

A photograph of a lush field filled with numerous yellow and purple wildflowers, likely daisies and lupines, growing densely together. In the background, several trees with green foliage are visible, suggesting a woodland or park setting. The overall scene is vibrant and natural.

PHYSICAL AND MECHANICAL ACTIONS TO RESTORE SOIL STRUCTURE

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Ecological Restoration is the process of **assisting** the recovery of an ecosystem that has been degraded, damaged, or destroyed.

Common abiotic filters:

Steep slopes

Adverse texture

Nutrient status (+/-)

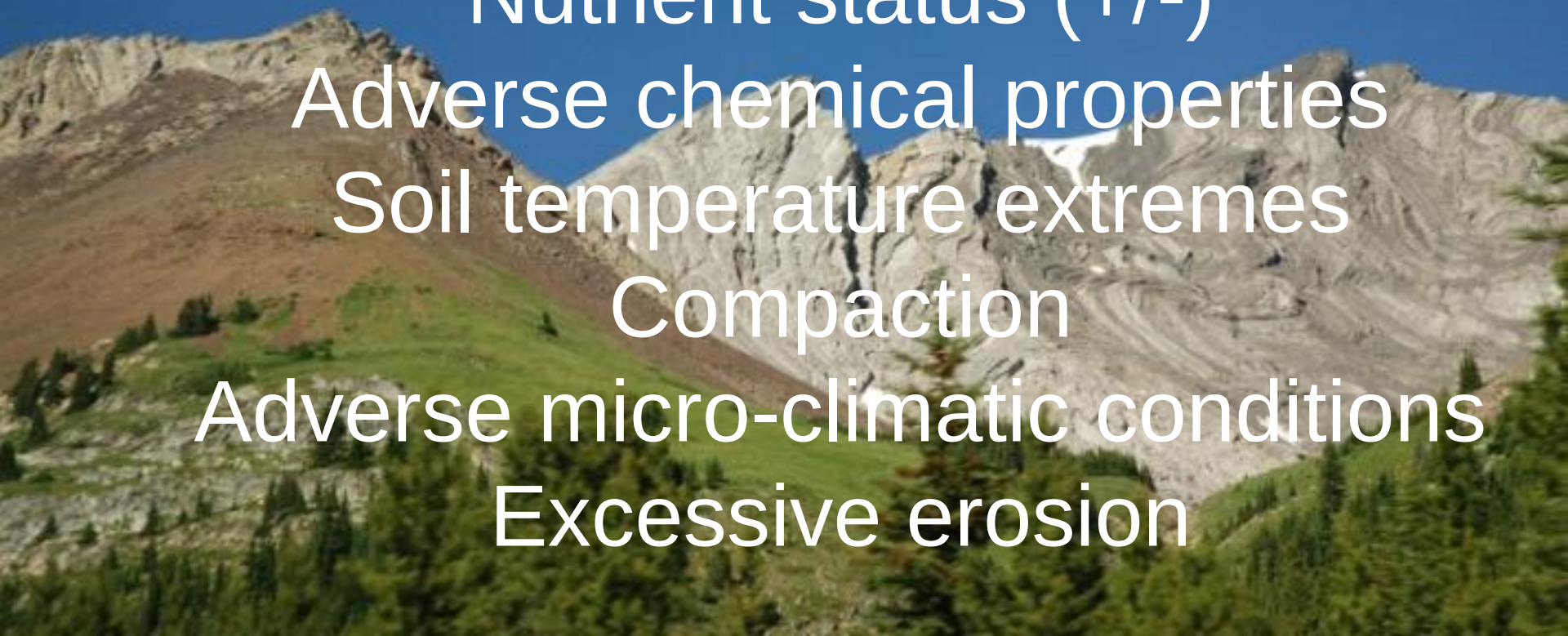
Adverse chemical properties

Soil temperature extremes

Compaction

Adverse micro-climatic conditions

Excessive erosion



Common biotic filters:

Herbivory
Competition
Propagule availability
Phytotoxic exudates
Facilitation
Species interactions

Spotted Knapweed

Centaurea maculosa

Let's look at how natural systems
address the limitations or filters
preventing natural recovery of
disturbed sites.



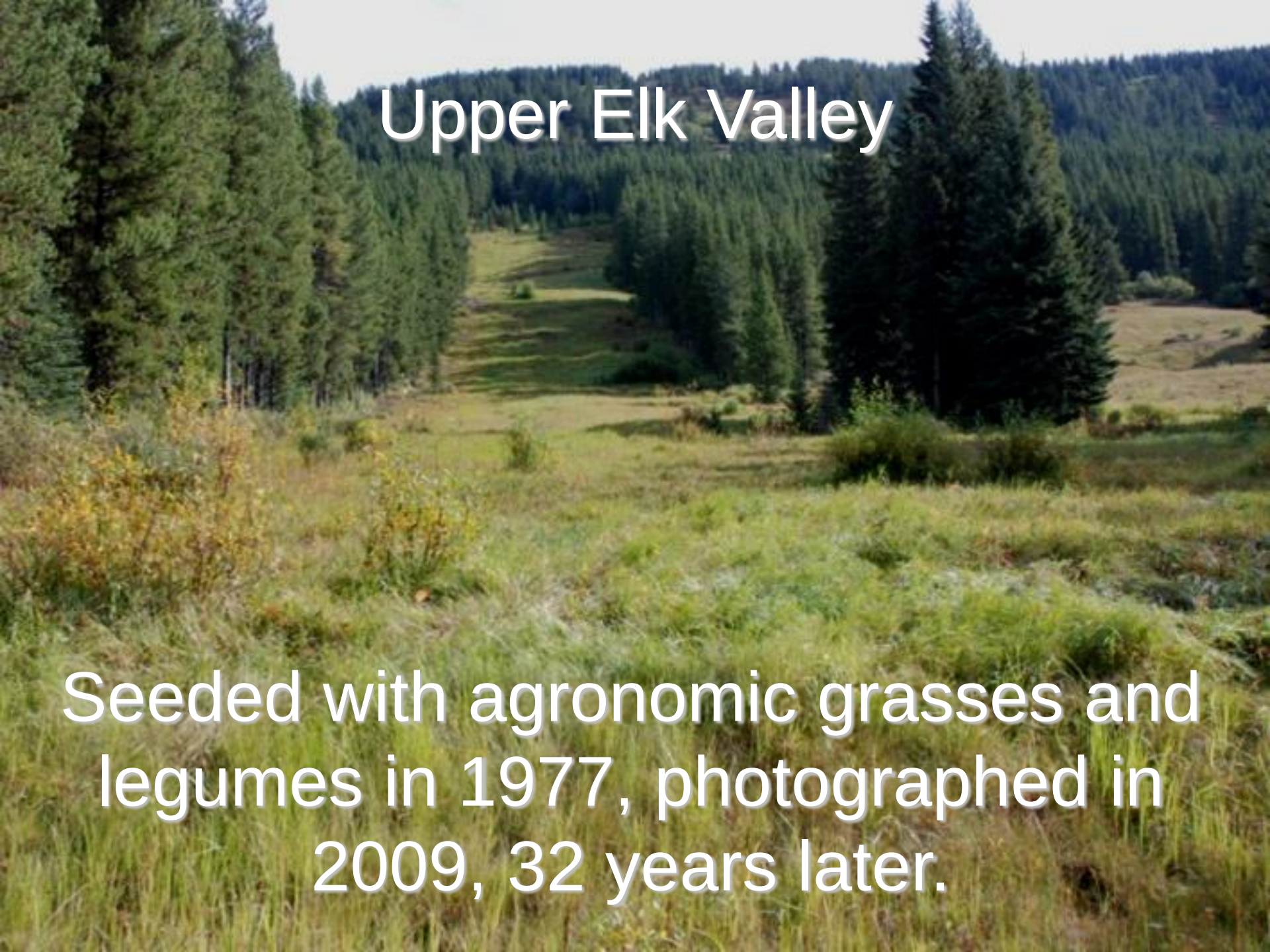
Erosion is one of our most significant
problems

Burrowing Owl



Helicopter seeding
exploration trench
in the Upper Elk
Valley in the fall of
1977

Upper Elk Valley



Seeded with agronomic grasses and legumes in 1977, photographed in 2009, 32 years later.

Upper Elk Valley

The agronomic grasses and legumes we have been using for reclamation prevent effective recovery of these sites.

11 7 2005

How can we deal with erosion without grass and legume seeding?



Spreading soil material...

“D 10” Bulldozer



Erosion starting on smooth surface
before spreading is even completed.



Making the surface rough and loose



Roughened the whole surface



Cost of rough and loose treatment at Kemess Mine was \$715/ha while hydroseeding costs over \$2,500/ha

Making surfaces rough and loose controls erosion and enhances native species establishment.



Northern BC, September 22, 2014

Rough and Loose Restoration
Treatments

Creating ideal conditions for vegetation growth.



NE Alberta

August 27, 2012



A photograph of a sandy dune with sparse vegetation. The dune is covered with small, green, bushy plants and patches of dry grass. In the background, a line of trees is visible, including several tall, thin, bare trees and some evergreens. The sky is overcast with grey clouds.

Happy willows...

NE Alberta,
September 10, 2014



Gas plant site 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

August 19, 2011



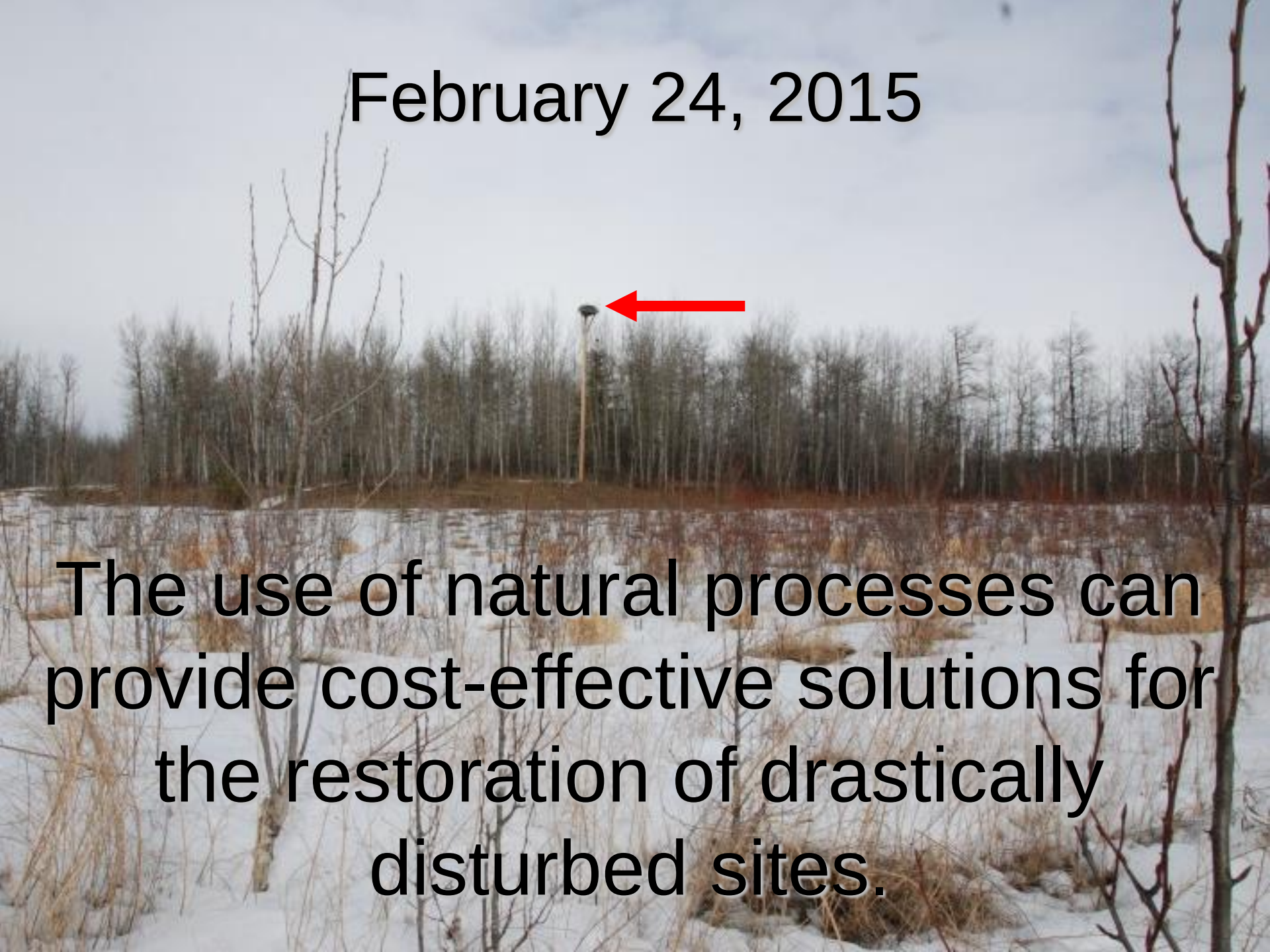
Two growing seasons

Happy Balsam Poplar...

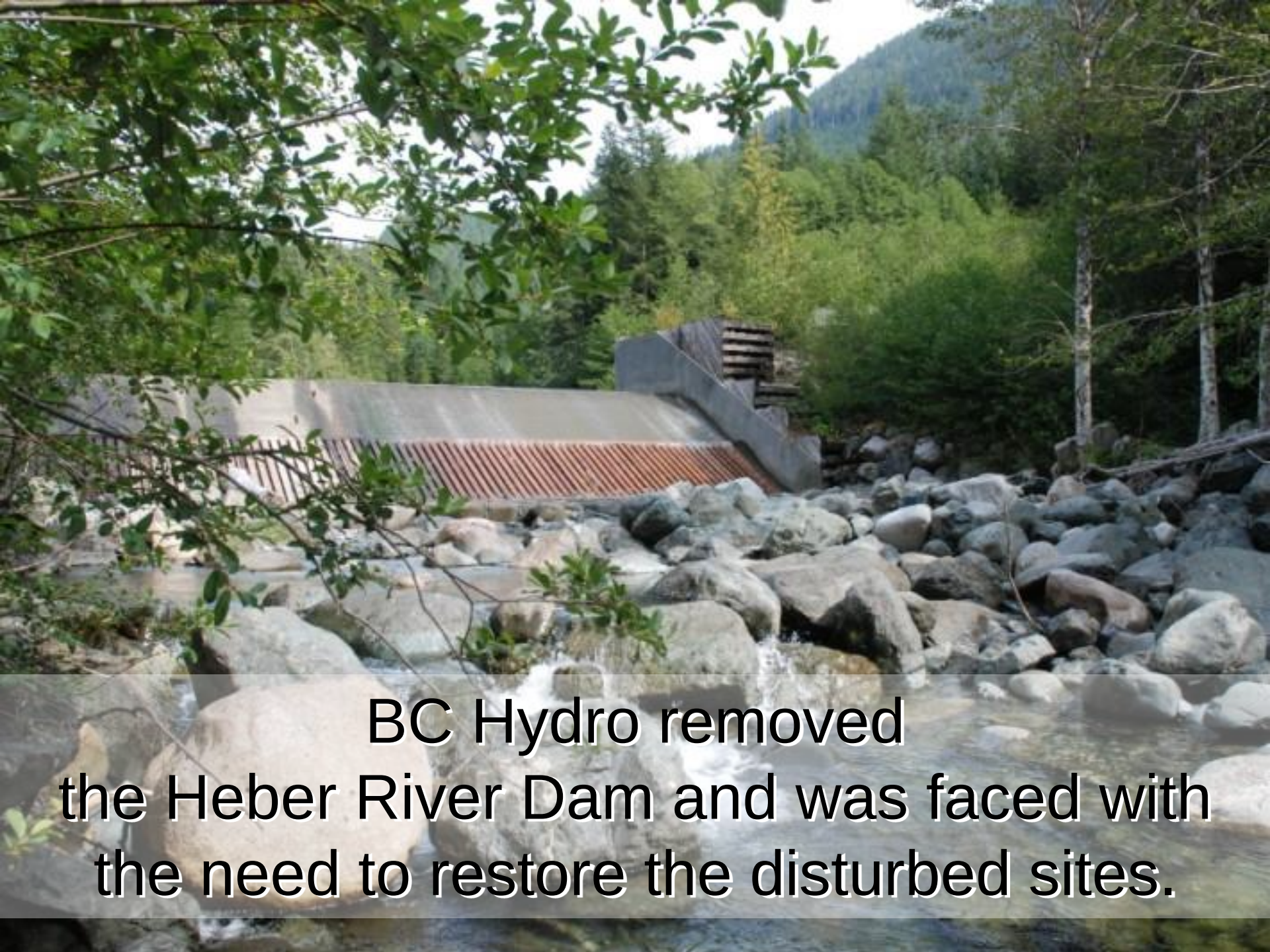


August 17, 2013

February 24, 2015



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



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

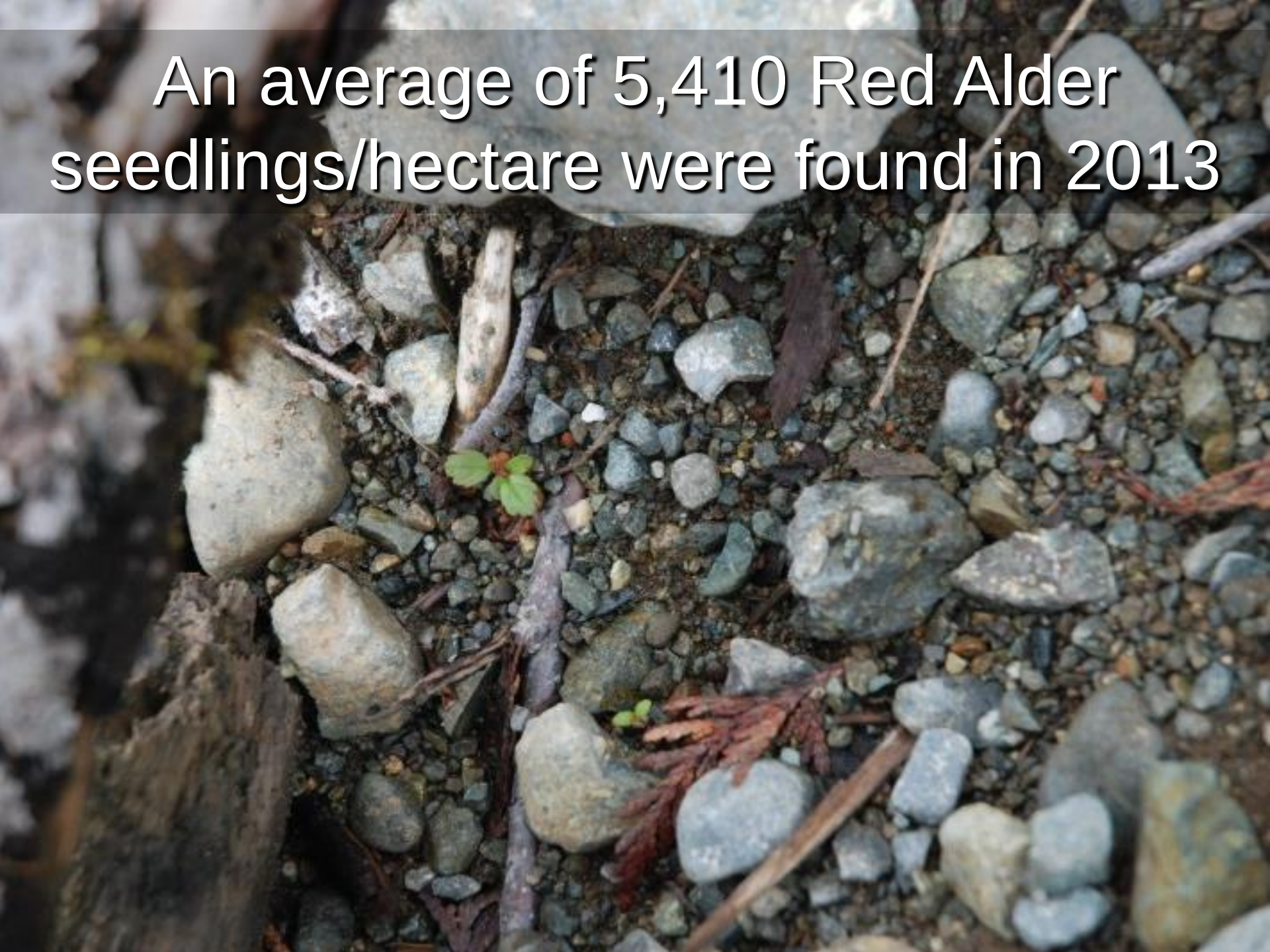
So we made project sites rough and loose and covered them with woody debris, October 7, 2012.



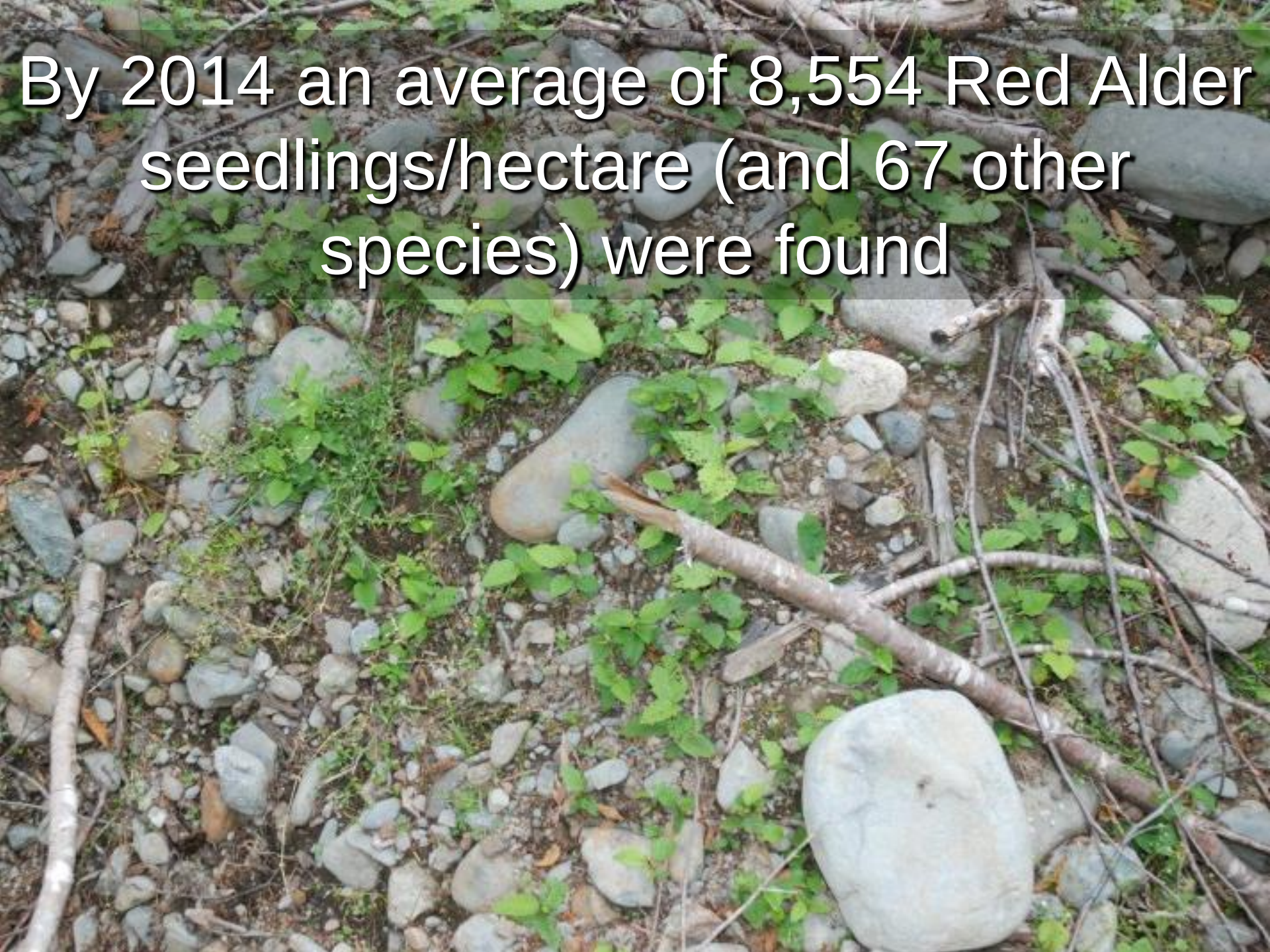
Monitoring transects were established
at 5 project locations, July 16, 2013.



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



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





In 2015 an average of 5,392 Red Alder seedlings/hectare were found along with 80 other species

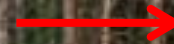
July 16, 2013



July 23, 2014



July 6, 2015



Mount Tuam Road Restoration



A photograph of a dirt road in a forest. The road is composed of loose, reddish-brown soil and is uneven, with several large mounds of earth and rocks. The road is flanked by dense green foliage and trees. The text "Rough and loose road" is overlaid in white at the top of the image.

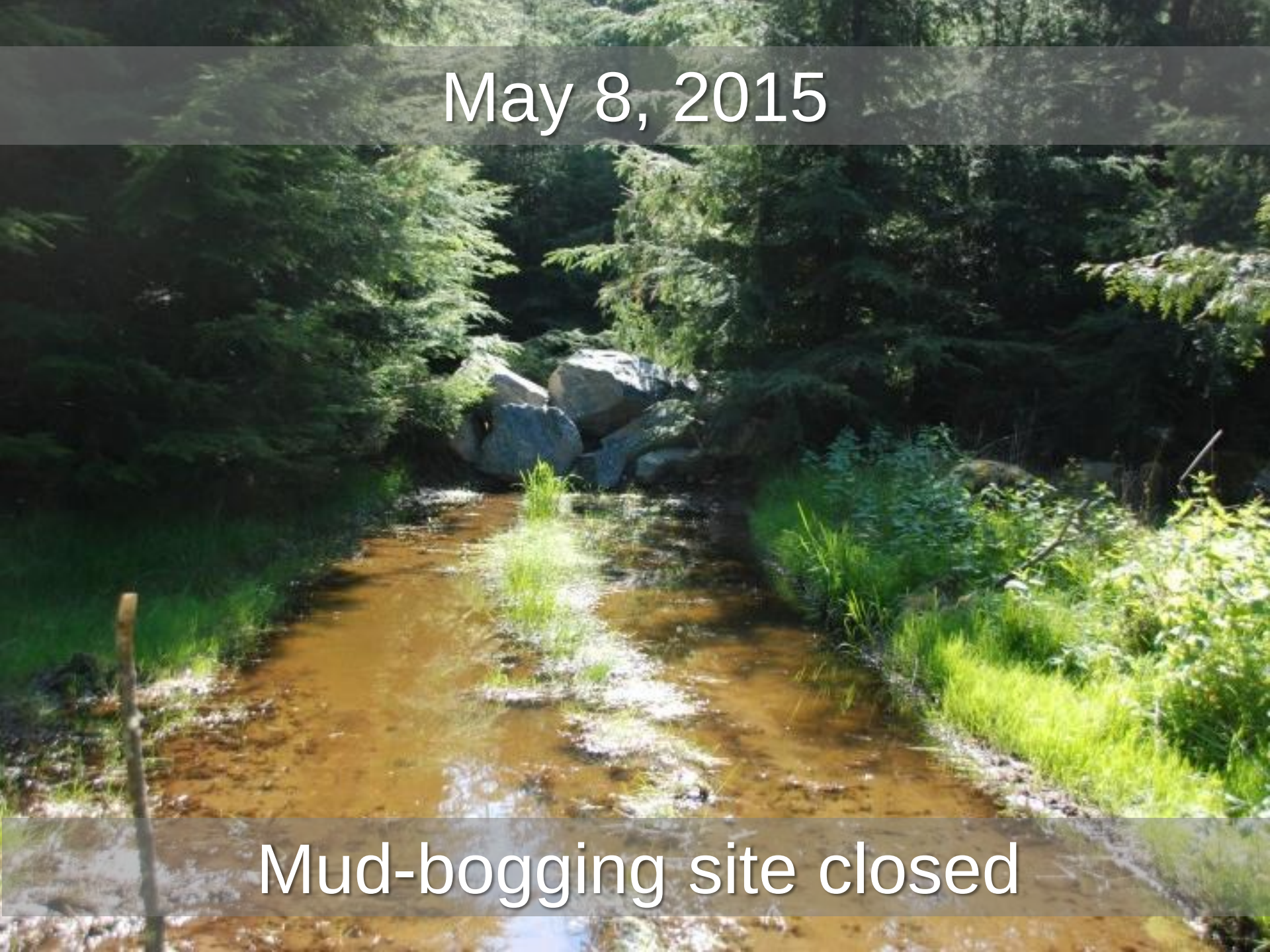
Rough and loose road

October 17, 2011



Carpet of new seedlings

June 28, 2012



May 8, 2015

Mud-bogging site closed

A close-up photograph of a person's hand holding a small, brown and black frog. The frog is positioned in the center of the palm, facing towards the left. The background is a blurred green, suggesting a natural outdoor setting. The lighting is bright, casting shadows on the hand and the frog.

May 8, 2015

SARA listed Red-legged Frog

Salt Spring Island

A group of approximately 14 people are standing in a grassy field on Salt Spring Island. They are dressed in outdoor gear, including jackets, hats, and boots. One person in the center-left is wearing a red jacket with a large yellow 'X' on the back. The background features a dense forest of evergreen trees under an overcast sky. Some tree branches with green and yellowing leaves are visible in the foreground.

Learning about cuttings collection and pruning, September 14, 2015

Developing strategies for treating the erosion.



Dense live staking along the toe of the slope to slow flow velocities and live bank protection on the shore.





A happy crew at the end of the first day.
Note the leaf litter that is being used to
protect the exposed soils from raindrop
erosion.



The second day a smaller eroding slope
was treated.

Stakes were added at the edge of the stream.





A happy but tired crew at the end of the
second day

Small slumps under straw blanket



'96 12 2



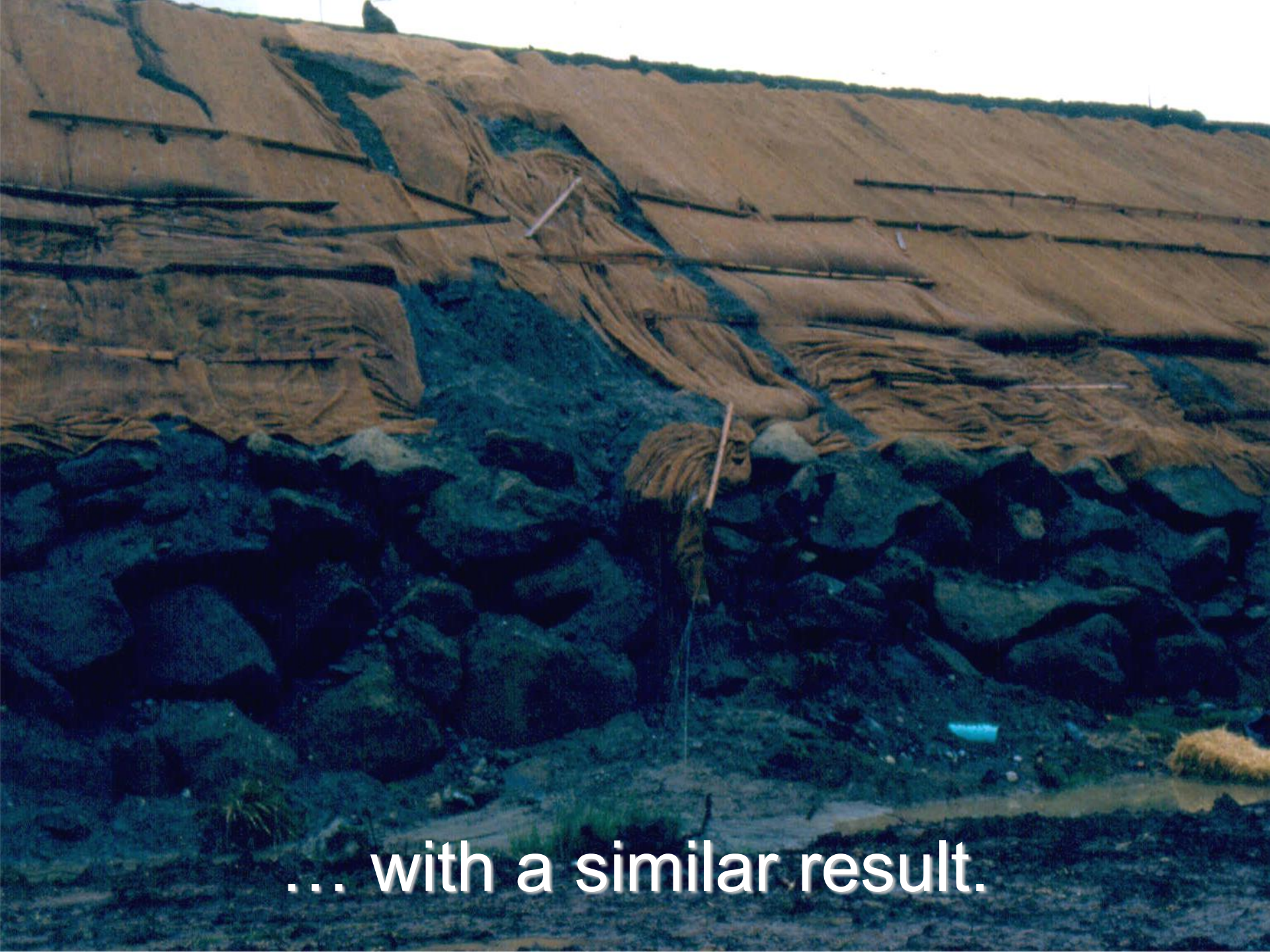
Moisture sensitive soils treated with
“Soil Guard”



Soil slumps under spray on blanket



Moisture sensitive soils treated next
with coco-fibre matting



... with a similar result.



As the winter progressed, the slope continued to unravel.

30 12 15



Repairs initiated



Wattle fences hold the mud but let the water out.



The cuttings love the wet soil...

'97 5 7



... and grow well.

'97 10 10



May 21, 2008



March 23, 2010

Road fill failure



At construction,
fall 1995



June 25, 1997



Catching rolling stones
We can get satisfaction!



06 06 28

Two types of treatment



\$320,000

\$13,000

'97 6 25



Substantially built...

...but does it contribute ecologically to the site?

36 6 28



Johnson's Landing Landslide



Landslide path

Working with local community members, October 18, 2012





Upper Landslide Area

Middle Landslide Area



Lower Landslide Area





Balsam Poplar, the only tree left
standing in the slide path

Another Balsam Poplar still standing in
the slide path



A photograph showing a wide, muddy riverbed or debris flow channel cutting through a forested area. The channel is filled with dark, silty water and debris, including branches and logs. The surrounding forest consists of tall evergreen trees, some of which are yellowed, suggesting autumn. The terrain appears to be a steep slope or a valley floor. The text "Extended access in transport zone is hazardous." is overlaid in white at the top of the image.

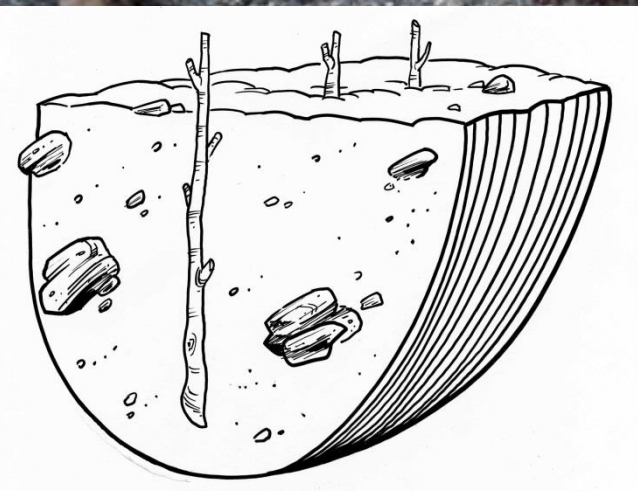
Extended access in transport zone is hazardous.

Aerial seeding the raw soils with Sitka Alder is recommended.

The upper transport zone was seeded with alder in the fall of 2012



Loosen soils solutions = establish
pioneering species so root systems knit
the soil together



Remember Balsam
Poplar

The deposition zone was staked with 2,290
Balsam Poplar cuttings, April 8, 2013



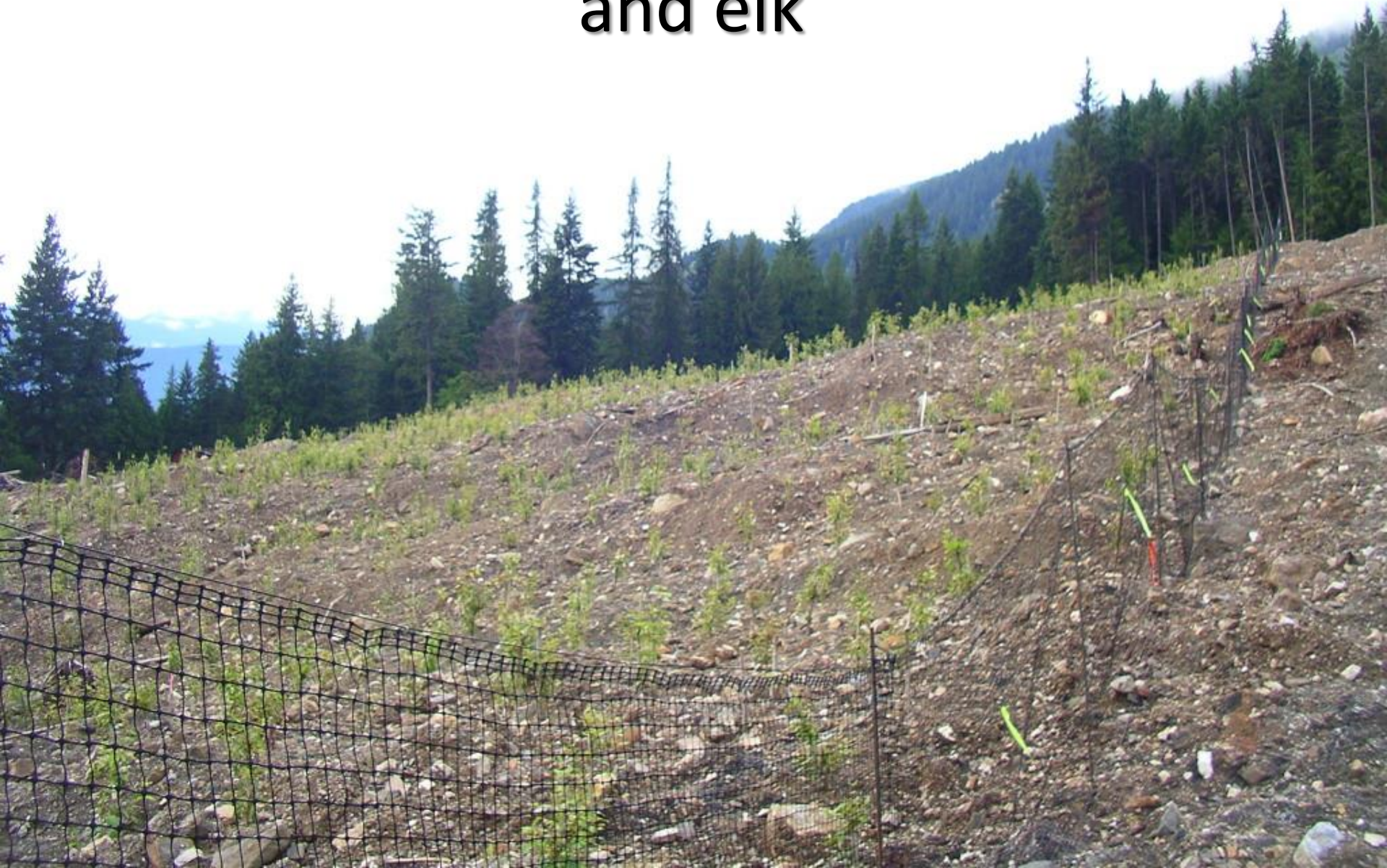
10 monitoring plots, each 1/100th ha in size, were established, April 12, 2013



Over 97.6% of the cuttings were growing,
August 3, 2013



Fence established to keep out hungry deer
and elk



September 16, 2013



May 16, 2014



Balsam Poplar from live staking



May 5, 2015

May 15, 2014



Sitka Alder seedlings from aerial seeding

A photograph of a fallen birch log on a rocky, forest floor. Several bright green oak ferns are growing from the exposed, light-colored rhizomes of the log. The ground is covered with small rocks, twigs, and some moss. The text "May 16, 2014" is overlaid in the upper center, and "Oak Fern from rafted rhizomes" is overlaid in the lower center.

May 16, 2014

Oak Fern from rafted rhizomes



May 16, 2014

Parsley Fern from residual rhizomes

A photograph of a forest floor covered in brown, fibrous duff (decayed organic matter). Several small, green, leafy plants are growing out of the duff. The plants have different leaf shapes: some are small and rounded, while others are larger with more deeply lobed or serrated leaves. The ground is also littered with small rocks, twigs, and pieces of dried wood. The overall scene is a close-up of the forest floor's surface.

May 16, 2014

Forest duff species from rafted forest floor

May 16, 2014

Hooker's Fairybells and Thimbleberry
from rafted forest floor



May 16, 2014

Western Red Cedar seedling from wind-borne seed



A close-up photograph of a young Douglas-fir seedling growing in a rocky, gravelly environment. The seedling is small, with a central cluster of bright green, needle-like leaves. It is surrounded by numerous small, dark grey and brown rocks and pebbles of various sizes. The ground appears to be a mix of soil and rock fragments. The lighting is bright, suggesting a sunny day.

May 16, 2014

Douglas-fir seedling from wind-borne seed

The seeded Sitka Alder is growing well

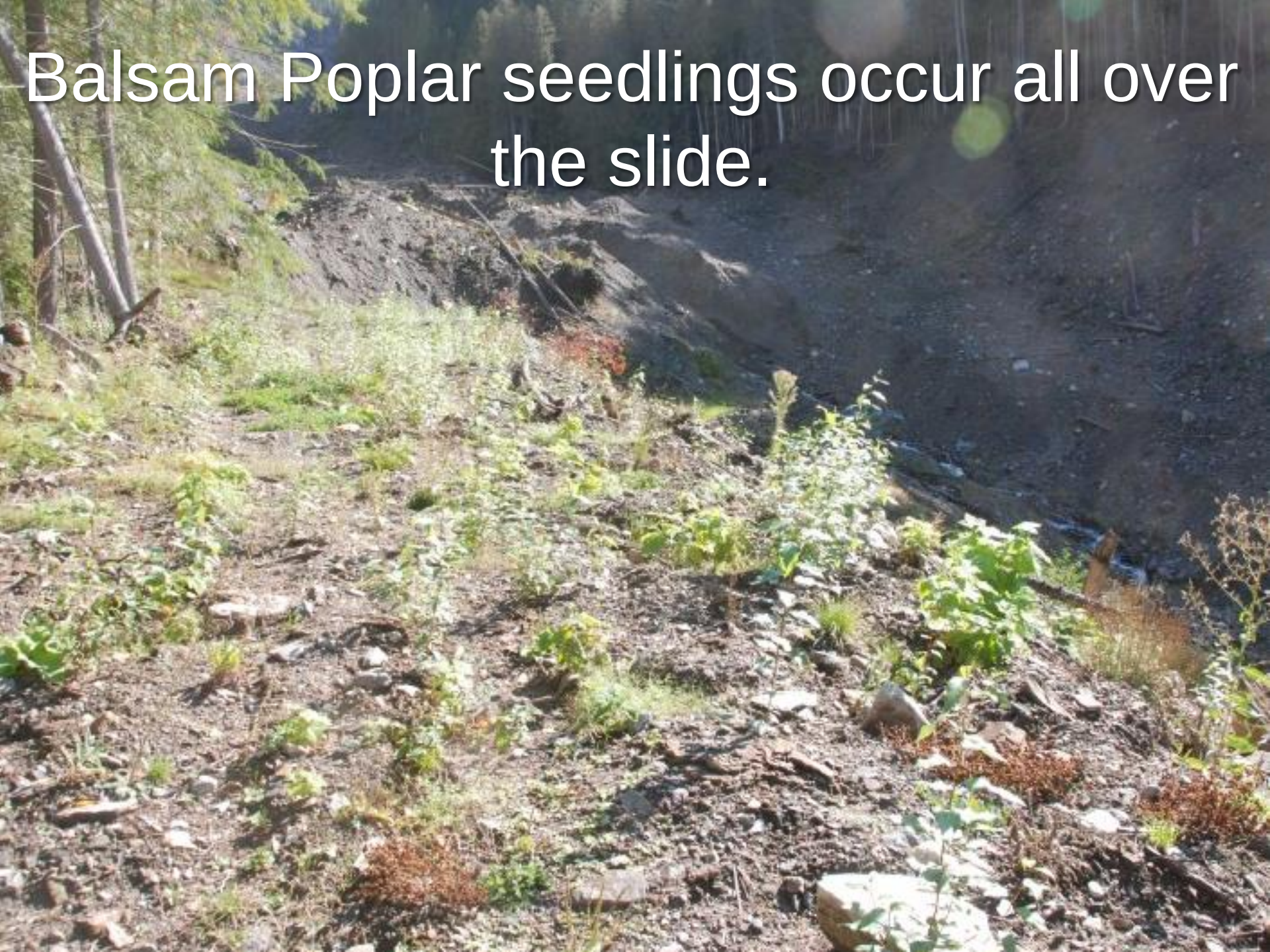


September 4, 2015

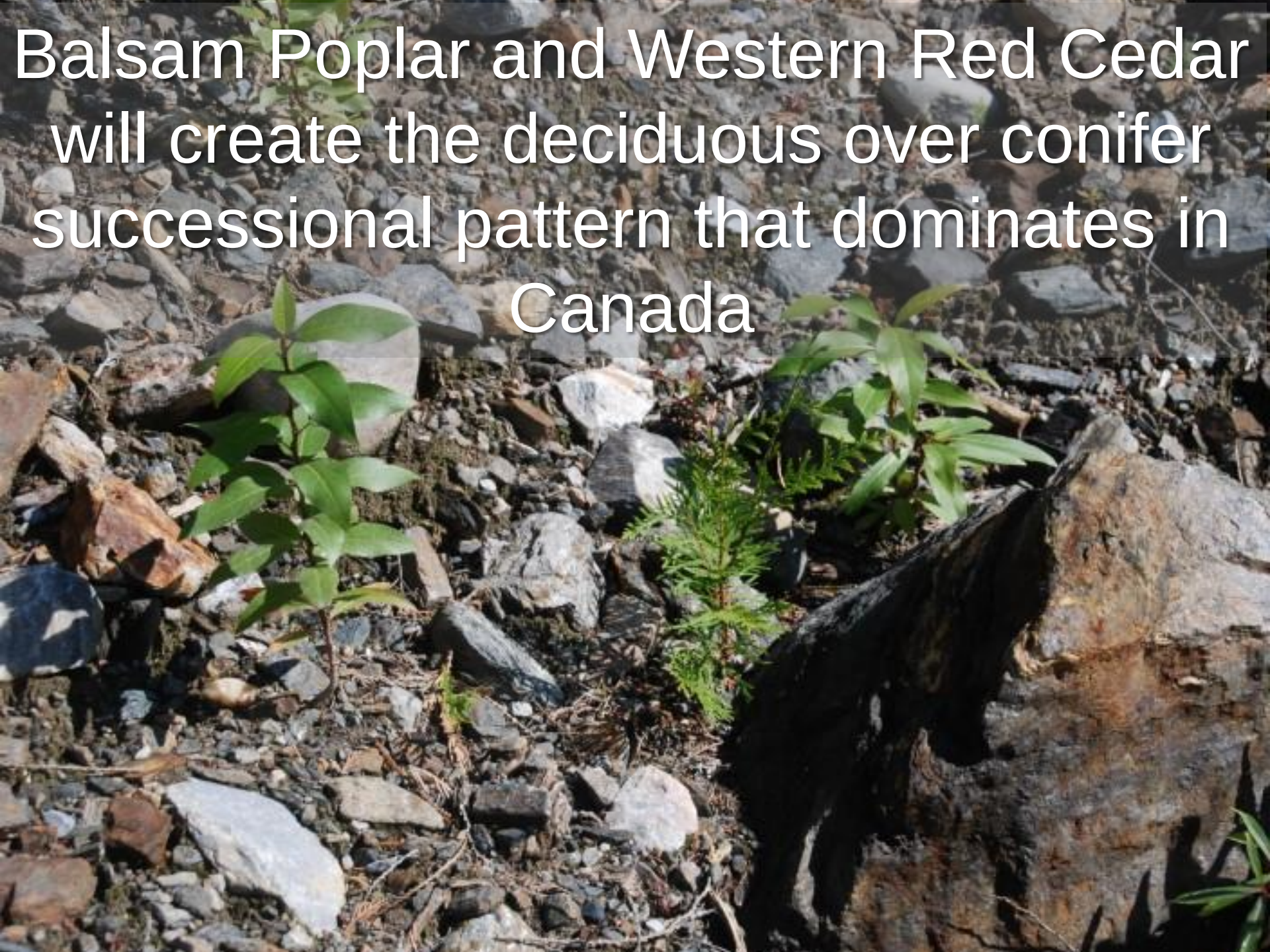


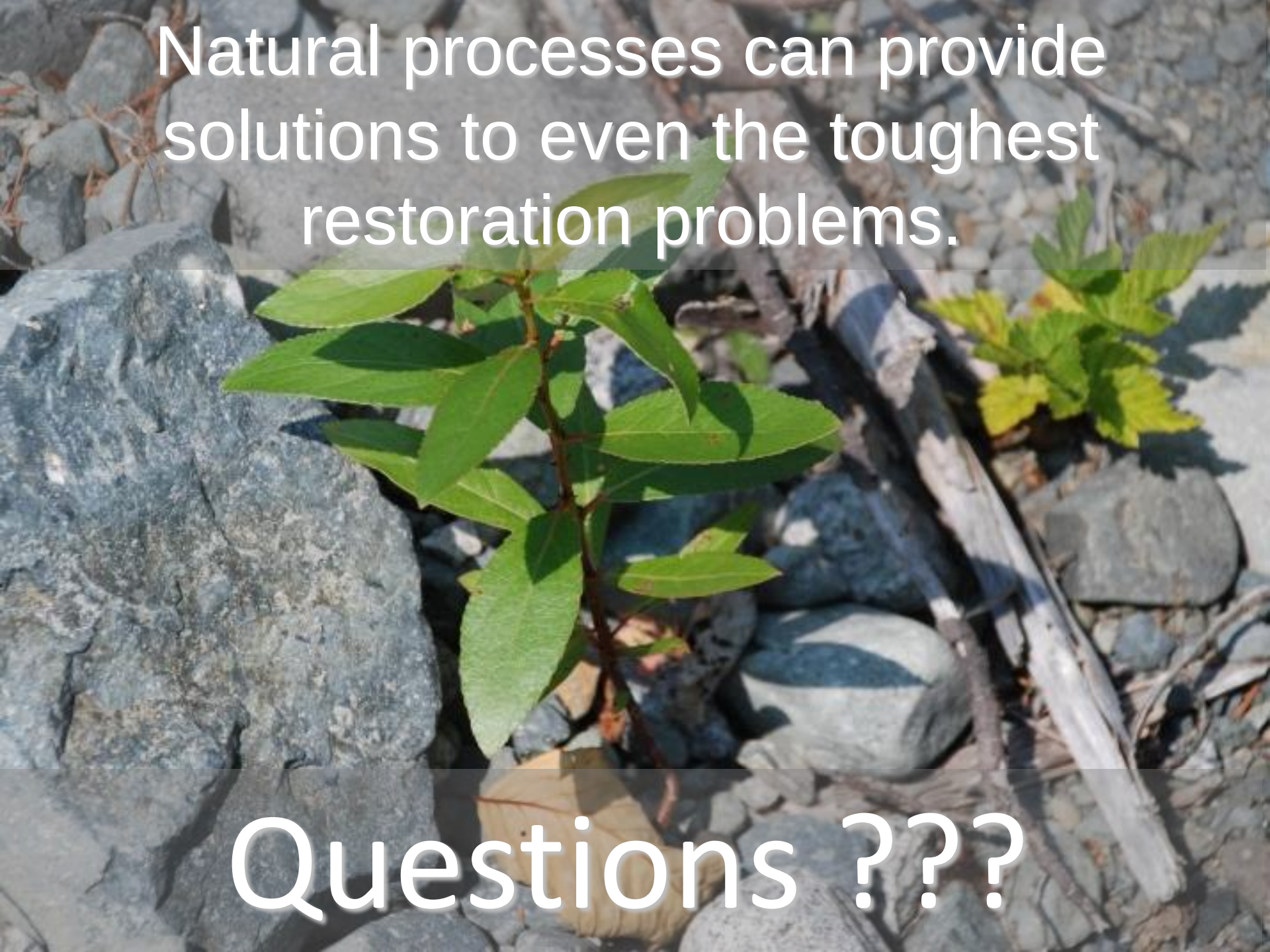
This Aspen seedling is doing very well.

Balsam Poplar seedlings occur all over the slide.



Balsam Poplar and Western Red Cedar
will create the deciduous over conifer
successional pattern that dominates in
Canada



A photograph of a rocky shoreline. In the foreground, a large, dark grey, textured rock is on the left. A small, green plant with several elongated leaves is growing out of a crack in the rocks. To the right of this plant, there is a piece of light-colored driftwood and another smaller green plant. The background consists of more rocks and some dry, brownish vegetation. The overall scene suggests a natural, perhaps coastal or riverbank, environment.

Natural processes can provide
solutions to even the toughest
restoration problems.

Questions ???