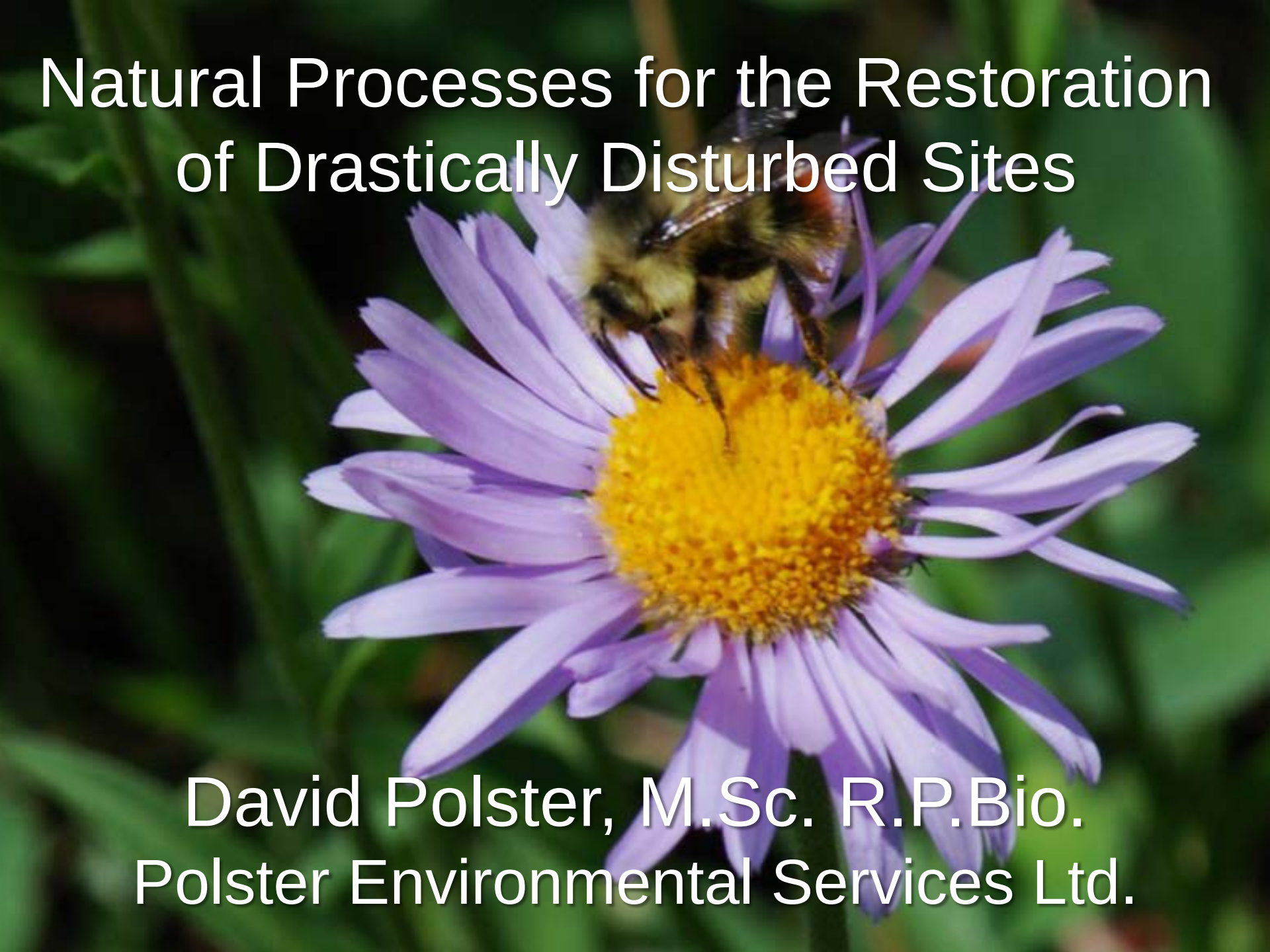
Natural Processes for the Restoration of Drastically Disturbed Sites



David Polster, M.Sc. R.P.Bio.
Polster Environmental Services Ltd.

Frank Slide

Over time natural processes “restore” these sites

Studying how this happens provides a foundation for the design of restoration programs for our largest disturbances


By looking at natural solutions to revegetation we can develop effective restoration systems
18 5 2006

Fine textures at the top, free draining in the middle, larger rock at the bottom


By pushing the fine textured materials over the face we can eliminate the limitations of the coarse substrate.
6 9 2007


By making the surface rough and loose
we can control erosion without seeding.


Planting pioneering species starts the recovery processes
Rough and loose restoration treatments at a northern mine

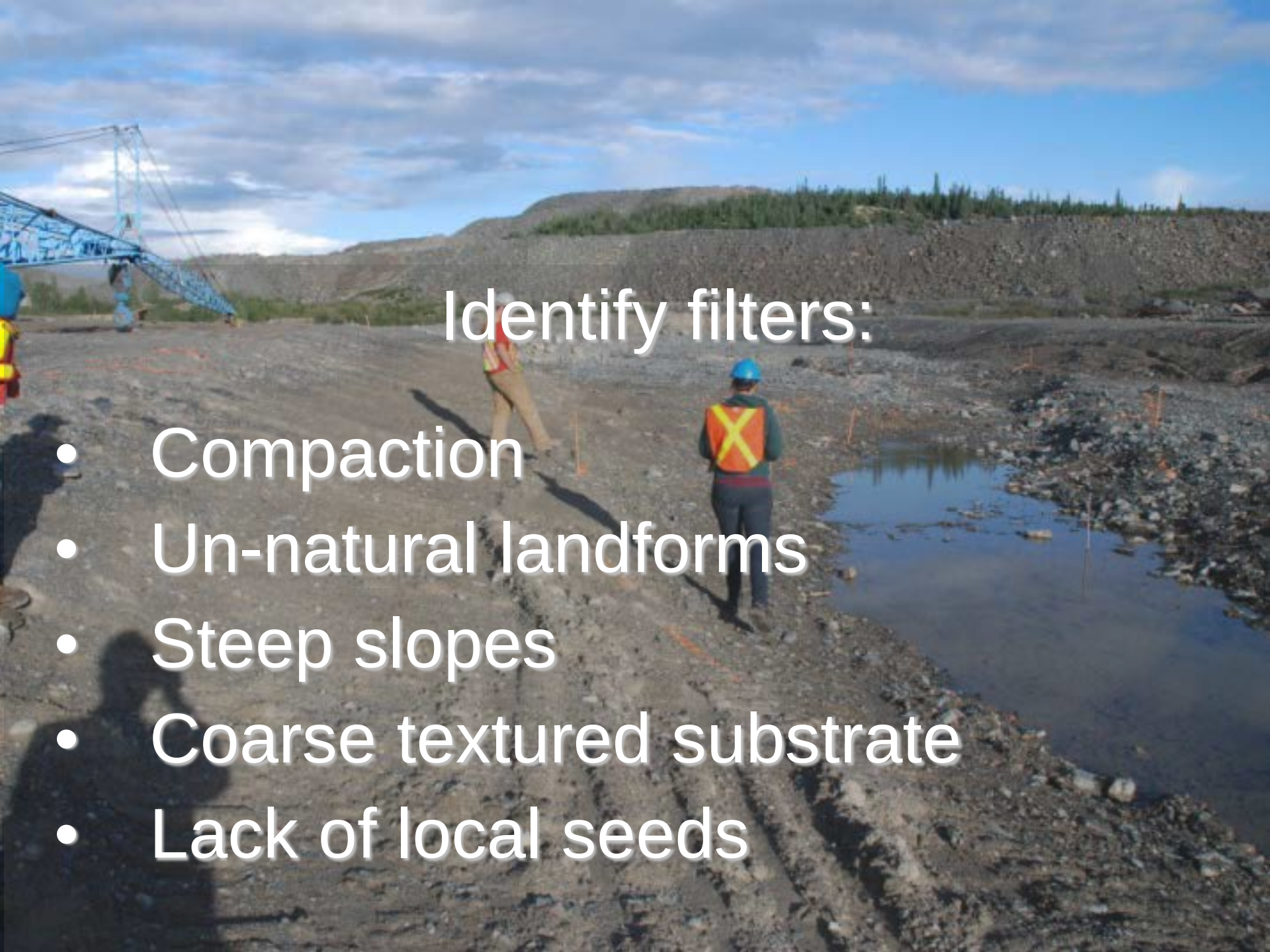

Making the surface rough and loose enhances diversity.


Cost of rough and loose treatment at this mine was $715/ha while hydroseeding costs about $3,500/ha
Creating rough and loose surfaces makes microsites for native species establishment.


These treatments can be used to create north and south facing sites at mines with dark substrates.

Adding of woody debris enhances recovery.

Colomac Mine, NWT
Restoration Strategy



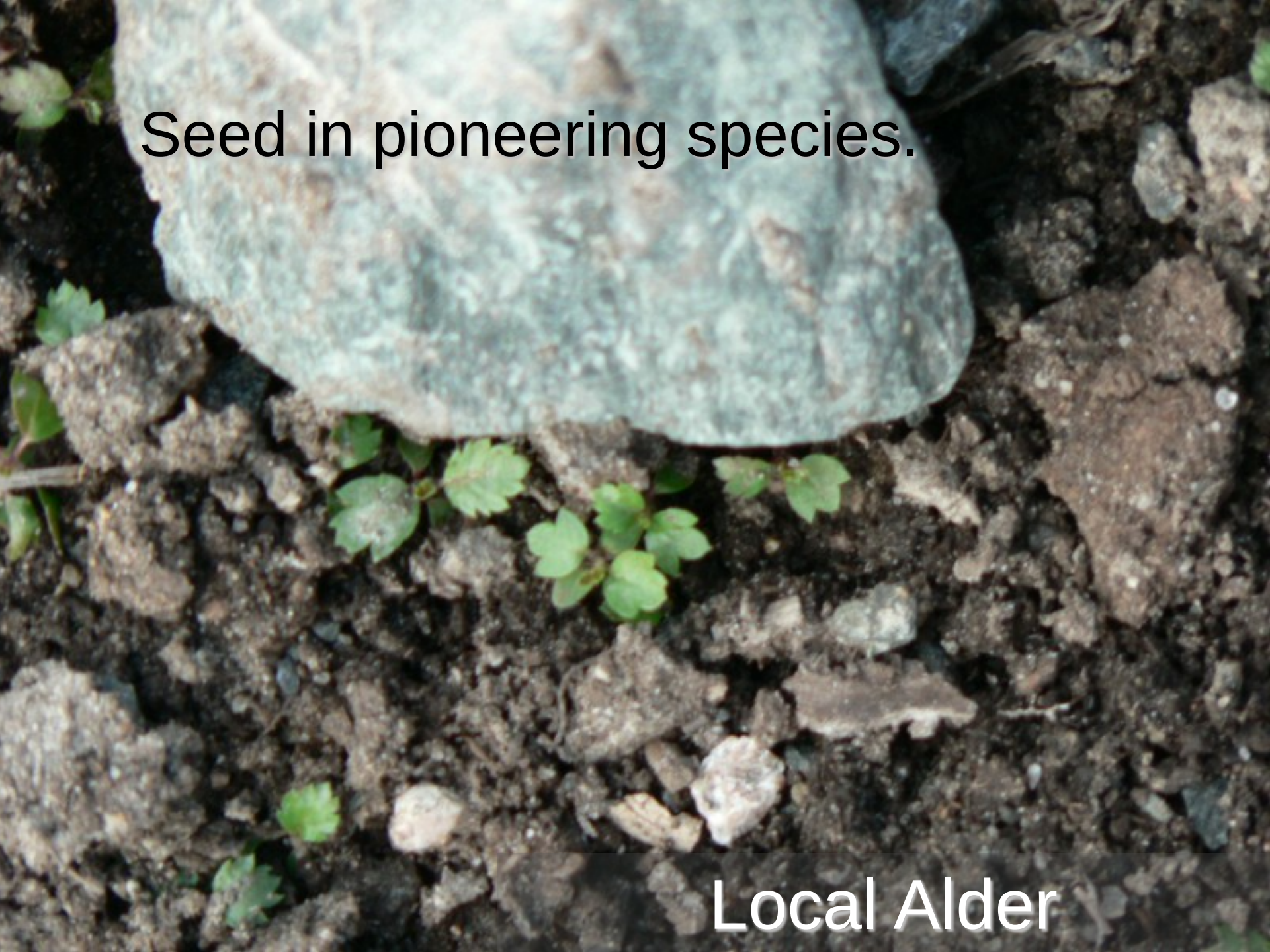
Identify filters:

- Compaction
- Un-natural landforms
- Steep slopes
- Coarse textured substrate
- Lack of local seeds

Re-slope and re-contour waste rock dumps to address landform and texture limitations.

Make it rough and loose and plant pioneering species.

Plant pioneering species in riparian areas


Seed in pioneering species.
Local Alder

Plant specialist species in wetland.

Stand back and watch it grow.


Growing a riparian ecosystem.

Failing Slope – Using plants to perform stability functions

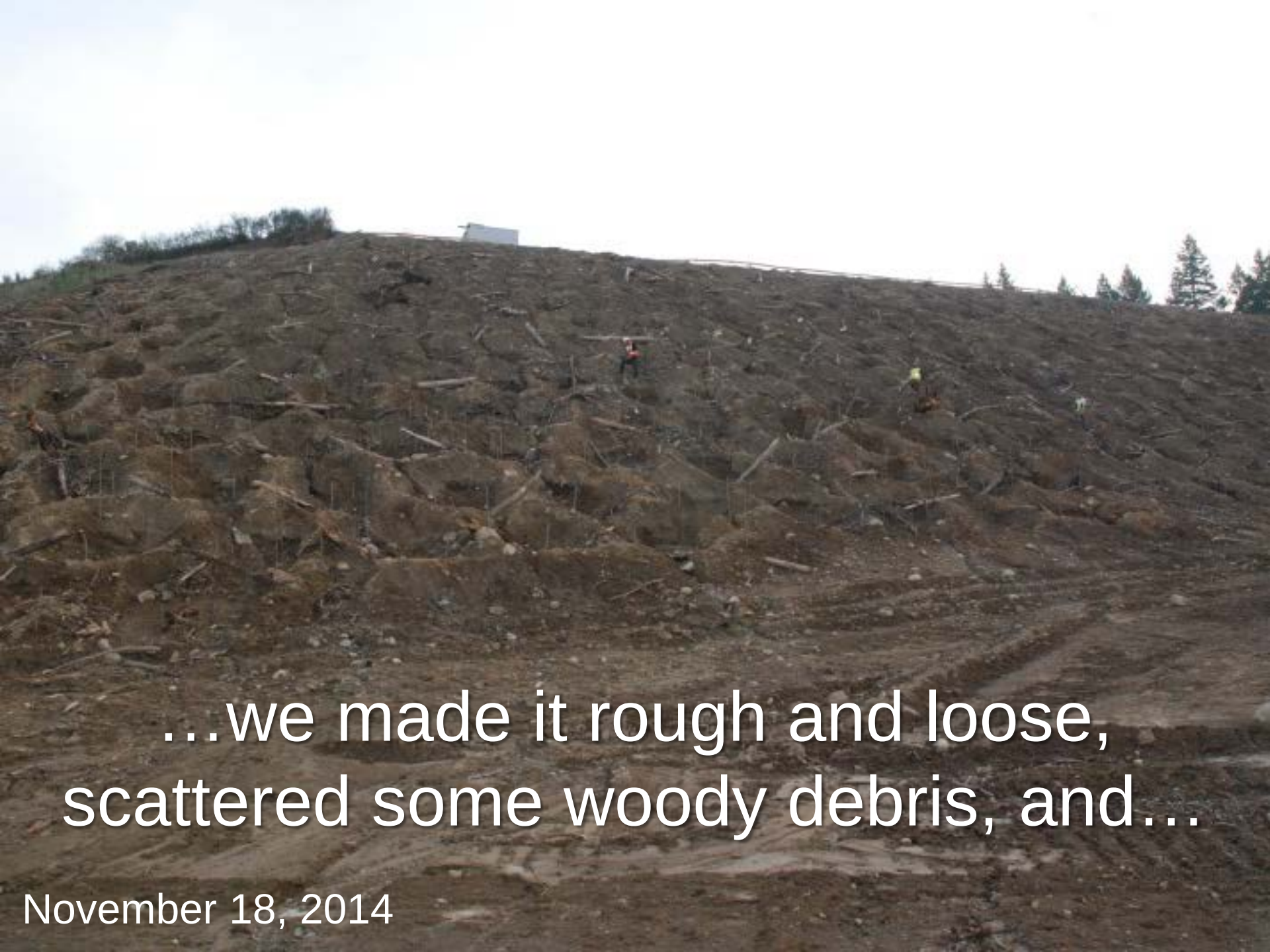

Shallowly rooted grasses provide no support for slope.

The hill was re-sloped.

September 6, 2014

The steep, smooth slope was prone to erosion, so…

September 6, 2014


…we made it rough and loose,
scattered some woody debris, and…
November 18, 2014

…installed 2,500 2 m long live stakes with 1 m in the ground.

November 18, 2014


A fence was installed to keep out the deer.

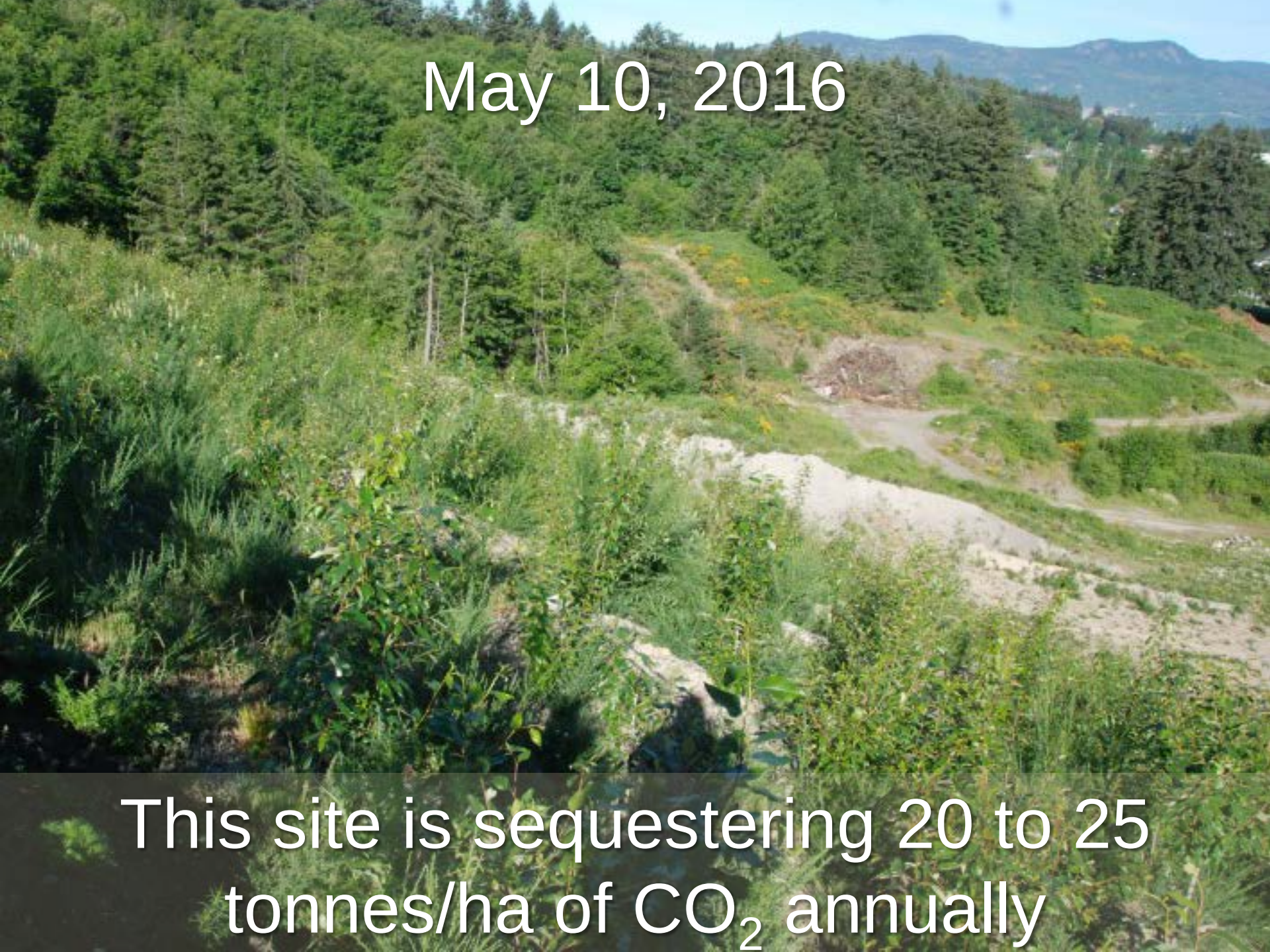
The slope was starting to turn green by May 12, 2015


Almost all of the cuttings were showing signs of growth, May 26, 2015

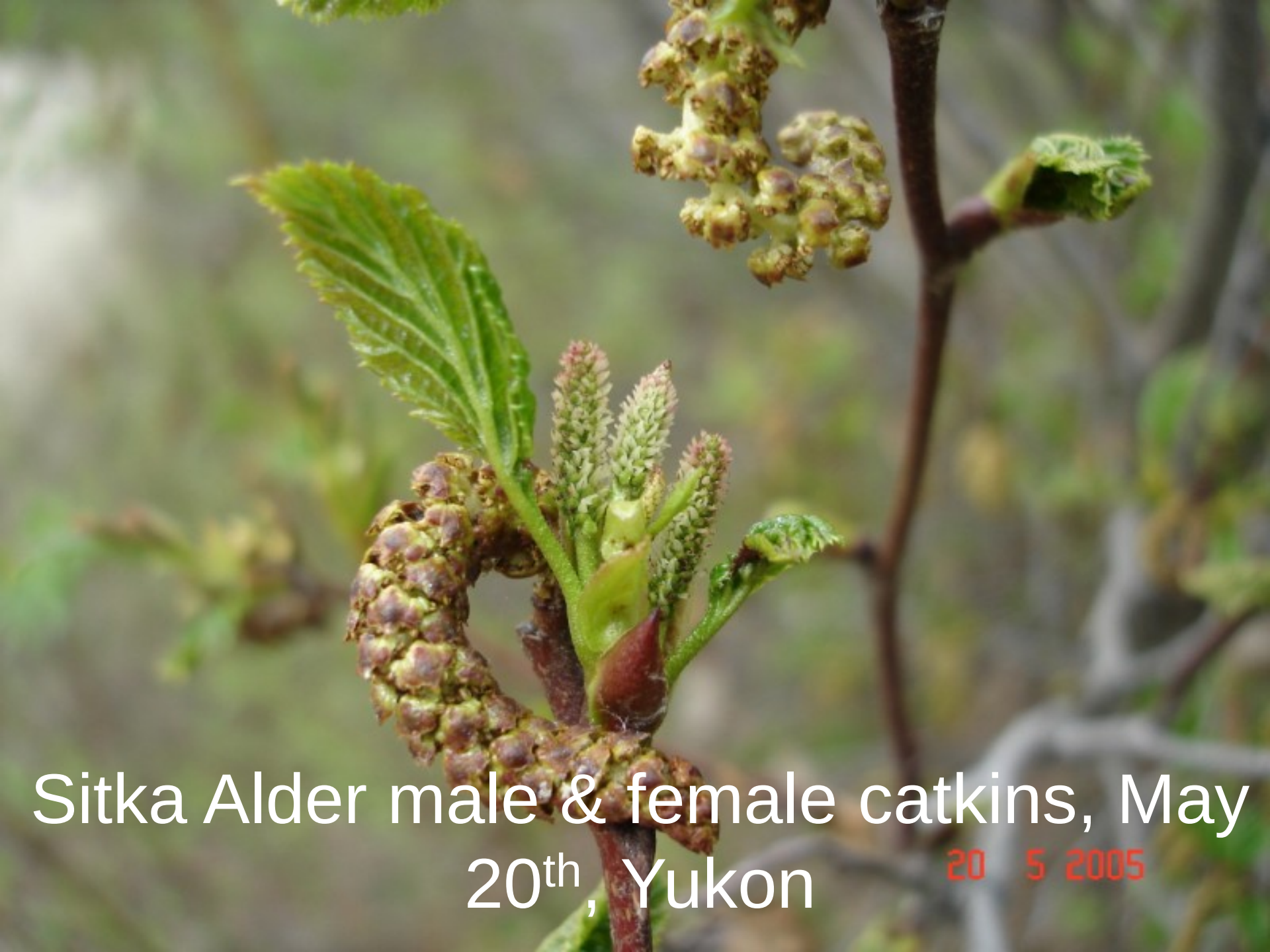

Some cuttings have almost a meter of new growth, July 21, 2015


August 13, 2015


September 23, 2015


May 10, 2016
This site is sequestering 20 to 25 tonnes/ha of CO_2 annually


Alder Seeding
Red Alder male catkins, March 17th, Vancouver Isl.
17 3 2006



Sitka Alder male & female catkins, May 20th, Yukon

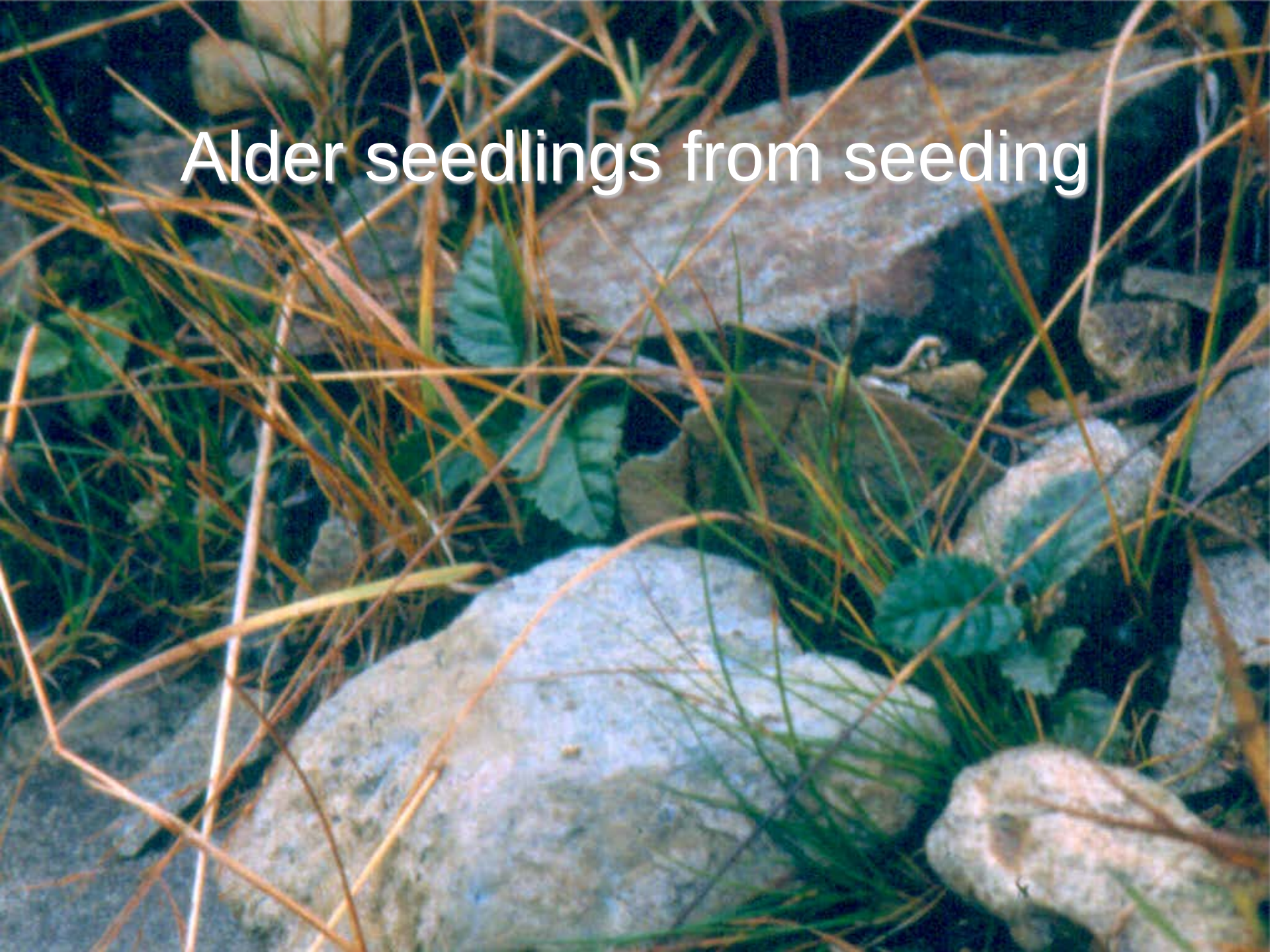
Alder Seeding

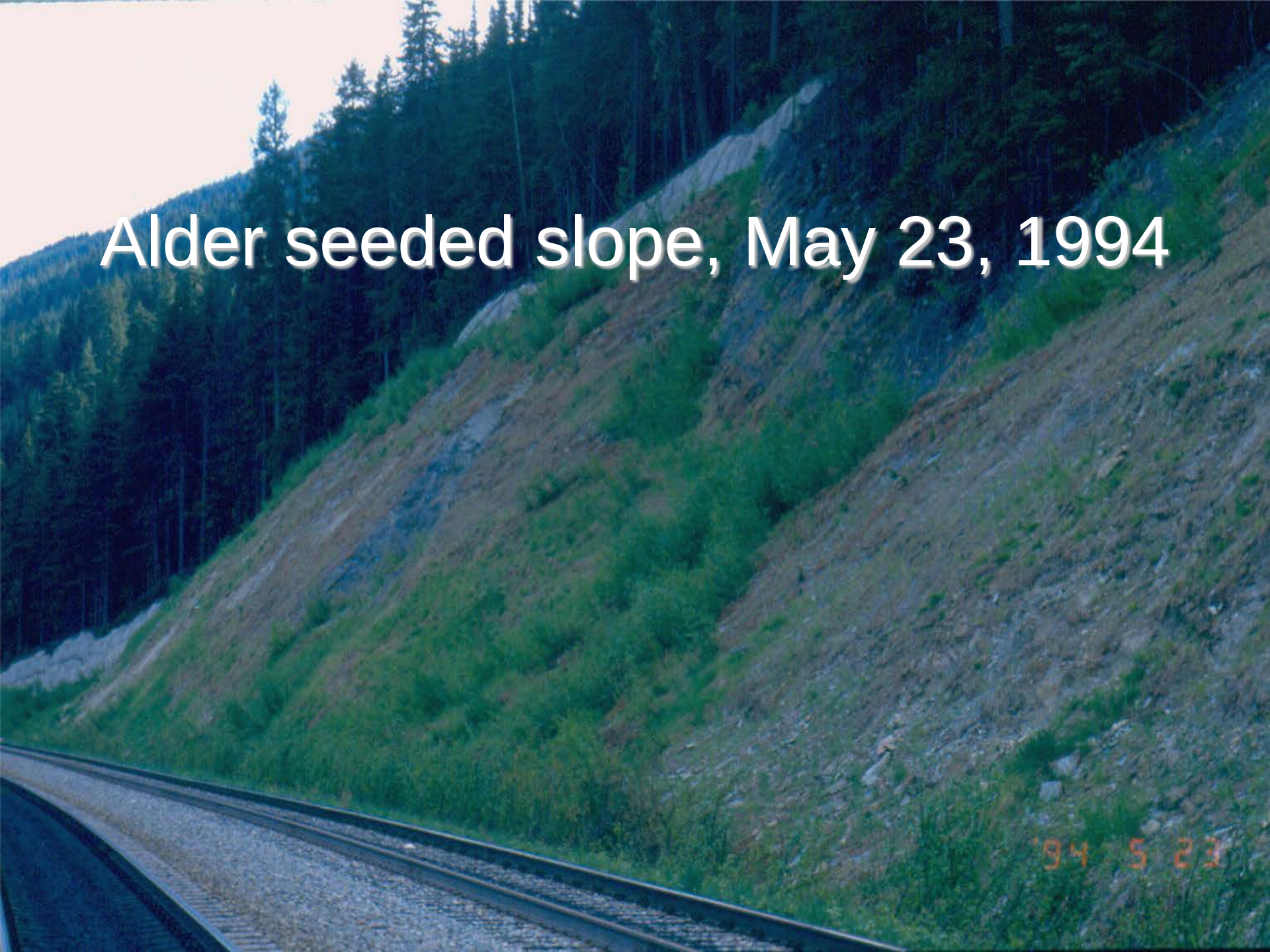
Sitka Alder Seed collection, September 25th, northern BC

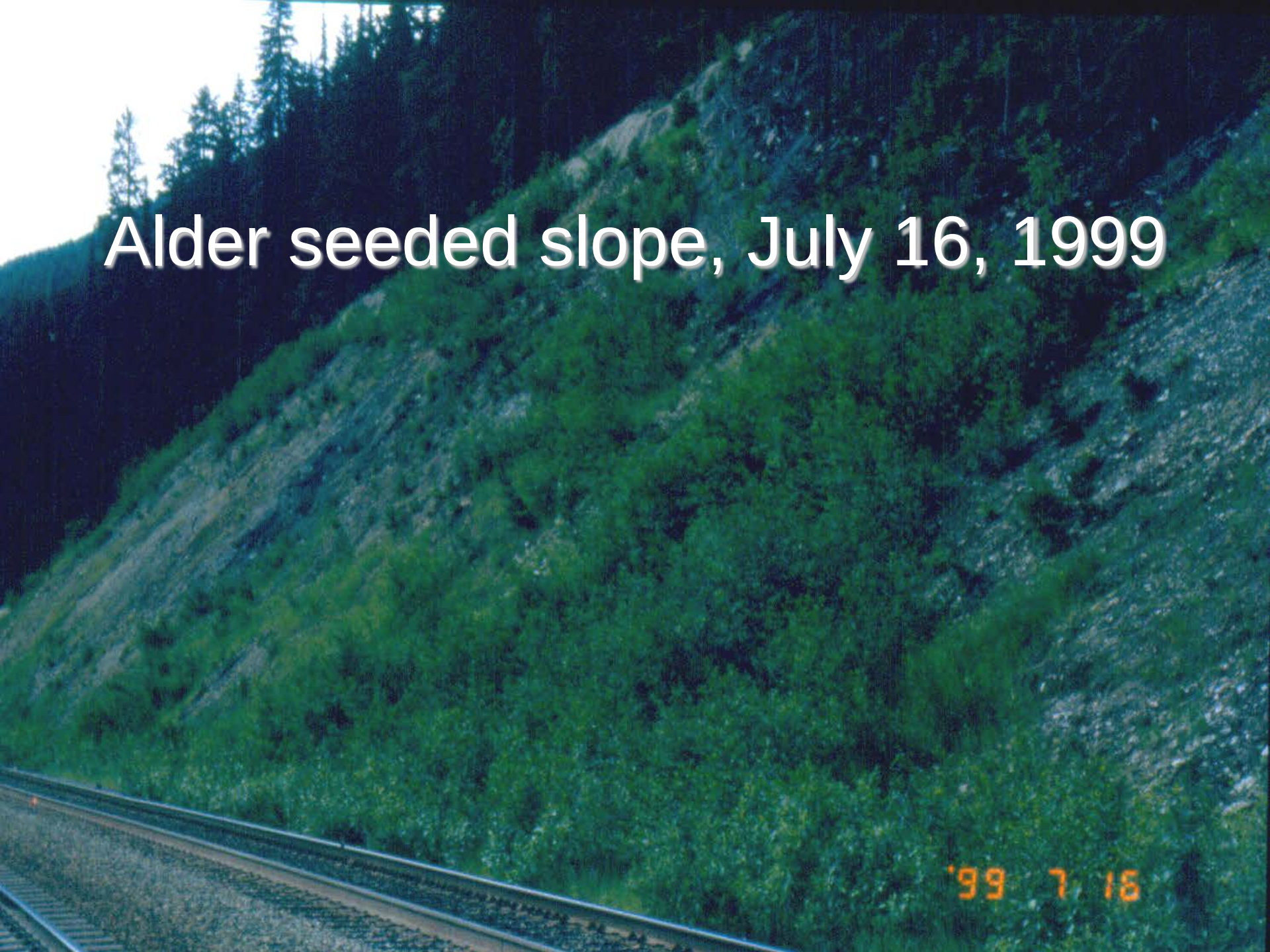
Sitka Alder Seed collection, October 4th, Interior BC


Seeding steep slopes (0.8 : 1 or 51.3º)
'06 5 23

Seeding Sitka alder, October 30, 1986


Alder seedlings from seeding


Alder seeded slope, May 23, 1994
'94 5 23

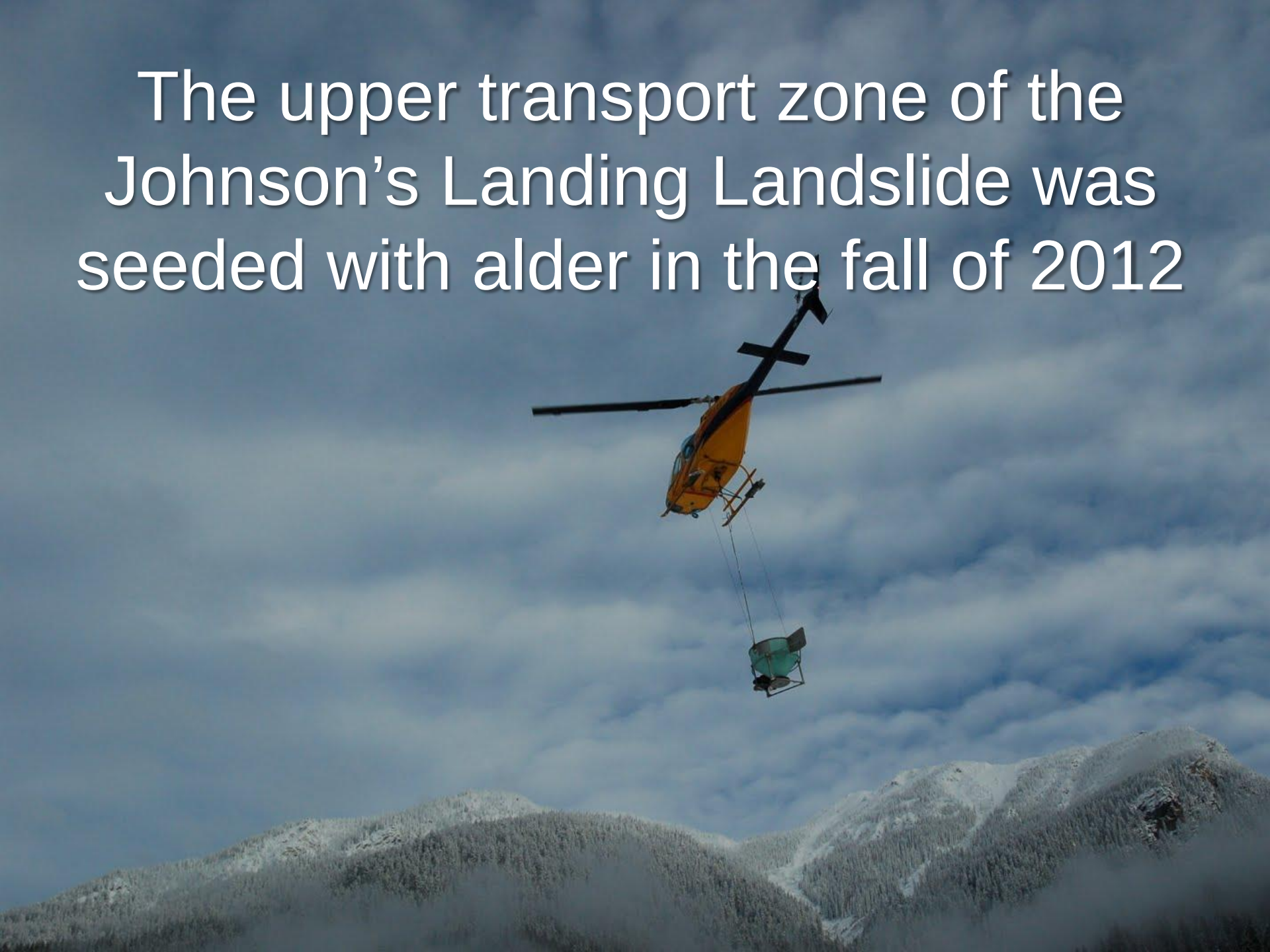

Alder seeded slope, July 16, 1999
'99 7 16

Alder seeded slope, July 16, 1999

Alder seeded slope, July 9, 2005

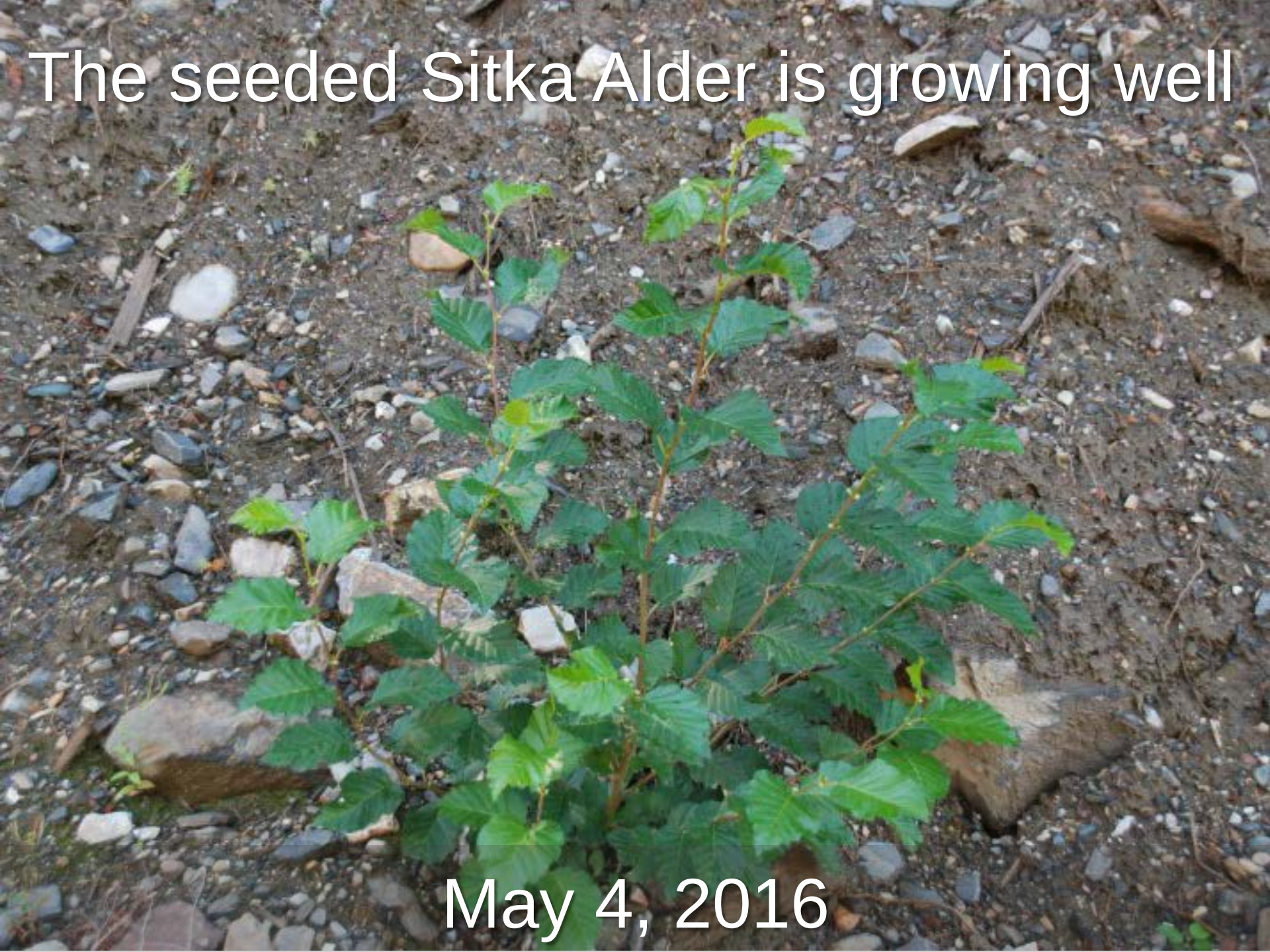

Alder seeded slope, August 1, 2009
Conifers continue to move in 23 years after the alder seeding.

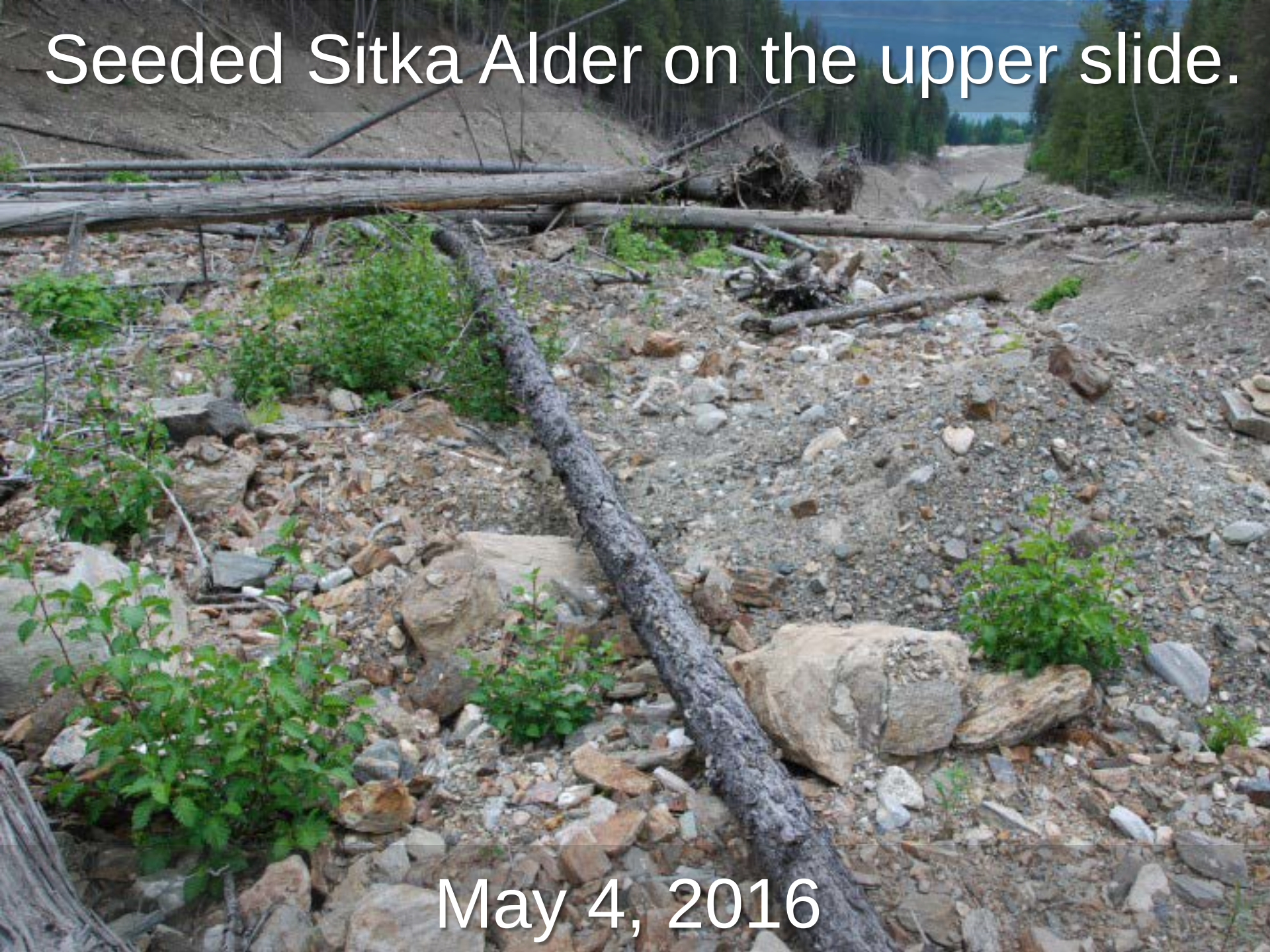
The upper transport zone of the Johnson's Landing Landslide was seeded with alder in the fall of 2012



Sitka Alder seelings from Johnson's Landing Slide aerial seeding

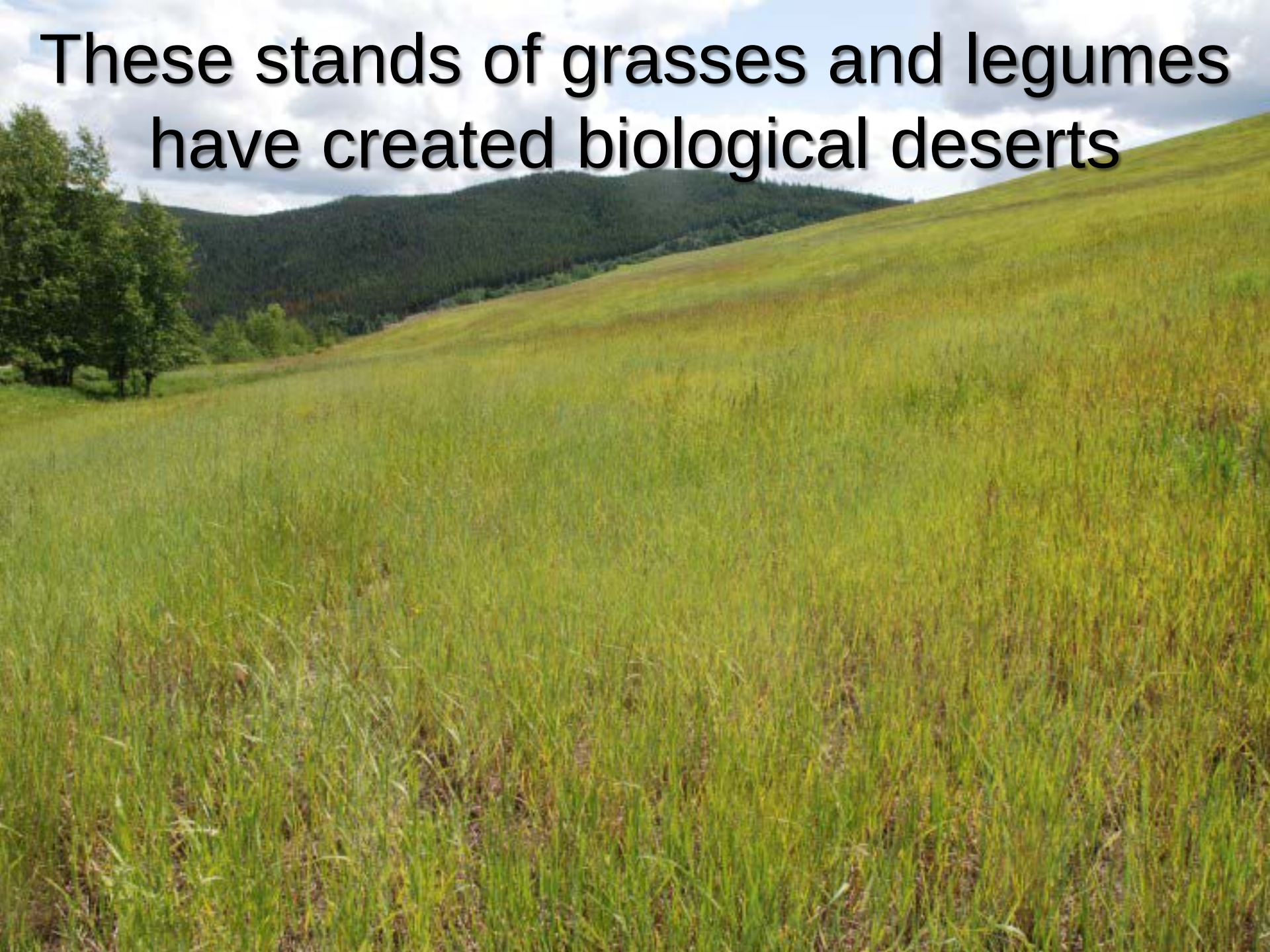

September 12, 2014
Alder seedling on Jonhnson’s Landing Slide from helicopter spread seed


The seeded Sitka Alder is growing well
May 4, 2016


Seeded Sitka Alder on the upper slide.
May 4, 2016

Enhancing Biodiversity on Drastically Disturbed Sites


Traditional reclamation has created vast stands of successionally stagnant grasses and legumes
9 6 2005


These stands of grasses and legumes have created biological deserts


Sparse vegetation cover limits site productivity = limited diversity

Slow, sparse growth limits diversity

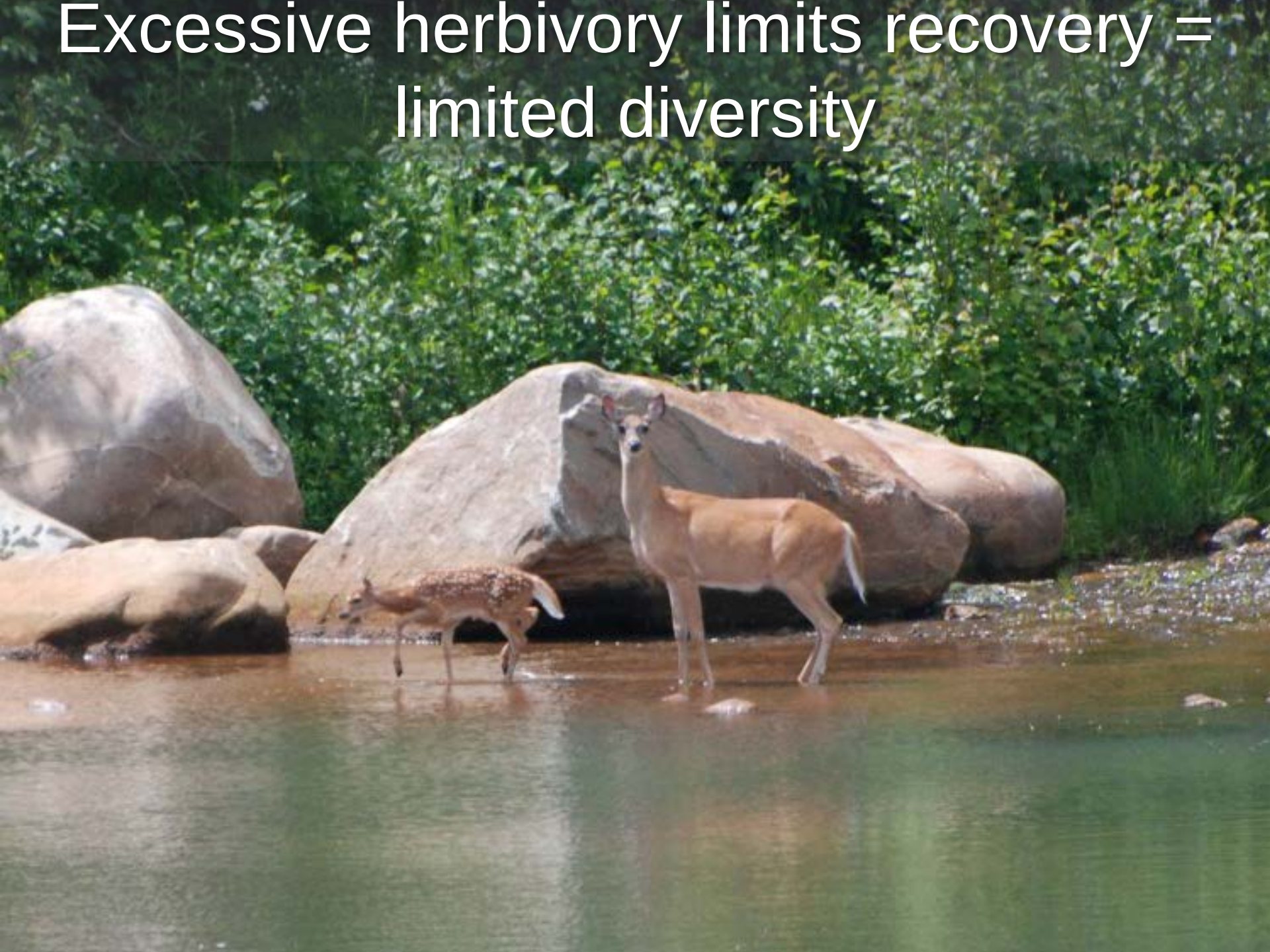
Long, unstable dump slopes prevent recovery = limited diversity

Unstable slopes and compacted benches = limited productivity = limited diversity

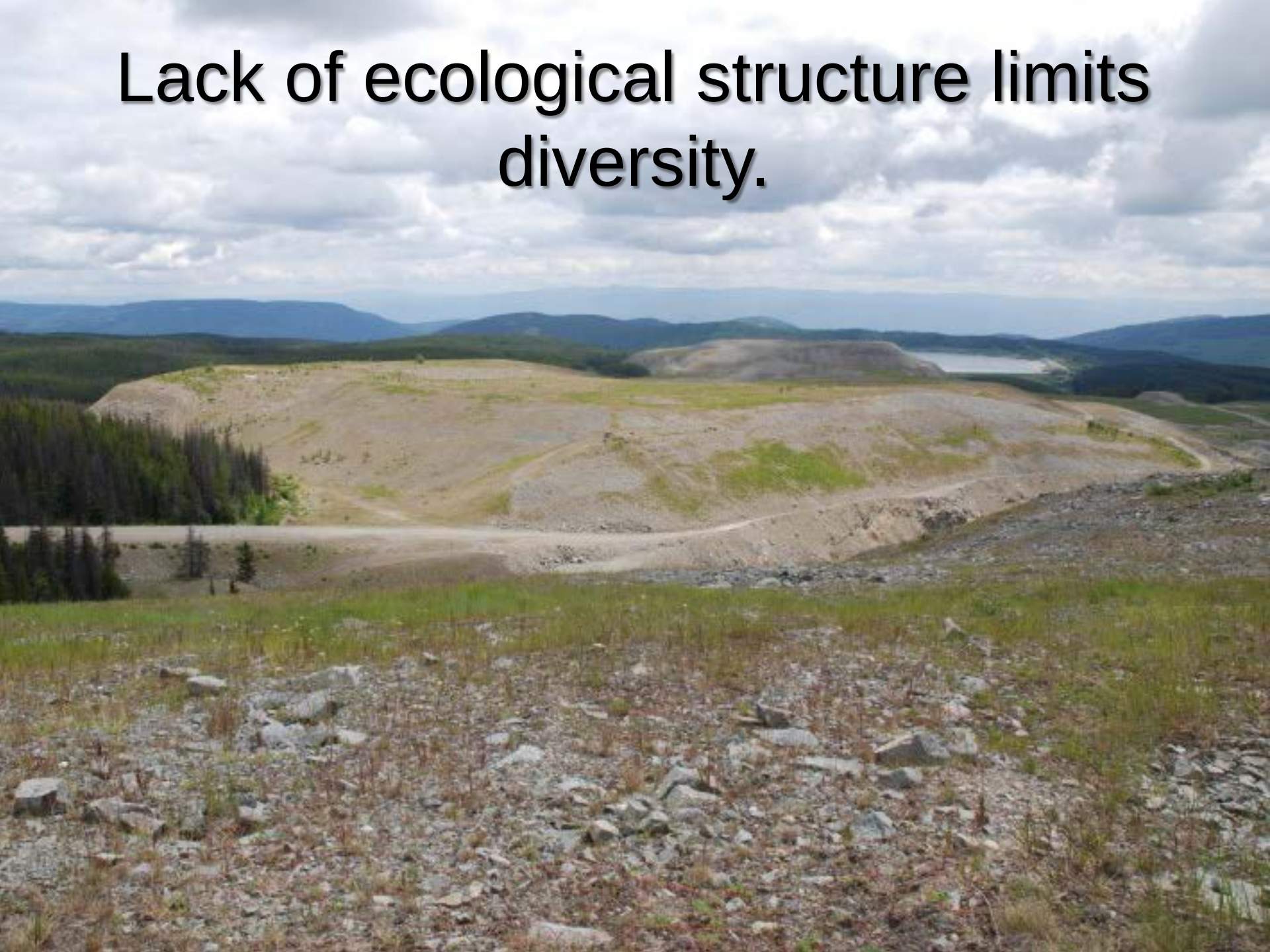
Seeded grasses and legumes coupled with no shooting zones creates an explosion of ungulate populations

These animals reduce shrub cover, limiting nesting habitat for songbirds

Excessive herbivory limits recovery = limited diversity



Lack of ecological structure limits diversity.



Limited diversity limits resilience.

So, what can we do?

Making sites rough and loose creates instant diversity

Topographic heterogeneity

Covering 10% of the mine with rough and loose patches will enhance the biodiversity while reducing costs.

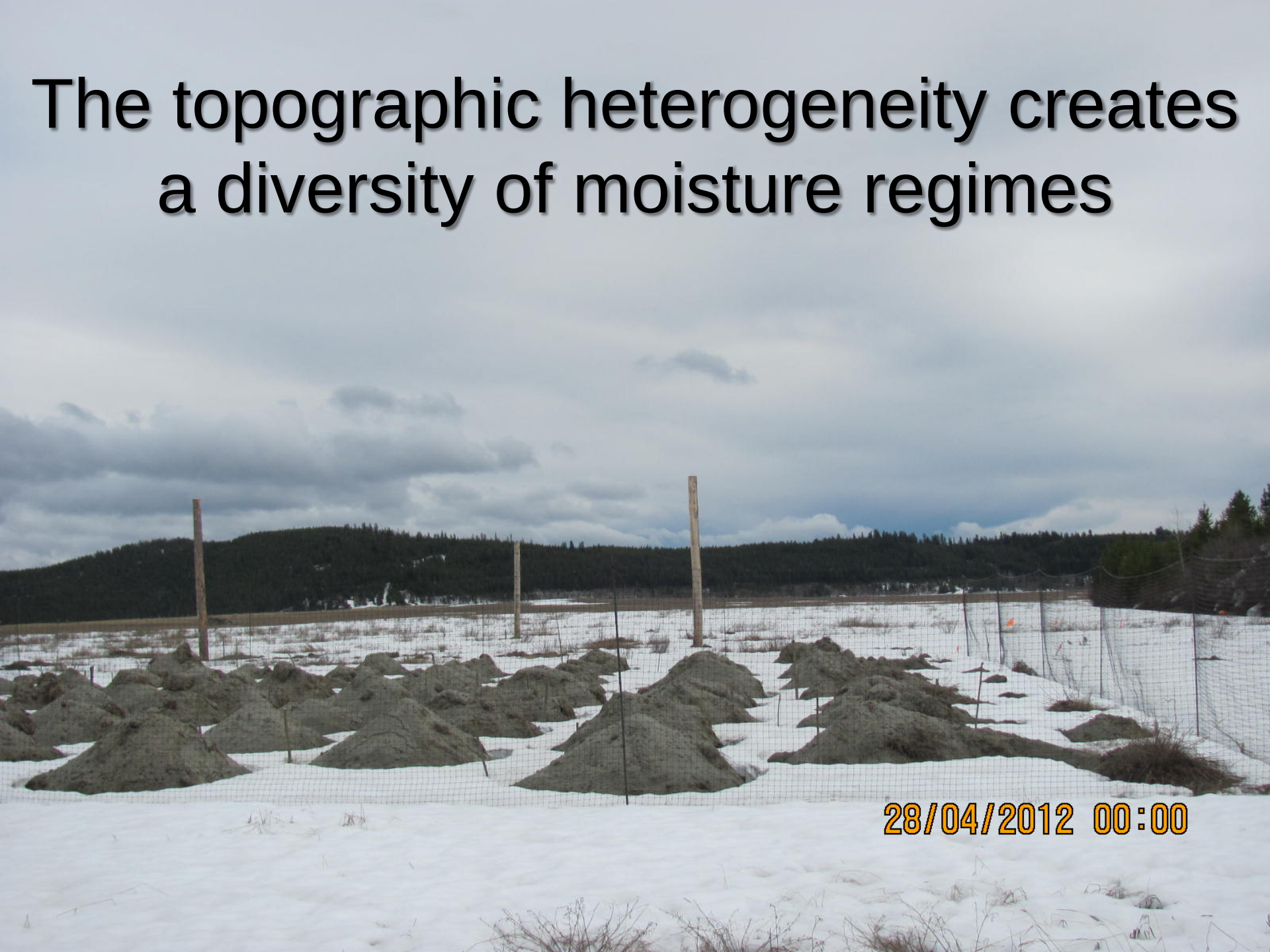

Treatments in various locations creates spatial heterogeneity

Treatments over a number of years creates temporal heterogeneity

At a big mine, there are lots of opportunities

Rough and loose sites address several issues

The topographic heterogeneity creates a diversity of moisture regimes

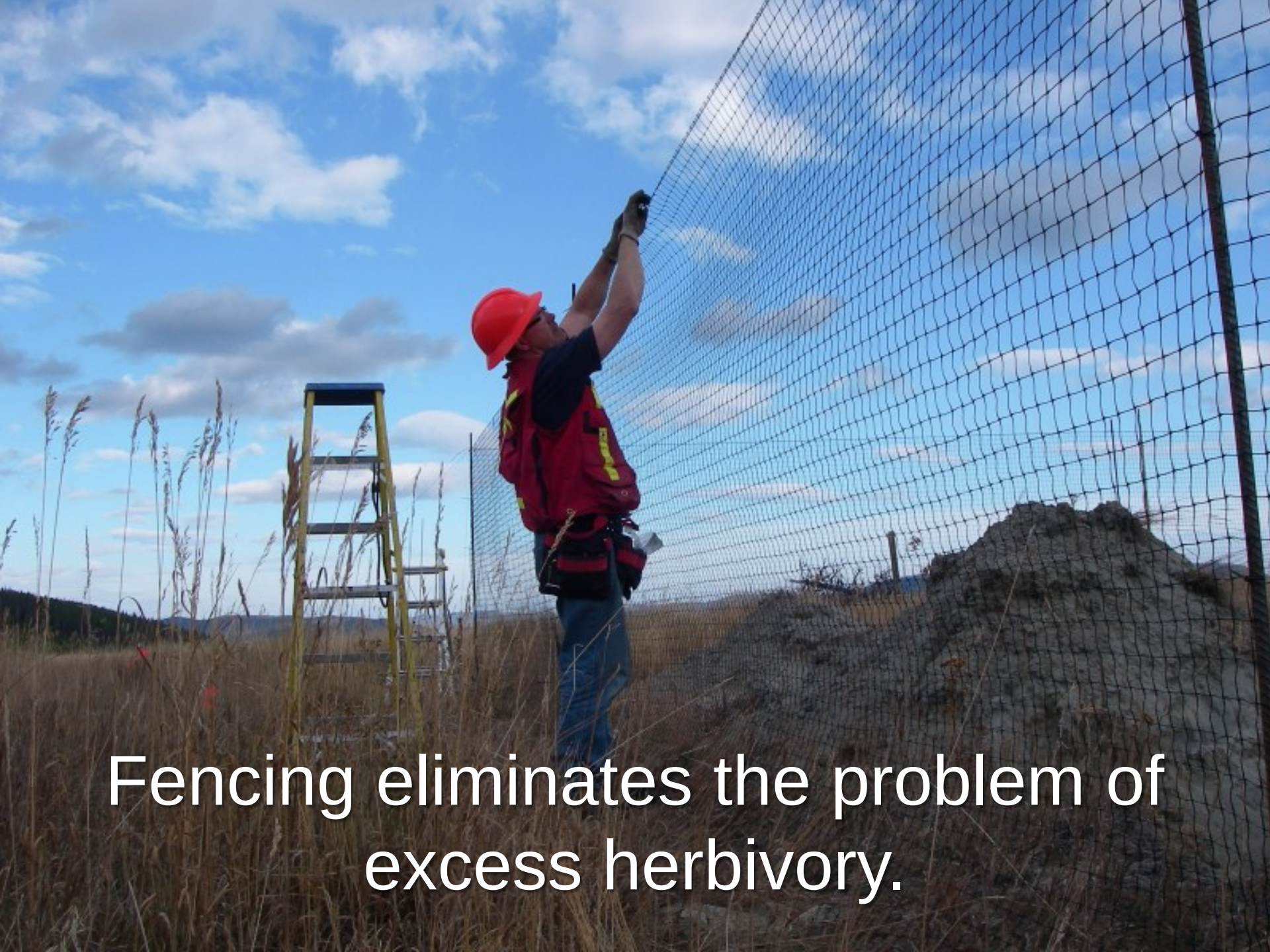


The loose substrate provides opportunities for live staking


Even on waste rock sites the rough and loose treatment makes live staking easy.

The symbiotic relationship between *Alnus* spp. And *Frankia alni* creates conditions that foster successional advancement.


Cuttings planted deeply and Alder plugs planted on the surface creates a system of niche complementarity = increased diversity



Fencing eliminates the problem of excess herbivory.

Brush piles can add habitat complexity and ecological structure.

Bluebird boxes bring back these charismatic birds*.

*Can build social licence.


Mountain Bluebirds moving in June 5, 2012
This is the mining story we like to see in the newspaper.


Cuttings starting to grow
June 5, 2012


August 9, 2012


May 18, 2015

Live staking with pioneering species initiates a recovery trajectory.

August 9, 2012


May 18, 2015


May 18, 2015
Making mine site ecosystems lumpy can foster diversity and resilience.

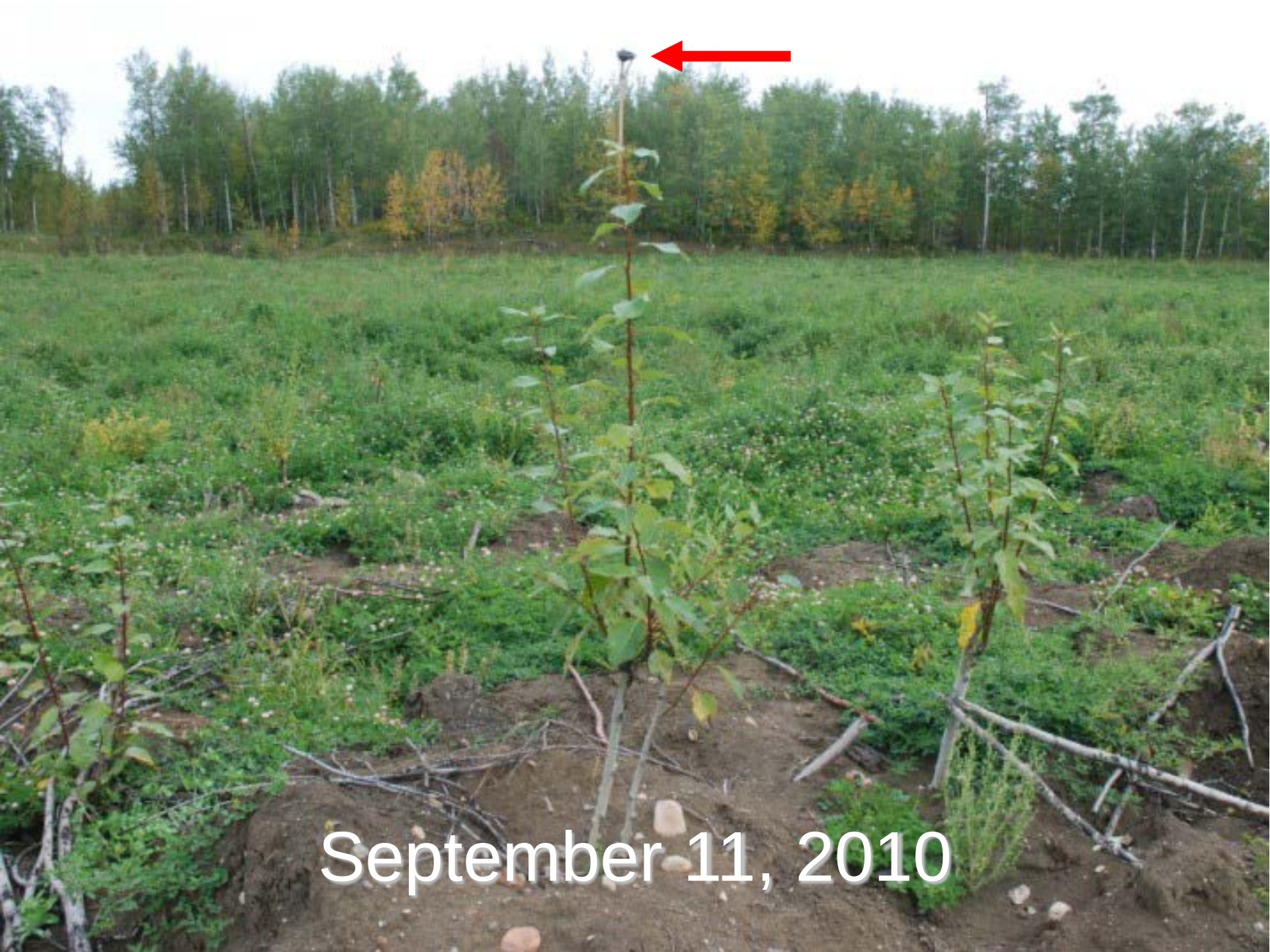
Gas plant near Edmonton to be restored, March 11, 2010

Rough and loose, April 14, 2010

Planting pioneering vegetation, April 14, 2010

Planting pioneering vegetation, April 14, 2010, note fence.


Cuttings growing, June 24, 2010


September 11, 2010


Red-osier Dogwood

April 10, 2011

August 19, 2011

Two growing seasons


February 29, 2012
29 2 2012


July 9, 2012

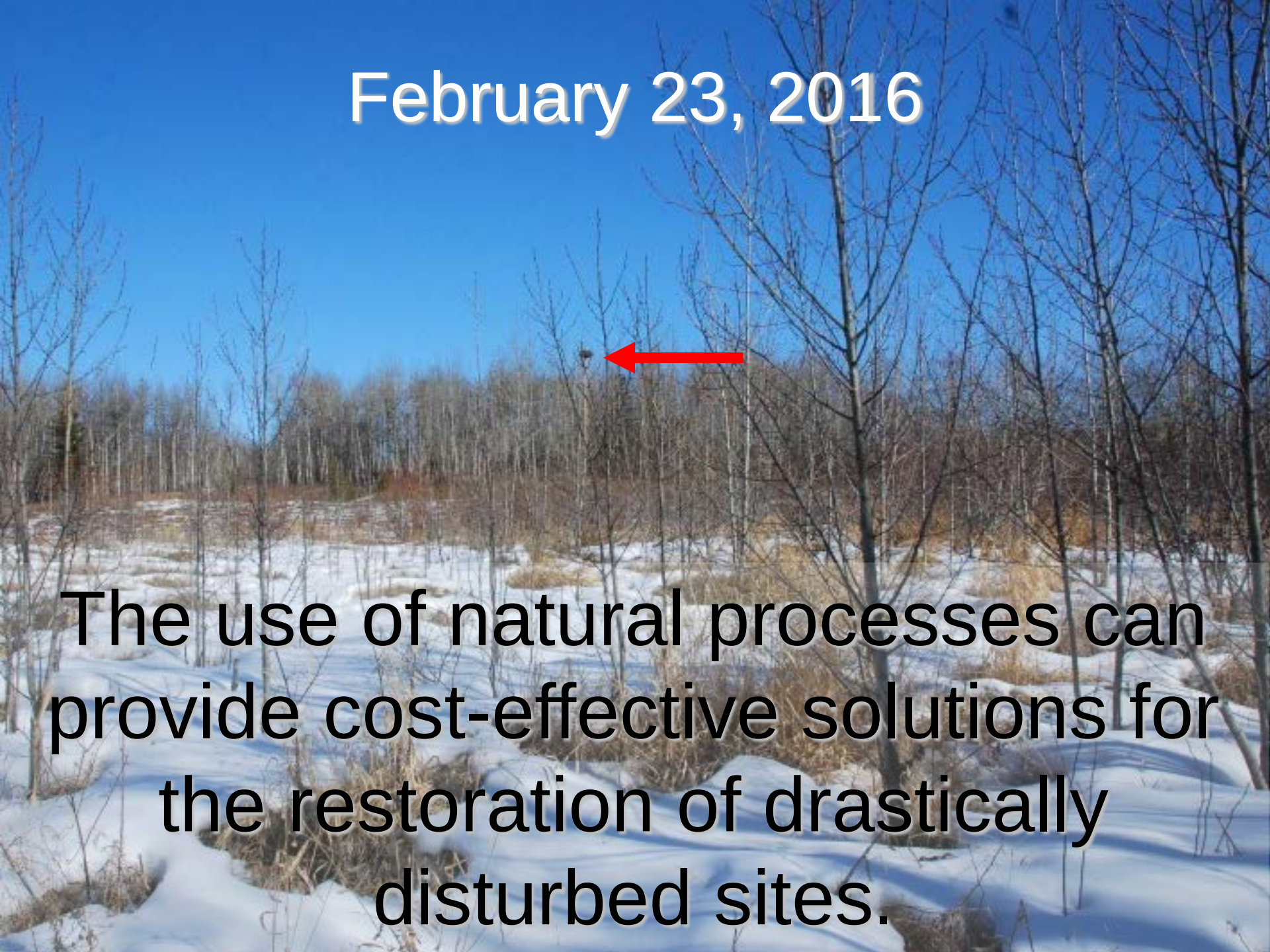
March 1, 2013


August 17, 2013


February 24, 2015

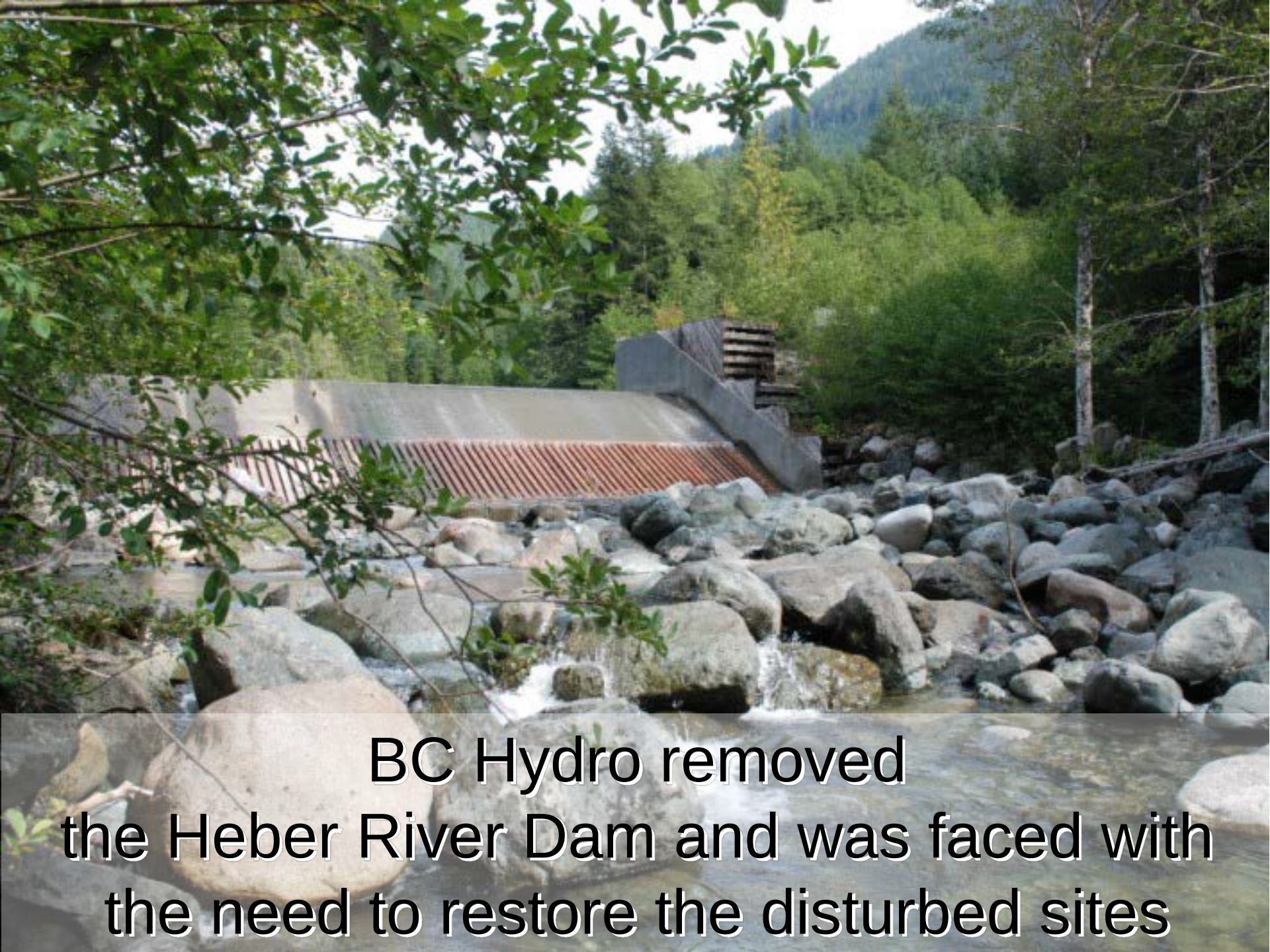

September 25, 2015


September 25, 2015
Six growing seasons after restoration


February 23, 2016
The use of natural processes can provide cost-effective solutions for the restoration of drastically disturbed sites.

Rough and loose 55 ha mine site in South Africa


Rough and loose Outpost Island, Great Slave Lake, NWT, Canada

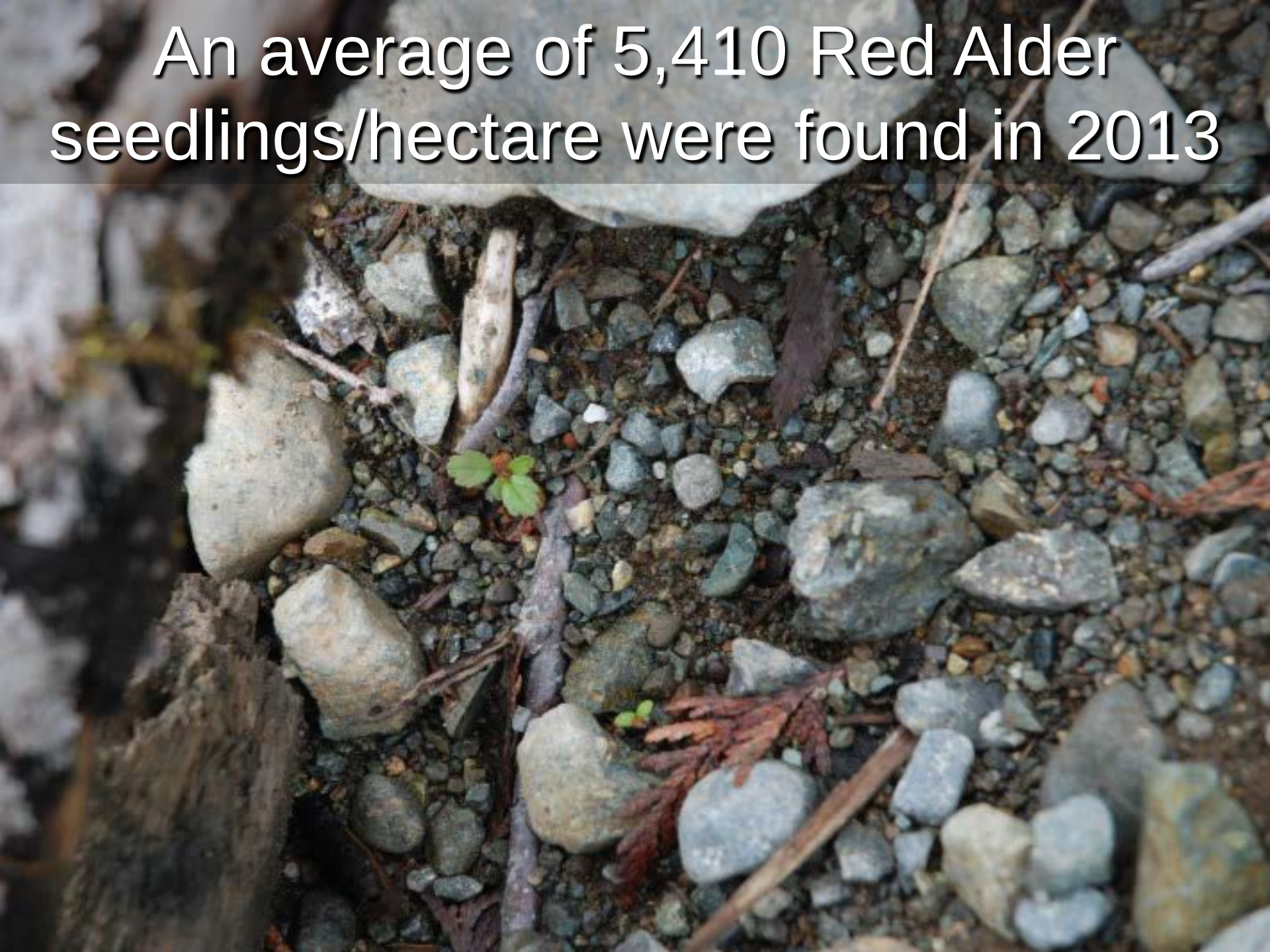


BC Hydro removed
the Heber River Dam and was faced with
the need to restore the disturbed sites


So we made project sites rough and loose and covered them with woody debris, October 7, 2012

Monitoring transects were established at 5 project locations, July 16, 2013

Woody debris is important for natural processes that bring in other species.


An average of 5,410 Red Alder seedlings/hectare were found in 2013

Including between the rocks of the rip-rap


These will grow to lock the rip-rap in place


By 2014 an average of 8,554 Red Alder seedlings/hectare (and 67 other species) were found


NONE OF THESE WERE PLANTED!
In 2015 an average of 5,392 Red Alder seedlings/hectare were found along with 80 other species.

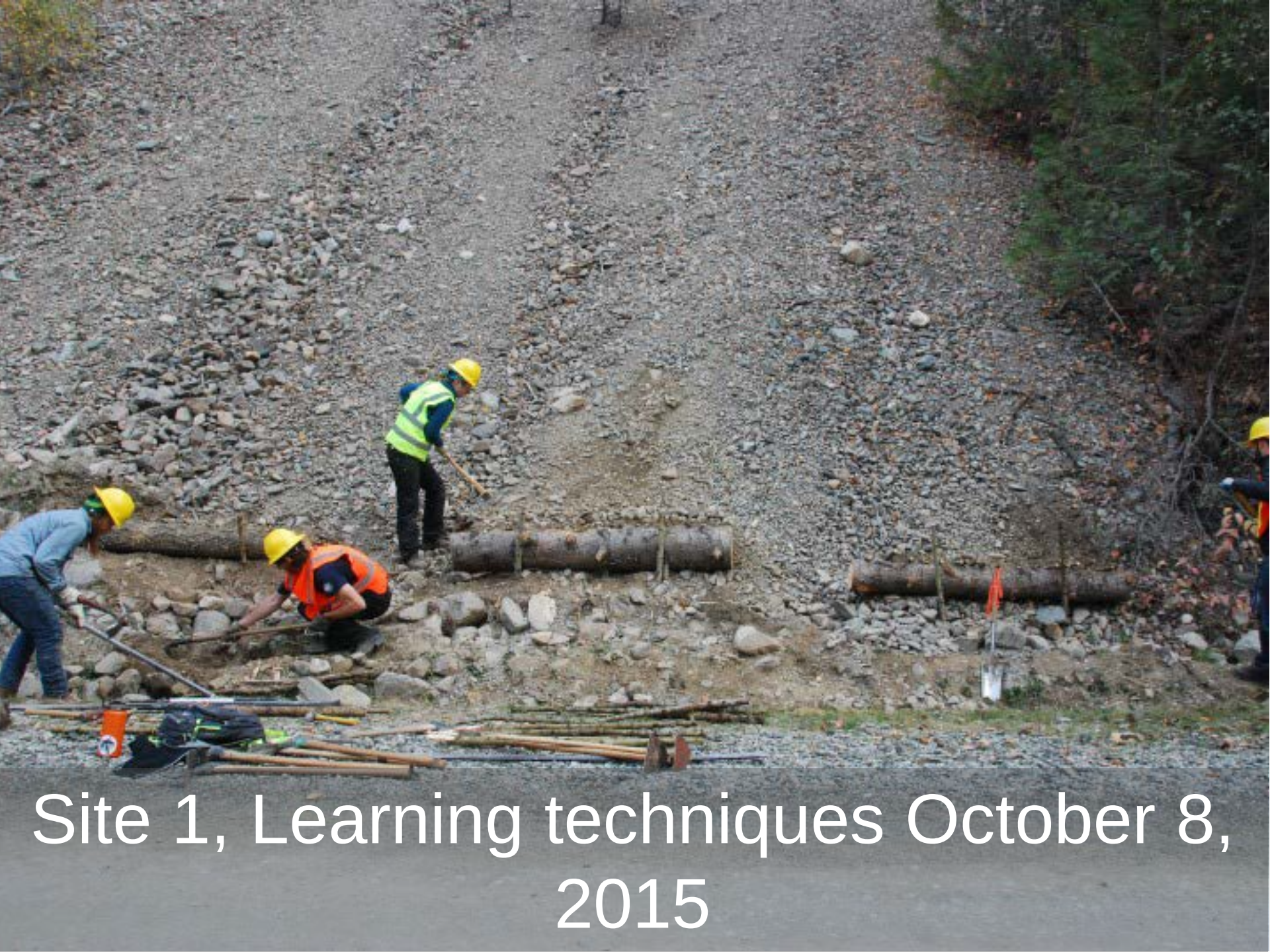

Sullivan Creek Landslides, Boundary Dam, Seattle City Light
Site 1, June 26, 2014

How do we fix this?

May 5, 2010

What is preventing recovery?

Site 1, June 25, 2014



Site 1, Learning techniques October 8, 2015

Site 1, Collecting cuttings, October 8, 2015

Site 1, Building up the slope, October 8, 2015

Site 1, Work completed for the year, October 29, 2015


Site 1, June 2, 2016

Site 1, Growing, June 2, 2016

Site 1, Growing, June 2, 2016


Site 2, June 25, 2014

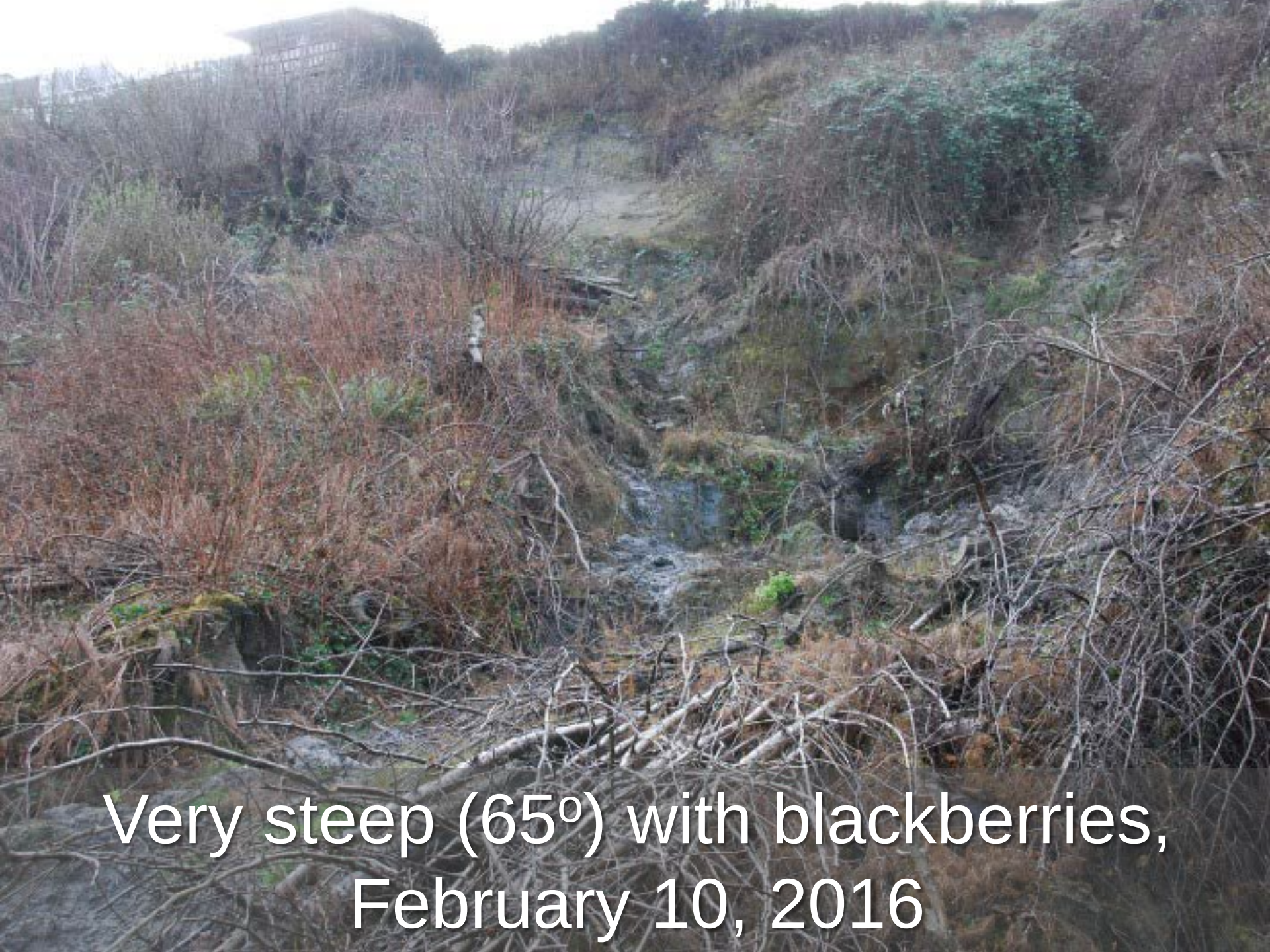
Strategy for treatment

Site 2, June 25, 2014

Site 2, Growing, June 2, 2016

Site 2, Growing, June 2, 2016

Juniper Place Landslide Restoration


Very steep (65º) with blackberries,
February 10, 2016

Lots of seepage water, February 12, 2016

Some compacted soils, February 12, 2016


This is a large slide, February 22, 2016


February 22, 2016

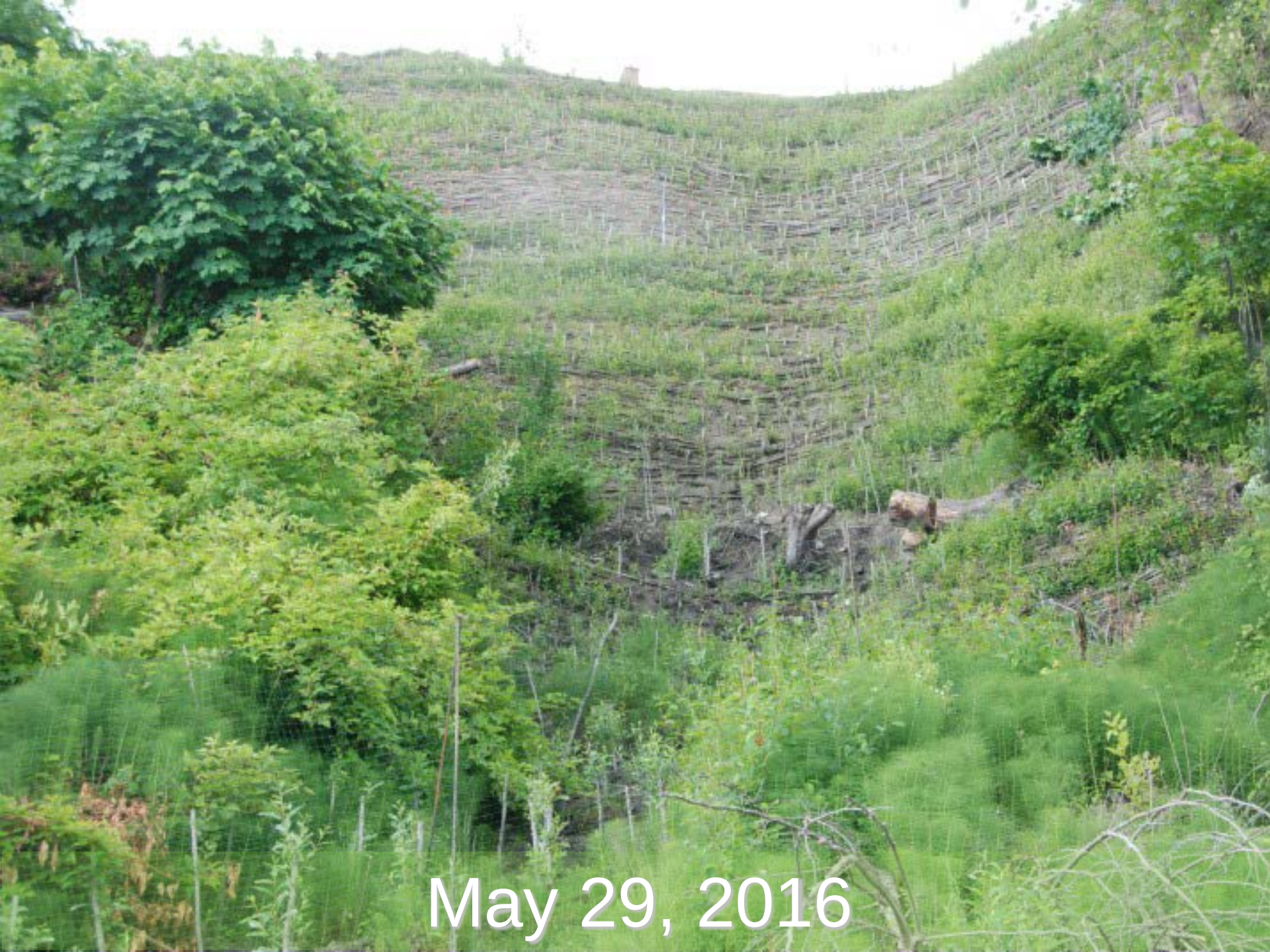

March 5, 2016


March 31, 2016

Done!

April 10, 2016


Growing
May 13, 2016


May 29, 2016

Natural processes provide solutions to even the toughest restoration problems

Questions ???

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