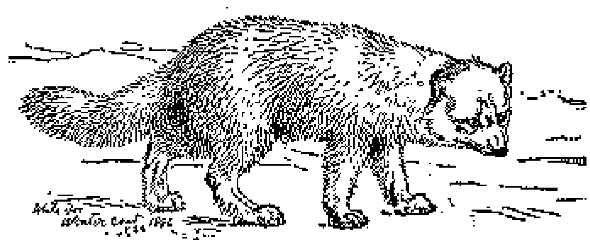
Foraging Behaviours and Population Dynamics of Arctic Foxes at Karrak Lake, Nunavut



Progress Report

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Summary: The abundance of mammals and birds fluctuates considerably among years in most northern environments. These fluctuations, in turn, are often related to variation in the abundance and distribution of foods. However, the influence of seasonally superabundant foods (such as seasonal influxes of colonial birds) on population dynamics of local consumers (e.g. arctic foxes) is poorly understood. The objectives of this study are to examine (*1*) how arctic foxes use seasonally superabundant foods such as geese and their eggs, (*2*) how access to these foods influence population dynamics of arctic foxes, and beginning in 2011, (*3*) analyses for the presence of various parasites, including *Toxoplasma gondii*, *Cryptosporidium*, *Giardia*, and others. This study will provide information on foraging behaviours, population dynamics, and disease ecology of arctic foxes that can be used for management and conservation of both arctic foxes and arctic-nesting birds. Proper management of natural resources is important to residents in many northern communities where hunting and trapping are integral parts of the economy and culture. Fieldwork in 2015 will include capturing and marking of adult foxes in spring and juvenile foxes (pups) in summer. We will also collect blood and fecal samples for analysis of various pathogens following techniques used successfully in arctic fox studies worldwide.

1. INTRODUCTION

The abundance of mammals and birds often varies considerably among years in northern ecosystems (Sinclair and Gosline 1997, Krebs et al. 2001). These fluctuations, in turn, are often related to variation in the abundance and distribution of foods (Krebs et al. 1995). However, the influence of food caching and use of temporally superabundant foods (e.g. large concentrations of nesting birds) on population dynamics of local consumers is poorly understood (Vander Wall 1990, Willson and Womble 2006). In fact, the extent of food caching and its implications on population dynamics are poorly understood for the majority of food caching animals (Vander Wall 1990).

Arctic foxes (*Vulpes lagopus*) are opportunistic predators and scavengers that rely heavily on small mammals throughout most of their range (Audet 2002). However, other foods such as birds and their eggs and carrion from the marine system can be important in arctic fox diets when small mammals are scarce (Bantle and Alisauskas 1998, Samelius et al. 2007b). In fact, Prestrud (1992) suggested that the ability to learn new hunting skills and exploit local variation of foods is crucial factors for arctic fox survival.

Arctic foxes commonly cache foods when it is abundant and these foods can be important in arctic fox diets during periods of food shortage (Bantle and Alisauskas 1998, Samelius and Alisauskas 2000, Samelius et al. 2007b). Caching and use of stored foods appears to be especially frequent among arctic foxes at large bird colonies where food is often superabundant during the nesting season of birds (Bantle and Alisauskas 1998, Samelius and Alisauskas 2000). Large bird colonies therefore provide an ideal setting to study various aspects of food caching and the link between seasonally superabundant foods and population dynamics.

2. OBJECTIVES

The objective of this study is to examine how foraging behaviours and population dynamics of arctic foxes are influenced by large concentrations of geese. Specifically, we will examine (*1*) how abundance, survival, and recruitment of arctic foxes vary among areas with and without large concentrations of geese, (*2*) how foraging behaviours of arctic foxes vary among individuals and in relation to individual attributes of foxes (size, sex, and reproductive status) and nesting distribution by geese, and (*3*) to determine the prevalence of helminth parasites, *Giardia*, *Cryptosporidium*, and other coccidia in feces and to determine the prevalence of *Toxoplasma gondii* and *Neospora caninum* antibodies in blood.

3. STUDY AREA

This study is done at Karrak Lake (67º 14' N, 100º 15' W) and surrounding areas in the Queen Maud Gulf Bird Sanctuary, Nunavut (Figure 1). Karrak Lake is the largest Ross's (*Chen rossi*) and lesser snow geese (*Chen caerulescens*) colony in the Sanctuary, consisting of about 1 million nesting geese in 2014 (R. T. Alisauskas, unpublished data). This study is part of long-term research on factors affecting the nutritional and population ecology of Ross's and lesser snow geese by Dr. R. T. Alisauskas of Environment Canada.

4. TRAPPING, MARKING, AND SAMPLING OF FOXES

Trapping and marking of arctic foxes is vital for monitoring population dynamics and estimating vital rates (e.g. survival and recruitment rates) of foxes. Trapping and marking of foxes was also important for observing foraging behaviours of foxes – a part of this study that is now completed (see results below). Trapping procedures for this study are reviewed annually by the University of Saskatchewan Animal Care Committee (UCACS protocol number 19990029) and follow the Guidelines of the Canadian Council on Animal Care.

4.1. Trapping of adult foxes

Adult arctic foxes are captured in spring by using box-traps (plastic and wire traps) and padded leghold-traps (Softcatch No. 1) that are placed at locations with signs of fox activity (e.g. elevated knolls and large rocks). Foxes are trapped in a 5×14 km area of the original and central part of the goose colony (Figure 1) in May. Box-traps are checked at least twice daily whereas leghold-traps are kept under continuous observation to minimise stress on animals (Samelius et al. 2003). Adult foxes are anaesthetised to provide safe handling and to reduce stress on animals. We use 15 mg of Telazol (corresponding to 0.15 ml of the solution reconstituted to 100 mg/ml) that is injected intramuscularly in the upper part of the back leg (Samelius et al. 2003). We have not seen any ill-effects of the drug and immobilisation with Telazol is characterised by safe handling and predictable recovery (Samelius et al. 2003). Foxes are individually marked with collared ear-tags (plastic ear-tags by Dalton ID Systems Ltd. that are 1×3.5 cm in size – these tags are permanent and remain on foxes throughout their life), weighed, sexed, and the right hind-foot is measured. Fur and blood was collected for stable isotope analyses in 2000 to 2004; we clipped a small sample of fur and collected a small sample of blood (ca 0.5 ml) from the cephalic vein on the lower front leg. Blood samples were collected in 2011-2014 and will be again in 2015 to examine parasite seroprevalence in arctic foxes. As before, blood will be collected from the cephalic or jugular veins.

A subsample of foxes were marked with radio-collars in 2001 to 2003 to help locating foxes for behavioural observations (MOD-105 Telonics Inc., weight = 70 g). Arctic foxes will not be radio-collared in 2015 as sufficient data exists for behavioural analyses (see preliminary results below).

4.2. Trapping of juvenile foxes

Juvenile arctic foxes (pups) were captured in wire traps in mid to late July in 2000-2007, and again in 2014. We plan to capture pups in 2015 to expand our understanding of disease ecology of arctic foxes, and are particularly interested in transfer of diseases from females to pups. Capturing and marking of arctic fox pups is a common technique in arctic fox studies worldwide with no reports of ill effects to foxes pups (e.g. Meijer et al. 2011 in Sweden, Eide et al. 2012 on Svalbard in Norway, Giroux et al. 2012 on Bylot Island in Nunavut, and Norén et al. 2012 in Sweden, Iceland, Svalbard, and at Karrak Lake). Traps will be kept under continuous observation when capturing pups. We will place traps on dens in early July to allow foxes to become accustomed to traps (fieldwork in 2000 showed this to be critical for successful capture of pups). Pups will be individually marked with collared ear-tags (same tags as used for adults above), weighed, sexed, and the right hind-foot will be measured. We will collect a small sample of blood (ca 0.5 ml) from the cephalic vein from pups following the methods used on Bylot Island (Nunavut) by Giroux et al (2012). We will not anaesthetise pups, as they are generally calm during handling.

4.3. Summary of fox captures in 2000-2014

We have captured and marked 142 and 159 individual adult and juvenile foxes, respectively at Karrak Lake in 2000-2014. Many of these individuals have been recaptured in subsequent years. In addition to foxes encountered at Karrak Lake, two foxes have been encountered in Resolute Bay on Cornwallis Island in 2001 (one subadult male and one subadult female that were both marked as pups at Karrak Lake in 2000), one fox (identity unknown) has been seen at Cambridge Bay in 2002, one fox was encountered in Coppermine in 2004 (a subadult female that was marked as a pup at Karrak Lake in 2004), and one fox was encountered in Taloyoak in 2012 (and adult male that was marked as an adult at Karrak Lake in 2010).

4.4. Methods of travel to study area and within study area

Personnel will travel to and from Karrak Lake by twin otter (Cambridge Bay-Karrak Lake return) and a snowmobile will be used to travel within the study area when trapping adults in May. Personnel will be housed at the Karrak Lake Research Station which was established for the long-term research on Ross's and lesser snow goose ecology at Karrak Lake by Dr. R. T. Alisauskas and Environment Canada.

5. POPULATION DYNAMICS OF ARCTIC FOXES

Abundance and reproduction of foxes were monitored through line-transects and den inventories (see Samelius 2006 for detail) whereas survival of foxes is monitored through a mark-recapture study following Pollock et al. (1990). The mark-recapture study will also allow estimation of the relative contribution of adult survival and recruitment to population growth by foxes by using reverse-time mark-recapture following Nichols et al. (2000). All aspects of population dynamics will be evaluated in relation to nesting distribution by geese and variation in small mammal abundance.

Small mammal abundance was the main factor affecting population dynamics by arctic foxes; fox numbers were closely related to small mammal abundance in the previous year (i.e. there was a time-delay of about 1 year in fox numbers relative to small mammal abundance) and fox reproduction was closely related to small mammal abundance (e.g. foxes did not breed in years when small mammals were scarce). Nesting by geese did not appear to influence changes in fox numbers among years. Nesting geese and their eggs did, however, elevate fox abundance about 2-3 times above that outside of the goose colony at Karrak Lake which illustrates that geese and their eggs provided foxes with additional foods that elevated breeding density and fox abundance above that which lemmings along could support (Samelius et al. 2011).

6. FORAGING BEHAVIOURS OF ARCTIC FOXES

Arctic fox diets were examined by stable isotope analyses where isotope signatures of fox blood and fur were compared to that of food items collected in the field (Kelly 2000, Samelius et al. 2007b). Stable isotope analyses showed that arctic foxes switched from small mammals to cached eggs in years when small mammals were scarce – cached eggs made up to about 50% of fox diets in years when small mammals were scarce whereas foxes rarely used cached eggs in years when small mammals were abundant (Samelius et al. 2007b). Caching of eggs may, thus, function as a buffer to unpredictable changes in small mammal abundance. This study also showed that cached eggs were important in arctic fox diets almost one year after caching.

We observed foraging behaviours of individually-marked foxes following Samelius and Alisauskas (2000). We are interested in how individual attributes of foxes (e.g. size, sex, and reproductive status), small mammal abundance, and nesting distribution by geese affect the rate at which foxes take eggs. We also plan to model how mobbing by geese influence the rate at which foxes take eggs to evaluate whether mobbing by geese acts as a cost of food acquisition for foxes. Preliminary analyses show that (1) arctic foxes take about 2,000-3,000 goose eggs per fox during the nesting season and (2) individual attributes of foxes did not affect the rate at which foxes took eggs – i.e. there was no partitioning within the population in the rate at which they took eggs.

7. PREVELANCE OF PARASITES

Laboratory work is ongoing for blood samples collected from captured foxes, and fecal samples collected from captured foxes and den sites. To date, *Toxoplasma gondii* and *Neospora caninum* antibodies have been detected in 58% and 3% of blood sampless, respectively. In fecal samples, we have detected Toxascaris spp. in 65% of samples, taeniids and unidentified tapeworm sp. in 18% and 25%, respectively, *Cryptosporidium* sp. in 20% and *Giardia* sp. in 32% (Elmore et al. 2013). Of 354 fecal samples collected from den sites during 2000-2011, three (<1%) were positive for infection with *Echinococcus multilocularis*.

8. APPLICATIONS OF RESEARCH AND RELEVANCE TO NORTHERN RESIDENTS

This study will provide information on foraging behaviours and population ecology of arctic foxes that can be used for management and conservation of arctic foxes and arctic-nesting waterfowl. Proper management of natural resources is important to residents in many northern communities where hunting and trapping are integral parts of the economy and culture (Usher 1971, Bromley 1996). The fox study at Karrak Lake has resulted in ten publications to date (Samelius et al. 2002, Samelius et al. 2003, Samelius 2004, Hendrickson et al. 2005, Samelius et al. 2007a, Samelius et al. 2007b, Wiebe et al. 2009, Samelius and Alisauskas 2009, Samelius et al. 2011, Elmore et al. 2013). We have also contributed to three studies on population genetics of arctic foxes (Dalén et al. 2005, Norén et al. 2011, Norén et al. 2012) which showed that there was little genetic separation of arctic foxes on a circumpolar scale (i.e. there is large exchange of foxes throughout its range) and that the amount of social complexity (e.g. addition of non-breeding adults and multiple mating) varied throughout the circumpolar range of arctic foxes. Our research has been noted in National Geographic for Kids (December 2002), National Geographic News (http://news.nationalgeographic.com/news/2007/10/071029-arctic-foxes.html), and Natural History Magazine (http://nhmag.com/new/1107/1107_samplings.html). More information about the project can be found at http://www.usask.ca/biology/fox which we hope will help to distribute information about the project.

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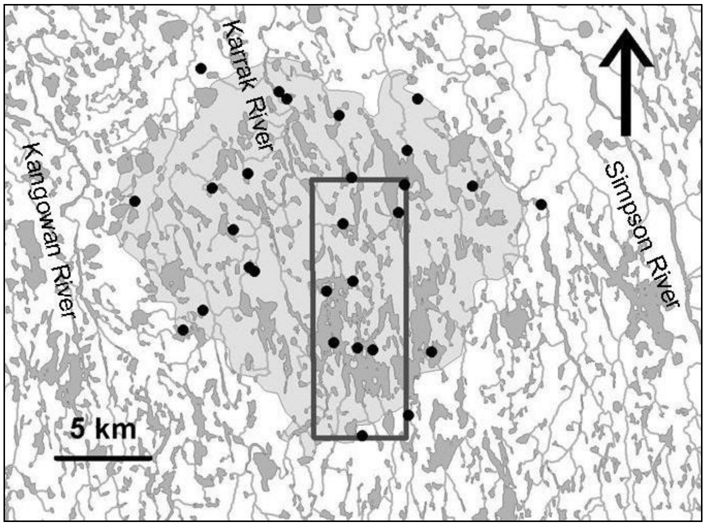

Figure 1. Extent of the goose colony (light grey) and location of the fox trapping area (grey square) at Karrak Lake goose colony (67^{o} 14' N, 100^{o} 15' W) in the Queen Maud Gulf Bird Sanctuary, Nunavut. Fox dens are symbolised by black dots.