Canada Goose foods: their significance to weight gain

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Introduction

Geese have been shown to be selective grazers, using some plants but refusing others (Owen 1972). Discrimination between preferred and non-preferred foods appears to be based on the relative nutritional benefits gained from them (Thomas and Prevett 1980). Owen (1975) and Harwood (1977) found that both breeding and wintering geese selected vegetation high in nitrogen content. On autumn staging areas, geese are building up energy reserves (Ankney and MacInnes 1978; Wypkema and Ankney 1979; Thomas and Prevett 1980), and may be selecting for other nutrients such as carbohydrates and fats, the high energy foods. Much research, concerned with testing aspects of foraging theory, has treated consumption in qualitative terms involving measurements of energy values (Rapport 1971; Pulliam 1974). However, Pyke *et al.* (1977) have indicated that there are limitations to this approach. In order to study the consequences of food selection, a measure of the relative benefits accruing to the consumer while foraging on each food type in a natural setting should be made. The food selected should be the one which produces the greatest relative benefit to the individual. This benefit can be measured in terms of weight change over time.

A population of Canada Geese *Branta canadensis* staging on the Nisutlin River delta during the autumn have access to a variety of vegetation zones but graze in only a few. The most preferred food appeared to be the rhizomes of *Potamogeton richardsonii* an aquatic species growing in shallow water. The stems of *Equisetum palustre* growing among several other species on exposed mudflats, ranked second. The least preferred of the food plants, *Equisetum fluviatile*, is apparently taken only if rising water levels prevented the geese from using the other two major vegetative zones. *Ranunculus reptans*, *Eleocharis palustris*, and *Hippuris vulgaris* were also eaten in small amounts. If geese staging on this delta base their preferences on organic nutrient content of the foods chosen, then one would predict a similar ranking in nutrient content to that shown in preferences.

In this paper we report on the nutrient content of these foods and examine the benefits to geese, in terms of weight change, of feeding in two of the vegetative zones.

Study area

The study area, a delta at the mouth of the Nisutlin River (60°12′–60°15′N, 132°35′–132°39′ W), is recognised in unpublished reports as one of the most important autumn staging areas for waterfowl in the southern Yukon. It is located 12.5 kilometers East North East of the settlement of Teslin, and supports a population of Canada Geese of varying size (Coleman 1984) from about August until freeze up (October 1st – November 1st).

Methods

Samples of plants were collected on August 24th 1983, five of 5 g (dry weight) each of *Potamogeton richardsonii* (rhizomes), *Equisetum fluviatile* (stems), *E. palustre* (stems), and *Hippuris vulgaris* (rhizomes). *E. palustre* was observed to be the main component (85%) of the diet of geese feeding in the zone where it grew; the remainder was made up of *Ranunculus reptans* (10%) and *Eleocharis palustris* (5%). Ten representative samples containing a mix of these three food items in proportion to their observed use, were also collected for analysis. Sample size was doubled in this case because of potential variability. The samples were sorted and dead material rejected as geese are known to select against this (Owen 1972). The samples were dried, stored for up to three months, and analysed for nutrient content. Faecal samples were collected from the groups of tame geese (see below) known to have been feeding on specific zones. Five samples of faecal pellets were collected from geese feeding on *Equisetum fluviatile*, on *E. palustre*, and on a combination of *E. palustre*, *Ranunculus reptans*, and

Wildfowl 38 (1987): 82–88

Eleocharis palustris. These samples were also dried and preserved for future analysis.

The dried samples were finely ground (60-mesh screen). Analyses were in duplicate and, when possible, in triplicate. Protein was obtained as percent nitrogen x 6.25 by Kjeldahl determination as in Marriot and Forbes (1970) and Burton *et al.* (1978). Cellulose and ash for all samples was determined through a neutral-detergent fibre (NDF) procedure which produces a measure of cell wall constituents (Goring and Soest 1970; Maynard and Loosli 1979). The amount of soluble carbohydrates (cell contents) was determined from the formula: 100−%NDF−%crude protein= %soluble carbohydrate (Schaible 1976). Proportional uptake of carbohydrates was determined by comparing carbohydrate composition of the plants and faeces. The latter was corrected for the concentration effect of fibre.

Protein, total non-structural carbohydrate (TNSC), and fibre levels for the plant samples were compared using a one-way analysis of variance and significance was determined using Sheffe's Multiple Contrast method (Zar 1974) and Students t procedures. The analysis of variance was run on a MINITAB (1981) statistical package sub-program. Data sets for the faecal material were analysed by un-paired t test as were comparisons between plant and faecal material.

The relative nutrient value of food plants to Canada Geese was tested by allowing one group of these birds to graze in each of two vegetative zones. The geese were raised from eggs collected in the wild near Brooks, Alberta, hatched, imprinted on humans, and reared until they were 10 weeks old, when they were transported to the Yukon. During the period of imprinting they were raised in isolation from other groups of Canada Geese and allowed to graze on natural vegetation. Being imprinted, we were able to lead them to specific vegetative zones on the delta where they grazed freely. Their primaries were clipped to prevent flight.

The geese were subdivided into two groups, each consisting of six juvenile birds, three of each sex. To avoid the possibility of genetic bias, siblings were not placed in the same group.

Because of the inaccessibility of the *Potamogeton* zone in 1983 and the importance of *Equisetum palustre* in years of average water levels, we compared the nutritional benefits of grazing on *E. palustre* with that of grazing on *E. fluviatile*. This latter zone was grazed less and only when water levels on the area were higher than normal.

The imprinted geese were allowed to graze freely on the chosen zones for about 9.0 hours per day. To determine rate of intake, a comparison of grazed and ungrazed areas was made every third day, from 14th to 22nd August, in the following way. The geese were restrained within a 6 m enclosure and allowed to feed for 30 minutes. Within this enclosure was a .50 m exclosure. The standing crop within the enclosure was then compared with the average of two or three representative grazed areas of similar size. In this way the rate of food consumption in each zone and total amount taken per day were estimated. The two groups of geese were allowed to graze freely on the separate areas from 10th to 24th August 1983. Their weights were recorded every morning prior to grazing using a Pesola 10-kilogram spring balance.

Grazing rates, in terms of bites per minute (BPM), were recorded for both tame and wild geese to compare rates of intake. Because the wild population fed mainly in the *E. palustre* zone, comparisons were only made in that area.

Analysis of BPM and weight change data sets was done using regression analysis and un-paired t test sub-programs of the MINITAB (1981) statistical package. Instructions for procedures in this program can be found in Ryan *et al.* (1976).

Results

A nutritional analysis of the samples of vegetation grazed showed that the fibre content of rhizomes of *Potamogeton richardsonii* was significantly lower (half or less) than that of all other foods ingested (Table 1). *E. palustre* was significantly lower in fibre than the rest of the samples. Although the fibre content of the faeces produced by geese feeding on different foods did not vary significantly from one another, all three showed some measure of fibre concentration from food to faeces.

The crude protein content of *E. palustre* was significantly greater than that of all other species tested, the other species of horsetail, *E. fluviatile*, coming second. Protein levels of faeces and plants were not

Table 1. Fibre, crude protein, total non-structural carbohydrate (TNSC) content (mean % dry weight ± SD) of food plants and faeces of Canada Geese staging on the Nisutlin River delta. Samples taken on August 24th 1983.

Food	Sample Size	Fibre Content	Crude Protein	TNSC Content	Ash Content
Potomageton richardsonii	5	13.77 ± 1.72[a1]	7.38 ± 1.33[a]	74.38 ± 4.18[a]	4.47
Equisetum palustre	5	26.00 ± 3.00[b]	18.56 ± 0.49[b]	51.28 ± 4.16[b]	4.15
Equisetum fluviatile	5	31.31 ± 2.97[c]	13.64 ± 1.02[c]	52.28 ± 3.62[b]	2.79
Mixture[2]	10	31.24 ± 7.35[c]	9.66 ± 1.41[d]	34.99 ± 12.10[c]	24.11
Hippuris vulgaris	5	30.37 ± 7.25[c]	9.08 ± 1.03[d]	40.88 ± 6.50[c]	19.57
Faeces					
Equisetum palustre	5	37.90 ± 8.26[d]		24.01 ± 6.89[d]	17.87
Equisetum fluviatile	5	31.38 ± 2.86[d]		41.26 ± 6.01[e]	15.76
Mixture	5	34.90 ± 2.20[d]		33.72 ± 8.26[f]	17.24
Proportional uptake[3]					
Equisetum palustre				53%	
Equisetum fluviatile				21%	

[1]Based on Sheffe's Multiple Contrast Method. Values with the same letter, within a column, not significantly different from one another (P>0.05).

[2]Contained stems of *Equisetum palustre* (85%), *Ranunculus reptans* (10%), and *Eleocahris palustris* (5%).

[3](%TNSC content in food – %TNSC content in faeces/%TNSC content in food) × 100.

compared because of the presence of uric acid in the faecal samples.

Non-structural carbohydrate levels present in *P. richardsonii* were significantly higher than in all the other foods, whereas those in the two species of *Equisetum* did not differ significantly, but were higher than in the other samples. The faecal samples showed a significantly lower level of TNSC in *E. palustre* than in *E. fluviatile*. Uptake of TNSC for the *E. palustre* was 53% of dry weight, whereas for *E. fluviatile* it was only 21%. Digestibility of carbohydrates is related to the relative proportion of non-digestible components, fibre and ash, of the food plants. Thus, TNSC was removed from foods at a rate relative to the proportion of non-digestibles present, making the more fibrous *E. fluviatile* less digestible than *E. palustre*. The goose foods tested are ranked according to preference and organic nutrient content in Table 2. This ranking suggests that fibre content and TNSC are more important than protein content during autumn staging.

Feeding rate, in terms of bites per minute

Table 2. Ranking of goose food plants growing on the Nisutlin River delta according to preference and content of fibre, protein and TNSC.

Food	Preference	Fibre	Protein	TNSC
Potamogeton richardsonii	1	4	4	1
Equisetum palustre	2	3	1	3
Equisetum fluviatile	3	1	2	2
Hippuris vulgaris	4	2	3	4

(BPM), for wild geese (n=130) and for geese in the two tame flocks (n=104 and 86) were recorded over the course of the day (Figure 1). No significant differences existed between grazing rates of the tame and wild flocks feeding in the *Equisetum palustre* zone (pooled t, 16df, P>.75), however, feeding rates in this zone were significantly greater than in the *E. fluviatile* zone (pooled t, 10df, P<.0005). If this difference in rate was related to handling time for the different foods, did it also reflect the amounts eaten per day in the two vegetative zones, or was the lower feeding rate compensated for by larger bite size? The tame geese grazing on *E. palustre* ingested an average of 91.8 grams (dry weight) per day, whereas the geese feeding on *E. fluviatile* ingested an average of 83.2 grams per day. The difference in intake between the two groups was not significant, indicating that the increased weight of food taken per bite, by the group grazing on *E. fluviatile*, compensated for the smaller number of bites taken.

The response, in terms of weight gain, by the two groups grazing on different vegetation, was followed over a period of 14 days (Figure 2). Weights in the groups of tame birds were similar at the onset of the experiment (Table 3). Weights taken when the feeding experiment was ended showed the birds grazing on *E. palustre* had gained steadily by an average of 21% of original body weight over the 2-week period and were significantly heavier (P<0.05) than those grazing on *E. fluviatile*, which had lost an average of 2%. There were no significant differences between sexes in the rate of change, actual weight changes, or BPM.

Discussion

Rhizomes of *Potamogeton richardsonii* are the most preferred food items of Canada Geese staging on the Nisutline River delta. When tested for organic nutrients against the three other major food types, *Potamogeton* was found to contain the lowest fibre

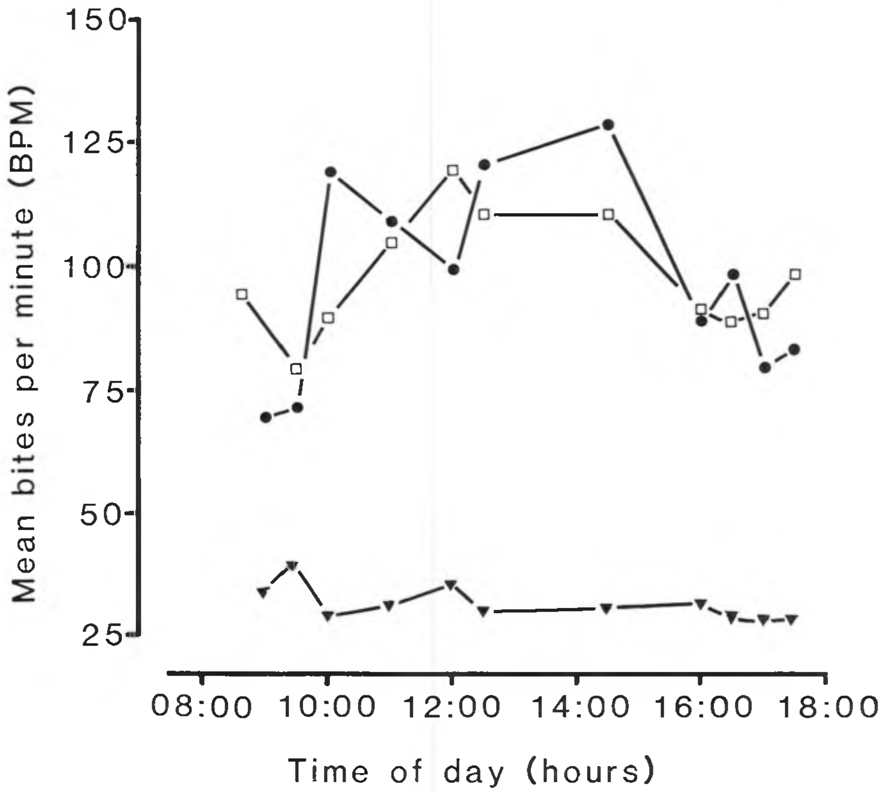

Figure 1. Feeding rates of Canada Geese. Upper two graphs, wild (squares) and tame (circles) geese foraging on *Equisetum palustre*; lower graph, tame geese on *E. fluviatile*.

Figure 2. Weight changes in tame Canada Geese foraging on two different habitats.

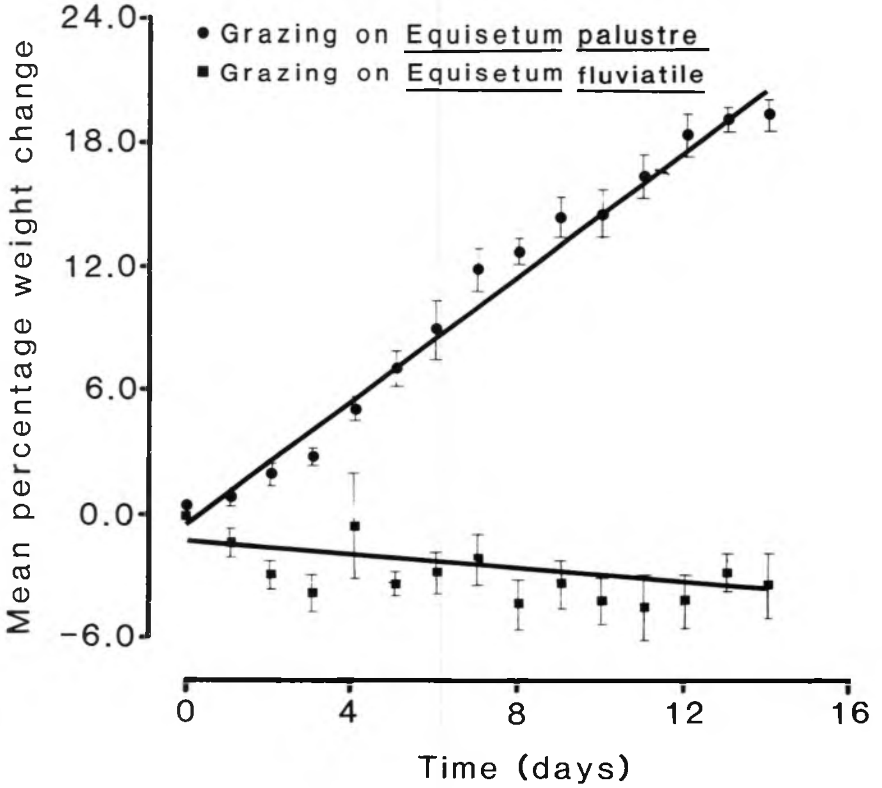

Table 3. Weights (kg) on days 1 and 14 for two groups of tame Canada Geese grazing for 9 hours per day on two different foods.

Sex and Bird No.	Group 1 (*E. palustre*)							Group 2 (*E. fluviatile*)						
	M_1	M_2	M_3	F_1	F_2	F_3	Mean	M_4	M_5	M_6	F_4	F_5	F_6	Mean
Aug 10th	2.80	2.00	2.23	2.91	2.47	2.21	2.44	2.72	2.29	2.04	2.49	2.49	2.43	2.41
Aug 24th	3.24	2.46	2.84	3.52	2.93	2.74	2.96	2.53	2.17	2.12	2.46	2.37	2.45	2.35
% gain/loss	+16	+23	+27	+21	+19	+24	+21	−7	−5	+4	−1	−5	+1	−2

and protein content, but the highest non-structural carbohydrate level, suggesting that the birds were selecting for readily available energy sources. It has been found that geese select foods for high nitrogen levels during wintering and breeding periods (Owen 1975; Harwood 1977), and this may be related to the physiological demands associated with preparation for breeding during winter and feather growth during the summer. It has also been suggested that autumn staging geese may benefit from high carbohydrate levels which provide for increased energy demands during migration (Wypkema and Ankney 1979; Thomas and Prevett 1980). These demands include increased thermoregulatory activity when confronted with decreased ambient temperatures in autumn as well as the deposition of energy reserves in the form of fats for use during migration. Thomas and Prevett (1980) suggested that increased fibre levels decreased the digestibility of the soluble carbohydrate component. As the

Potamogeton rhizomes contained the least fibre as well as the greatest proportion of carbohydrates, digestibility of this plant should be high. Because TNSC levels are derived from the formula: 100−%protein + %fibre + %ash = %TNSC, it is apparent that the levels are subject to the accuracy of measurements of the other components. Furthermore, ash content will vary with the amount of mineral material adhering to the vegetation or, in the case of the faeces, to the amount directly ingested by the geese. For the measurements taken in this study, we consider these potential problems were not important in the analysis. TNSC levels in foods used on the Nisutlin River delta compared well with those used by staging geese on James Bay (Thomas and Prevett 1980) i.e. *Triglochin maritima* 40% and *T. palustris* 76%, and by moulting geese at Teshekpuk Lake, Alaska (Darksen *et al.* 1982) i.e. sedges 5%, grasses 13%. The difference in TNSC uptake could be explained on the basis of *E. fluviatile* having a higher fibre content than *E. palustre*. This may also help to explain why the latter was preferred on the Nisutlin River delta. The need for TNSC may become the determining factor in the food selection process in Canada Geese staging in autumn.

The grazing rates of geese are reported to vary considerably over the daylight period. Owen (1972) found a positive linear relationship between time of day and BPM in White-fronted Geese *Anser a. albifrons*, rising from 110 BPM at 10:00 hours to 134 at 17:00 while grazing on a variety of graminoid species. Likewise, Barnacle Geese *Branta leucopsis* wintering in the Netherlands grazed at rates that varied from 135 BPM in the morning to 110 at noon to 160 BPM by 18:00 hours (Ebbinge *et al.* 1977). However, for the days in which Canada Geese grazing rates were measured on the Nisutlin River delta, there appeared to be little relationship between time of day and BPM in either the wild or tame geese.

There were no differences in feeding rates between wild and tame geese when grazing on *E. palustre*, thus it would seem justifiable to extrapolate the results obtained for the tame birds to the wild geese. Geese using short vegetation in the *E. palustre* zone fed at a higher rate throughout the day than did the birds using the tall *E. fluviatile*. Feeding rates in White-fronted Geese are reported to be inversely related to vegetation height (Owen 1972; Drent and Swierstra 1977). This relationship may also hold for Canada Geese on the Nisutlin River delta where the average height of vegetation in the *E. palustre* zone was about 10 cm, while that of the *E. fluviatile* zone was about 40 cm. The geese grazing on the latter were ingesting larger plant fragments which required more handling time and hence they were unable to take as many bites per minute. Despite this difference in grazing rate, the dry weight intake per unit time was not significantly different in the two groups.

Barnacle Geese were found to ingest about 41 grams (dry weight) of grasses per day (Ebbinge *et al.* 1977). Although these values are lower than those obtained for Canada Geese, Barnacle Geese are smaller than Canada Geese (mean = 2.0 kg (Owen 1980) versus 2.7 kg in this study). By extrapolation, on a weight for weight basis, the Canada Geese should have been consuming about 55 grams dry weight per day. In fact they were consuming about 87 grams dry weight. The age of the geese and their circumstances were also different in the two studies. The tame Canada Geese were juveniles feeding to attain full growth and energy stores for migration, whereas the Barnacle Geese were fully grown birds on their wintering grounds with limited time for feeding. The difference in intake in these two studies may also be related to the quality of the foods consumed; graminoids being nutritionally superior to horsetails.

The weight changes recorded in the two groups of Canada Geese feeding on the two vegetation types have implications for geese staging on the Nisutlin River delta. Because the wild geese choose to graze in the *E. palustre* zone rather than on *E. fluviatile*, some mechanism of selection must be operating. The most obvious is that Canada Geese can gain more by grazing on the former than on the latter. The difference in relative benefits of the two food zones probably plays a major role in the ranking of zones on the area. Geese grazing on *E. fluviatile* apparently could not acquire, in 9 hours, sufficient nutrients from their food to maintain body weight. Since the experimental geese were not subjected to energetically demanding activities such as flight, it is probable that the wild population would be at some considerable energetic disadvantage if forced to feed on *E. fluviatile* and would select against it if given a choice.

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Summary

Major foods, taken by Canada Geese *Branta canadensis* while staging on the Nisutlin River delta in the Yukon Territory, were analysed for nutrient content. The most preferred of three food plants, rhizomes of *Potomageton richardsonii*, was lowest in fibre and protein content but highest in total non-structural carbohydrate (TNSC) content. The least preferred food, stems of *Equisetum fluviatile*, had the highest fibre content and lowest TNSC content. The third species, *Equisetum palustre*, was intermediate in preference and in content of the fibre.

The value of the two species *Equisetum* to grazing geese was investigated by allowing one group of geese to graze only on stands of one species, and a second on stands of the other. Based on weight gain over 14 days, the value to geese of grazing on *E. palustre* was significantly greater than that of grazing on *E. fluviatile*.

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