History of DNR Management of Ice Road Construction

Impacts of Different Construction Methods

Alaska Department of Natural Resources
Division of Mining, Land and Water

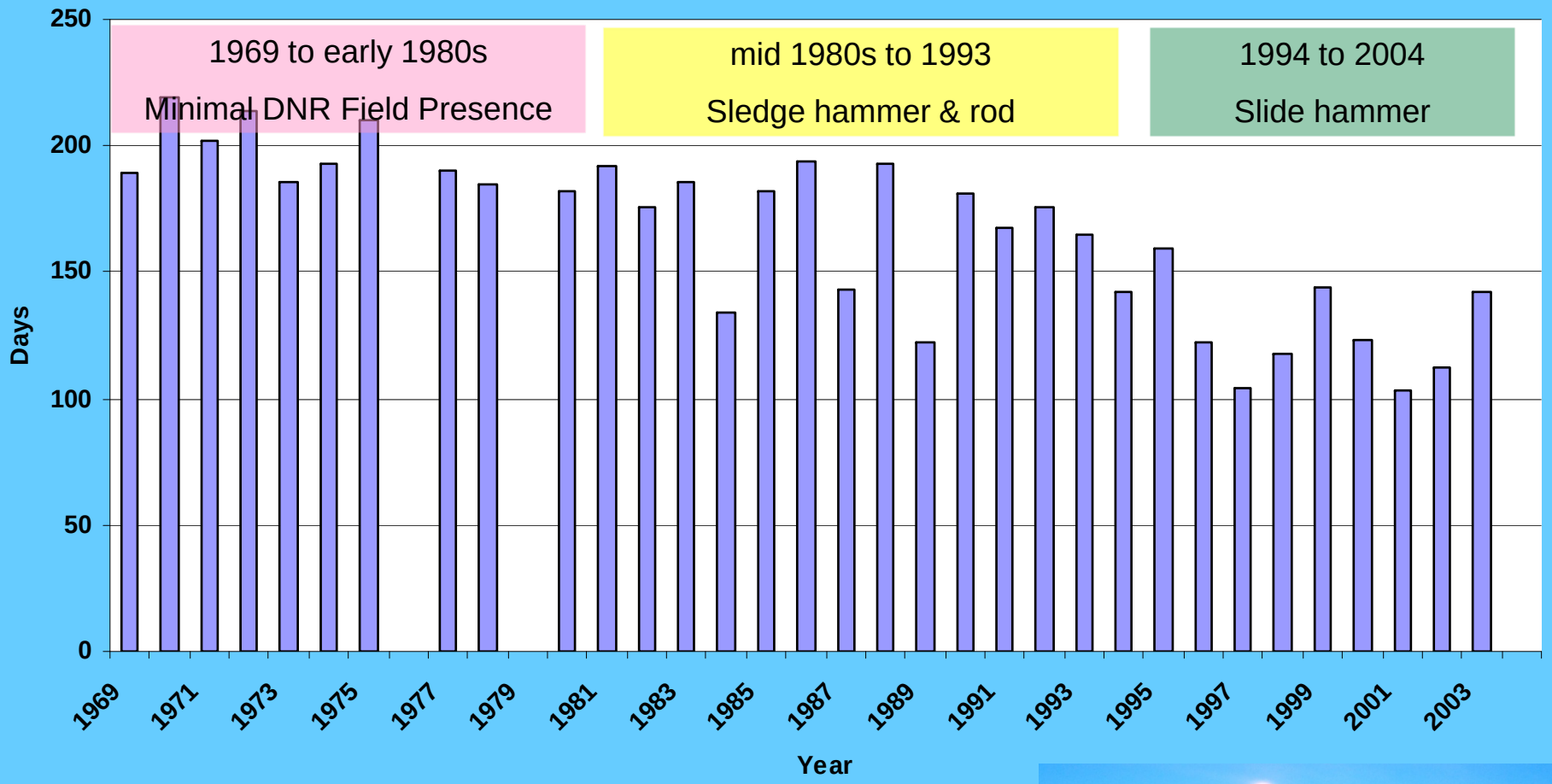
Gary Schultz, Natural Resource Manager

DNR Management Goals

Maximize winter exploration season

Ensure that tundra disturbance does not exceed allowable levels

Alaska North Slope Winter Exploration Season Length



Tundra Opening Standard:

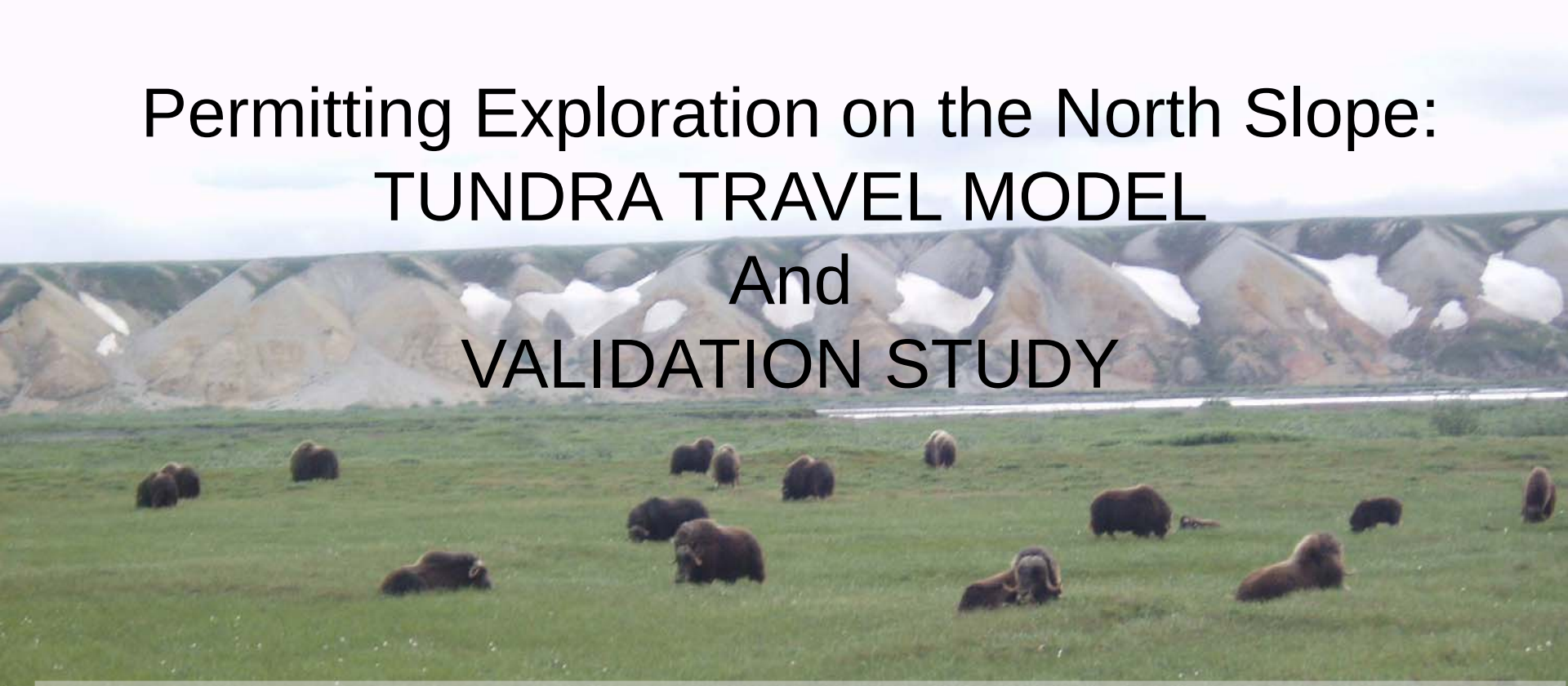
6” Snow, 12” Frozen Ground

DNR Response to Shortening Winter Season

Conduct tundra travel model study

Implement the results of study into tundra opening protocol

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

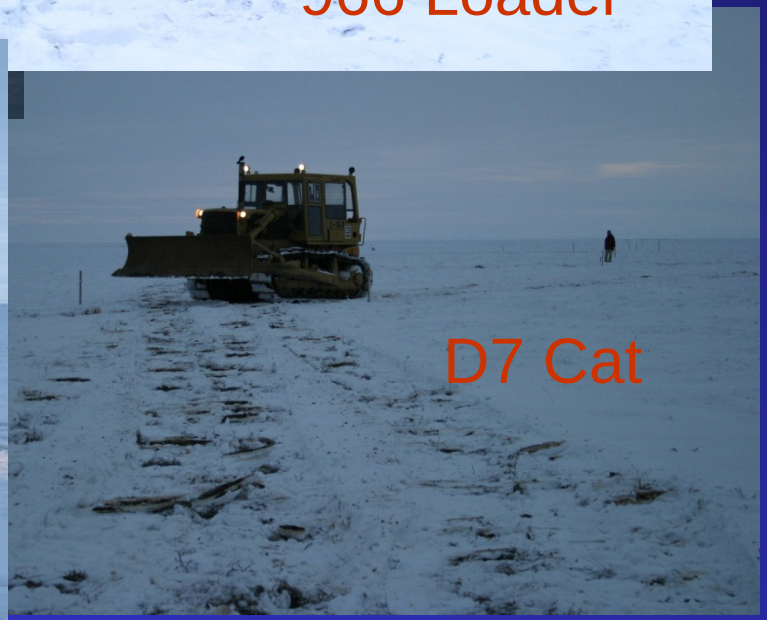


Research Project by Alaska Dept. of Natural Resources
in collaboration with
Alaska Oil and Gas Association
U.S. Dept. of Energy
Yale University
University of British Columbia


Challenger


966 Loader


Tucker Snocat


D7 Cat

New Tundra Opening Management Standards

COASTAL PLAIN

6 inches of Snow

-5° C Soil Temperature

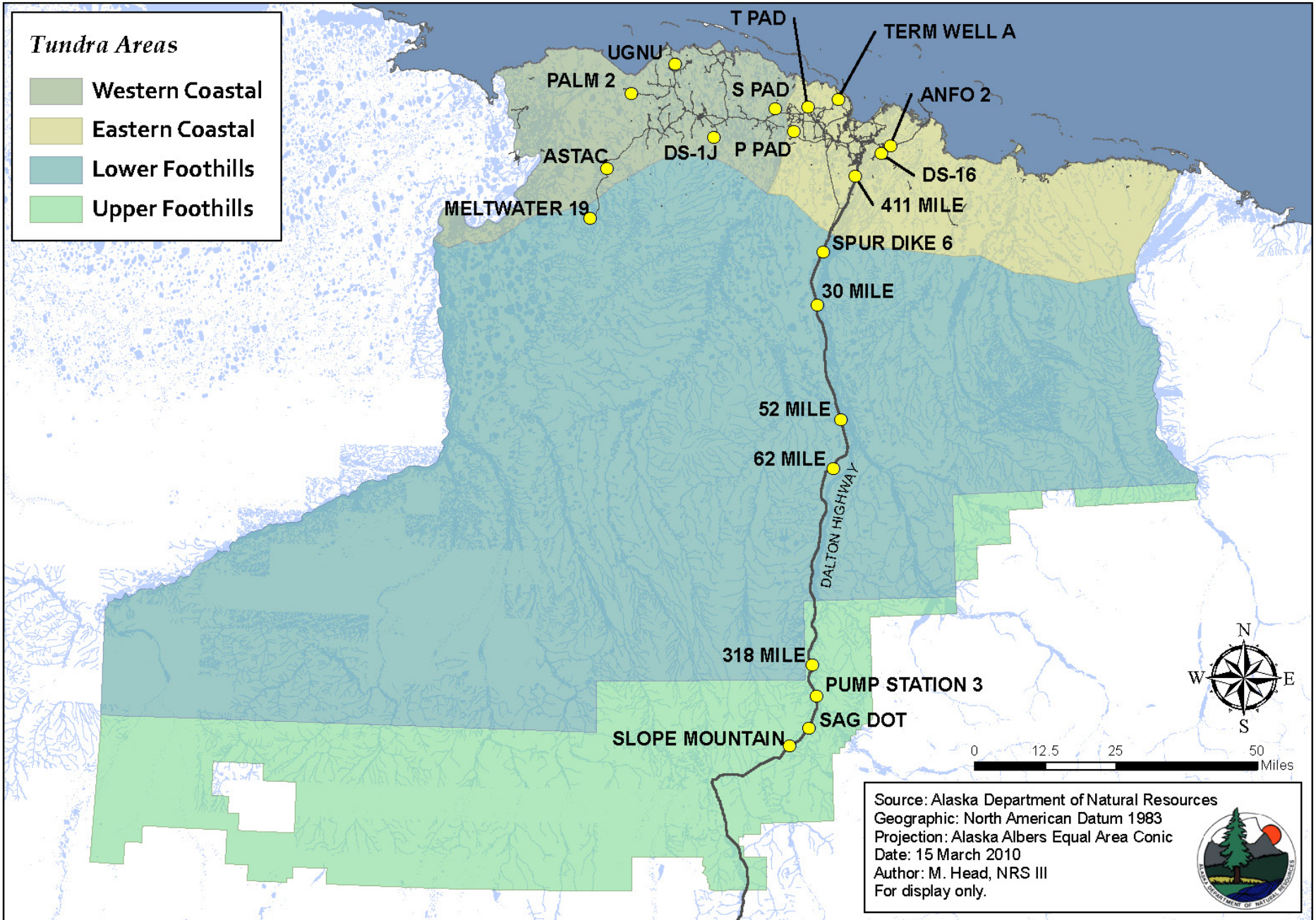
FOOTHILLS

9 inches of Snow

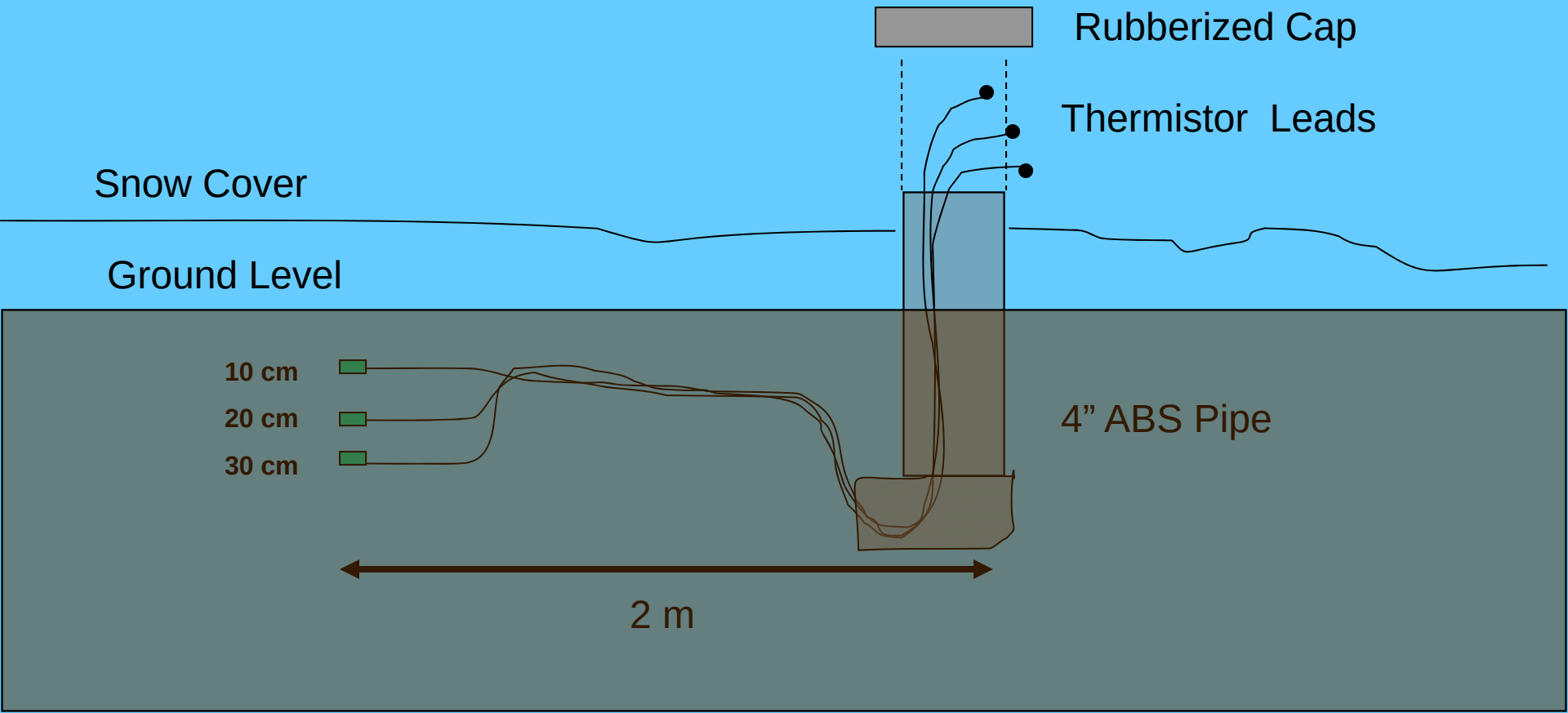
-5° C Soil Temperature

State of Alaska North Slope Tundra Areas

Soil Temperature and Snow Depth Monitoring Station Locations



DNR Soil Temperature Station Set Up



DNR Response to Shortening Winter Season

Conduct tundra travel model study

Implement the results of study into tundra opening protocol

Work with industry to develop new ice road construction methods

Monitor ice road construction projects to determine what methods work

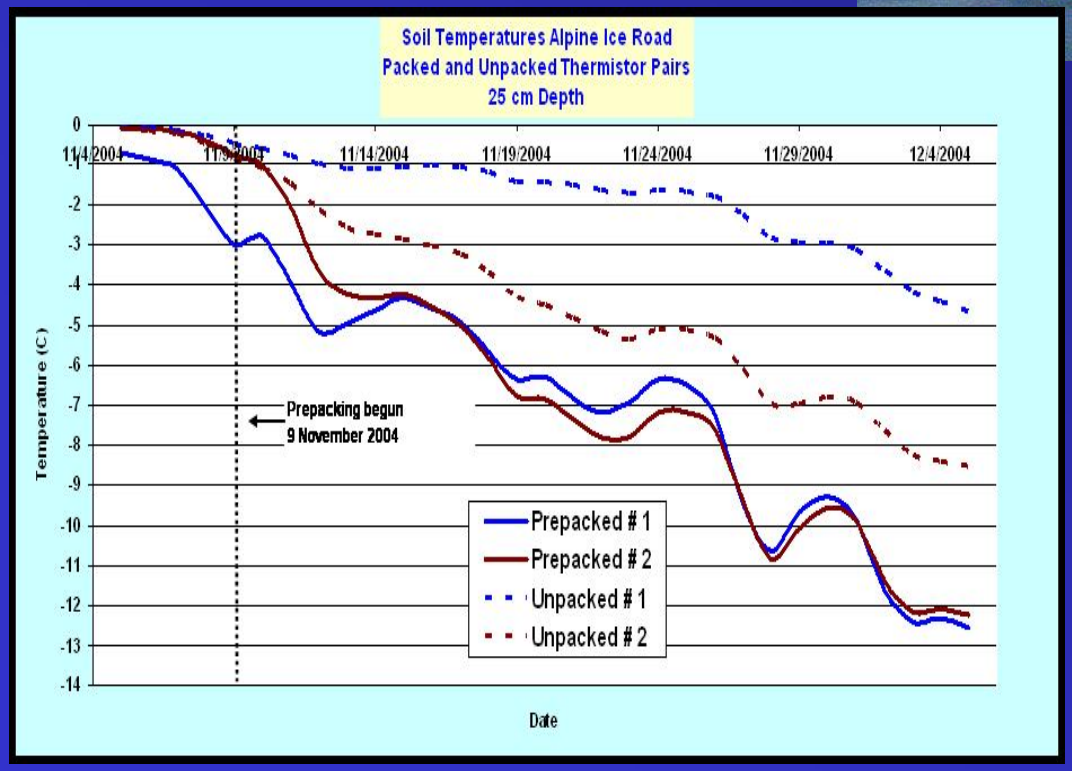
Methods of Ice Road Construction

- Construct after tundra opening with no pre-packing (standard construction)
- Construct early with no pre-packing
- Pre-pack, side-cast water from rolligon
- Pre-pack, then construct on packed area (including “snow road”)
- In low snow years use ice chips

Lessons Learned

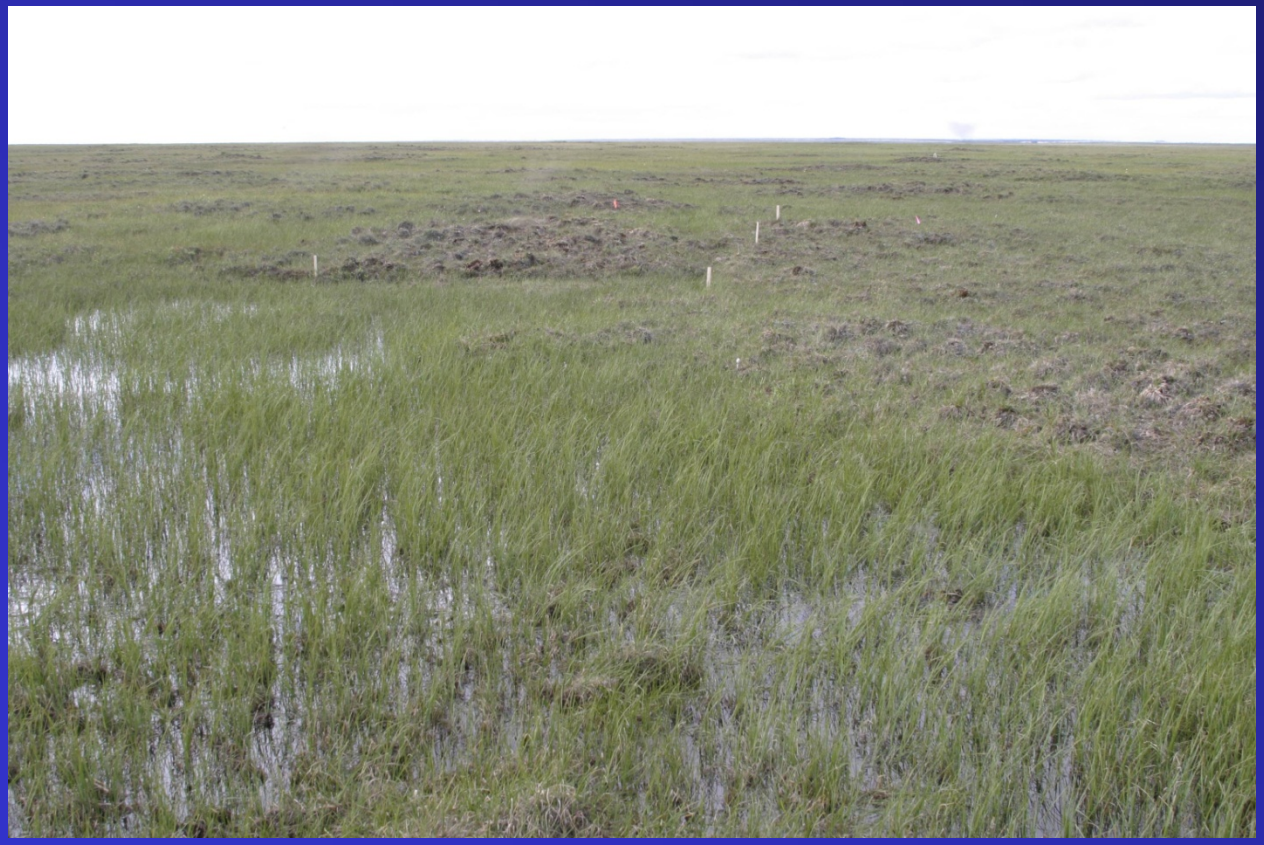
Pre-packing works

- accelerates freeze-up
- saves snow from wind events



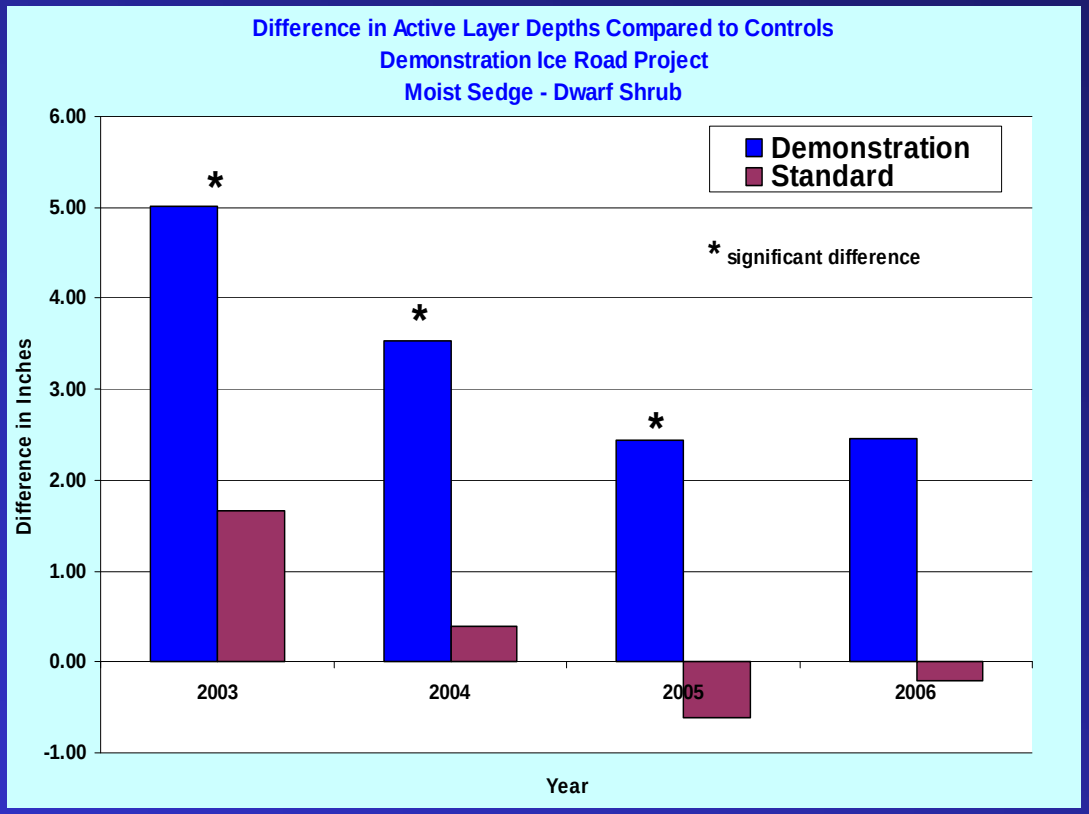
Lessons Learned

Sedge vegetation is very resistant to disturbance



Lessons Learned

Moist sedge – significantly deeper active layer
With early construction, no pre-pack



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

Pioneer Hail Storm Ice Road

Mean Active Layer Depths:

On Ice Road = 16.29 inches

Adjacent tundra = 16.86 inches

No Significant Difference

White Hills 08/09

October 7, 2008 – Started pre-packing

November 7, 2008 – Started watering

December 31, 2008 – Ice road completed

January 14, 2009 – Tundra opened

Earliest tundra opening: October 20, 1970 !

2008/2009 White Hills Ice Road

Mean Active Layer Depths:

On Ice Road = 19.7 inches

Adjacent tundra = 21.2 inches

Mean Soil Moisture:

On Ice Road = 80.3%

Adjacent tundra = 85.9%

Both significantly different

p-value = 0.008, 0.002

Lessons Learned

Tussock tundra can be easily disturbed by off-road travel

Some construction methods are less likely to disturb tussocks than other methods

Methods that protect tussocks can have very early start date

Lessons Learned

Disturbed tussock tundra can take many years to recover

2002 Ice Road Scrape

Recovery

2003 to 2006


1 m x 5m Sample Plot

Tussock Disturbance Ratings

Level 0 - Undisturbed

Level 1 - Scuffed

Level 2 – Cracked or smashed

Level 3 – Crushed or removed

Tussock Disturbance Index

$$\text{Tussock Index} = \frac{\sum (\text{number of tussocks})\ (\text{rating})}{\text{Total number of tussocks}}$$

Convenient way to compare ice roads

Calculated for every ice road with tussock tundra

Calculated for adjacent raw tundra with tussock tundra

2004 Ice Road – Tussock Tundra

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

White Hills 08/09

October 7, 2008 – Started pre-packing

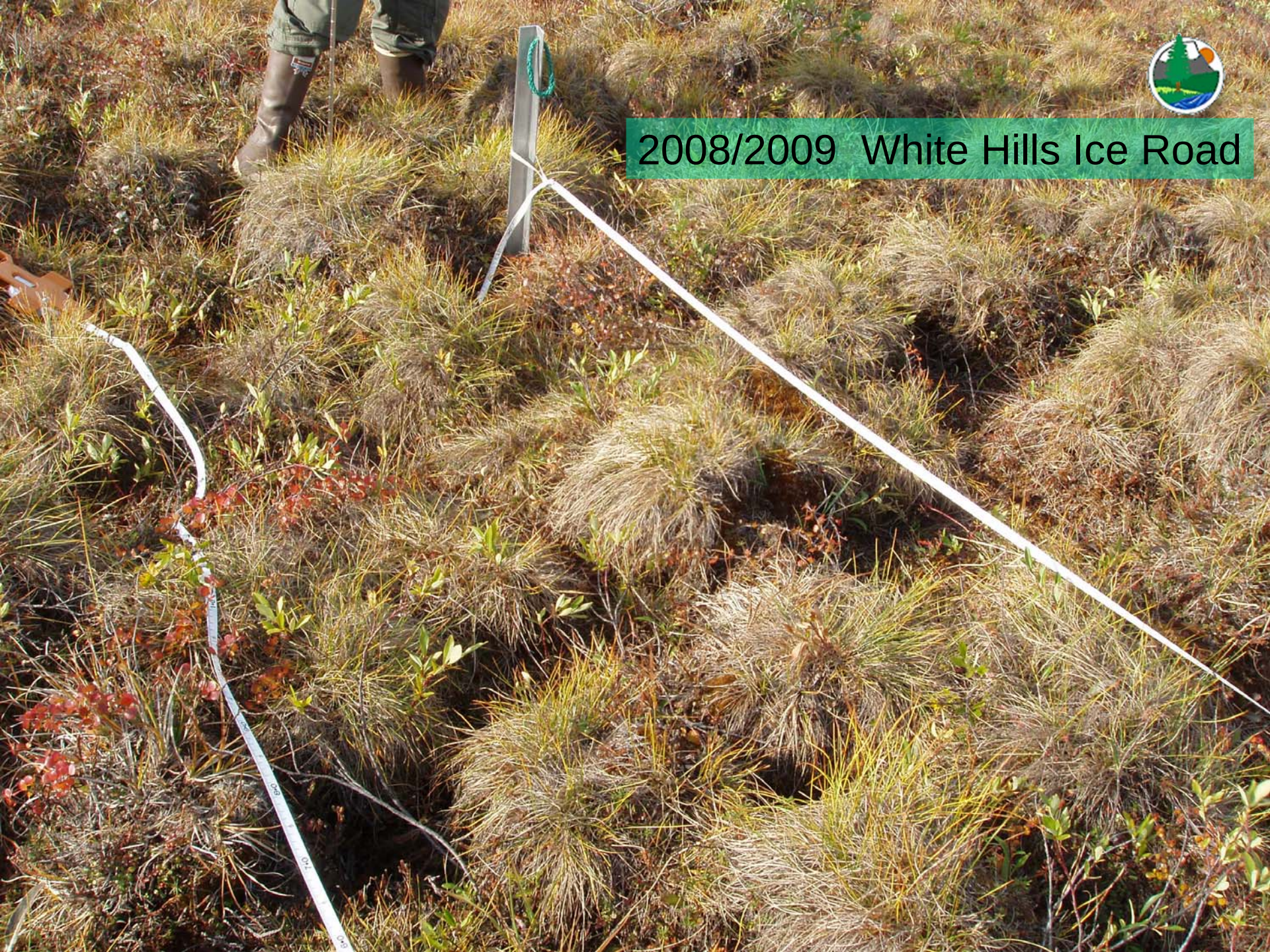
November 7, 2008 – Started watering

December 31, 2008 – Ice road completed

January 14, 2009 – Tundra opened

2008/2009 White Hills Ice Road

2008/2009 White Hills Ice Road


2008/2009 White Hills Ice Road

2008/2009 White Hills Ice Road

White Hills Ice Road 2008/2009

Tussock disturbance ratings from 4 plots sampled in tussock tundra

Plot	Level 0	Level 1	Level 2	Level 3
A	17	5	0	0
B	11	6	3	2
C	34	2	0	0
D	17	15	0	0
Total	79	28	3	2
% Total tussocks	70.5%	25.0%	2.7%	1.8%

Tussock Disturbance Index = 0.36

Possible Factors to Explain Low Impact

Pre-packing started early while snow was still loose, tussocks still flexible

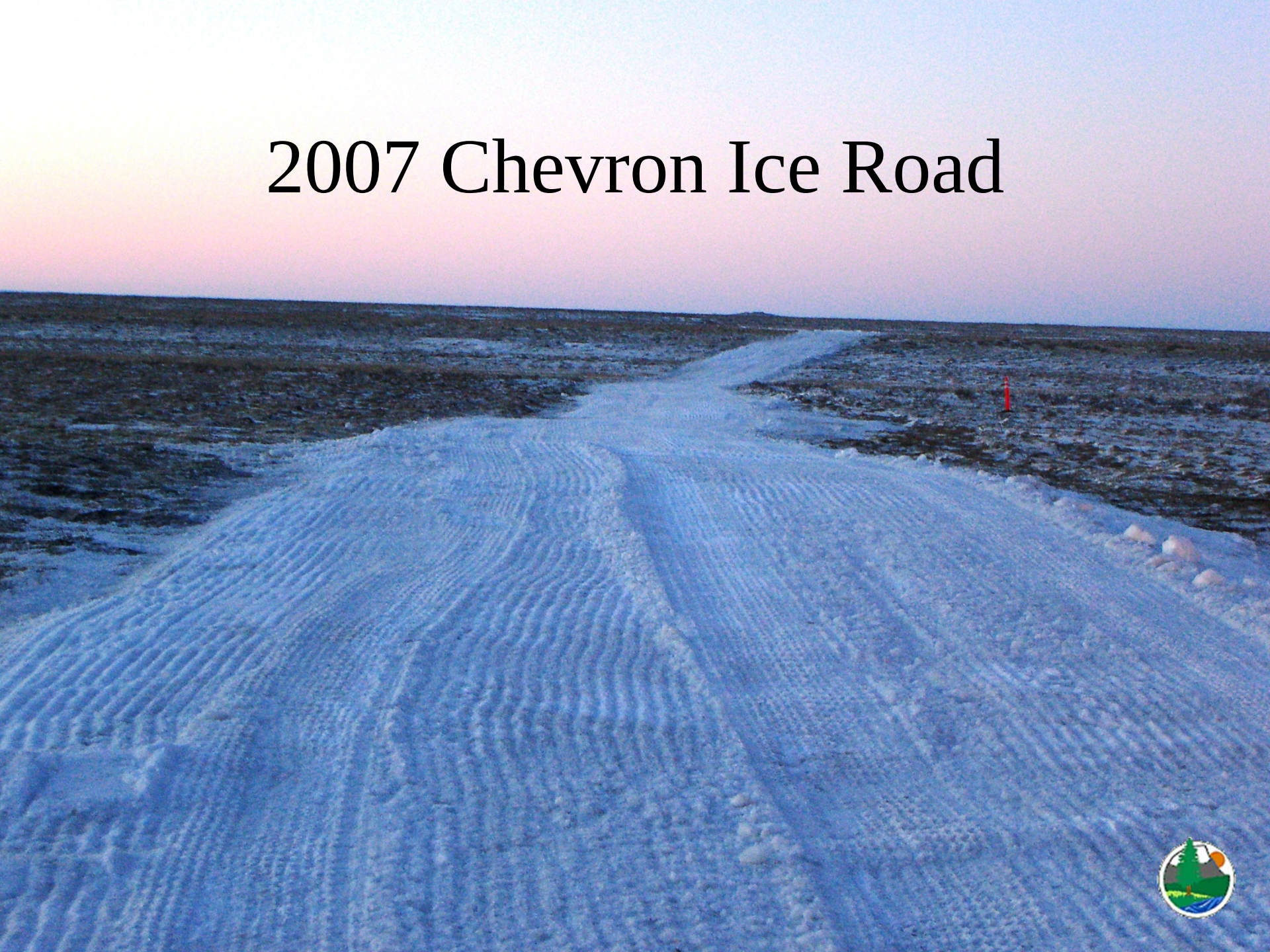
Pre-packing was done using light duty vehicles

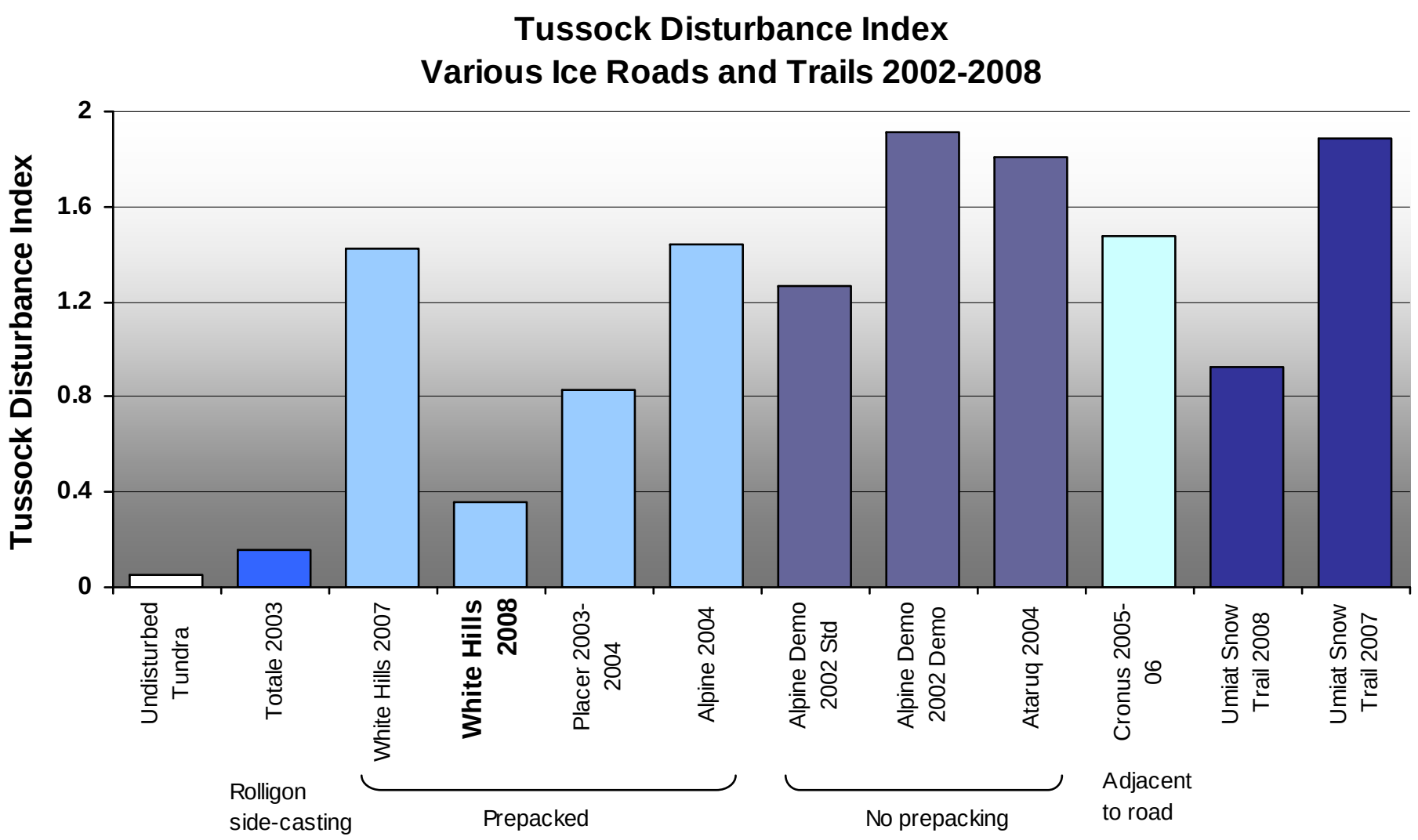
Permittee had good communication and contractor oversight

Low Snow Year Ice Road Construction


CATERPILLAR
SECONDARY
CONTAINMENT

2007 Chevron Ice Road




Tussock Disturbance Index
Various Ice Roads and Trails 2002-2008
Tussock Disturbance Index
2
1.6
1.2
0.8
0.4
0
Undisturbed Tundra
Totale 2003
White Hills 2007
White Hills 2008
Placer 2003-2004
Alpine 2004
Alpine Demo 2002 Std
Alpine Demo 2002 Demo
Ataruq 2004
Cronus 2005-06
Umiat Snow Trail 2008
Umiat Snow Trail 2007
Rolligon side-casting
Prepacked
No prepacking
Adjacent to road

Ice Road Best Management Practices

- Route Selection - choose route that avoids tussock tundra if possible

- Construction Method – use pre-packing methods if there is early snow, use least aggressive method possible to suit needs

  Cost – pre-packing is additional expense

  Benefit – may be able to drill additional well with the extra time that is gained

- Equipment Operators - use best, most experienced equipment operators during pioneer phase

Ice Road Best Management Practices

- Vary ice road location from year to year to allow recovery

Measures to Use in Low Snow Years

- Use of ice chips and snow from road accessible lakes to build pioneer ice road
- Use temporary mesh snow fences to aid snow accumulation
- Make artificial snow with fine spray of water

Promising New Equipment

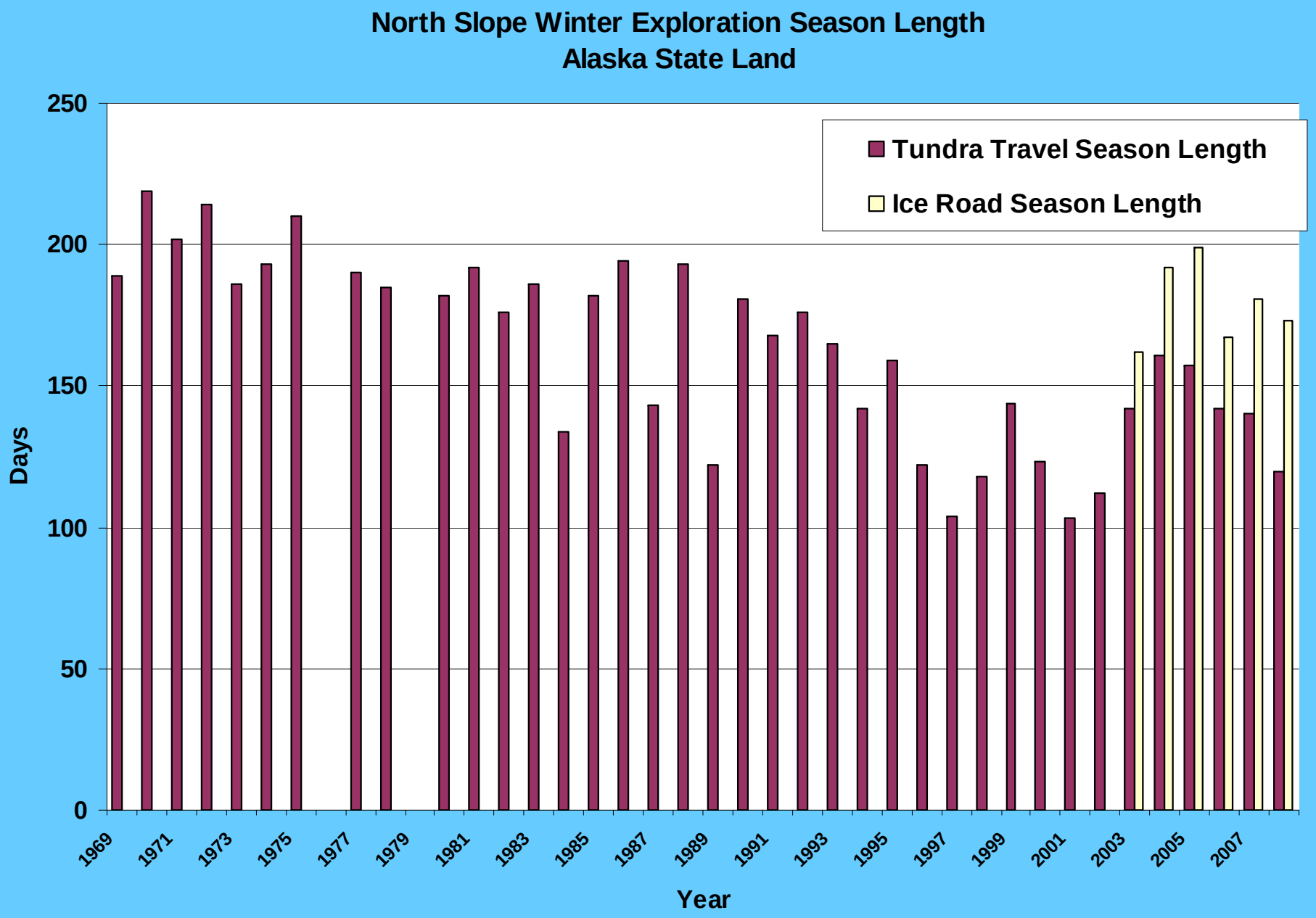
Ag-Chem TerraGator

Promising New Equipment

Smooth Tires on Volvo Water Buffalo

Promising New Equipment

Smooth and Standard Volvo Tires


North Slope Winter Exploration Season Length
Alaska State Land
Tundra Travel Season Length
Ice Road Season Length
Days
250
200
150
100
50
0
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
Year