

Natural Processes for the Restoration of Drastically Disturbed Sites

A close-up photograph of a purple flower with a yellow center, with a bumblebee on it. The flower has many thin, light purple petals radiating from a bright yellow, textured center. A bumblebee is perched on the yellow center, its body angled towards the top right. The background is a soft, out-of-focus green, suggesting foliage.

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

Frank Slide


Over time natural processes “restore”
these sites

14 10 2007



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

14 10 2007



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

28 6 2005


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



A photograph of a construction or mining site. In the foreground, two workers wearing hard hats and high-visibility vests are walking on a dark, gravelly surface. One worker is in the center, facing away from the camera, wearing a blue hard hat and an orange vest with a yellow 'X'. Another worker is further ahead, also in a high-visibility vest. To the left, a large blue crane or conveyor system is visible. In the background, there is a large, steep pile of dark gravel or rock, and a line of green trees on a distant hill under a blue sky with scattered clouds.

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



June 18, 2014



Shallowly rooted grasses provide no support for slope.

The hill was re-sloped.

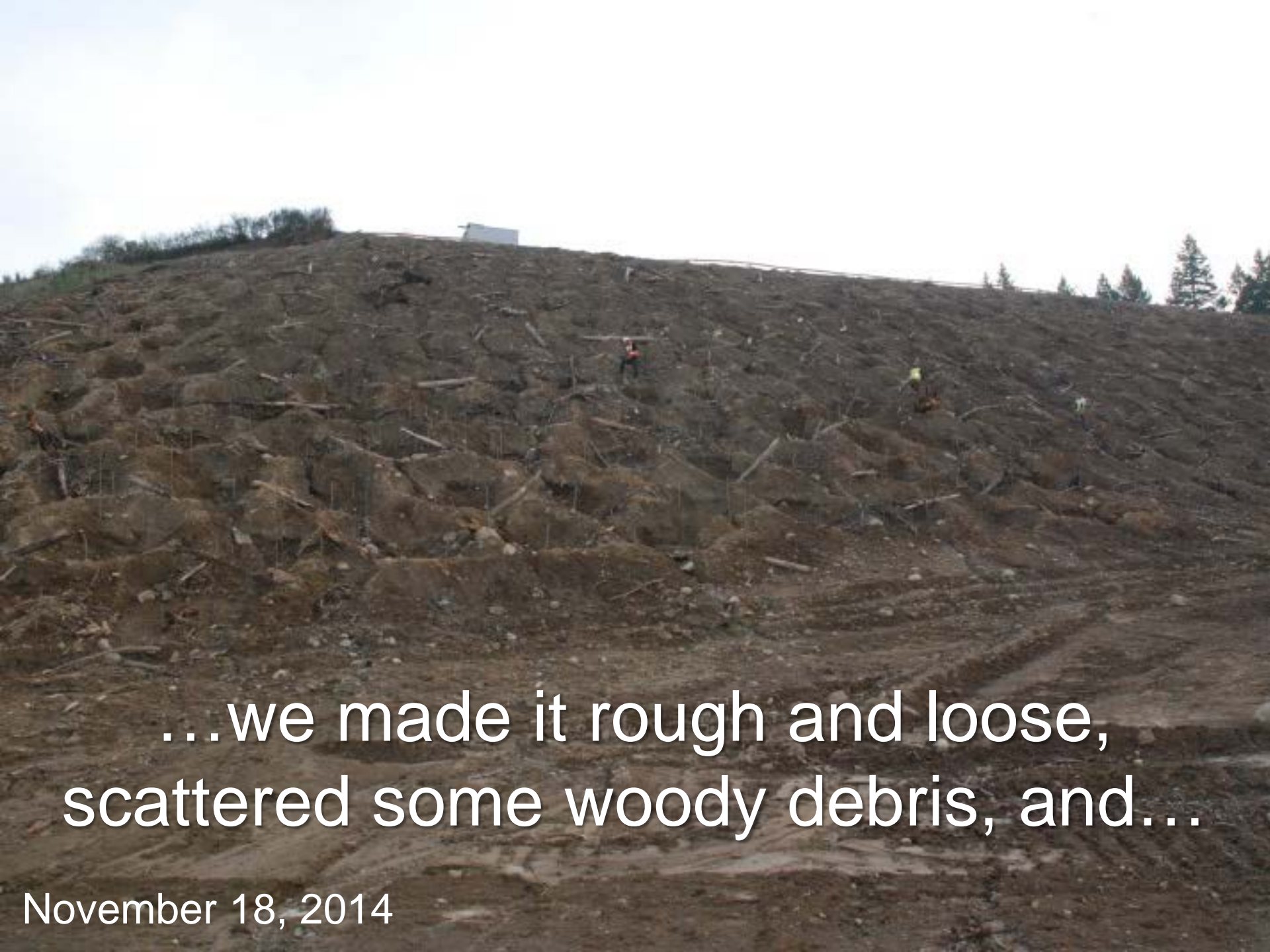


September 6, 2014




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

A photograph showing three workers in safety gear (hard hats, orange vests) installing live stakes into a steep, eroded soil slope. One worker is kneeling in the foreground, another is standing in the middle ground, and a third is standing on the right. The slope is covered with loose soil and some debris. The background shows a forest of evergreen trees.

...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



A photograph of a forested hillside. The foreground is dominated by dense green vegetation, including tall grasses and shrubs. A dirt path or road winds through the middle ground, leading towards a rocky outcrop. The background shows a dense forest of evergreen trees, with distant mountains visible under a clear blue sky.

May 10, 2016

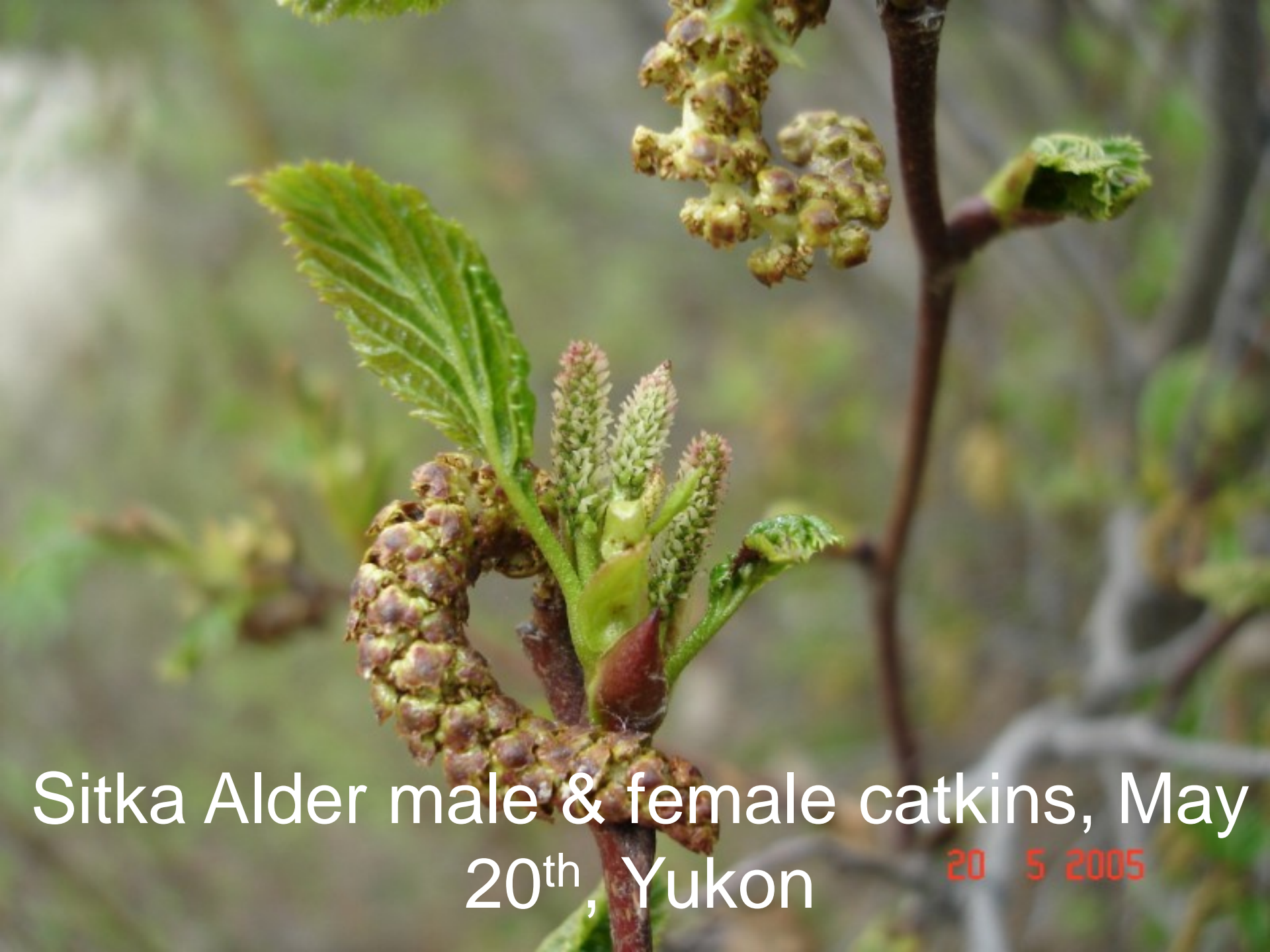
This site is sequestering 20 to 25 tonnes/ha of CO₂ annually

Alder Seeding

A photograph of Red Alder male catkins. The catkins are long, cylindrical, and covered in small, reddish-brown flowers. They hang from thin, brown branches. The background is a blurred landscape with green hills and a cloudy sky.

Red Alder male catkins, March 17th,
Vancouver Isl.

17 3 2006

A close-up photograph of a Sitka Alder branch. The branch features several catkins: a large, elongated, brownish-green male catkin in the lower center, and a smaller, more compact, yellowish-brown female catkin at the top. Fresh green leaves with serrated edges are emerging from the branch. The background is a soft-focus view of other branches and foliage.

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

20 5 2005

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 51.3°)

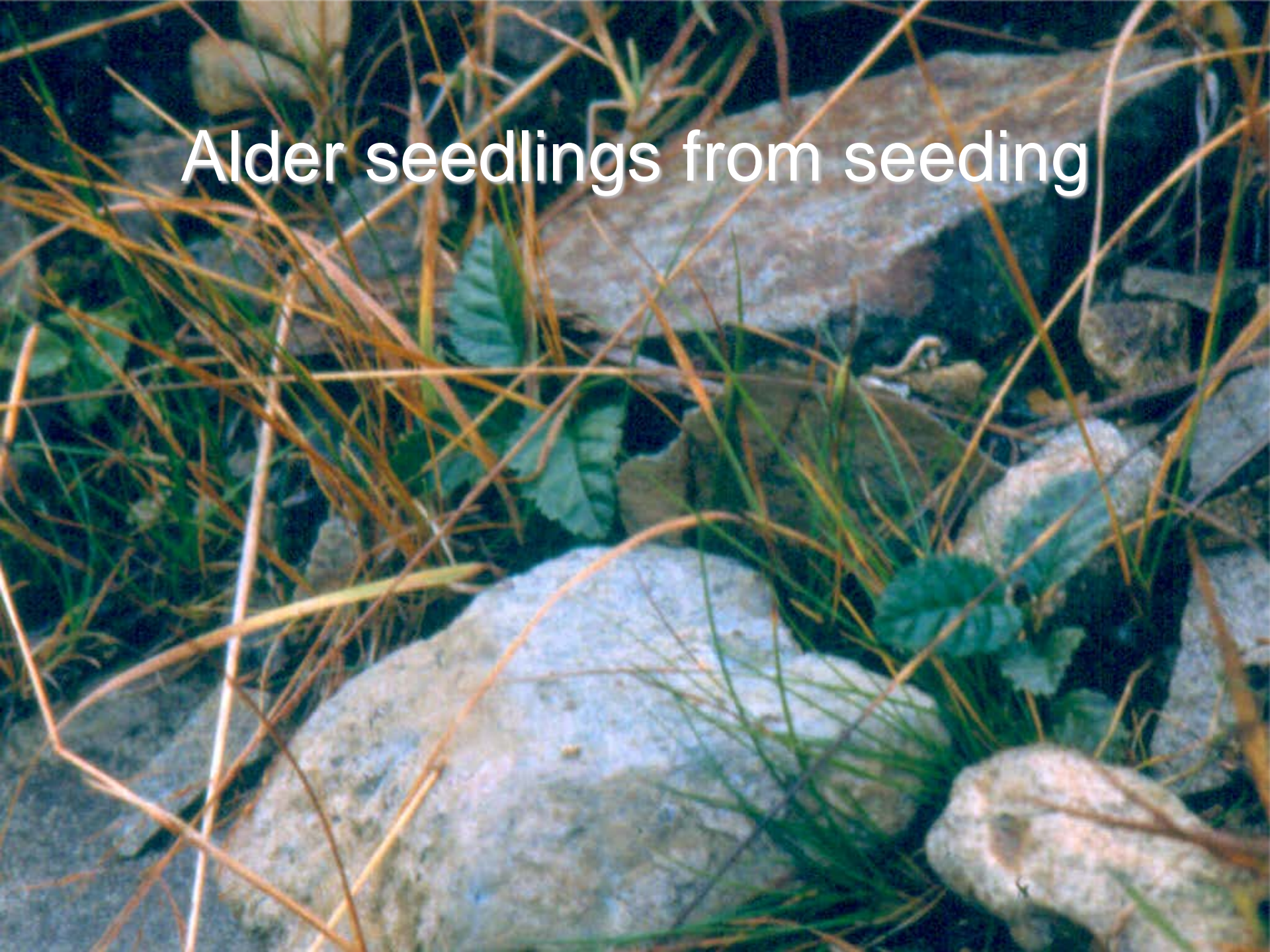


A photograph showing a person in a yellow safety vest and helmet standing on a steep, grassy hillside. They are holding a long hose that extends down the slope, likely for seeding. The hillside is covered in green grass and some small plants. In the background, a dense forest of tall evergreen trees is visible under a clear sky.

Seeding Sitka alder, October 30, 1986

'86 10 30

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

'99 7 16



Alder seeded slope, July 9, 2005

9 7 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



May 15, 2014



Sitka Alder seedlings from Johnson's
Landing Slide aerial seeding



September 12, 2014

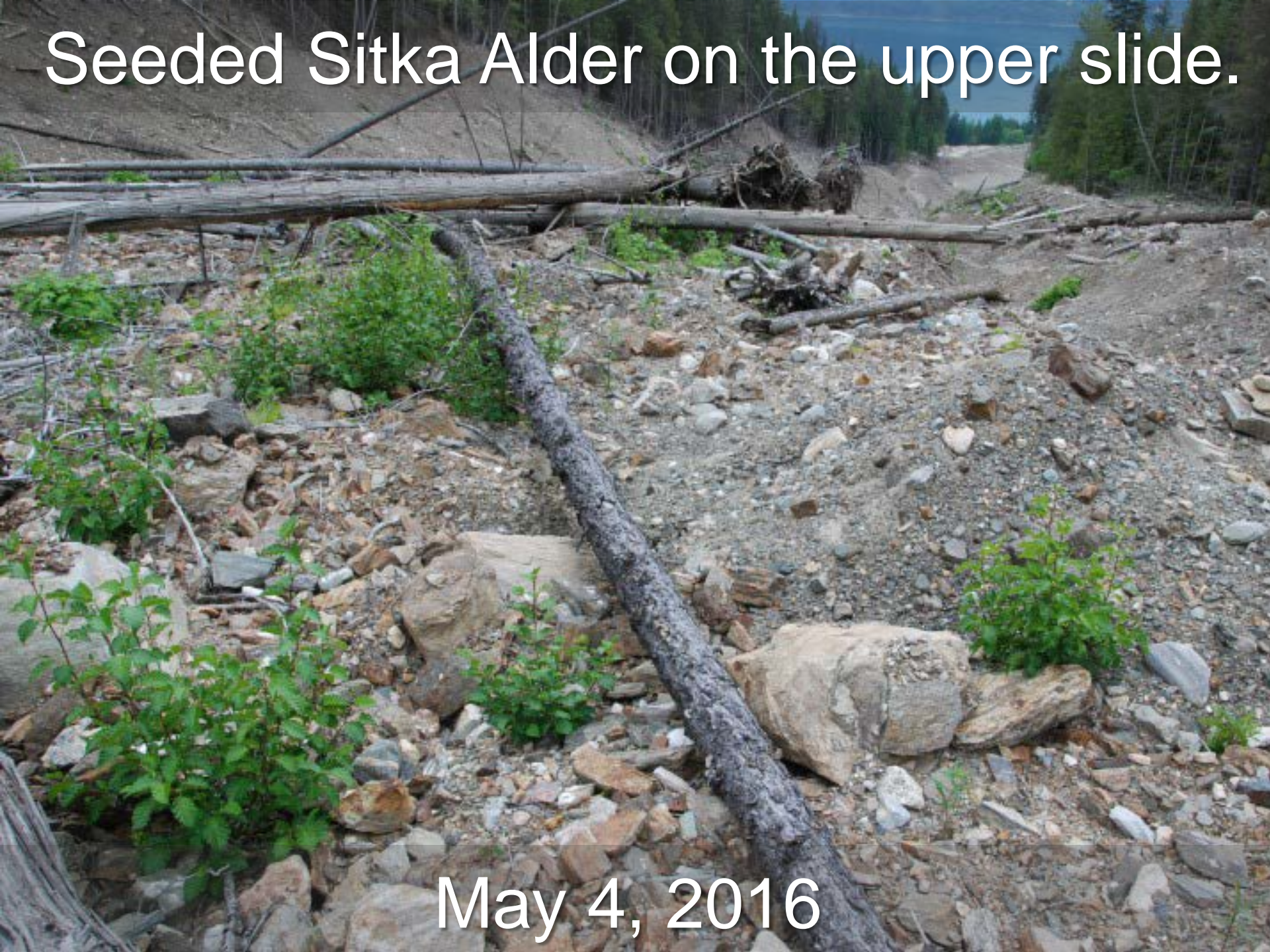
Alder seedling on Johnson's Landing
Slide from helicopter spread seed

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 successional stagnant grasses and legumes

29 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



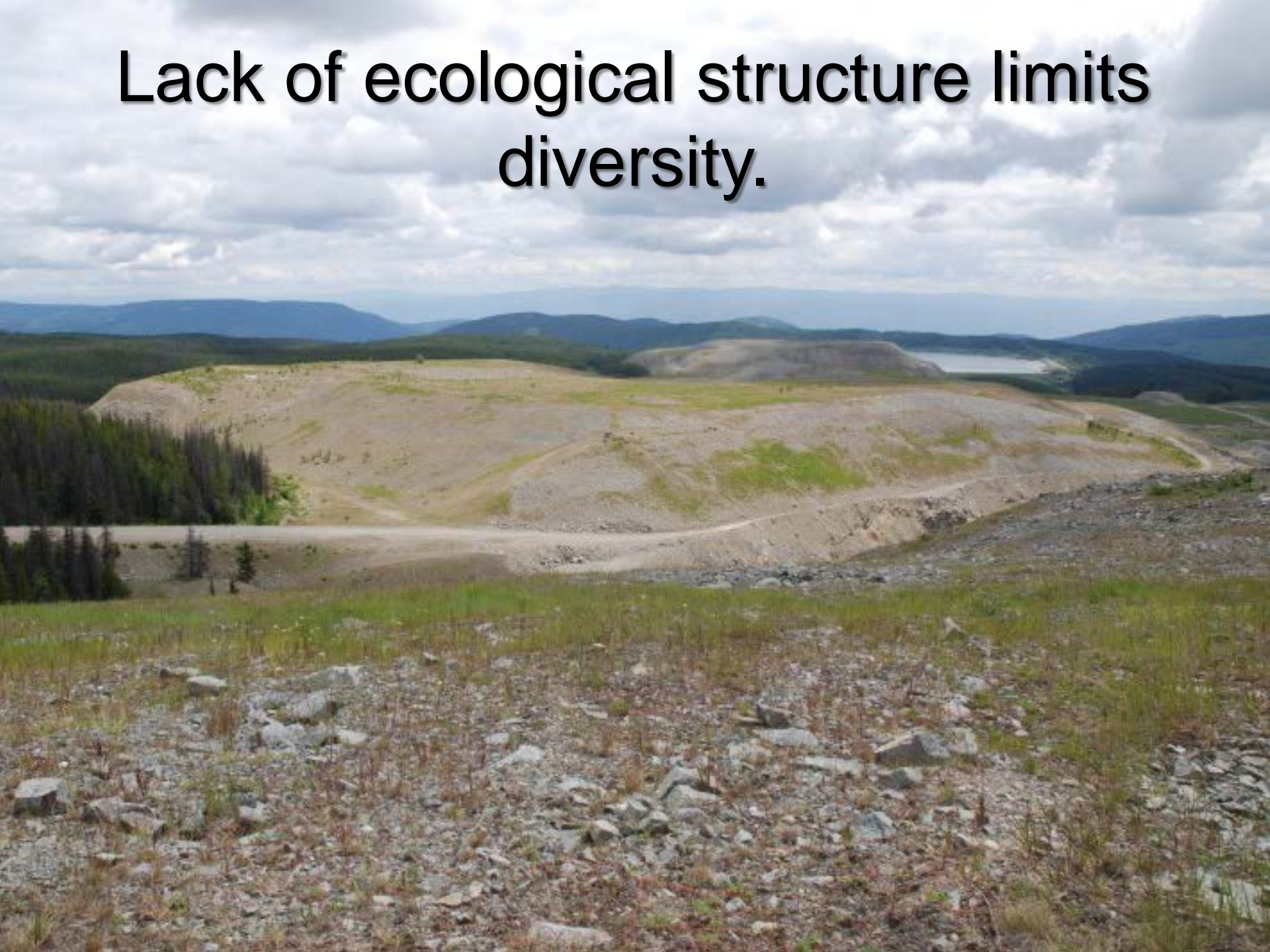


These animals reduce shrub cover,
limiting nesting habitat for songbirds

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



28/04/2012 00:00

The loose substrate provides opportunities for live staking





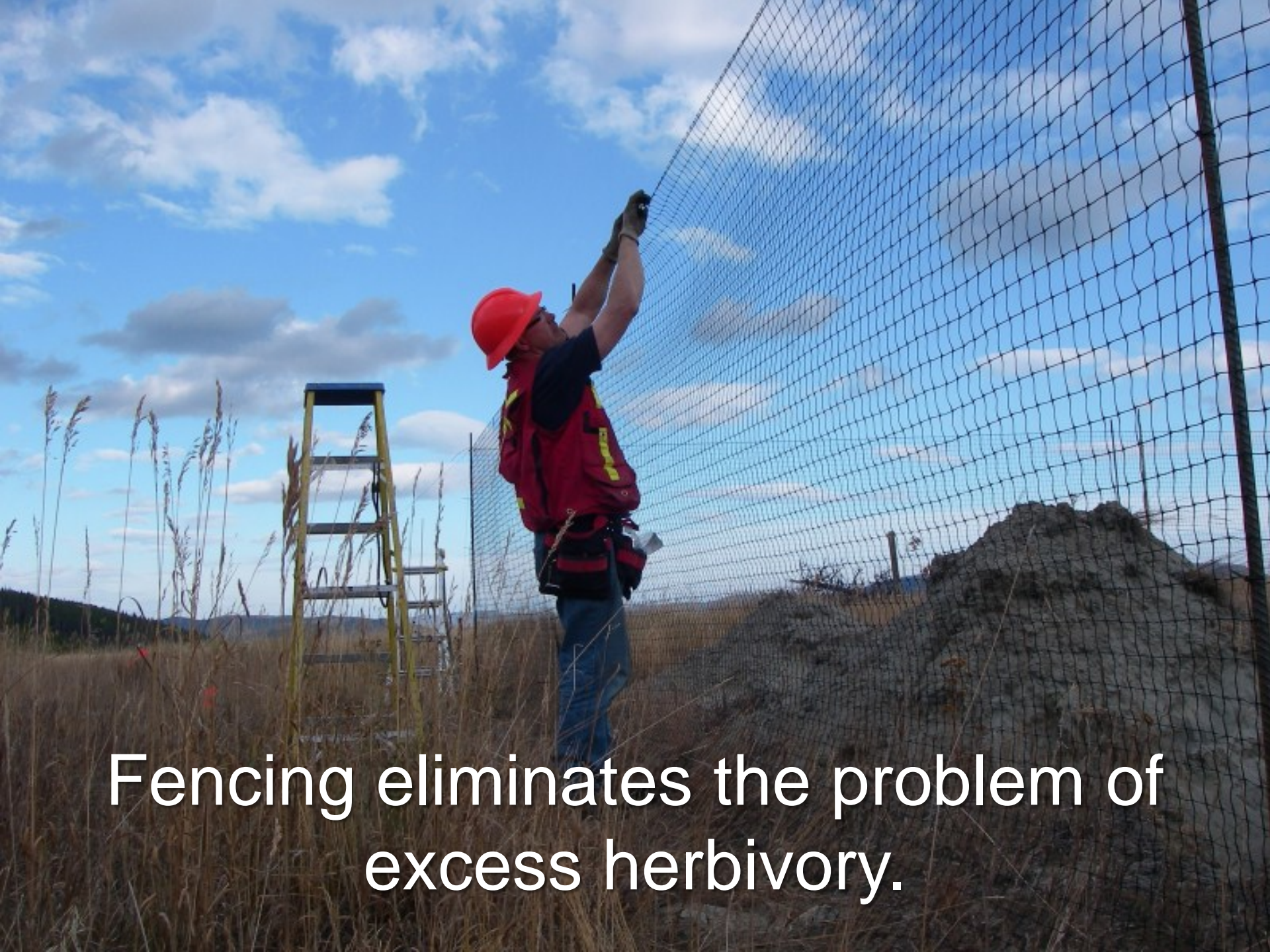
Even on waste rock sites the rough and loose treatment makes live staking easy.

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*.



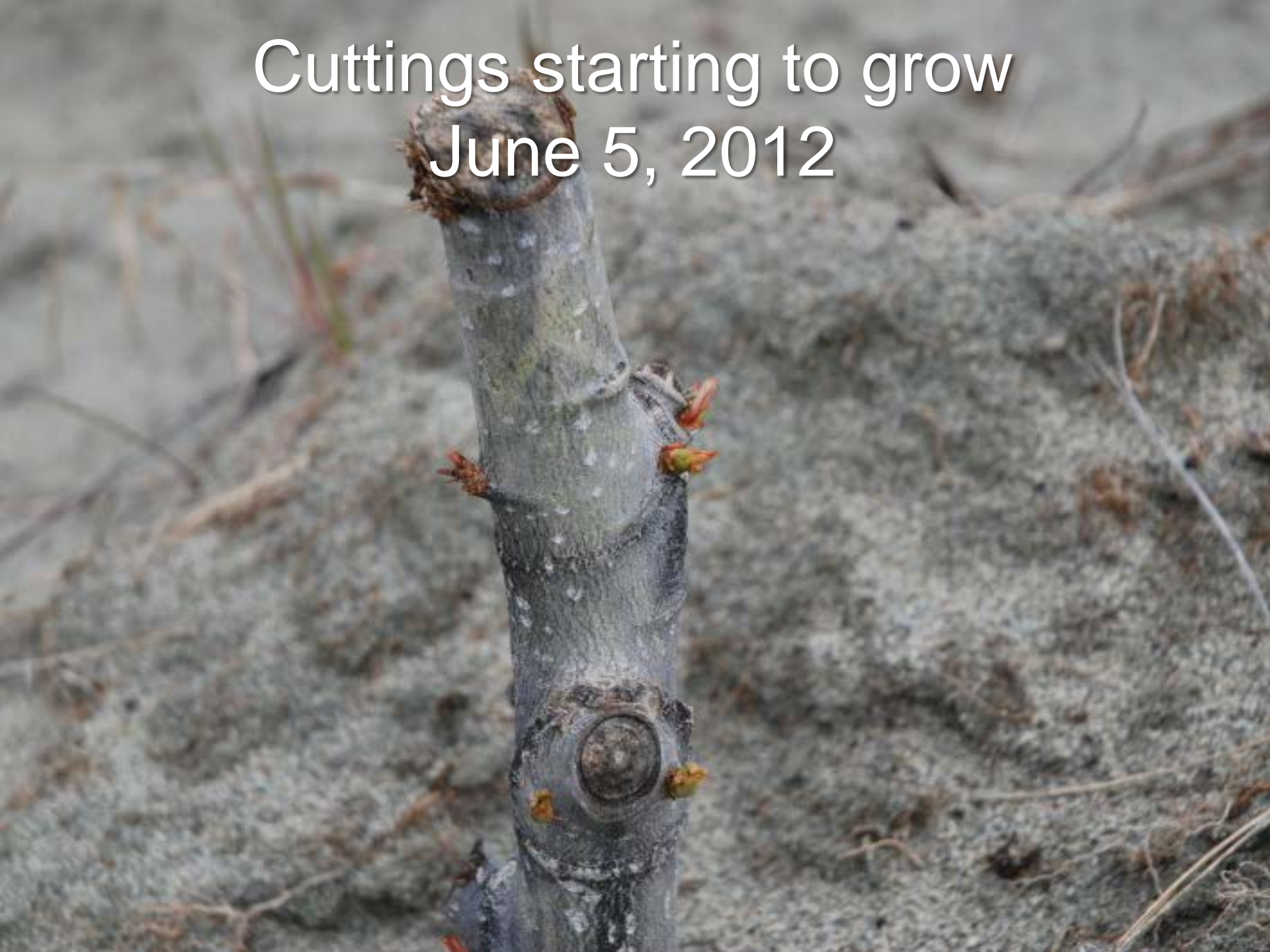
*Can build social licence.

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

14 4 2010



Planting pioneering vegetation,
April 14, 2010

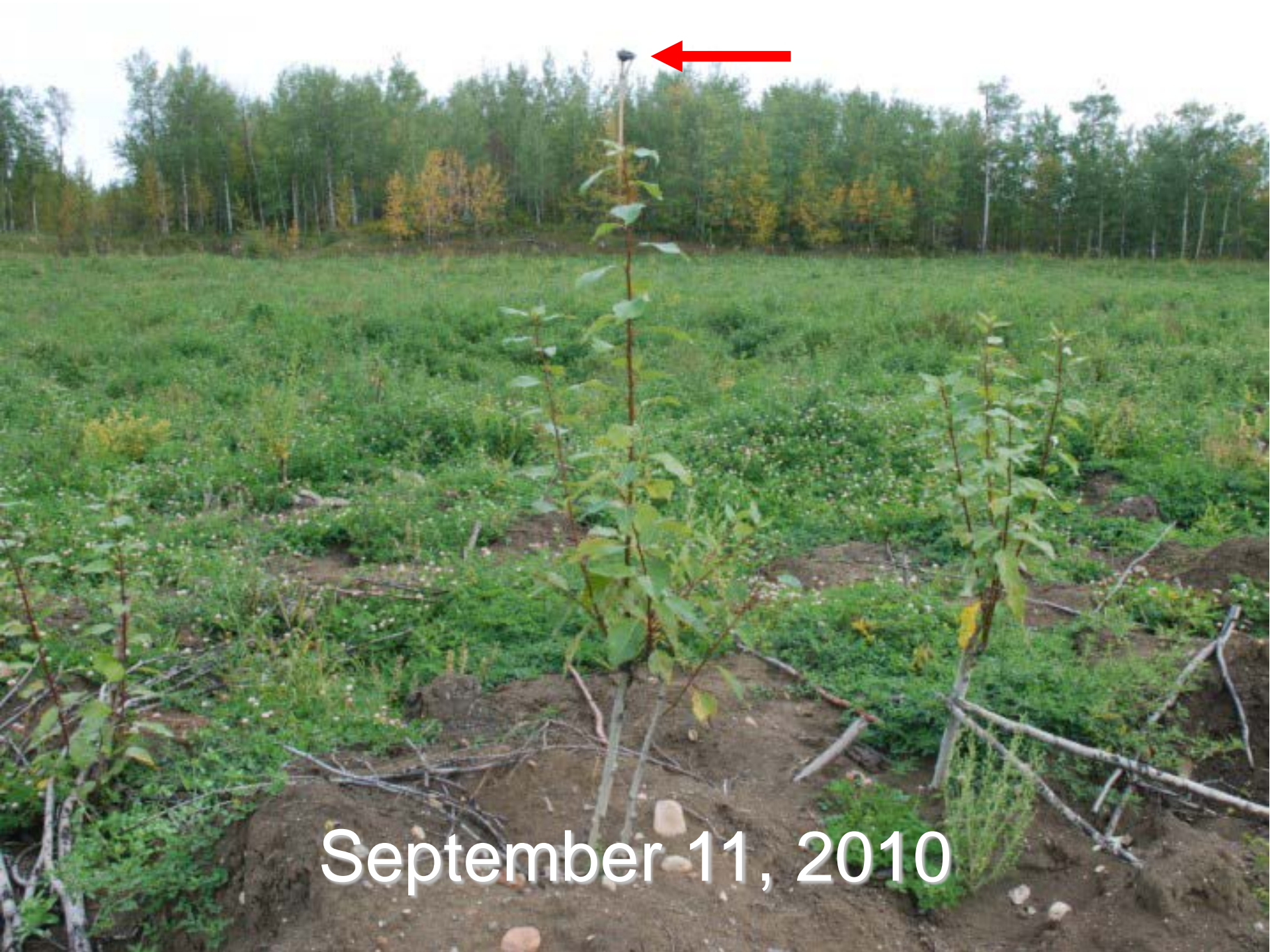


Planting pioneering vegetation,
April 14, 2010, note fence.

10 4 2010

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



1 3 2013

August 17, 2013



February 24, 2015



September 25, 2015



September 25, 2015



Six growing seasons after restoration

February 23, 2016



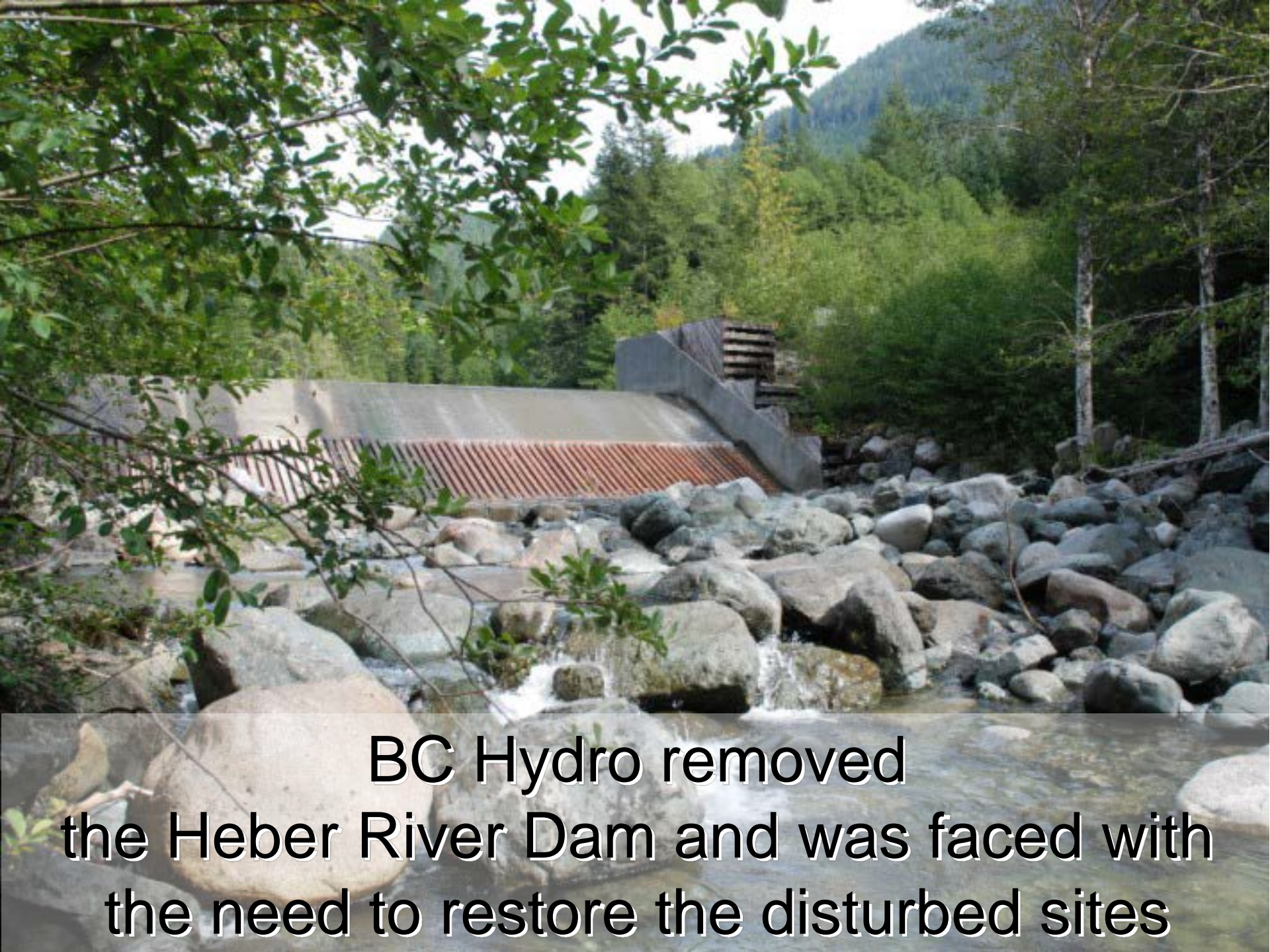
The use of natural processes can provide cost-effective solutions for the restoration of drastically disturbed sites.

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



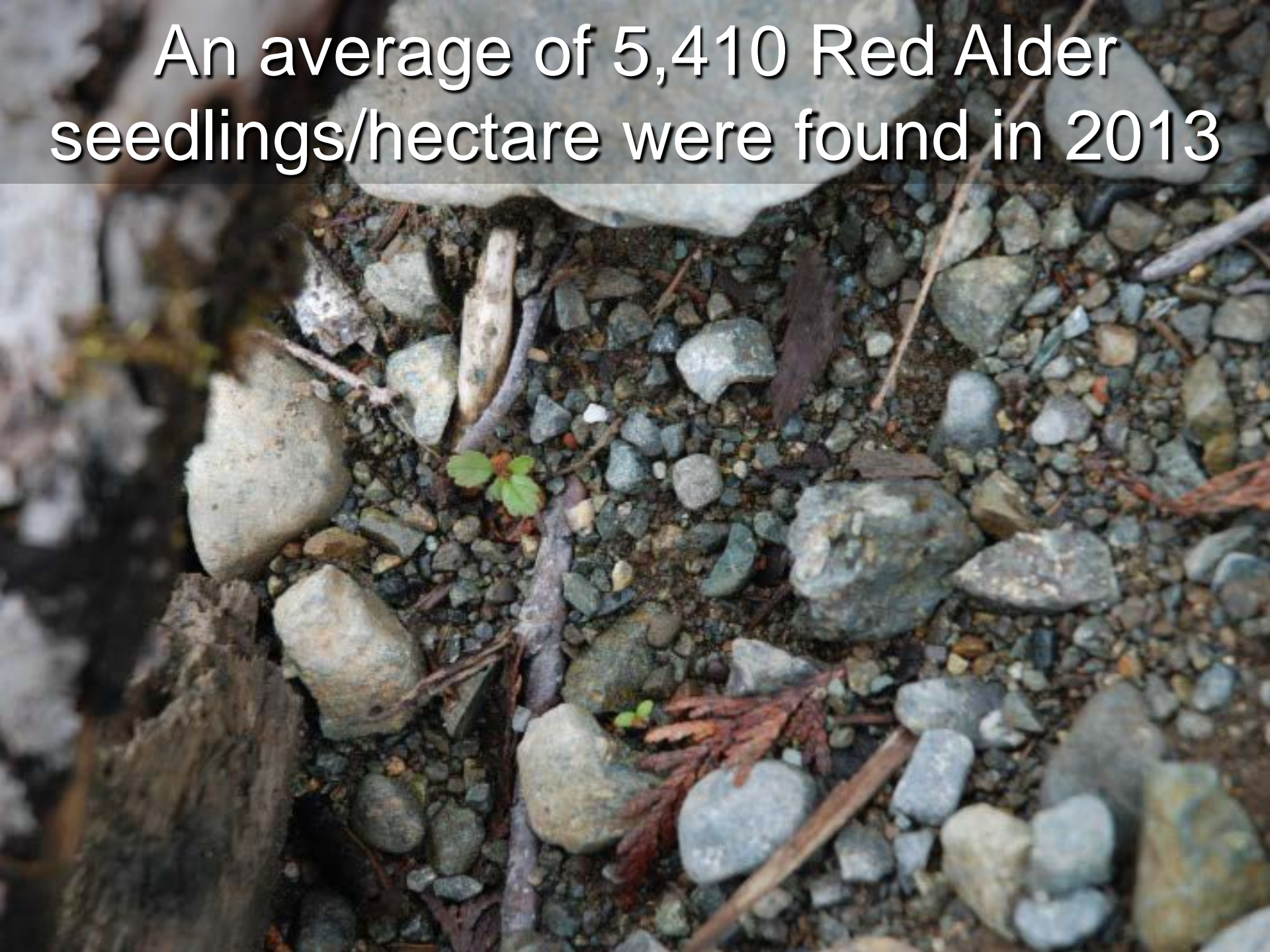
Monitoring transects were established
at 5 project locations, July 16, 2013



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 (65°) 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!

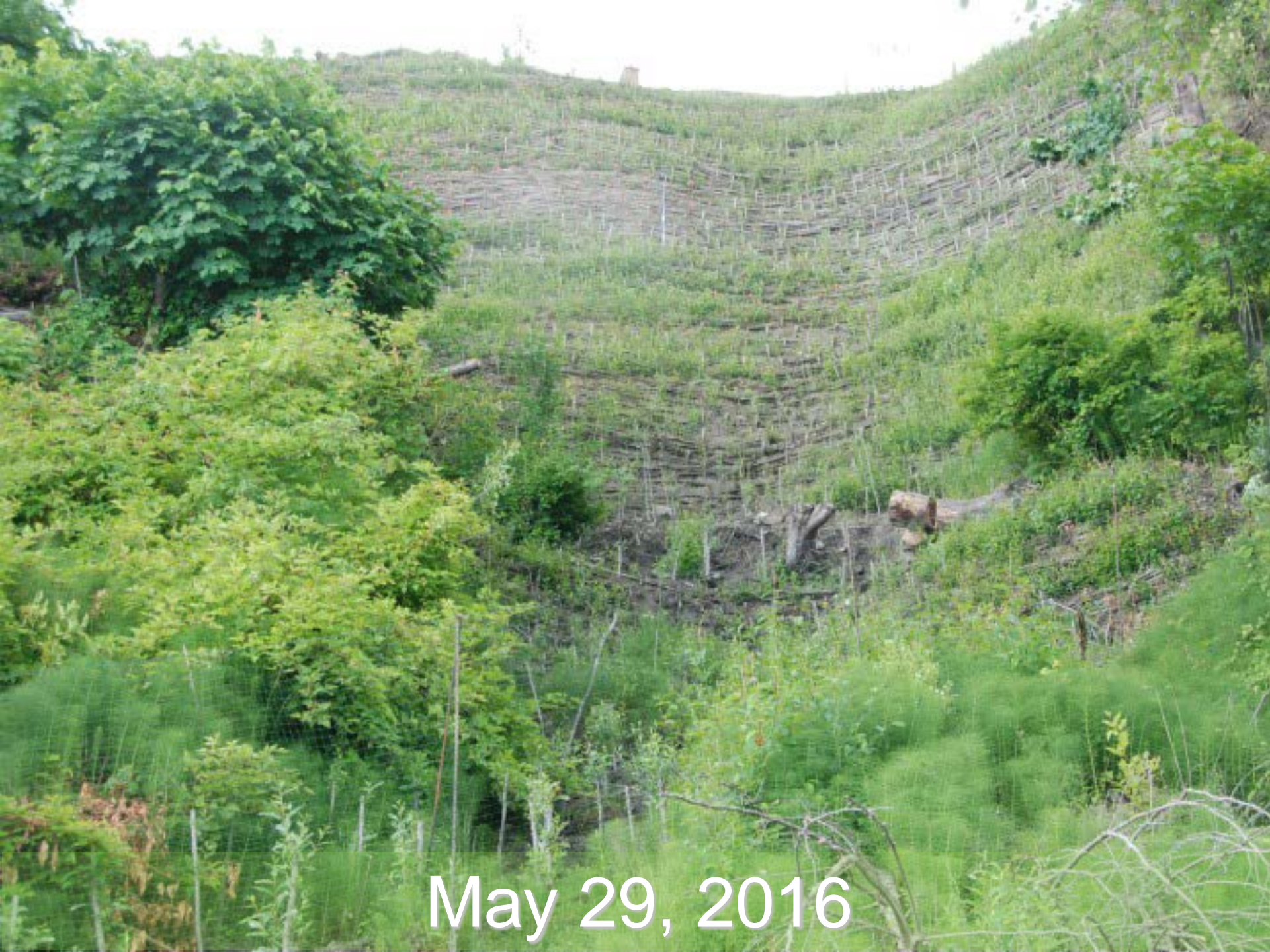
April 10, 2016



Growing

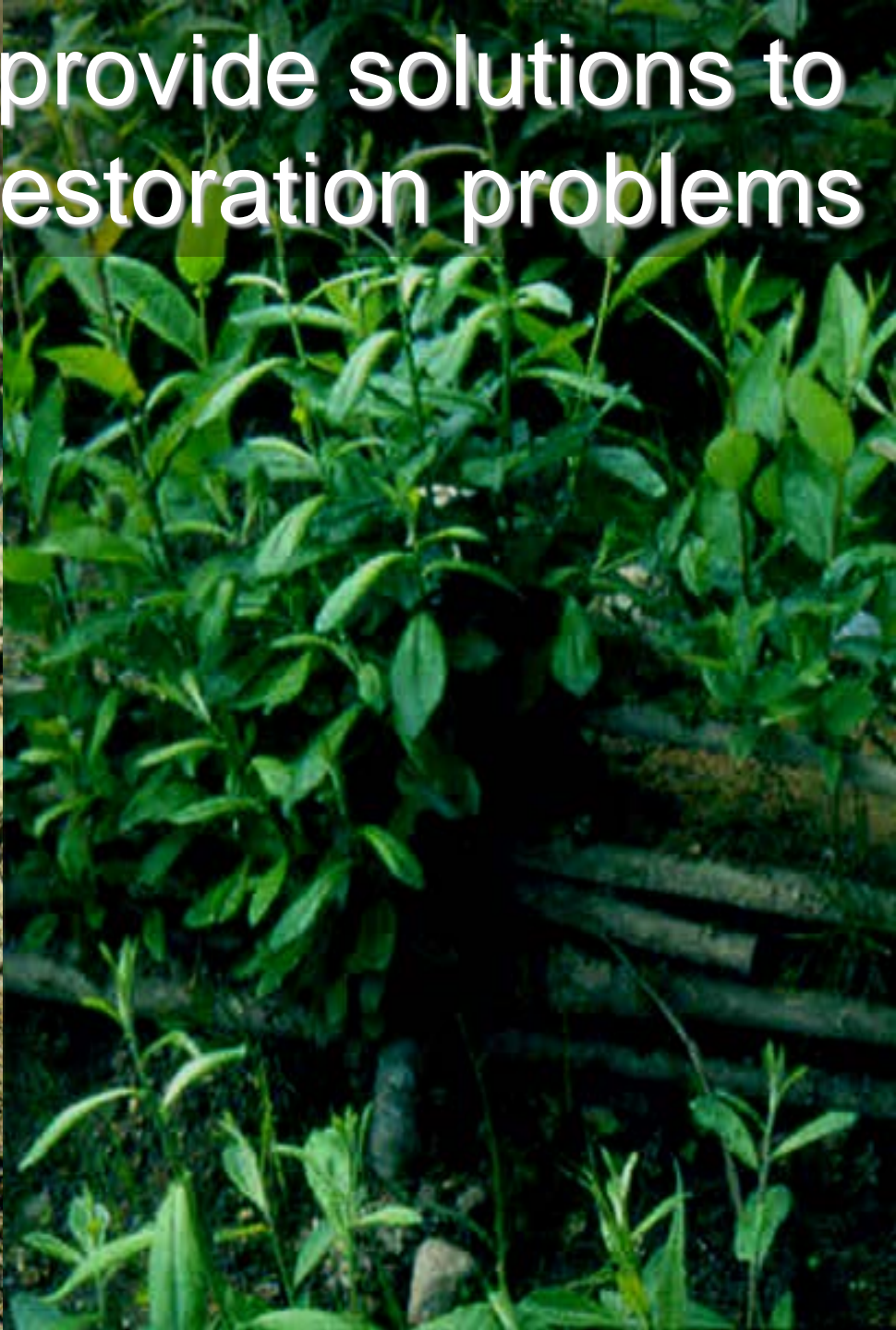
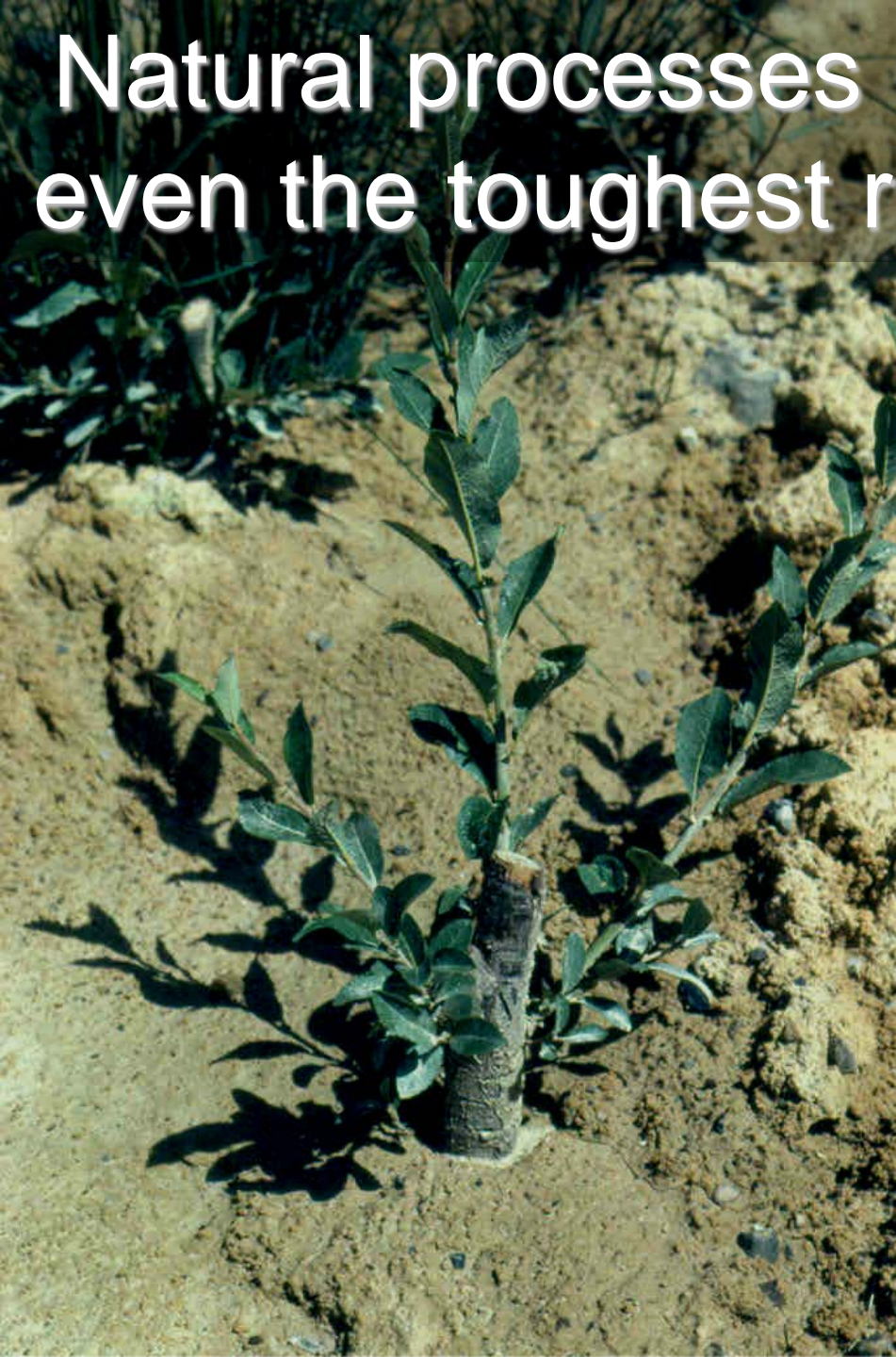
A photograph of a steep hillside covered in a dense grid of young green plants, likely a reforestation project. The hillside is surrounded by mature trees and shrubs. The sky is clear blue.

May 13, 2016



May 29, 2016

Natural processes provide solutions to even the toughest restoration problems



Questions ???



Contact: d.polster@telus.net