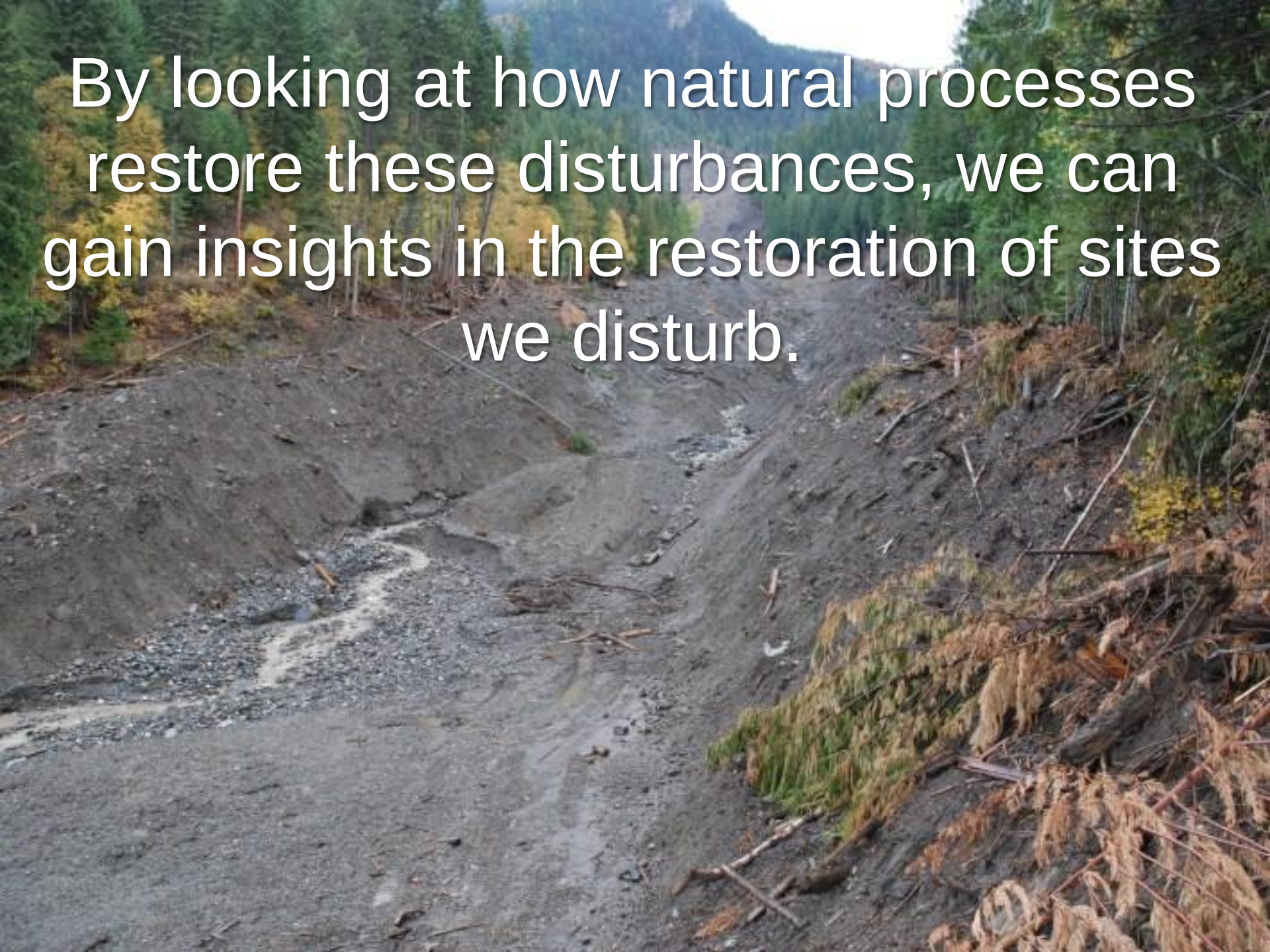
Natural Processes for the Restoration of Drastically Disturbed Sites

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

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

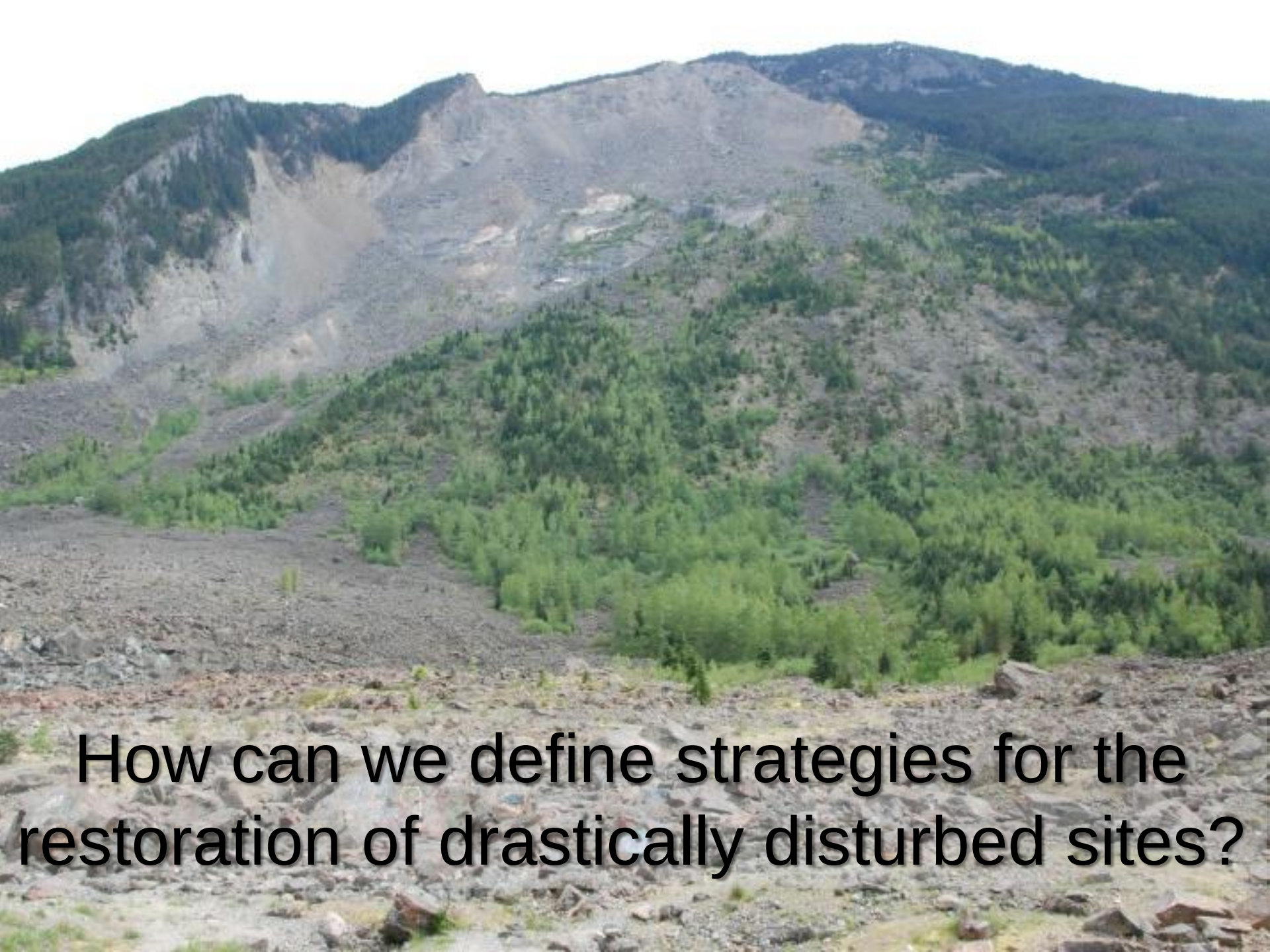
Natural disturbances have occurred since the beginning of earth.


By looking at how natural processes restore these disturbances, we can gain insights in the restoration of sites we disturb.


At one point not long ago most of the northern hemisphere was covered by ice.

Now we have a diversity of ecosystems,


with all sorts of fancy interactions and connections.
Natural processes made this happen.


How can we define strategies for the restoration of drastically disturbed sites?


Milk River, AB
What are the species that establish naturally on disturbed sites?

What characteristics do these species have?


What are the mechanisms of establishment?

How do pioneering species build soils on sites with no soil?


On gravel bars?

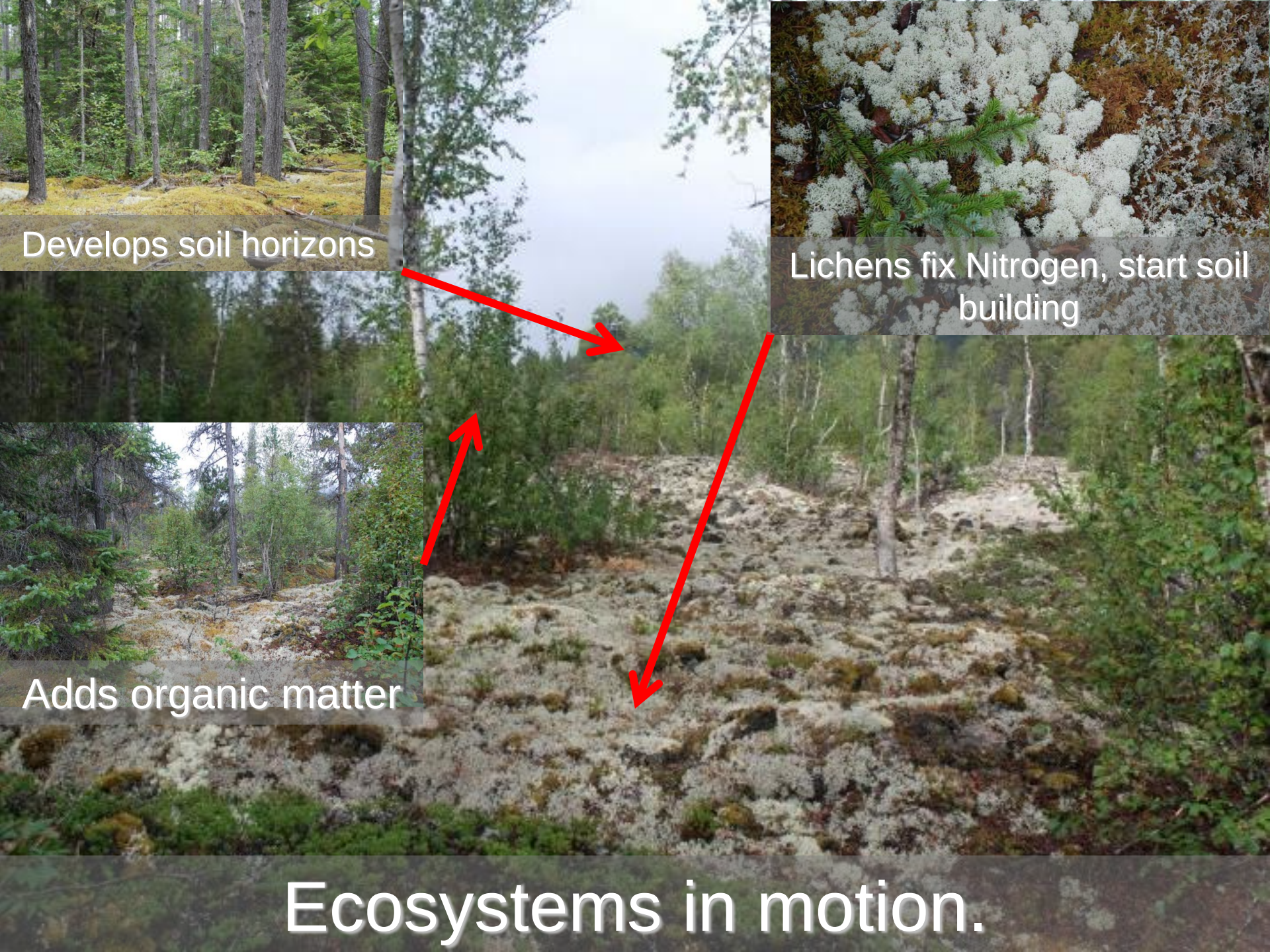
Develops soil horizons

Starts soil building, N fixing

Adds organic matter

Ecosystems in motion.


On lava flows?


Develops soil horizons
Lichens fix Nitrogen, start soil building
Adds organic matter
Ecosystems in motion.


Behind retreating glaciers?

Conifers develop soil horizons

Alders fix Nitrogen, start soil building

Willows add organic matter

Ecosystems in motion.

On talus slopes?

Ecosystems in motion.

On landslides?

Ecosystems in motion.


Natural processes build ecosystems
from scratch.

So how can we use these natural processes to restore ecosystems?

What are the “filters” that are preventing recovery, and how can we “assist” that recovery?

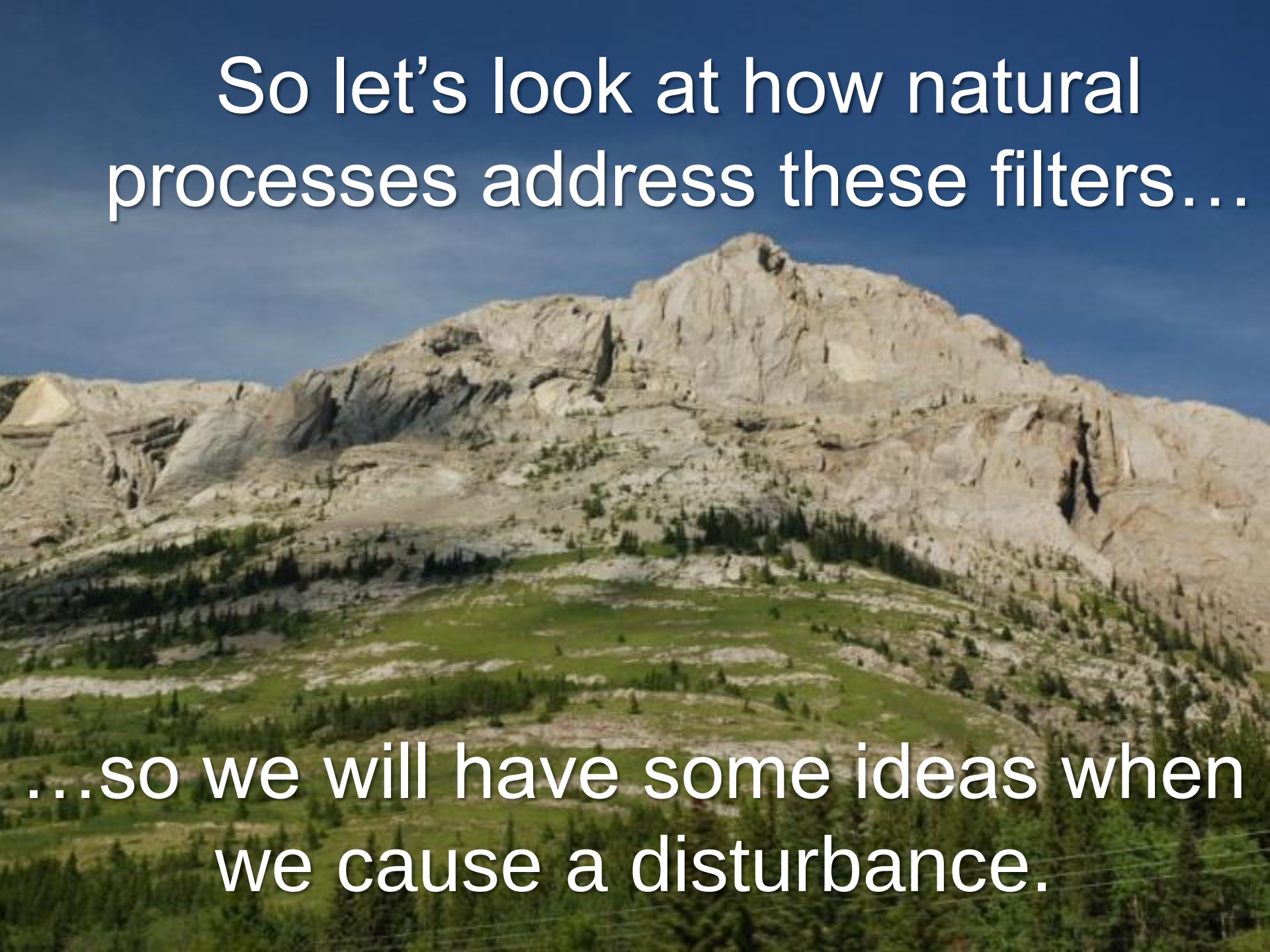
Common abiotic filters:

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*


So let's look at how natural processes address these filters…
…so we will have some ideas when we cause a disturbance.

What about steep slopes and adverse textures?

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

Phytocoenologia	8 (1)	1 – 12	Stuttgart-Braunschweig, September 10, 1980

Vegetation of talus slopes on the Liard Plateau, British Columbia*

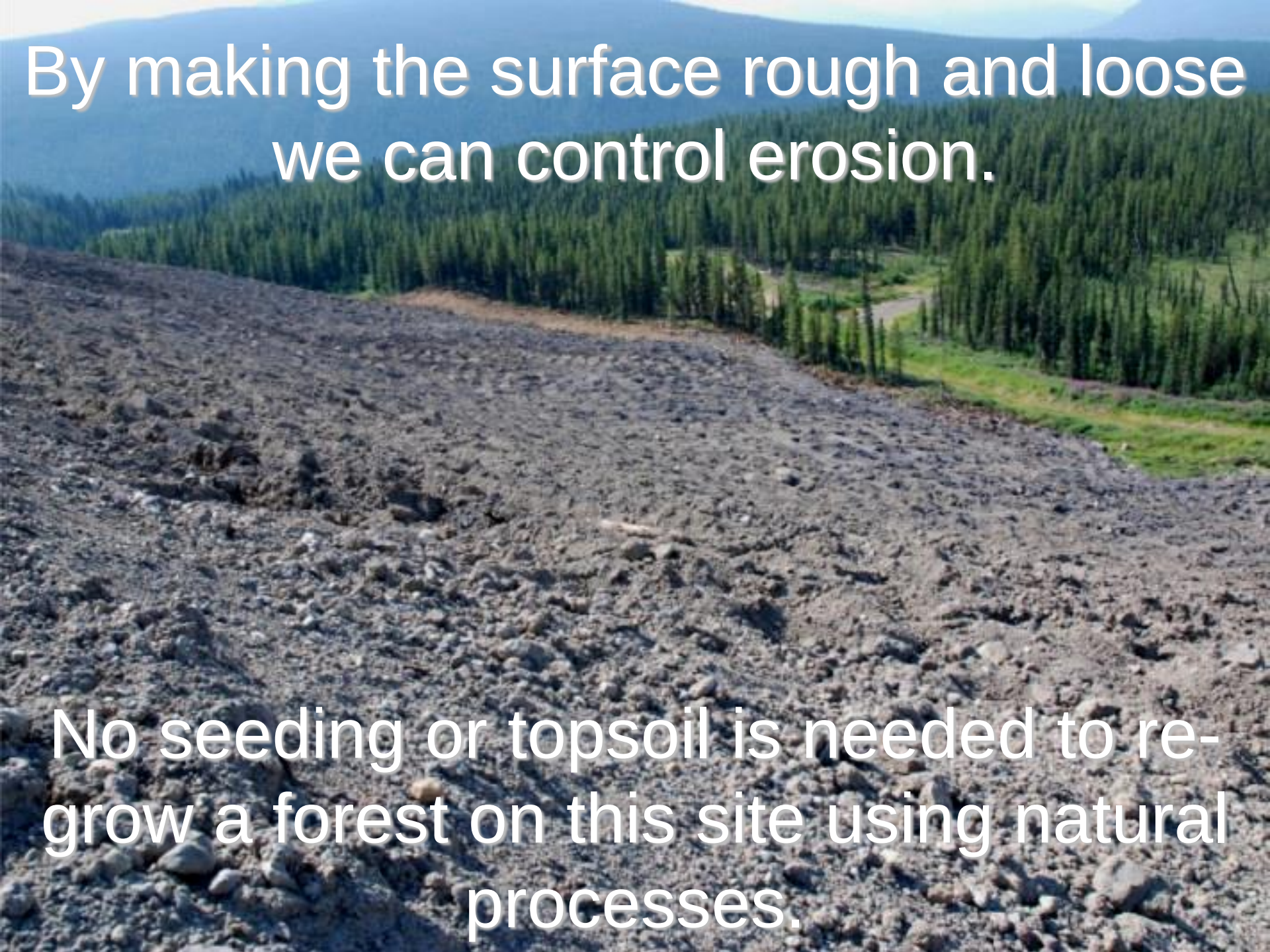
by D.F. POLSTER, Calgary, and M.A.M. BELL, Victoria

See any similarities???

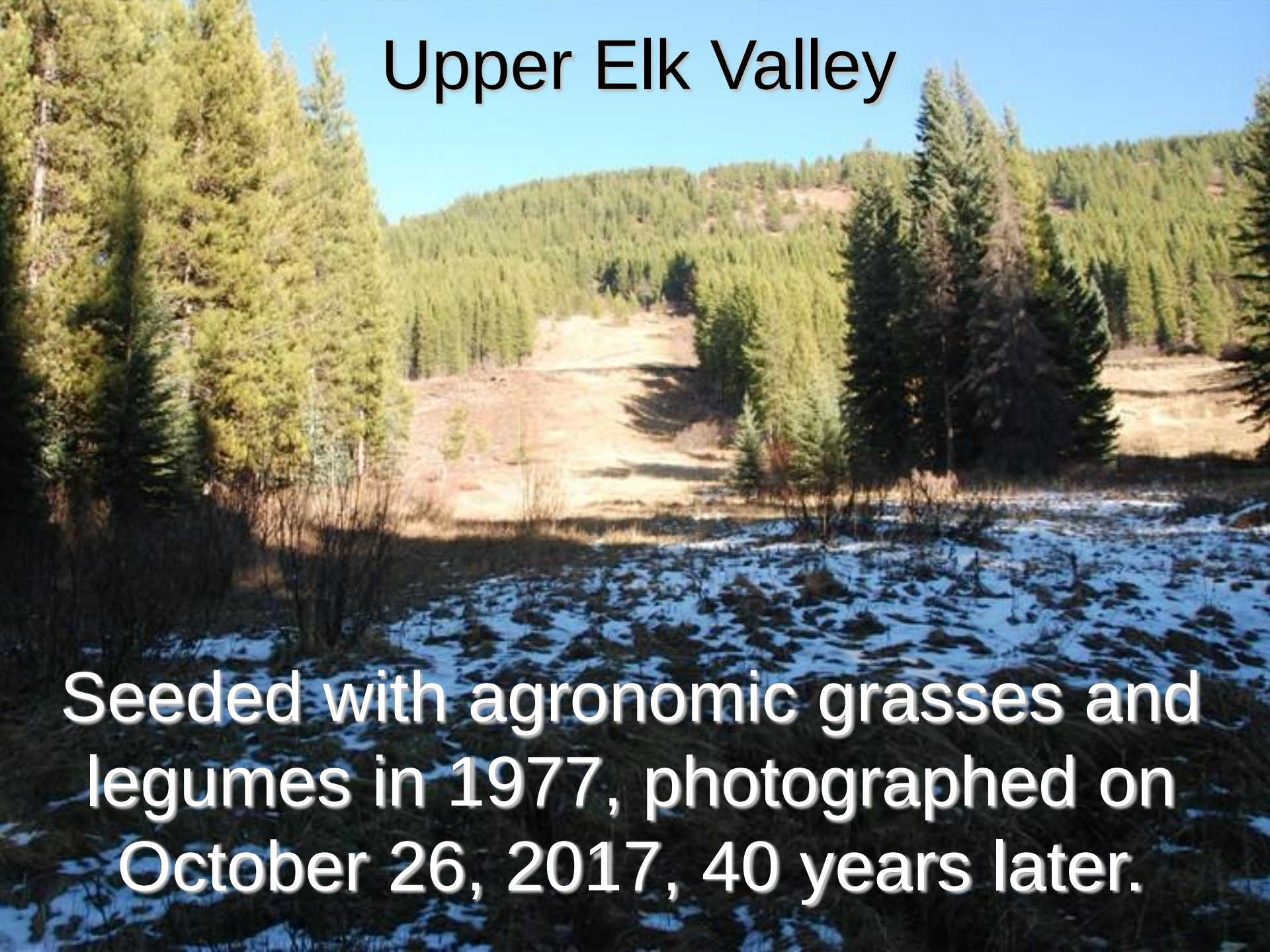

By looking at natural solutions to revegetation we can develop effective restoration systems


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

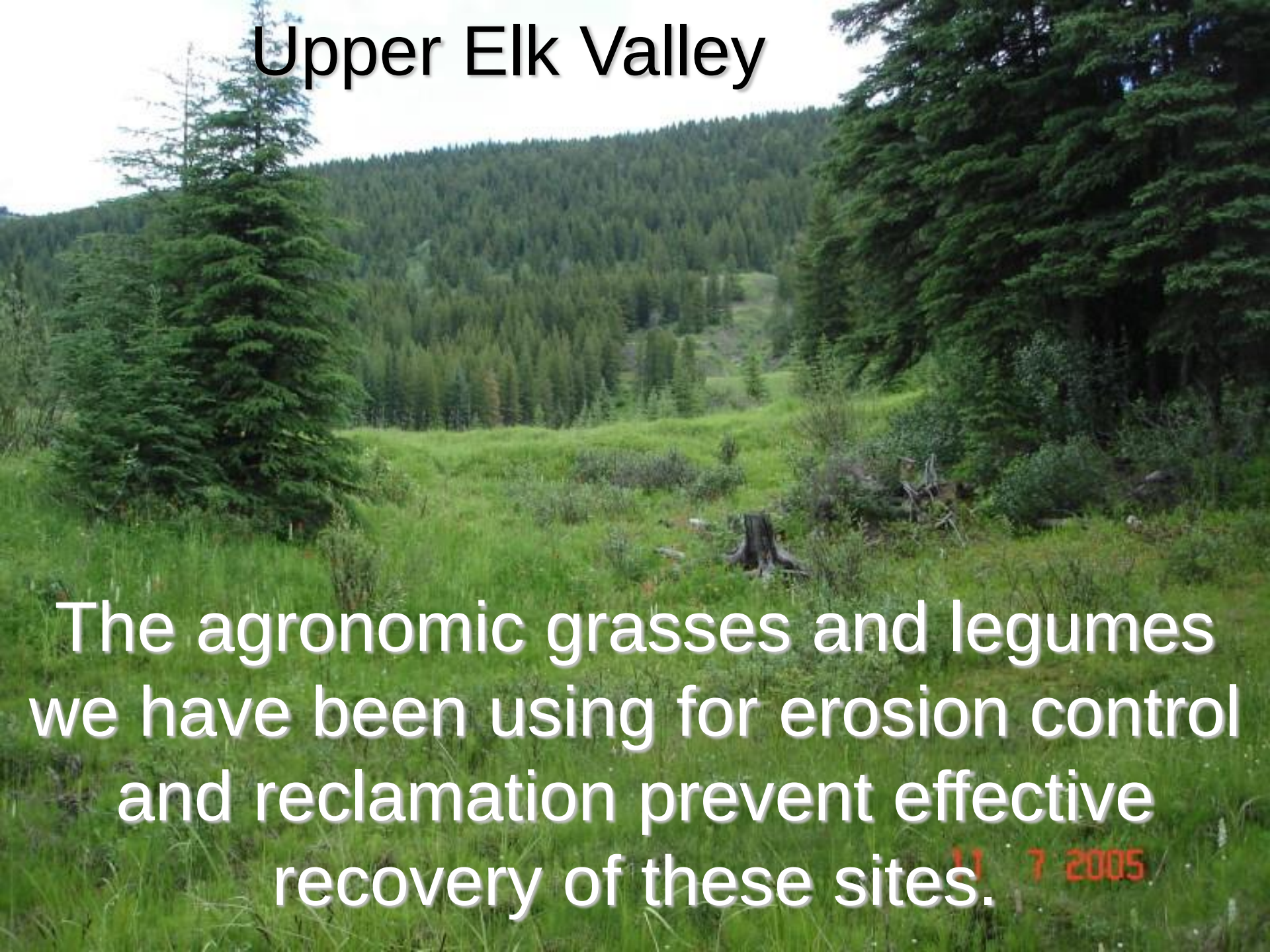

By pushing the fine textured materials over the face we can eliminate the limitations of the coarse substrate.
6 9 2007


By making the surface rough and loose we can control erosion.
No seeding or topsoil is needed to re-grow a forest on this site using natural processes.

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 on October 26, 2017, 40 years later.

Upper Elk Valley



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

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

Spreading soil material…


Erosion starting on smooth surface
before spreading is even completed.


Making the surface rough and loose

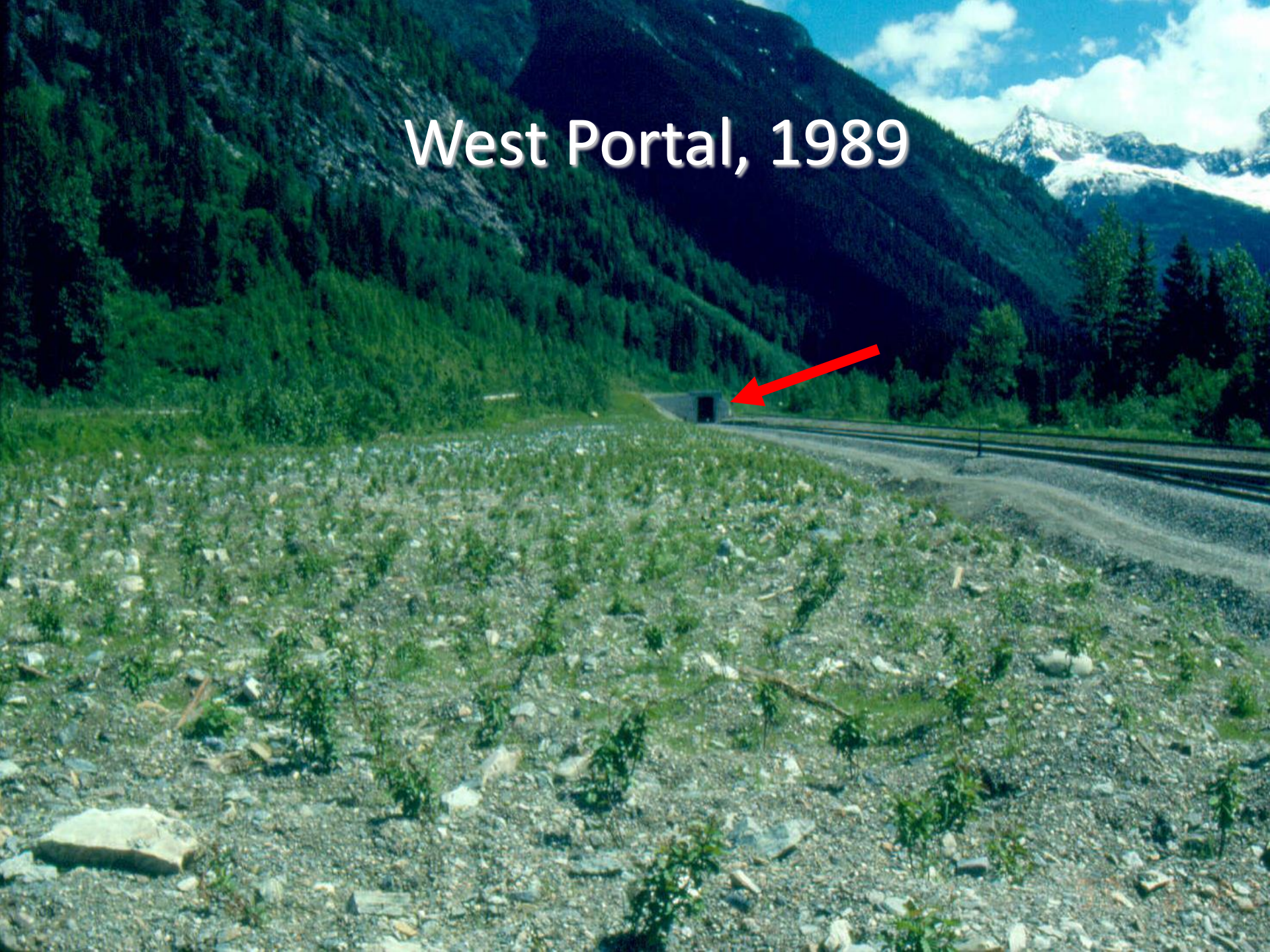

Roughened the whole surface


Cost of rough and loose treatment at Kemess Mine was $715/ha while hydroseeding costs over $3,500/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.


West Portal, Planting in 1989
Rough and loose

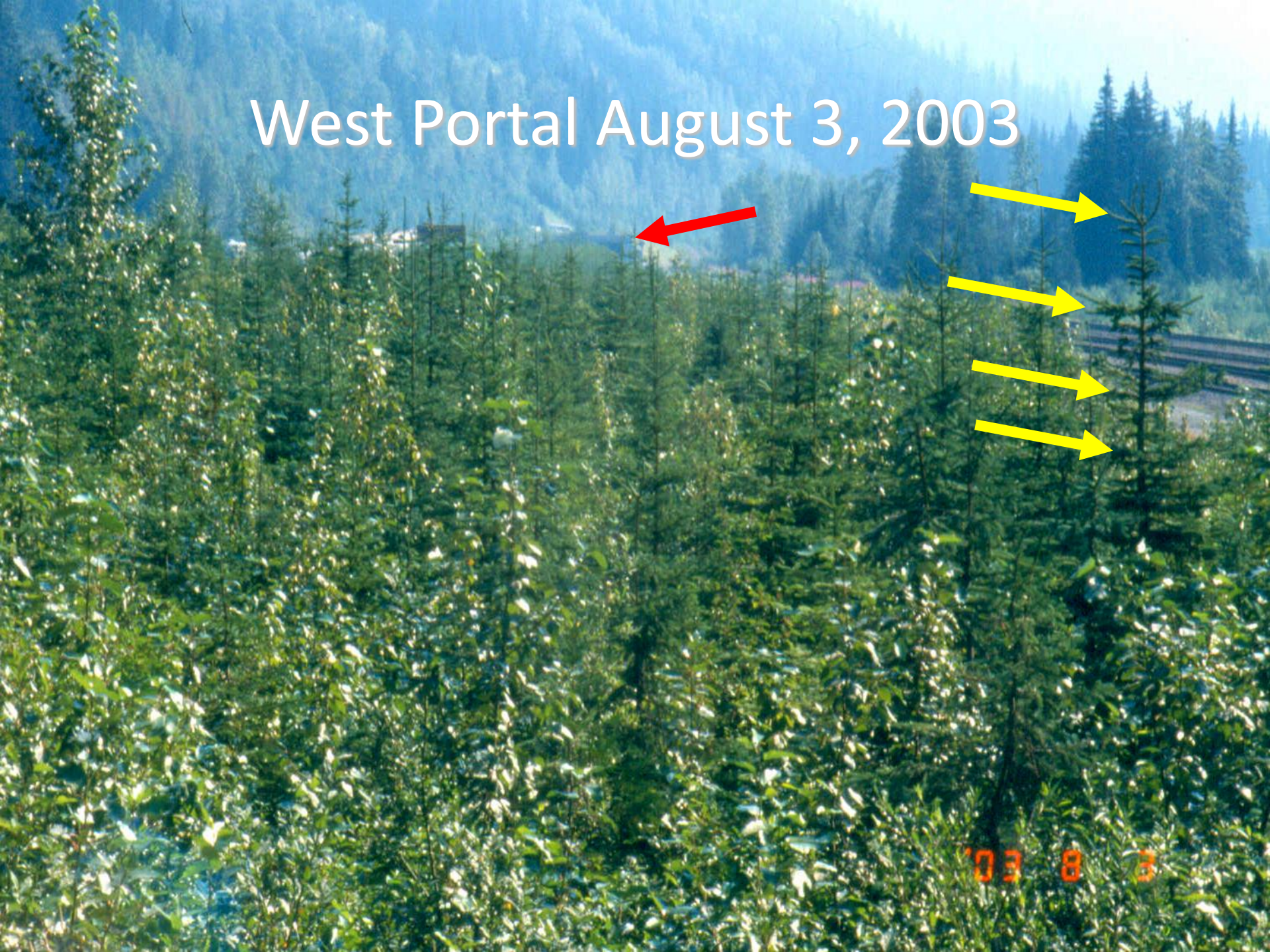

West Portal, 1989

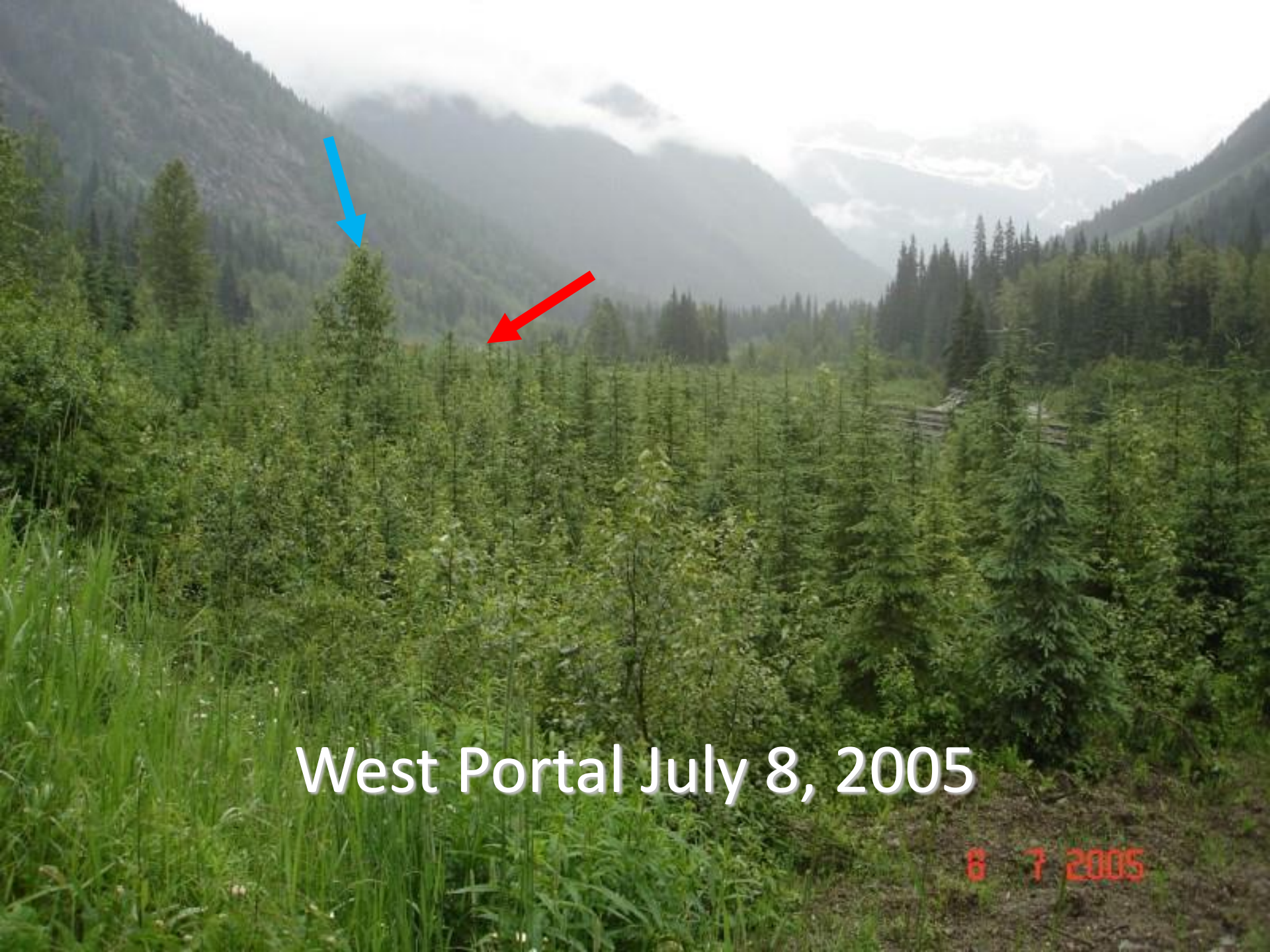
West Portal tree & shrub planting, 1989


West Portal August 25, 1992

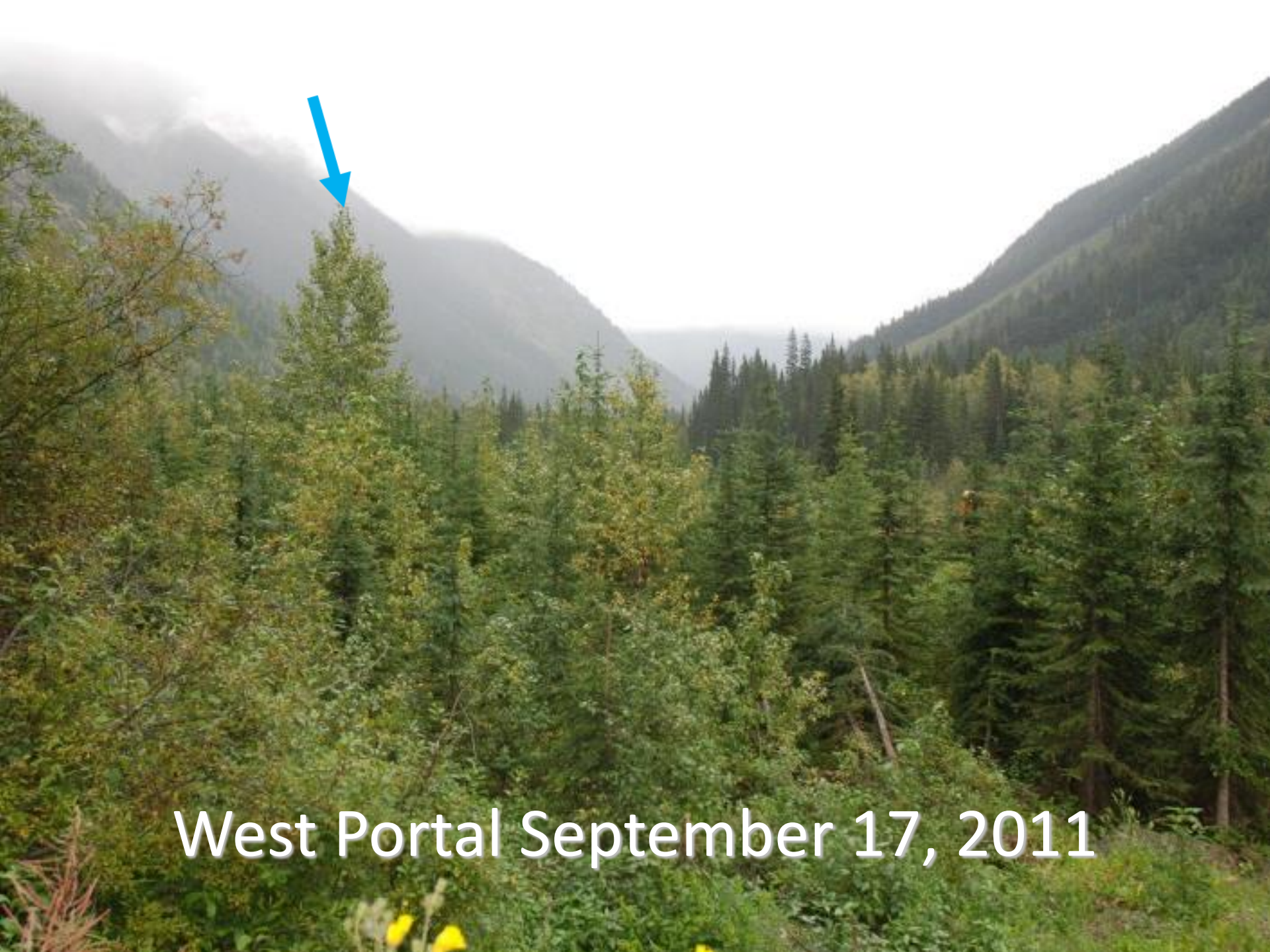

West Portal August 5, 1997
'97 8 5

West Portal July 15, 1999


West Portal August 3, 2003
'03 8 3

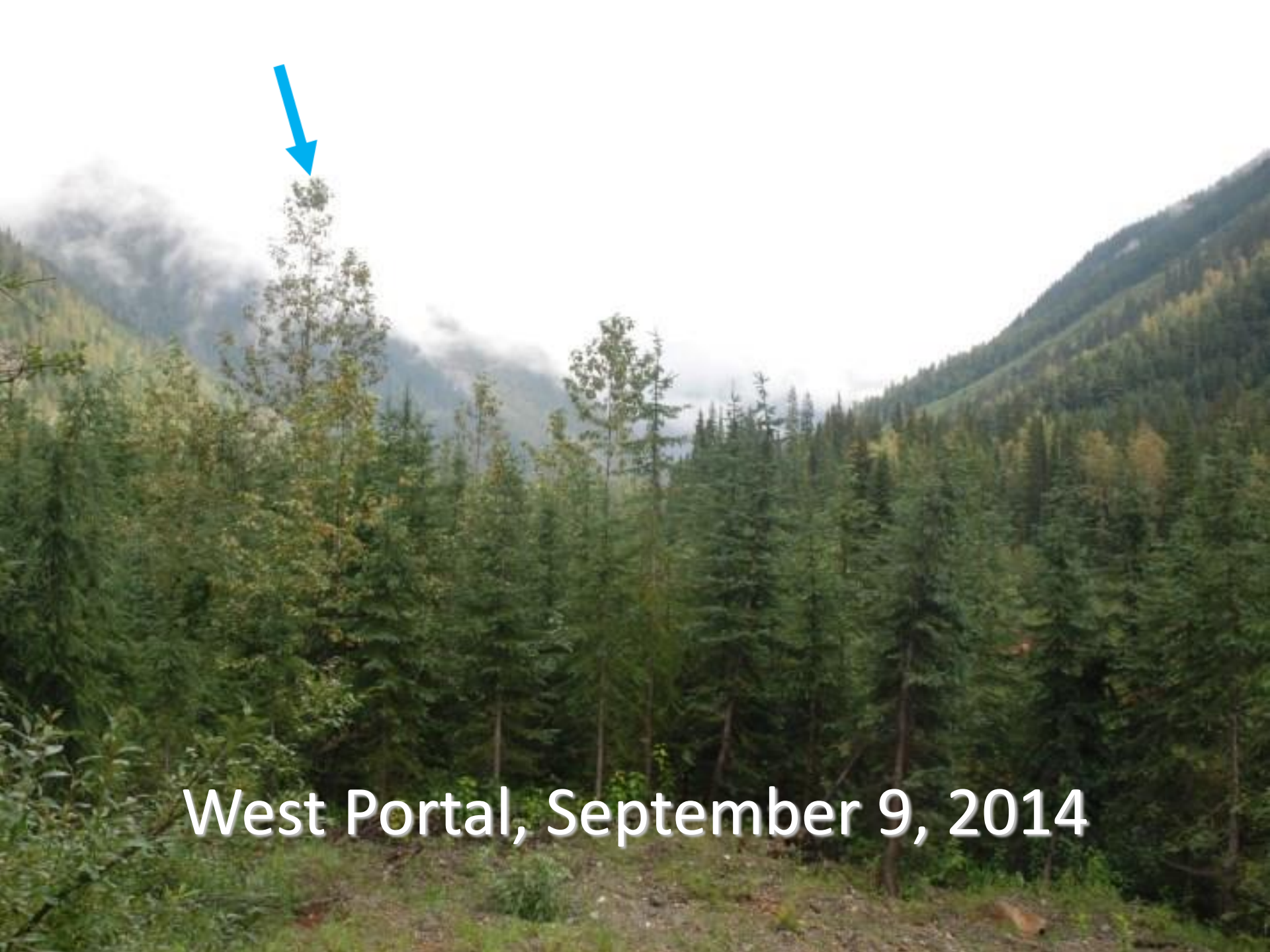

West Portal July 8, 2005
8 7 2005

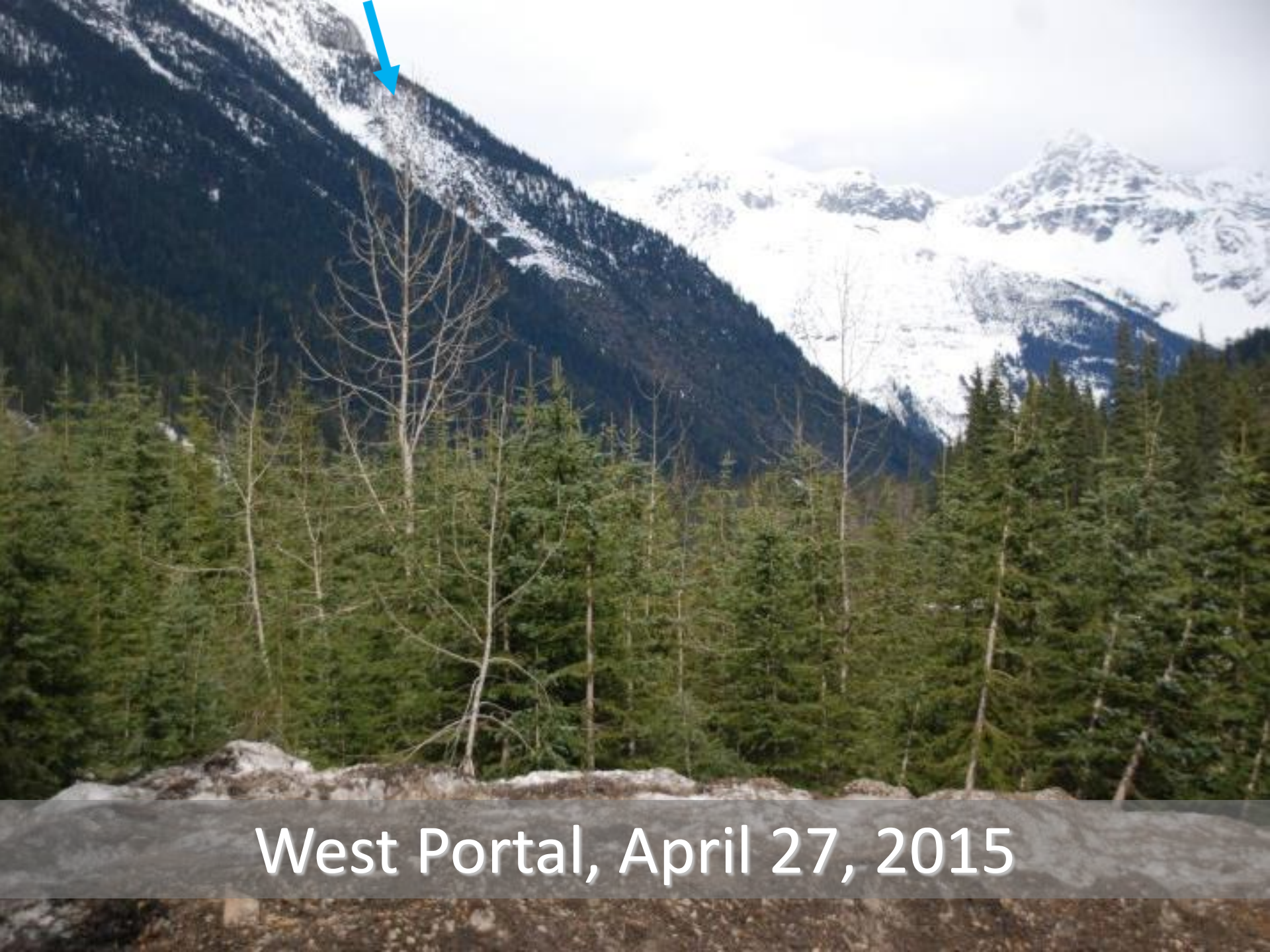

West Portal July 27, 2008


West Portal September 17, 2011

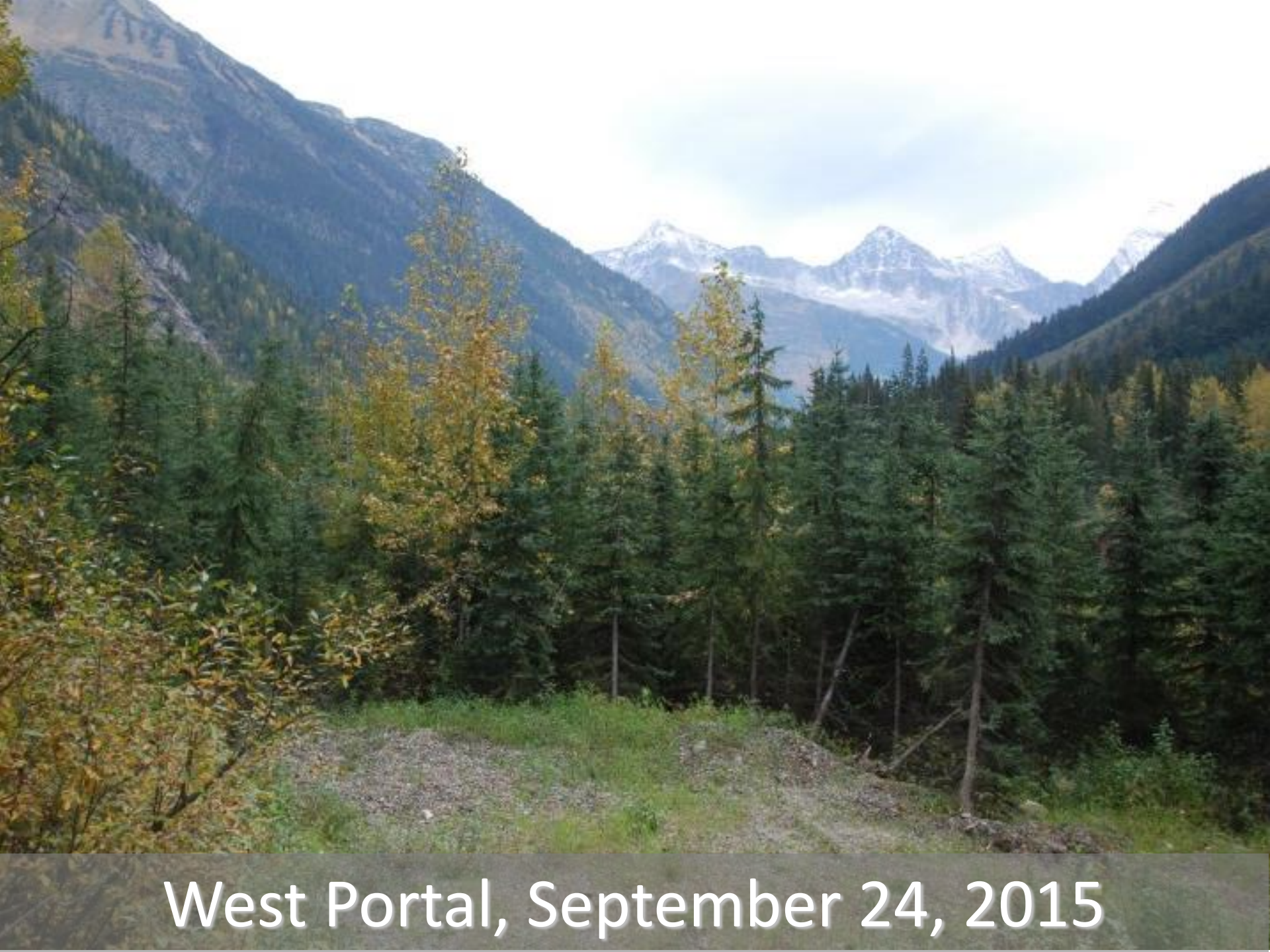

West Portal September 17, 2011


West Portal September 17, 2011


West Portal, September 9, 2014

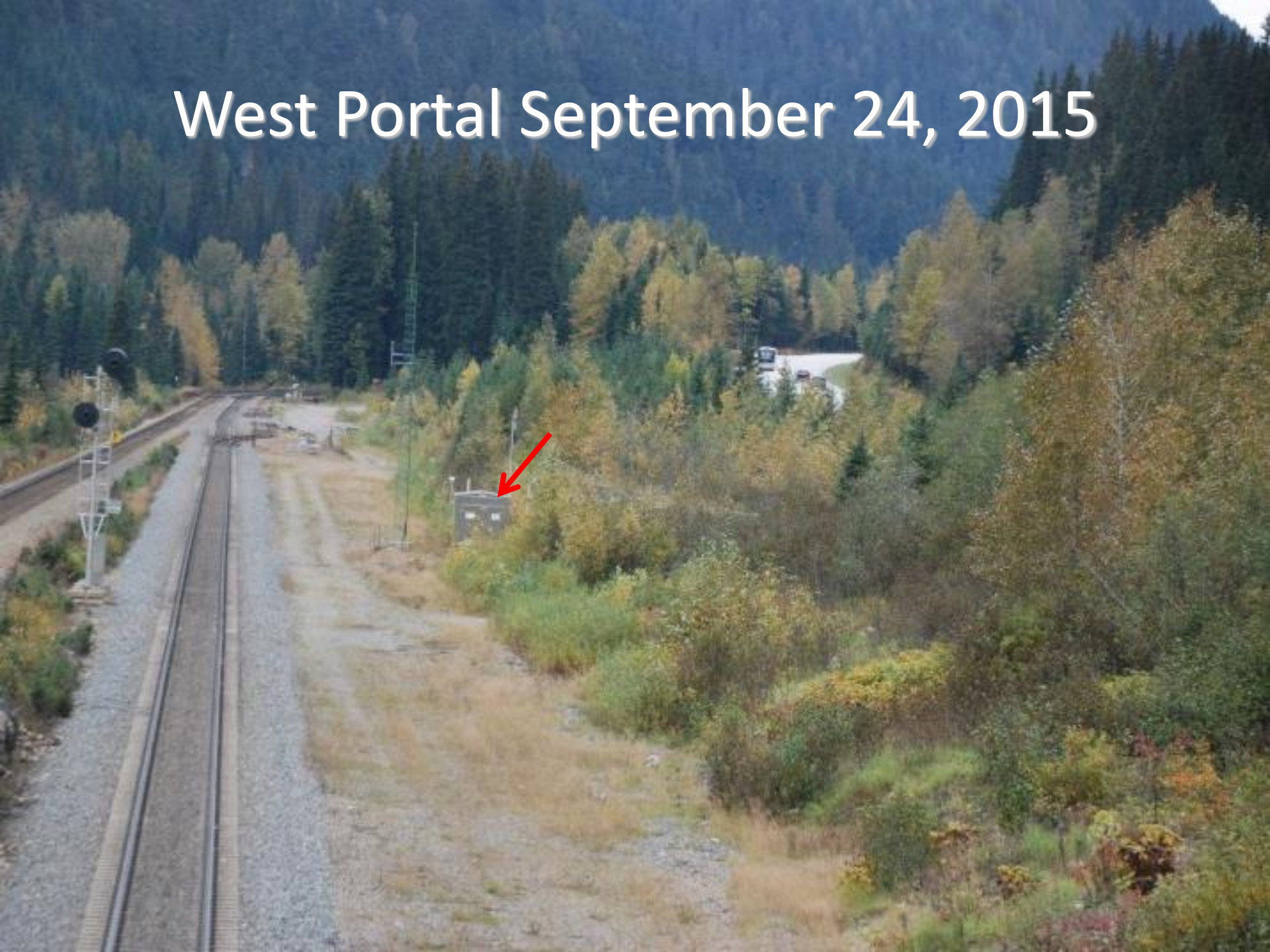


West Portal, April 27, 2015



West Portal, September 24, 2015

West Portal September 24, 2015

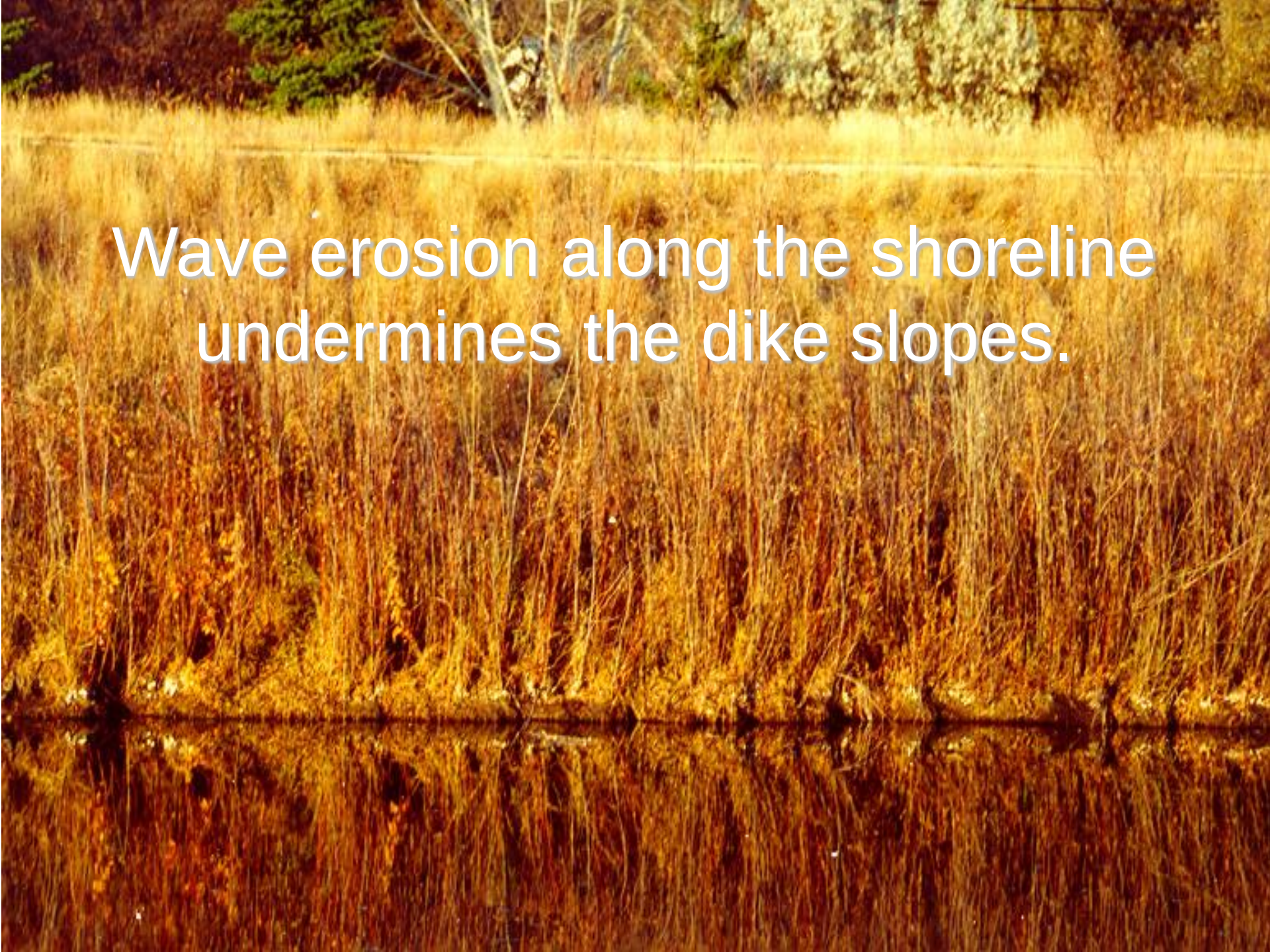


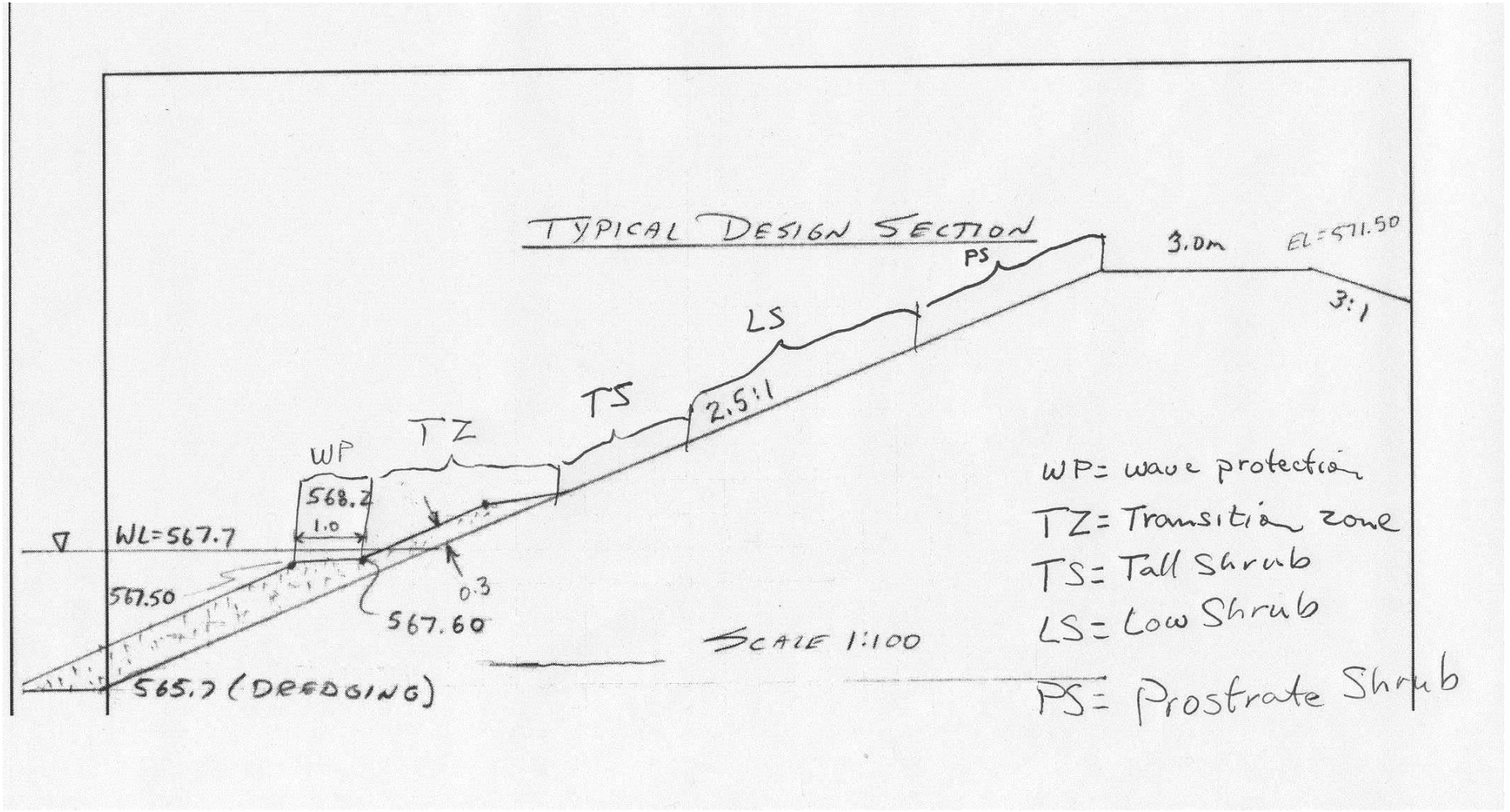
West Portal, October 12, 2016.

West Portal Sept. 22, 2017, 28 years after planting.

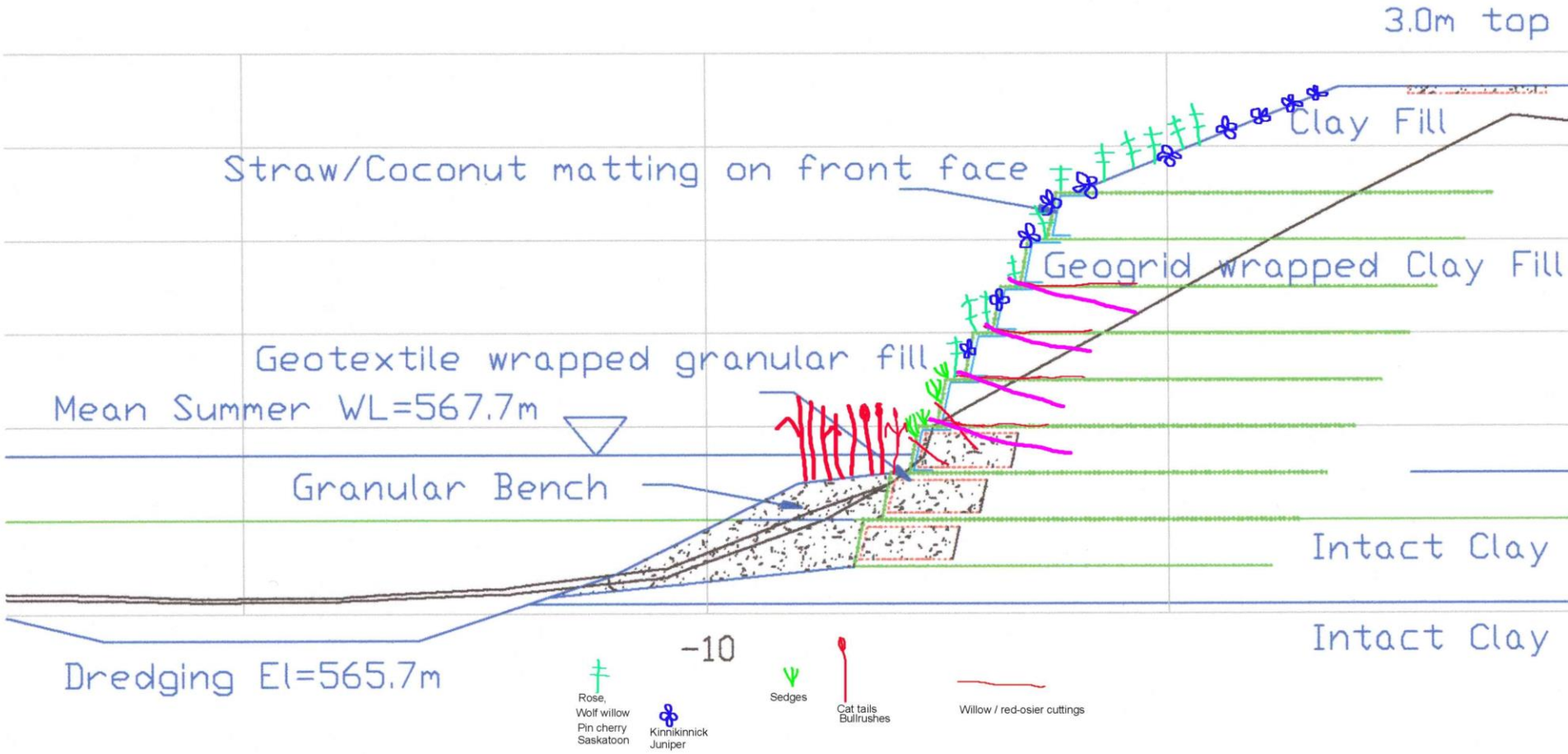

Wascana Creek Restoration

Small slumps threaten the integrity of the dike


Wave erosion along the shoreline undermines the dike slopes.



Detailed restoration designs developed



Soil bioengineering treatments incorporated into slope designs


May, 2003

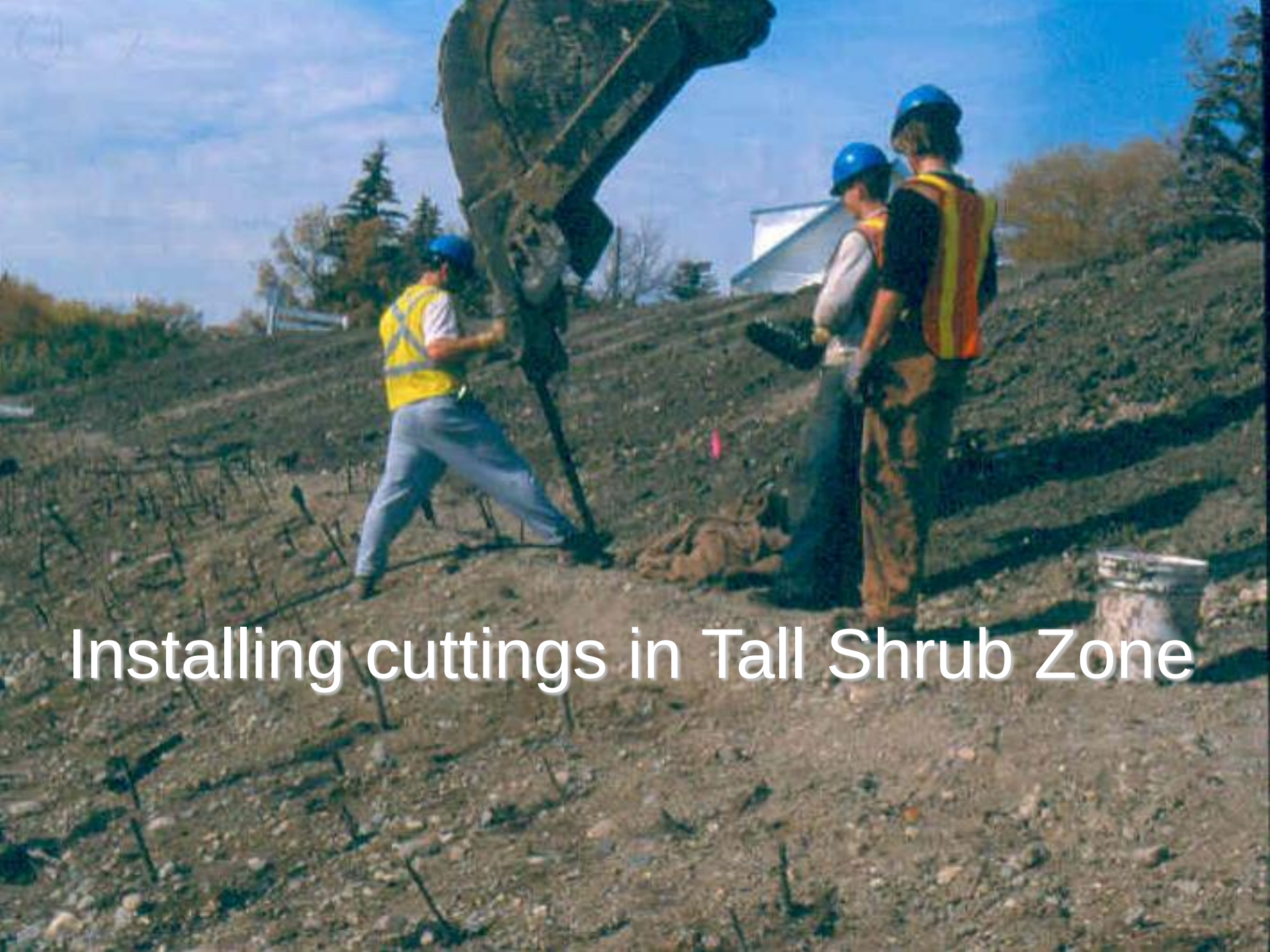

October, 2003

Collecting plants for Wave Protection Zone

Planting Wave Protection Zone

Using emergent aquatic plants to protect shores


2011
Very successful treatments on Wascana Creek

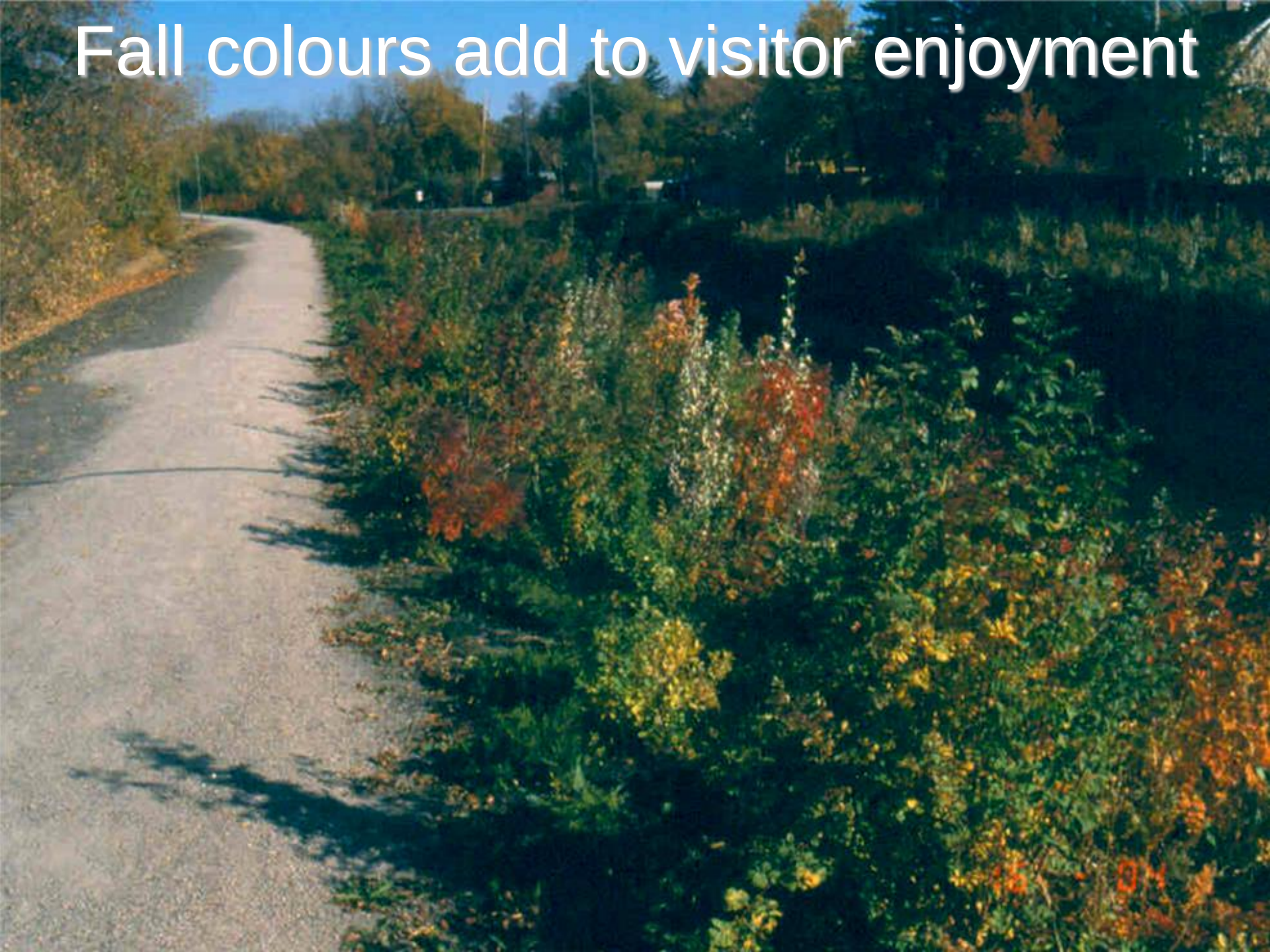

Installing cuttings in Tall Shrub Zone


June, 2004


June, 2004
'04 6 28

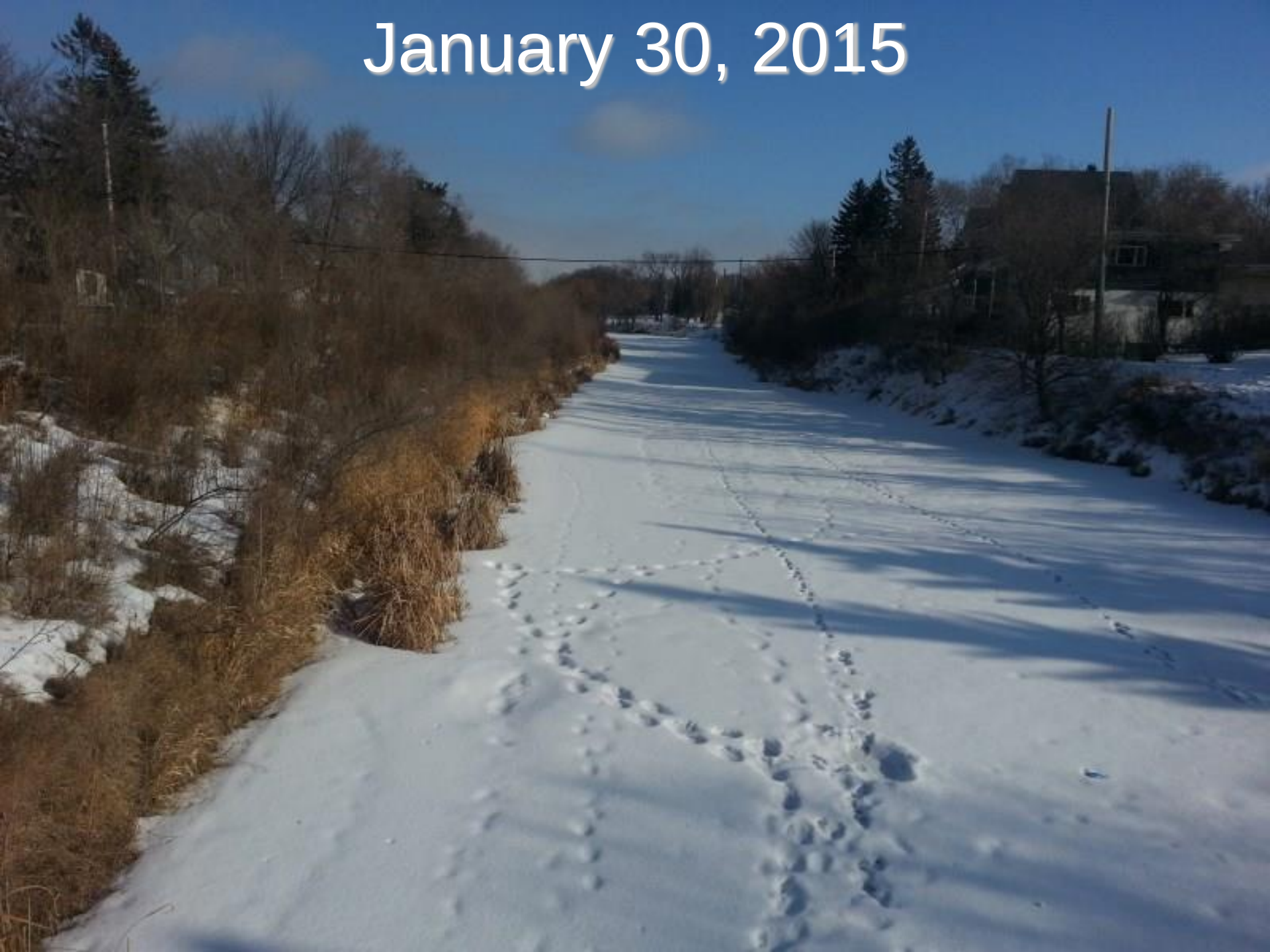

Many species spread by suckers

Fall colours add to visitor enjoyment

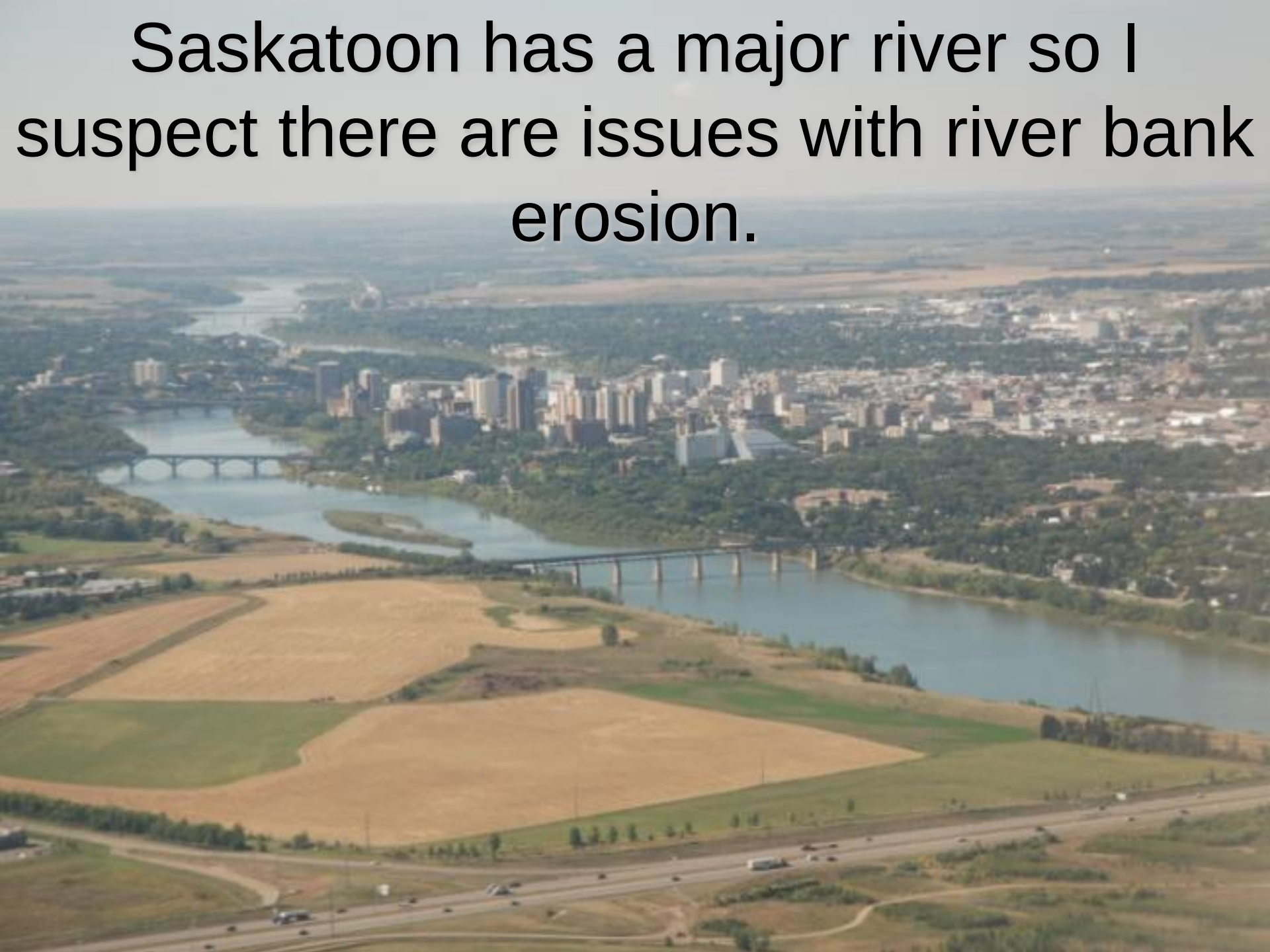


October, 2011

Building soil bioengineering into designs can provide ecological, social and financial benefits


January 30, 2015

Saskatoon has a major river so I suspect there are issues with river bank erosion.

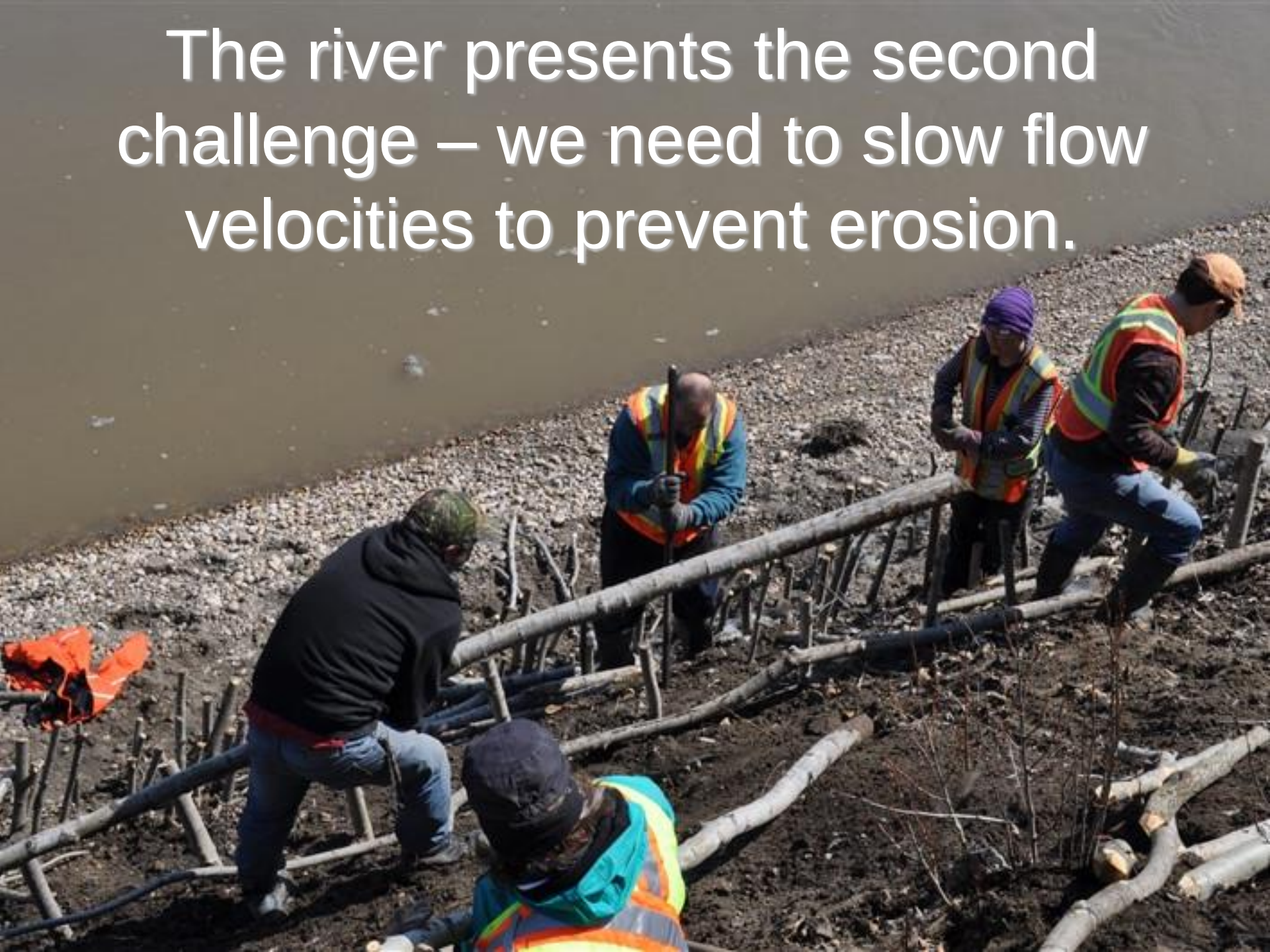


Finding suitable plant materials is the first step in restoring river banks.

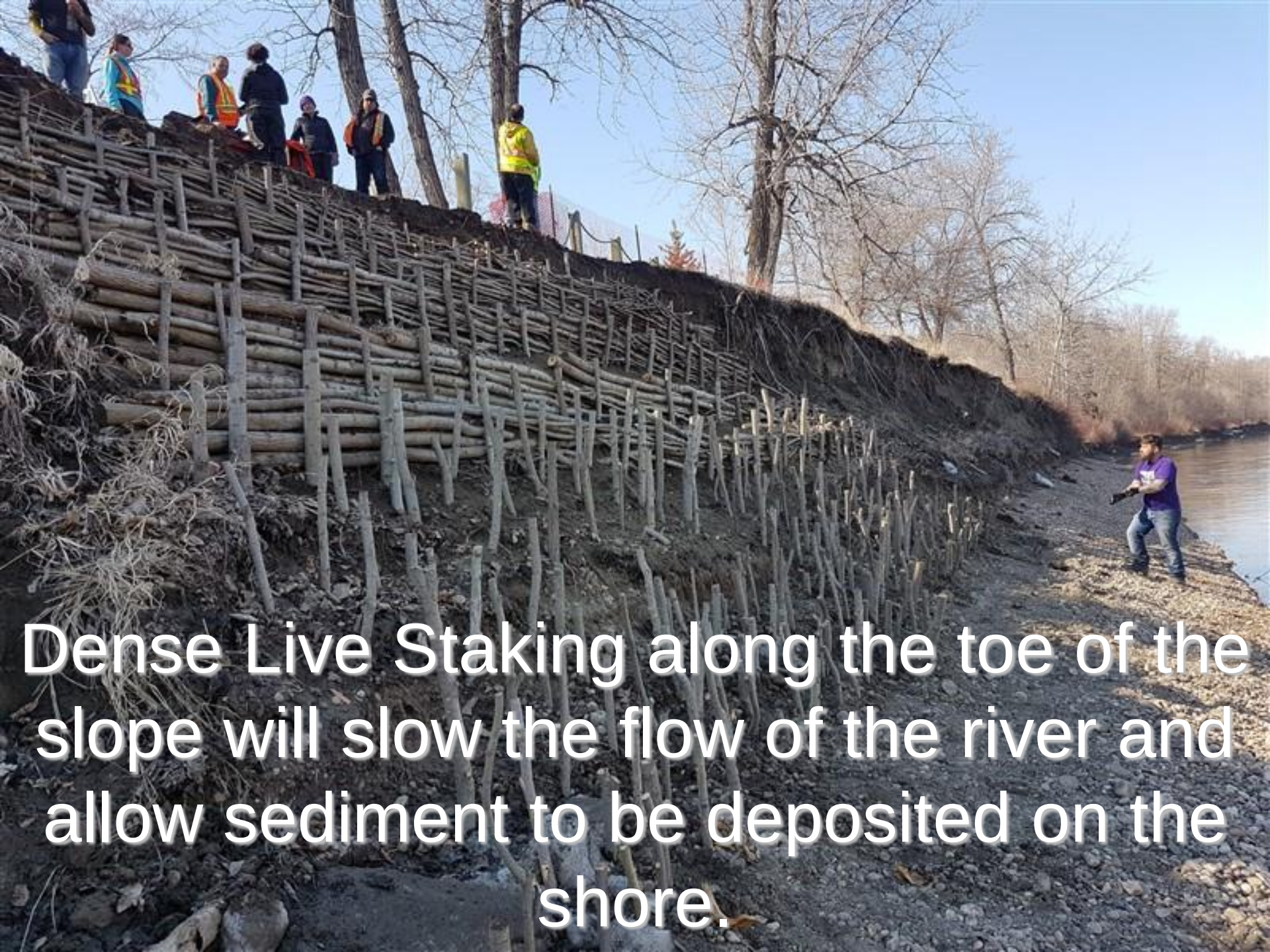

This is a site on the North Saskatchewan River in Devon AB


First we identify the filters that are preventing recovery (steep slopes and a big river).
Looking at the site from the other way.

Wattle fences are short retaining walls built of living cuttings


The river presents the second challenge – we need to slow flow velocities to prevent erosion.

A happy class
Devon Alberta, April 19, 2017


Dense Live Staking along the toe of the slope will slow the flow of the river and allow sediment to be deposited on the shore.


Sediment collected after high flows
July 3, 2017


August 3, 2017


November 13, 2017

Dense stands of riparian vegetation protect river banks by slowing the velocity of the water (Porcupine River, YT).

Gas plant site 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.

August 19, 2011

Two growing seasons


Happy Balsam Poplar…
August 17, 2013

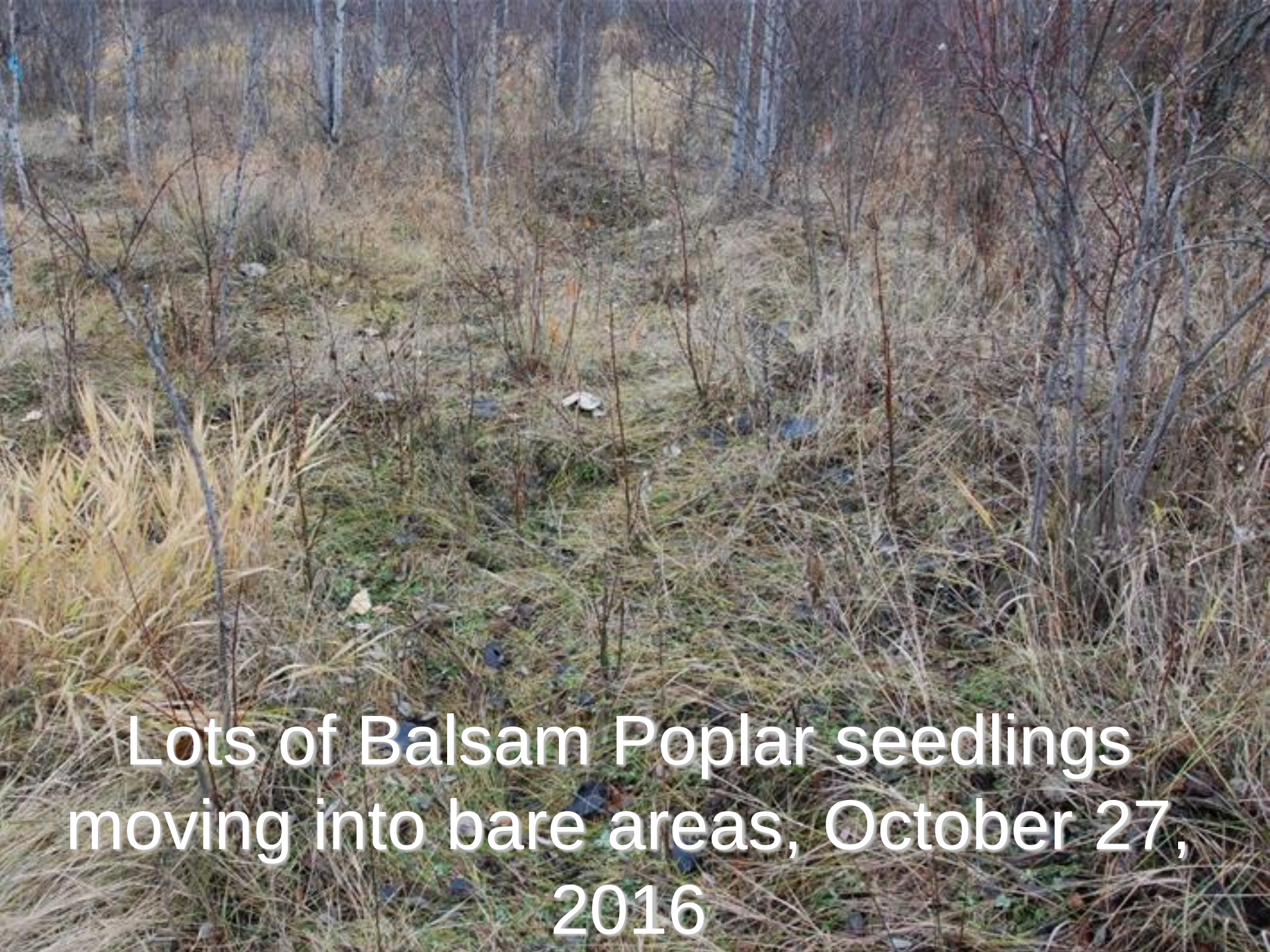

February 24, 2015


September 25, 2015


September 25, 2015
Six growing seasons after planting and we have 25 ft. high trees!

Pioneering forest established, October 27, 2016.

Conifers coming in around the edges for free, October 27, 2016



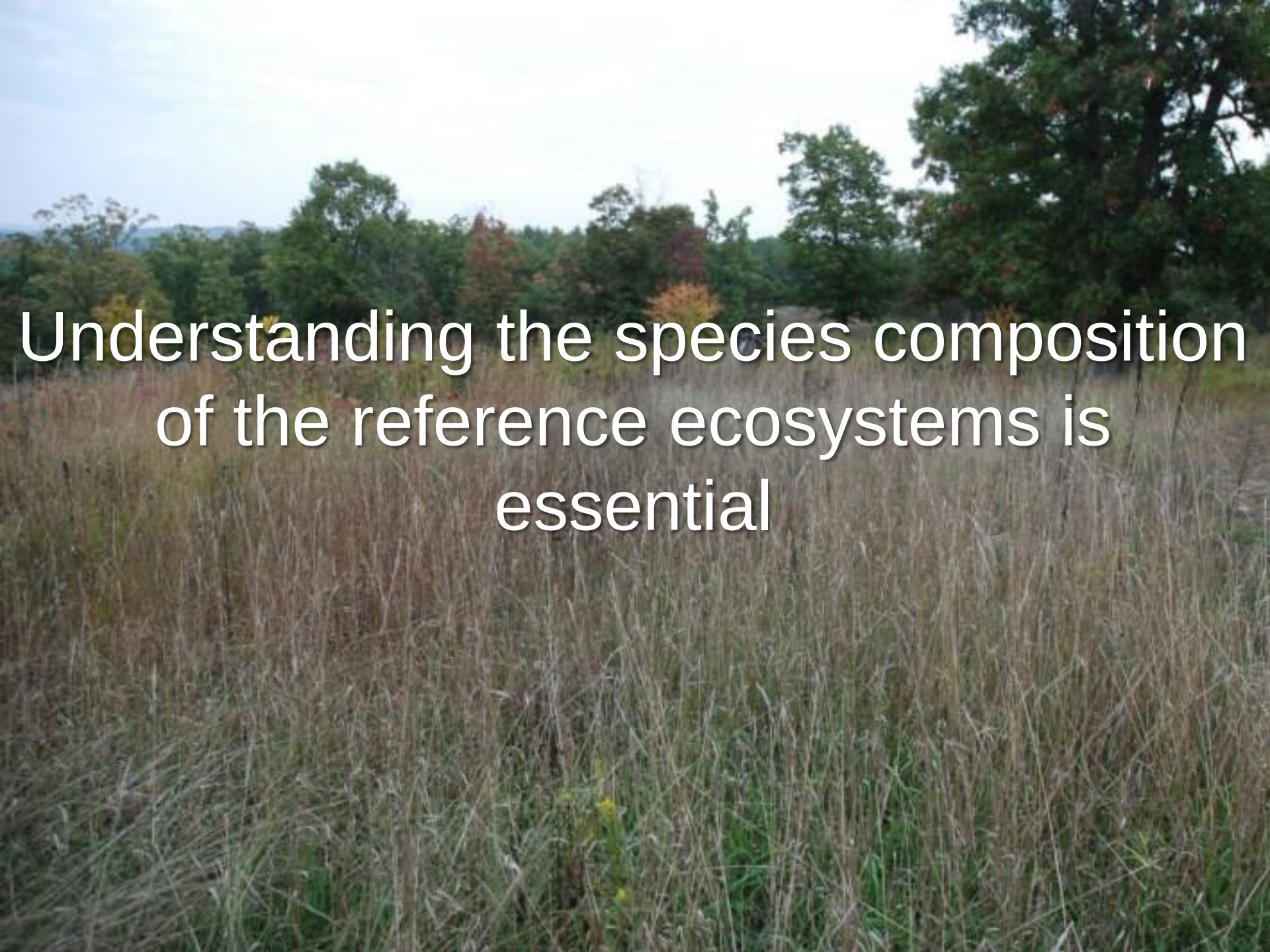
Lots of Balsam Poplar seedlings moving into bare areas, October 27, 2016

Lots of Prickly Rose found in many areas, October 27, 2016

A diverse forest has a diversity of organisms, October 27, 2016


As the forest matures, additional species will establish, October 27, 2016
The use of natural processes can provide cost-effective solutions for the restoration of drastically disturbed sites.


Tall Grass Prairie Restoration, Madison, Wisconsin


Understanding the species composition of the reference ecosystems is essential


Tall grass prairies are very diverse ecosystems


Where species composition changes depending on the edaphic conditions of the site being considered.

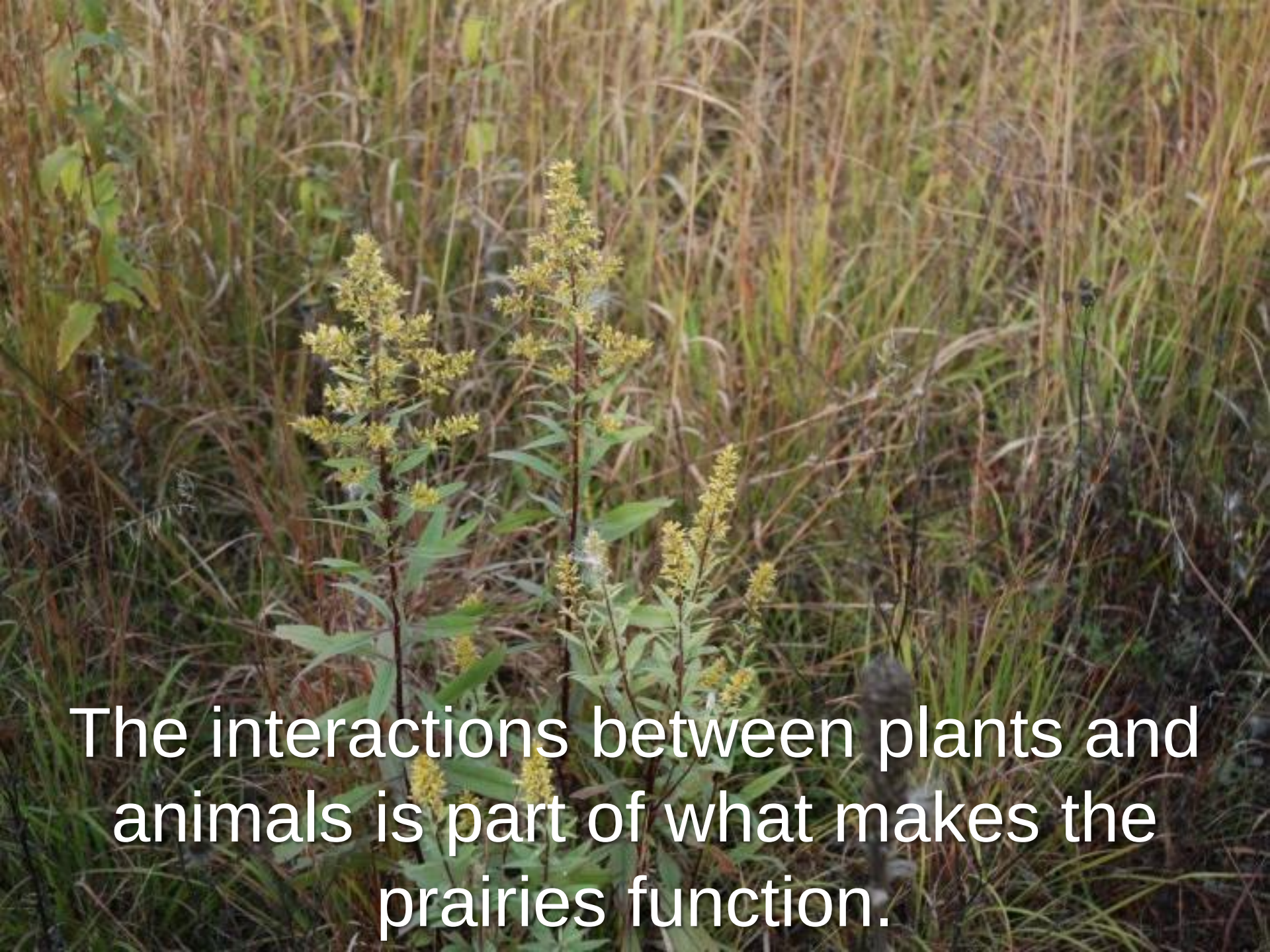

Maintaining the level of diversity and the options for species to shift successionally is important.

Grasses form the framework of these ecosystems.


Many of these species have evolved in the grasslands,


With the herbivores that roamed the prairies.


Incorporation of a diversity of herbaceous species in the prairie is important.



The interactions between plants and animals is part of what makes the prairies function.


Restoration activities follow agricultural treatments. Native seed is collected and seeded into prepared fields.


The resulting native grasslands provide
a wide diversity of biota.

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

There was a 3 km penstock that was also removed.


What are the constraints or filters preventing natural recovery?


What are the successional patterns that operate in the region?


So we made project sites rough and loose
(= increased topographic heterogeneity)
and covered them with woody debris
(October 7, 2012).

Dam area, October 7, 2012

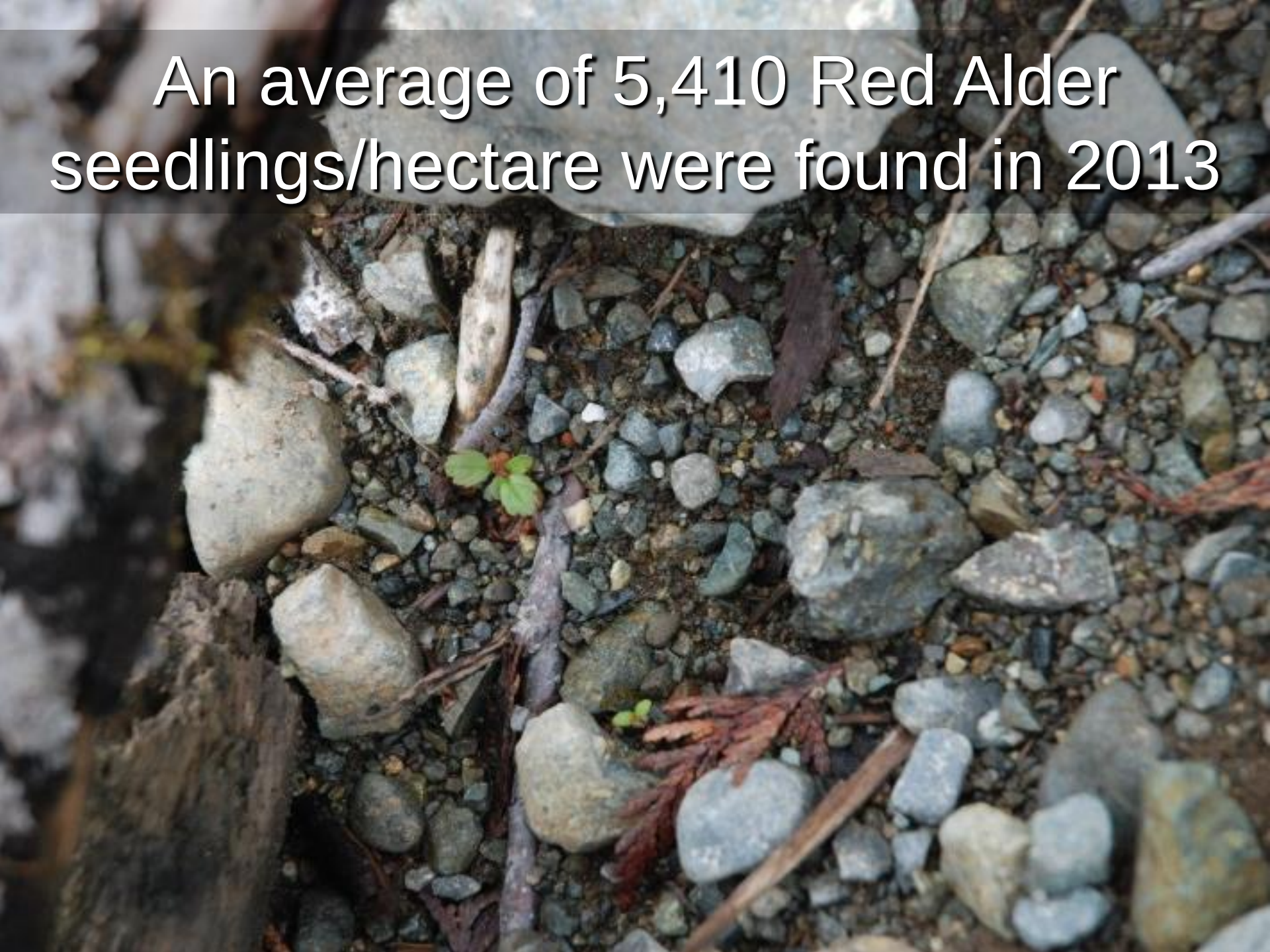
Dam area, July 15, 2017


By November 13th, 2012 the project sites were ready for winter.

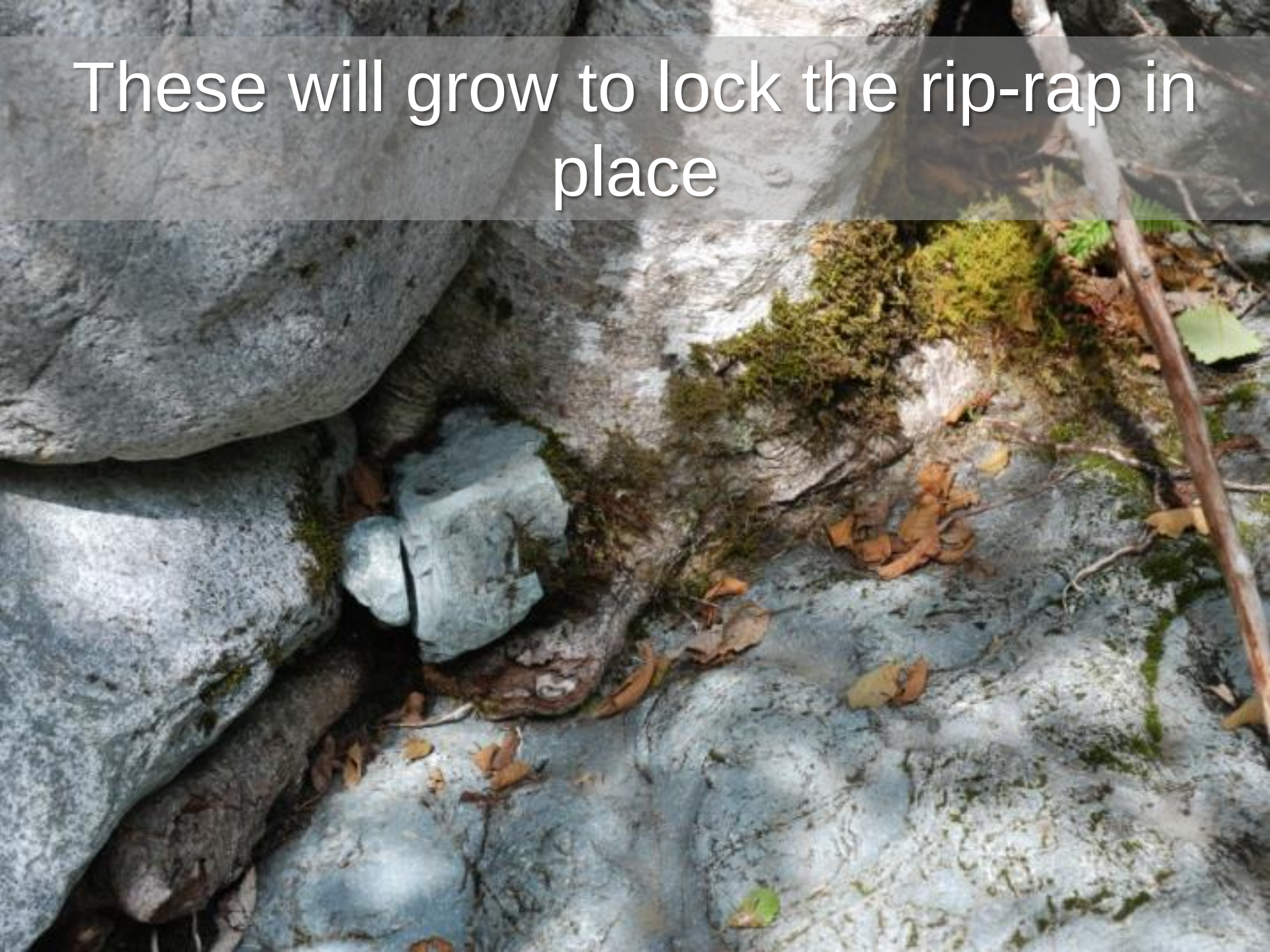

Monitoring transects were established at 5 project locations, July 16, 2013
Dam area, July 16, 2013

Woody debris is an important natural process for bringing in other species.


In 2017, fruit bearing plants were found in 98 % of the 50 plots.


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


Alder are establishing in the rip-rap along the river.
July 15, 2017

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

By 2016 an average of 6,162 Red Alder seedlings/hectare were found along with conifers in most of the plots.


In 2017 an average of 6,963 Red Alder seedlings/hectare were found along with conifers in 98 % of the plots and 84 other species.


July 15, 2017
The growth of conifers under a canopy of deciduous species is enhanced.


March 9, 2016
Penstock crossing area


July 16, 2013

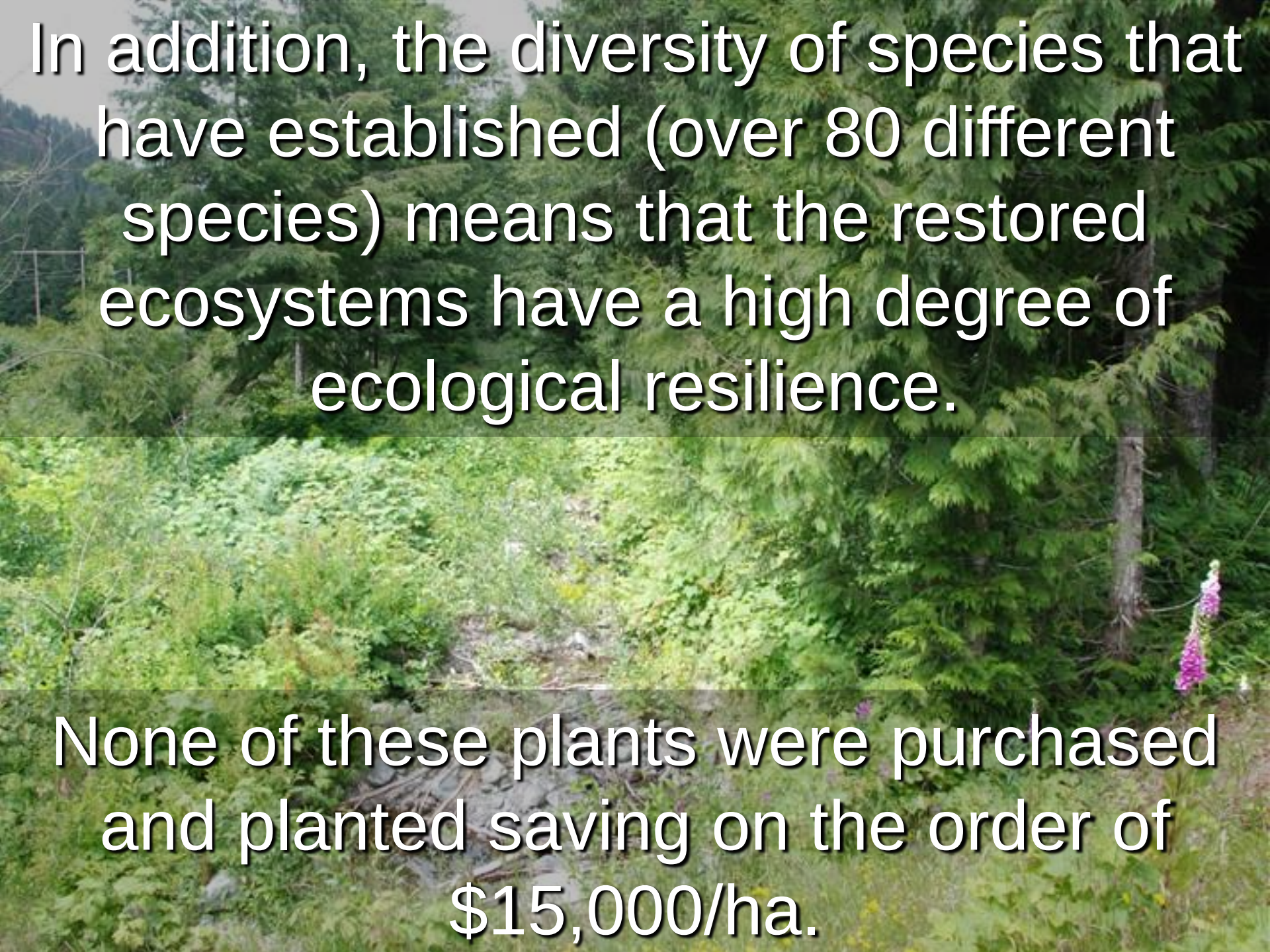

July 23, 2014


July 6, 2015


March 9, 2016


July 20, 2016


July 15, 2017



In addition, the diversity of species that have established (over 80 different species) means that the restored ecosystems have a high degree of ecological resilience.

None of these plants were purchased and planted saving on the order of $15,000/ha.

Including a bunch of showy species.

Year	No. of Alder / ha	Cover of Alder	No. of Other Spp.	No. of Conifer Occurrences out of 50 plots	Total Cover
2013	5,412	Less than 1%	32	3 (1 spp.)	1.10%
2014	8,550	2.60%	68	31 (2 spp.)	9.20%
2015	5,392	17.72%	80	30 (4 spp.)	36.30%
2016	6,162	27.04%	75	40 (3 spp.)	46.40%
2017	6,963	34.58%	84	49 (5 spp.)	54.00%

Salient features of 5 years of monitoring at the former Heber Dam


Questions???
July 15, 2017

Consider applying to become a Certified Ecological Restoration Practitioner

RESTORATION *for* RESILIENCE

ECOLOGICAL RESTORATION

IN THE 21ST CENTURY

Hosted by

SER WESTERN CANADA SOCIETY FOR ECOLOGICAL RESTORATION

FEBRUARY 13-17, 2018

SIMON FRASER UNIVERSITY

BURNABY, BRITISH COLUMBIA

WWW.SERWC2018.CA | #SERWC2018