

Snowshoe Hare Abundance near Wiseman, Alaska
Gates of the Arctic National Park and Preserve

Seventh Annual Survey--2003
with 2004 Update and the New Study Plan



A swath of dead willow stems extend above new growth in a densely vegetated area of the snowshoe hare study area in June, 2003.

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EXECUTIVE SUMMARY

The snowshoe hare project has been tracking the hare population near Wiseman, Alaska, in Gates of the Arctic National Park and Preserve since 1997. The original purpose of the study was to monitor the snowshoe hare population through one entire population cycle (roughly 10 years); we chose track counts to provide us with an index to population size. This report documents the seventh and eighth years of the snowshoe hare study, and the plans currently being developed for its expansion into a more detailed study of the relationships between hares, soil, vegetation and lynx.

During the 2003 survey, the hare population in our study area was at very low levels. We surveyed the established route February 4 and 5, 2003. We saw no hare tracks along the entire survey route at that time. The route was surveyed again March 19 and 20, 2003. We counted 1-3 hare tracks in each of two of the six habitat types. During four counts in February and March, 2004, we found no hare tracks anywhere along the survey route. This compares to over 50 tracks counted per 100m in the densely vegetated portions of the study area in 1998 and 1999 when the hare population was still building to its peak.

We received additional funding in 2004 to expand the project's scope in order to investigate the observed relationships between snowshoe hares and soils, vegetation and lynx. The University of Alaska Fairbanks signed a cooperative agreement with the NPS to work jointly on this long-term project, which will likely continue through a second snowshoe hare cycle of 10 years or more. In 2004, we made the first steps in the new phase of the project by exploring new areas that could be used as additional study sites: two more sites in areas where hares access mineral deposits during the peak phase of their cycle, and three non-mineral sites for control purposes. We hypothesize that the use of mineral licks by hares is responsible for increased density during population highs in this region (hares have not been observed to consume the mineral during population lows) but that excessive damage to habitat eventually causes the population to crash and is responsible for extreme lows. We further hypothesize that consumption of hares that have ingested mineral soil toxins are responsible for the change in appearance of muscle tissue of lynx (thus, there may be a "good" and a "bad" side associated with the mineral soil consumption).

Alternatively, we hypothesize that plant toxins consumed by hares may be transferred to and accumulate in lynx, thereby affecting lynx health and body condition.



While no hare tracks were seen during the 2004 survey, new growth extending above the snow indicated the hare population may soon begin to rebound.

INTRODUCTION

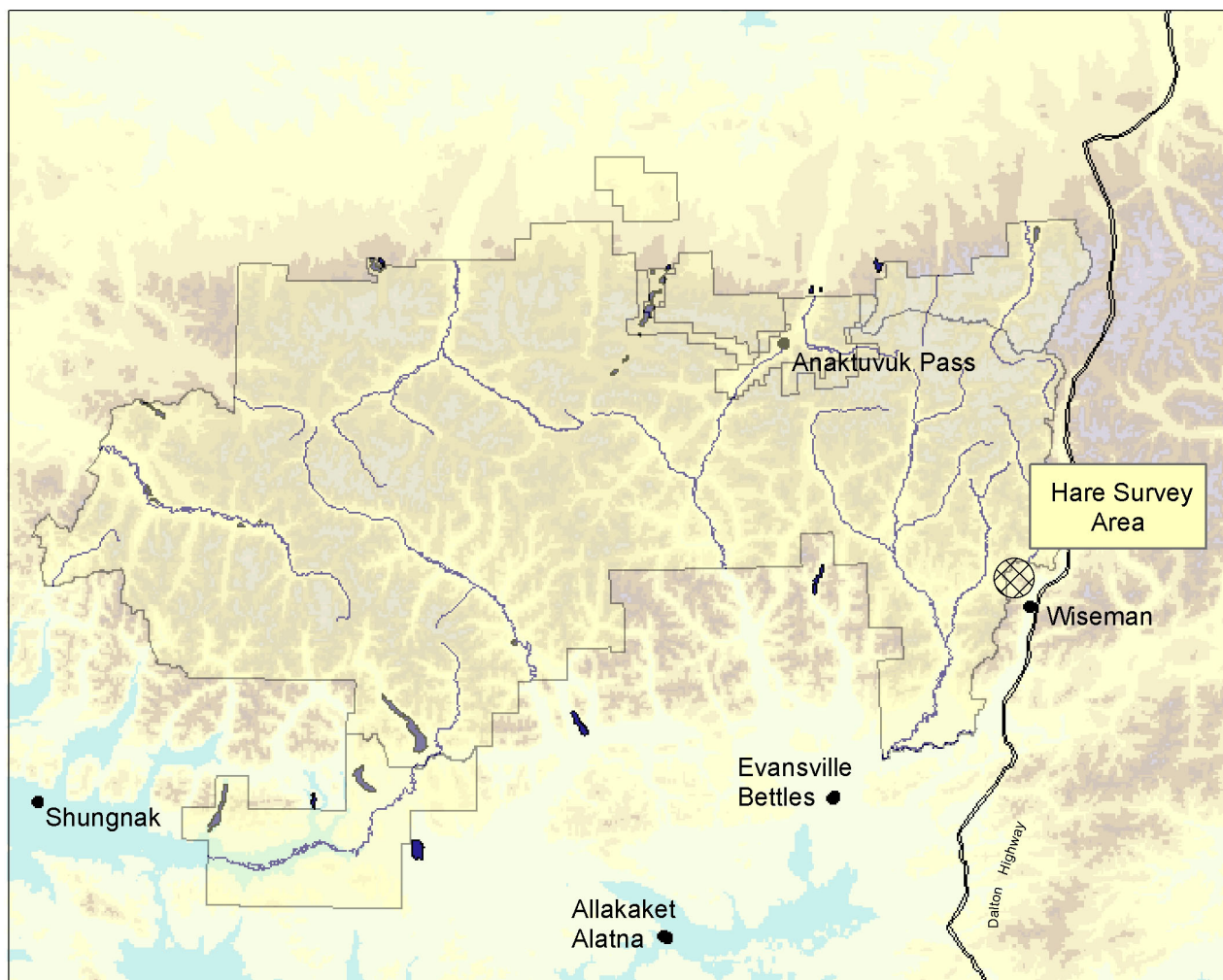
In March 1997, resource personnel at Gates of the Arctic National Park and Preserve (GAAR) began a long-term monitoring program of the snowshoe hare (*Lepus americanus*) population in the eastern portion of the park (DiFolco 1997). This project was developed in response to a 5-year furbearer study that discovered a female dominated sex ratio and a low juvenile age ratio in the lynx (*Lynx canadensis*) population in this area (Swanson 1994). Concluding that these abnormal ratios may be attributed to food stress, the furbearer study recommended monitoring the snowshoe hare population in the area. The close association between lynx and their primary prey, snowshoe hares, has been well documented (Elton and Nicholson 1942, Brand et al. 1976, Brand and Keith 1979). Park managers hope to gain a better understanding of the naturally functioning ecosystem within (and surrounding) GAAR, including the cyclic nature of the snowshoe hare population and corresponding fluctuation in the lynx population, by monitoring snowshoe hares, as well as continuing to collect information from local subsistence trappers.

Originally, the snowshoe hare project planned to monitor the hare population through a single cycle (approximately 10 years) using track counts in order to provide managers with an index of the hare population at each stage of the cycle. We now have completed eight years of monitoring the hare population in this area through snowshoe hare track counts, documenting the rise, a sustained peak, and fall of the hare population in our study area. During the peak phase of the population cycle, we observed unusual hare behavior and body condition, most notably the consumption of particular mineral soils, accompanied by a shabby appearance and lethargic behavior. Our observations were corroborated with those of Wiseman resident Jack Reakoff, who has lived and trapped in the area since childhood and has observed the past four hare population peaks. Reakoff has made numerous other observations during the peak phase of the hare population, most notably bloody diarrhea in hares, and unusually dark meat in lynx that have consumed hares during times when hares have been ingesting mineral. In addition to counting tracks, for six years we have collected data on vegetation browsed by hares (including measurements of the diameter-at-point-of-browse and two years of measuring the tannin and nitrogen content of twigs). We also have collected soil samples from 10 licks visited by hares and two licks not visited by hares during population highs. The soil samples were analysed for levels of mineral salts (sodium, calcium, potassium, phosphorus and chloride) and a broad spectrum of other minerals, including some heavy metals. We are currently moving into a new phase of the study to expand the project's scope in order to investigate the observed relationships between snowshoe hares and soils, vegetation and lynx.

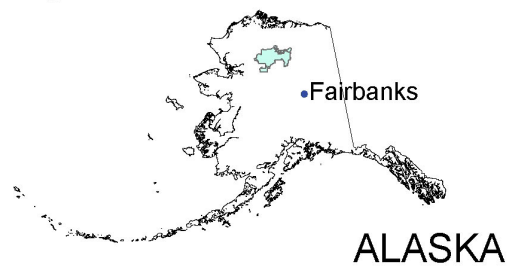
The collection of browse data was prompted by the extreme degree to which hares in our study area browsed the vegetation when the hare population was most dense. Severely browsed deciduous shrubs grow juvenile-form stump sprouts containing secondary compounds to deter herbivory (Bryant and Kuropat 1980, Bryant et. al. 1983, Fox and Bryant 1984, and Bryant et. al. 1985). Production of these secondary compounds relaxes after 2-3 years (Fox and Bryant 1984). Mature-form twigs, being higher on the plant and therefore usually out of reach of hares, do not have such chemical deterrents and are more palatable to snowshoe hares (Bryant et al. 1985). Production of these carbon-based secondary compounds requires energy in the form of sunshine. Experimental studies have shown that shading decreases the production of

Snowshoe Hare Survey

Gates of the Arctic National Park & Preserve



Map Location



25 12.5 0 25 Miles



Gates of the Arctic
National Park and Preserve
Resources Division

Fig. 1. Study area for snowshoe hare survey near Wiseman, Alaska, in eastern Gates of the Arctic National Park and Preserve, February and March 2003.

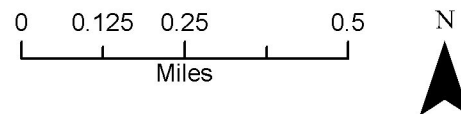
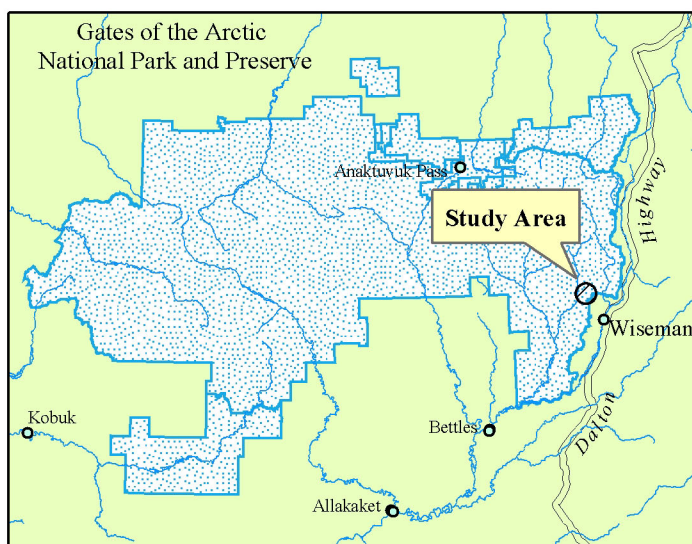
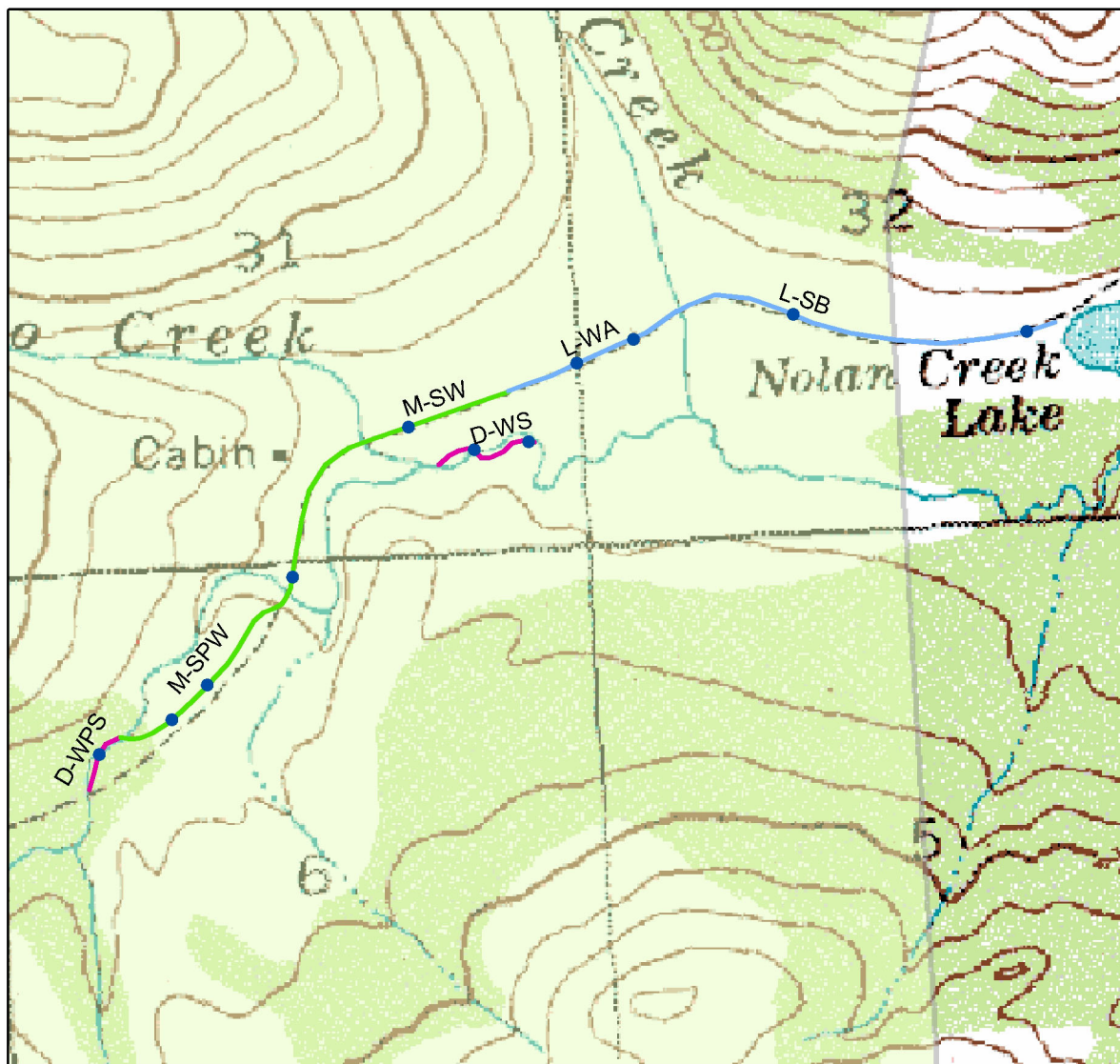
carbohydrates and secondary compounds, meaning less antiherbivory defenses and increased palatability to hares (Bryant et. al. 1983, Bryant 1987). Also, *repeated* pruning of juvenile plants *increased* palatability, probably because the plants' carbon reserves were reduced to such low levels the plants could not continue producing secondary compounds (Bryant, et. al. 1983). During the second phase of the snowshoe hare study, we will measure levels of secondary compounds (such as the proanthocyanadine family of tannins) in browse species in our study area to document fluctuations in these chemical deterrents as the hare population climbs, peaks, and falls again.

The soil samples were collected in an attempt to determine what hares may be craving by visiting the mineral licks. We also hope to understand more clearly why hares practice geophagy at particular mineral licks and why they *don't* visit exposed mineral soils in other areas. While hares may visit the licks to replenish sodium lost through the secondary compound detoxification process (John Bryant, Institute of Arctic Biology, Univ. of Alaska Fairbanks, pers. commun.), lab results showed that the soils which hares visited had high concentrations of calcium (DiFolco 2000). An experiment done during the summer of 2000 in the study area tested the preference of hares for sodium, calcium, potassium, phosphorus and chloride. Plates holding samples of each mineral were set out in different vegetation types (5 plates in each vegetation type). In each case, hares consumed more calcium than any other mineral. Other minerals were also consumed to a degree, but not as readily as calcium (J. Reakoff, pers. commun., M. Reakoff, unpublished data). We can only speculate that additional calcium may be aiding the hares by binding some of the secondary compounds produced by plants. The lethargy observed during periods when hares consume the soil may be a symptom resulting from the consumption of plant toxins, from another element in the soil not yet identified (e.g. a heavy metal), or perhaps disease (e.g. tularemia).

The 2003 report documents the seventh year of the snowshoe hare study. We've also included an update from the 2004 survey, during which the hare population appeared to be at its lowest density. While we will continue to monitor the hare population through track counts, we will also be expanding the study to investigate the complex relationships between snowshoe hares, soils, vegetation and lynx. This report includes a general outline for the new study plan.

STUDY AREA

Gates of the Arctic National Park and Preserve is located north of the Arctic Circle (66° 33' N latitude) in the central Brooks Range, Alaska (Fig. 1). Two climate zones occur in the park and preserve: the subarctic zone at lower elevations south of the continental divide and the arctic zone to the north and at high elevations. Precipitation is low within the park and preserve and yearly averages fall between 30 - 45 cm in the west and 13 - 25 cm in the north (National Park Service 1986). Snowfall averages south of the divide range between 152 - 203 cm and averages of 89 - 127 cm are typical in the north. Yearly temperatures in the south fluctuate from an average July maximum of 21° C (70° F) to an average January minimum of -34° C (-30° F). Temperatures in the north fluctuate from an average July maximum of 18° C (65° F) to an average February minimum of -23° C (-10° F).



Legend

- 100m transect (start point)
- Dense vegetation zone
- Moderate vegetation zone
- Light vegetation zone
- National park land

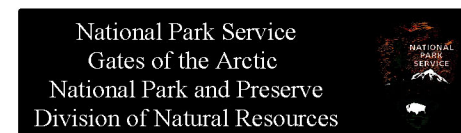


Fig. 2. Snowshoe hare survey area, showing 100 m transects along survey route. At periods of high hare densities, only tracks within 100 m transects are counted. At low densities, tracks are counted along the entire survey route, which is divided into vegetation zones by density of vegetation and dominant species. Names of vegetation zones are abbreviated: First letter signifies **D**ense, **M**oderate, or **L**ight vegetative cover; dominant species follow hyphen—B=shrub birch, W=willow, P=poplar, S=spruce, A=alder.

Boreal forest, tundra, and shrub thicket are the major vegetation communities in the park and preserve (National Park Service 1986). The snowshoe hare study area lies in the boreal forest, which covers the southern flanks and valleys of the Brooks Range and is composed of black spruce (*Picea mariana*), white spruce (*P. glauca*), paper birch (*Betula papyrifera*), shrub birch (*B. glandulosa*), aspen (*Populus tremuloides*), and balsam poplar (*P. balsamifera*). Willow (*Salix* spp.) and alder (*Alnus* spp.) thickets up to 3.5 m in height occur along stream channels and gravel bars. The study was conducted near the eastern park boundary north of Wiseman (Fig. 1).

METHODS

Field Methods:

As recommended after the 2002 snowshoe hare survey (DiFolco 2003), the survey transect line was set up early in 2003: each vegetation cover and composition (VCC) zone was flagged, and all old tracks were brushed out along the transect line. Due to the extremely low number of hares in the area, the entire lengths (Appx. IV) of all 6 VCCs (2 in lightly vegetated areas, 2 in moderately vegetated areas, and 2 in densely vegetated areas, Fig. 2) were marked for counting tracks, rather than just the eleven 100 m transects (Fig. 2). After accessing the study area from Nolan by ski, we counted tracks on 4-5 February and 19-20 March. We counted track deposition (the number of tracks deposited in one day) on both sides of the trail, following the winter trail (snowmobile) route established by local subsistence users. A “track” is the trail of tracks left by a single hare that intersects the transect. To compare this year’s data with previous years, the number of tracks counted on each side of the trail were averaged and the resulting number converted from the number of tracks/entire VCC length/day to the number of tracks/100 m/VCC/day.

During the 2002 and 2003 surveys, we collected samples of twigs from shrubs browsed by hares and had them analyzed for tannin and nitrogen content. In 2002, we grouped all the willow species together as “willow” (DiFolco 2003). We tried differentiating between willow species in 2003. We were unable to make positive identifications on a few samples, and so those were arbitrarily placed in one group or another. Samples were collected along the survey route, a neighboring hillside east of Snowshoe Creek dominated by birch trees (dubbed “Birch Hill”), and along the winter trail in the wide valley bottom just southwest of Nolan. We collected 1 sample from a browsed poplar (*Populus balsamifera*) and 12 samples from several species of browsed willow (*Salix* spp.). For each sample, we clipped 4-6 twigs from each shrub. The samples were delivered to Rich Kedrowski of the chemical-nutritional lab at the University of Alaska Fairbanks for analysis of nitrogen and tannin content. To obtain a relative measure of tannin content, the amount of proanthocyanadine in each sample was measured (Martin and Martin 1982). Percent nitrogen gives a rough measure of the protein content in the sample, while tannins may be digestion inhibitors, although recent investigations suggest that tannins may be toxic (Bryant et. al. 1992).

RESULTS

For brevity, acronyms are used to describe the vegetation cover and composition types (VCCs) and the transects within them. The first letter describes the cover classification: L = lightly vegetated, M = moderately vegetated, and D = densely vegetated. Main species composition is listed after the hyphen (in order of relative abundance): W = willow, P = poplar, S = spruce, B = shrub birch, and A = alder.

Weather and Track Deposition

Fresh snow immediately before our February and March counts made for perfect tracking conditions this year (Appx. I). Golden (1994) recommends counting tracks 12-24 hours after snowfall. Several inches of fresh snow (10 cm) had accumulated the day before we set up the transect on February 4, 2003, so we noted all tracks along the route as we flagged the beginning and ending points of each VCC. More snow fell that night (4.7 cm), and a second count was made the following day. Tracking conditions were excellent in the soft, fresh snow (even vole tracks were easily sighted); however, no hare tracks were seen anywhere along the transect line or within the study area during the two counts. We did see some large lynx tracks: one in D-WPS, and two in M-SPW going opposite directions along the same trail. For the March survey, 12 mm of snow fell March 18. We surveyed the route March 19 and 20, counting only a few tracks along the entire survey route. Appendix II shows the results of the 4 counts.

In order to compare this year's results with previous years', the number of tracks counted along the entire length of each VCC was converted to the number of tracks/100 m/VCC/day (Table 1). Four of the 6

Table 1. Deposition of snowshoe hare tracks/100m/day in eastern Gates of the Arctic National Park and Preserve, Alaska, during surveys in 2003. Vegetation cover and composition codes are as follows: L, M and D = lightly, moderately and densely vegetated cover, respectively, dominated by tree or shrub species where A = alder, B = shrub birch, P = poplar, S = spruce, W = willow.

	L-SB	L-WA	M-SW	M-SPW*	D-WS	D-WPS
4 Feb. 2003	0	0	0	0	0	0
5 Feb. 2003	0	0	0	0	0	0
19 Mar. 2003	0	0	0	4.5	0	0
20 Mar. 2003	0	0	0	2	0	1
average	0	0	0	1.63	0.00	0.25
standard deviation				2.14		0.50
95% CI				2.09		0.49
# tracks / 100 m	0	0	0	0.15	0.00	0.14

* For calculation purposes, I counted each trail deposited in M-SPW as 3 tracks. A trail is a pathway used multiple times by the same or different hares. Since I could not distinguish the number of tracks after 3 or 4 passes by hares over the same place, I conservatively estimated a trail to equal 3 tracks. Left and right sides were averaged to get the number of tracks deposited/day.

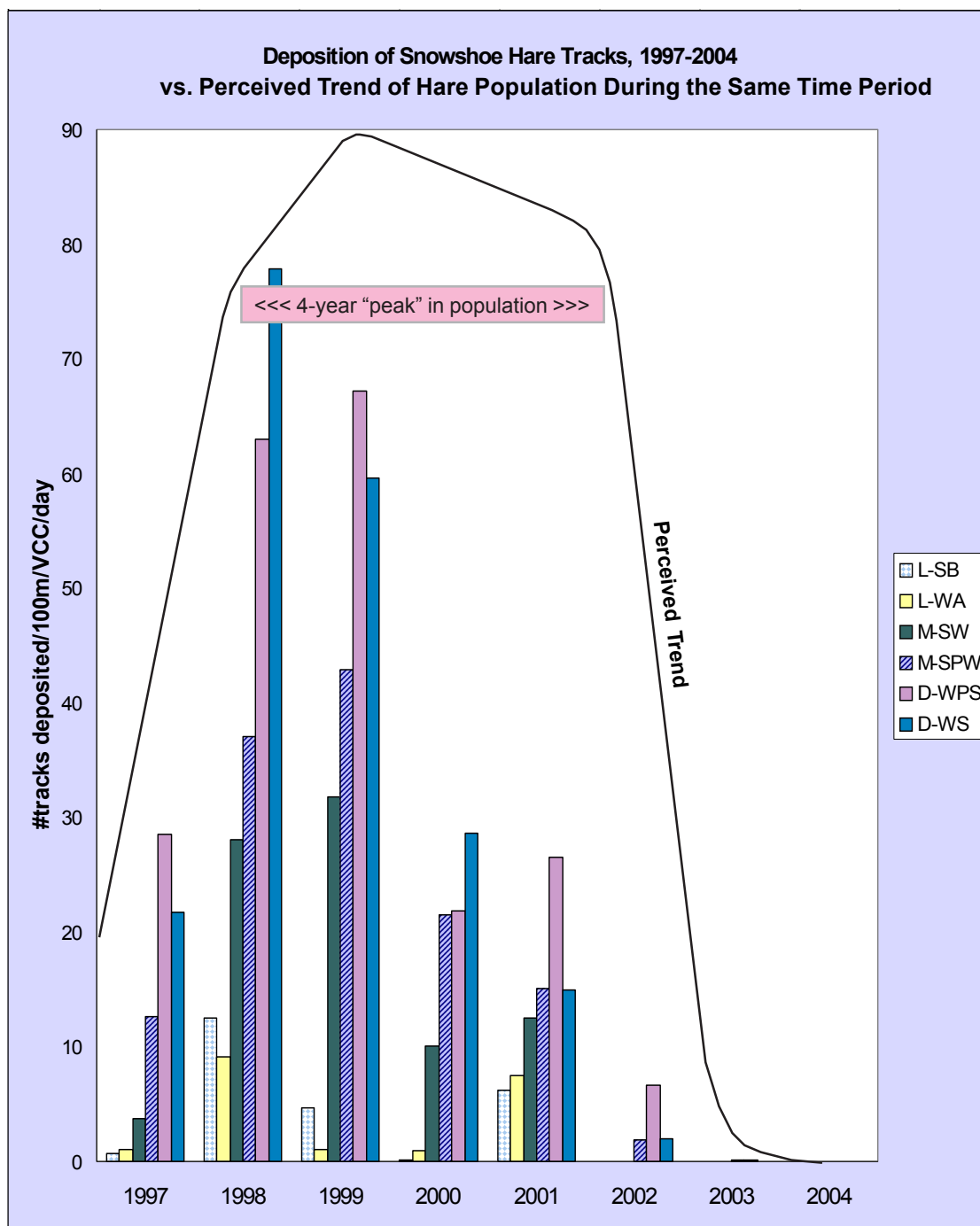


Fig. 3. Average number of tracks deposited/100m/day (shown by bars) in 6 vegetation cover and composition (VCC) classes over 7 years during the snowshoe hare survey in Gates of the Arctic National Park and Preserve near Wiseman, Alaska. VCC classes are coded as follows: L, M, and D denote lightly, moderately and densely vegetated cover, respectively; dominant species follow the hyphen: A=alder, B=shrub birch, P=balsam poplar, S=spruce, and W=willow. The line depicts the trend in the hare population *perceived by the surveyors* during the same time period—it is *not* a measured quantity. The line represents the average number of tracks deposited/100m/day that we felt we *should have counted*, had tracking conditions been perfect. Hare sightings, tracks and trails observed throughout the study area (not just the 100m transects), degree of freshly browsed vegetation, and reports of hare population levels by Wiseman residents all contributed to the “perceived trend” line. The low number of tracks counted in 1999, 2000, and 2001 relative to the perceived trend are attributed to poor tracking conditions in those years due to lack of fresh snow.

VCCs had no hare tracks deposited. There were only 0.15 tracks/100 m/VCC/day deposited in M-SPW and 0.14 tracks/100 m/VCC/day deposited in D-WPS. Figure 3 compares the average number of tracks counted/100 m/VCC/day in each of the VCCs over the 7-year history of the hare survey. Superimposed on the count data is a line representing the perceived trend in the hare population during the same time period.

In 2004, we counted no snowshoe hare tracks on February 11 (after a 12 mm snowfall), and none again during a count conducted March 14 (after a dusting of snow within the previous 48 hours).

Browse Nutritional Analysis

Results from the percent nitrogen and proanthocyanidin content of the clipped vegetation are summarized in Figs. 4-7; full results are tabulated in Appendix III. The nitrogen content ranged from 0.881% in *Salix glauca* collected from Birch Hill to 1.278% for the same species in M-SPW; the poplar sample contained 1.4% nitrogen. Proanthocyanidin content was by far lowest in the poplar sample (0.43), and ranged from 9.25% to 16.01% in the willows.

2004 Update

Track counts were again initiated in February of 2004 and concluded in March. No snowshoe hare tracks were seen throughout the study area during either count period. Correspondingly, no browsing by hares was seen in the study area either. No browse samples were collected during the 2004 count period.

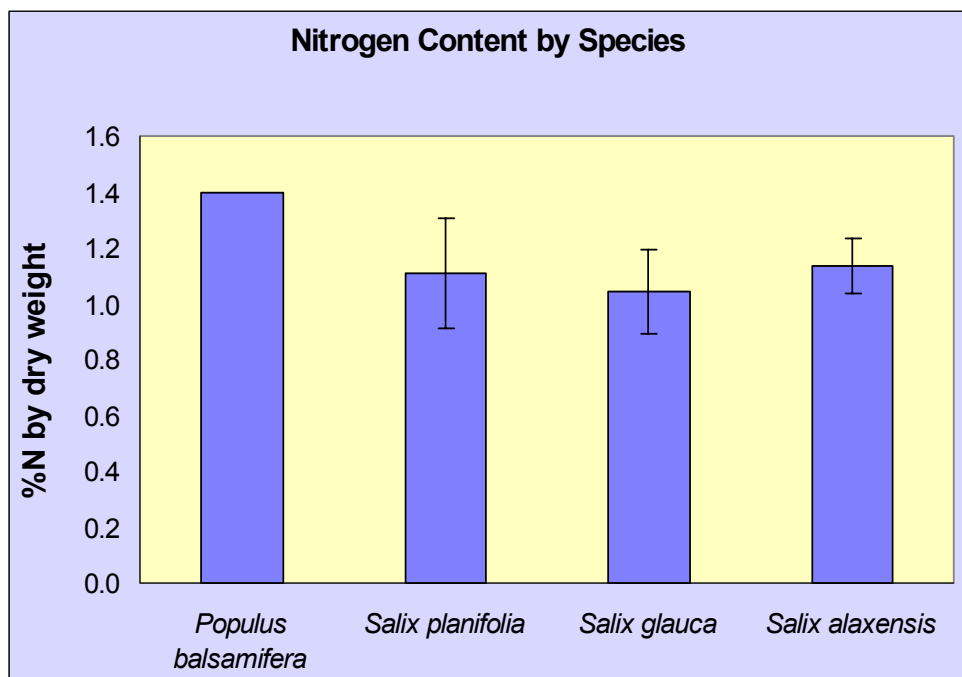


Fig. 4. Mean percent nitrogen content (+/- SD) of species browsed by snowshoe hares near Wiseman, Alaska, Gates of the Arctic National Park and Preserve, March 2003. This graph shows the species from various habitat types combined. Only one sample was collected of *P. balsamifera*.

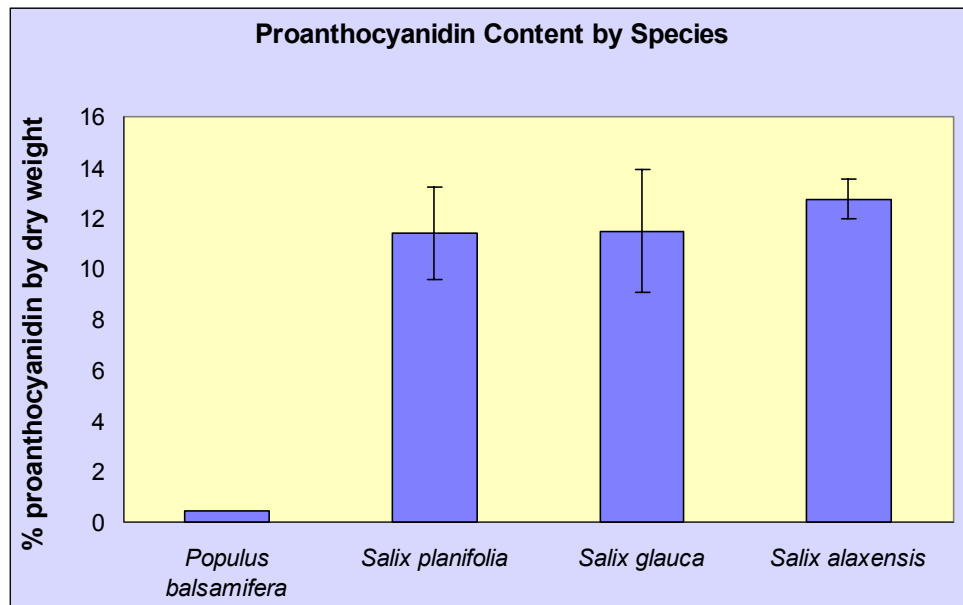


Fig. 5. Mean percent proanthocyanidin content ($\pm$ SD) of species browsed by snowshoe hares near Wiseman, Alaska, Gates of the Arctic National Park and Preserve, March 2003. This graph shows the species from various habitat types combined. Only one sample was collected of *P. balsamifera*.

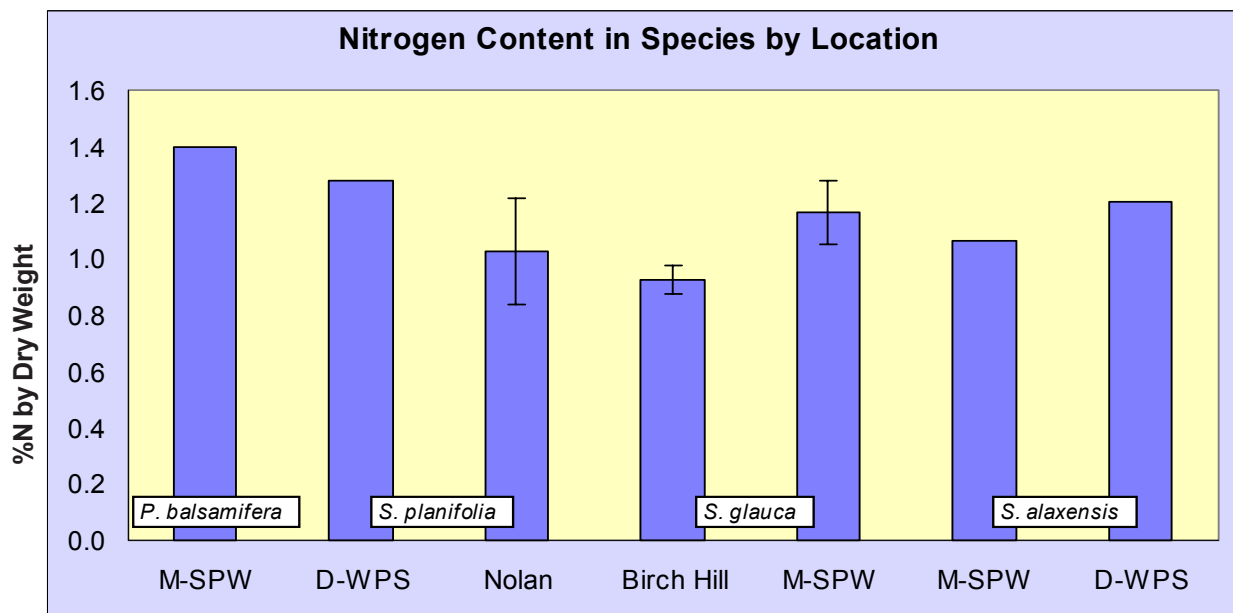


Fig. 6. Percent nitrogen content ($\pm$ SD) of species browsed by snowshoe hares within different habitat types near Wiseman, Alaska, Gates of the Arctic National Park and Preserve, March 2003.

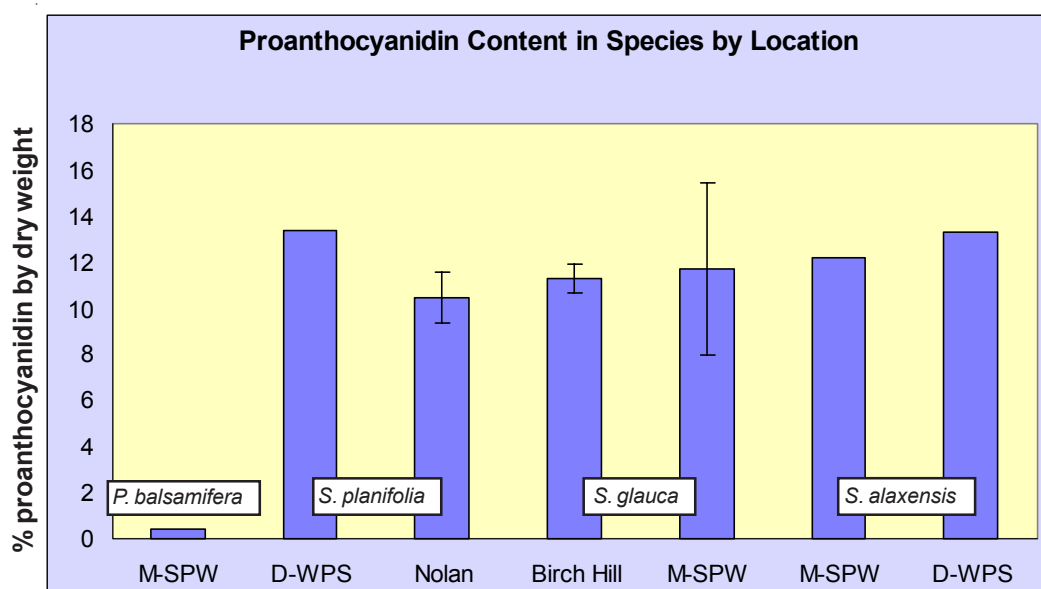


Fig. 7. Percent proanthocyanidin content (+/- SD) of species browsed by snowshoe hares within different habitat types near Wiseman, Alaska, Gates of the Arctic National Park and Preserve, March 2003.

DISCUSSION

The Rise and Fall of the Hare Population and the Evolution of Methods

After 8 years of monitoring the snowshoe hare population in eastern Gates of the Arctic National Park, we have almost documented an entire hare cycle. When we began the survey in 1997, the hare population was beginning its climb up from extremely low levels. The population surged the following year and maintained an extended, 4-year “peak,” from 1998 through 2001. Then, in the last 3 years, hare numbers dwindled to very low numbers. It may be another few years before the population recovers (following the recovery of the vegetation) and once again dominates the landscape.

We’ve discovered that track counts are very much dependent on the weather when the hare population is high. Without fresh snow, counting tracks accurately becomes extremely difficult, if not impossible, at high hare densities. Figure 3 compares the track count data with the “perceived trend” in the hare population over the years, which incorporates the amount of tracks seen throughout the survey area (not just in the transects), the number of daily hare sightings, the level of freshly browsed vegetation, and the reported observations of Wiseman residents. The line represents a generalized trend in the population that we perceived from the above mentioned factors, particularly the severity of freshly browsed vegetation, to show that the actual “peak” lasted four years, not just one or two years as the track data indicate. Whereas the track data show that the hare population peaked in 1998 (when we had a little fresh snow fall during the survey period), we felt that there were actually more hares in 1999 (when no fresh snow fell), mainly because of the numerous daily incidental hare sightings, the great degree to which the vegetation was browsed, as well as the other factors just mentioned. I might add here that we never really *looked* for hares in any systematic way during the survey period, but we would see them as we did our other work or as

we travelled along the survey route or to and from the study area. It was during this time we noticed the lethargic behavior of the hares, as we could walk up to within a few meters of the hares before they would slowly hop away. Jack Reakoff (Wiseman resident and trapper, pers. commun.) observed that hares had bloody diarrhea at this time. Also noted during the high phase, were hare trails leading to/from bare mineral soil banks.

Another index of the hare population we measured was vegetation browsing. Hares tend to prefer the smaller diameter twigs of willows. As these become scarce, hares will resort to eating whatever is available, including relatively large stems of spruce and alder, which hares tend to reject if more palatable browse is available (Bryant and Kuropat 1980). We began to measure diameter at point of browse in 1998, the second year of the study. From this we saw that the hares in the study area were browsing stems mostly larger than 3mm and some greater than 8mm (DiFolco 2002). While some studies have found that hares tend to prefer stems 3 mm or less in diameter (Pease et al. 1979, Wolff 1980), the consumption of twigs by hares is determined by a number of factors, including relative nutritional values vs. the levels of secondary compounds of browse available in any particular area (Schmitz et. al. 1992). In 2000, we felt that simply measuring the diameter of browsed stems was not enough, for the data did not reflect the intensity of browsing we were observing in the form of girdling, which is when hares chew bark off the stem. Also, since many browsed stems were severely girdled, removing not only bark but also some wood, our measurements of diameter tended to be considerably smaller than what the actual stem diameter would have been without girdling. So we devised a method to quantify the “degree of browsing” (DiFolco 2000, DiFolco 2002) by categorizing stems according to how severely they were being browsed by hares. (Stems browsed by hares have a clean-cut, beveled edge, as distinguished from moose-browsed stems, which have a ragged, torn look.) By 2001, nearly 85% of the available vegetation (willow, poplar, spruce, alder and shrub birch) had been browsed by snowshoe hares, with the remaining 15% being mainly mature trees (DiFolco 2002).

Results from the nitrogen and tannin content analyses did not show a difference between willow species in nitrogen or tannin content (Figs 4 and 5). Also, there appears to be little difference in content of nitrogen or tannin among species from different locations (Figs. 6 and 7) although other studies have found differences between species and locations (Bryant et al. 1994). However, the locations from which our samples were collected may not have been far enough apart to exhibit measurable differences. Incorporating additional study areas several miles apart (as planned for in the second phase of the study) may reveal locational differences in nutritional and tannin content. Analysis of a single specimen of poplar showed it to be higher in nitrogen (Figs. 4 and 6) and lower in tannin (Figs. 5 and 7) than willow, but additional sampling would be necessary to verify this suggestion. Data from samples collected in 2002 also show poplar to have a slightly higher nitrogen content and a lower tannin content than willow (DiFolco 2002).

Bryant et. al. (1985) reported that the juvenile form stump sprouts of *Salix alaxensis*, which grow following severe winter browsing, are much less palatable to snowshoe hares than the adult form twigs. *Salix alaxensis* is also the dominant willow species in the more densely vegetated sections along the Wiseman Creek floodplain where hare densities reached their greatest proportions. This reversion to a

juvenile form, which is unpalatable to snowshoe hares and has lower nutritional quality than the adult twigs of *Salix alaxensis*, relaxes after two years (Bryant et. al. 1985). Tracking the changing concentrations of tannins and nitrogen in hare browse as the hare population fluctuates will provide additional insight into the interrelationships of this ecosystem.

Expanding the Project Scope: Investigations into Browse, Minerals, Hares and Lynx Interrelationships

Since the initiation of the hare study, we have spent many hours in discussion with Wiseman residents who have shared their intimate knowledge, experiences and observations of the landscape. They have also encouraged us to investigate some of the intriguing peculiarities that seem to be unique to the area. Hares in our study area maintained a high population for 4 years while neighboring populations did not reach such high levels, did not browse the vegetation to such an extent, and crashed after only a 2-year peak (J. Reakoff and S. Schoppenhorst, Wiseman trappers, pers. commun.). During the cycle maximum, hares hopped lethargically about, and then recovered later to normal, energetic conditions. They also consumed mineral soils at times during their peak phase, a behavior not reported for hares in neighboring areas. It appears that hares may be trying to medicate themselves from the toxic affect of plant secondary compounds by consuming the soil. This may enable the hares to sustain themselves longer and consume the vegetation to a greater degree than hares who do not have access to the mineral in neighboring areas. At the same time, however, the lethargy and diarrhea may be symptoms of another toxic affect produced by, perhaps, heavy metals in the mineral that are consumed along with the medicinal element. On the other hand, the unhealthy symptoms may be due to additional plant toxins that the hares continue to ingest due to the sustaining ability of their “medicine” that they otherwise would not survive to eat. Lynx, meanwhile, appeared skinny and otherwise unhealthy while the hares practiced geophagy in our study area; lynx elsewhere, where hares did not consume soil, were fat with the abundance of hares (J. Reakoff, Wiseman trapper, pers. commun.).

Over the next several years, we plan to expand our investigation to look more intensively at browse and soils, and how hares are affected by their consumption at different stages of the hare cycle (except for soil, which they consume only during peak hare densities when the vegetation has already been severely browsed), and likewise, how the condition of hares affects lynx. Some of the questions we’ll be grappling with include, what is it that hares seek by consuming mineral soils during the peak phase of their cycle that seems to help them sustain such high population densities? At the same time, does something in the mineral soil (e.g. heavy metals) cause the lethargic disposition and bloody diarrhea associated with the geophagic behavior? Or would these symptoms be caused by disease (e.g. tularemia) or perhaps from an extraordinarily high level of plant antiherbivory compounds?

THE NEW STUDY PLAN

In March 2004 and February 2005, we began preparing for the more intensive study we are embarking on of the ecological relationships tied to snowshoe hares. To broaden the area of study and to include control sites for comparison, we are searching for five additional study sites. Ideally, we will have three sites in “mineral” areas and three sites in “non-mineral” areas. One of the mineral sites will be the

original study area. The sites should be similar in vegetation species composition and topography, and also be areas where hares reach dense proportions during the peak phase of their population cycle. The main variable should be the presence or absence of mineral. The distance between sites should be at least 20 km (Flora 2002) in order to minimize the likelihood of hares emigrating from one site to another during a hare population peak. We may be forced to place some sites closer together, since the mineralized area lies within a fairly limited geographical range, and good hare habitat also is limited by the natural vegetation mosaic. Access is another issue. The sites must be fairly accessible, since we will need to access six separate study sites within approximately a week's time on a biannual (or more frequent) basis. Figure 8 shows several potential study sites we are currently considering.

We will measure the following variables (listed in general terms) on each of three 100-m transects at each site (vegetation, soil, hare track counts), and from collected lynx and hare carcasses:

Vegetation

- Cover
- Quality
- Phenolics
- Heavy metals
- Browsing intensity

Soil

- Trace minerals
- Heavy metals

Lynx

- Body condition
- Reproductive status
- Luteal scars
- Heavy metals (kidney, teeth)
- Phenolics (kidney, liver)

Hares

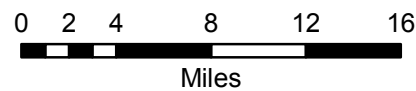
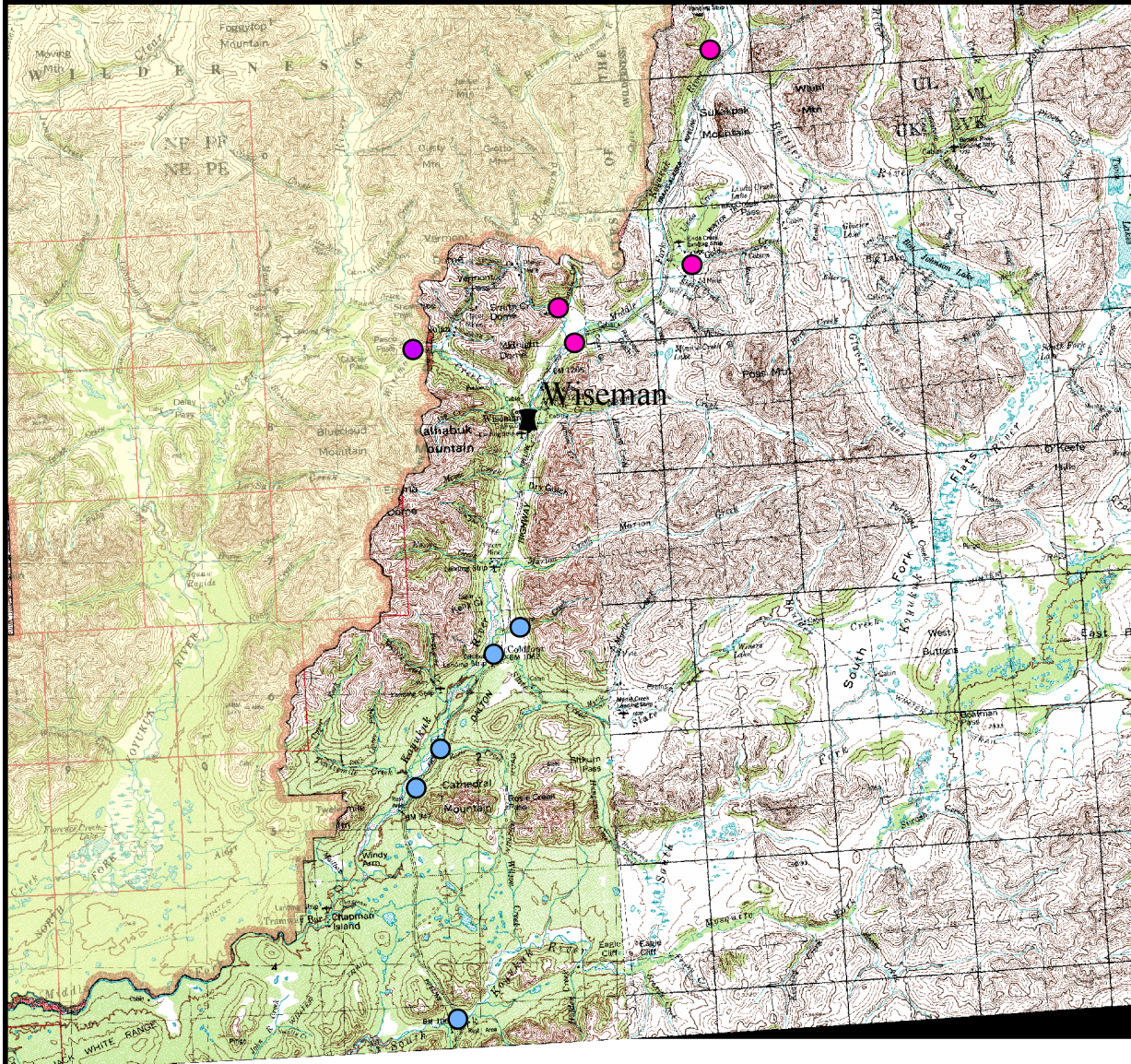
- Track counts
- Heavy metals (kidney)
- Phenolics (kidney, liver)
- Fecal samples



Jennie Bluff is a potential new mineral site in the hare-lynx study. During hare population highs, hares consume the mineral soils exposed on this bluff.

We will continue to count tracks and quantify browsing intensity in late winter. In March, June, and September, we will collect vegetation samples to determine the effects of season on nutritional quality, secondary compounds, and heavy metals in important browse species. We will also purchase lynx and hare carcasses from subsistence trappers in and around the Park to estimate body condition from kidney and visceral fat reserves, note reproductive status, count luteal scars, and collect samples of the kidney cortex and liver.

We collected soil samples to investigate the presence of important minerals in soils repeatedly visited and ingested by hares at the peak of the population cycle. We also collected samples from some of



Legend

- Original Study Site
- Potential Non-mineral Sites
- Potential Mineral Sites
- Gates of the Arctic NP&P



Fig. 8. Potential new study sites in mineral (pink) and non-mineral (blue) areas, snowshoe hare-lynx study in and near Gates of the Arctic National Park and Preserve, Alaska.

those sites and additional sites to investigate the possibility of arsenic poisoning as an explanation of the lethargy and bloody diarrhea exhibited by hares during periods of high population densities. Additional soil samples collected from both the mineral and nonmineral sites will be assayed for heavy metals and minerals in an effort to understand the importance of soil composition in buffering toxic plant compounds. We will assay vegetation as well as lynx and hare organ tissue for heavy metals to assess the levels of specific metals (e.g. arsenic, cadmium, and lead) found in plants as compared to levels found in animals.

Should additional funding become available, our study could be developed into a much more comprehensive investigation, rather than the pilot study that the current level of funding will support. Many questions surround the long-range and local movements of lynx. Do lynx “ride the wave” across broad regions from one hare high to another? During the hare high, do lynx stay in a small area (mineral) or do they travel among areas (mineral and nonmineral)? Part of the hypothesis of why lynx muscle tissue changes color from normal “white” to a dark purplish-blue is that they are ingesting these mineral-dependent hares and something the hares are eating (either plant toxins or metals in soil) is affecting lynx. We’d like to get GPS collars for lynx to help determine long-range movements and also to document their use of hares in mineral versus nonmineral sites.

We’d also like to implement and maintain grids to conduct mark-recapture operations of hares to better ascertain hare densities throughout the cycle in both mineral and nonmineral sites. If we could support a masters student, that person would be able to run the population grid systems, characterize the elemental makeup of the soils and vegetation in the mineral and nonmineral sites, and examine phenolics and nutritional quality of plants at all sites. A Ph.D. student might want to expand the minerals research, particularly cadmium research, to include other wildlife species that utilize these licks--especially those that are important to humans (e.g. moose, Dall’s sheep). At the moment, however, the hare population is very low, and it may be several years before the hare population builds up to the high levels where the effects (lethargy, bloody diarrhea in hare, and purplish-blue muscle tissue in lynx) observed during past hare peak phases recur.

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Appendix I. Weather data from the 2003 and 2004 snowshoe hare track counts, conducted near Wiseman, Alaska, in eastern Gates of the Arctic National Park and Preserve.

DATE	TIME		TEMP (F)		WIND		SKY		SNOWFALL** (mm)
4 Feb. 2003	12:10	15:05	26	28	slight breeze	slight breeze	overcast	snowing	100
5 Feb. 2003	12:15	14:45	32	29	slight breeze	slight breeze	snowing lightly	snowing lightly	47
19 Mar. 2003	11:35	14:15	20	22	slight breeze	slight breeze	clear	clear	12
20 Mar. 2003	10:35	12:15	5	13	slight breeze	slight breeze	clear	clear	0
10 Feb. 2004	11:58	*	30	*	windy (trees blowing)	*	overcast	*	*
11 Feb. 2004	14:10	14:40	14	20	nil	nil	scattered high clouds	partly cloudy	12
14 Mar. 2004	13:50	15:25	17	20	slight breeze	slight breeze	clear	clear	trace

* Not recorded.

** Snowfall since last survey or within previous 48 hours, whichever is less.

Appendix II. Number of hare tracks deposited during track count surveys of snowshoe hare in Gates of the Arctic National Park and Preserve, near Wiseman, Alaska, 2003 and 2004. The letters in the vegetation types stand for the following: L=light vegetation, M=moderate vegetation, D=D-WS vegetation, W=willow sp., P=M-SPW, S=spruce, B=shrub birch, A=alder.

Date	L-SB	L-WA	M-SW	Vegetation Type				D-WS	D-WPS
				left side	right side	left side	right side		
4 Feb. 2003	0	0	0	0	0	0	0	0	0
5 Feb. 2003	0	0	0	0	0	0	0	0	0
19 Mar. 2003	0	0	0	1 track, 1 trail	2 tracks, 1 trail	0	0	0	0
20 Mar. 2003	0	0	0	1	3	0	1	1	1
10 Feb. 2004	0	0	0	0	0	0	0	0	0
11 Feb. 2004	0	0	0	0	0	0	0	0	0
14 Mar. 2004	0	0	0	0	0	0	0	0	0

Appendix III. Nitrogen and tannin content of twigs collected from browsed shrubs in the snowshoe hare survey area near Wiseman, Alaska, Gates of the Arctic National Park and Preserve, 20 March 2003. In VCCs, the letters stand for the following: L=light vegetation, M=moderate vegetation, D=D-WS vegetation, W=willow sp., P=M-SPW, S=spruce, B=shrub birch, A=alder. "Birch Hill" is a shrubby, southwest facing hillside east of Snowshoe Creek adjacent to the study transect. "Nolan" is in the flat valley bottom south of the mining camp below the Nolan road.

Species	Site	%N	Crude Protein* (=%N x 6.25)	% Tannin
<i>Populus balsamifera</i>	M-SPW	1.400	8.750	0.43
<i>Salx planifolia</i>	D-WPS	1.276	7.975	13.33
<i>Salx planifolia?</i>	Nolan	0.891	5.571	9.66
<i>Salx glauca/planifolia</i>	Nolan	1.162	7.263	11.24
Mean <i>S. planifolia</i>		1.110	6.936	11.41
SD		0.198	1.235	1.84
<i>Salx glauca</i>	Birch Hill	0.881	5.504	11.68
<i>Salx glauca</i>	Birch Hill	0.978	6.113	11.55
<i>Salx glauca?</i>	Birch Hill	0.921	5.756	10.56
<i>Salx glauca?</i> ' mature twigs'	M-SPW	1.052	6.575	16.01
<i>Salx glauca</i>	M-SPW	1.278	7.988	9.79
<i>Salx alaxensis/glauca</i>	M-SPW	1.159	7.244	9.25
Mean <i>S. glauca</i>		1.045	6.530	11.47
SD		0.151	0.945	2.42
<i>Salx alaxensis</i>	M-SPW	1.066	6.663	12.20
<i>Salx alaxensis</i>	D-WPS	1.204	7.525	13.30
Mean <i>S. alaxensis</i>		1.135	7.094	12.75
SD		0.098	0.610	0.78
<i>Salx alaxensis/glauca</i> ***	Nolan	0.371	2.318	4.32

* Crude Protein is a rough calculation—percent nitrogen may also include nitrogen-based defense compounds in addition to crude protein.

***Looks like all dead material—not included in mean calculations.

Appendix IV. Lengths of the vegetation cover and composition (VCC) zones within the snowshoe hare survey route in Gates of the Arctic National Park and Preserve near Wiseman, Alaska. Hare tracks are counted along the entire length of each VCC during years of low hare densities. During population highs, tracks are counted in 11 100m transects within the 6 VCCs.

VCC	Length (m)
L-SB	1,000
L-WA	480
D-WS	300
M-SW	425
M-SPW	1,020
D-WPS	180



Julie Maier, with the University of Alaska Institute of Arctic Biology, and Raphaela Stemmelmayer, of the Alaska Native Technology and Development Group, are the new team members in the newly expanded snowshoe hare-lynx study near Wiseman, Alaska.