

Natural Processes for the Restoration of Drastically Disturbed Sites



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

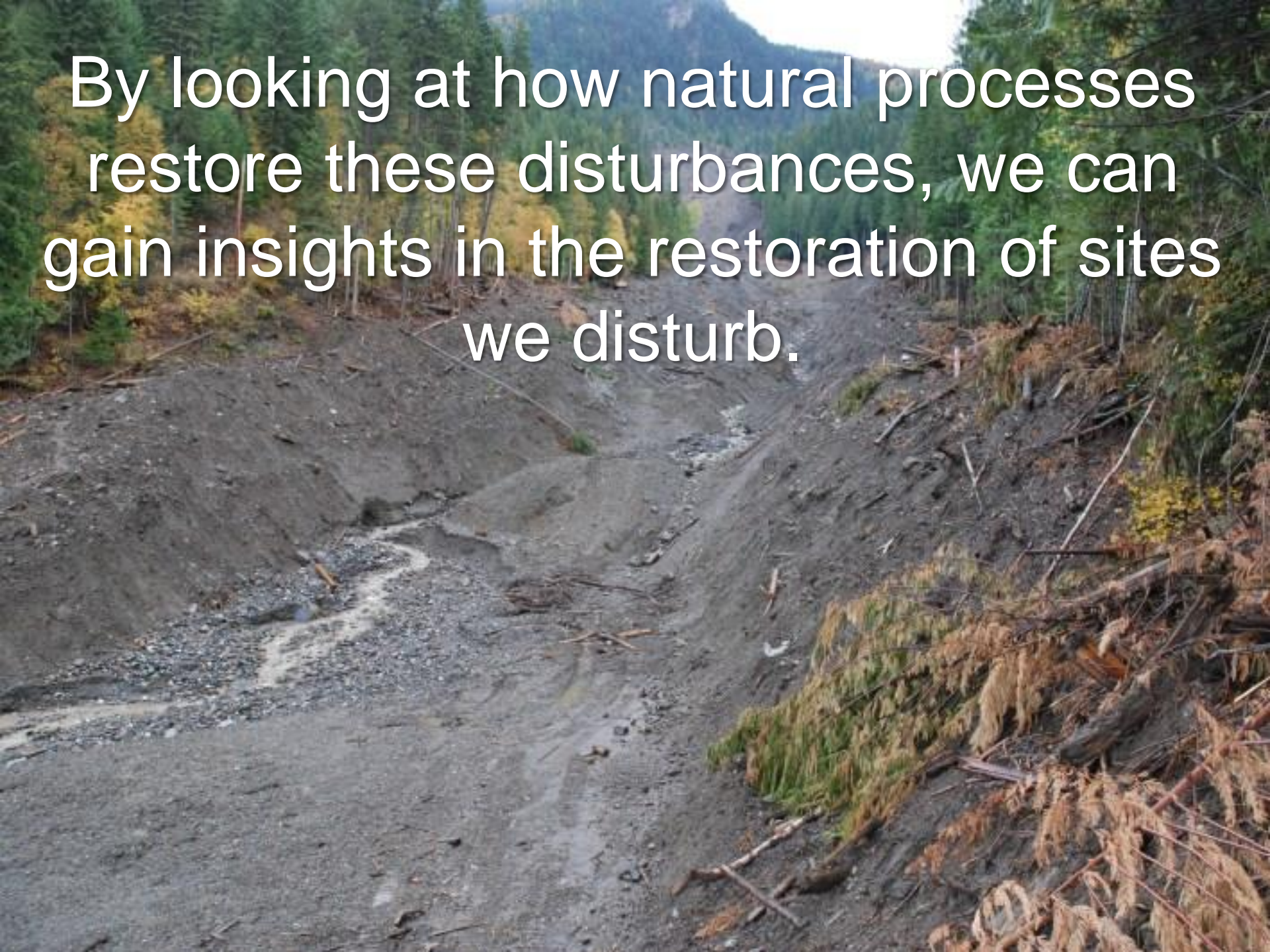
Ecological restoration is the process of **assisting** the recovery of an ecosystem that has been degraded, damaged, or destroyed.





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.



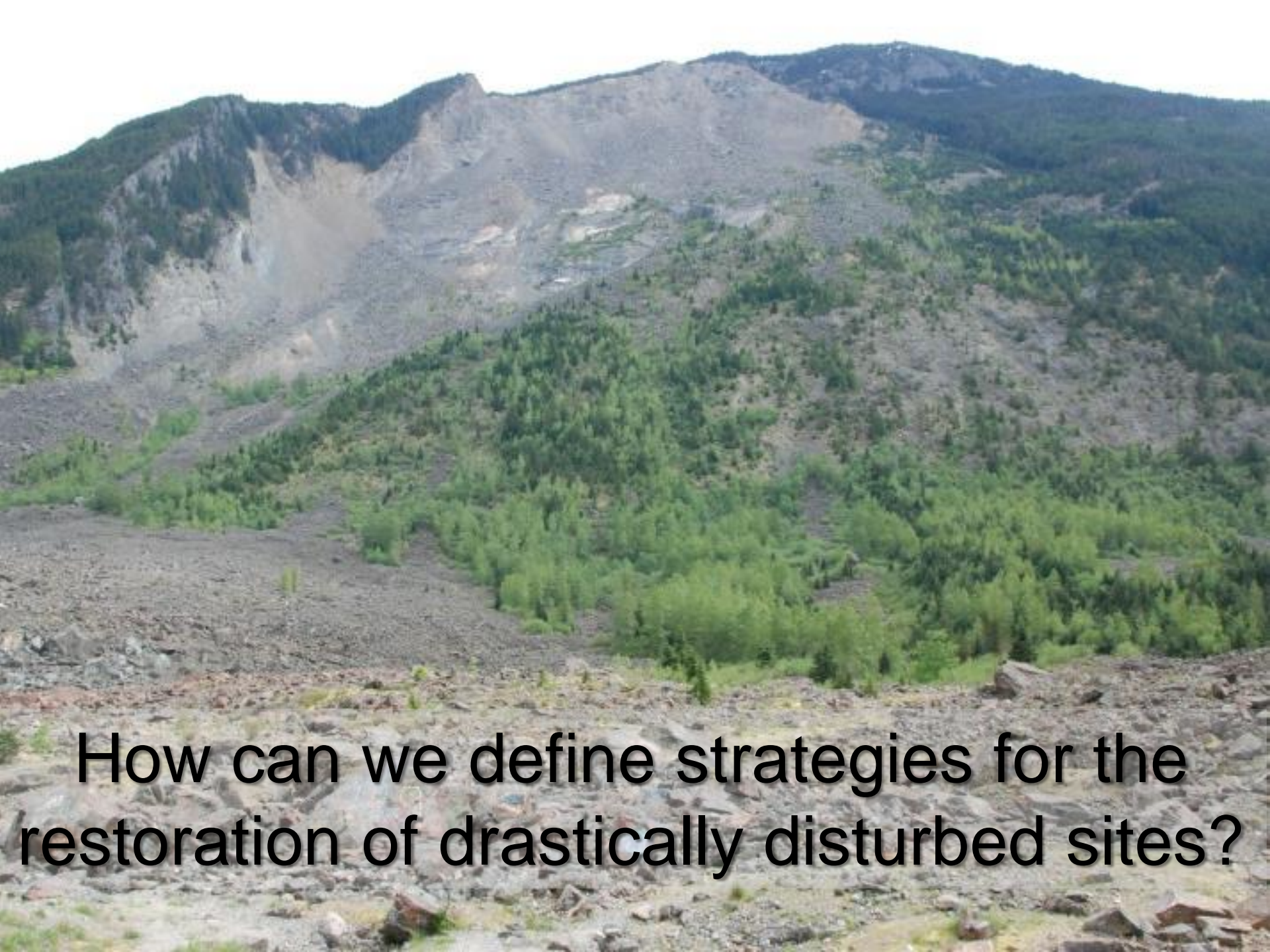
Now we have a diversity of
ecosystems,



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?

9 10 2007



What characteristics do these species have?



What are the mechanisms of
establishment?

14 10 2007



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

18.10.2007



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 24 7 2007



Alders fix Nitrogen, start soil building



Willows add organic matter 22 8 2005

Ecosystems in motion.



On talus slopes?


18 5 2006



Conifers develop soil horizons



Lichens fix Nitrogen, start soil building



Deciduous species add organic matter



Ecosystems in motion.



On landslides?



Showy plants add
diversity



Pioneering plants start
rebuilding the ecosystem



Conifers move in

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 (+/-)

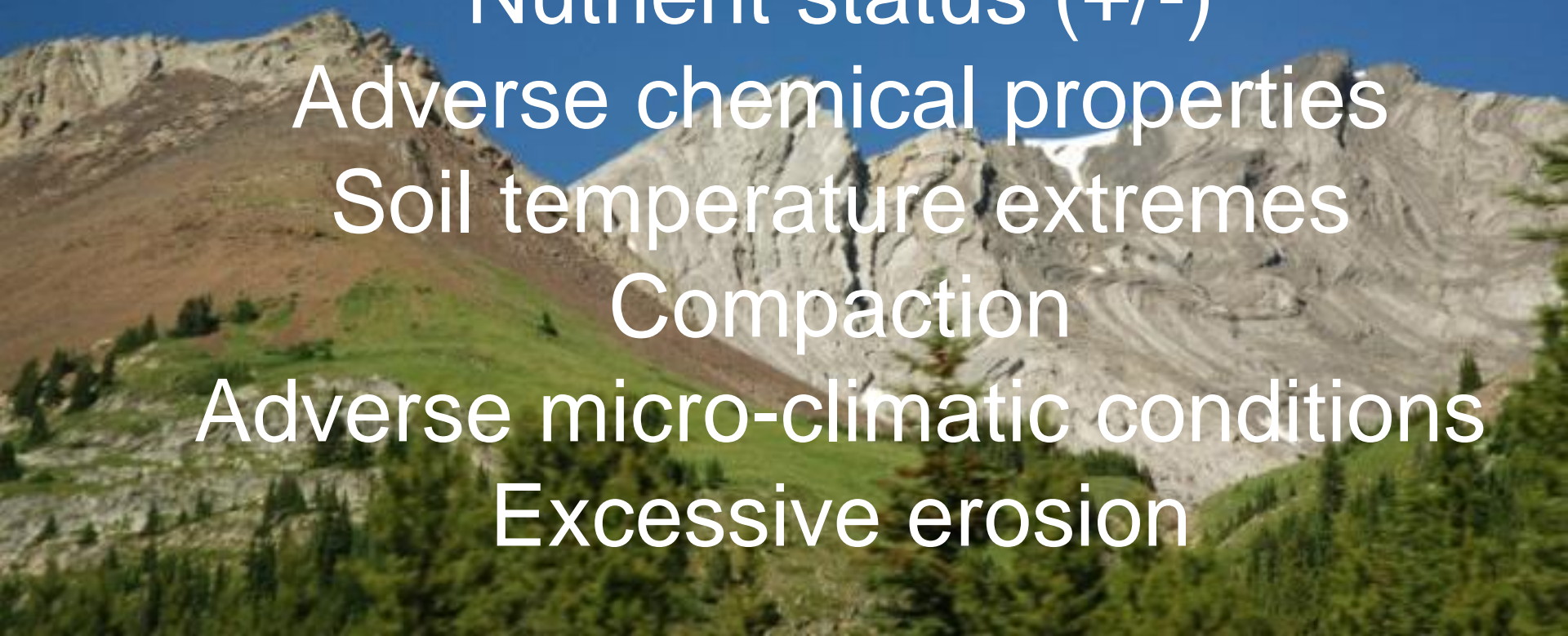
Adverse chemical properties

Soil temperature extremes

Compaction

Adverse micro-climatic conditions

Excessive erosion



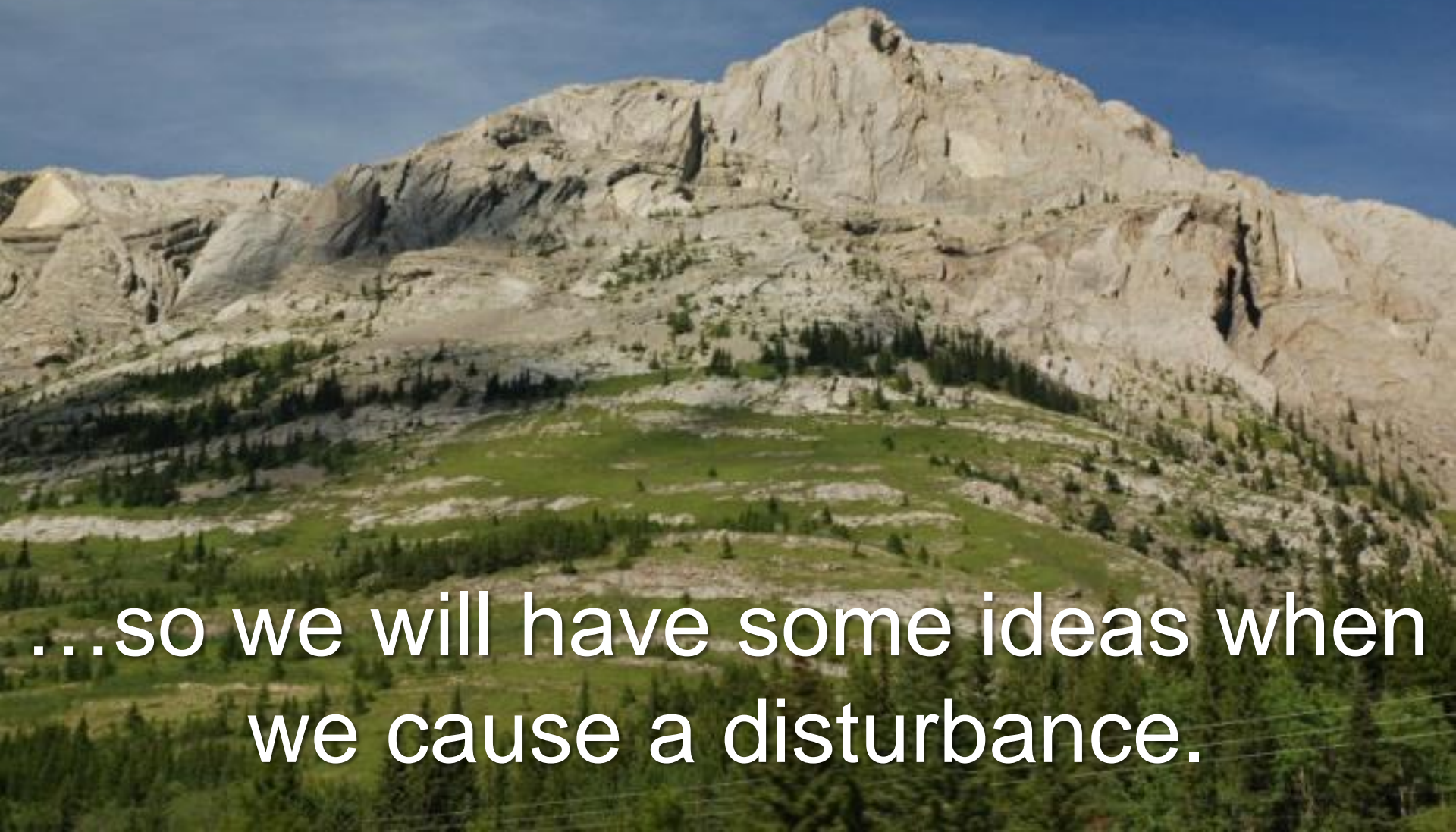
Common biotic filters:

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?

11 7 2005

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

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

A photograph of a river flowing through a valley. The river is in the foreground, with water reflecting the sky and surrounding trees. The banks are covered with dense evergreen forests. In the background, a hillside rises, also covered in forest. The sky is clear and blue.

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.

11 7 2005

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



"D 10" Bulldozer

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 \$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.

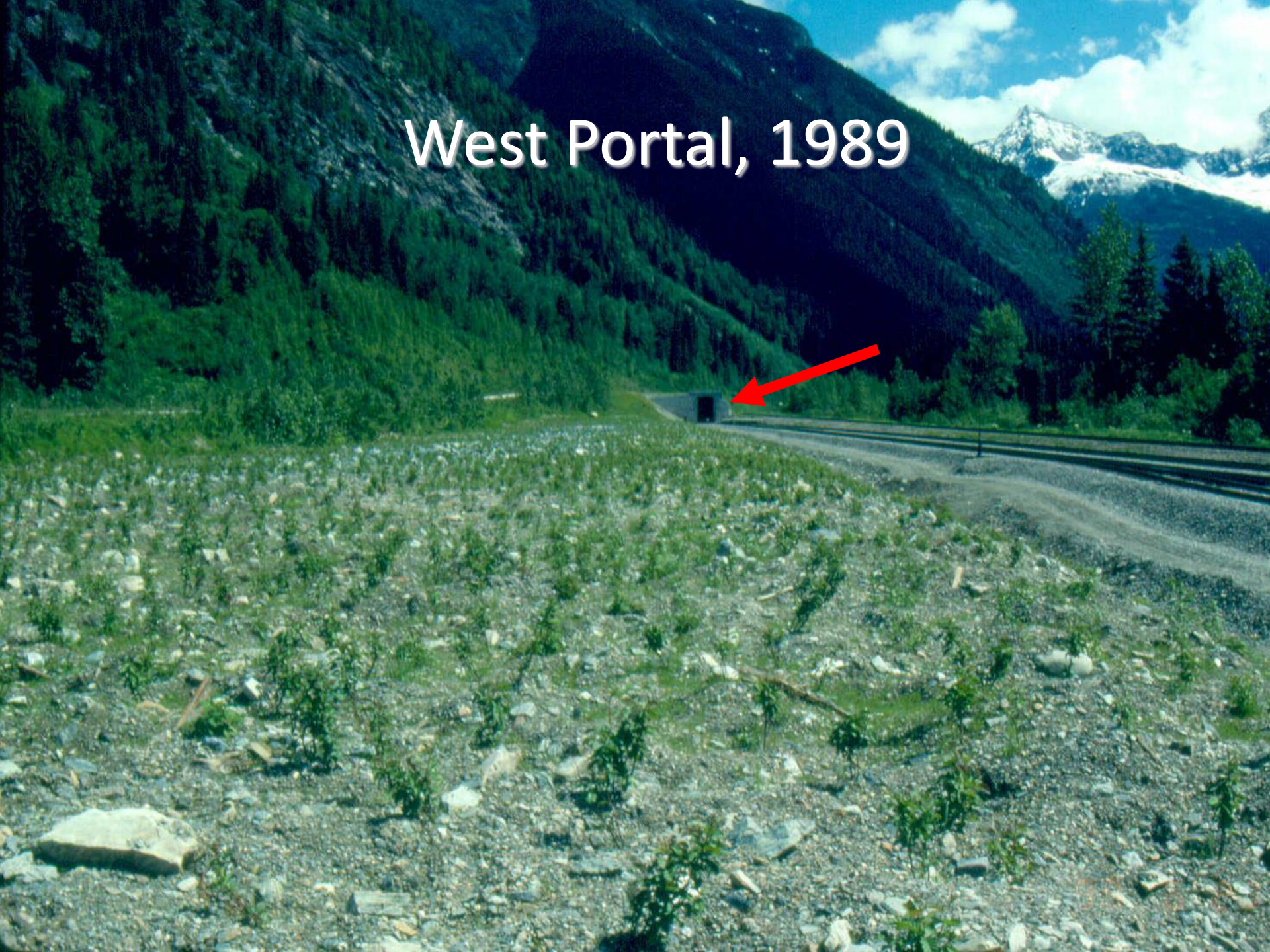




West Portal, Planting in 1989

Rough and loose

West Portal, 1989



West Portal tree & shrub planting, 1989



West Portal August 25, 1992



West Portal August 5, 1997



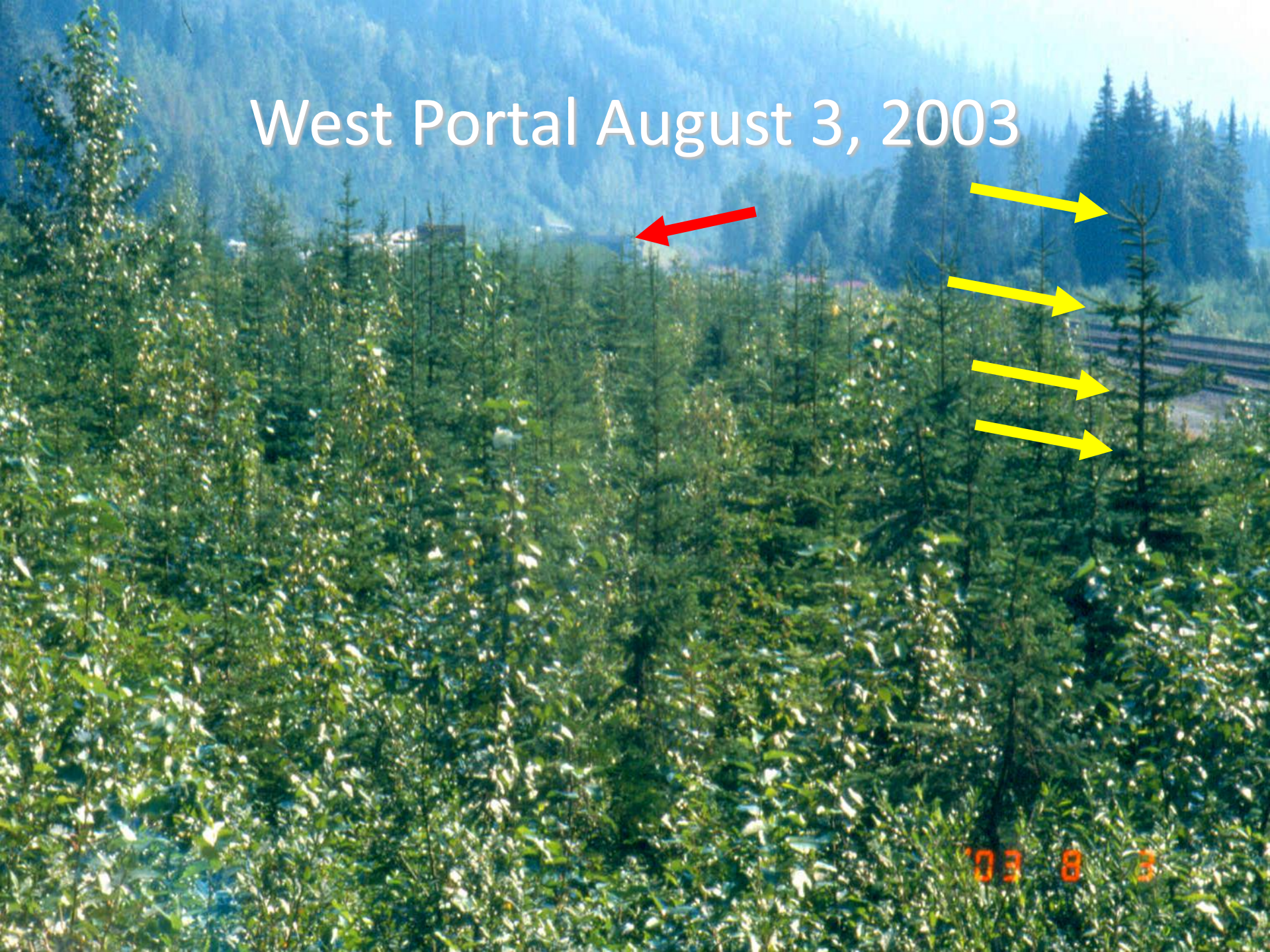
'97 8 5

West Portal July 15, 1999

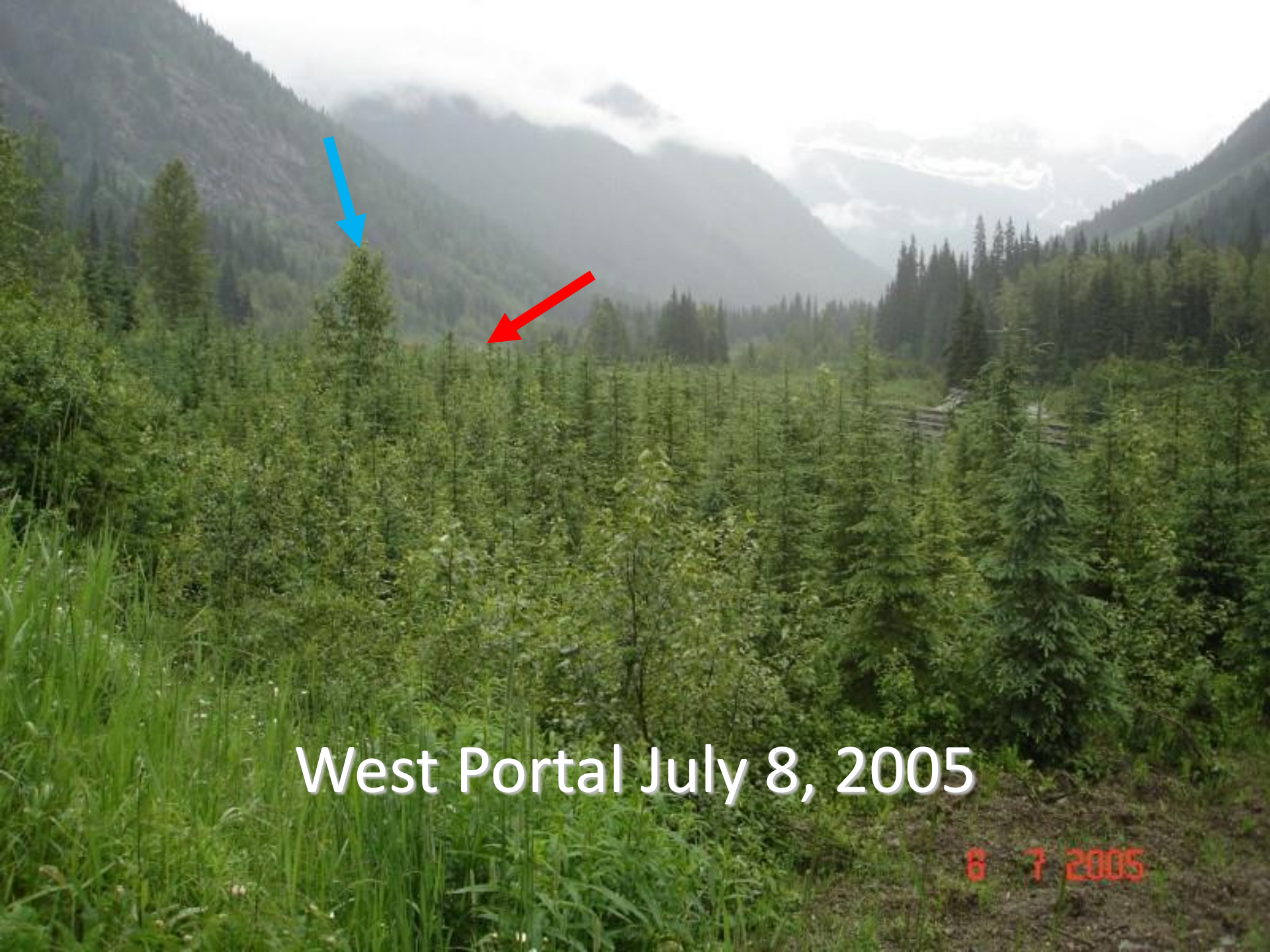


'99 7 15

West Portal August 3, 2003



03 8 3

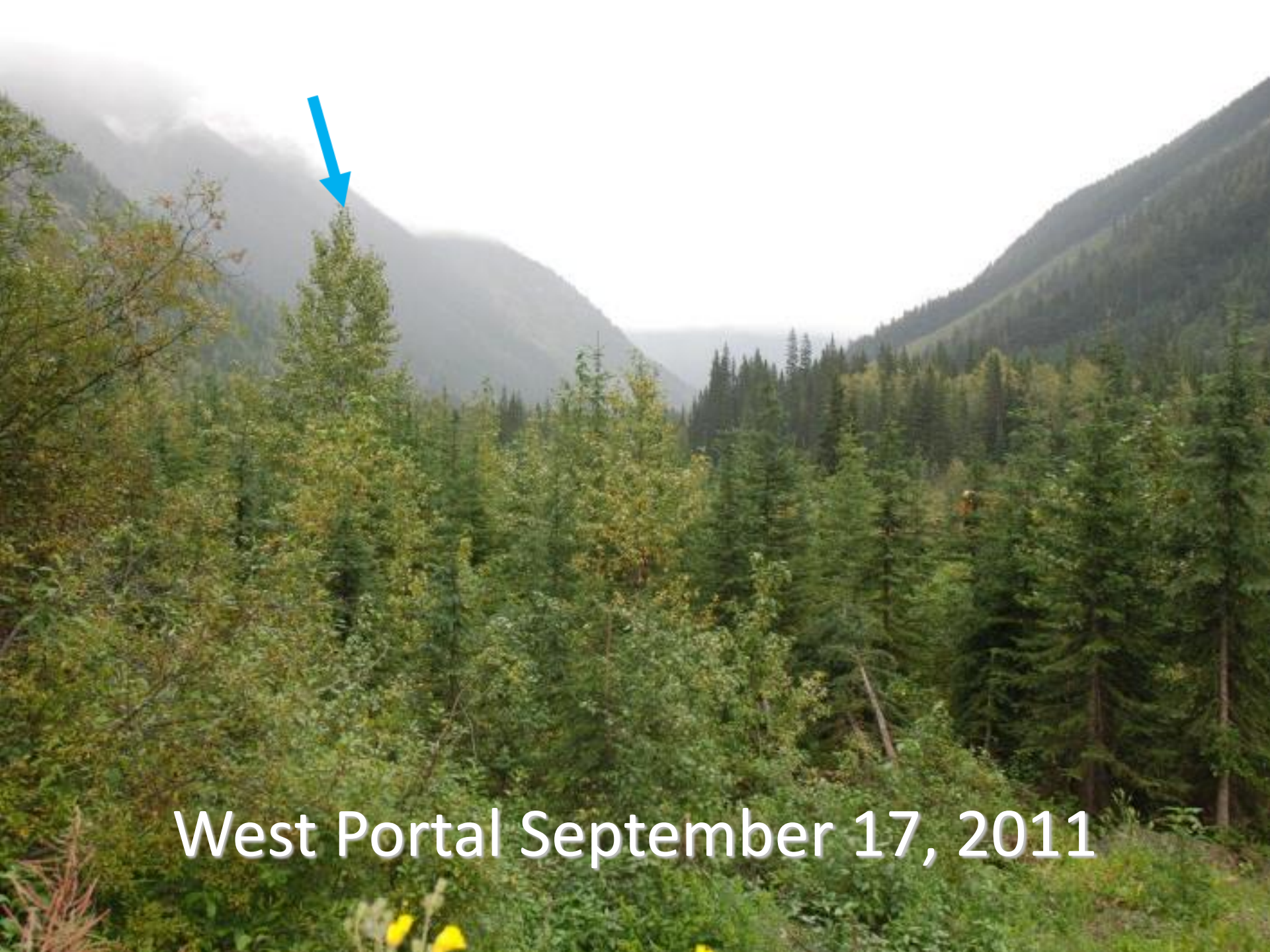


West Portal July 8, 2005

6 7 2005



West Portal July 27, 2008



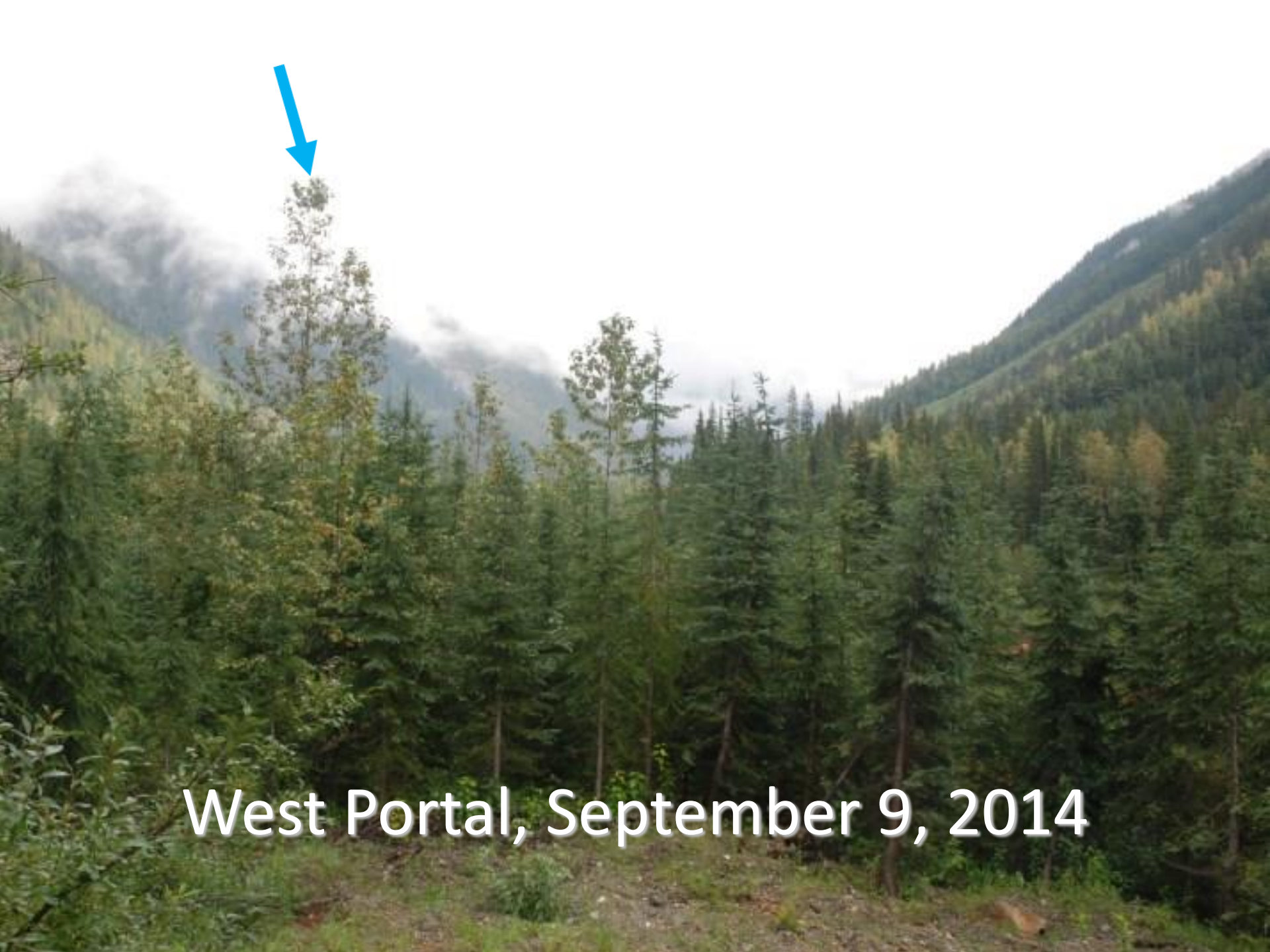
West Portal September 17, 2011

A photograph of a forest landscape. In the foreground, there are various shrubs and small trees, some with green leaves and others with yellow and orange autumn foliage. The background is filled with tall evergreen trees, likely spruce or fir, with some deciduous trees interspersed. The sky is visible at the top, appearing overcast. The text "West Portal September 17, 2011" is overlaid at the bottom of the image.

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.



A wide-angle photograph of a creek restoration project. The creek flows from the background towards the foreground. On the left bank, there is a series of terraced, vegetated slopes made of straw or similar material, designed to stabilize the soil. The right bank also shows some terracing and vegetation. The water is calm, reflecting the sky and the surrounding greenery. In the background, there are more trees and a utility pole with wires. The overall scene is a naturalistic landscape with human-made restoration features.

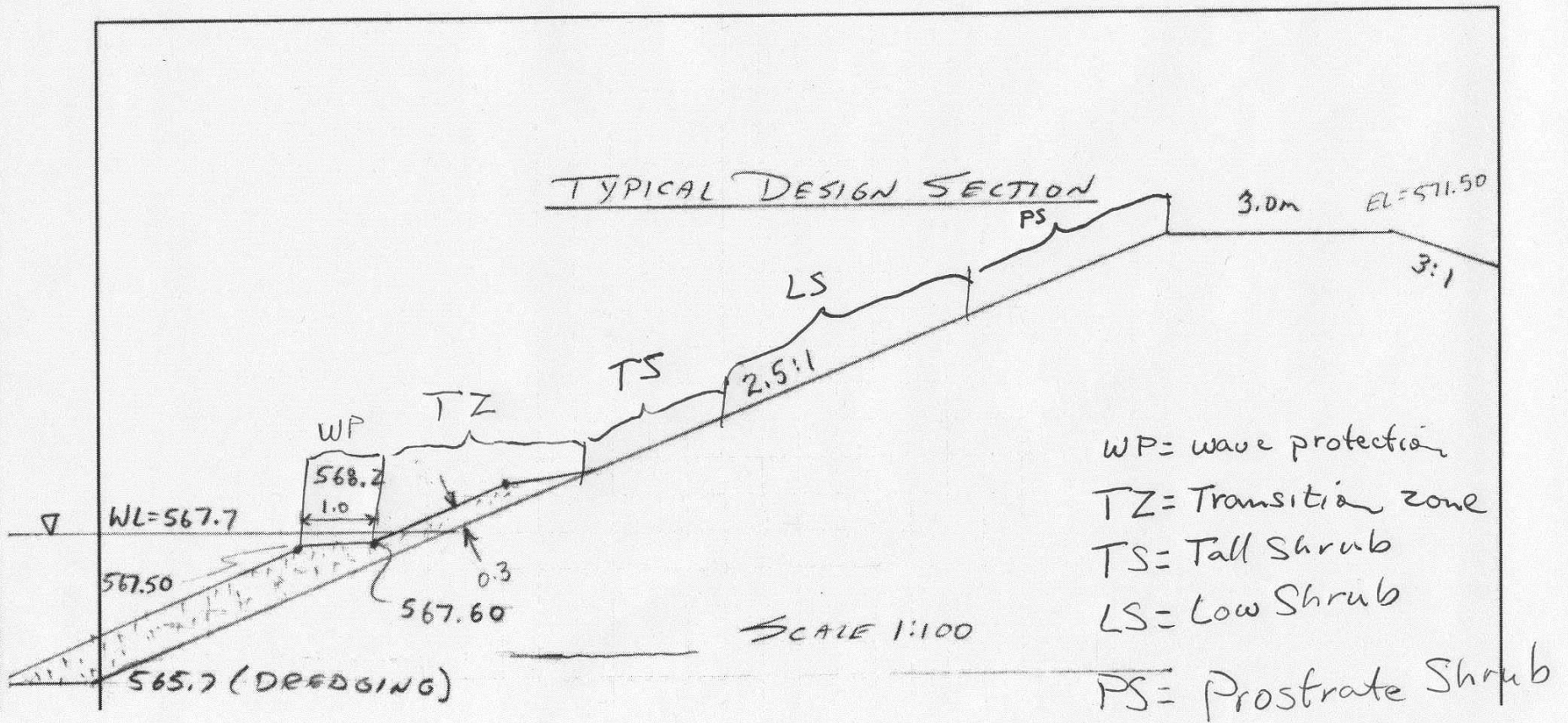
Wascana Creek Restoration



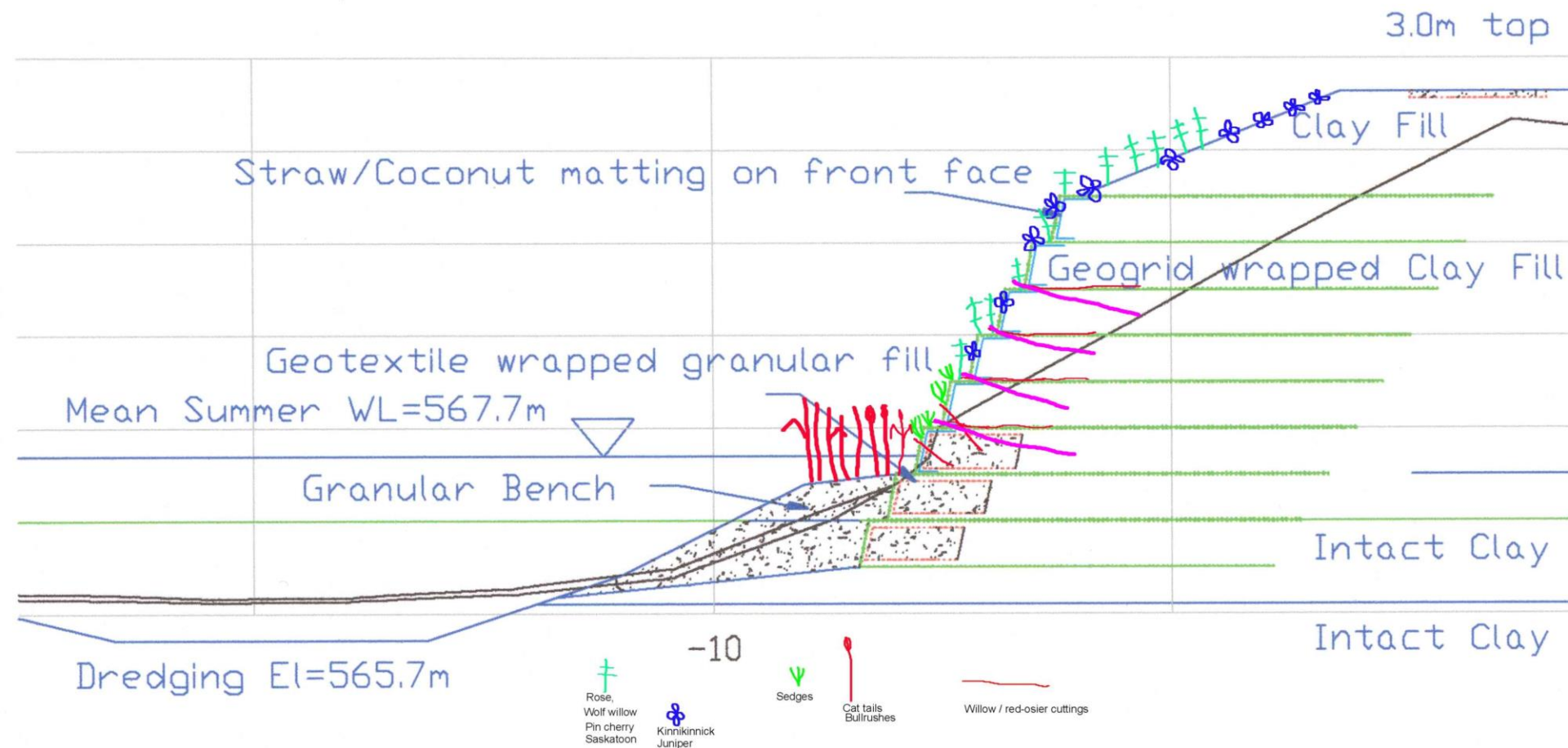
Small slumps threaten the integrity of
the dike

A photograph of a grassy field with a body of water in the foreground. The grass is tall and yellowish-brown, indicating it might be autumn or the grass is dry. In the background, there are trees with some green and some yellow leaves. The water in the foreground is calm, reflecting the grass and trees. The text "Wave erosion along the shoreline undermines the dike slopes." is overlaid on the image in white font.

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





May

2002

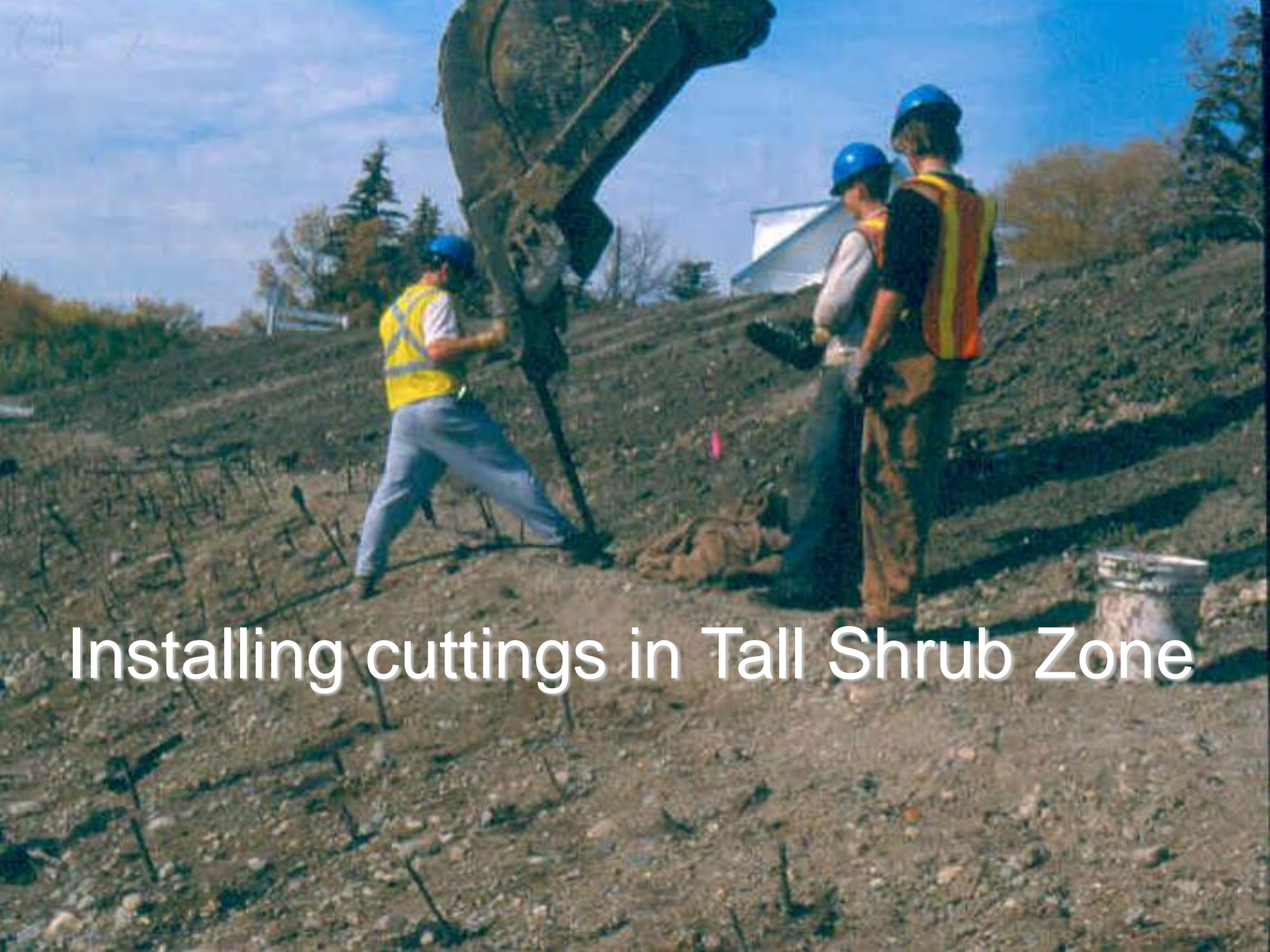
August

Using emergent aquatic plants to
protect shores

A photograph of a pond in Wascana Creek, 2011. The foreground is dominated by tall, dry, golden-brown grasses and some green shrubs. The pond is in the middle ground, reflecting the blue sky and white clouds. The background shows a line of trees with some autumn-colored foliage and a few buildings in the distance under a bright blue sky with scattered white clouds.

2011

Very successful treatments on
Wascana Creek



Installing cuttings in Tall Shrub Zone



June, 2004



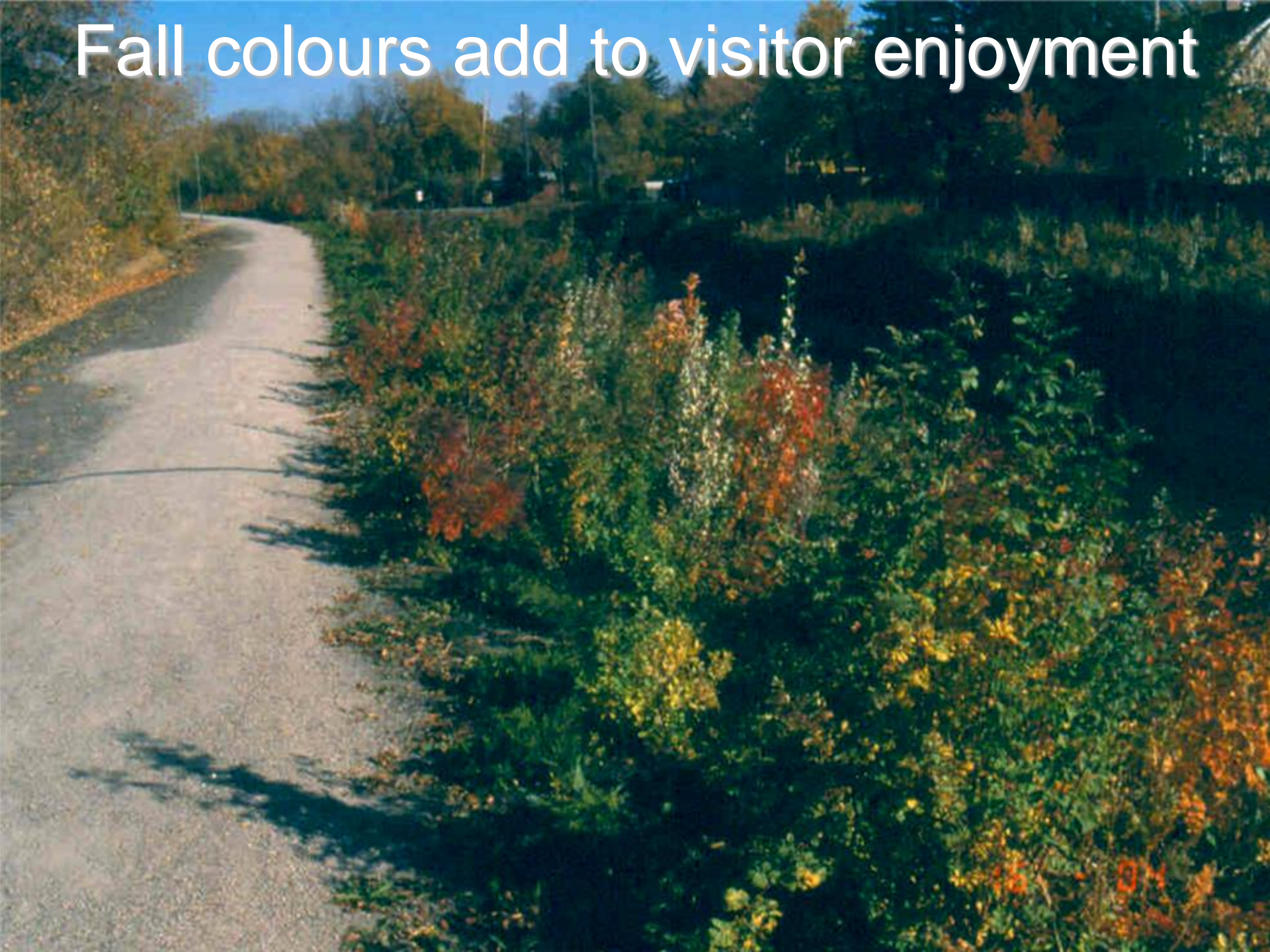
June, 2004

04 6 28



Many species spread by suckers

Fall colours add to visitor enjoyment



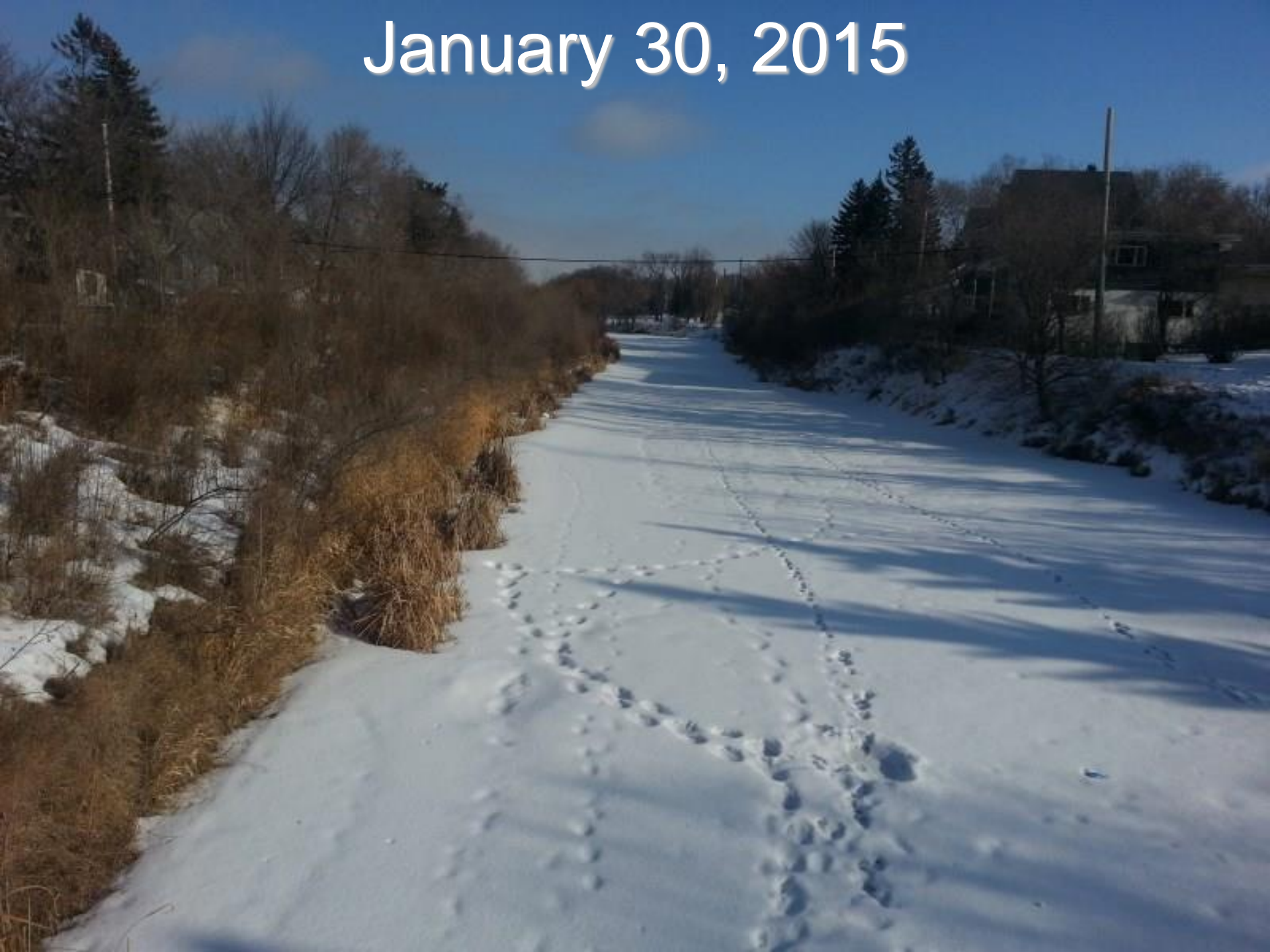
October, 2011



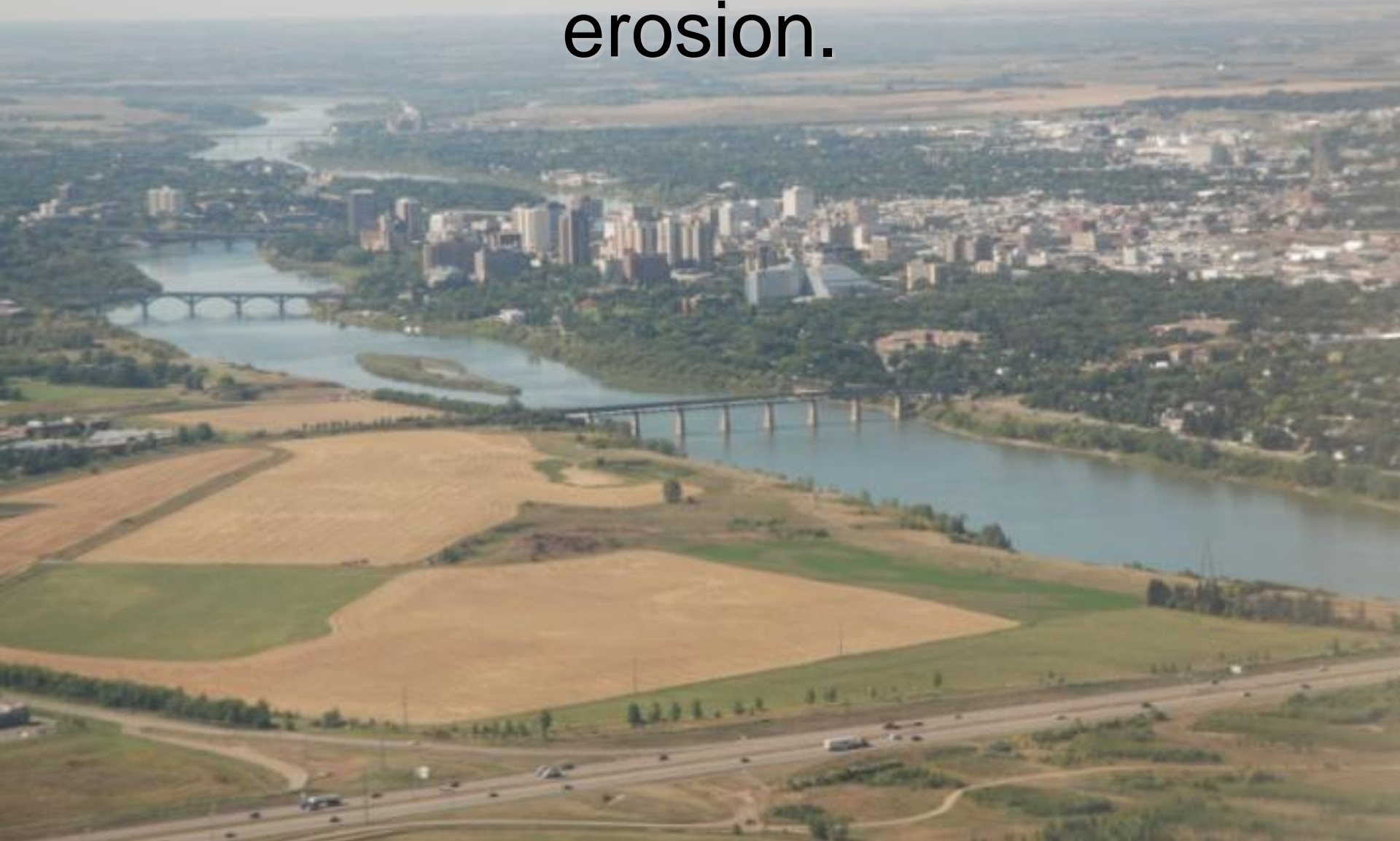
May 2003

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

A photograph showing a steep, eroded riverbank. In the foreground, there is a wooden fence made of vertical posts and horizontal rails, partially obscured by dry grass and fallen leaves. The bank itself is a mix of brown soil and sparse vegetation. In the background, a large, calm river flows, its surface reflecting the overcast sky. The overall scene suggests a natural barrier or a site of environmental concern.

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

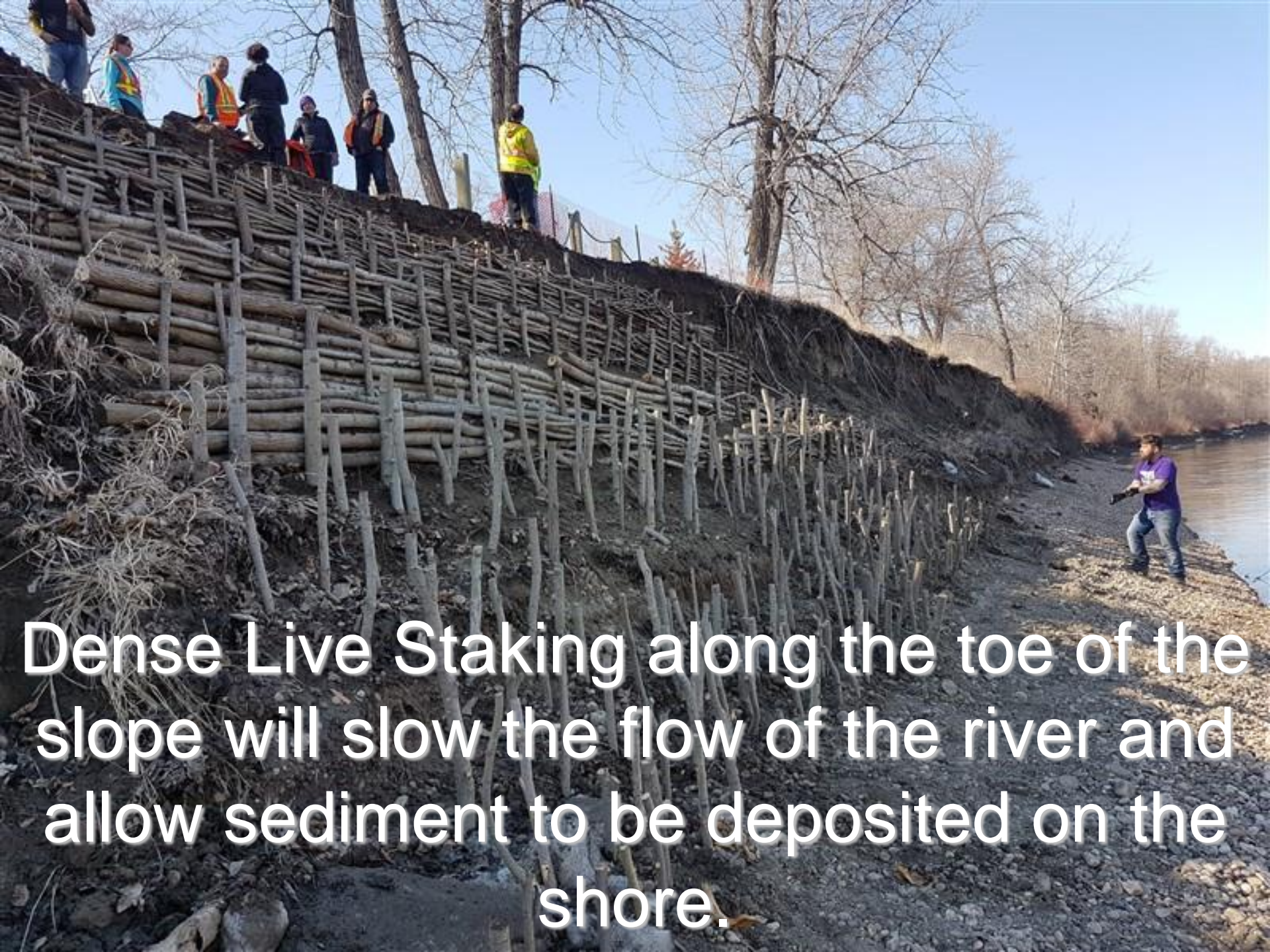


The river presents the second challenge – we need to slow flow velocities to prevent erosion.






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

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



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

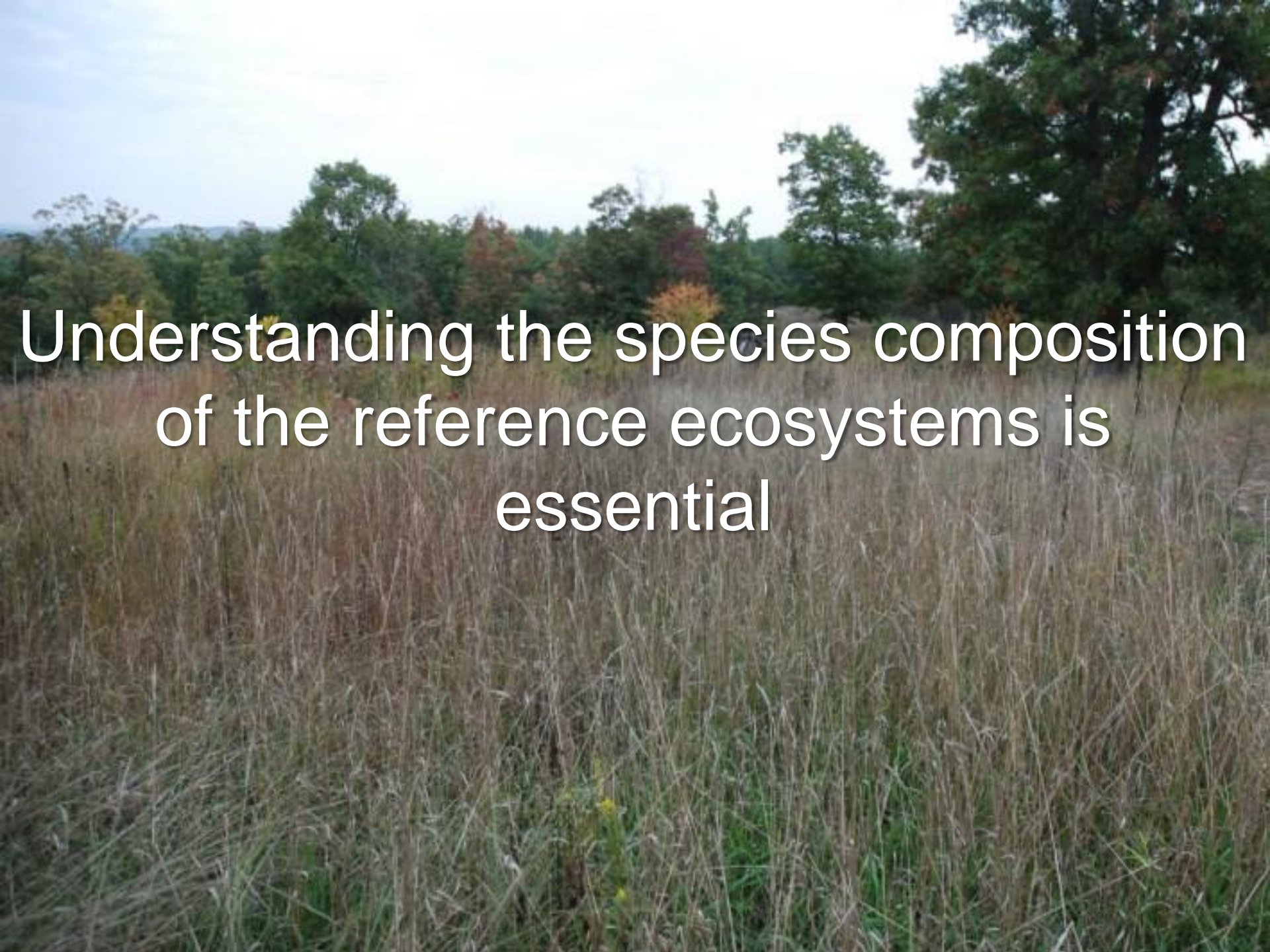
As the forest matures, additional species will establish, October 27, 2016



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



Tall Grass Prairie Restoration, Madison, Wisconsin

A photograph of a tall grass field with trees in the background. The grass is a mix of green and brown, indicating it might be late summer or early autumn. In the background, there is a line of trees with some showing early fall colors. The sky is overcast and grey.

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,

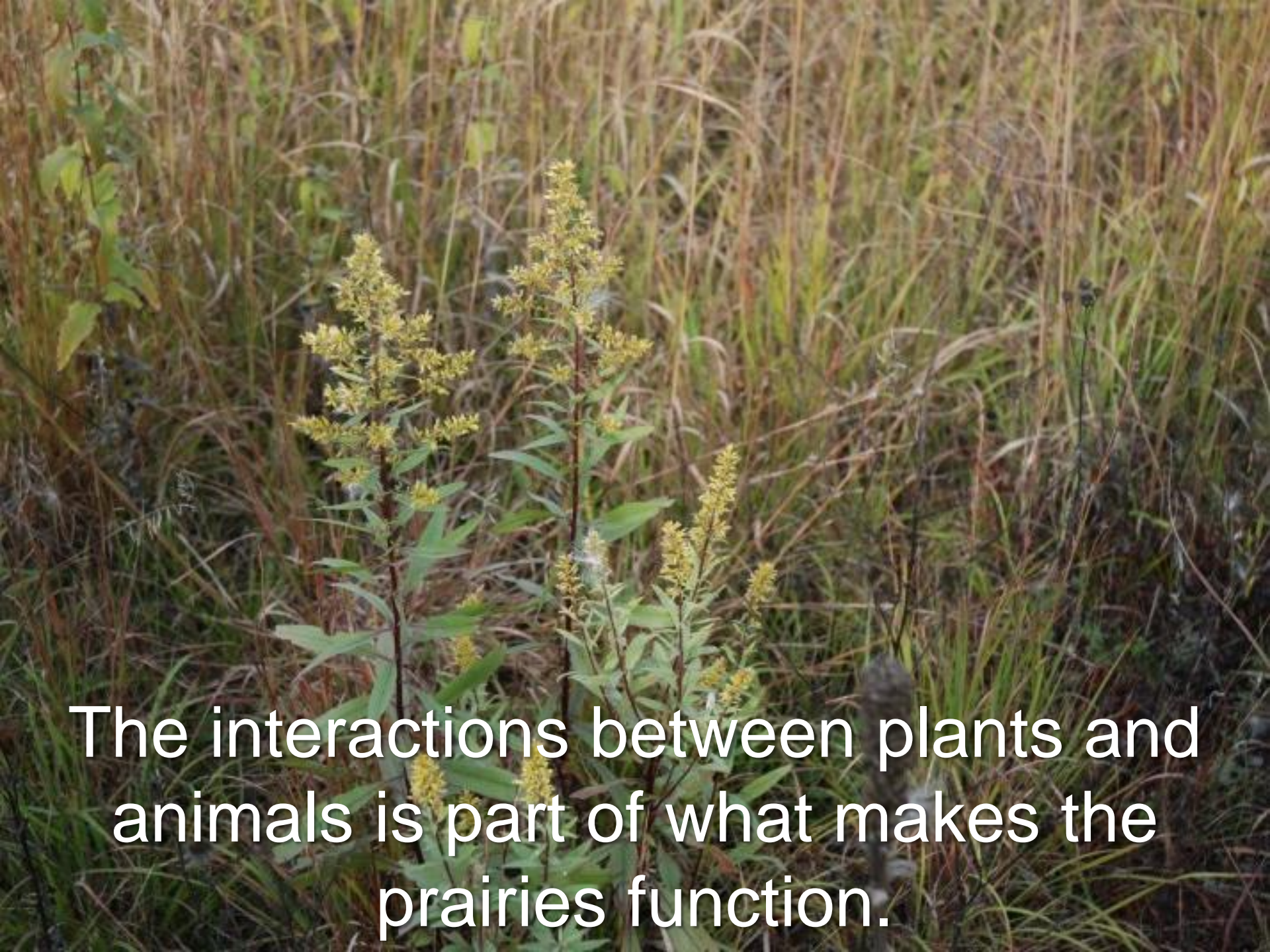


With the herbivores that roamed the
prairies.



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



A photograph of a prairie landscape. In the center, a plant with several upright stems and clusters of small yellow flowers stands out against a background of tall, dry grasses. The text is overlaid at the bottom of the image.

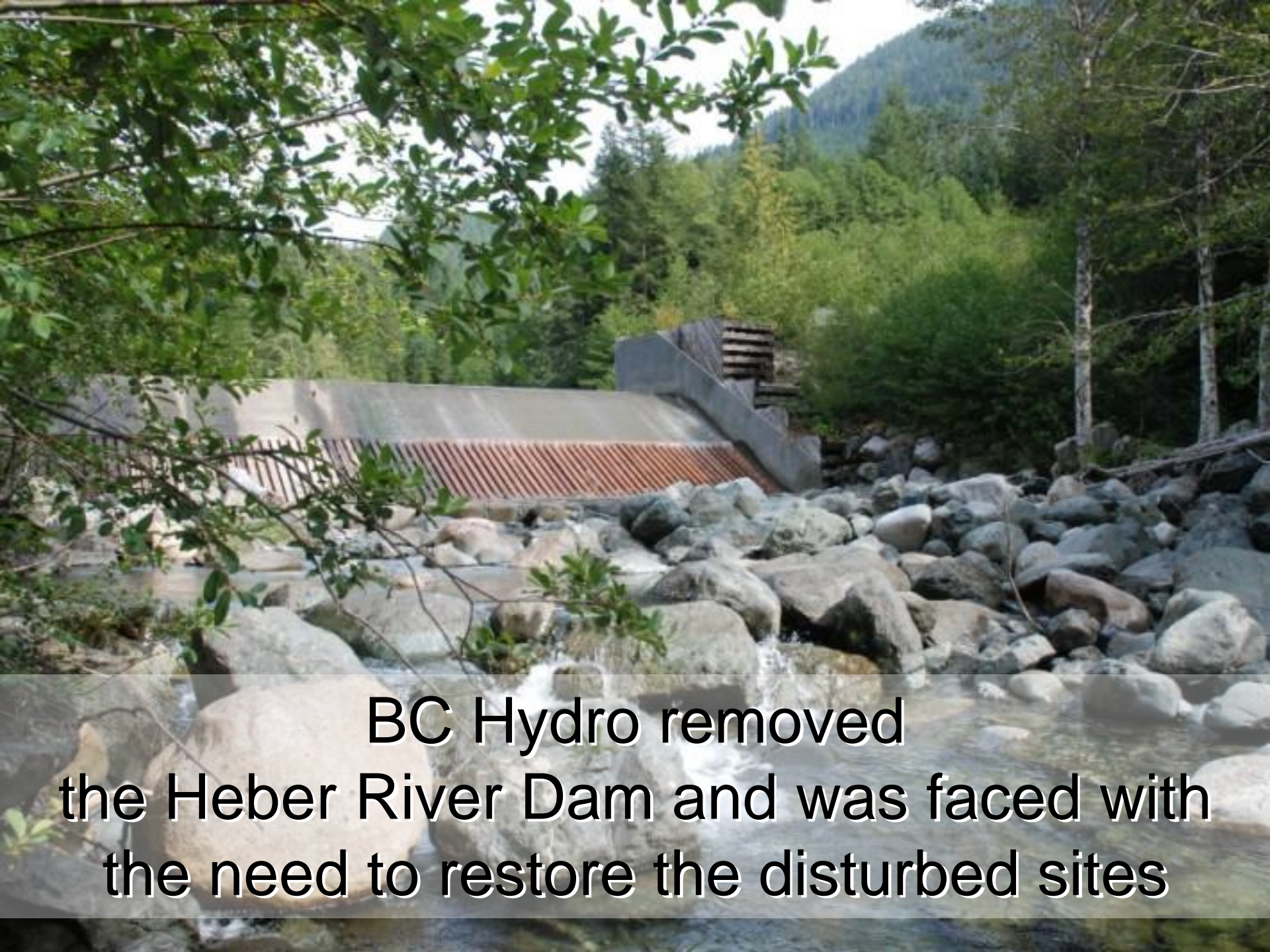
The interactions between plants and animals is part of what makes the prairies function.

A photograph of a large, mature tree with a thick, textured trunk and dense green foliage. The tree is situated in a field of tall, dry grass. The background shows a clear sky and some distant trees. The text is overlaid on the lower half of the image, centered horizontally.

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

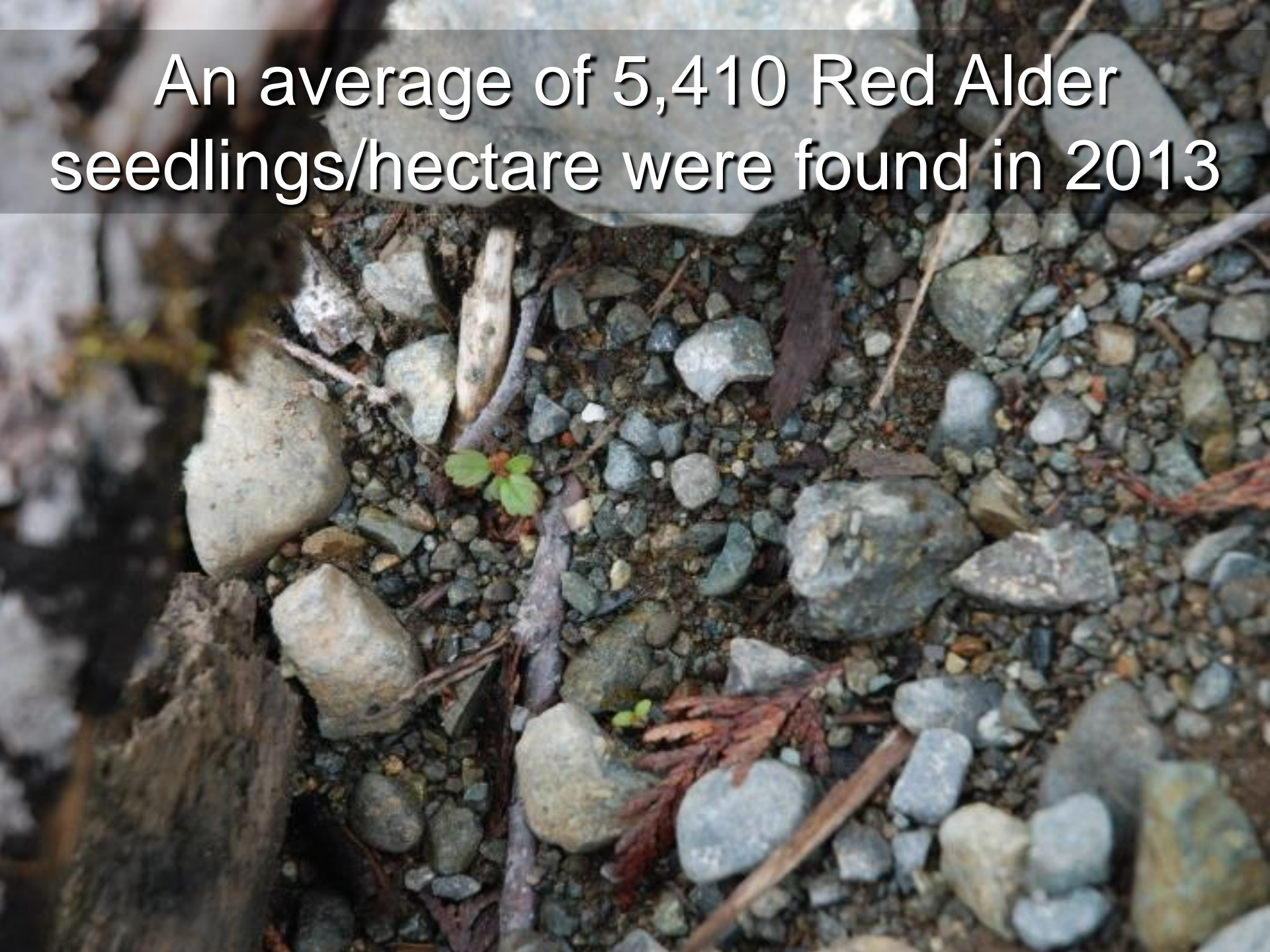
Woody debris is an important natural process for bringing in other species.



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



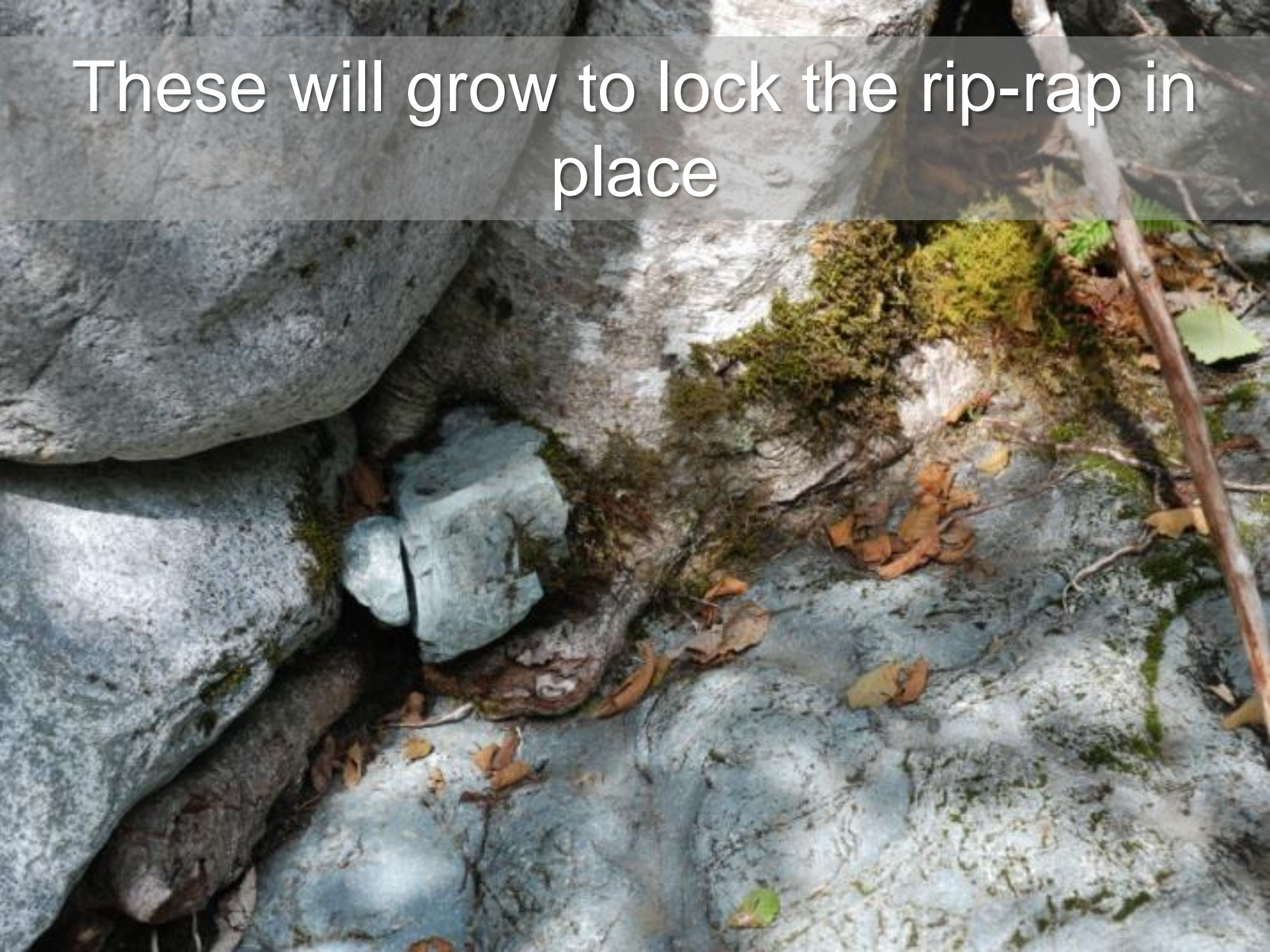
An average of 5,410 Red Alder seedlings/hectare were found in 2013



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.

A close-up photograph of a forest floor. In the foreground, there are several green plants with serrated leaves, likely deciduous species. Behind them, a young coniferous plant with needle-like leaves is visible. The background is slightly blurred, showing more foliage and a dark, moist forest floor.

July 15, 2017

The growth of conifers under a canopy of deciduous species is enhanced.




March 9, 2016

Penstock crossing area

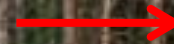
July 16, 2013



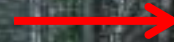


July 23, 2014

July 6, 2015



March 9, 2016

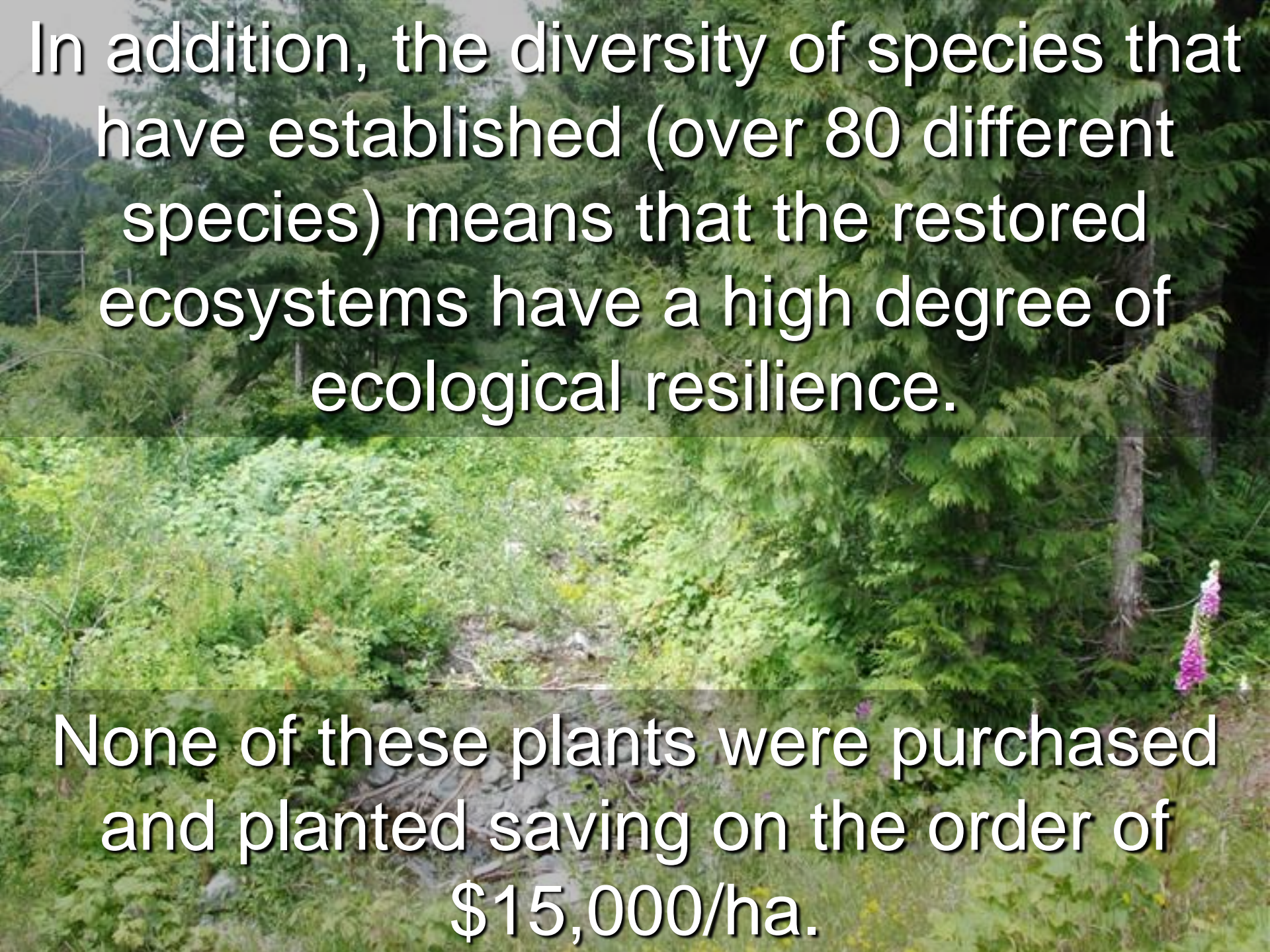


July 20, 2016





July 15, 2017

A photograph of a forest landscape. In the foreground, there is a rocky stream bed with some green vegetation. The middle ground is filled with dense green foliage and trees. The background shows a forested hillside under a slightly overcast sky. The text is overlaid on the upper half of the image.

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**



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