<u>Oral Presentation</u>

Influence of Forage Quality on Gosling Growth and Survival

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Extended Abstract: Keystone herbivores such as geese in Arctic ecosystems are highly sensitive to reduced quantity and quality of available forage. At many stop-over and brood-rearing areas, intensive grazing by geese has resulted in dramatic habitat changes that influence goose populations (Jefferies *et al*. 2004). To determine the effects of diet quality on growth and survival of sympatric geese, we raised 100 Canada and 100 Snow goose goslings on grass-based diets with high or low protein and fiber content. Goslings were fed one of six diets (Fig. 1) that included a factorial combination of three levels of protein (10, 18 and >20%) and two levels of neutral detergent fiber (30 and 45%), but were similar in overall energy content (~18 kJ g^{-1}). We measured body mass and structural size of goslings every ca. 3 days from hatch until up to 120 days old. We used Proc Lifetest and GLM to evaluate the effect of diet quality on survival and growth rates of goslings.

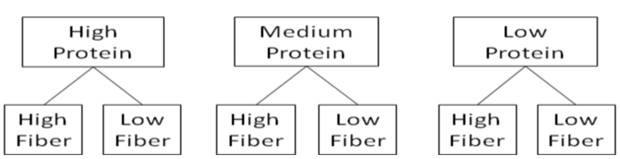

Fig. 1. Grass-based experimental diets fed to captive goslings.

Survival probabilities were relatively low for Snow goslings especially during early growth phase (< 15 days) when fed the low protein, high fiber diet. Hazard ratios were 4 and 5 times higher for Snows fed this low-quality diet relative to those fed higher-quality diets, and Snow geese had consistently higher mortality rates than Canada goslings (Fig. 2, Kaplan-Meier log-rank survival estimates between diets for Canada $\chi^2 = 2.7$, $df = 5$, $P = 0.74$ and Snow goslings $\chi^2 = 28.34$, $df = 5$, $P = <0.0001$).

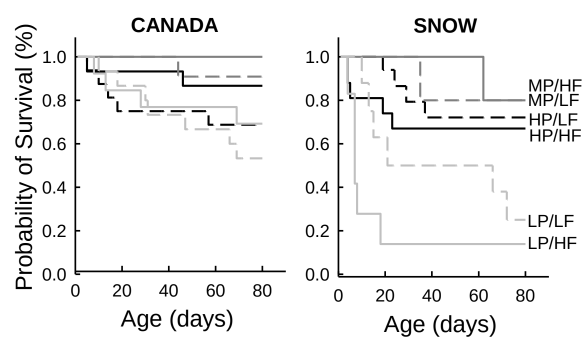

Fig. 2. Survival probability of captive-reared Canada and Snow goose goslings fed one of six experimental diets of varying protein and fiber content.

Canada and Snow goslings fed the low protein diets had lighter body mass (Canada~40%; Snow ~65%) and reduced growth rates of all structural measurements (skull, culmen, tarsus, and 9th primary) compared to goslings raised on the higher protein diets. The effects of dietary protein and fiber were more extreme for Snow goslings compared to Canada goslings, especially on the low protein diets.

In general, Snow goslings had higher protein requirements than Canada goslings, and interspecific differences in compensatory growth between species were best explained by diet quality (both protein and fiber content) and digestive physiology.

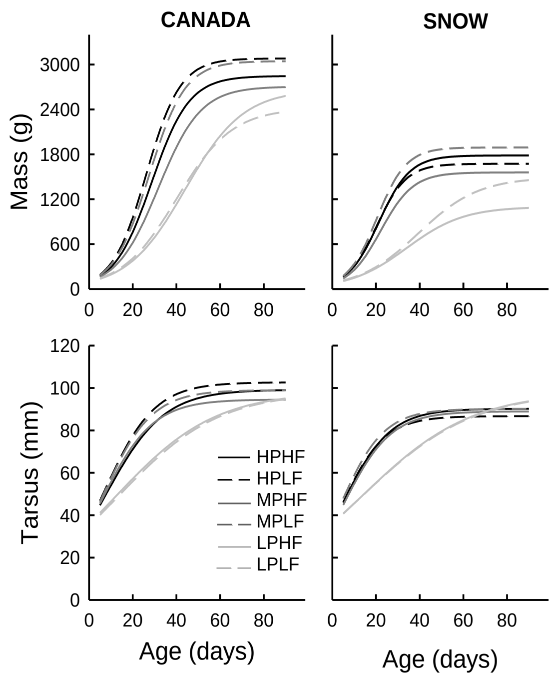

Fig. 3. Growth curves of body mass (g) and tarsus length (mm) fit to the logistic-growth equation for individual Canada and Snow goose goslings fed experimental diets with certain levels of protein and fiber (see text for details).

Snow and Canada goslings fed low protein diets reached asymptotic size ca. 35 days later than goslings fed higher protein diets (Table 1). This delay in growth has dire consequences for arctic-nesting geese and especially for Snow geese that must grow rapidly and depart before the early onset of winter. In addition, the smaller snow geese had lower food intake and smaller gut size which limited their ability to compensate for reduced forage quality (McWilliams and Leafloor 2005).

Although phenotypic flexibility in gosling growth and their digestive system allows geese to respond successfully to considerable habitat change, there appears to be a lower limit to the quality of forage eaten (<10% protein and high fiber) on survival and growth that is to a degree species-specific. The reduced growth and survival of keystone herbivores such as arctic-nesting geese in response to changes in plant quality suggest that they are good indicators of the health of arctic ecosystems.

Table 1. Mean age when reaching 90% (T_{90}) of asymptotic body mass (g) and tarsus length (mm) of captive-reared Canada and Snow goose goslings fed grass-based diets of high, med or low protein (HP, MP, LP) and high or low fiber (HF, LF) content.

Diet	Canada		Snow	
	Mass T_{90} (d)	Tarsus T_{90} (d)	Mass T_{90} (d)	Tarsus T_{90} (d)
HPHF	48	38	38	30
HPLF	44	33	35	27
MPHF	53	32	38	29
MPLF	46	31	36	26
LPHF	75	65.1	63	69
LPLF	68	64.9	70	70

Literature Cited:

Jefferies, R.L., Rockwell, R.F. & Abraham, K. 2004 Agricultural food subsidies, migratory connectivity and large-scale disturbance in arctic coastal systems: a case study. Integrative and Comparative Biology, 44, 130-139.

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