

## **INTRODUCTION AND METHODS**

**Introduction:** Changes in infrastructure and climate are affecting the vegetation of the Prudhoe Bay, Alaska area. Oilfield roads and warming temperatures have affected the permafrost and soils, modifying the conditions for plant growth.

This study, initiated in 2014, builds on baseline changes in vegetation are also displayed using a data collected in the same area by the Nonmetric Multidimensional Scaling (NMS) ordination International Biological Program, Tundra Biome Project in the 1970s (Brown 1975, Everett and Parkinson 1977, Walker et al. 1980, Walker 1985, Walker and Everett 1991).

**Methods**: Maps were prepared from aerial photographs taken in 1972 (shortly after construction of the Spine Road) and 2013 to determine changes in the extent of the major physiognomic-level vegetation units within the 60 x 400 m area of the transects. We used a simple categorization of moist tundra, wet tundra, aquatic tundra, and water based mostly on density of gray tones of the vegetation evident in black and white images [see figure 1].

Vegetation plots were set up in polygon centers and troughs at 5, 10, 25, 100 and 200 m from both sides

of the heavily-traveled Spine Road. Sorted-table analysis (Westhoff and van der Maarel 1978) was used to examine changes in vegetation species composition between1974-75 and 2014. Plot data collected from the same vegetation types in the 1970s (Walker 1985) were used to determ diagnostic taxa of the original vegetation, and compared with plot data from this study [2]. The

Cover was estimated for species and lifeforms at each plot [4, 5]. Leaf area index (LAI), a measure of productivity and biomass, was measured using an

sampling, using a 100-point quadrat, was used to determine quantitative changes in the major species and growth forms [7, 8]. Soil characteristics such as organic matter, pH and thaw depth were sampled

in detail (Buchhorn et al.) and the permafrost characteristics determined from core drilling (Kanevskiy et al)

AccuPAR LP-80 PAR/LAI Ceptometer [6,8]. Point

Other posters from this project describe the transects

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Major vegetation changes occurred over 42 years: The ordination showed major shifts in species Aquatic vegetation and water increased on both sides composition over time [3]. Moist tundra plots got wetter and less diverse, with lower moss cover; wet tundra of the road, but most dramatically on the southwest side which is regularly flooded during spring snow melt plots got drier and somewhat more diverse, and aquatic period [see figures 1 and 3]. Major changes in the tundra, while experiencing some of the greatest changes, did not show a consistent direction in the ordination species composition of the dominant moist and wet vegetation types due mostly to dust [2, 3]. For moist space [3]. vegetation types (Types U3 and U4), 20 of 27 diagnostic species recorded in the 1970s (mostly lichens and small Variation with proximity to road: forbs) were either not recorded or recorded in greatly reduced abundance [2]. For wet vegetation types (M2 and M4), 4 of 12 diagnostic species diagnostic species recorded in the 1970s (mostly lichens and small forbs) were either not recorded or recorded in greatly reduced abundance [2].

A few species showed major changes in plant productivity and abundance most likely due to flooding and disturbance (mostly Carex aquatilis, Eriophorum angustifolium, and some salt tolerant species (e.g. Braya purpurascens) [2]. Shrub abundance (Salix richardsonii, Salix arctica) was noticeably higher [2, 4], probably due to a combination of road-related disturbance factors and regional warming.

The effects of the road were evident on both the vegetation and physical environment. Moss cover decreased and bare soil cover increased with road proximity [5]. Total plant cover also decreased, especially on the north side. Organic matter in the thawed soil horizons decreased [8A], pH increased [8B], and thaw depth increased, especially on the south side of the road [8C].

Differences between the north side vs. south side of the road: The south side of the road had greater LAI [6], greater cover of live and dead vascular vegetation (mostly graminoids) [7], and deeper thaw

Vegetation changes related to 45 years of heavy road traffic along the Spine Road at Prudhoe Bay, Alaska



Prior to road construction in 1969, the north side of the road had more wet tundra and thermokarst pits than the south side of the road. After the road was built, extensive deep thermokarst developed along polygon troughs on the south side of the road and aquatic vegetation increased. Other more subtle changes occurred to the species composition of the major vegetation

Hand Strand



160

140

100

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60



Sorted table of undisturbed plots (Walker 1980) and matching disturbed plots. Species in red are uncommon or do not occur in disturbed plots. Species in blue occur more commonly in disturbed plots. Note much species richness in undisturbed plots, especially in the drier types, U3, U4 and M2.

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				BURN CAN LITER	Drepanocladus brevifolius	2.5 3.9	16	14.4 9 7.5 2	<mark>. 15</mark>	0.1	3 3 16	16 3 28.8	63.5 49.5 2.2	5.9		3	3 38		3			
and the second second			Aquatic tundra (Types M4 + E1)	Same and the same	Carex marina		0.8	0.1 0.7				1.6	0.1 0.1									
			Linvegeteted water	and the second s	Carex fuliginosa ssp. misandra (=C. misandra)	0.1	0.1	0.4 0.8	3			0.1	0.1	0.1								
	Unvegetated water		Unvegetated water	Seal Statements	Differential taxon for community group U3, U4, M2, E1:																	
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1月1日 1月1日 1月1日 1月1日 1月1日 1月1日 1月1日 1月1日			Disturbed moist tundra (Types U3d + U4d)	A May BAR	Meesia triquetra		0.1					15.5	5.2 8	0.1 0.1	3		3	0.1				
				- CANTER OF	Carex saxatilis							1 0.1	1.3 2.6					1.		0.5		
The georges party			Disturbed wet tundra (Types M2d)	CALCULATION OF STREET	Carex sp.	0.1	0.1		0.1			0.1 0.1	1.6 0.3									
		The second se			Eriophorum russeolum			0.1				0.1	0.1 0.9	0.1				0.6			L	
Sint and a second			Disturbed aquatic tundra (Types M4d + E1d)	FLEWING X 3	Salix ovalifolia	~ 1		1		16	3	16 1 0.1	0.1 0.2			3						
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Live vascular

Dead vascular

**3** NMS ordination of plant species cover 4 egetation Гуре 🛑 U3 🔺 U3d U4 🔋 U4d 🌒 M2 🔺 M2d M4 🔺 M4d E1 🔺 E1d Axis 1 Total plant cover cover, diversity Nater cover, site moisture







NMS ordination of plant species cover with explanatory environmental data. Circles (and solid ovals) are plots sampled in 1974-75 (Walker 1985). Triangles (and dashed ovals) are plots in similar, but disturbed habitat, sampled in 2014. See details of vegetation types in table above. Disturbed moist tundra plots changed to an area of the ordination with more moisture, less plant cover, less moss cover and less diversity than non-disturbed plots. Disturbed wet tundra plots had less moss cover, but slightly greater diversity and plant cover. Effects of disturbance on aquatic tundra were more variable.

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Estimates of percent live plant cover for different lifeforms on 1-m<sup>2</sup> plots. Dark outline - polygon troughs (T); North side on right. Compared to polygon centers, troughs had almost no shrub cover, high graminoid cover and higher moss cover (often below water). Moss cover increased with distance from road, and total plant cover increased with distance from road on N side, but not on S side.



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Cover proportion of lifeforms on North and South sides of the Spine Road (N,S). Note greater live and dead vascular cover on the South side of the road. Vegetation type descriptions are in the table above.

## References

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Physical soil characteristics. Polygon centers are shown light gray, polygon troughs - dark gray. Dust from road traffic, and gravel from construction and maintenance changed the characteristics of the soil along the road, creating surface soils with low organic matter (A) and higher pH (B) than soils away from the road. The road also blocked surface water drainage, which increased thaw depths (C) to the south (left in graphs), adjacent to Lake Colleen.



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