YUKON GOLD ICE PAD TUNDRA VEGETATION ASSESSMENT: 1993 Through 1995

Final Report

LGL ALASKA RESEARCH ASSOCIATES, INC.
4175 Tudor Centre Drive, Suite 101
Anchorage, Alaska 99508

For

BP EXPLORATION (ALASKA) INC.
P.O. Box 196612
Anchorage, Alaska 99519-6612

In Compliance to Department of the Army Permit Number 4-930426 (Staines River 1)

29 March 1996

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Prepared By

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EXECUTIVE SUMMARY

This report describes results from the second growing season after melt of the 1992–1994 Yukon Gold ice pad, located approximately 5 km west of the Staines River at T8N, R23E, Sect. 13, Umiat Merdian, Alaska. In 1993, a baseline vegetation study was conducted to characterize the tundra vegetation in the area surrounding the multi-season ice pad. In 1994, the first growing season after the ice pad was allowed to melt, live vegetation cover within the pad footprint was compared with control sites outside of the pad footprint. All classes of vegetation for paired control and impact plots were reduced in 1994; live vegetation (t = 4.703, $p<0.0001$), graminoid (t = 4.998, $p<0.0001$), forb (t = 2.716, $p=0.0123$), shrub (t = 4.733, $p<0.0001$), and combined vascular plant cover (t = 7.564, $p<0.0001$). The threshold of ≥70% of control live vegetation was not met, requiring continuation of monitoring in 1995.

In 1995, significant differences in live vegetation (t = 6.801, $p<0.0001$), graminoid (t = 6.062, $p<0.0001$), shrub (t = 4.709, $p<0.0001$), and combined vascular plant cover (t = 8.234, $p<0.0001$) were measured between paired control and impact plots. In association with these differences in live cover was a significant increase in barren cover (t = -6.927, $p<0.0001$) within the pad footprint. Non-vascular plant cover, primarily mosses, and forb cover were not different between control and impact plots.

The live vegetation cover within the pad footprint was 67% of the control area in 1994 and 66% in 1995. With the addition of 50% of the control taxa standard deviation, percent of control live vegetation cover within the pad footprint was 53% of the control area in 1994 and 58% in 1995. Because the impact to live cover was greater within the 2 m edge zone, the overall recovery within the pad footprint may be more accurately described by omitting the edge plots. When the edge zone is excluded, the percent of live vegetation within the pad footprint increased to 75% of the control area.

There was no evidence of thermokarsting or subsidence of the tundra surface except in the area of the well head and the short trench on the south edge of the pad footprint. The most obvious ice pad impacts were compaction and decreased live cover on strangmoor ridges, and decreased live cover at the pad edges. New graminoid seedling growth was observed. Forbs have apparently already returned to normal levels within the impact area. Strangmoor ridges may be visibly impacted for a much longer period. The effects of the multi-year Yukon Gold ice pad appear to be similar to effects of ice roads, seismic trails and snow pads, except for the lack of decrease in non-vascular plant cover and lack of increased thaw depth for the pad area. Recovery should continue in a similar fashion for several additional years.

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INTRODUCTION

In the winter of 1992–1993, BP Exploration (Alaska) Inc. (BPXA) constructed the Yukon Gold ice pad approximately 16 km south of Point Thomson and 5 km west of the Staines River at T8N, R23E, Sect. 13, Umiat Merdian, Alaska. The pad was insulated over the 1993 summer and was subsequently used to support equipment for drilling an exploratory well during the 1993–1994 winter. During summer 1993, BPXA and LGL Alaska Research Associates, Inc. (LGL) initiated a study to evaluate the potential effects of this ice pad on tundra vegetation. Using ice pads which are maintained over the summer is a new approach to oil exploration in the arctic, and therefore the effects on tundra vegetation are unknown. There are studies which document the effects of compaction on tundra vegetation from winter ice roads (Brown and Grave 1979; Walker and Webber 1980; Walker et al. 1987), but with an ice pad which is maintained over the summer, the vegetation also loses a growing season. This study evaluates the joint effects of compaction and loss of a growing season on tundra vegetation, and documents tundra damage resulting from sources other than the ice pad.

In summer 1993, the vegetation and plant cover in the area surrounding the ice pad was characterized (Kertell 1993), with the goal of evaluating the effects of the multi-year ice pad on plant cover during subsequent monitoring. Impact live vegetation cover measured during summer 1994 was 53% of control live cover, when calculated with the addition of 50% of the cumulative control cover standard deviation. This was less than the threshold 70% of control live cover required by permit to suspend further monitoring. These results necessitated a continuation of live cover monitoring during summer 1995 (Schick and Noel 1995).

All three years of monitoring data (1993 to 1995) are summarized within this report (Appendix A through D). Live vegetation cover and species composition in the area surrounding the pad and within the footprint of the pad for 1994 and 1995 monitoring data (Appendix C and D) are compared to evaluate the impact of the ice pad on pre-existing tundra vegetation. Results of 1995 monitoring are compared to 1993 and 1994 monitoring data. Moss species identifications previously unavailable for 1994 data are presented. The Yukon Gold Monitoring Plan: Vegetation 1993–1996 which provides the basis for this study is presented in Appendix E.

METHODS

Study Design and Sampling

The study design involves sampling the vegetation surrounding the ice pad (control plots), and sampling the vegetation in the "footprint" of the pad (impact plots) after it melted in summer 1994 (as per the Yukon Gold Monitoring Plan, Appendix C). The study is modeled after a general impact assessment study design presented by Stewart–Oaten et al. (1986), and is designed so that possible differences in plant phenology or sampling dates among years are controlled for experimentally by sampling paired control and impact sites in each year. Plant phenology or live plant cover may vary among years, for example, due to a substantially late or early snow melt relative to the other years or disparate sampling dates. This experimental design detects impacts independent of these potentially confounding effects. The detection of an impact depends on the assumption that the vegetation and plant cover around the perimeter of the pad (where control plots were sampled in 1993) did not differ, before development, from the vegetation and plant cover under the pad (where impact plots were sampled in 1994 and 1995). That is, any differences found in vegetation and plant cover between control and impact sites must be assumed to be due solely to the effect of the ice pad.

We evaluated this assumption in 1994 by scrutinizing large scale (1955, 1:53,000 black and white, and 1979, 1:60,000 color infra-red) pre-development aerial photographs and determined the vegetation under and around the pad appeared homogeneous. This area was fairly uniform in vegetative cover, with little variation in color or texture. Because vegetation under the pad looked similar to the surrounding area in pre-development photographs, the assumption that the two areas did not differ was considered valid (Schick and Noel 1995). The area where the Yukon Gold ice pad was placed is within a large expanse of wet strangmoor vegetation which stretches for several kilometer in all directions.

In 1993, 25 paired plots (50 total plots) were sampled outside the ice pad boundaries from 13–16 July (Kertell 1993). These data indicated that the undisturbed vegetation surrounding the pad was statistically homogeneous on a large scale, and that this intensity of sampling was sufficient to overcome micro-geographic differences in vegetation and plant cover. In 1994, we sampled at the same intensity, although later in the season, 2–4 August, to gather data on taxa missing from the 1993 data. In particular, grasses and some forbs are not conspicuous on the Arctic Coastal Plain until August, and many of these taxa were absent from the 1993 data (Kertell 1993). This change did not result in early flowering taxa being underrepresented, because early flowering taxa were not yet senescing, and were still identifiable by fruit and vegetative structures in early August. In 1995, sampling was conducted on 27–29 July, grasses and forbs were in flower.

Vegetation sampling was conducted using the point method. This method is the preferred technique for measuring cover in low growing vegetation (Mueller–Dombois and Ellenberg 1974; Hays et al. 1981). Vegetation sampling was conducted using a $1m^2$ frame constructed of 1" aluminum bars fitted with adjustable legs at each corner (Kertell 1993) (Fig. 1). This frame is subdivided into 100 square decimeters by monofilament line wrapped at two levels to create a "crosshair" sighting device (Fig. 1). Five randomly selected locations were used in each of the ten rows for a total of 50 sample points. Within the frame, sample points for each plot were determined by sighting through the frame's "crosshairs" and recording two specific points of intersection, one in the canopy and one on the ground. These intersections are termed "hits." After recording sightings at both the canopy and ground layers for a sample of 50 points in a plot, a new plot location was selected and the process was repeated.

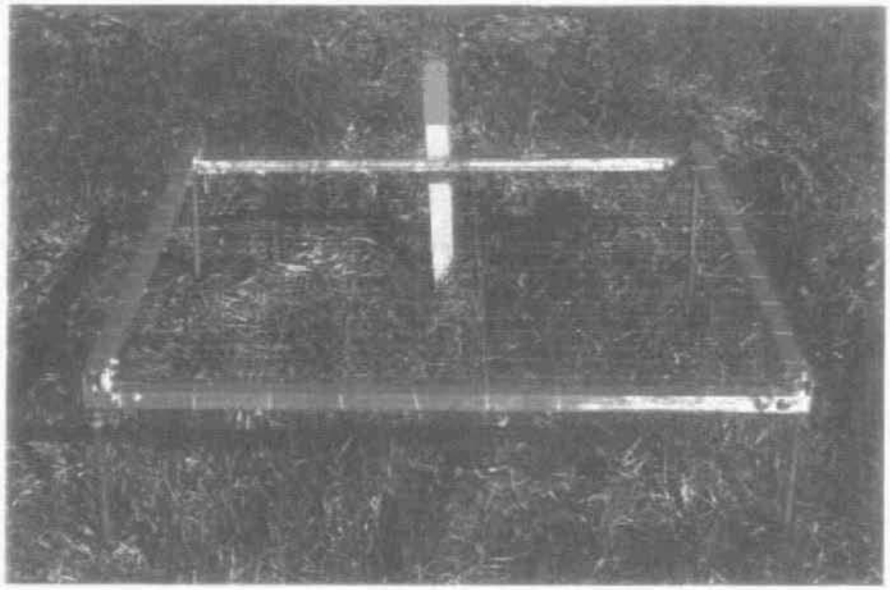
These data permit calculations of percent cover as follows:

$$\% \ Cover = \frac{number\ of\ hits\ for\ species\ A}{total\ number\ of\ sample\ points\ =\ 50} \ x \ 100$$

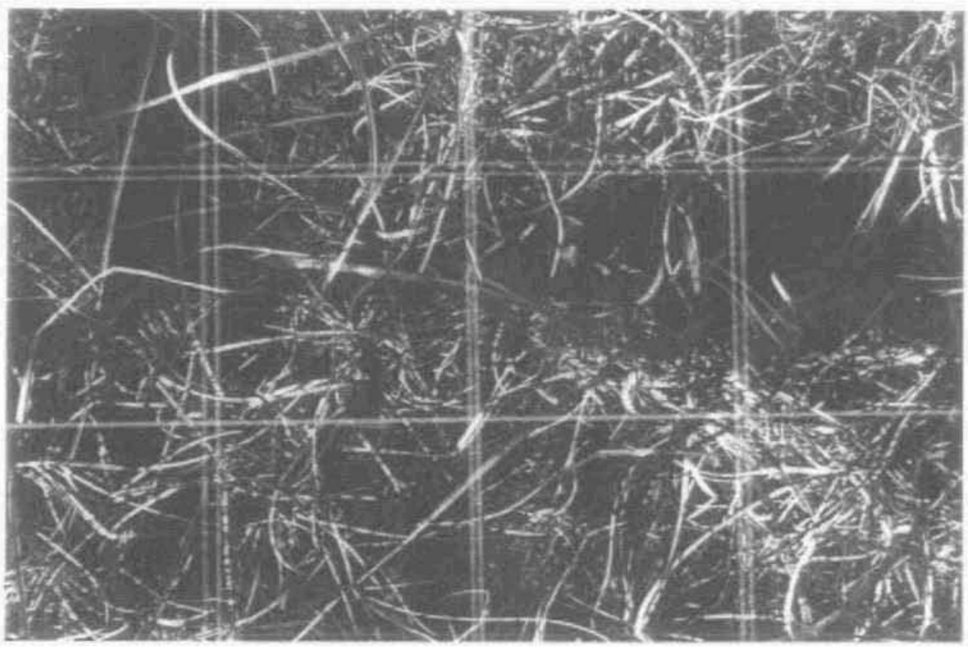
This results in a total possible ground cover of 200%, 100% for the canopy layer and 100% for the ground layer.

In 1993, estimates of percent cover were obtained by recording only the first hit from each "crosshair" sighting; i.e. either canopy or ground hits, not both, were recorded. This approach resulted in a maximum of 50 hits per m^2 plot and a maximum cover value of 100% for all categories combined. This methodology results in an accurate estimate of plant cover at the canopy level, but underestimates the ground cover of mosses and lichens (Kertell 1993). To more adequately describe this two layered plant community, in 1994 and 1995 we recorded both the first canopy hit and the ground layer hit for each "crosshair" sighting as explained above. This allowed us to more accurately determine the impact of the Yukon Gold ice pad upon both the vascular plant community and the non–vascular plant community. Where 1993, 1994 and 1995 data are compared, a total possible ground cover of 100% is used by combining canopy and ground cover for 1994 and 1995 and dividing by the total 100 hits per 50 sample points.

In 1994 and 1995, we sampled 25 control plots outside the boundary of the ice pad, and 25 impact plots within the boundary of the melted ice pad (Fig. 2 and 3). Prior to sampling, we located the reinforced steel rods ("rebar") placed at the pad boundary corners and marked the



A.



B.

Figure 1. Sampling frame used for point–method vegetation sampling at the Yukon Gold site, Alaska, for monitoring studies during 1993 to 1995, photo 29 July 1995. A.—view of frame within ice pad footprint. B.—close–up view of cross–hairs at location outside the pad footprint.

Yukon Gold Ice Pad - 1994 (1st Summer Post Melt)

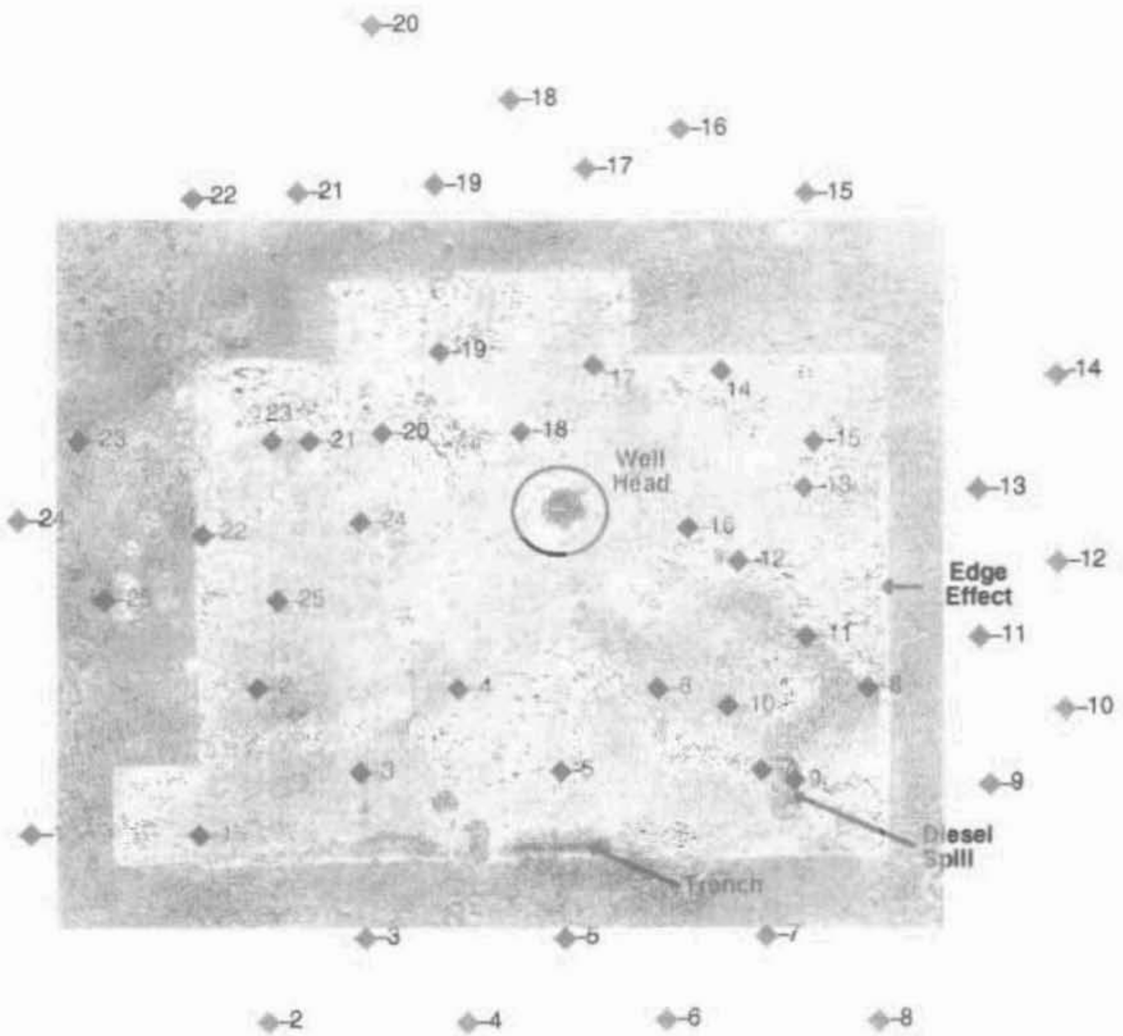


Figure 2. Sample locations for paired vegetation plots at the Yukon Gold site, Alaska, for data collected 2-4 August 1994, with references to visual impacts (1994 color infrared photo). Plot numbers refer to data in Appendix C.

Yukon Gold Ice Pad - 1995 (2nd Summer Post Melt)

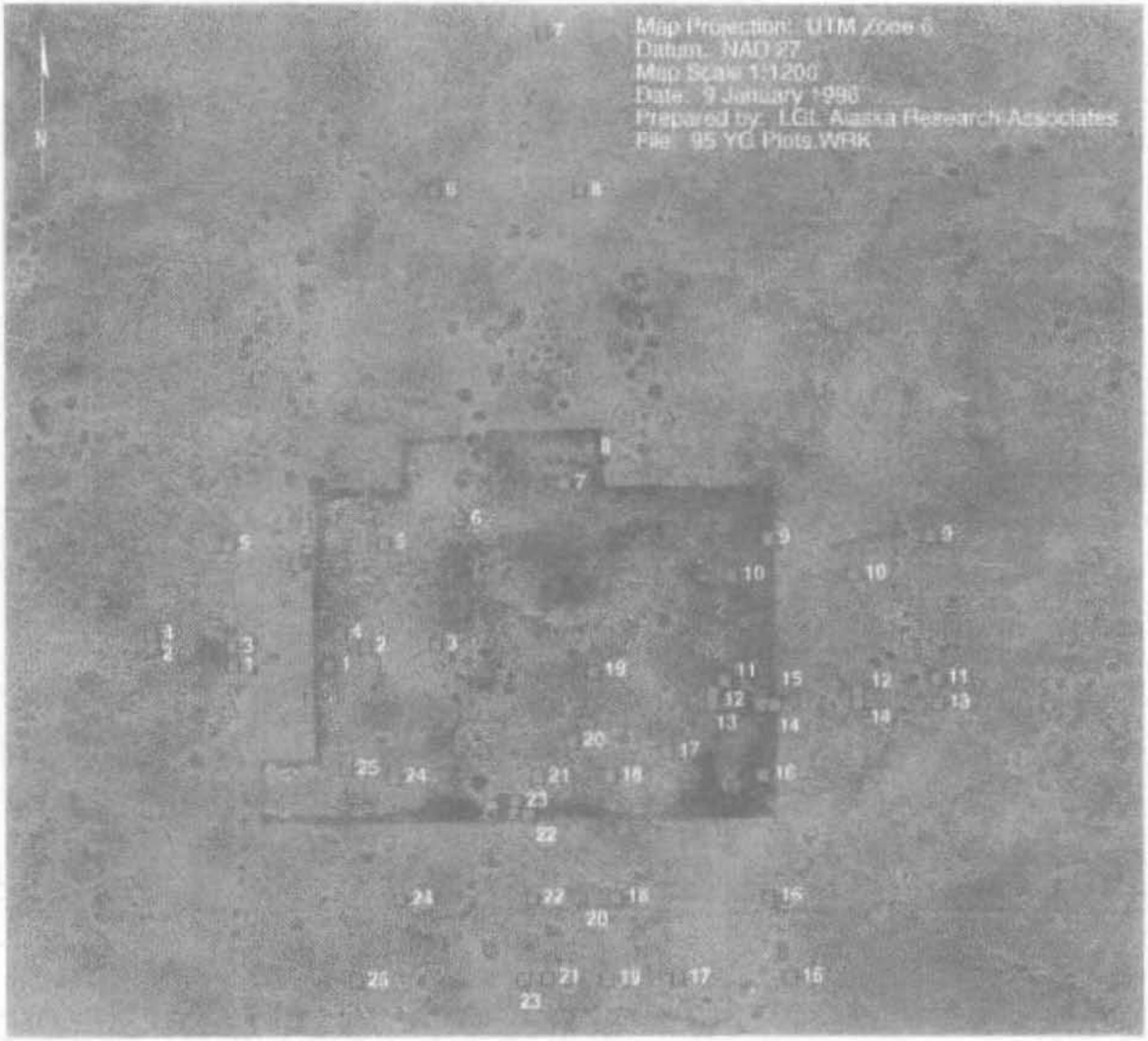


Figure 3. Sample locations for paired vegetation plots at the Yukon Gold site, Alaska, for data collected 27-29 July 1995 (10 August 1995 color infrared photo). Plot numbers refer to data in Appendix D.

boundary of the ice pad with laths to delineate control and impact areas. The boundary of the ice pad remained obvious from compaction of vegetation and increased plant mortality at the edge of the pad footprint. Impact plots were randomly sampled within a numbered grid overlaying the ice pad map. Areas impacted by the well head, trench, and diesel spill were removed from sampling. Impact sites were located by measuring from the nearest pad corner and then perpendicular and within the pad boundary. The corresponding control plots were then located using either 20, 40, 60, or 100 m distances perpendicular and away from the pad boundary. Both control and impact plots in each pair were sampled on the same day. An area to the north of the pad site was used to pile snow, removed while the ice pad was in use. This resulted in some minor, patchy disturbances such as trash accumulation and scrapes on the tundra surface. In this area, control sites were located by moving 60 and 100 m away from the pad boundary.

Data Analysis

The null hypothesis tested in this study was:

Ho: There is no difference in plant cover between the area previously covered by the Yukon Gold ice pad and the surrounding control area.

Test: Paired *t* tests were used to compare plant cover values in impact versus control plots.

Plot data were analyzed in two ways. First, vegetation plot data were pooled and mean percent cover for impact and control plots were calculated to illustrate the relative contribution of the different cover types (complete data for 1994 in Appendix C, Table C–1 and C–2; for 1995 in Appendix D, Table D-1 and D-2). Second, two-tailed paired-sample *t* tests were used to test for differences in cover values between paired impact and control plots. We conducted paired tests for each taxon separately and for natural groupings (graminoids, forbs, shrubs, vascular plants, and non-vascular plants) to evaluate responses of specific taxa and the vegetation as a whole to compaction and the loss of a growing season. Finally, percent cover was calculated to determine the "Percent of Control" vegetation for compliance with the Yukon Gold Monitoring Plan (Appendix E).

RESULTS

Description of the Area

The site of the now-melted Yukon Gold ice pad lies within a large area of continuous wet graminoid, dwarf shrub tundra (Walker and Webber 1980), which extends nearly unbroken for several kilometers in all directions and slopes very gradually and almost imperceptibly down to the Staines River some 5 km to the east. A small, beaded stream occurs approximately 1.5 km to the west. Prominent micro-sites in the area are the abundant strangmoor ridges and the somewhat less common frost boils. The area is apparently completely flooded with melt water in early spring (Declan Troy, pers. comm.). By mid-July, the area was fully drained, but heavy rains prior to sampling on 27–29 July left flooded tundra and saturated soils across most of the sampling area. The peat soils in the area contain a large component of gravel not far below the tundra surface and this may contribute to the relatively good drainage in the area.

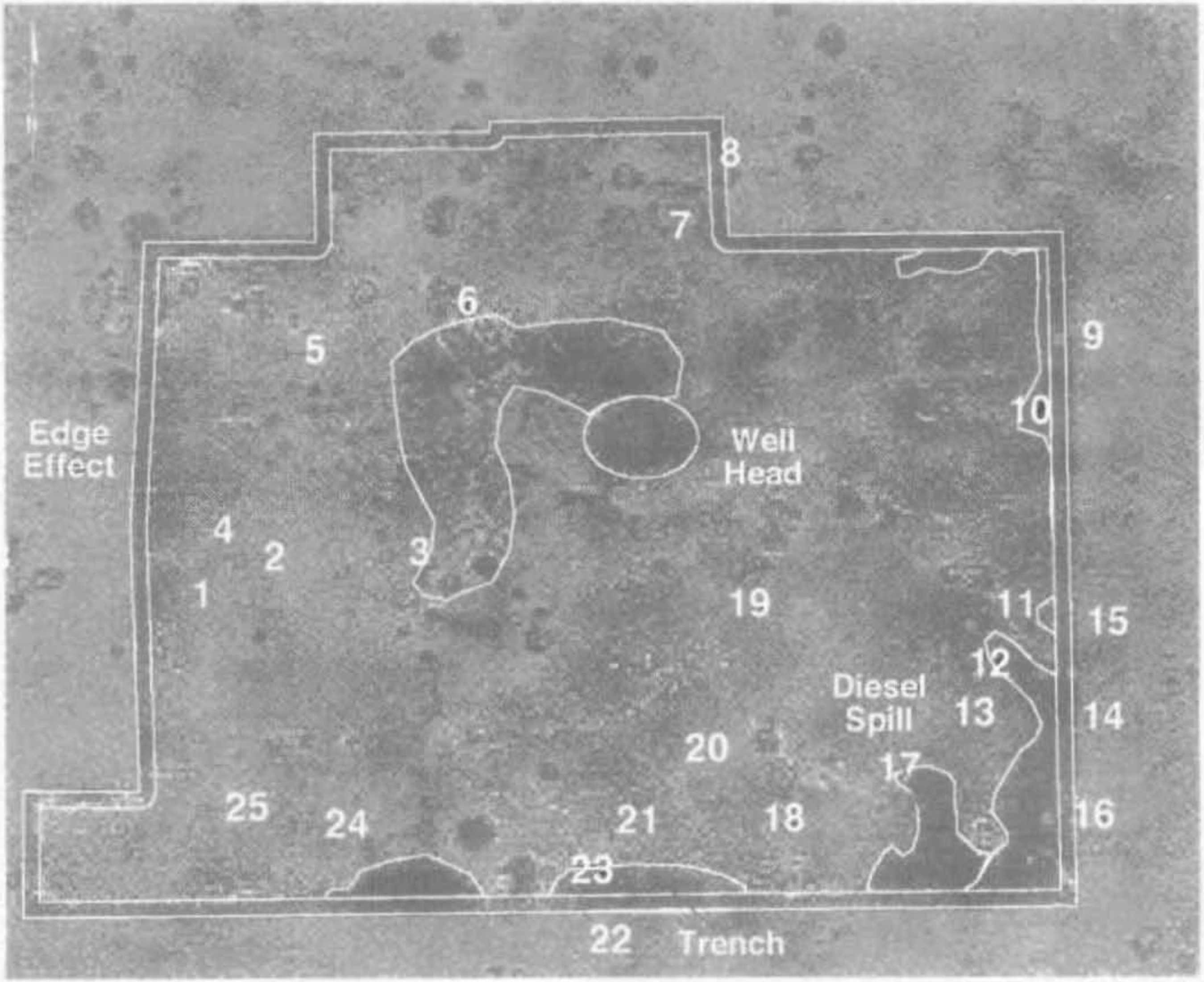
There were several impacts from the ice pad visible in 1995 (Fig. 4).

1. The prominent "edge effect" described in 1994 was still clearly discernible because of the increase in dead vegetation (Fig. 5) and visible standing water (water appears black on color infrared, Figs. 3 and 4). The edge varied in width, but was roughly 1 m covering approximately 0.22 acres, or 8% of the pad area. Edge plots 9, 15, and 22 averaged 10% live cover in 1995 (Fig. 4, Appendix D).

2. Several additional irregularly shaped areas of plant mortality extended from the edge into the pad's footprint, especially along the east pad edge and at one location on the south pad edge. These areas were less conspicuous and generally showed greater vegetative recovery than the edges. Plots 14 and 16 within these areas averaged 25% live cover (Fig. 4, Appendix D). However, some of the mortality along the east edge of the pad footprint may be a result of surface water spread of a nearby diesel spill.

3. The strangmoor ridges within the pad area continued to show damage due to compression and, in a few cases, scraping. These areas appear as light worm-like tracks on the color infrared image (Fig. 4). In contrast, the intervening, low-lying wet areas sometimes appeared scarcely different from similar areas outside of the pad. Figure 6 illustrates the lack of vascular plant cover on ridges and the damaged moss mat, especially as compared to a nearby normal ridge.

Yukon Gold Ice Pad - 1995 (2nd Summer Post Melt)



Disturbed Areas Within the Pad Perimeter

Description	Acres
Pad Footprint	2.65
Edge Effect	0.22
Well Head	0.03
Trench	0.02
Diesel Spill	0.03
Unknown Cause	0.23

Color Infrared photo taken 10 August 1995, by Aeromap U.S., Inc. Photo has been modified to enhanse contrast.

Map Projection: UTM Zone 6
Datum: NAD 27
Map Scale 1:600
Date: 4 October 1995
Prepared by: LGL Alaska Reseearch Associates
File: 95 YG Pad Impacts.WRK

Figure 4. Color infrared photo of the Yukon Gold site, 10 August 1995, showing disturbances and vegetation sampling plots for 27-29 July 1995. Plot numbers refer to data in Appendix D.

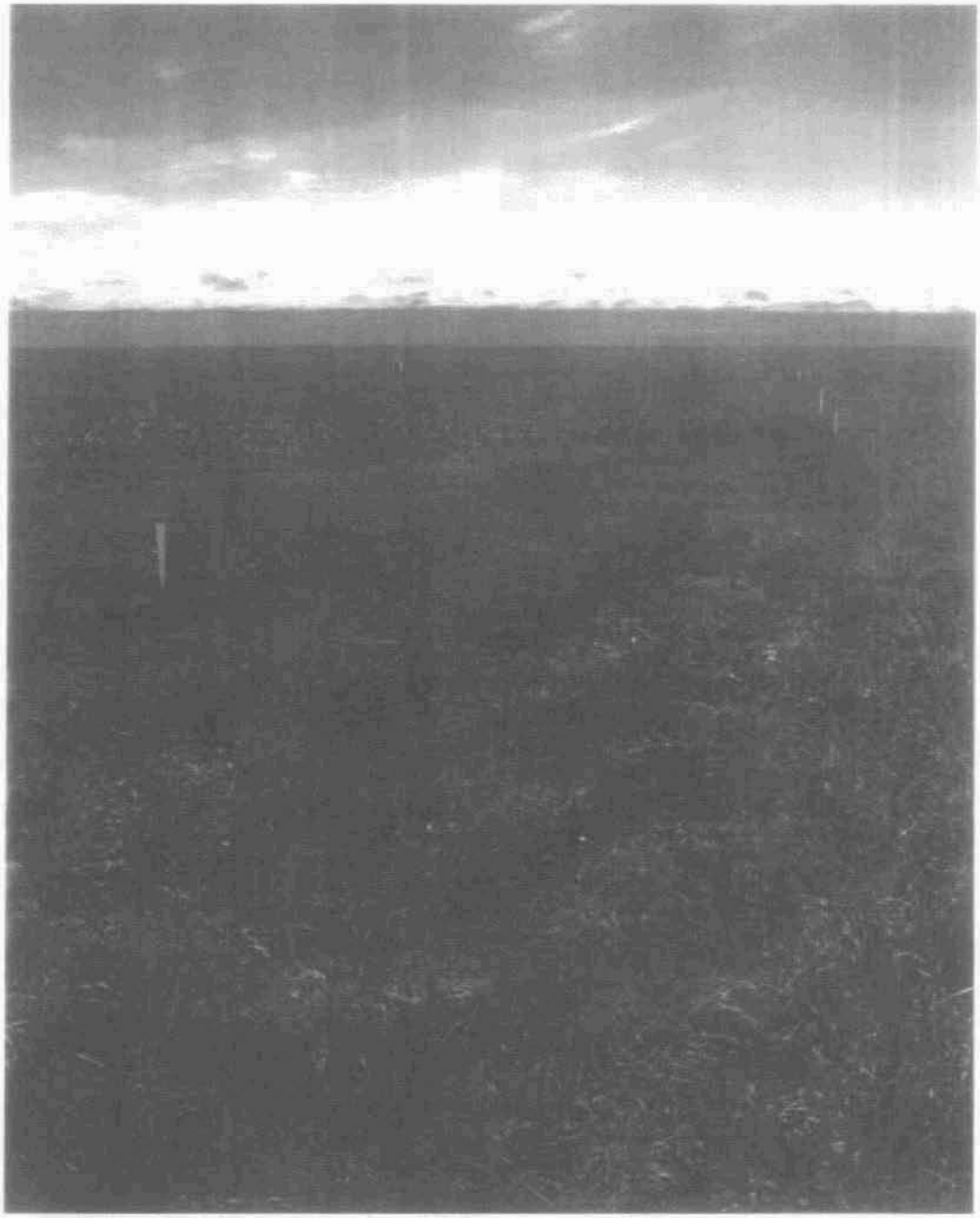


Figure 5. East edge of the Yukon Gold site footprint, Alaska, illustrating vegetation recovery within the "edge effect" after two growing seasons. Edge effect is distinguishable because of reduced live cover and reduced standing dead vegetation, photo 29 July 1995.

A.

B.

Figure 6. Strangmoor ridges within and outside the Yukon Gold site footprint, Alaska, illustrating the effect of compaction and the extent of recovery after two growing seasons, photos 29 July 1995. A.—strangmoor ridge within pad footprint. B.—strangmoor ridge outside of pad footprint.

In addition there were several impacts not directly attributable to the ice pad, but which resulted from drilling activities. These areas cover between 0.24 and 0.28 acres or about 9 to 10% of the ice pad footprint area in 1994 (Fig. 4).

1. The area surrounding the well head had subsided to ≥ 1.3 m depth (Fig. 7). This depression was filled with water during sampling and covered approximately 0.03 acres, or 1%, of the pad area. The area of decreased live cover near the well head, which may be due to the temporary storage of drilling cuttings on the ice pad, covers approximately 0.15 acres, or 5%, of the pad area (Figs. 4 and 7).

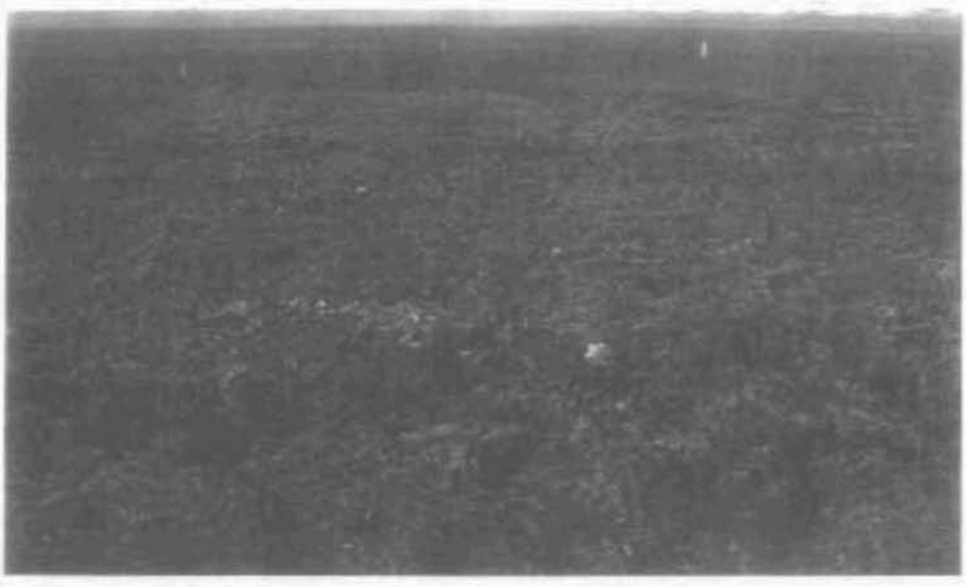
2. An area of tundra vegetation approximately 0.03 acres or 1% of the pad area, located in the southeast corner was impacted by a diesel fuel spill (Figs. 4 and 8). It may be likely that a portion of the area in the pad corner was impacted by spreading of the diesel spill by surface water, possibly increasing the impact area to 0.08 acres, or 3%, of the pad area. Some live vegetation was beginning to grow within the diesel spill area.

3. A small trench up to 0.6 m deep and 1 m wide was dug to provide space for camp utility lines. This area covers about 0.02 acres or 0.8% of the ice pad area (Figs. 4 and 9).

Pooled Plot Analyses

Vegetation plot data were pooled to calculate means for the number of hits and percent cover of both natural vegetation groupings (Table 1) and individual plant taxa (Table 2 and Table 3) for control and impact plots during 1994 and 1995. Variability around each mean is described as plus and minus (±) one standard deviation (SD). Mean percent cover for total live vegetation averaged lower within the "footprint" of the pad compared to surrounding tundra in both 1994 and 1995 (Table 1), but variation and ranges for individual plots were large (Fig. 10). Mean cover of dead plant material was roughly similar between the control and impact areas, but the No Canopy and Bare Ground categories were higher at impact sites than control sites for both 1994 and 1995. Generally, canopy cover was lower at impact sites due to lower vascular plant cover than at control sites. The ground cover of non-vascular plants, however, was similar at impact and control plots. Vascular plants, primarily graminoid vegetation, dominated the live vegetation category at both impact and control plots, but made up a larger proportion of the total live vegetation at control sites (86%) than at impact sites (77%) in 1995.

A.



B.

Figure 7. Area of subsidence and an area of decreased live vegetation near the well head within the Yukon Gold site footprint, photos 29 July 1995. A.—well head. B.—area of decrease live vegetation near well head.

A.

B.

Figure 8. Diesel spill area within the footprint of the Yukon Gold site, Alaska, photos 29 July 1995. A.—close view of spill area. B.—southeast corner of ice pad footprint and spill area. (Note *Eriophorum* inflorescence in foreground and background.)

Figure 9. Trench on the south edge of the Yukon Gold site, Alaska, facing east, photo 29 July 1995.

Table 1. Mean number of hits and percent cover by vegetation category for impact and control plots at the Yukon Gold site, Alaska, for data collected 2-4 August 1994 and 27–29 July 1995. Data for canopy level and ground level are combined, yielding a theoretical maximum of 200 percent cover. Standard deviation is abbreviated SD.

	Mean No. Hits (±SD)	Mean % Cover (±SD)	Mean No. Hits (±SD)	Mean % Cover (±SD)
	1994 Data			
	Impact (n=24)		Control (n=24)	
Living Vegetation	30.58 ±10.10	61.16% ±20.20%	45.38 ±14.40	90.76% ±28.80%
Dead Plant Material	36.08 ±12.65	72.16% ±25.30%	33.38 ±18.01	66.76% ±36.02%
Barren Ground	33.33 ±8.52	66.66% ±17.04%	21.25 ±7.77	42.50% ±15.54%
Graminoids	9.08 ±6.35	18.16% ±12.70%	16.96 ±6.49	33.92% ±12.98%
Forbs	0.21 ±0.41	0.42% ±0.83%	0.75 ±0.90	1.50% ±1.79%
Shrubs	0.04 ±0.20	0.08% ±0.41%	2.54 ±2.54	5.08% ±5.07%
All Vascular	9.33 ±6.36	18.66% ±12.72%	20.25 ±5.53	40.50% ±11.06%
All Non-Vascular	21.25 ±12.21	42.50% ±24.42%	25.13 ±15.68	50.26% ±31.36%
	1995 Data			
	Impact (n=25)		Control (n=25)	
Live Vegetation	36.76 ±12.26	73.52% ±24.52%	55.72 ±5.61	111.44% ±11.22%
Dead Plant Material	40.48 ±7.65	80.96% ±15.30%	40.00 ±6.64	80.00% ±13.28%
Barren	22.76 ±13.64	45.52% ±27.28%	4.28 ±2.72	8.56% ±5.44%
Graminoids	26.44 ±13.11	52.88% ±26.22%	42.36 ±3.05	84.72% ±6.10%
Forbs	1.08 ±1.22	2.16% ±2.44%	1.32 ±1.14	2.64% ±2.28%
Shrubs	0.88 ±1.17	1.76% ±2.34%	4.16 ±3.74	8.32% ±7.48%
All Vascular	28.40 ±12.68	56.80% ±25.36%	47.84 ±3.44	95.68% ±6.88%
All Non-Vascular	8.36 ±7.47	16.72% ±14.94%	7.88 ±6.44	15.76% ±12.88%

Table 2. Mean number of hits and percent cover by plant taxa for impact and control plots at the Yukon Gold site, Alaska, for data collected 2–4 August 1994. Data are organized with two hits recorded, one at canopy level and one at ground level, yielding a theoretical maximum of 200 percent cover. Standard deviation is abbreviated SD.

	Impact (n=24)		Control (n=24)	
	Mean No. Hits (±SD)	Mean % Cover (±SD)	Mean No. Hits (±SD)	Mean % Cover (±SD)
Barren				
Bare Canopy or Ground	32.38 ±8.95	64.76% ±17.90%	21.25 ±7.77	42.50% ±15.54%
Gravel	0.96 ±2.44	1.92% ±4.88%	0.00 ±0.00	0.00% ±0.00%
Dead Plant Material				
Litter	24.83 ±11.37	49.66% ±22.74%	21.67 ±13.94	43.34% ±27.88%
Standing Dead	11.25 ±7.62	22.50% ±15.24%	11.71 ±5.52	23.42% ±11.04%
Graminoids				
Carex aquatilis	1.33 ±1.40	2.66% ±2.80%	3.75 ±2.27	7.50% ±4.54%
Carex atrofusca	0.08 ±0.41	0.16% ±0.82%	0.21 ±0.59	0.42% ±1.18%
Carex bigelowii	0.00 ±0.00	0.00% ±0.00%	0.42 ±1.84	0.84% ±3.68%
Carex saxatilis	1.00 ±1.44	2.00% ±2.88%	1.96 ±2.44	3.92% ±4.88%
Eriophorum angustifolium	6.58 ±5.12	13.16% ±10.24%	10.46 ±5.26	20.92% ±10.52%
Juncus biglumis	0.00 ±0.00	0.00% ±0.00%	0.04 ±0.20	0.08% ±0.40%
Forbs				
Equisetum variegatum	0.13 ±0.34	0.26% ±0.68%	0.25 ±0.68	0.50% ±1.36%
Pedicularis sudetica	0.08 ±0.28	0.16% ±0.56%	0.46 ±0.66	0.92% ±1.32%
Polygonum viviparum	0.00 ±0.00	0.00% ±0.00%	0.04 ±0.20	0.08% ±0.40%
Shrubs				
Dryas integrifolia	0.00 ±0.00	0.00% ±0.00%	1.13 ±2.23	2.26% ±4.46%
Salix arctica	0.00 ±0.00	0.00% ±0.00%	0.58 ±0.72	1.16% ±1.44%
Salix lanata	0.00 ±0.00	0.00% ±0.00%	0.33 ±0.92	0.66% ±1.84%
Salix reticulata	0.04 ±0.20	0.08% ±0.40%	0.50 ±0.66	1.00% ±1.32%
Non-Vascular Plants				
Lichens	0.04 ±0.20	0.08% ±0.40%	0.13 ±0.61	0.26% ±1.22%
Liverworts	0.04 ±0.20	0.08% ±0.40%	0.08 ±0.28	0.16% ±0.56%
Mosses	21.27 ±12.11	42.54% ±24.22%	24.92 ±15.58	49.84% ±31.16%
Bryum pseudotriquetrum	0.63 ±1.13	1.26% ±2.26%	0.88 ±1.23	1.76% ±2.46%
Hypnum bambergeri	1.38 ±2.22	2.76% ±4.44%	2.04 ±4.29	4.08% ±8.58%
Oncophorus wahlenbergii	0.13 ±0.45	0.26% ±0.90%	0.29 ±0.75	0.58% ±1.50%
Scorpidium scorpioides	13.88 ±9.67	27.76% ±19.34%	13.88 ±11.54	27.76% ±23.08%
Tomenthypnum nitens	5.17 ±8.25	10.34% ±16.50%	7.79 ±11.59	15.58% ±23.18%

Table 3. Mean number of hits and percent cover by plant taxa for impact and control plots at the Yukon Gold site, Alaska, for data collected 27–29 July 1995. Data for canopy level and ground level are combined, yielding a theoretical maximum of 200 percent cover. Standard deviation is abbreviated SD.

	Impact (n=25)		Control (n=25)	
	Mean No. Hits (±SD)	Mean % Cover (±SD)	Mean No. Hits (±SD)	Mean % Cover (±SD)
Barren				
Bare Canopy or Ground	22.76 ±13.64	45.52% ±27.28%	4.28 ±2.72	8.56% ±5.44%
Dead Plant Material				
Litter	39.88 ±7.74	79.76% ±15.48%	39.48 ±6.50	78.96% ±13.00%
Standing Dead	0.60 ±1.00	1.20% ±2.00%	0.52 ±0.65	1.04% ±1.30%
Graminoids				
Carex aquatilis	6.04 ±3.86	12.08% ±7.72%	6.28 ±3.40	12.56% ±6.80%
Carex atrofusca	0.00 ±0.00	0.00% ±0.00%	0.36 ±1.60	0.72% ±3.20%
Carex bigelowii	0.08 ±0.40	0.16% ±0.80%	0.68 ±2.43	1.36% ±4.86%
Carex misandra	0.00 ±0.00	0.00% ±0.00%	0.44 ±0.87	0.88% ±1.74%
Carex saxatilis	1.44 ±2.22	2.88% ±4.44%	4.28 ±4.71	8.56% ±9.42%
Eriophorum angustifolium	18.72 ±11.87	37.44% ±23.74%	29.08 ±5.28	58.16% ±10.56%
Juncus biglumis	0.00 ±0.00	0.00% ±0.00%	0.04 ±0.20	0.08% ±0.40%
Forbs				
Caltha palustris arctica	0.00 ±0.00	0.00% ±0.00%	0.04 ±0.20	0.08% ±0.40%
Equisetum variegatum	0.84 ±1.14	1.68% ±2.28%	0.40 ±0.71	0.80% ±1.42%
Pedicularis sudetica	0.04 ±0.20	0.08% ±0.40%	0.48 ±0.65	0.96% ±1.30%
Polygonum viviparum	0.16 ±0.47	0.32% ±0.94%	0.32 ±0.63	0.64% ±1.26%
Saxifraga hirculus	0.04 ±0.20	0.08% ±0.40%	0.08 ±0.28	0.16% ±0.56%
Shrubs				
Dryas integrifolia	0.00 ±0.00	0.00% ±0.00%	1.44 ±1.61	2.88% ±3.22%
Salix arctica	0.68 ±1.03	1.36% ±2.06%	1.52 ±1.64	3.04% ±3.28%
Salix lanata	0.00 ±0.00	0.00% ±0.00%	0.32 ±0.90	0.64% ±1.80%
Salix reticulata	0.16 ±0.37	0.32% ±0.74%	0.76 ±1.51	1.52% ±3.02%
Salix rotundifolia	0.04 ±0.20	0.08% ±0.40%	0.12 ±0.44	0.24% ±0.88%
Non-Vascular Plants				
Liverworts	0.00 ±0.00	0.00% ±0.00%	0.04 ±0.20	0.08% ±0.40%
Mosses				
Bryum pseudotriquetrum	0.48 ±0.92	0.96% ±1.84%	0.60 ±0.87	1.20% ±1.74%
Distichium sp.	0.00 ±0.00	0.00% ±0.00%	0.36 ±0.76	0.72% ±1.52%
Funaria hygrometrica	0.04 ±0.20	0.08% ±0.40%	0.04 ±0.20	0.08% ±0.40%
Hypnum bambergeri	1.32 ±5.19	2.64% ±10.38%	0.96 ±2.82	1.92% ±5.64%
Oncophorus wahlenbergii	0.00 ±0.00	0.00% ±0.00%	0.20 ±1.00	0.40% ±2.00%
Scorpidium scorpioides	3.16 ±4.20	6.32% ±8.40%	3.52 ±3.56	7.04% ±7.12%
Tomenthypnum nitens	3.20 ±4.99	6.40% ±9.98%	1.68 ±1.99	3.36% ±3.98%