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A decade and a half ago populations of Arctic ground squirrels (hereafter AGS) began to decline precipitously in the boreal forest of the SW Yukon. It was assumed at that time that the decline was a predictable process that has likely happened many times before. Populations of other species whose ranges overlap with the snowshoe hare are known to cycle in a similar fashion—this small mammal was therefore expected to rebound in a few short years after the initial crash. This, however, did not happen and today localised extinctions are common-place. Because AGS once accounted for nearly one quarter of the energy flow through the ecosystem, this dramatic change in both distribution and abundance are of particular interest. AGS were used by First Nations as an important source of food, clothing and tools. Today they are seasonal source of food, and traditional hunting continues to be a culturally important activity.

The objective of this project is to establish new populations of ground squirrels within First Nations traditional hunting areas. These efforts are part of a larger program aimed at recovering populations of this important herbivore while determining why numbers have declined in recent decades (see Enhancement Application for details concerning the wider scheme). Major project activities during 2013 included site assessment and preparation, squirrel translocation and intensive post release monitoring. The monitoring portion of this wildlife enhancement will ensure that the outcomes contribute to our understanding of this important mammal and to the success of future management actions. The $11,550 contribution from the Enhancement Trust was used to directly support preparation, release and monitoring activities between May and September 2013.

Project Activities

Two historically occupied, but currently vacant, habitats were chosen as release locations in consultation with Kluane First Nation. Both sites are within 1 Km of one another on traditional territory and are in meadow habitats known to have supported healthy populations in the recent past [source populations: Destruction Bay post office (61°15'4.60"N 138°48'7.55"W) and Burwash Landing airport (61°22'5.85"N 139° 1'43.10"W); translocation site: Duke River meadows (61°23'21.35"N 139° 6'13.86"W)]. The translocation site has a long history of traditional harvest. Figure 1 provides an overview of the Duke meadow system. It is hoped that translocation efforts will result in a growing population that will support harvesting and traditional use by First Nations in future years.

We used powder tracking (described by Donker 2010) to verify the absence of AGS at the proposed Duke reintroduction site and to verify the local abundance of source populations. Plastic tiles, covered in mineral oil and talc, were placed at the entrances of all burrows within a 2 hectare area. Tiles were retrieved six hours later and each burrow was scored as active or inactive based on the presence or absence footprints. The number of ground squirrels was estimated using the linear relationship

$$y=0.82x-0.84$$

developed by Hubbs et al. (2000; $r^2=0.65$, $p<0.01$) for ground squirrels in the Kluane region, where the density of squirrels (y) is a linear function of active burrow density (x). The Duke site was found to harbour no individuals, a fact corroborated by a lack of any visual sign (sightings, recently excavated burrows, feces) or alarm calls during 2012 and 2013. The density of ground squirrels at Burwash was estimated to be in excess of 15/ha. This area contained 9ha of suitable looking habitat which might yield as many as many as 135 release candidates.

Site preparation and release methods were designed using an experimental framework in order to maximise the learning potential of these 'population recovery' efforts (Armstrong et al. 1994). Arctic ground were placed into a variety of manipulated and un-manipulated meadow habitats, which included the provision all possible combinations of short/tall grass and high/low burrow availability in a 500 x 250 m area. Vegetation height in 50x50m blocks was reduced to

10cm using a grass trimmer [Figures 2-4]. We boosted burrow density using a Dutch hand auger following methods described by Gedeon et al. (2012) [Figure 6].

On July 1 through July 5, 2013 45 squirrels were captured from various locations in the vicinity of the Burwash Landing Airport, marked with individual ear tags, radio collared, and translocated (~8 km north) into Duke meadows (Figure 6). Squirrels were released during the time of peak activity (between 7 and 9 a.m.) into burrows outfitted with retention caps and supplemental food (Gedeon et al. 2011). The retention caps were designed to force squirrels to invest energy into their novel home by digging a second entrance. Sliced apple and 1 cup of black sunflower seeds were placed within each release burrow to promote site fidelity and reduce stress associated with foraging in a novel environment.

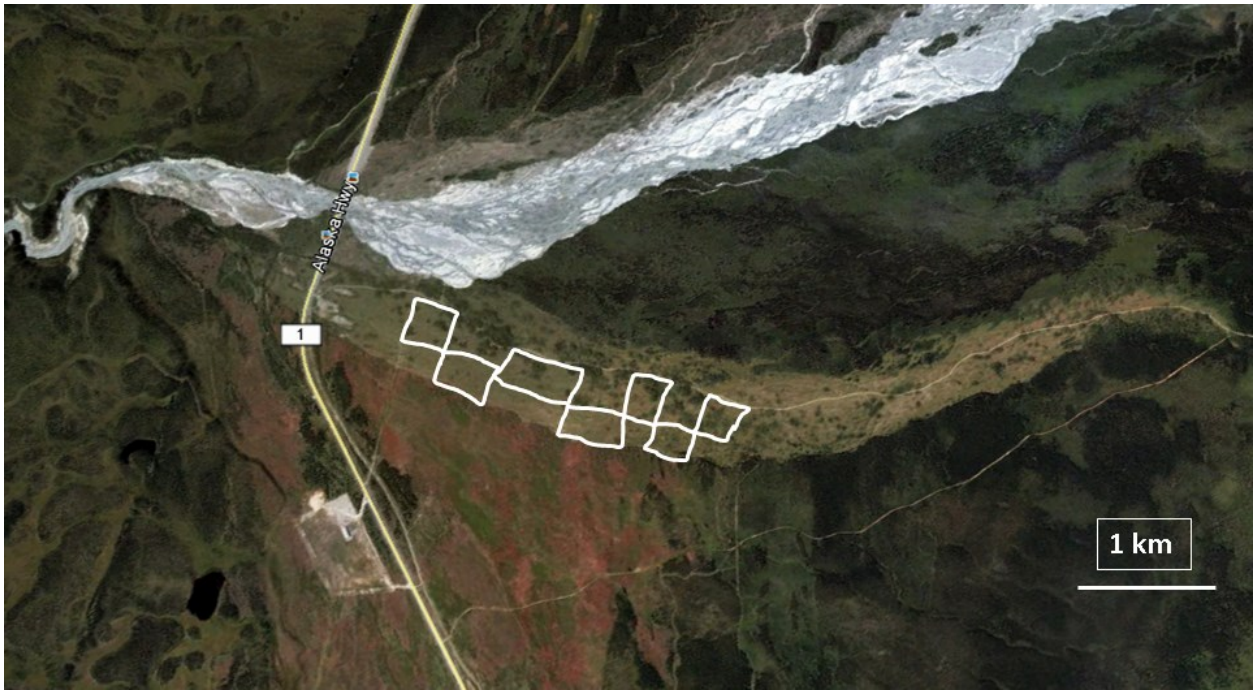

Figure 1: Duke Meadow reintroduction site with approximate locations of short grass treatments.

The survival, movements and habitat choice of all released individuals were studied by locating animals daily during the first three months post-release. Both Kluane First Nations and Parks Canada have been involved in these release and monitoring efforts. Ten squirrels were also captured at a second location (Destruction Bay post office) and placed back into the depopulated 'source' colony at the Burwash airport as a control to evaluate the influence of artificial movement on squirrel behaviour and survival.

Although the ultimate success of this project—to establish a growing population at Duke Meadows—will be determined during 2014, several preliminary conclusions may be drawn. Of the 45 squirrels released, 16 (12 females, 4 males) successfully settled within the intended release area. We view this as a success.

Based upon the literature on reintroductions we expected that most individuals would move away from the release site. Indeed, many animals left the meadows and moved into the surrounding forest, despite there being ample meadow habitat. All those that left the release site died within 2 months. Areas of short grass and high burrow density were not 'chosen' by individuals more than what would be expected based on their availability. It appears that Arctic ground squirrels do not necessarily use grass height or burrow density as cues for identifying high quality habitat. However, by late September those surviving in Duke Meadows had largely settled in manipulated areas, where mean vegetation height had been reduced from 120 cm to 10 cm. Females moved less and exhibited higher survival than males.

A second key result was the discovery that unmarked immigrants were frequenting the vicinity of the release during August through September. Regular monitoring of the remaining habitat in the Duke Meadow system indicates that areas further from the reintroduction site remained unoccupied all summer, despite the presence of adequate forage and burrow shelter. These findings point to the potential importance of patch occupancy and to the role that conspecific attraction (Smith and Peacock 1990) may play in the settlement decisions of dispersing squirrels. It may be that future recovery efforts to re-establish old colony sites will be further bolstered by immigrants from remote source populations seeking to settle in meadow habitats that already contain some [reintroduced] individuals. By initiating a mark-recapture program during the spring of 2014 we hope to confirm whether unmarked squirrels who were observed post-reintroduction, settled in the area and bred with the released population.

From a theoretical perspective, squirrels may intentionally settle in occupied patches in order to benefit directly from living in aggregation (Reed & Dobson 1993). Metapopulation models that rely on random dispersal risk over-estimating the probability that a patch will be recolonized after a localised extinction (Smith & Peacock 1990, Ray et al. 1991). For example, in fragmented habitat Weddell (1991) found that marked Columbian ground squirrels visited

many suitable unoccupied habitats but settled only in occupied areas. At the population level, conspecific attraction results in extant patches receiving a disproportionately large fraction of dispersing animals relative to empty patches (Smith & Peacock 1990, Mihoub et al. 2011). Reliance on conspecific cues for habitat assessment might buffer overall metapopulation structure from localised extinctions at the expense of slowing population expansion via the recolonization of extinct patches. Our intention is to conduct more reintroductions in 2014 in a manner that takes advantage of this potential phenomenon.

Our enhancement efforts were fully planned in advance. By approaching this enhancement project experimentally we are now in a position to answer several questions that would not have been possible without site preparation and intensive monitoring. Spatial patterns in survival and movement will be analysed during the spring of 2014 and recommended strategies for future reintroduction will be provided to Kluane First Nation. Future recovery efforts will likely focus on the translocation of female biased groups into short grass habitats.

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Communications

The results of this reintroduction are currently being shared with Kluane First Nation (Geraldine Pope) the Wildlife Conservation Society (Don Reid), Parks Canada (Carmen Wong, Sarah Chisholm), Yukon Territorial Government (Tom Jung, Shawn Taylor), and members of the Biodiversity Research Centre (University of British Columbia) and members of the Institute of Arctic Biology (University of Alaska).

Scheduled communications include a published paper once monitoring is complete in 2014 and a chapter within a Ph.D. thesis. The use of reintroductions to enhance wildlife populations is of growing interest to both scientists and resource managers, and we anticipate that the results of this project will be made public in conferences and public presentations during the coming years. In all of these communications the Yukon Fish & Wildlife Enhancement Trust has, and will continue to be, acknowledged as the primary funder.

Financial Statements

Below is a summary of our anticipated budget and actual costs. Receipts for the 'actual claim' column have been submitted to the Enhancement Trust. Overall, we came slightly over budget due to the expense associated with travel and the price of gas at Destruction Bay, and the choice to minimise time spent camping at the release site following repeated bear encounters. These extra costs were covered using money that came from a grant issued by the Arctic Institute of North America. The travel charges to/from the Yukon were removed from the Enhancement Trust budget in order to pay a larger proportion of the costs of a second field assistant at the Kluane Lake Research Institute. This was done with prior consultation with Dennis Zimmerman.

Requested Funds from Enhancement Trust

Item	Anticipated	Actual Claim	Description
AINA	9,450	11,550	3 people x 3.5 months accommodation x $45/day
Travel through UBC	1,200	0	tickets Vancouver—Whitehorse paid
Truck costs	900	0	Mileage charged to UBC account
Total Requested	**11,550**	**11,550**	

Total Project Costs

Item	Anticipated	Actual	Description
AINA	9,450	12,699	3 people x 3.5 months accommodation x $45/day
Travel Whitehorse	1,200	1,700	2 x $800 airplane return tickets Vancouver--
Truck costs	2,250	3,400	7000 km x 49¢/km
Salary field assistant 2013)	8,800	8,800	4 months x $2,200/month (May—August
Salary graduate student September 2013)	8,000	8,000	5 months x $1,600/month (May—
Radio Collars	7,800	7,800	40 x $195 holohil PD2-C units[1]
Telemetry receiver	1,390	1,390	2 x $695 (model R-1000 comm. spec.)[2]
Telemetry Antenna	250	250	2 x $125 (RA-XX directional yagi antenna)
GPS	690	690	2 x $345 (Garmin GPS Map 62S)
Bear Spray	100	100	4 x $25 (225g canister)
Total Costs	**39,930**	**44,829**	

[1] http://www.holohil.com/bd2.htm [2] http://www.com-spec.com/r1000/r1000.htm

Figure 2: Duke meadow dominated by tall grass before site preparation.

Figure 3: Duke meadow short-grass manipulation in 50m x 50m grids. Vegetation height is approximately 10 cm.

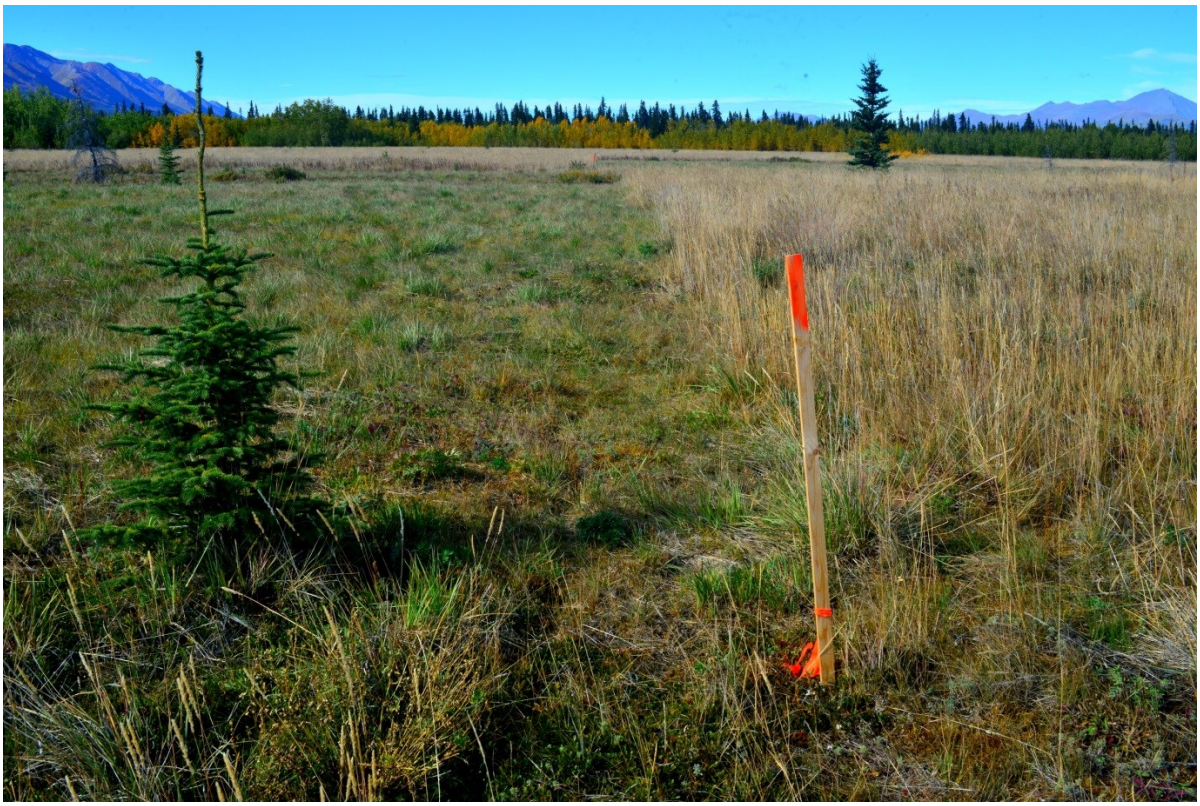

Figure 4: Short grass (left) and tall grass (right) treatments 2 months post-release (photo taken September 9, 2013).

Figure 5: Juvenile female trapped on July 5, 2013 at Burwash airport for release at Duke meadow.

Figure 6: An example of an artificial burrow. Burrows were constructed at a 30° angle from the ground to a depth of 40 cm.