OBSERVATIONS ON THE ROLE OF LEGUMES IN SHAKWAK HIGHWAY REVEGETATION SOUTH OF HAINES JUNCTION

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Yukon
Renewable Resources

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OBSERVATIONS ON THE ROLE OF LEGUMES IN SHAKWAK HIGHWAY REVEGETATION SOUTH OF HAINES JUNCTION

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OBSERVATIONS ON THE ROLE OF LEGUMES IN SHAKWAK HIGHWAY REVEGETATION SOUTH OF HAINES JUNCTION

1.0 Introduction

In April 1994 Renewable Resources asked C&TS to remove legumes (Alsike Clover and Alfalfa) from the revegetation seed mixture to be used on the Shakwak Highway reclamation north of the White river. The concern was attraction of pregnant caribou to the roadside due to the legume component of the seed mixture and the increased danger of animal/vehicle collisions.

As legumes had been recommended in the seed mix by a consultant, based on their noted success on the Haines road and the assumption that nitrogen fixation was taking place, C&TS prepared a cost estimate for a second application of nitrogen fertilizer to replace lost nutrient due to the absence of legumes.

The Agriculture Branch was then asked to comment on C&TS cost estimates and provide input on the role of legumes in roadside revegetation. Our response was a proposal to investigate the role of legumes in terms of nitrogen fixation, success as a species in revegetation and their contribution to the development of a self supporting ecosystem.

1.1 Background

In the fall of 1993, C&TS contracted M. Vaartnou and Associates to identify bioclimatic zones and soil types, km. 1965.8 - 1907 Alaska Hwy. and to recommend seed mixtures and application rates based on this information and the objectives of the Shakwak project. These objectives included the moderation of aesthetic impact due to construction, erosion control and reduced sedimentation of waterways, reduced maintenance costs through the use of grasses and forbs to retard the invasion of trees and to a lesser extent maintenance of the thermal regime.

Included in this study was a rapid reconnaissance survey of the Shakwak reclamation program on the Haines Road. Eight stops were made on route and surviving grass and legume species were identified. It was noted in these stops that despite the use of seven species in any seed mixture, three species, which together comprised no more than 40% of the weight of any mixture, provided from 95 - 100% of extant ground cover. These species were:

Red fescue	(Festuca rubra)	
Timothy	(Phleum pratense)	
Alsike Clover	(Trifolium hybridum)	(M. Vaartnou 1994)

Alsike clover has been recommended at 10 - 15% species composition of every mixture recommended for revegetation km. 1965.8 - 1907 Alaska Highway. If Creeping Red fescue and Timothy are included, the species composition ranges from 35 - 60% of recommended seed mixtures.

2.0 Methodology:

The Haines Highway revegetation is recognized as one of the most successful to date in the Yukon. It is also an example of revegetation where alsike clover was present in the original mix and also a significant survivor after 5 to 7 years. Alsike clover was included in the Beaver Creek revegetation proposal because of the success of this species along the Haines Highway.

Our sample methodology measured two parameters of alsike clover distribution along the Haines Highway. These were:

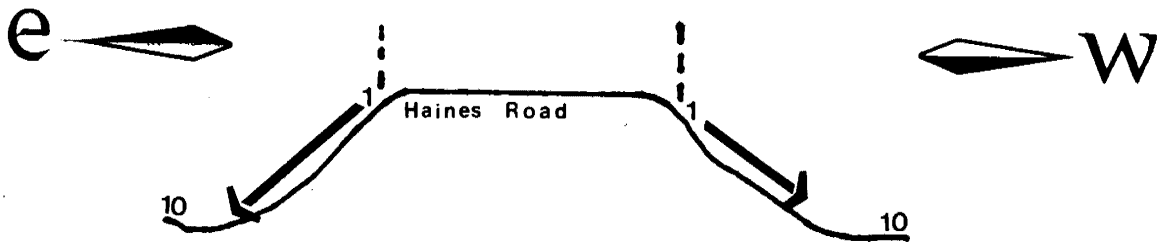
1. where is the clover located along transects, and;
2. how much clover is there.

Based on the answers we will make an evaluation of the importance of alsike clover to the overall success of the revegetation and provide observations on the ways that alsike clover contributes to the revegetation success.

The revegetation project included the complete right-of-way of the highway as well as borrow pits and cut off loops of the old right-of-way. The breadth of the revegetation project means that there are a multitude of sites in the revegetated area that differ according to site variables. Our data needed to be as complete as possible within time constraints, and comparable between sample sites.

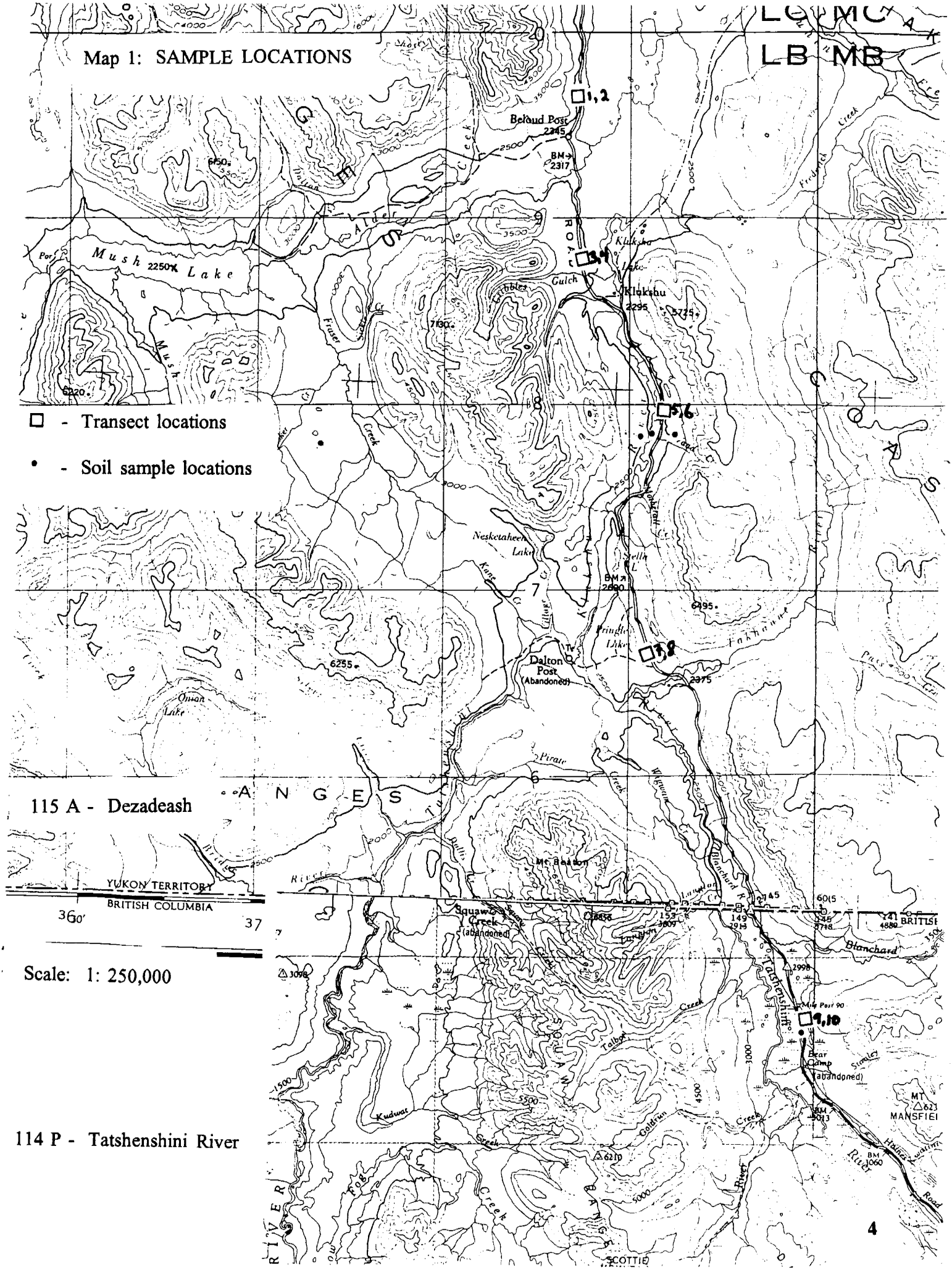
We confined our investigation to the shoulder of the highway and down into the ditch on opposite sides of the highway (see Figure 1). We recorded the percent cover of vegetation within a 20 cm by 50 cm rectangle at one metre intervals along a 10 m transect. The road shoulder is one of the most difficult areas to revegetate so data from shoulder to ditch bottom transects tests the revegetation success under harshest conditions. The road runs north to south so sampling on opposite sides of the road provided a variety of east and west aspects.

Figure 1: Transect Location on Right-of-way



The sample interval was 10 km starting 2 km north of Dezadeash Lodge and proceeding south to Million Dollar Falls campground. These sites are all within the "Boreal Interior Forest Zone" described in the revegetation proposal under which this area was seeded (Hardy Associates, 1980). We also sampled once in the subalpine (approximately 20 km south of Million Dollar Falls) and once in the alpine to see how the alsike performed in these more difficult revegetation environments. Sample sites are shown on Map 1 and the data on vegetation cover is found in Appendix 1.

Soils were sampled to get an indication of the nutrient status within the revegetation area. Two samples were taken under healthy well nodulated alsike clover plants to see if there is an increase in available nitrogen. Other samples were taken to compare these values with sites where alsike clover constitutes a small fraction of the vegetation. The original idea that we would sample extensively to try to quantify the degree to which alsike might improve the nutrient status of the revegetation area was abandoned after we observed the soil conditions. There was no soil preparation in the ditches and extant vegetation is growing in very coarse gravelly substrate. The nutrient holding capability of this type of material is negligible. The decision to undertake detailed soil sampling was deferred until results from the preliminary samples were analyzed.


Map 1: SAMPLE LOCATIONS
LB MB
1,2
3,4
5,6
7,8
9,10
Belaud Post
2245
BM
2317
Klaksha
Lake
Klaksha
2295
Gulch
Mush
2250
Lake
Neskataheen
Lake
Dalton
Post
(Abandoned)
Pirate
Creek
Squaw
Creek
(abandoned)
Mt. Bradson
Blanchard
Bear
Camp
(abandoned)
Talbot
Creek
Goldtrin
Creek
Kudwac
Creek
Tatshenshini
River
Alsek
River
YUKON TERRITORY
BRITISH COLUMBIA
360'
37
115 A - Dezadeash
114 P - Tatshenshini River
Scale: 1: 250,000
□ - Transect locations
• - Soil sample locations
4

3.0 Results and Discussion

3.1 Soil Test Results:

Table 1: Summary of Soil Characteristics and Soil Fertility

#	Soil Characteristics	Sample Site	Nitrate (ppm)*	Phosphorus (ppm)	Potassium (ppm)	Sulphur (ppm)	pH	Organic Matter (%)
1	Texture: gravely sand 80 - 90% total coarse fragments Slope: 7%	100% Alsike clover cover, well nodulated	<1	25	98	8	8.2	1.8
2	Texture: gravelly sand 80 - 90% total coarse fragments Slope: 5%	100% Aliske clover cover, well nodulated	<1	11	87	12	8.1	1.0
3	Texture: gravelly Loamy sand 50% stones and cobbles total coarse fragments = 80% Slope 8%	50% alsike clover; 50% grass cover	<1	4	124	3	7.6	1.8
4	Texture: gravelly loam 30% stones and cobbles Relatively deep and easy to dig Slope 4%	Grass and forbs, no alsike clover	<1	58	140	1	7.1	1.8
5	Texture: gravelly loam 30% stones and cobbles total coarse fragments = 80% Extremely dense and difficult to dig. Slope: Level	Grass and forbs, <10% alsike clover; very strong turf formed	<1	>60	221	5	7.5	5.4
6	LFH layers = 25 cm Texture: gravelly loam; well developed Bm horizon; total coarse fragments = 70% Slope: level	Forest floor sample adjacent to right-of-way	<1	27	189	6	6.3	6.4

* parts per million - rule of thumb is that 1 ppm = 2 lbs/acre or 2 kg/ha

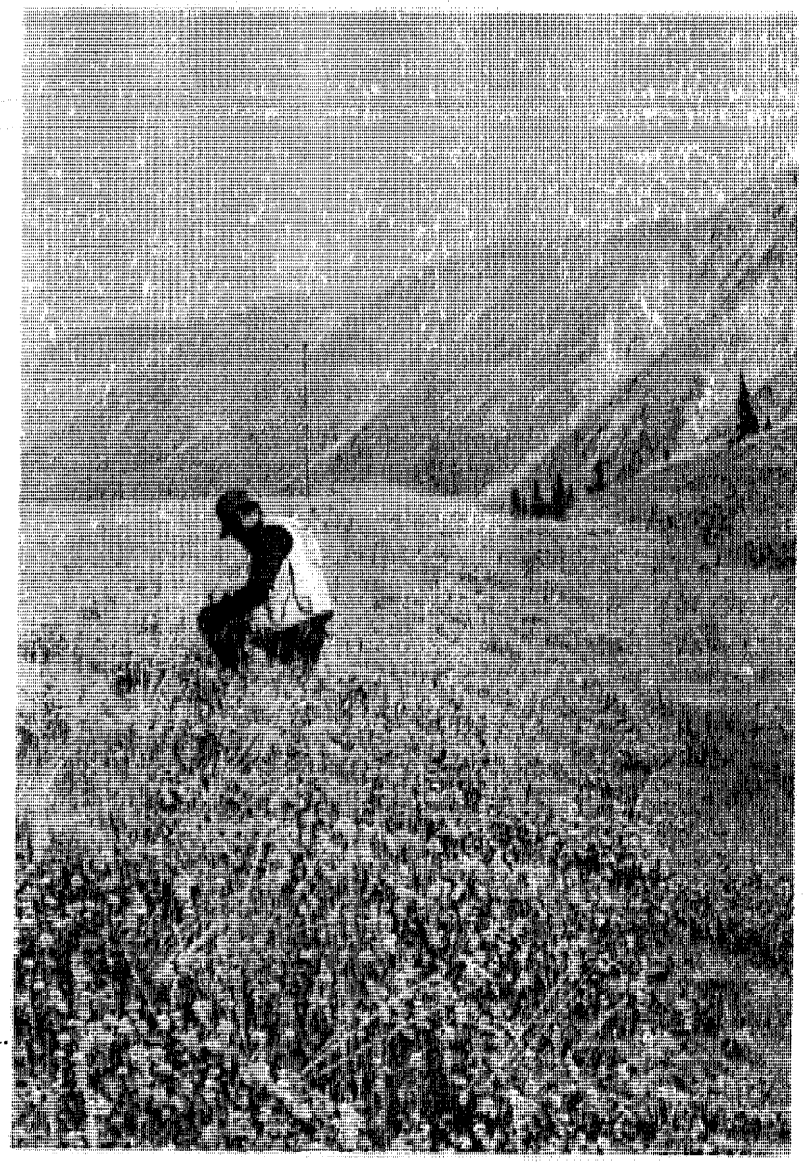
Soils along the Haines Road consist of coarse gravelly loams and sands. The moisture holding capability of these soils is low and the drainage through these soils is rapid. The inherent "droughtiness" of the soil is offset to some extent by the structure of highway grades. The road surface is waterproof and sloped to deliver rainfall from the sealed surface to the ditches. The road grade is also compacted to high densities. Moisture conditions along the transects described consist of periods of extreme drought with periodic inputs of large amounts of water from the road surface. The ditch bottom is the only point on the described transects that will remain moist for protracted periods.

The soil samples analyzed in Table 1 were collected to address the question of whether available nitrogen was increased by the nitrogen fixing capability of the alsike clover. Samples 1 and 2 were collected directly from beneath the roots of robust, well nodulated clover plants. The nodules of these plants were a bright pink and showed good activity. The results show that virtually no nitrogen was found in these samples. If there is no increase in nitrogen found in samples 1 and 2 (collected to maximize the potential for transference of nitrogen to the soil) it is not surprising that available nitrogen was extremely low in all the samples submitted for analysis. Soil textures are so coarse and organic matter values so low that there is effectively no soil medium for the plants to utilize.

The phosphorus values from the soil test are much higher than expected in all but sample 3. Even the forested sample (#6) shows near optimum phosphorus values. This leads to the speculation that the local geology may contain phosphate rich mineralogy.

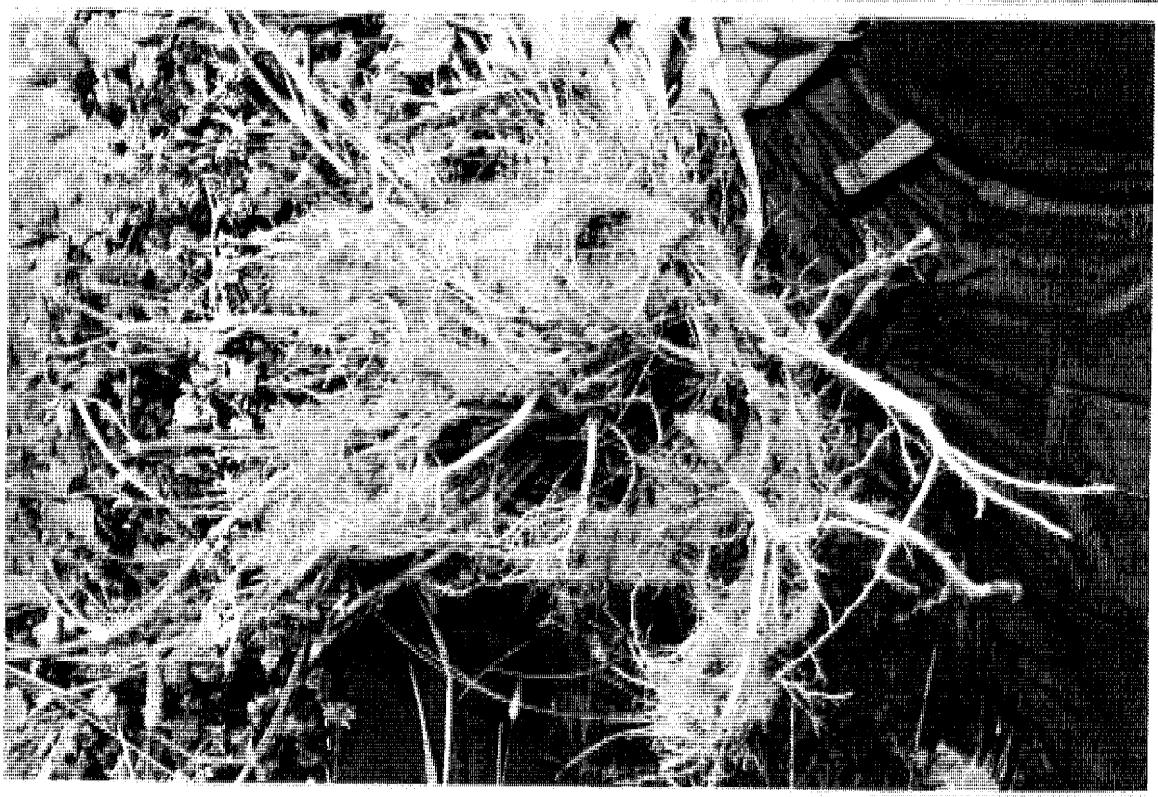
Photograph 1

Top Right: Alsike clover on the east aspect of the Haines Road. Soils are very gravelly on a 7 - 10% slope.



Photograph 2

Below: Well developed fiberous root system with active nodules on alsike clover from the side of the road.



Photograph 3

West aspect of Haines Road, 10 - 15% slope. Interior boreal forest zone.

Photograph 4

West side of the road, level surface, below the slope pictured above.

3.2 Transect Results

Alsike clover is persistent in all the revegetated sites observed along the Haines Road from Interior Boreal Forest to moist alpine at over 3000 ft. elevation. Table 2 summarizes the results from the 7 transects in the Interior Boreal Forest Zone. Regardless of moisture condition alsike clover, creeping red fescue and timothy were the dominant species observed.

Table 2: Summary of Interior Forest Zone Transects

Site #	Moisture Condition	Aspect	% Cover Alsike	% Cover Red Fescue	% Cover Timothy	% Cover Other Seeded	% Cover Invaders
1	Very Xeric	90°	7.0	22.0	<1.0	<1.0	<1.0
3	Mesic	270°	13.7	16.0	5.7	6.7	1.0
4	Mesic	90°	11.5	17.0	5.7	3.0	none recorded
5	Mesic	120°	31.0	24.5	4.5	<1.0	<1.0
6	Mesic	300°	25.0	32.0	4.2	5.0	none recorded
7	Mesic to subhygric	244°	11.0	30.0	10.5	2.2	none recorded
8	Mesic to subhygric	64°	44.5	15.5	5.0	8.0	none recorded

The role of timothy in the revegetation is understated in these results because the road shoulder makes up a large part of the transects. Timothy thrives in moister environments and generally had largest percent covers beyond our transects (i.e. ditch bottoms and other low lying areas; see photo 4). Alsike clover dominated the road shoulder (see photo 1). This is a very difficult area to revegetate due to the poor moisture holding capacity and high compaction. Legumes, both native and introduced, seem to choose this particular environment. The ability to fix nitrogen for its own use combined with an ability to withstand periodic drought seem to be the keys to legume dominance in these sites. Creeping red fescue was the work horse of the revegetation troika. Red fescue is capable of thriving in very dry conditions and dominates on the warmer, dryer western aspects, while alsike clover had a small edge in percent covers on eastern aspects (Table 3).

Table 3: Summary of Major Revegetation Species by Aspect

	Alsike Clover % Mean cover	Creeping Red Fescue % Mean cover	Timothy % Mean cover
Eastern Aspect	23.5	19.75	4.05
Western Aspect	16.5	26.0	6.8
Occurrence	10 of 10 transects	10 of 10 transects	10 of 10 transects

Nodulation was abundant on samples of clover examined at all but the driest sites. Pink pigmentation was observed in most nodules cut open indicating nitrogen fixation. It was possible to predict which plants were fixing nitrogen based on observed vigour. Not surprisingly, large strongly green plants had abundant nodules.

Extreme mechanical disturbances such as road construction produce soils consistently low in nitrogen (N) as a consequence of volatization, leaching, run-off erosion and biomass removal. In soils that are low in N, recolonization is the primary means of restoring N fertility over time (Burns and Hardy, 1975). On the Haines Road, although no nitrogen bulge was detected in clover covered mineral soils, successional revegetation by grasses in areas where clover had been the initial species appeared to be the pattern. This result may be due to alsike clover's characteristics as a short lived perennial with a non-aggressive nature (Fairly, 1986). Over time, grasses dominate on sites where both clovers and grasses established. As the alsike dies out it contributes nitrogen rich litter to gravelly soils, increasing organic matter and fertility (see photo 3 for fibrous root mat). In road shoulder situations described above, the natural advantages of clover allow it to remain dominant on these sites.

The above discussion of alsike clover gives an indication of its importance to the revegetation of the Haines Road. Its persistence on all sites covering a multitude of site conditions demonstrates that it is one of the important species for Yukon revegetation projects. If the above interpretation is correct the role of alsike clover is both subtle and pervasive. It should be pointed out that in the absence of strong reasons to the contrary alsike clover **should be included** in revegetation mixes, at least until native legumes become commercially available.

The work done on this study has helped focus attention on where to look for problems in the absence of alsike clover west of the White River. Road shoulders are one area where we would expect, based on these findings, to see poor establishment if clovers are absent from the mix. Assessing the degree of success on road shoulder sites may give an overall indication of the success of the project. Assessing percent vegetation cover reveals that bareground and litter account for 40% of the transect on average. Conversely, this provides an indication that percent covers in the 50 to 60% range are adequate to meet the aesthetic goals of revegetation.

Trying to identify causes for the outcome of the north highway revegetation in terms of "presence or absence" of alsike clover would restrict our observations to a single variable. Results observed on the north Alaska Highway may correlate more highly with climate variables (temperature and precipitation) in any given year than with seed choice or nutrient availability.

The Haines Road revegetation area is extremely moisture stressed this year and the drought may cause a significant decrease in vegetation next season. It is possible that the drought will reduce vegetation to such low levels that the cover will no longer be self-sustaining.

4.0 Recommendations:

We would recommend yearly observation following the seeding of the north Alaska Highway to monitor the vigour of the vegetation. More specifically, comparisons should be made of percent vegetation covers between those areas where alsike clover is part of the mix and those areas where it has been left out.

In the absence of experimental data, yearly observations will give an indication of the health of the vegetation cover and may help optimize refertilization timing should additional fertilizer become necessary. Other goals of the monitoring program will be quantification of invader species and classification of these species as desirable (any plant that will not create visibility problems) and undesirable (mainly shrubs, but also trees).

At the same time efforts should be made to monitor the caribou attraction problem through tracking of collision information from RCMP, and Conservation Officers. Of particular interest will be observed use of the highway right of way by the caribou to graze on grass species.

APPENDIX 1

DETAILED VEGETATION INFORMATION BY TRANSECT

SITE 1

TRANSECT 1
% COVER

NO.	SPECIES	1	2	3	4	5	6	7	8	9	10
1	Salix sp.					5					
2											
3											
4	Epilobium angu.										
5	Achillea mill.							T*			
6	Lupinus arct.										
7	Rubus stri.										
8	Trifolium hybr.								70		
9											
10											
11											
12											
13	Bromus iner.										
14	Agropyron trach.				5					T	
15	Phleum prat.		T	T				T			
16	Festuca rubr.	30	20	20	10	15	50	15	20	40	
17	Agropyron cris.										
18											
19											
20											
21											
22											
23	Bare ground	65	75		75	45	55	50	10	75	50
24	Litter	5	T	5	5	45	30	--	5	5	15

* T = trace. % covers are rounded to nearest 5%.

SITE 1

TRANSECT 2
% COVER

NO.	SPECIES	1	2	3	4	5	6	7	8	9	10
1	Salix sp.										
2											
3											
4	Epilobium angu.										
5	Achillea mill.		10								
6											
7	Rubus stri.							10			10
8	Trifolium hybr.								70		
9	Hedysarum alpi.										
10	Taraxacum offi.		15					25			
11											
12											
13	Bromus iner.										
14	Agropyron trach.										
15	Phleum prat.				T	20	10				
16	Festuca rubr.	80	50	25	40	20	40	10	70	70	60
17	Agropyron cris.										
18	Poa prat.	15									
19	Agropyron viol.	5			5						
20											
21											
22											
23	Bare ground				45	30	40	20	10		
24	Litter	100	15	35	20	20	30	45	30	30	40

SITE 2

TRANSECT 3
% COVER

NO.	SPECIES	1	2	3	4	5	6	7	8	9	10
1											
2											
3											
4	Epilobium angu.										
5											
6											
7											
8	Trifolium hybr.					40	50	10	35	T	
9											
10	Taraxacum offi.	T					5	15		T	
11											
12											
13											
14	Agropyron trach.								T		
15	Phleum prat.	T	5	5	5	10	10		10	T	5
16	Festuca rubr.	10	20	20	10	15		40	20	5	20
17	Agropyron cris.								10		
18											
19											
20	Equisetum scri.					20	15	10			
21											
22											
23	Bare ground	65	65	60	80	10	15	5	20	85	65
24	Litter	20	10	10	5	5	5	20	15	5	10

SITE 2

TRANSECT 4
% COVER

NO.	SPECIES	1	2	3	4	5	6	7	8	9	10
1											
2											
3											
4	Epilobium angu.										
5											
6											
7											
8	Trifolium hybr.		95	20							
9											
10	Taraxacum offi.										
11	Asragalus sp.										
12	Medicago sp.										
13											
14											
15	Phleum prat.		T	10	T		5	10	10	15	T
16	Festuca rubr.	10	5	30	20	20	10	35	25	10	5
17											
18											
19											
20	Equisetum scri.								5		
21											
22	Moss sp.									25	25
23	Bare ground	85	25	75	50	50	25	25	65	10	
24	Litter	50	15	5	10	30	30	30	10	50	50

SITE 3

TRANSECT 5
% COVER

NO.	SPECIES	1	2	3	4	5	6	7	8	9	10
1	Salix sp.										
2											
3											
4	Epilobium angu.										
5											
6											
7											
8	Trifolium hybr.	25	40	50	25	60	50	30	15	0	15
9											
10	Taraxacum offi.										
11											
12											
13	Mertensia pani.										
14	Agropyron trach.										
15	Phleum prat.		10	10	10				15		10
16	Festuca rubr.	20	15	5	25	25	30	30	15	20	60
17											
18											
19											
20	Calamagrostis cana.										
21											
22	Moss sp.										
23	Bare ground	40	20	25	15	5		20	50	60	
24	Litter	10	15	10	25	10	20	20	15	10	15

SITE 3

TRANSECT 6

% COVER

NO.	SPECIES	1	2	3	4	5	6	7	8	9	10
1	Salix sp.										
2											
3											
4	Epilobium angu.										
5	Achillea milli.										
6											
7											
8	Trifolium hybr.	15	50	25	35	25	35	25	50		
9	Artemesia cana.							5			10
10	Taraxacum offi.									5	
11	Polemonium pulch.							10	20		
12	Mertensia pani.										
13											
14	Agropyron trach.										
15	Phleum prat.		15	10	15				T		
16	Festuca rubr.	35	35	60	50	25	20	40	15	25	20
17											
18											
19											
20	Equisetum scri.										
21											
22	Moss sp.										
23	Bare ground	40				25	35		5	55	60
24	Litter	10		5	15	25	10	20	10	15	10

SITE 4

TRANSECT 7
% COVER

NO.	SPECIES	1	2	3	4	5	6	7	8	9	10
1	Salix sp.	T									
2											
3											
4	Epilobium angu.										
5											
6	Lupinus arct.										
7											
8	Trifolium hybr.				5	10	15	25	25	15	15
9											
10	Taraxacum offi.	T				5					
11											
12											
13											
14											
15	Phleum prat.	15			5	5	15	5	10	40	10
16	Festuca rubr.	75	5	10	50	5	20	25	40	10	60
17											
18											
19											
20	Equisetum scri.	5	5								
21											
22	Moss sp.										
23	Bare ground	15	25	90	20	75	20				15
24	Litter		50		20		30	45	25	30	

SITE 4

TRANSECT 8

% COVER

NO.	SPECIES	1	2	3	4	5	6	7	8	9	10
1	Salix sp.										
2											
3											
4	Epilobium angu.										
5											
6	Lupinus arct.									80	
7											
8	Trifolium hybr.	25	85	70	60	75	35	50	40	5	
9											
10											
11											
12											
13											
14											
15	Phleum prat.							25	20		5
16	Festuca rubr.	5	15	20	10	15	35	25	10		20
17											
18											
19											
20	Equisetum scri.										
21											
22											
23	Bare ground	60		10		10	15			15	55
24	Litter	5			30		15		30		20

SITE 5

TRANSECT 9
% COVER

NO.	SPECIES	1	2	3	4	5	6	7	8	9	10
1											
2											
3											
4											
5	Achillea mill.										
6											
7											
8	Trifolium hybr.	15	60	50	90	70	40	70	30	85	50
9	Trifolium prat.										
10											
11											
12											
13											
14	Agropyron trach.										
15	Phleum prat.					5	20	20		5	
16	Festuca rubr.	40	20	15	5	25	40	11	10	5	5
17											
18											
19											
20											
21											
22											
23	Bare ground	20	10	20					55		40
24	Litter	25	10	15	5				5	5	5

SITE 5

TRANSECT 10
% COVER

NO.	SPECIES	1	2	3	4	5	6	7	8	9	10
1	Salix sp.	50									
2											
3	Epilobium lati.										
4	Epilobium angu.	5									
5	Achillea mill.										
6	Sanquisorba sitch.		5	5							
7	Rosa acic.										
8	Trifolium hybr.				T	5		10	35	25	85
9	Trifolium prat.										
10	Agrostis scab.										
11	Hordeum juba.										
12	Poa arctica										
13	Bromus iner.										
14	Agropyron trach.										
15	Phleum prat.		10	15	25	25	5		5		
16	Festuca rubr.		5	5	10	5	50	50	20	10	5
17	Calamagrostis cana.										
18	Juncus arct.										
19	Equisetum prat.										
20	Equisetum scri.	50	75	65	10	5	20	30			
21	Equisetum fluv.										
22											
23	Bare ground								40	65	10
24	Litter					55	70	30	5	5	

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