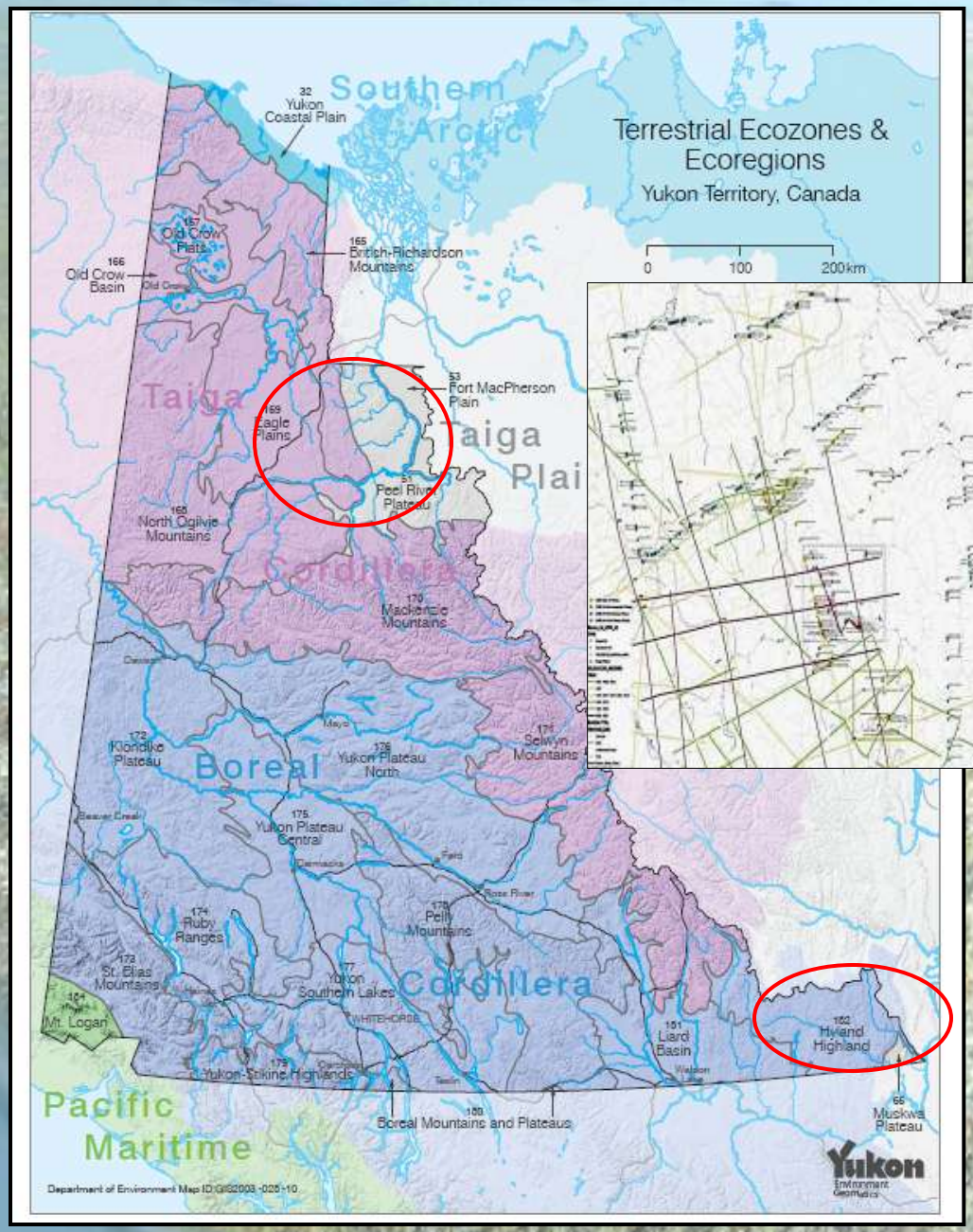
Defining Disturbance and Recovery

The Influence of Landscape Specific Ecological Responses to Linear Disturbances

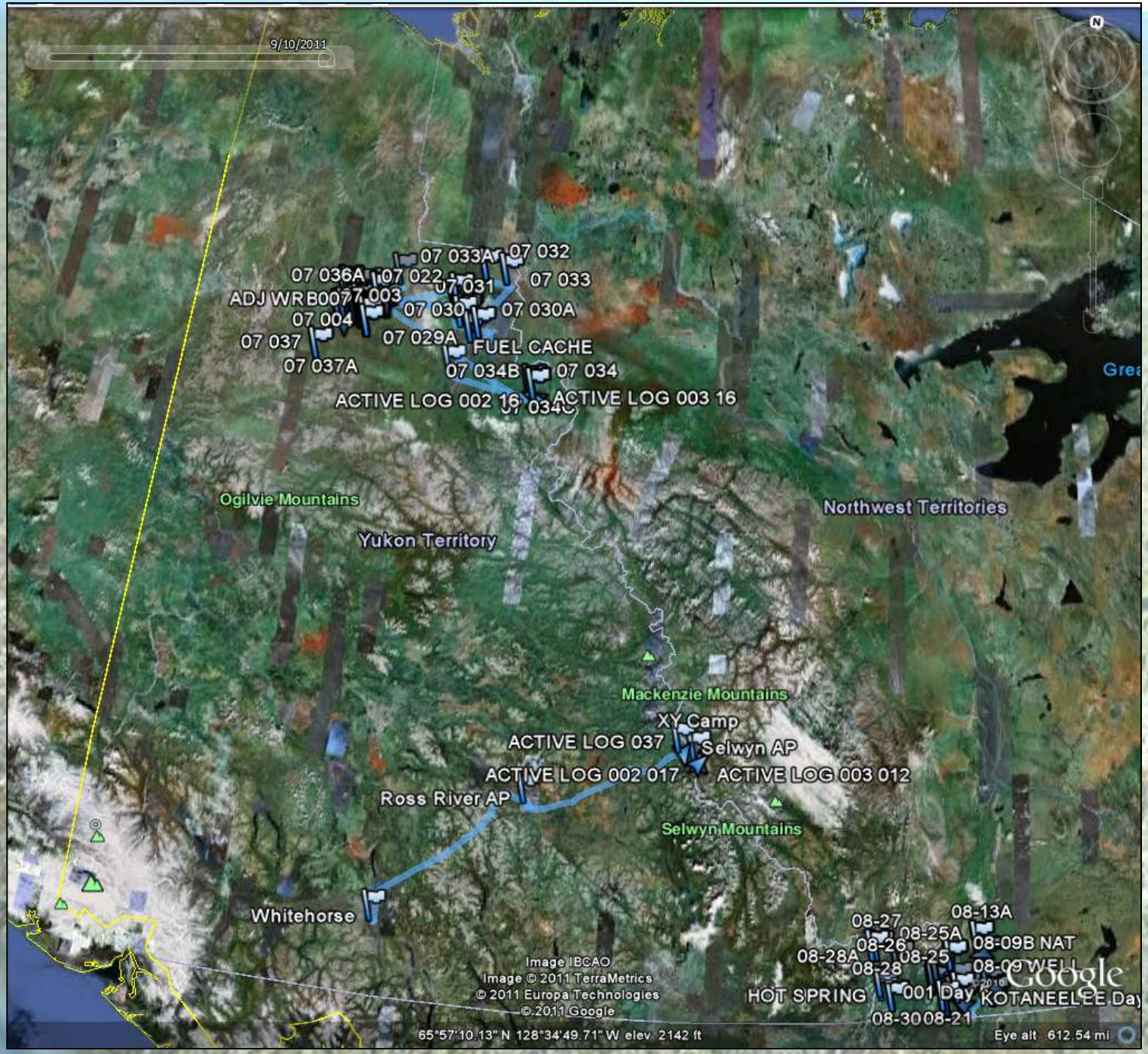
Kirstie Simpson
Energy Mines and Resources
Yukon Government

Yukon
Energy, Mines and Resources

OIL & GAS
BEST MANAGEMENT PRACTICES



In 2006, 2007 and 2008, research was conducted by the Yukon Government, Department of Energy Mines and Resources to better understand the recovery status of historical oil and gas exploration features on the landscape.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HOT SPRING
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Image IBCAO
Image © 2011 TerraMetrics
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65°57'10.13" N 128°34'49.71" W elev 2142 ft
Eye alt 612.54 mi

Why the Oil and Gas Disturbance Study ?

Agencies and organizations trying to understand the status of historical linear features in order to:

- Estimate the existing physical footprint of disturbance
- Model the cumulative effects of disturbance over time
- Propose a limit to acceptable change (Threshold)

Why the Oil and Gas Disturbance Study ?

- To date, very little work has been done in the north to quantify and qualify the recovery and regeneration of these remaining features but we do know that a number of linear features remain visible from the air and sometimes from the ground.

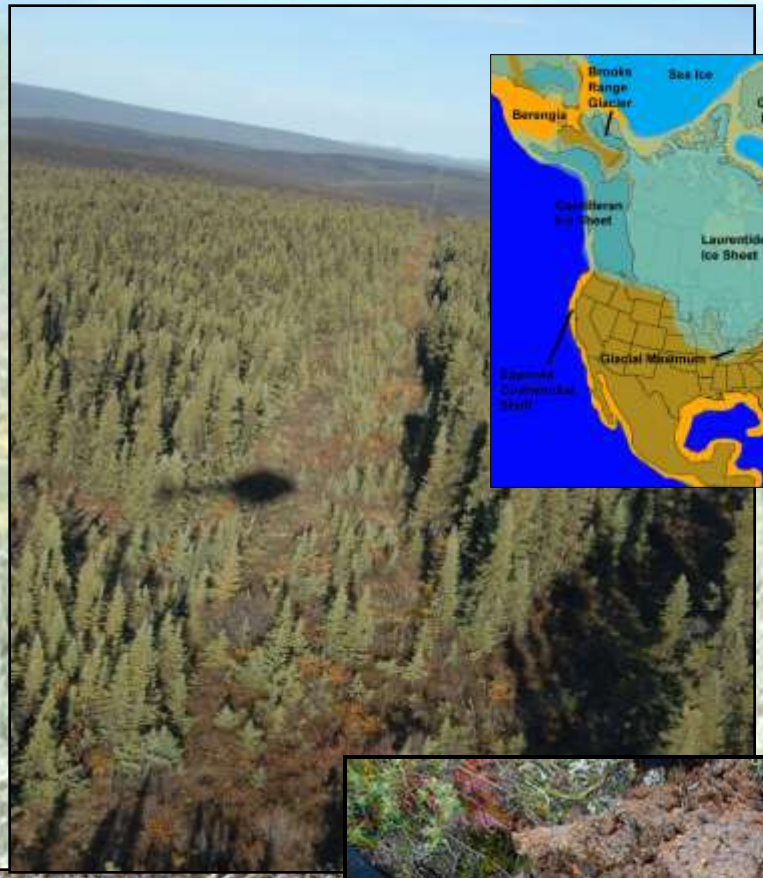
- We did not know the correlation between line visibility and existence on a topographical map or remote image with the recovery status of these features.

Why the Oil and Gas Disturbance Study ?

- “Disturbance” and “Recovery” are not defined and without clearly defined terms we cannot provide advice to operators about our expectations at end of project life nor can we develop appropriate monitoring strategies .

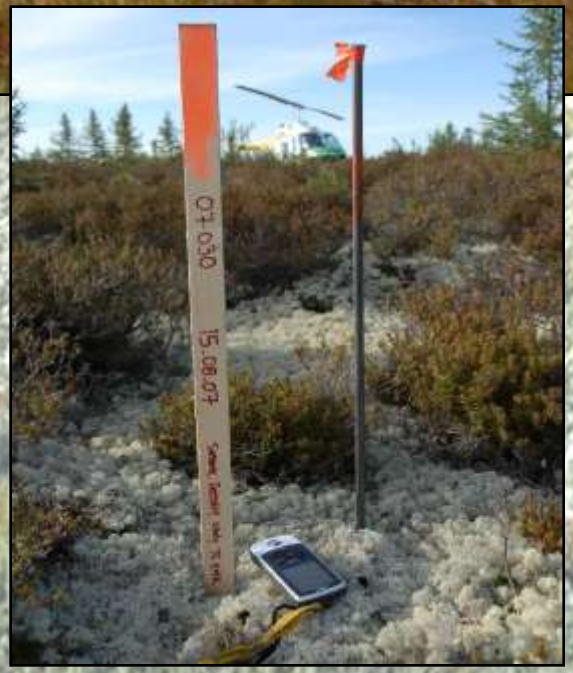
Broadly the study area was divided into:

- Beringian vs. non-Beringian
- Treed vs. Taiga
- Mineral soil vs. organic soil
- Soil moisture and structure



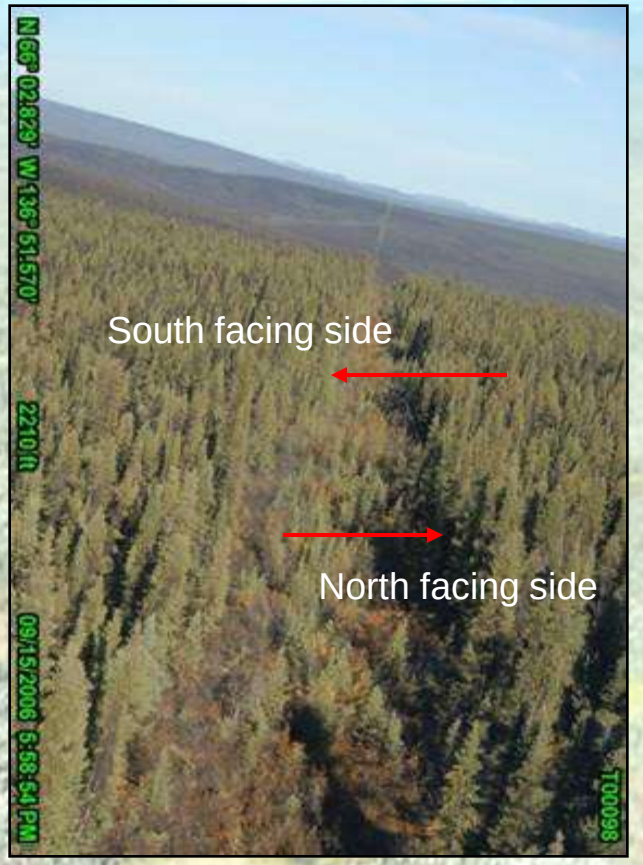
Landscape position:

- High elevation
- Mid-slope
- Valley bottom



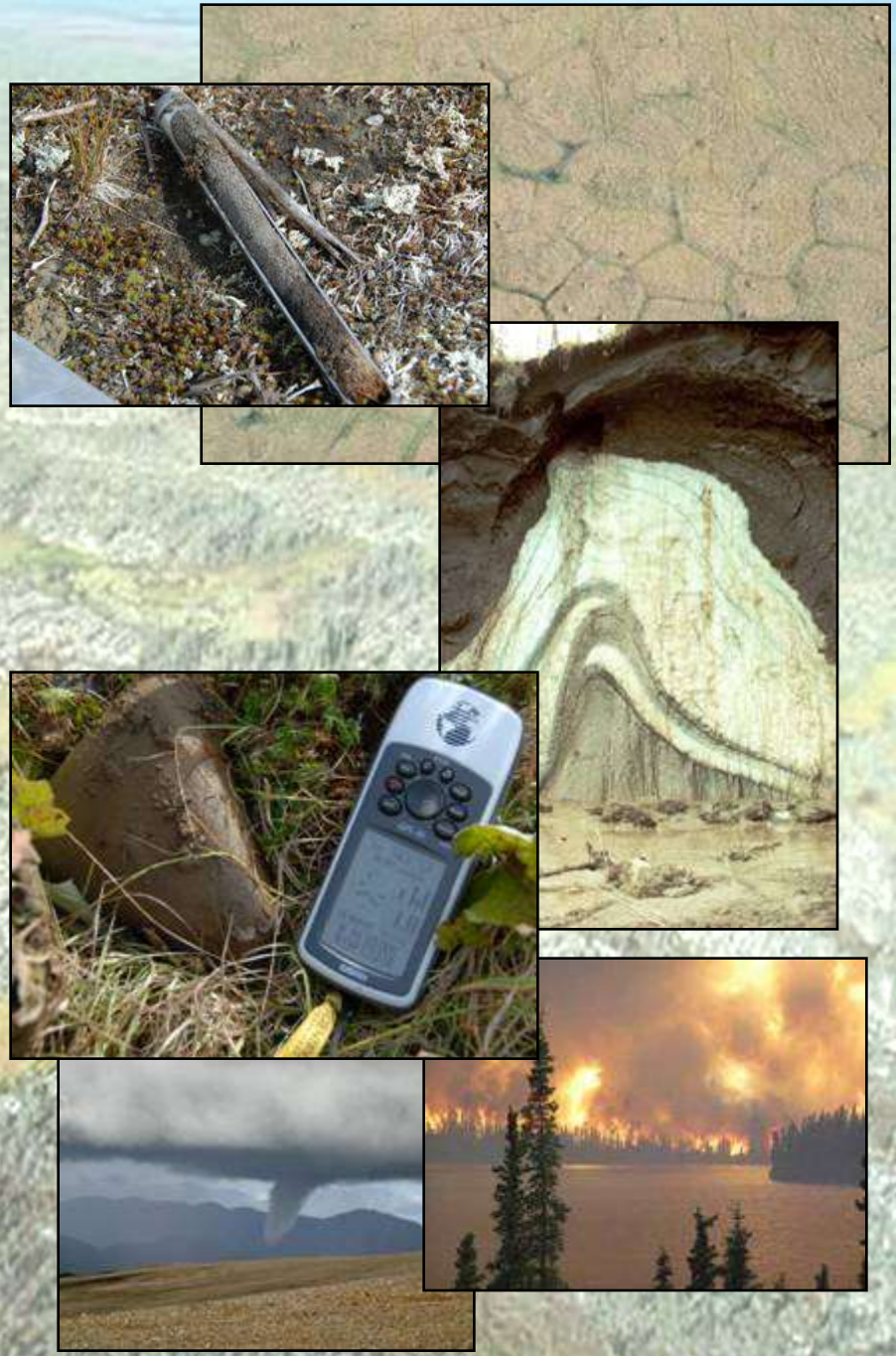
- Vegetation communities
- Depth to permafrost
- Tree age

- aspect to sun and line orientation
- exposure to wind
- potential for snowfall accumulation due to geography and topography



Variables considered:

- Climate
  - temperature, precipitation
- Presence of permafrost
- Hydrology:
  - water level fluctuations and flow
- Chemistry:
  - Nutrient availability (N, P)
- Soil material:
  - Structure, texture, chemistry
  - depth, composition of peat
- Biotic factors:
  - Vegetation
  - biological productivity
  - fire



Observations were made of wildlife use and predation as well as on landscape change associated with wildlife


8/9/2006
9/10/2011
2006
2011
08-06
08-05
08-04A
08-04
Image © 2011 DigitalGlobe
© 2011 Google
Imagery Date: 6/15/2004
2004
60°11'31.48" N 123°30'16.23" W elev 1008 ft

We observed Six different levels of disturbance:

- No observable disturbance.
- Removal of trees and large shrubs without disturbing the insulating ground cover or active layer
- Removal of the trees and large shrubs with associated disruption to the ground cover
- Compaction of ground cover and mineral soils leading to a vegetation bloom
- Removal of all surface vegetation and active layer over permafrost
- Stripping to mineral soil and removal of thermal protection

Recovery Types

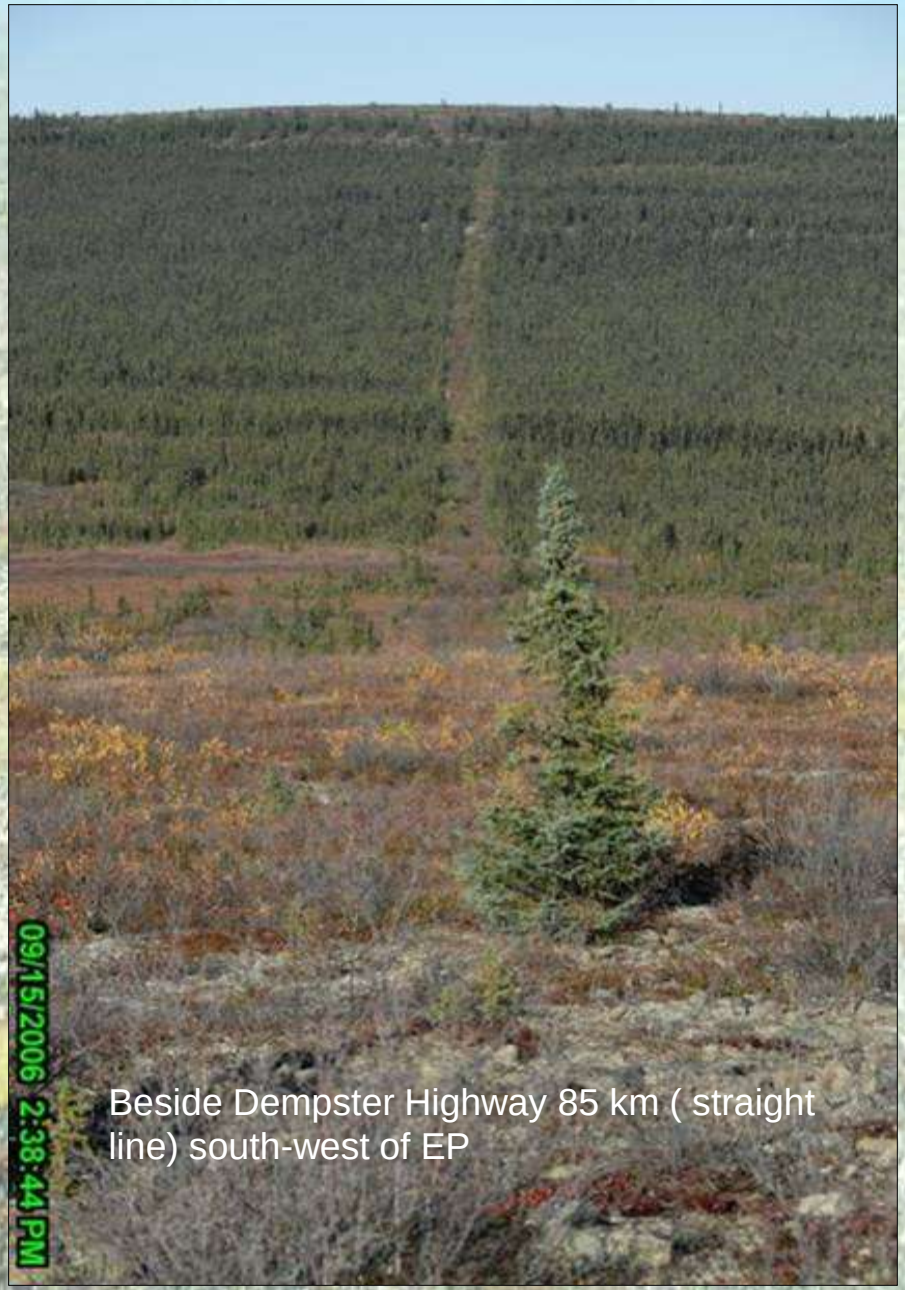
1. No recovery needed.
2. Early seral species established (locally consistent and the site is moving on the appropriate successional trajectory).
3. Recovery Varies depending on Disturbance Level and Site Characteristics

1. No recovery needed

- No or very limited disturbance
- Hand-cut lines
- Blade kept high – surface protected by heavy snow cover
- Frozen wetlands
- Line same width as tree spacing
- No succession - insufficient release of nutrients and or disturbance to allow succession.
- Natural disturbances have re-set the successional trajectory

No Disturbance

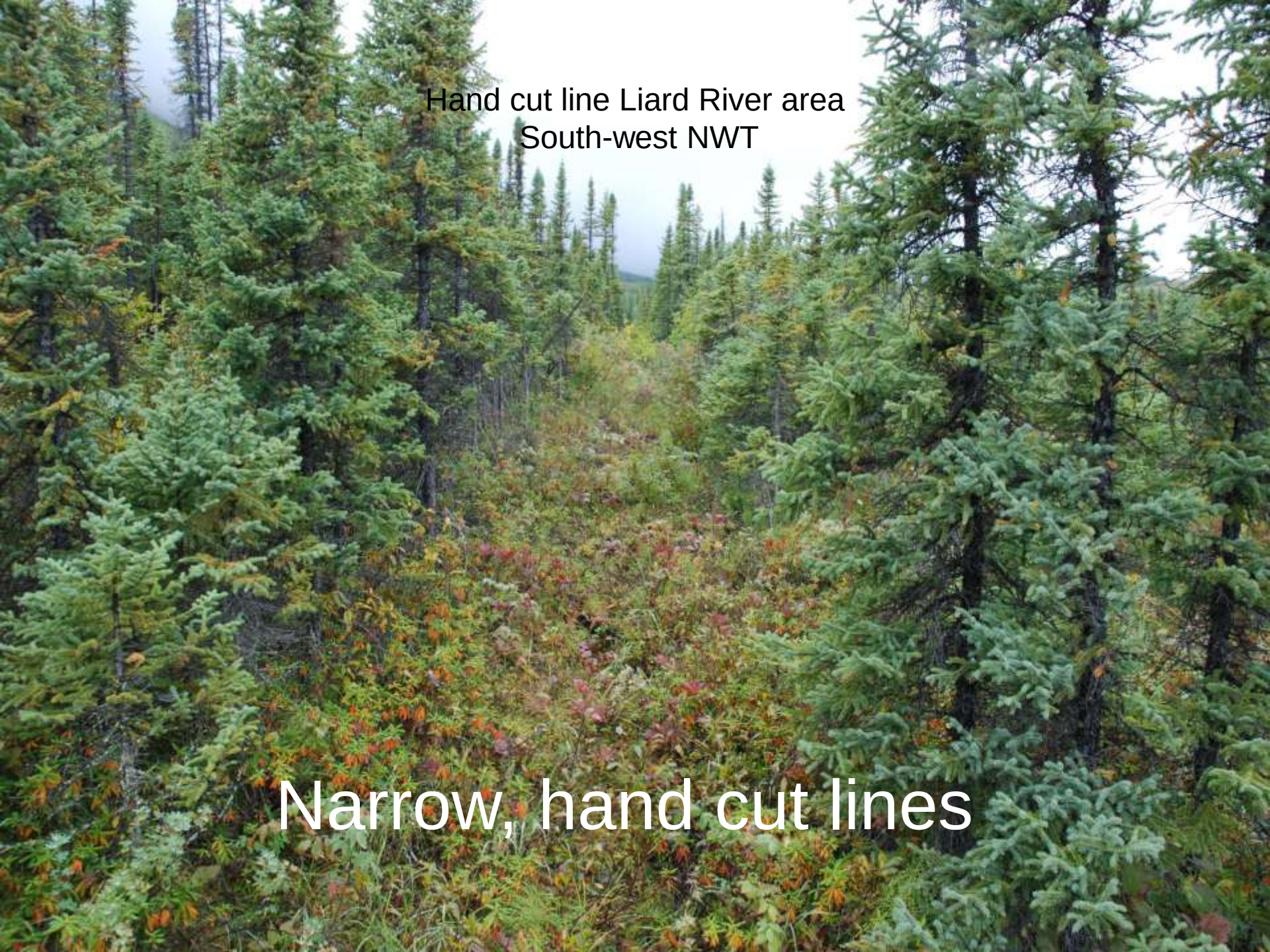
- In the portion of the line where there were no trees to remove there was no observable or measurable disturbance



Beside Dempster Highway 85 km (straight line) south-west of EP

Limited or No Disturbance

Hand cut lines


Hand cut line Liard River area
South-west NWT
Narrow, hand cut lines

Keep blade high, work with ample snow cover and frost.


Frozen wetland protects surface.


Frozen wetland protects surface.


This small line (with track) has no successional processes as it is minimally disturbed.


20060622_jsh_0012
No succession but no ecological differences except forest opening is linear instead of random – natural spacing and disturbance spacing is comparable
18 km W of Eagle Plain
N 66.36473° W 137.14070°
WGS 84 596 m
2006/06/22 11:12:04

Natural disturbances (fire) re-set the successional clock.

Succession starts fresh on the entire landscape.

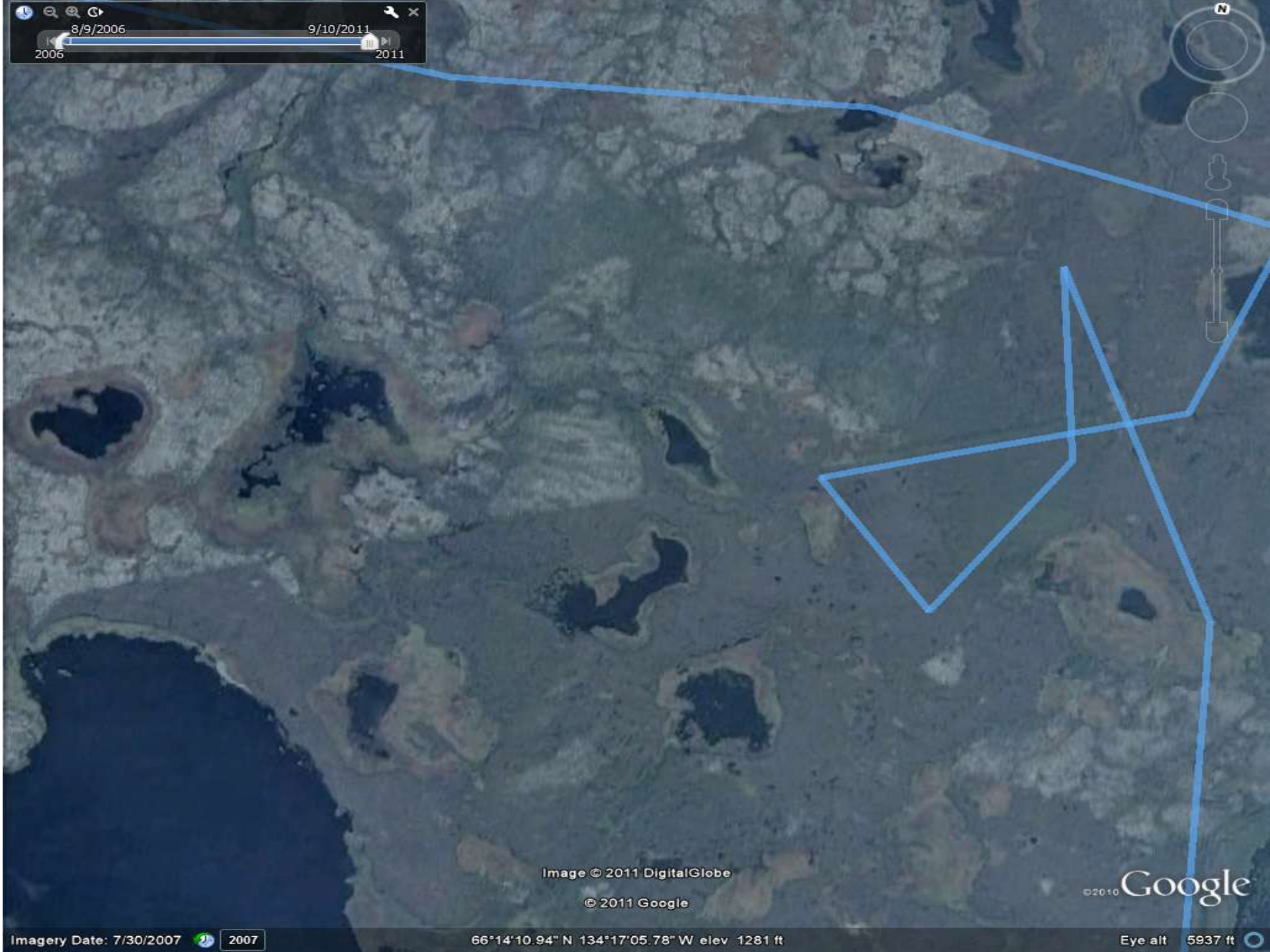

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Image © 2011 DigitalGlobe
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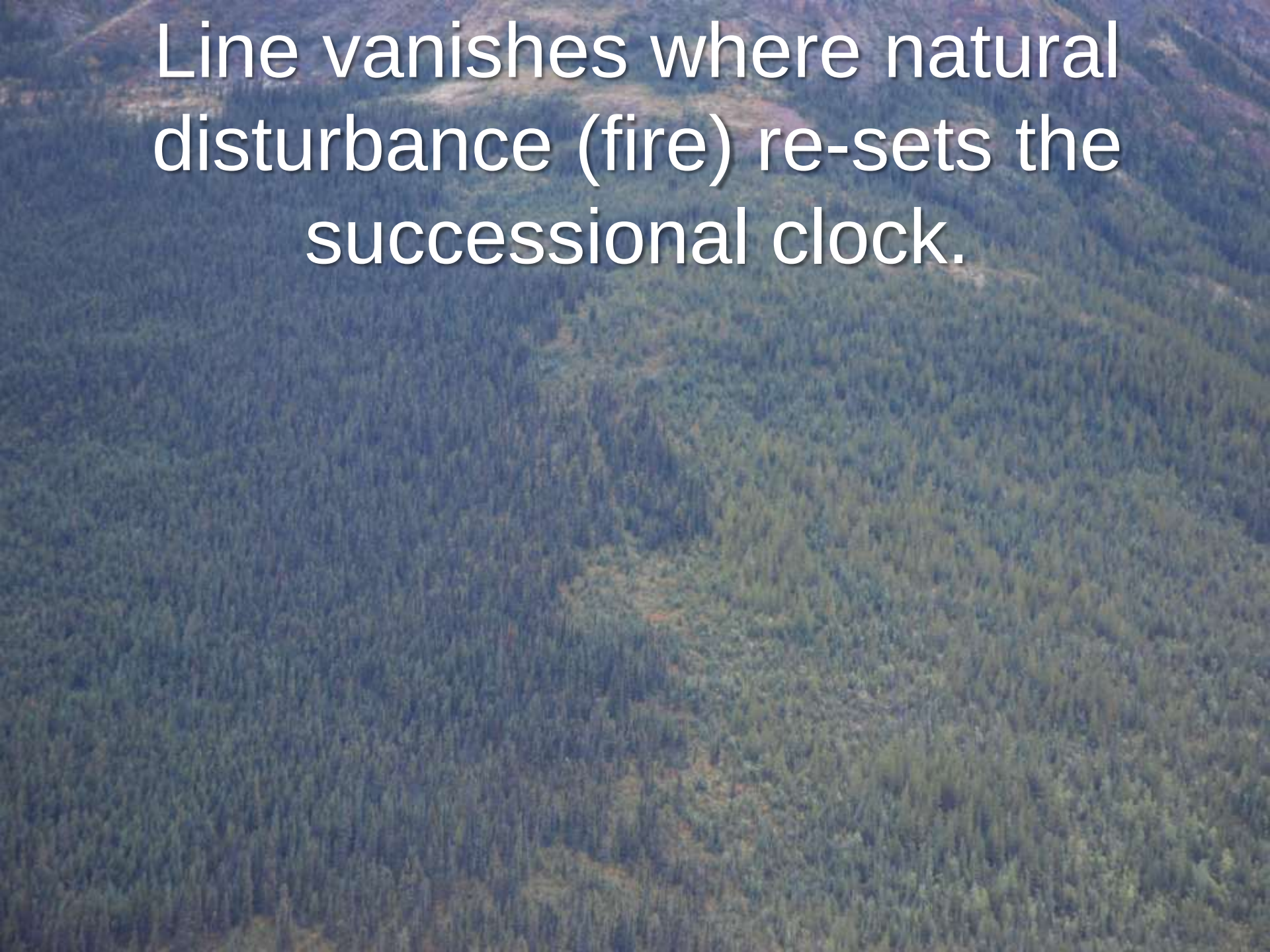
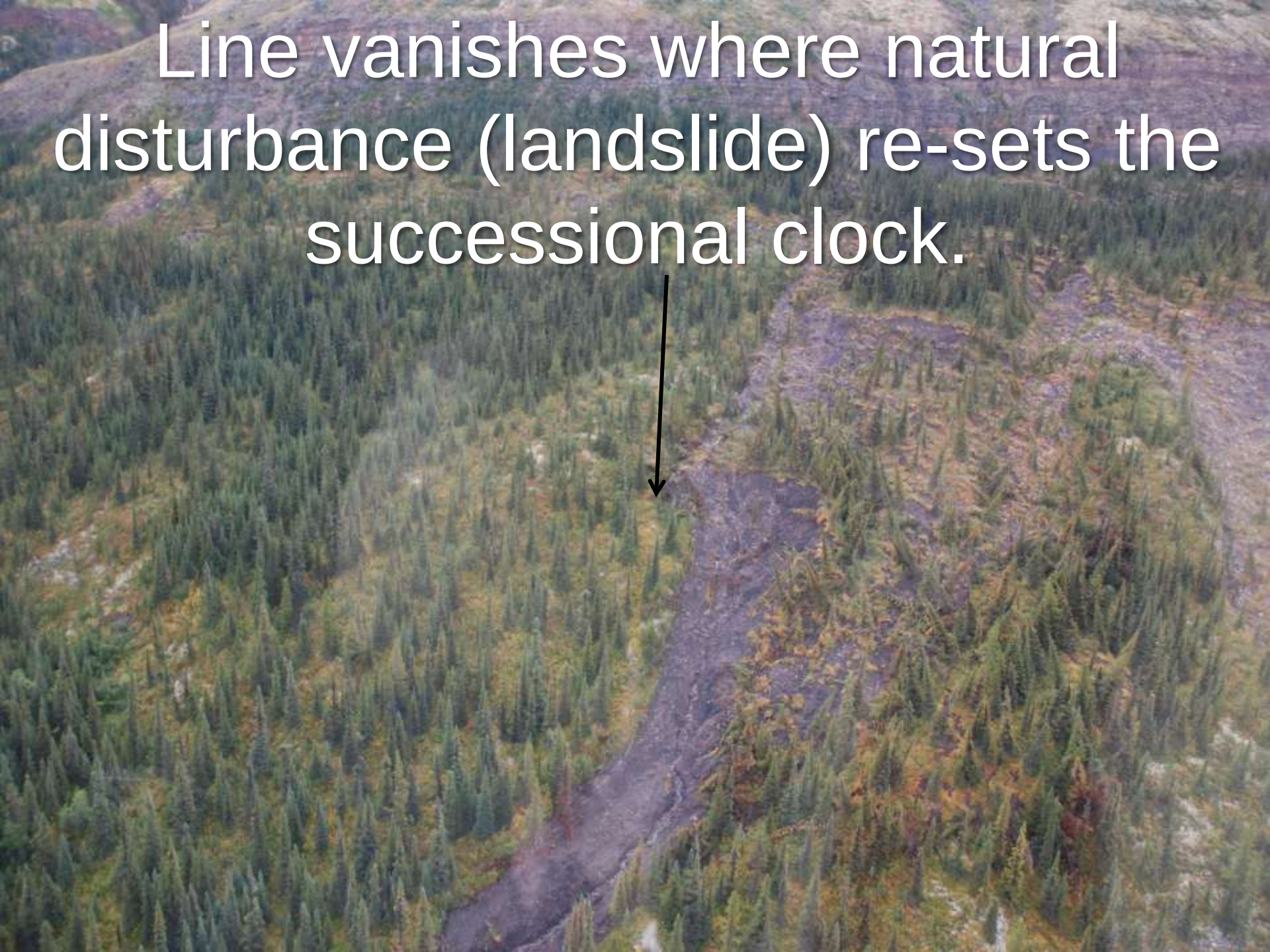
Imagery Date: 7/30/2007
2007
66°14'10.94" N 134°17'05.78" W elev 1281 ft
Eye alt 5937 ft


Line vanishes where natural disturbance (fire) re-sets the successional clock.

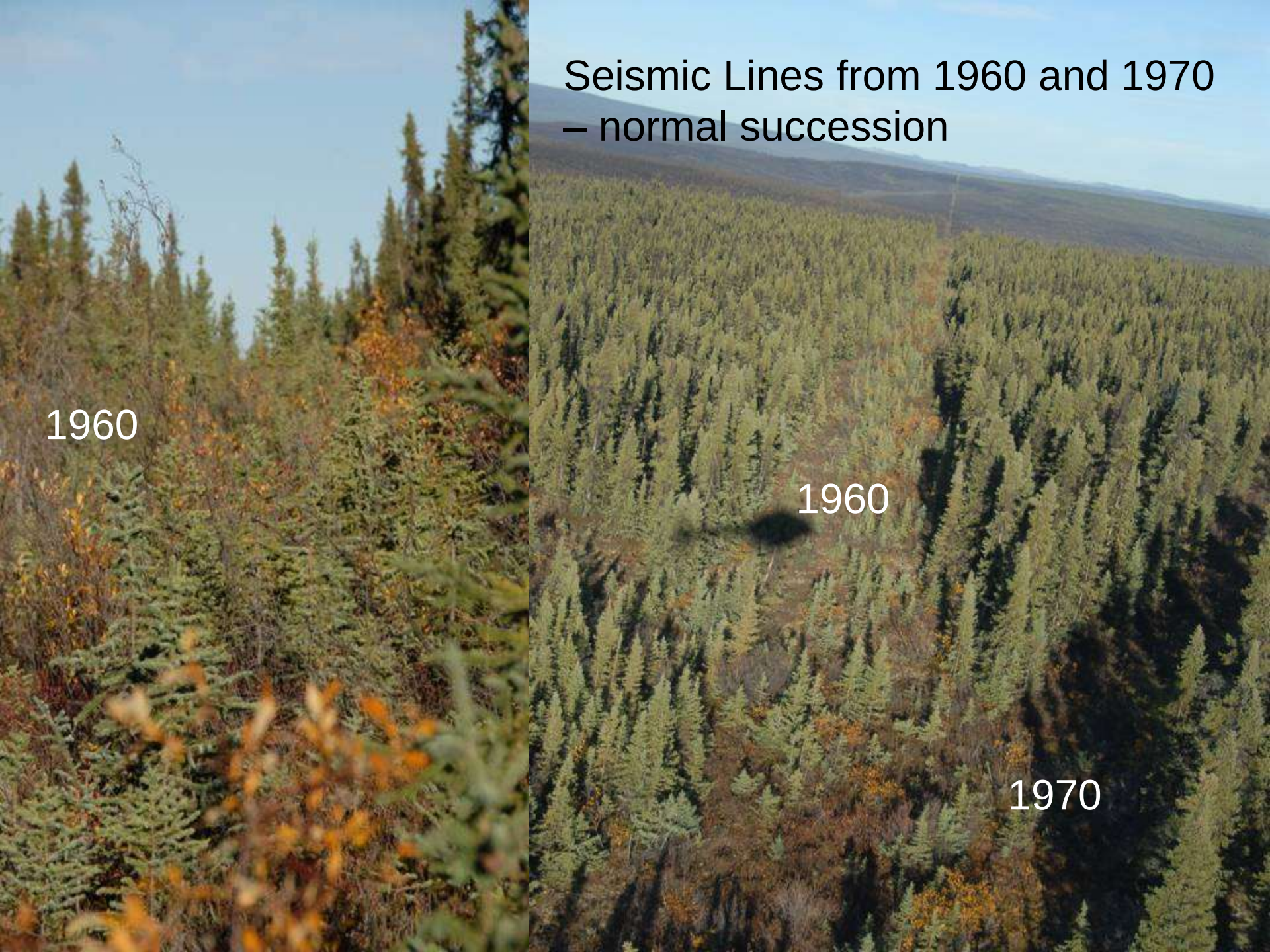

Line vanishes where natural disturbance (landslide) re-sets the successional clock.

2. Early seral species established (locally consistent and the site is moving on the appropriate successional trajectory)

- Minimal Disturbance
- Limited stripping where tops of hummocks are removed*
- Crushing of lichens (increased nutrients, slight (30 cm) depression along line)
- Frozen wetlands

Normal succession - Airstrip circa 1970

SW of EP


Seismic Lines from 1960 and 1970 – normal succession
1960
1960
1970


Successional compatibility allows seismic lines to recover quickly in this fire dominated landscape.


Successional compatibility allows seismic lines to recover quickly.


Successional compatibility allows seismic lines to recover quickly.

20060622_jsh_0002

The trees on the line have probably grown at a faster rate because of soil warming, bacterial colonization and resulting higher fertility.

14 km W of Eagle Plain and 4 Km E of inset slide

N 66.37229° W 137.03590° WGS 84 530 m 2006/06/22 11:08:36

3. Recovery Varies depending on Disturbance Level and Site Characteristics

- Mineral Soil Exposed (Calamagrostis successional stagnation)
- Re-seeded Successional Stagnation
- Permafrost Exposed and/or active layer removed
- Retrogressive succession that fire cannot re-set (Linear wetlands)

3. Recovery Varies depending on Disturbance Level and Site Characteristics

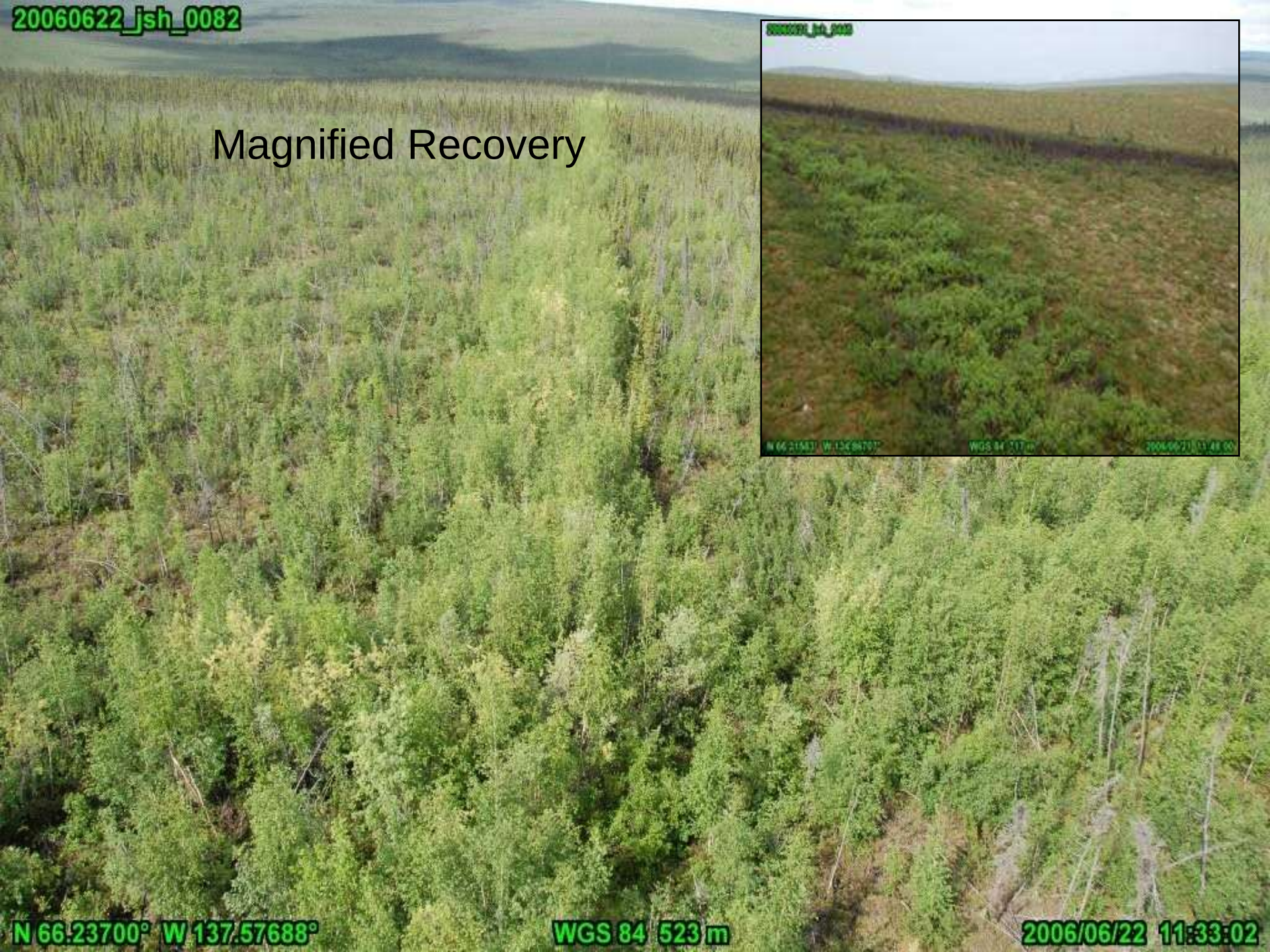
- Modified successional trajectory – locally inconsistent
- Mixed Soil Horizons
- Windrows – Enhanced growth
- Delayed Recovery
- Degraded Recovery (Erosion from drill pad)

Modified successional trajectory – locally inconsistent due to stripping to mineral soil in ancient boreal forest

Mineral soil well pads such as this one establish entirely different successional trajectories than the surrounding area

Displaced successional trajectory – due to stripping to mineral soil in thaw unstable soils

Freegold Road


20060622_jsh_0082
Magnified Recovery
N 66.23700° W 137.57688°
WGS 84 523 m
2006/06/22 11:33:02


Crushing surface vegetation may change the thermal and nutrient properties of the line…

This pattern of magnified recovery disturbance arises out of a complex range of factors that include increases in snow depth as a result of wind transport, snow trapping, warming of soils, increased nutrient levels and increased rodent populations. In this example, these visual differences are not reflected in species compositional changes. These changes are quantitative not qualitative.

Mineral Soil Exposed (Calamagrostis successional stagnation) caused by ground disturbance

Calamagrostis canadensis

Dense stands of Bluejoint Reedgrass (*Calamagrostis canadensis*) can create successional dead ends.

Seeded agronomic grasses and legumes can create the same successionally stagnant conditions.

Successional stagnation caused by re-seeding a non-native species on an airstrip in the North Yukon

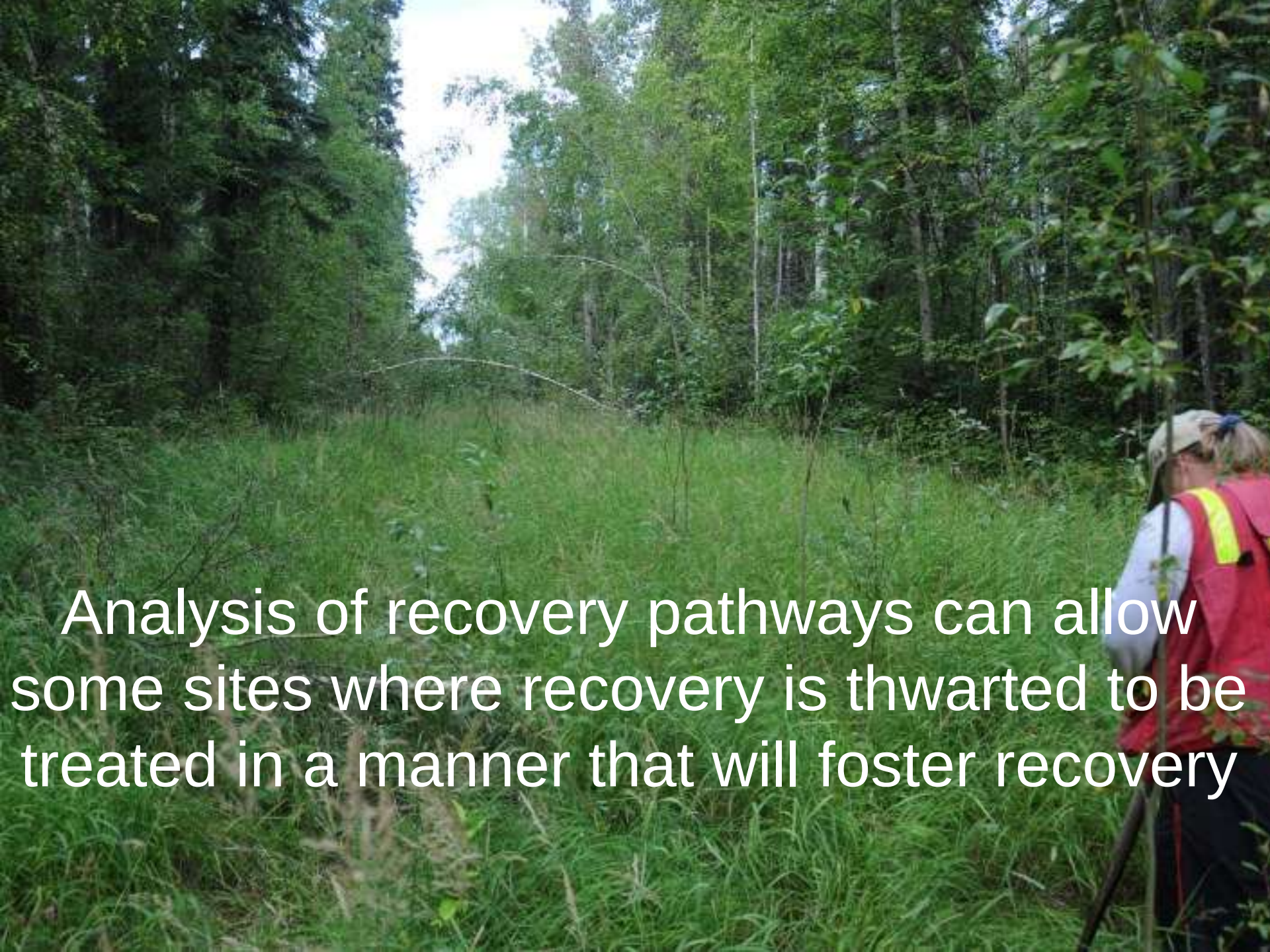
SW NWT well site camp seeded with clovers….result is both successional stagnation, reduced native species recruitment and a wildlife attractant

Anthropogenically influenced successional stagnation caused by the planting of white sweet clovers and other clovers at a SW NWT well site.

The planting of this species caused reduced recruitment of early successional native species.

SW NWT

Matricaria perforata
(scentless chamomile)


Analysis of recovery pathways can allow some sites where recovery is thwarted to be treated in a manner that will foster recovery

Degraded Recovery

As a soil stabilizer/erosion control measure, the clover planting was a failure

Erosion can be a major constraint limiting recovery.

Mixing soil profiles creates conditions that may prevent effective recovery.


Where conditions are particularly harsh,
recovery may be significantly delayed.

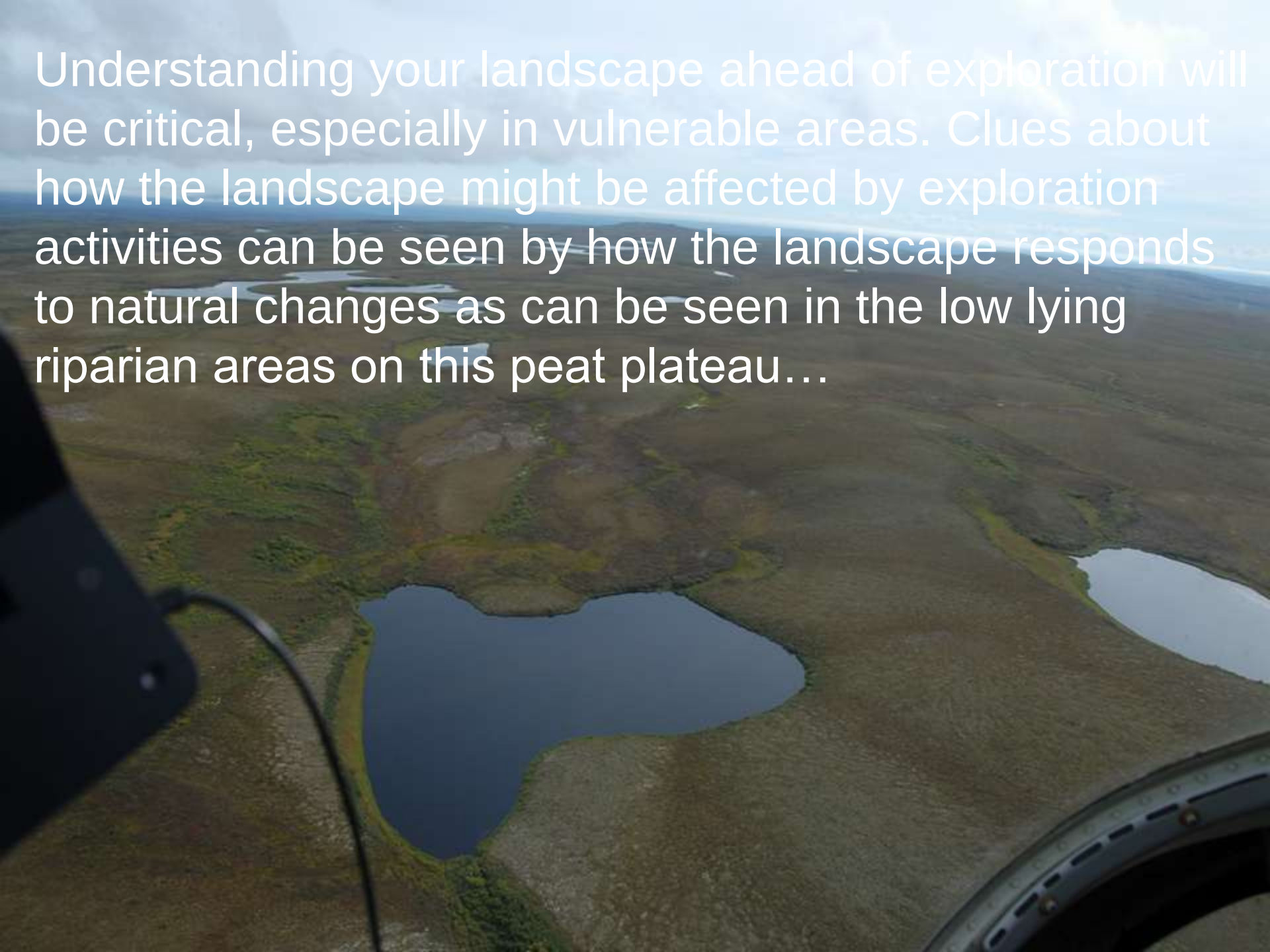

Where seismic lines create new drainage channels, impacts can be long lasting.

Retrogressive succession

Retrogressive succession occurs when the insulating layer is removed and the line turns into a linear wetland.

Unfortunately, fire will not re-set the successional trajectory on these sites.


0621_jsh_0420
Recovery may take several millennia.
.17942° W 134.56805°
WGS 84 444 m
2006/06/21 11



Understanding your landscape ahead of exploration will be critical, especially in vulnerable areas. Clues about how the landscape might be affected by exploration activities can be seen by how the landscape responds to natural changes as can be seen in the low lying riparian areas on this peat plateau…

Summary of findings

- The geophysical histories of these ecoregions set the stage for the present vegetation communities found across the landscape.

- Understanding the dynamics of recovery of disturbed sites provides a foundation upon which best management practices and strategies can be developed for minimizing the environmental and social impacts of linear developments.

Summary of findings

- Linking natural successional processes with successful restoration has shown that defining disturbance and recovery status as well as designing mitigation strategies on natural successional patterns provides the most effective design for both natural recovery and restoration of human caused disturbances.

Summary of findings

BUT !

The bottom line is the limiting factor or filter to the recovery of the disturbance is the

DISTURBANCE

Thank you

Funding for this ongoing Research was provided by:

- Oil and Gas Resources, EMR, Government of Yukon
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