SR-23-08

Results of a 2021 Survey of Arctic Ground Squirrels (*Urocitellus parryii*) in Southwestern Yukon

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Authors

Heather E. Milligan, Piia M. Kukka, Caitlin N. Willier, Élise Brown-Dussault, Kazuhisa Kuba, Shawn D. Taylor, and Thomas S. Jung

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Copies available from:

Government of Yukon
Fish and Wildlife Branch, V-5
Box 2703, Whitehorse, Yukon Y1A 2C6
Phone 867-667-5721
Email: environmentyukon@yukon.ca
Online: Yukon.ca and open.yukon.ca

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Executive Summary

- The Arctic ground squirrel (*Urocitellus parryii*) is a semi-fossorial rodent, common throughout much of the Yukon. It is a key food source for many other species, including people. They are culturally important for several Yukon First Nations.
- Although ground squirrels remain common in alpine and arctic tundra, Indigenous knowledge and scientific monitoring concurrently report that populations in lowland habitats of southwestern Yukon collapsed in 2000 and have not recovered.
- In 2021, in response to requests by others, we conducted surveys of ground squirrels at two locations in lowland habitats where they were historically abundant but are now sparse.
- One survey area was the Duke Meadows, near Kluane Lake, where Kluane First Nation was interested in monitoring the impact of a potential prescribed burn on ground squirrels and other species.
- The second survey area was in the Takhini Valley, near Whitehorse, where the Yukon Agricultural Branch is exploring the feasibility of cattle grazing within woodlands.
- We used strip transects to establish a baseline of ground squirrel burrow densities at these two study areas, coupled with adjacent control areas, prior to burning (Duke Meadows) and cattle grazing (Takhini Valley).
- Average burrow densities were 119 per hectare at Duke Meadows and 69 per hectare at Takhini Valley. Many burrows at both sites were inactive (97% and 96%, respectively), suggesting that ground squirrel occupancy is very low at both sites.
- Additionally, we established 21 permanent vegetation plots to monitor for changes over time in ground squirrel habitat at Duke Meadows. At the Duke Meadows site, we used remote sensing images taken in 1984 and 2019 to detect historical habitat change. Little change was detected with the analysis.
- Periodic, repeated burrow surveys are recommended to assess changes in the relative abundance of ground squirrels, before and after a proposed prescribed burn in the Duke Meadows and cattle grazing in the Takhini Valley.

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Introduction

Arctic ground squirrels (*Urocitellus parryii*; hereafter ground squirrels) are semi-fossorial rodents that live in burrows but feed above ground. They are common in northwestern Canada, Alaska and eastern Siberia (**Figure 1;** Eddingsaas et al. 2004). Ground squirrels are a key herbivore in terrestrial food webs (Boonstra et al. 2018) and are considered ecosystem engineers (Wheeler and Hik 2013). They establish colonies in habitats with friable soil, suitable for digging burrows, and are associated with open habitats that facilitate predator detection (Kukka et al. 2021). They are common in arctic and alpine tundra habitats and near disturbed habitats, such as roadsides and agricultural areas.

Ground squirrels (also known as Säl in Southern Tutchone) are a culturally important species for Yukon First Nations, who snare or shoot them for food and their hides (Southern Lakes Wildlife Coordinating Committee 2012; Hebda et al. 2017). In earlier times, household items made from ground squirrel furs were common. For example, the naturally mummified remains of a young man, Kwäday Dän Ts'inchi ("Long Ago Person Found" in Southern Tutchone) dating 300–550 years ago, wore a robe made of 95 ground squirrel pelts (Hebda et al. 2017). Ground squirrel harvesting continues to be an important cultural activity for Yukon First Nations.

Arctic ground squirrels are classified as Apparently Secure by the Yukon Conservation Data Centre (2023). They appear to remain common in alpine tundra habitat; however, in the late 1990s, local First Nations and researchers both described a population collapse in lowland forest and meadow habitats in southwestern Yukon, and populations have not recovered (Donkor and Krebs 2011; Werner et al. 2015; Boonstra et al. 2018). Prior to the collapse, ground squirrel densities in boreal habitats rose and fell in predictable cycles along with snowshoe hares (*Lepus americanus*; Donkor and Krebs 2011). Predation of ground squirrels is thought to be a major limiting factor to population growth, especially when snowshoe hares are in low abundance and their predators, such as lynx (*Lynx canadensis*) and coyotes (*Canis latrans*), turn to ground squirrels as prey (Krebs et al. 2014; Werner et al. 2015; Boonstra et al. 2018; Kukka et al. 2021). Flooding of their dens in late winter or spring may also impact regional populations.

Here, we provide the results of two surveys for ground squirrels in southwestern Yukon and associated vegetation monitoring. In response to anticipated activities that would affect habitat suitability for ground squirrels, we aim to provide baseline data on relative abundance before these activities occurred. Habitat modifications that reduce encroachment of trees and shrubs into open habitats and the height of understory vegetation (such as mowing, burning or grazing) may improve ground squirrel habitat and affect local occupancy (Werner et al. 2015; Kukka et al. 2021). At one study area (Duke Meadows), Kluane First Nation is considering burning a portion of a grassland that is an important area for ground squirrel hunting. At another location (Takhini Valley), the Government of Yukon's Agricultural Branch is initiating trials of cattle grazing in open woodland habitats and are interested in determining the effects on this culturally important species. At each site, ground squirrel populations were historically abundant before the collapse. Our 2021 surveys will provide baseline data to evaluate the effects of these habitat modifications on ground squirrels, within a before-after-control-impact (BACI) framework. Along with the ground squirrel surveys, we also established vegetation monitoring plots to understand the encroachment of shrubs in Duke Meadows and establish a baseline for habitat modifications such as prescribed burning or cattle grazing.

Figure 1. Arctic ground squirrel (*Urocitellus parryii*) and their habitat in Takhini Valley, Yukon. Photo credits: J.R. Werner (left) and P.M. Kukka (right).

Methods

Study areas

Our study took place at two study areas in southwestern Yukon that have been proposed for habitat modification projects (**Figure 2**). Our first study area was the Duke Meadows, a grassland ecosystem near Kluane Lake. This area is located in the Traditional Territories of Kluane and White River First Nations and is an important cultural site and traditional ground squirrel hunting area. Following the ground squirrel population collapse in the late 1990's, an experiment was conducted from 2009 to 2014 to relocate ground squirrels to Duke Meadows (Werner 2015). However, despite limited short-term success, the population at Duke Meadows remains low. The encroachment of tall grass and shrubs likely contributed to the decline of ground squirrels in the area. Kluane First Nation is planning a prescribed fire to reduce the tall vegetation.

Our second study area was in the Takhini Valley, approximately 50 km west of Whitehorse. This area is located with the Traditional Territories of Ta'an Kwäch'än Council, Kwanlin Dün First Nation, and Champagne and Aishihik First Nations. Following an extensive wildfire that burned the valley in 1958, forest cover is now dominated by trembling aspen (*Populus tremuloides*), with extensive areas now converted to agriculture (Smith et al. 2004). The Yukon Government's Agricultural Branch is developing trials to assess the effects of cattle grazing on woodland habitat (**Figure 3**). Considerable variation in the response to plant and small mammal communities to cattle grazing has been documented (e.g., Fehmi et al. 2005). Cattle grazing of woodlands is currently uncommon in the Yukon and its effects on biodiversity, including ground squirrels, is unknown.

At each study area, we established transects at areas that were planned for habitat modifications (pre-treatment) as well as control sites where no habitat modifications (i.e., burning or cattle grazing) were planned. Given that our study occurred before habitat modification, our study design allows us to assess changes to ground squirrel habitat in Duke Meadows and Takhini Valley using a before-after-control-impact (BACI) framework. Study designs based on a BACI approach can reliably detect change (Chevalier et al. 2019).

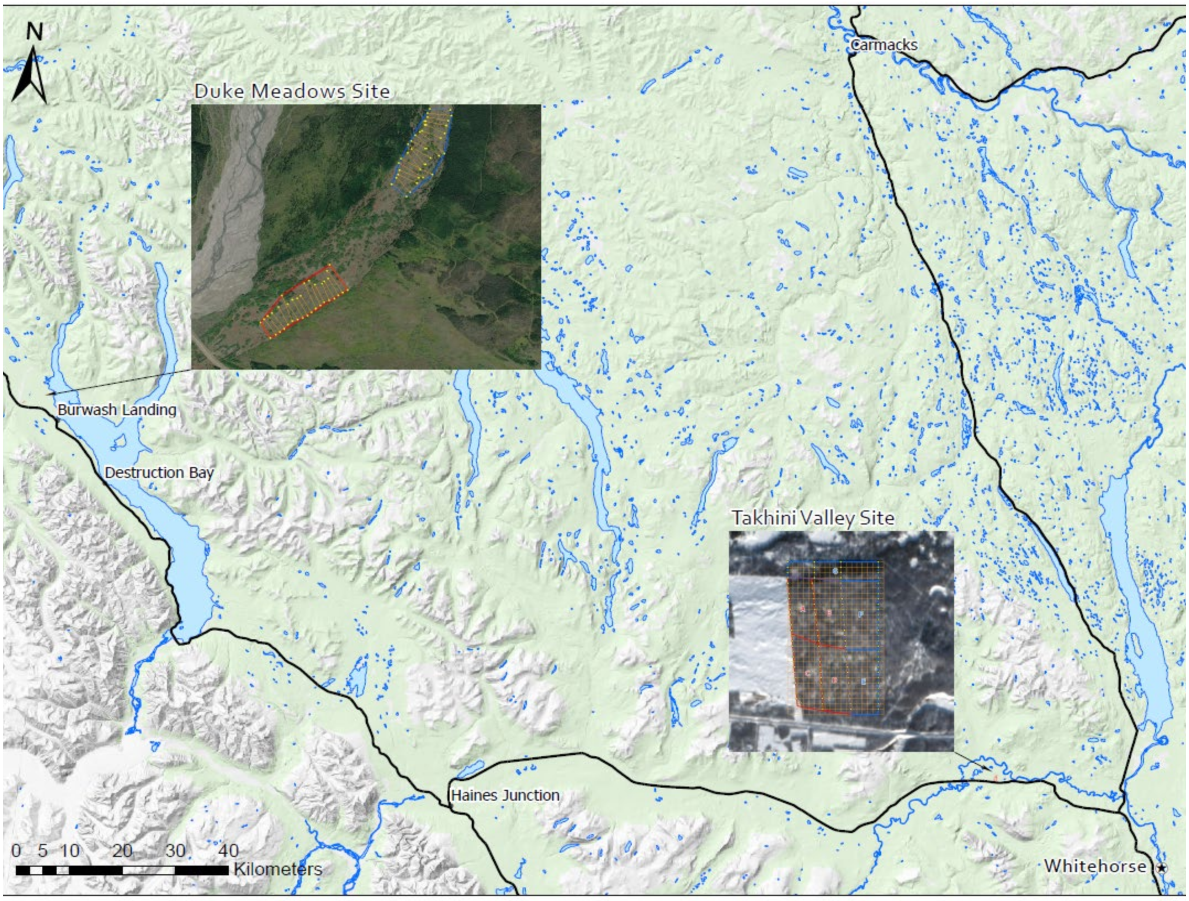

Figure 2. Areas surveyed in 2021 for Arctic ground squirrels (*Urocitellus parryii*) in southwestern Yukon, Canada.

Figure 3. Woodland grazing experiment plots in Takhini Valley in southwestern Yukon, Canada.

Ground squirrel surveys

Initially, we aimed to determine the density of ground squirrels in each study area. However, upon visiting the study areas, it was apparent that ground squirrel densities were extremely low and methods used to estimate density were not appropriate or efficient. Instead, we decided to use counts of active and inactive burrows as an index of relative abundance. A primary advantage of burrow counts is that they are easy and efficient to conduct, repeatable, and easily interpretable by the public.

We conducted area-based surveys of ground squirrel burrows in pre-treatment and control plots at each study area by walking transects and counting burrows within a 3 m wide strip of each transect. Observers carried a marked stick to determine if burrows were within 1.5 m to the right and left of the observer's transect line. At Duke Meadows, transects were approximately 50 m apart and situated to survey as much apparent ground squirrel habitat as possible. At Takhini Valley, transects were 50 m parallel to provide stratified coverage across each study plot. Observers classified burrows as active or inactive. Active burrows showed sign of recent activity, such as freshly dug earth, whereas inactive burrows were covered by leaves or roots (Van Horne et al. 1997; McCullough Hennessy et al. 2018). To calculate the density of active and inactive ground squirrel burrows at both pre-treatment and control plots at each study area, we standardized the density of burrows per transect by calculating the density of burrows per hectare.

Vegetation monitoring

We established and surveyed 21 permanent vegetation plots in Duke Meadows to monitor changes over time in ground squirrel habitat using adapted methods described by Myers-Smith and colleagues (2012). The centres of plots were marked using a handheld GPS unit and permanently marked with a magnetic nail and metal tag. Within each plot we counted tree and shrub stems in height classes and cored trees using an increment borer to determine tree age and growth rates. We also photographed the plots. To facilitate linkages between field and remote sensing data, we established nested plots at multiple scales of satellite imagery pixel resolution. The core area 900 m^2 plot corresponded to a single 30 x 30 m Landsat pixel. Within the core plot, a smaller nested plot of 100 m^2 was used to correspond to a 10 x 10 m Sentinel-2 pixel. Each of these plots contained multiple 1 m^2 plots to correspond to SPOT 5 and Maxar pixels.

To examine historical vegetation changes to Duke Meadows, we compared remote sensing images taken in 1984 and 2019. We conducted a pixel change analysis using Normalized Difference Vegetation Index (NDVI) derived from Landsat imagery to quantify the land cover change from 1984 to 2019. NDVI is a satellite-based index used to measure the amount of vegetation in an area and identify changes in vegetation cover and composition. NDVI distinguishes areas of higher and lower vegetation density (a measure of greenness). Increases in NDVI over time are thought to be mostly a result natural succession or when low vegetation or sparsely vegetated areas fill in with shrubs (Goetz et al. 2006) and thus can be used to assess the effects of management strategies on vegetation.

Results

Ground squirrel densities

On July 7th, 2021, we conducted ground squirrel burrow surveys at Duke Meadows. We surveyed 36 strip transects, walking over 8 km, with 18 transects in the pre-treatment, and 18 in the control, plots (**Figure 4**). Our strip transects effectively surveyed 2.4 hectares.

We detected 295 burrows, nearly all of which (97%) were inactive (**Table 1**). Only 7 active burrows were observed, and all of these were in the pre-treatment site.

Overall, the mean density of burrows was 119.3 ± 10.5 (SE) per hectare. At the pre-treatment site, we observed a mean density of 112.9 inactive burrows per hectare (range = 48-350) and 4.7 active burrows per hectare (range = 0-50). At the control site, we observed a mean density of 121.0 inactive burrows per hectare (range = 0-211) and no active burrows. The difference in density of ground squirrel burrows between pre- treatment and control sites (**Figure 5**) was not statistically significant ($t_{34} = 0.159$, $p = 0.874$).

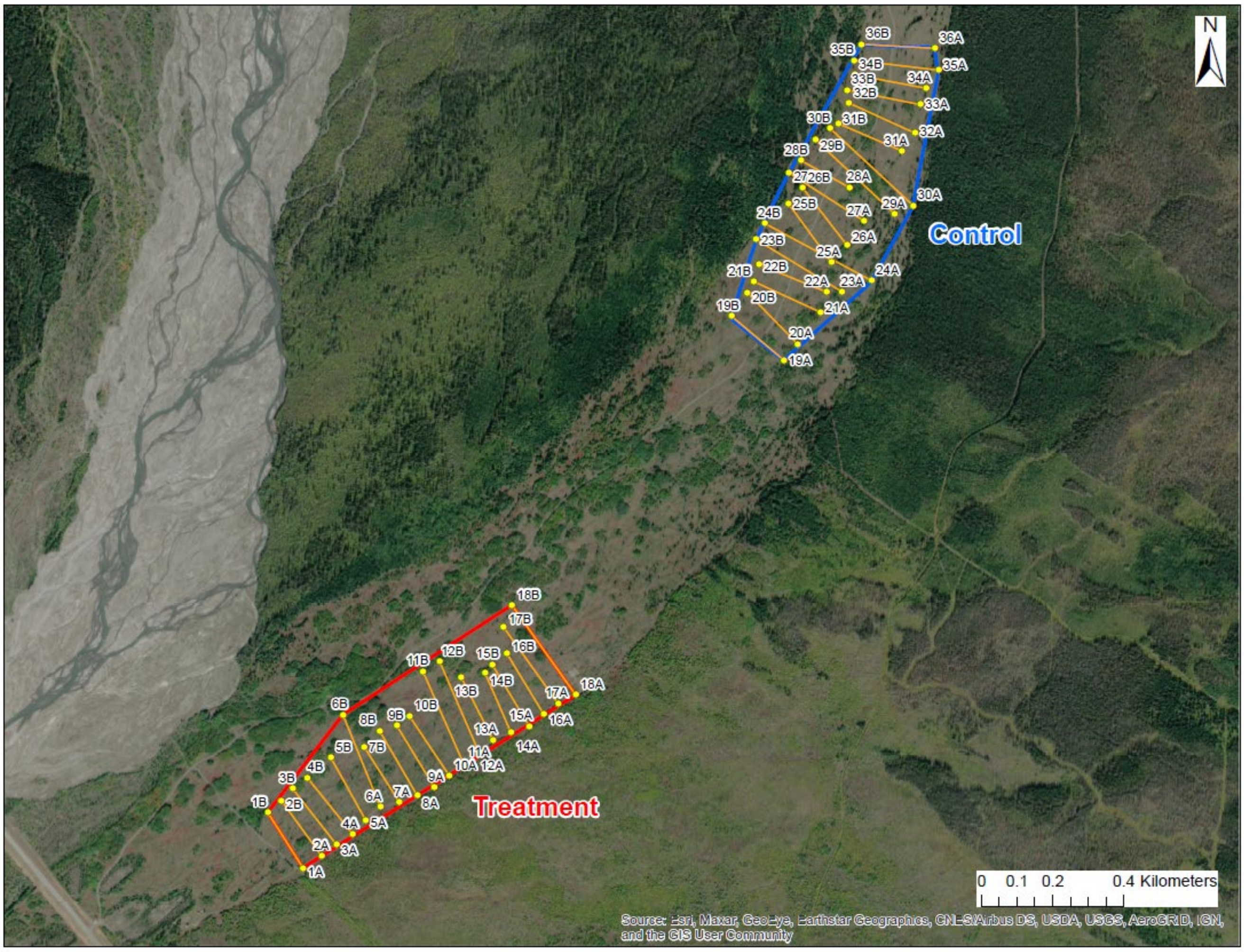

Figure 4. Location of study plots by treatment type (pre-treatment and control) and transects surveyed for ground squirrel burrows in the Duke Meadows, southwestern Yukon.

Table 1. Total area surveyed, number of transects surveyed, and results of ground squirrel burrow surveys at Duke Meadows, southwestern Yukon.

Treatment Type	Site Area (ha)	Number of Transects	Area surveyed (ha)	Inactive burrows	Active burrows	Mean (SE) Active burrows per ha	Mean (SE) Inactive burrows per ha
Pre-treatment	28	18	1.20	135	7	4.7 (3.0)	112.9 (16.9)
Control	40	18	1.23	153	0	0 (0)	120.97 (12.0)
Total and Means	68	36	2.43	288	7	2.33 (1.5)	119.28 (10.5)

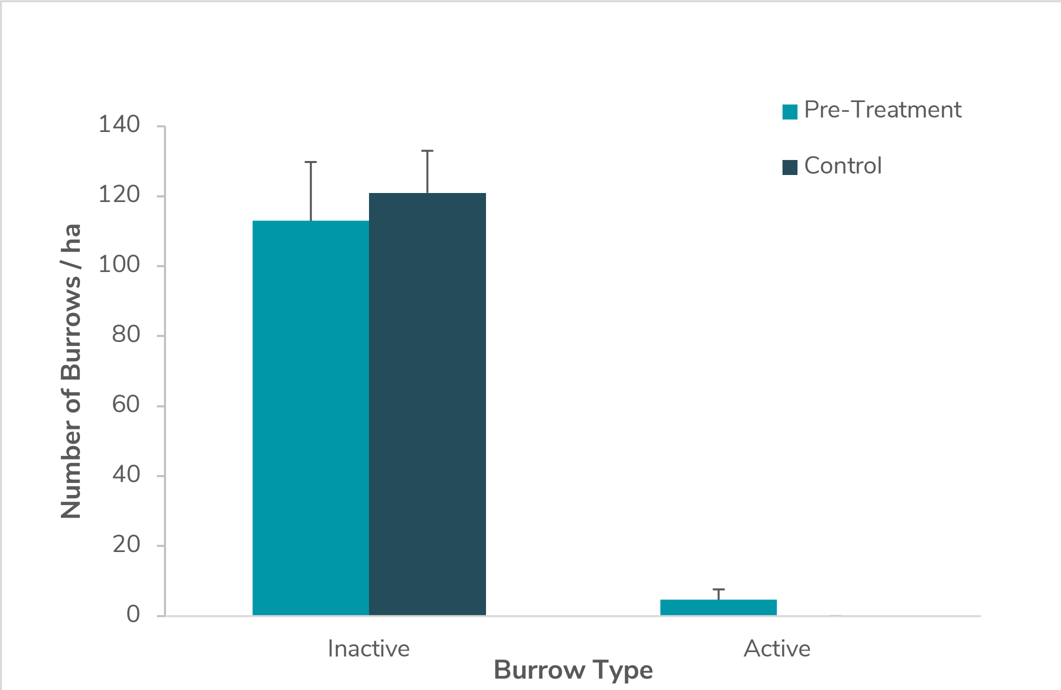

Figure 5. Mean (SE) number of ground squirrel burrows per hectare in pre-treatment and control plots at Duke Meadows, Yukon.

On August 19th and September 16th, 2021, we conducted ground squirrel burrow surveys at our Takhini Valley study area. We surveyed 80 strip transects, walking over 21 km, with 47 transects in the pre-treatment, and 33 in the control plots (**Figure 6**). Our strip transects effectively surveyed 6.4 hectares.

We detected 447 burrows, nearly all of which (96%) were inactive (**Table 2**). Only 13 active burrows were observed, of which 10 were in the pre-treatment site.

Overall, the mean density of burrows was 69.5 ± 6.1 (SE) per hectare. At the pre-treatment site, we observed a mean density of 57.0 inactive burrows per hectare (range = 0-168) and 2.9 active burrows per hectare (range = 0-28). At the control site, we observed a mean density of 80.4 inactive burrows per hectare (range = 0-347) and 1.2 active burrows per hectare (range = 0-27). The difference in density of ground squirrel burrows between pre- treatment and control sites (**Figure 7**) was close to being statistically significant ($t_{78} = 1.793$, $p = 0.077$).

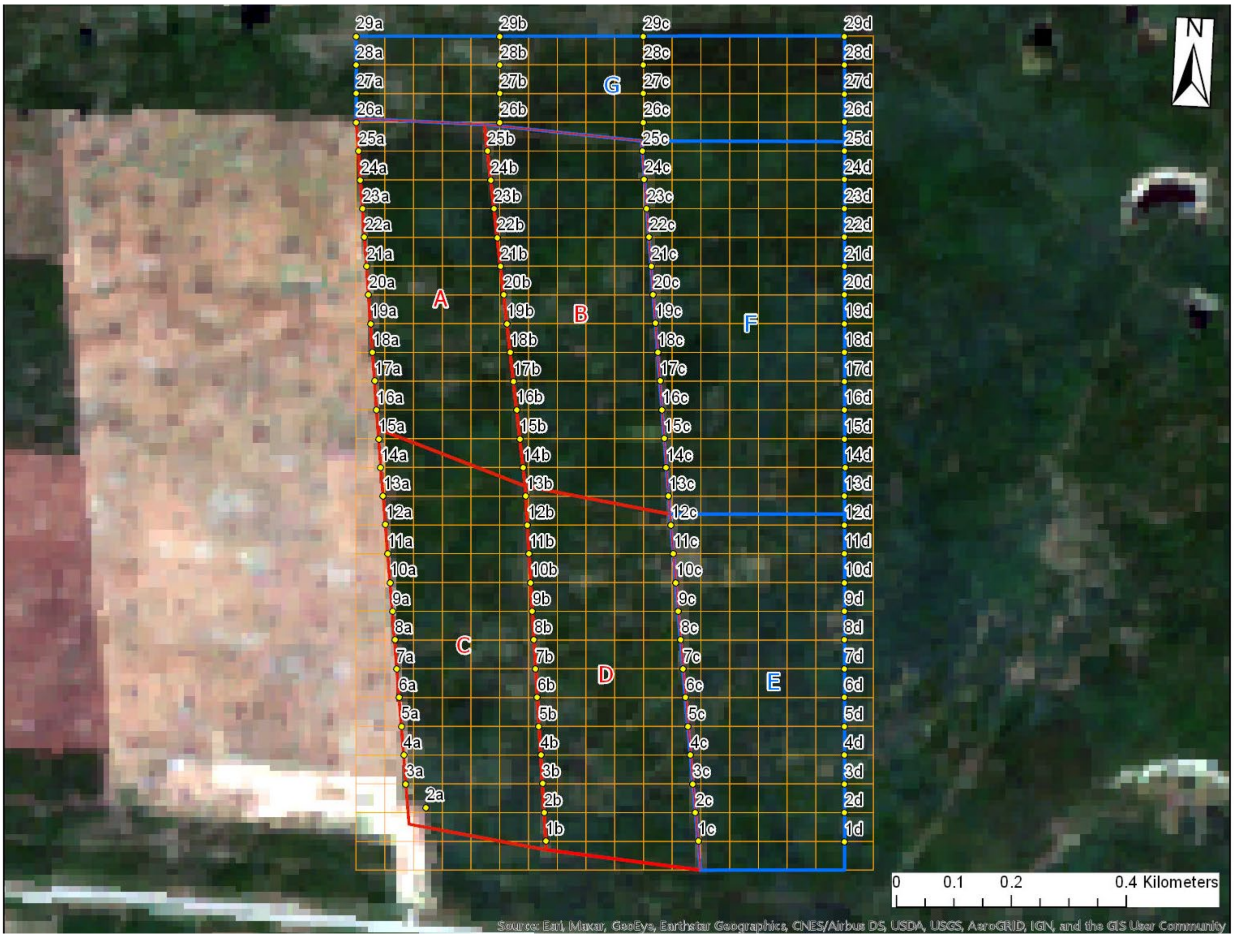

Figure 6. Arctic ground squirrel survey locations in the Takhini Valley, southwestern Yukon. Pre-treatment plots (A, B, C, D) are delineated by an existing cutline for proposed fencing. Control sites are plots E, F, and G. Transects ran from west to east along points.

Table 2. Total area surveyed, number of transects surveyed, and results of ground squirrel burrow surveys in the Takhini Valley, Yukon.

Treatment Type	Site Area (ha)	Number of Transects	Area surveyed (ha)	Inactive burrows	Active burrows	Mean (SE) Active burrows per ha	Mean (SE) Inactive burrows per ha
Pre-treatment	62.3	47	3.5	199	10	2.87 (1.09)	56.95 (5.33)
Control	52.9	33	2.9	231	3	1.21 (0.89)	80.38 (12.05)
Total and Means	115.2	80	6.4	430	13	2.19 (0.7)	69.47 (6.1)

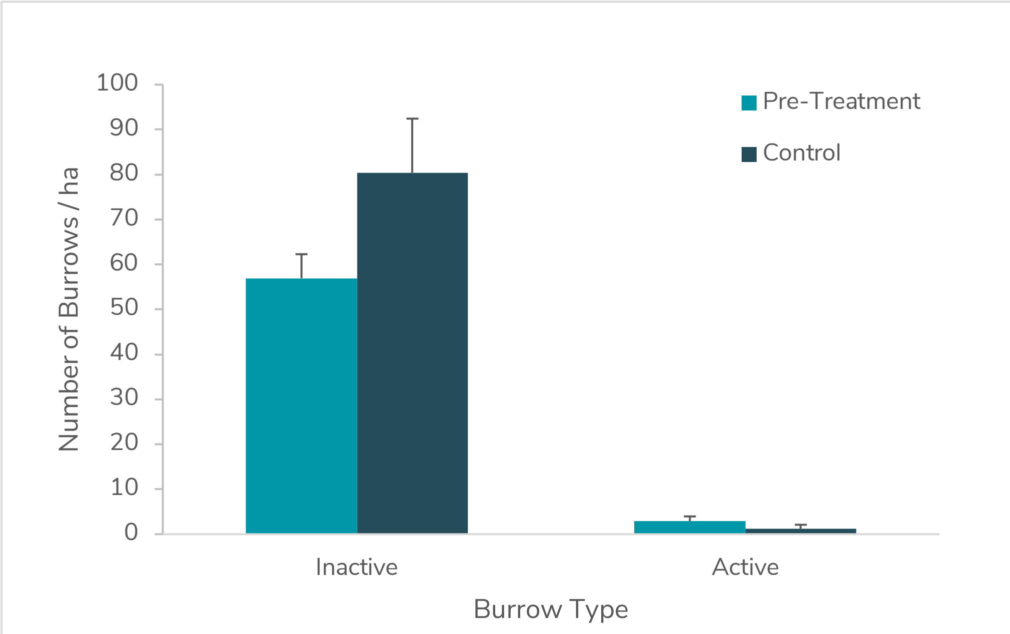

Figure 7. Mean (SE) number of ground squirrel burrows per hectare in pre-treatment and control plots in the Takhini Valley, southwestern Yukon.

Time series of vegetation change

We detected very little change in vegetation at Duke Meadows from comparing remote sensing satellite imagery from 1984 to 2019. We detected some pixel changes of NDVI greenness in a forested area to the east of the meadows where wildfires burned in 1999, as well as an active clearing around the Kluane First Nation cultural site within the meadows (Figure 8). Field surveys of the vegetation plots revealed that the recruitment of aspen and balsam poplar (*Populus balsamifera*) is extremely high on the edges of Duke Meadows and that recruitment is much lower for white spruce (*Picea glauca*) saplings. Young aspen shoots appeared to be suppressed by ungulate browsing, however, balsam poplar (which is less palatable due to its bitter sap secretions) were more prolific and less browsed by ungulates.

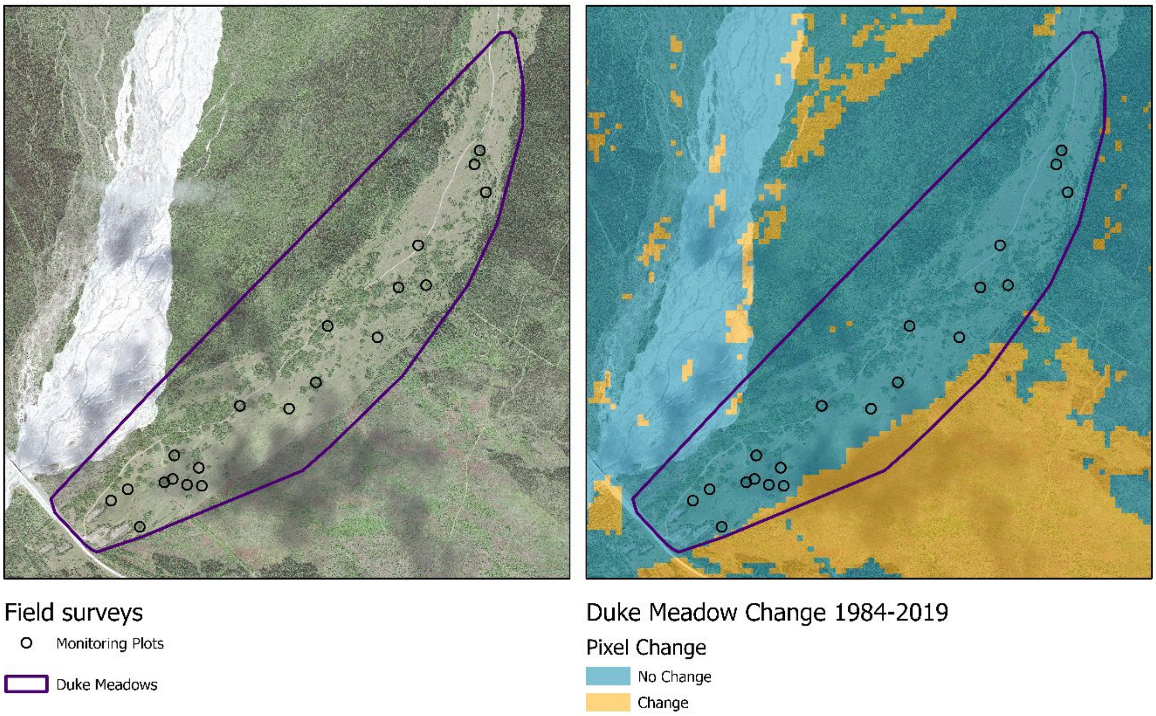

Figure 8. Left: SPOT 5 satellite imagery at Duke Meadows with 21 permanent vegetation monitoring plots. Right: NDVI pixel change analysis of Duke Meadows from Landsat imagery from 1984 and 2019.

Discussion

We used a simple and repeatable burrow count method to provide a baseline for future studies aimed at evaluating how changes to ground squirrel habitat from prescribed burns and cattle grazing may affect the density of active burrows. We surveyed ground squirrel burrows at the Duke Meadows and the Takhini Valley study areas before proposed changes to the landscape occurred. At both sites, pre-treatment and control sites were similar habitats and they both had numerous inactive burrows. Periodic burrow surveys after potential habitat modifications in the Duke Meadows and Takhini Valley will be needed to understand how prescribed fire or cattle grazing may affect ground squirrel populations.

Given few ground squirrels were in our study areas, burrow counts may be an ideal survey method and index of abundance (McCullough Hennessy et al. 2018). If ground squirrel populations increase substantially, burrow counts may become a less reliable metric (Van Horne et al. 1997) and other survey techniques may be required, such as mark-recapture, distance sampling, powder tracking, thermal imaging, or playback alarm calls (e.g., Hubbs et al. 2000; Downey et al. 2006; Proulx et al. 2012).

We detected very little historical change in vegetation in the meadow habitat at Duke Meadows study area from 1984 to 2019. The change we could detect using NDVI analysis of Landsat imagery was of a forested area at the eastern peripheries of the meadow that was burned by wildfire in 1999. Our results are likely due to the resolution of the satellite imagery. Landsat imagery at the scale of 30 m x 30 m pixels may be too broad to detect changes relevant to ground squirrel habitat. Other remote sensing products such as Sentinel-2 and SPOT 5 may prove more useful for detecting changes in the future, however, these products lack the historical time series of Landsat imagery. Further work is needed to analyse the tree cores and match the field data to satellite imagery.

As a result of this work, we now have baseline data prior to potential habitat modifications. These results and data can be used to inform and evaluate management strategies, such as fire management and habitat modifications, on ground squirrel populations and their habitat at these two survey areas.

Literature Cited

Boonstra R, Boutin S, Jung TS, Krebs CJ, Taylor S (2017) Impact of rewilding, species introductions and climate change on the structure and function of the Yukon boreal forest ecosystem. Integrative Zoology 13:123-138.

Chevalier M, Russell JC, Knape J (2019) New measures for evaluation of environmental perturbations using Before-After-Control-Impact analyses. Ecological Applications 29:e01838.

Donker SA, Krebs CJ (2011) Habitat-specific distribution and abundance of arctic ground squirrels (*Urocitellus parryii plesius*) in southwest Yukon. Canadian Journal of Zoology 89:570-576.

Downey BA, Jones PF, Quinlan RW, Scrimgeour GJ (2006) Use of playback alarm calls to detect and quantify habitat use by Richardson's ground squirrels. Wildlife Society Bulletin 34:480–484.

Eddingsaas AA, Jacobsen BK, Lessa EP, Cook JA (2004) Evolutionary history of the arctic ground squirrel (*Spermophilus parryii*) in Nearctic Beringia. Journal of Mammology 85:601-610.

Fehmi JS, Russo SE, Bartolome JW (2005) The effects of livestock on California ground squirrels (*Spermophilus beecheyii*). Rangeland Ecology and Management 58:352-359.

Goetz SJ, Fiske GJ, Bunn AG (2006) Using satellite time-series data sets to analyze fire disturbance and forest recovery across Canada. Remote Sensing of Environment 101:352-365.

Hebda RJ, Greer S, Mackie AP (Editors) (2017) Kwäday Dän Ts'inchi: teachings from Long Ago Person Found. Royal British Columbia Museum, Victoria, British Columbia.

Hubbs AH, Karels T, Boonstra R (2000) Indices of population size for burrowing mammals. Journal of Wildlife Management 64:296-301.

Krebs CJ, Boonstra R, Boutin S, Sinclair ARE, Smith JNM, Gilbert BS, Martin K, O'Donoghue M, Turkington R (2014) Trophic dynamics of the boreal forests of the Kluane Region. Arctic 67:71–81.

Kukka PM, Werner JR, Andresen LM, Krebs CJ, Jung TS (2021) Landscape drivers of site occupancy by remnant populations of arctic ground squirrels (*Urocitellus parryii*). European Journal of Wildlife Research 67:93.

McCullough Hennessy S, Marczak SA, Nordstrom LA, Swaisgood R (2018) Reconsidering habitat associations in the Anthropocene. Global Ecology and Conservation 14:e00397.

Myers-Smith IH, Lantz TC, Leathem J (2012) Tall Shrub Monitoring Protocol for Arctic Canada and Alaska. Unpublished protocols

Proulx G, MacKenzie K, MacKenzie M (2012) Distribution and relative abundance of Richardson's ground squirrels, *Urocitellus richardsonii*, according to soil zones and vegetation height in Saskatchewan during a drought period. Canadian Field-Naturalist 126:103-110.

Southern Lakes Wildlife Coordinating Committee (2012) Regional Assessment of Wildlife in the Southern Lakes Region: Volume 1: Context and Recommendations. Environment Yukon, Whitehorse, Yukon. 76 pp.

Smith CAS, Meikle JC, Roots CF (Editors) (2004) Ecoregions of the Yukon Territory: biophysical properties of Yukon landscapes. Agriculture and Agri-Food Canada, PARC Technical Bulletin No. 04-01. Summerland, British Columbia.

Van Horne B, Schooley RL, Knick ST, Olson GS, Burnham KP (1997) Use of burrow entrances to indicate densities of Townsend's ground squirrels. Journal of Wildlife Management 61:92-101.

Werner JR (2015) Factors governing the distribution and abundance of Arctic ground squirrels. Arctic 68:522-526.

Werner JR, Krebs CJ, Donker SA, Boonstra R, Sheriff MJ (2015) Arctic ground squirrel population collapse in the boreal forests of the Southern Yukon. Wildlife Research 42:176-184.

Wheeler HC, Hik DS (2013) Arctic ground squirrel *Urocitellus parryii* as drivers and indicators of change in northern ecosystems. Mammal Review 43:238-255.

Yukon Conservation Data Centre (2023) *Urocitellus parryii* element occurrence and observation data in Yukon Biotics database. Yukon Department of Environment, Whitehorse, Yukon.