (2-way ANOVA).

[c]$p = 0.022$; Year X Period interaction (2-way ANOVA).

diet in early January 1981 (Period 5). A similar pattern occurred during 1981–82; the proportion of row crops increased and native foods decreased as the season progressed. Native foods were the predominant food item throughout the 1982–83 season (Table 1). In contrast to January 1981 and 1982, row crops comprised only 25% of the diet in early January 1983 (Period 5). Winter wheat did not occur in goose diets throughout most of the 1982–83 season.

Discussion

Native foods were among the most important items in diets of Canada geese in our study. Thirty years earlier, native foods also were important in the fall and early winter diets of Canada geese in north-central Missouri (Korschgen 1955). In the earlier study, native foods accounted for 76.4%, row crops 8.7%, winter wheat 6.1%, and other forage 8.1% of the aggregate food volume in gizzards collected between late October and mid-December. Canada geese also used native foods when weather conditions were severe or when corn fields were covered with snow (Helm 1951). Geese remained on large lakes in the refuge and used exposed native foods on adjacent shorelines, rather than flying to corn fields.

We did not account for potential biases resulting from temporal and spatial

patterns in goose feeding or harvest. For example, if geese were shot predominantly as they left either moist-soil areas or agricultural fields, that particular food type potentially may have been over-represented. However, gizzard collections occurred throughout the day, the zone, and the season each year to minimize these potential biases. The relative proportions of food types reported in this study do not conflict with patterns of food use expected based on habitat use in the Swan Lake Zone (Austin 1988).

Seasonal patterns in goose diets varied among years during our study. Shifts from use of native to agricultural foods corresponded to periods of severe weather conditions, which is in contrast to Helm's (1951) findings. Flooding in early November 1981 and 1982 and early December 1980 and 1982 inundated additional native foods, and geese fed extensively on this food type. The seasonal pattern of food habits during 1982–83 differed from the previous 2 years. Geese fed largely on native foods throughout the 1982–83 season, rather than switching to row crops as winter progressed. Abundant native foods, mild weather, and flooding likely explain continued use of native foods during early winter 1982. During the mid-1980s, Austin (1988) found that Canada geese in the Swan Lake Zone during the hunting season (early November through mid-December) spend a larger proportion of the day feeding in seasonal wetlands than in all other habitats combined. In late fall and winter, Canada geese using inundated seasonal wetlands feed almost entirely by tipping-up and by foraging on the water surface (Austin 1988). In the Swan Lake Zone, Canada geese use seasonal wetlands in proportion to or greater than their availability in nearly all seasons and years of the study (Austin 1988).

Grain produced on Swan Lake NWR has been particularly important for geese during November and December (Miss. Flyway Counc. Tech. Sec. 1986). From 1955–84, the number of Canada geese present on Swan Lake NWR in early December was related to the amount of agricultural crops produced on the refuge, but goose numbers in early January, when geese begin to leave public areas (Miss. Flyway Counc. Tech. Sec. 1986), were not correlated with refuge crop production (Humburg et al. 1985). During 1980–82, geese consumed native foods during periods of relatively mild weather or flooding and used crops to the greatest extent late in the season when severe weather occurred. Management of native foods provides more feeding options for geese early in the fall and increases the likelihood that crops will be available on managed areas later in the season.

Based on the observed seasonal diet shifts, agricultural crops and native foods seem to be complimentary in diets in Canada geese in the Swan Lake Zone. We believe the use of row crops and of forage would have been consistently greater if other food alternatives were less available in the Swan Lake Zone. Food availability to geese in the Swan Lake Zone is influenced by habitat management, land use, and environmental conditions throughout the year. Food availability on private lands is influenced by weather during the growing season and harvesting, and by the prevalence and timing of fall tillage (Humburg et al. 1985).

Corn and wheat have been the primary components of Canada goose habitat management; however, our study and others conducted in the Swan Lake Zone

indicate that Canada geese use a wide range of foods, including substantial amounts of native foods, when available. Although row crops provide an important energy source, especially during cold temperatures, a diet comprised solely of row crops may be nutritionally inadequate, if research on duck nutrition holds true for geese (see discussions in Fredrickson and Taylor 1982, Baldassarre et al. 1983). Managing agencies must assume responsibility for providing a substantial portion of goose food requirements for all seasons because Canada goose management programs depend on tolerance and support by private landowners. A balanced management program will ensure that a range of nutritional alternatives is available despite weather variances, budget constraints, or other factors. We recommend that native or moist-soil type foods be incorporated, perhaps by management of seasonal wetlands, into crop/wheat management systems for wintering Canada geese.

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