

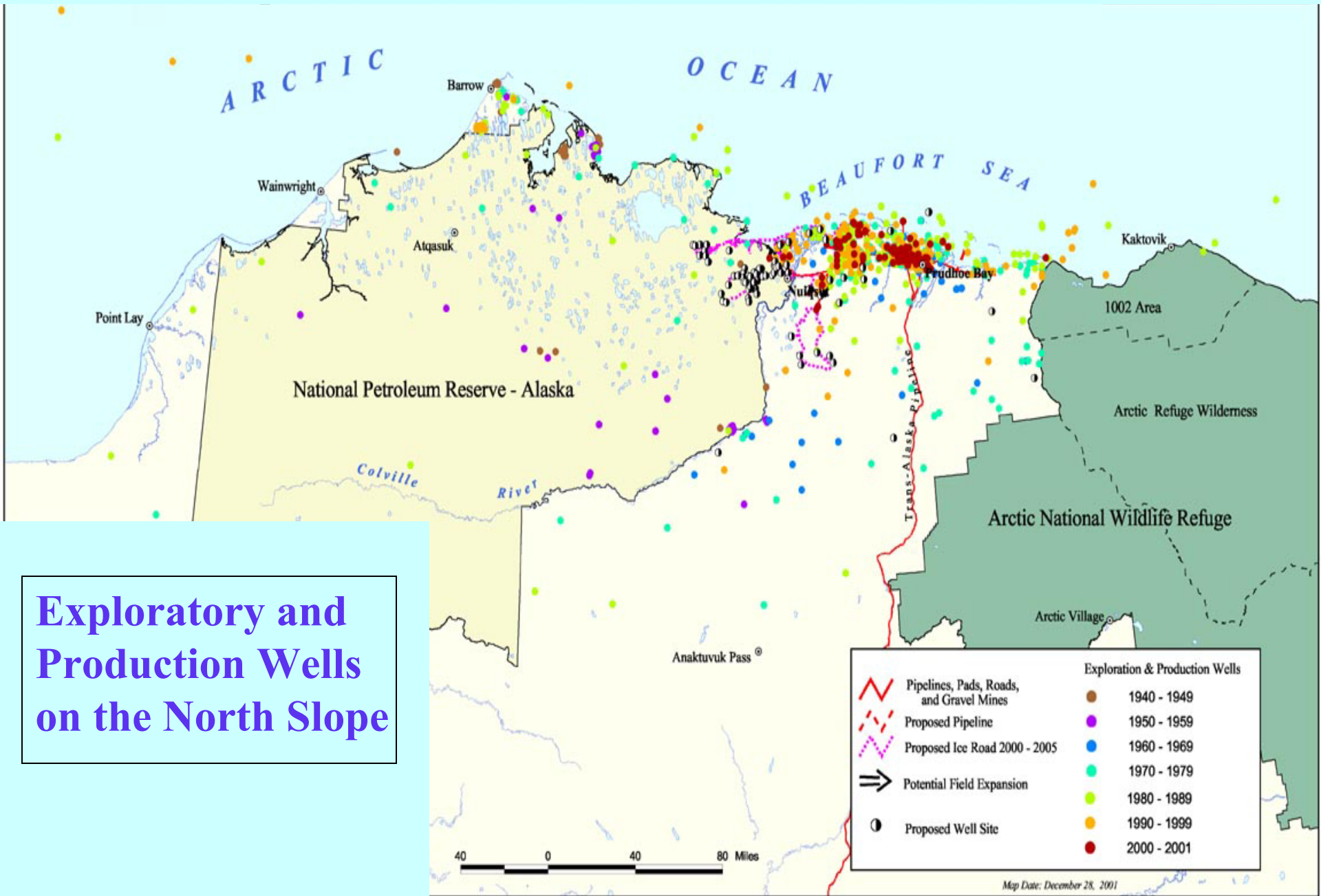
North Slope Tundra Travel and Ice Road Construction

By

**Alaska Department of
Natural Resources**



Wyn Menefee & Gary Schultz



Exploratory and Production Wells on the North Slope

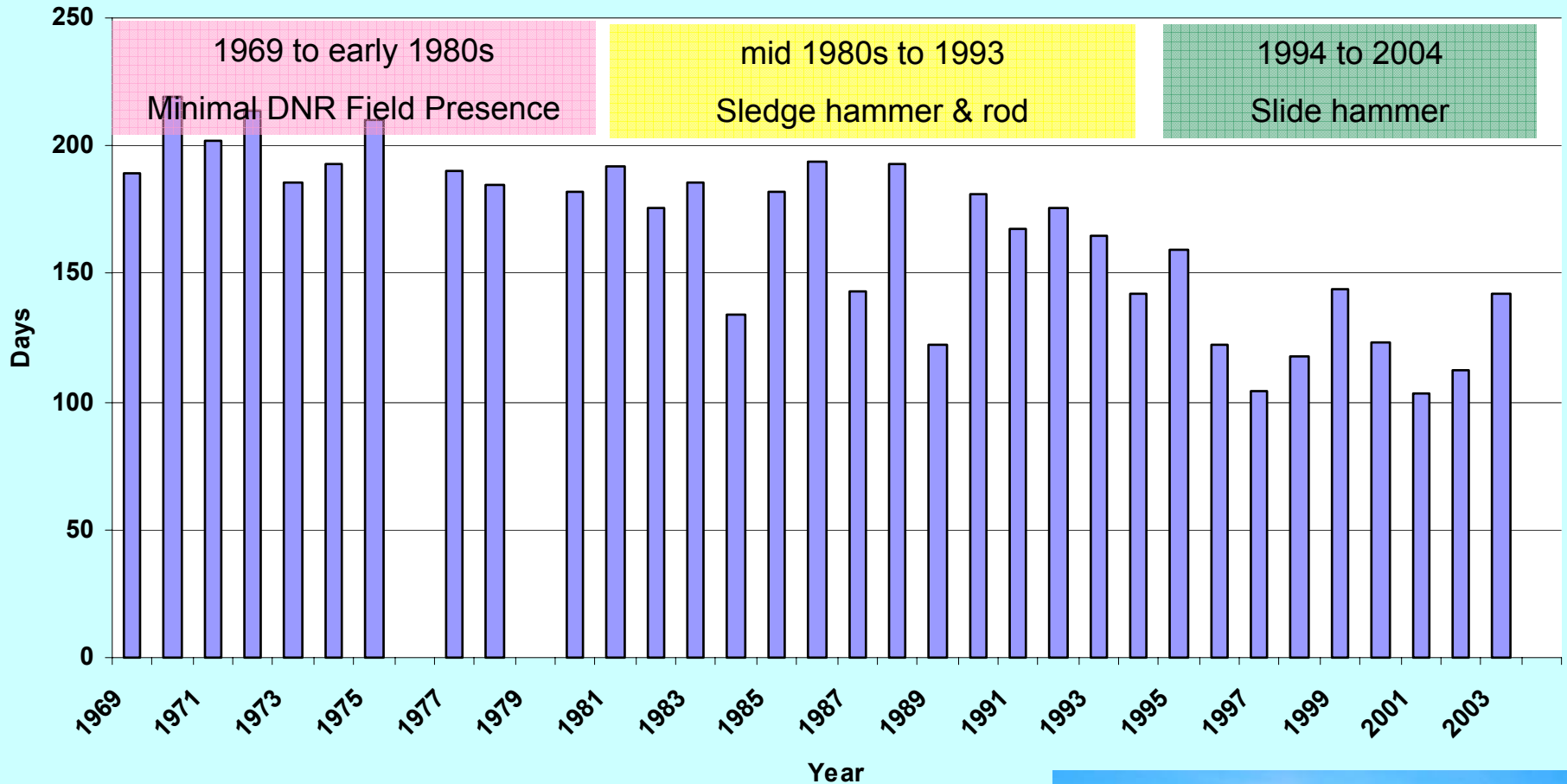
	Pipelines, Pads, Roads, and Gravel Mines		1940 - 1949
	Proposed Pipeline		1950 - 1959
	Proposed Ice Road 2000 - 2005		1960 - 1969
	Potential Field Expansion		1970 - 1979
	Proposed Well Site		1980 - 1989
			1990 - 1999
			2000 - 2001

Ice Road Construction



Cross Country Travel
e.g. Seismic Surveys

Alaska North Slope Winter Exploration Season Length



**Tundra Opening Standard:
6" Snow, 12" Frozen Ground**



DNR Response to Shortening Winter Season

- Conduct tundra travel model study
Implement the results of study into tundra opening protocol
- Develop new ice road construction methods
Monitor ice road construction projects to determine what methods work.



Permitting Exploration on the North Slope:
TUNDRA TRAVEL MODEL
And
VALIDATION STUDY

Research Project by Alaska Dept. of Natural Resources
in collaboration with
Alaska Oil and Gas Association
U.S. Dept. of Energy
Yale University
University of British Columbia

GOALS

- Increase winter work window to enhance oil and gas exploration on the North Slope
- Enhance our ability to prevent damage to tundra resources

Prudhoe Bay Model Research Study Area

Test Date Oct 30/31

 = Treatment Date One

Cat Tractor – I2

Tucker – G2

Front Loader – G1

Challenger – I5

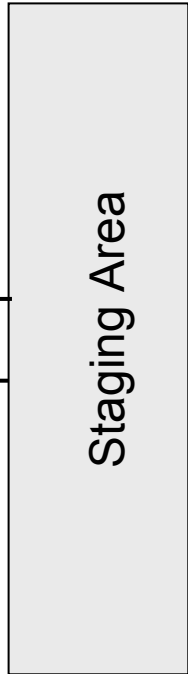
No Treatment – J3

1	39	40
2	38	41
2	37	42

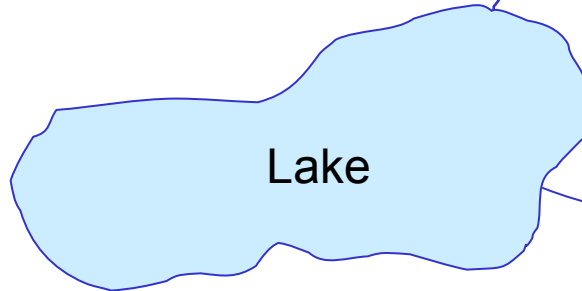
1	1	12	13
2	2	11	14
3	3	10	15
4	4	9	16
5	5	8	17
5	6	7	18

24	25	36
23	26	35
22	27	34
21	28	33
20	29	32
19	30	31

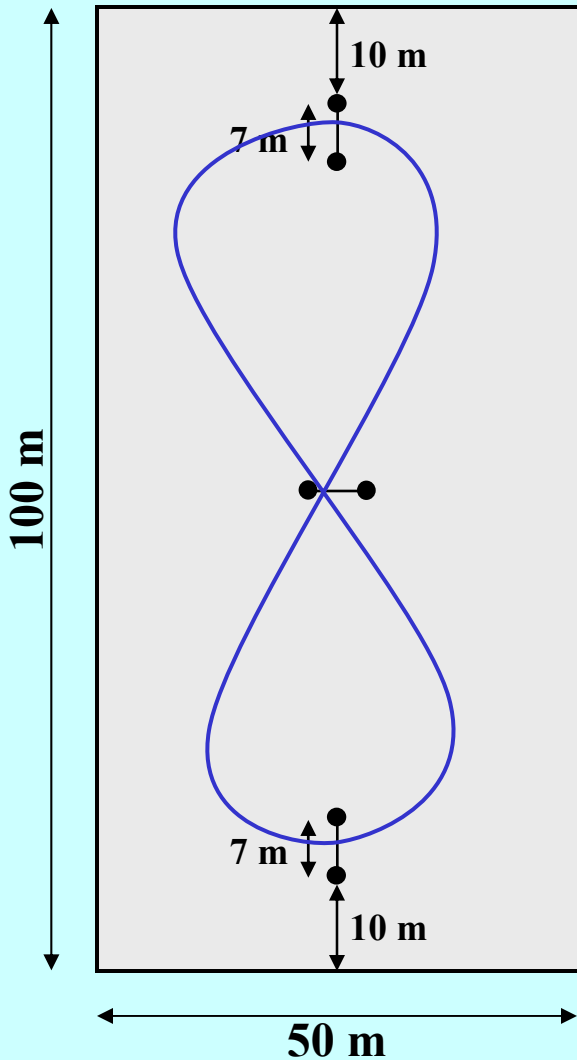
1	46	53	54	43	44
2	47	52	55	58	45
3	48	51	56		
	49	50	57		



Dalton Highway



Access Road



- 100 x 50 meters
- Figure “8”
- 5 Treatments
- 6 Test Dates
- 30 Plots

COASTAL PLAIN

- Wet Graminid
- Moist Sedge Shrub



FOOTHILLS

- Tussock Tundra
- Moist Sedge Shrub Tundra



Summer 2003 – Identify study locations, take base measurements

Winter 2003/2004 – Conduct vehicle tests late October thru January

Summer 2004 – Measure all plots

Fall 2004 – Produce Tundra Travel Model

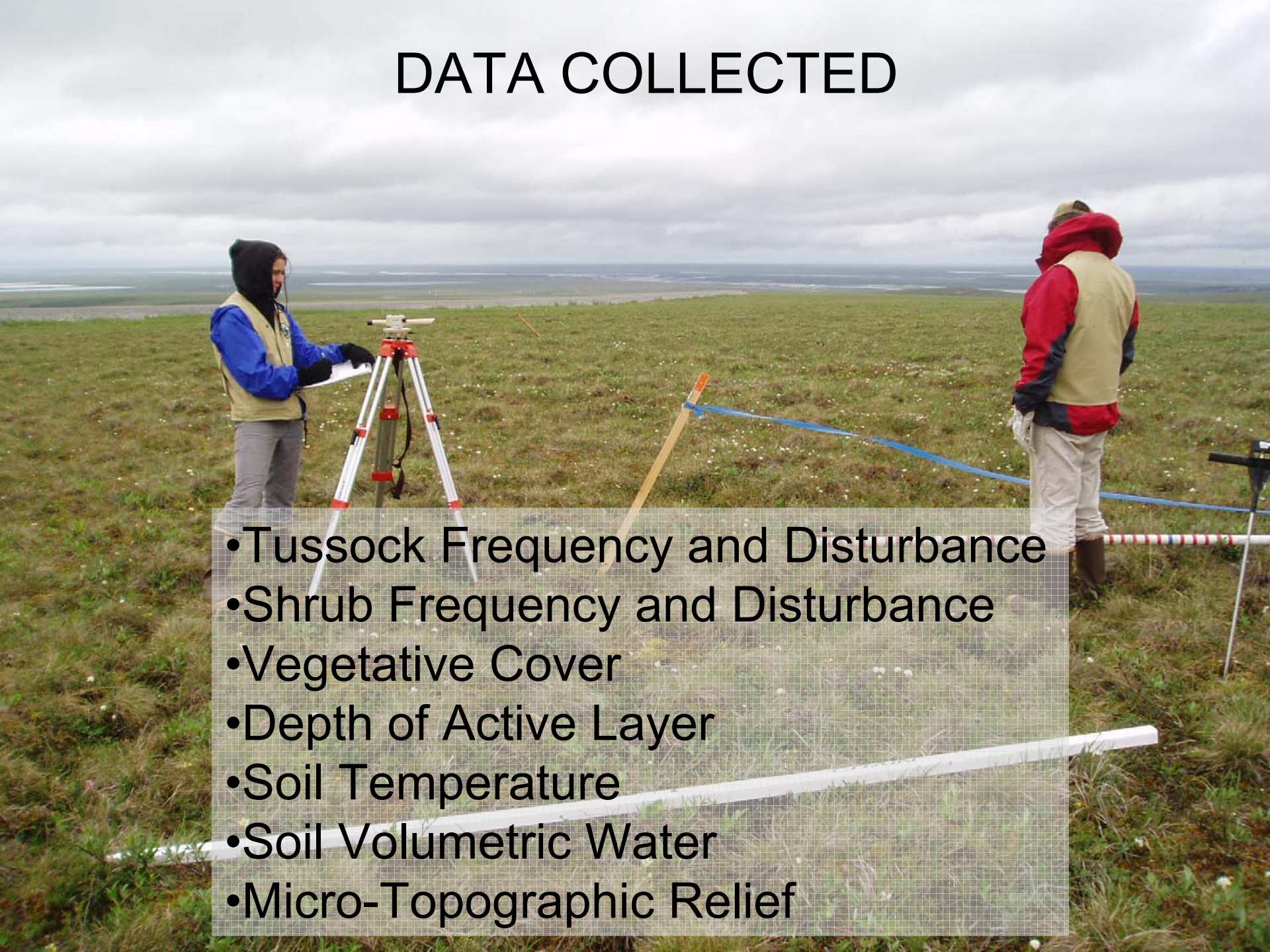
Winter 2004 – Open tundra using model. Set up test plots for conducting seismic validation study

Summer 2005 – Measure original plots and validation plots

Fall 2005 – Analyze results, complete validation report

Winter 2005 – Open tundra using new tundra travel model

DATA COLLECTED

- 
- A photograph showing two researchers in a grassy field under a cloudy sky. One researcher on the left is adjusting a surveying instrument on a tripod. The other researcher on the right is standing near a blue tape marking. A white measuring tape is stretched across the foreground. A semi-transparent text box is overlaid on the bottom half of the image.
- Tussock Frequency and Disturbance
 - Shrub Frequency and Disturbance
 - Vegetative Cover
 - Depth of Active Layer
 - Soil Temperature
 - Soil Volumetric Water
 - Micro-Topographic Relief

WINTER MEASUREMENTS

Snow Depth

Snow Slab Thickness

Hoar Frost Thickness

Ground Hardness



TREATMENT: TUCKER



Tucker: 15,000 lbs; 1.25 psi; rubber track

OCTOBER 2003

TREATMENT: FRONT END LOADER



OCTOBER 2003

966 Loader : 40,000 lbs; 40 psi; rubber wheel

TREATMENT: CHALLENGER



Challenger: 33,500 lbs; 4 psi; rubber tracks

OCTOBER 2003

TREATMENT: TRACTOR



D7 Tractor: 50,500 lbs; 9 psi; steel tracks

OCTOBER 2003

IMPORTANT VARIABLES IN ORDER OF CONTRIBUTION TO TUNDRA RESISTANCE TO DISTURBANCE

- SNOW SLAB THICKNESS
- SNOW DEPTH
- SOIL TEMPERATURE

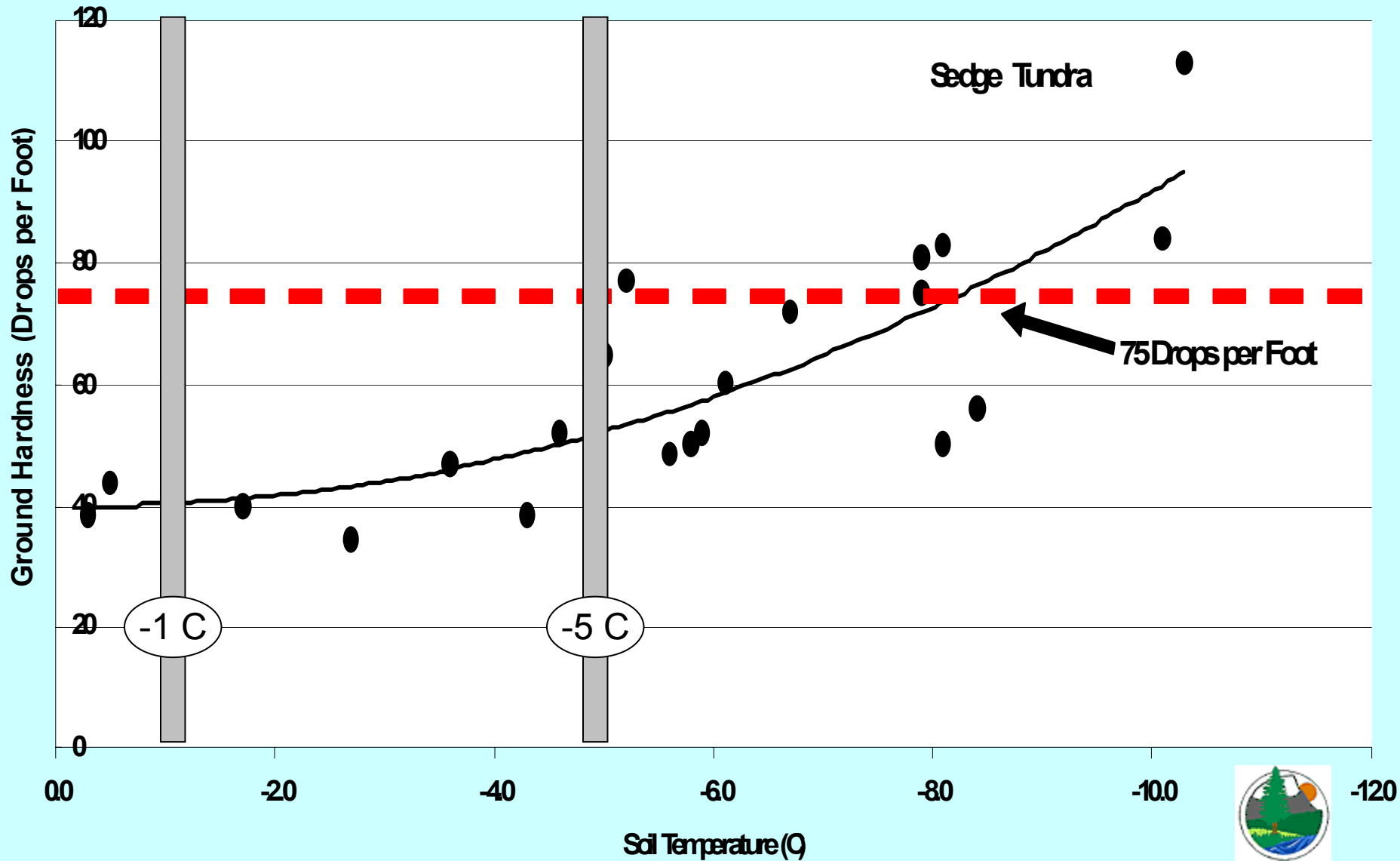


New Tundra Opening Management Standards

- **COASTAL PLAIN**
6 inches of Snow
-5° C Soil Temperature

- **FOOTHILLS**
9 inches of Snow
-5° C Soil Temperature

Ground Hardness vs Soil Temperature (30 cm)
Six DNR Thermistor Stations
Winter 2005-06

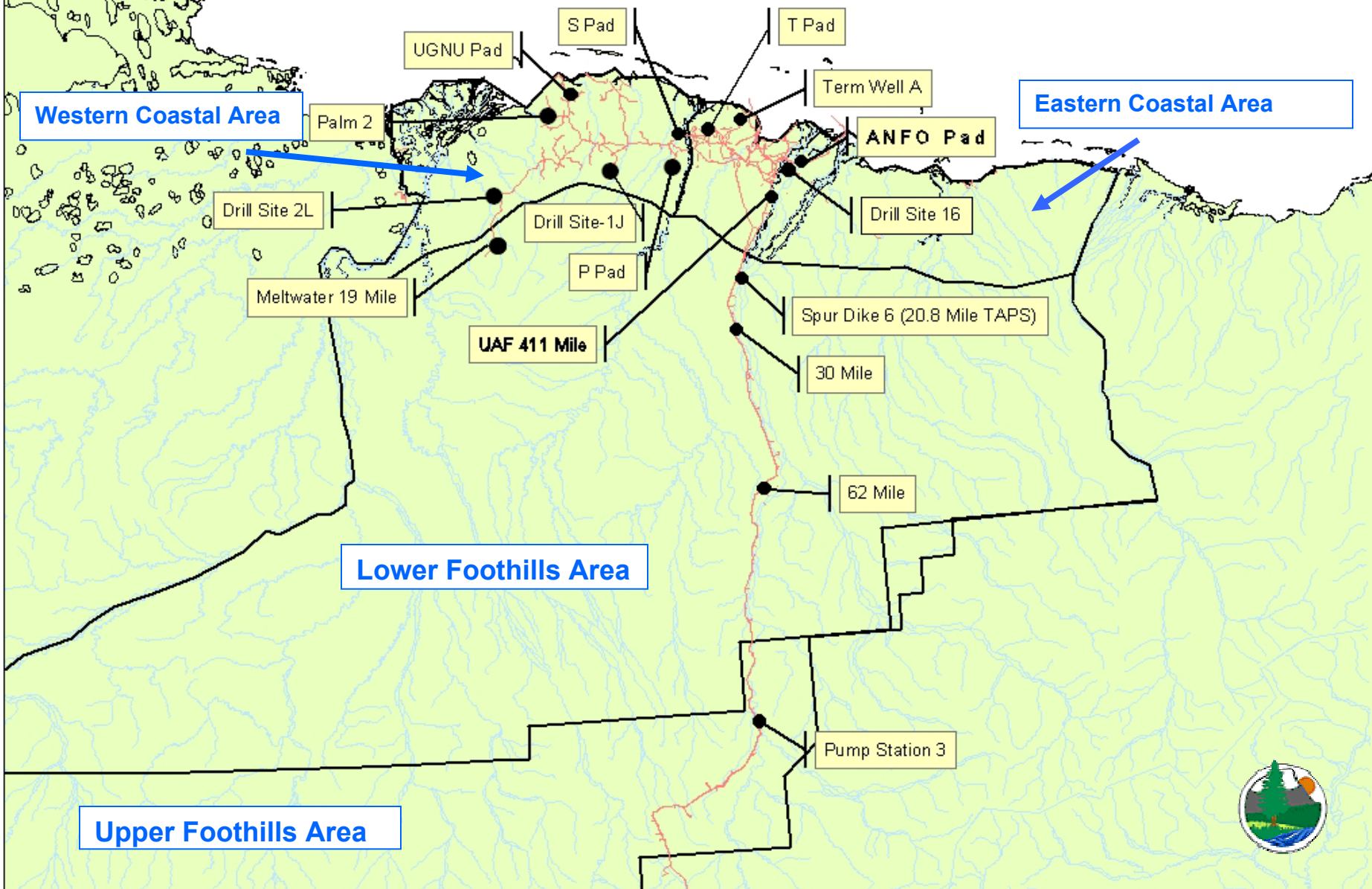




Implementation of the DNR Tundra Model



Alaska Department of Natural Resources
Soil Temperature and Soil Moisture Stations
Winter 2005-06





Onset 4 Channel Data Logger
(Thermistor & Moisture Sensor)



Omega Thermistor & Thermometer

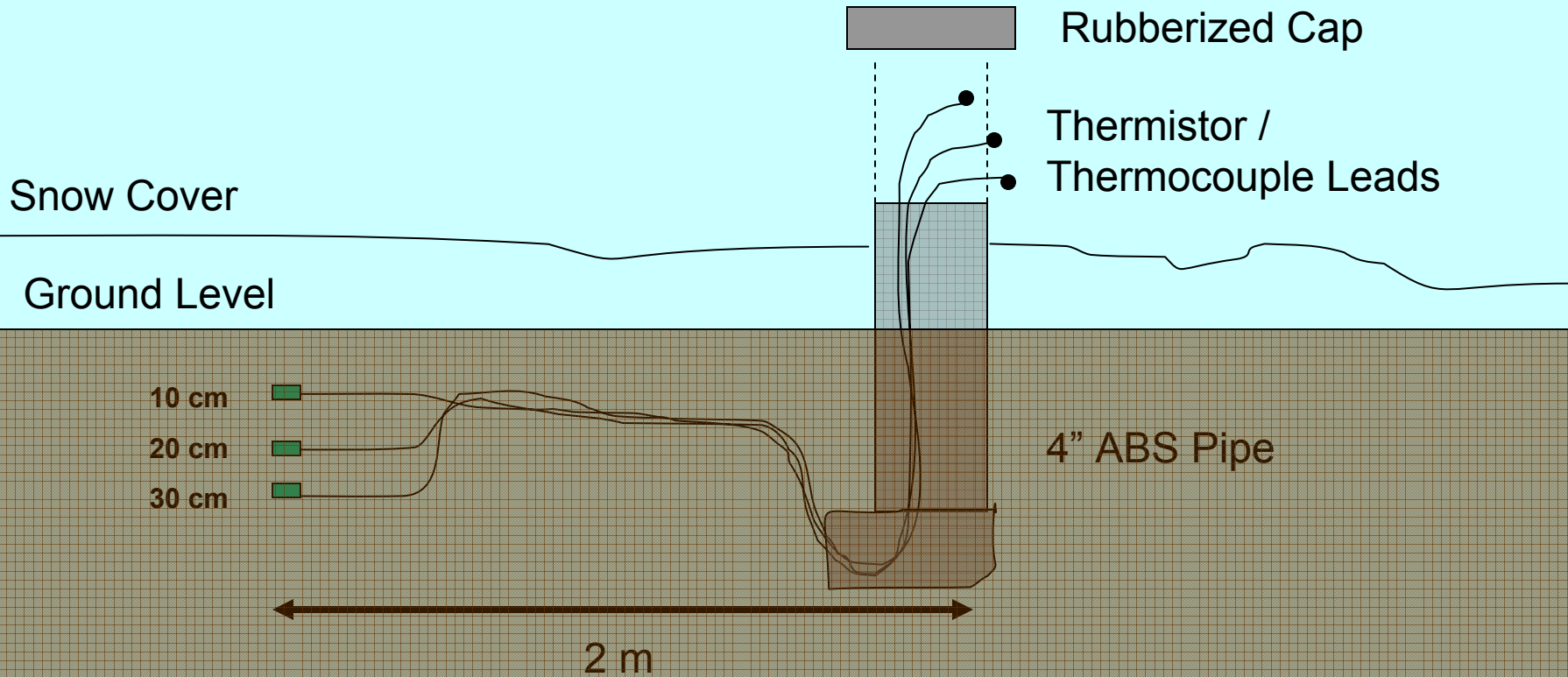


Omega Thermocouple & Thermometer





DNR Soil Temperature Station Set Up







Number of sites -5° C. or colder during sampling week.

Area	Total Sites	Nov 15	Nov 28	Dec 5	Dec 12	Dec 19
East Coastal	6	1	4	6*		
West Coastal	5	0	2	5*		
Lower Foothills	4	0	2	3	4*	
Upper Foothills	1	0	0	0	0	1*

* Tundra Opening Area opened this week.

Tundra Opening Dates – Winter 1995 to 2005

Coastal Tundra Opening Areas

<u>Year</u>	<u>Eastern Coastal</u>	<u>Western Coastal</u>
1995	December 4	December 4
1996	January 6	January 6
1997	January 7	January 7
1998	January 14	January 14
1999	December 20	December 20
2000	January 10	January 10
2001	January 25	January 25
2002*	January 27	January 20
2003*	December 23	January 4
2004*	December 10	December 16
2005*	December 6	December 6

Change in Soil Temperature (30 cm) Over Two Weeks

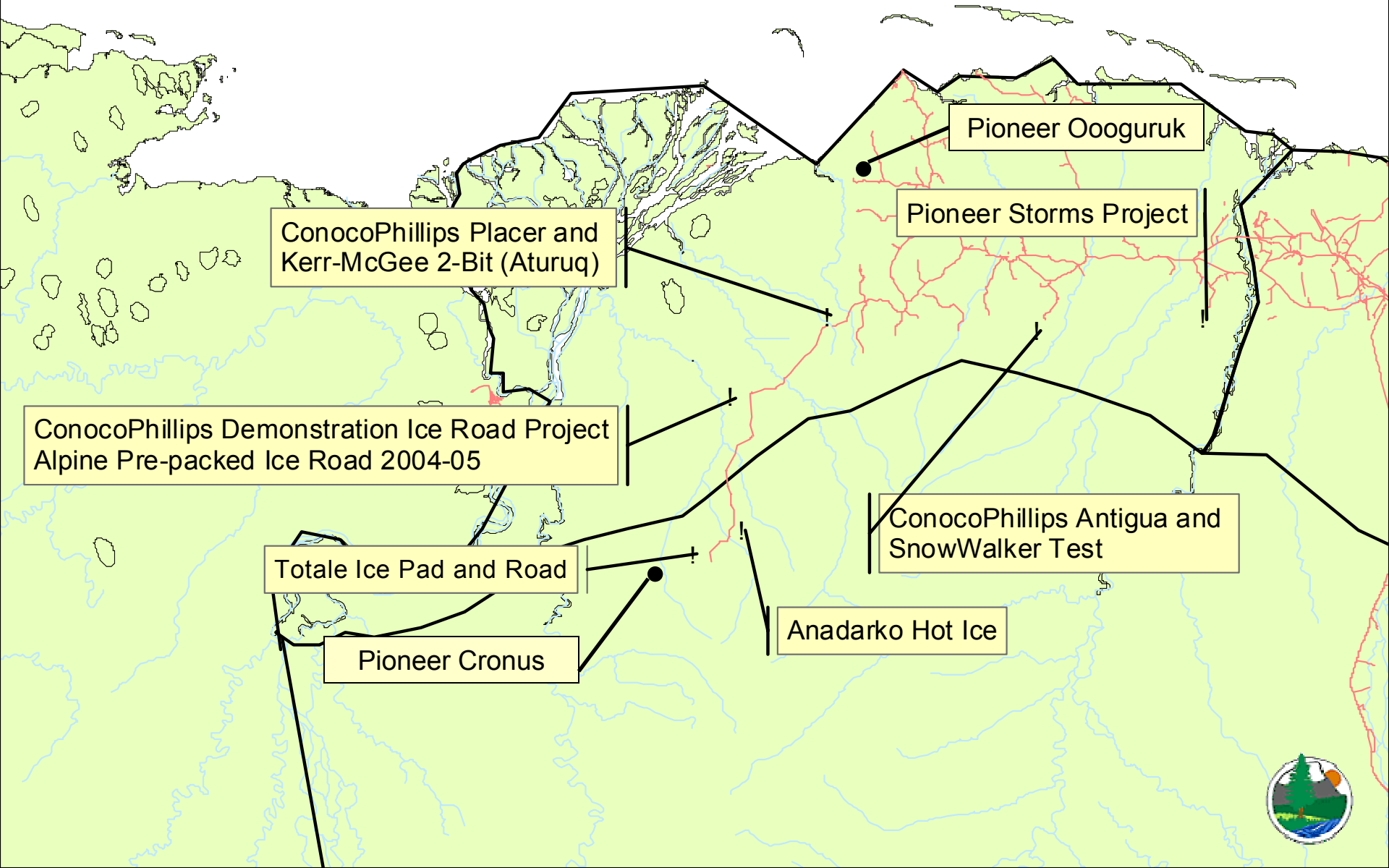
Sedge Tundra Sites

<u>Site</u>	<u>Date</u>	<u>Temp</u>	<u>Temp 2 weeks later</u>
P Pad	Nov 15	-2.5°	-5.8°
Term Well A	Nov 1	-2.2°	-6.1°
DS 16	Nov 15	-2.7°	-5.6°
DS 1J	Nov 15	-0.5°	-3.6°
30 Mile	Nov 28	-1.7°	-8.9°
Meltwater 19	Nov 15	-3.0°	-5.9°
Pump 3	Nov 28	-3.4°	-4.5°

Methods of Ice Road Construction

- Pre-pack, side-cast water from rolligon
- Pre-pack, then construct on packed area
- Construct early with no pre-packing
- Construct after tundra opening with no pre-packing
- In low snow years use ice chips

Locations where DNR has studied the effects of ice roads and ice pads



Moist Sedge / Dwarf Shrub Vegetation Type



7/30/2003

Effects of Ice Roads on Vegetation

Wet sedge and moist sedge vegetation types are fairly resistant to disturbance from one-time ice road construction

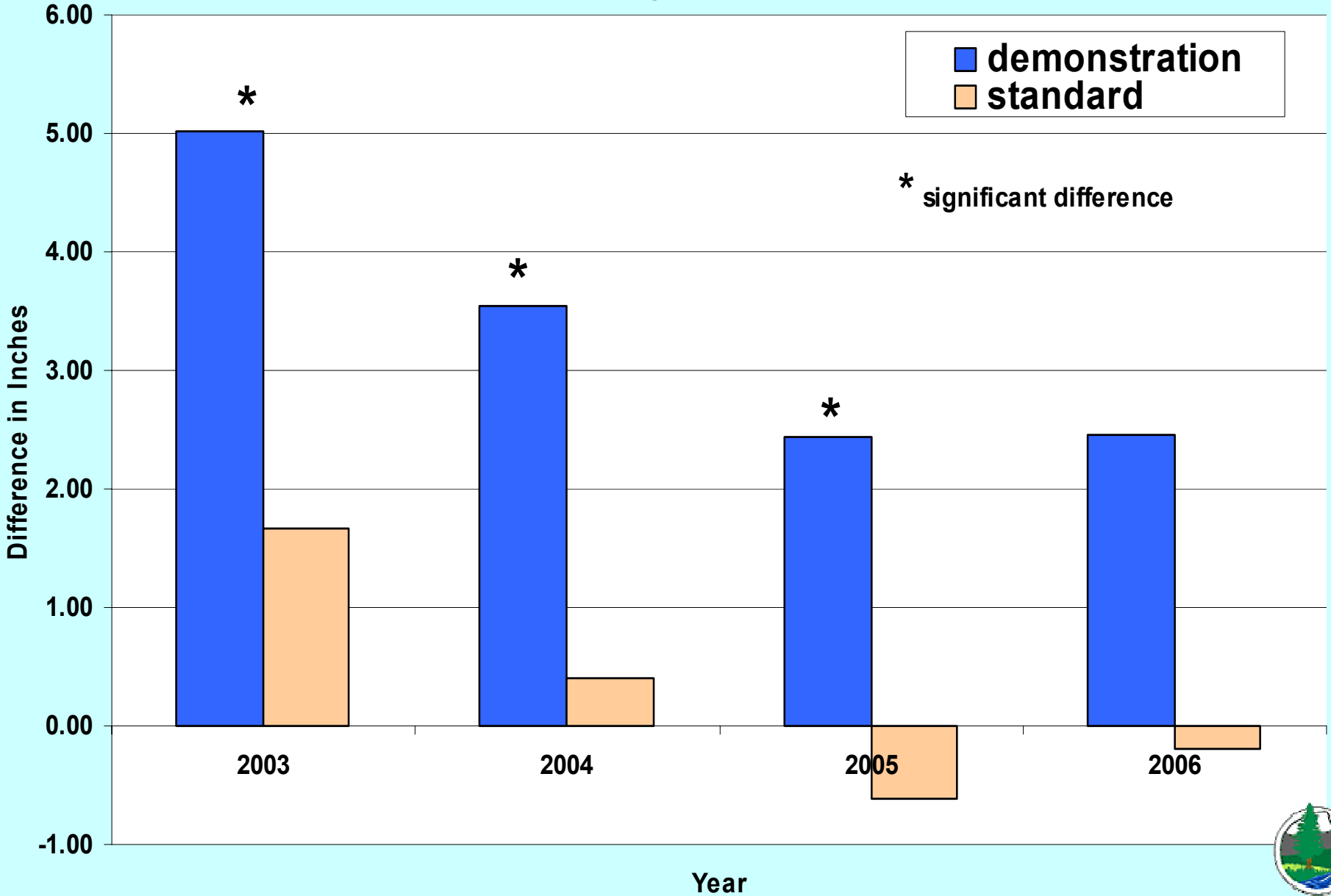
Tussock tundra can be easily disturbed by ice road construction techniques

Disturbance to tussock vegetation can be of long duration

**Solution: Stake routes in summer
Avoid tussock tundra when possible**



Difference in Active Layer Depths Compared to Controls
Demonstration Ice Road Project
Moist Sedge - Dwarf Shrub



Tussock Disturbance Ratings *

<u>Level</u>	<u>Tussock Disturbance</u>
0	Undisturbed
1	Scuffed
2	Crushed or Cracked
3	Shattered or uprooted

* Modified from rating scale of Felix and Reynolds (1989)



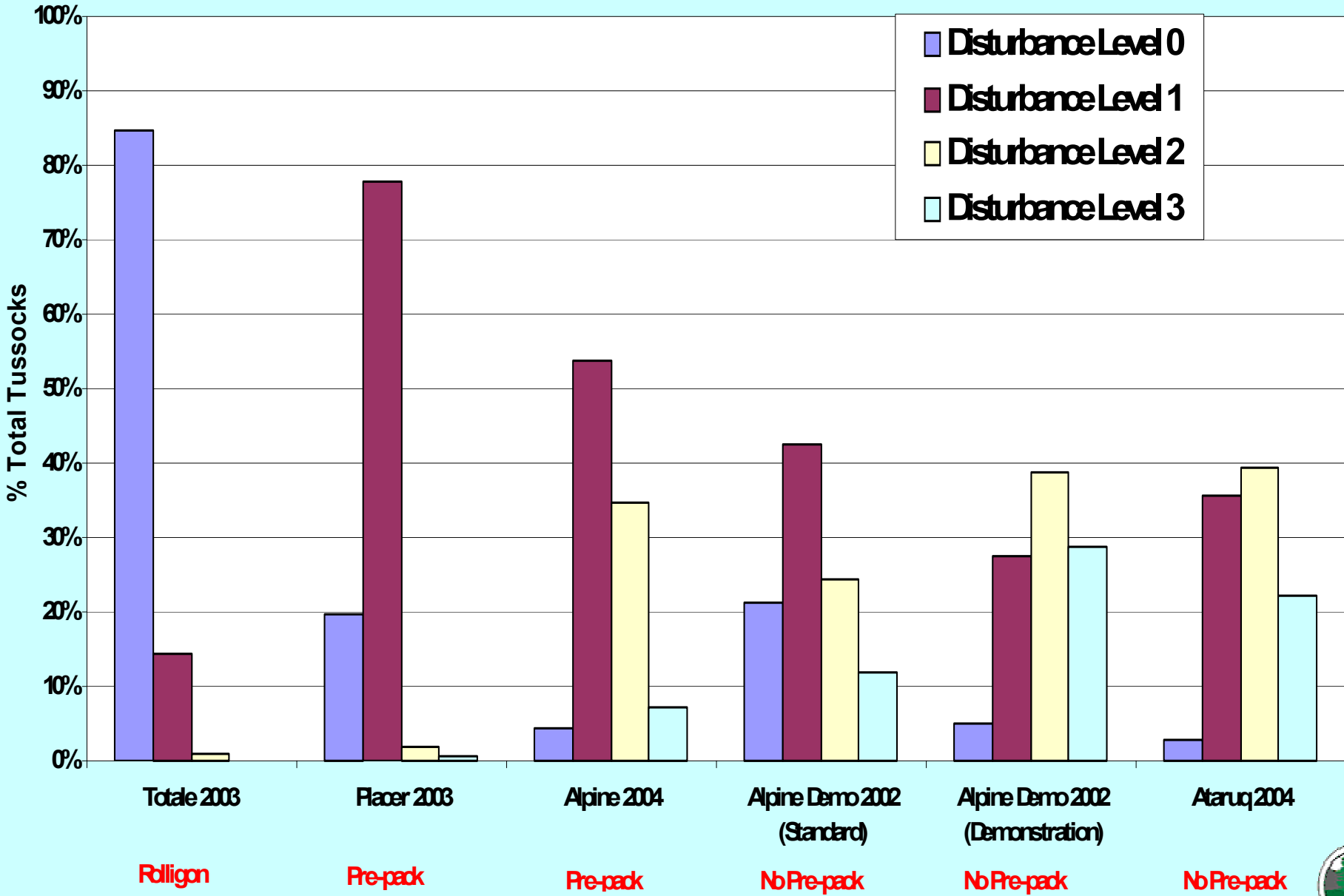
Tussock Disturbance Level 0
Undisturbed



Tussock Disturbance Level 3
Shattered



Tussock Disturbance Ratings Summer Following Construction



Pre-packing and Side-casting Water from a Rolligon

- **Reduces insulation effect of deep snow**
- **Secures snow in place during high wind events**
- **Least disturbance to tussocks of any technique**

Encapsulates tussocks in ice

- **Possible to start ice road construction very early**



Started ice road construction December 2, 2003

Tundra opened January 9, 2004

Pioneer Hail Storm Ice Road

October 25, 2005 – Started pre-packing

November 7, 2005 - -5° C. soil temp

November 14, 2005 – Started watering

**December 9, 2005 – Ice road & pad were
completed**

December 6, 2005 – Tundra Opened





Mean Active Layer Depths:

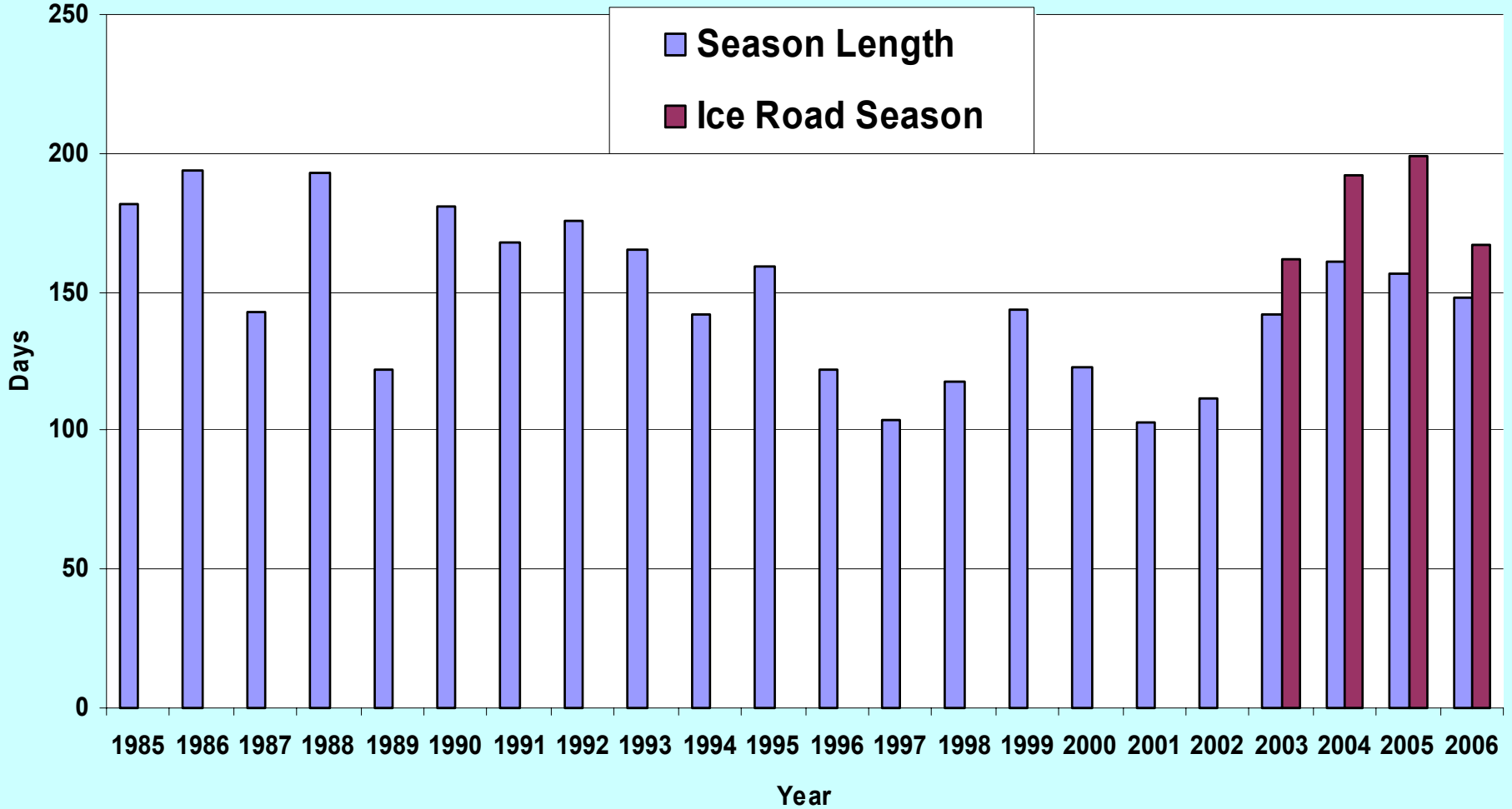
On Ice Road = 16.29 inches

Adjacent tundra = 16.86 inches

No Significant Difference



Alaska North Slope Winter Exploration Season Length



Note: 2006 data assumes mid-May 2006 tundra closure.



What does the future hold?

- **Ice Road Construction**

Early snow will result in early construction

- **General Off-road Travel (e.g. seismic)**

Early snow can delay freeze-up