Successful Erosion Control and Revegetation Techniques for Mine Reclamation

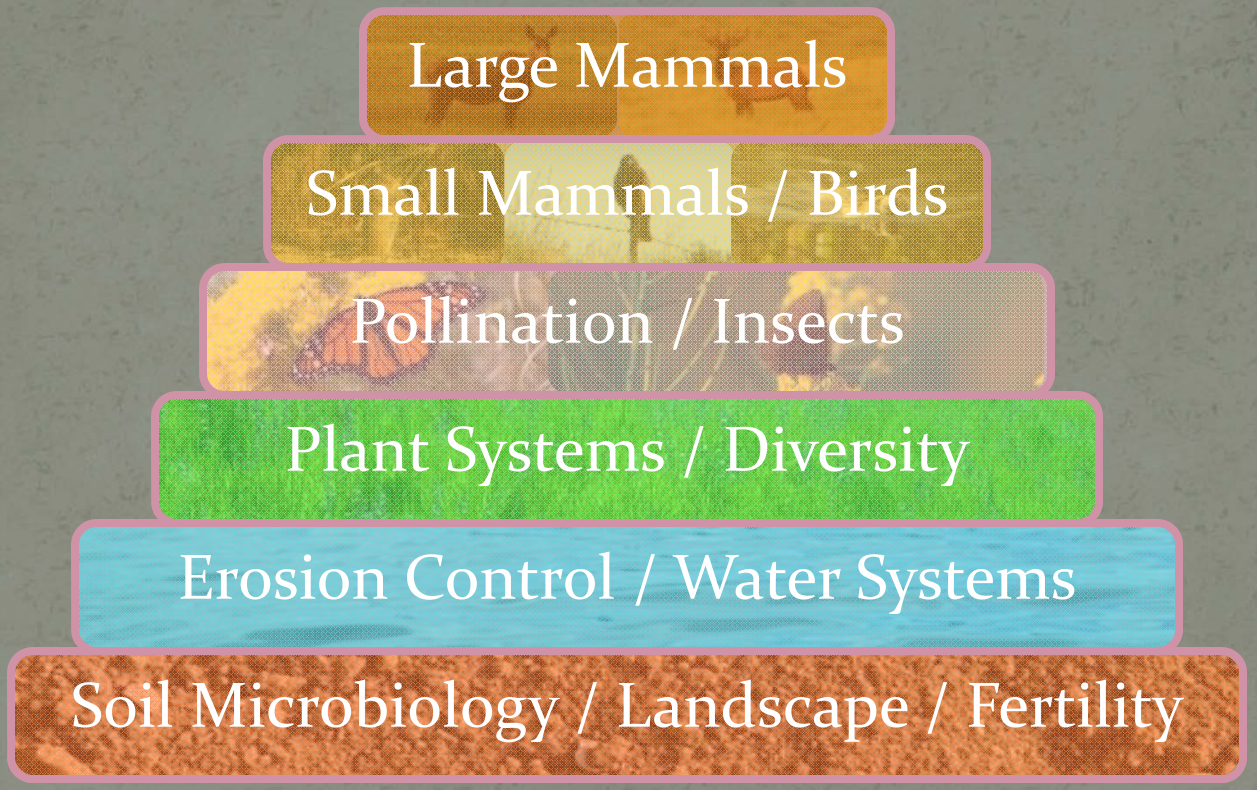
Presented by:

Michael Vice,

Consulting Reclamationist

Ecological Restoration

Restoring natural systems beginning with a solid foundation, and a **platform**.



This presentation will focus on the bottom three systems.

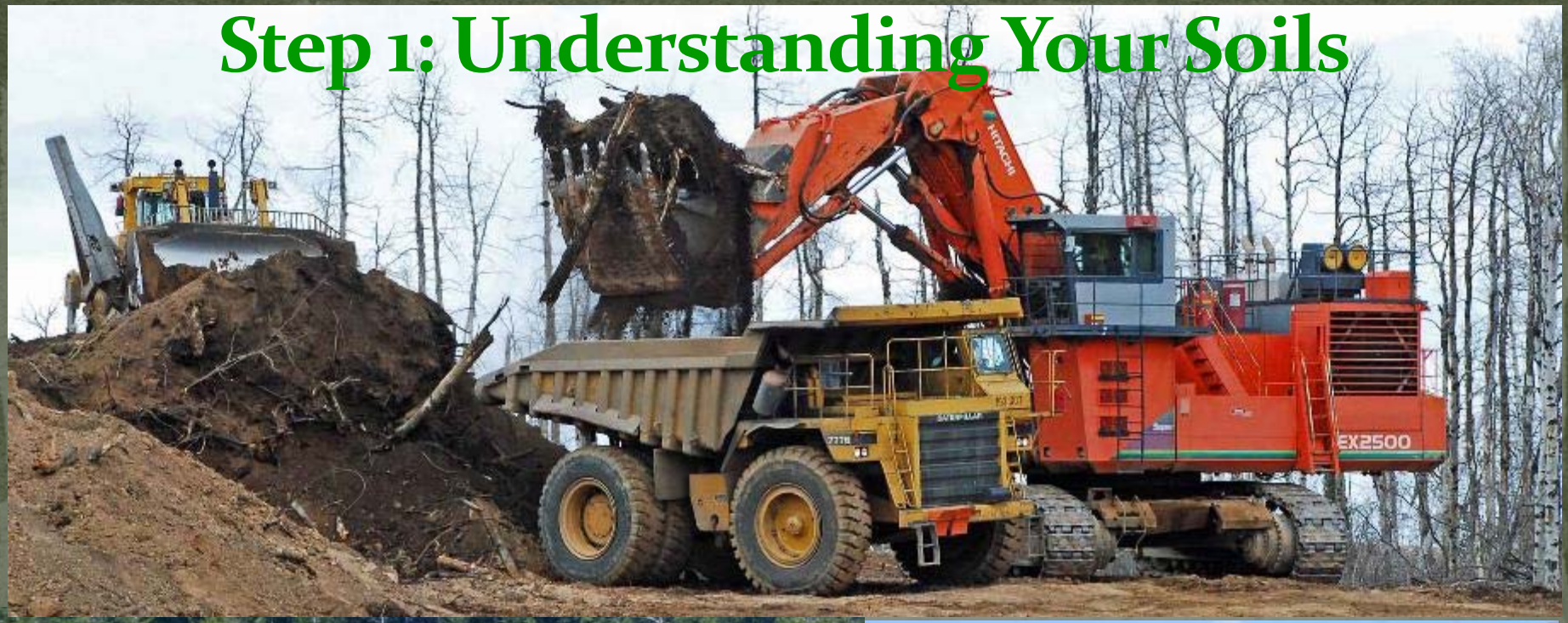
3-Step Approach

1. Understanding Your Soils

2. Keeping Soils Where They Belong, and Out of Water Bodies (Erosion Control)

3. Establishing and Maintaining Long-Term Vegetation

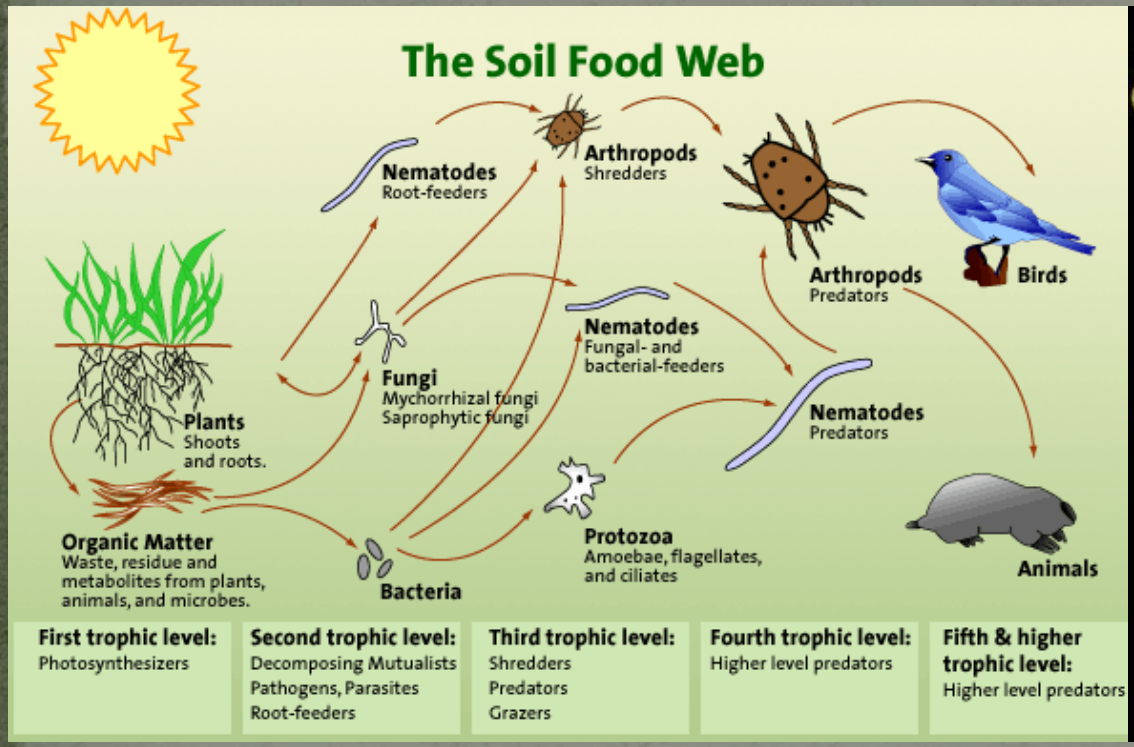
Step 1: Understanding Your Soils



Handling of soils plays a critical role in successful restoration.


Stockpiled Topsoil
~30 ft tall
8.8 acre footprint

Direct placement of soils **will NOT harm** most of the living components of the soils.



However, **stockpiling** of soils **WILL destroy** most, if not all, of the living components of the soils.

Know how the soils will be placed, and walk lightly.

Weight differences of a wide-track D6T (21-tons) vs a D10T (73-tons)

Soil Testing

- Conduct representative soil tests in each unique area to determine:
  - Soil pH
  - Fertility requirements/deficiencies
  - Organic matter content
- In challenging situations conducting these tests is critical to helping improve your vegetation in the short and long term.
- Design your revegetation plan based on the results.

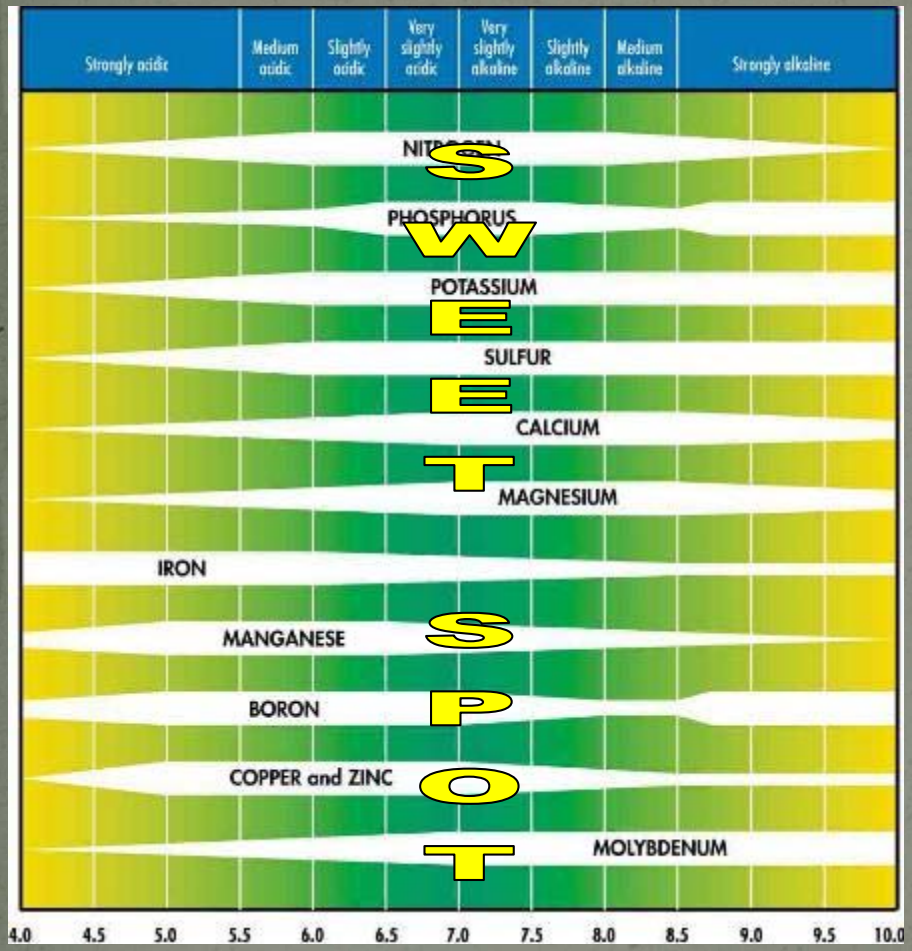
Test Results (using Profile's PS3 program)

Sample (#)	Texture (USDA)	Sand (%)	Silt (%)	Clay (%)	Soil pH (6.3 - 7.3)	TDS[1] (ppm) (< 256)	SAR[2] (< 2)	Organic Matter (%) (3 - 5%)	CEC % Sodium[4] (%) (< 2%)
1	Loamy Sand	85.6	7.6	6.8	8.2	230.4	0.23	0.5	0.4
(Optimum Plant Growth Conditions)									

Sample (#)	NO_3 (lb/acre)[5]	PO_4 (lb/acre)[5]	K (lb/acre)[5]	Ca (lb/acre)[5]	Mg (lb/acre)[5]	Zn (lb/acre)[5]	Mn (lb/acre)[5]	Cu (lb/acre)[5]	Fe (lb/acre)[5]	B (lb/acre)[5]	SO_4 (lb/acre)[5]
1	5.68	2.06	28.93	5012	35.49	2	10.2	1	23.2	0.2	54.76

Notes: 1. Total Dissolved Salts, 2. Sodium Absorption Ratio, 3. NeutraLime is also available in a liquid form, please contact a Profile representative with questions. 4. Sodium as % Base Saturation Cation Exchange Capacity (CEC), 5. lb/acre associated with a 6-inch depth.

Nutrient Uptake



Soil Acidity	Nutrients Wasted	
4.0 pH	- 90%	
4.5 pH	- 71%	
5.0 pH	- 54%	
5.5 pH	- 33%	
6.0 pH	- 20%	
↓ 6.3 pH	- 0% ↓	Sweet Spot
↑ 7.3 pH	- 0% ↑	
8.0 pH	- 20%	
8.5 pH	- 33%	
9.0 pH	- 54%	
9.5 pH	- 71%	
10.0 pH	- 90%	
Soil Alkalinity	Nutrients Wasted	

What is Sustane 3-7-2 w/ Mycorrhizae & Humates?

SUSTÅNE®
Naturally...

SUSTÅNE® 3·7·2
with Mycorrhizae & Humates

Guaranteed Analysis

Total Nitrogen (N)	3%
0.2% Ammoniacal Nitrogen	
0.2% Other Water Soluble Organic Nitrogen	
2.6% Water Insoluble Organic Nitrogen*	
Available Phosphate (P_2O_5)	7%
Soluble Potash (K_2O)	2%
Calcium (Ca)	4%
Sulfur	3%

Derived from aerobically composted turkey litter and feather meal.

*2.6% slowly available nitrogen from aerobically composted turkey litter and feather meal

Non-Plant Food Ingredients

Humic Acid 12%
Derived from lignite and composted turkey litter.

Arbuscular Mycorrhizae Inoculum ..... 4.80 propagules per g
3.36 propagules Glomus Intraradices
0.48 propagules Glomus Etunicatum
0.48 propagules Glomus Deserticola
0.48 propagules Glomus Clarum

70% Glomus Intraradices (Utah isolate)
10% Glomus Deserticola (Mojave isolate)
10% Glomus Etunicatum (Colorado isolate)
10% Glomus Clarum (Arizona isolate)

Coverage & Application Rates

-For Revegetation

Final fertilizer recommendations should be based on laboratory soil tests and specific site conditions including but not limited to aspect and slope. Use high rates for soils low in organic matter and steeper slopes.

Apply 1-3 tons per acre

-Turfgrass Coverage

50 lb. covers 1500 ft²
@ 1 lb. N per 1000 ft²
provides 44 lb. N per acre

22.67 kg covers 139 m²
@ 0.5 kg N per 100 m²
provides 50 kg N per hectare

37.5 lb. per 1000 ft²
187.5 g per 1 m²

Medium Grade: Mesh Size -7+14
(2.8 mm to 1.4 mm) SGN 200

121213 F689

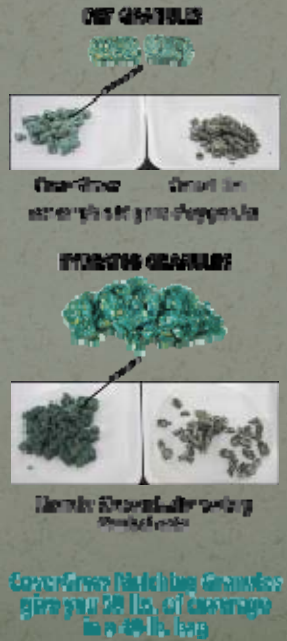
Sustane Natural Fertilizer, Inc.
310 Holiday Avenue
Cannon Falls, MN 55009 USA
+1 507-263-3003 • www.sustane.com

SUSTÅNE Naturally

Mycorrhizae are the fungi that colonize the root system of a host plant. They provide increased water and nutrient absorption capabilities, while the plant provides the fungus with carbohydrates formed from photosynthesis. A perfect symbiotic relationship.

Step 2: Keeping Soils Where They Belong and Out of Water Bodies (Erosion Control)

Mulch Products



Why use a spray applied stabilizer?

2013 seeding/mulching at Monsanto's Blackfoot Bridge Mine

- Access is poor
- Time is of essence (quicker results)
- Water (run-on and run-off) is under control
- Large areas of coverage needed 5+ acres

*Think of your mulch purchase as an insurance policy and a **platform** to success. What you invest will reflect in your results. Save $ elsewhere, NOT in restoration.*

Two 13-acre Water Management Ponds (WMPs) at Monsanto's Blackfoot Bridge Mine

Dry application when there is a lack of water, long slopes, equipment limitations , &/or tight material specifications on cap & cover systems.

Reclamation over a GCLL at Monsanto's Blackfoot Bridge Mine

Pelletized products that act like hydro-mulch when broadcast applied.

- Expanding granules protect seed from washing away,
- Hold water & nutrients to improve seed germination,
- Organic tackifier,
- Bio-stimulant increases root mass and top growth, and
- Easy to apply.

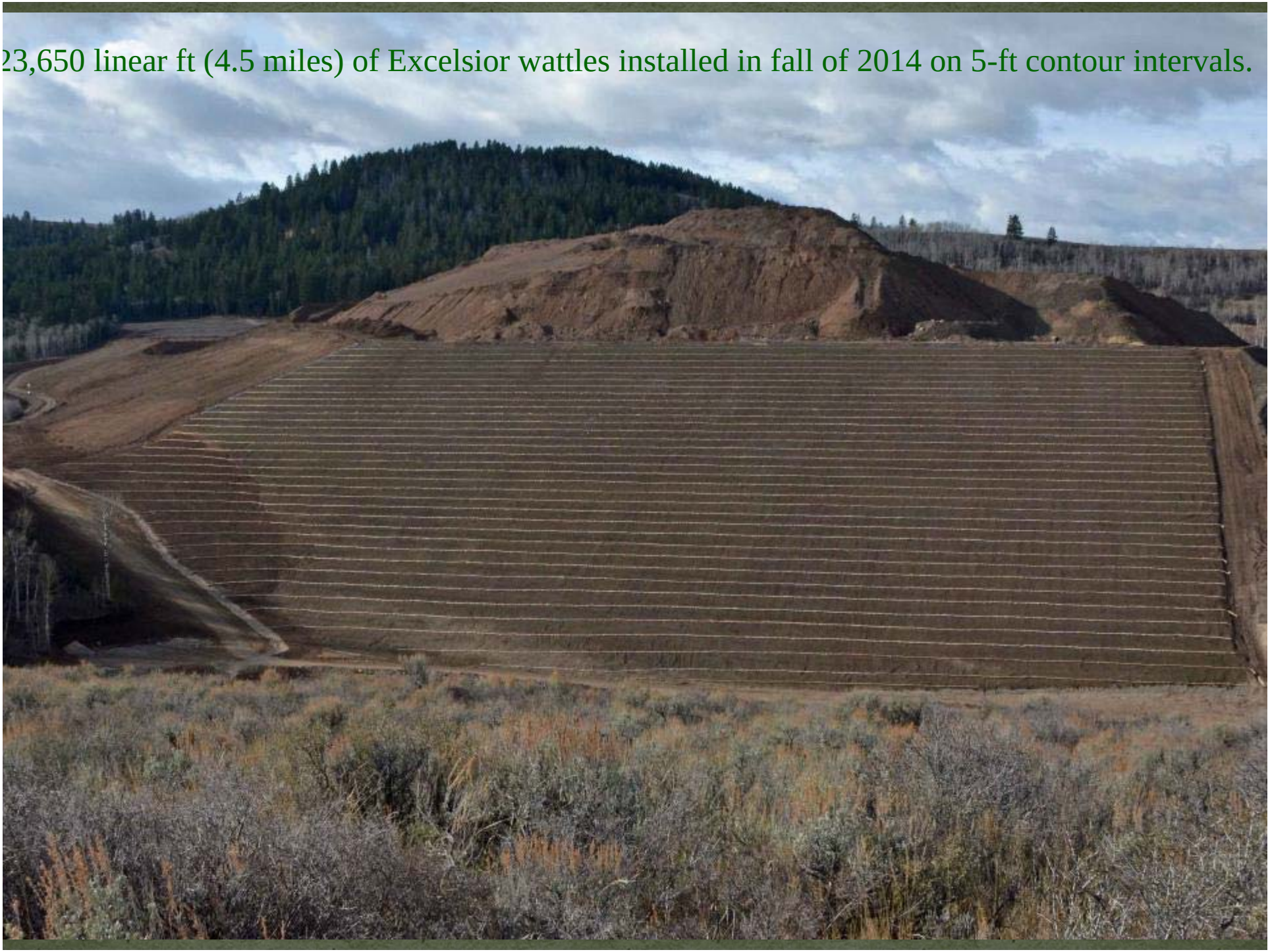

2,800 lbs/acre

What!? (wattle carelessness)

Installation of wattles/coir logs to slow runoff and capture sediment.

Installation of wattles is very labor intensive. A shallow trench needs to be dug for the wattles to lay in. Pull wattles tight between stakes, drive 18” stake thru 9” wattles w/ minimal end showing, & trench.

23,650 linear ft (4.5 miles) of Excelsior wattles installed in fall of 2014 on 5-ft contour intervals.



Always install wattles on the contour for maximum effectiveness.

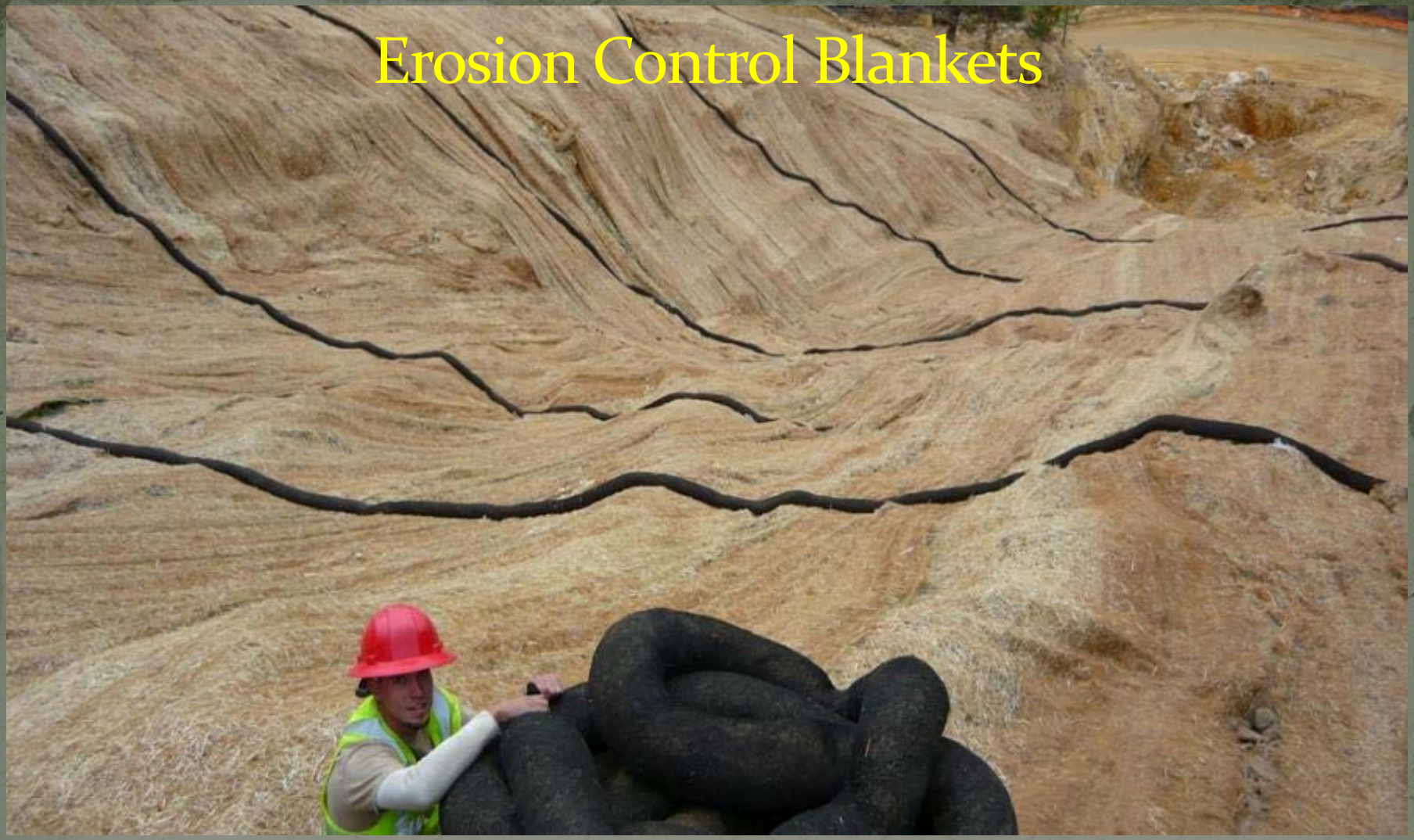
Slope length was 600+ feet on a 3:1 (33%) east-facing slope.


June 2016


June 2016


Nov 2016

Erosion Control Blankets



- Erosion Control Blankets
  - Straw
  - Straw/Coconut mix
  - Coconut

Keeps soil in place, but can be difficult to get uniform soil contact.

Step 3:
Establishing & Maintaining Long-Term Vegetation

Simple 1 Cover at BfB Mine

% / lbs	NAME	*SCIENTIFIC NAME*	VARIETY	Seeds/lb	Seeds in Mix/lb	% of Total Seeds/lb	Type
10.70%	Mountain Bromegrass	*Bromus marginatus*	Garnet	64,000	6,848	**7.00%**	Bunch-N
6.00%	Great Basin Wildrye	*Leymus cinereus*	Magnar	130,000	7,800	**7.97%**	Bunch-N
5.00%	Bluebunch Wheatgrass	*Pseudoroegneria spicata ssp spicata*	Goldar	140,000	7,000	**7.16%**	Bunch-N
0.75%	Big Bluegrass	*Poa secunda ssp ampla*	Sherman	882,000	6,615	**6.76%**	Bunch-N
1.00%	Idaho Fescue	*Festuca idahoensis*	Winchester	450,000	4,500	**4.60%**	Bunch-N
0.65%	Sheep Fescue	*Festuca ovina*	Covar	680,000	4,420	**4.52%**	Bunch-N
4.25%	Thickspike Wheatgrass	*Elymus lanceolatus ssp lanceolatus*	Bannock	154,000	6,545	**6.69%**	Sod-N
4.25%	Western Wheatgrass	*Pascopyrum smithii*	Rosanna	110,000	4675	**4.78%**	Sod-N
5.50%	Pubescent Wheatgrass	*Thinopyrum intermedium ssp barbulatum*	Greenleaf	100,000	5,500	**5.62%**	Sod-Intro
1.50%	Orchardgrass	*Dactylis glomerata*	Paiute	427,200	6,408	**6.55%**	Sod-Intro
0.25%	Kentucky Bluegrass	*Poa pratensis*	Ginger	2,177,000	5,443	**5.56%**	Sod-Intro
1.75%	Northern Sweetvetch	*Hedysarum boreale*	Timp	46,000	805	**0.82%**	Legume-N
6.00%	Sainfoin	*Onobrychis viciifolia*	Eski	30,000	1,800	**1.84%**	Legume-Intro
0.80%	Rocky Mtn Penstemon	*Penstemon strictus*	Bandera	592,000	4,736	**4.84%**	Forb-N
7.30%	Small Burnet	*Sanguisorba minor*	Delar	49,000	3,577	**3.66%**	Forb-Intro
0.50%	Lewis Blue Flax	*Linum lewisii*	Appar	293,000	1,465	**1.50%**	Forb-N
0.05%	Western Yarrow	*Achillea millefolium var. occidentalis*	VNS*	2,770,000	1,385	**1.42%**	Forb-N
3.00%	Blanket Flower	*Gaillardia aristata*	VNS*	132,000	3,960	**4.05%**	Forb-N
0.50%	Scarlet Globemallow	*Sphaeralcea coccinea*	VNS*	500,000	2,500	**2.56%**	Forb-N
0.25%	Mountain Big Sagebrush	*Artemisia tridentata ssp. vaseyana*	VNS*	2,500,000	6,250	**6.39%**	Shrub-N
19.00%	Antelope Bitterbrush	*Purshia tridentata*	VNS*	15,000	2,850	**2.91%**	Shrub-N
21.00%	Quickguard-Cover Crop	*Triticum aestivum x Secale cereale*		13,000	2,730	**2.79%**	Cover
100.00%					97,812	**100.00%**	

Re-establishing Native Plants with a Diverse Seed Mix

A diverse seed mix attracts pollinators, which are important to a healthy ecosystem.

Re-establishing native trees and shrubs

Successful Reclamation






Reclamation is more than planting grasses and trees. Ecological restoration, involves restoring systems, such as providing habitat and cover for wildlife.

Ecological Restoration

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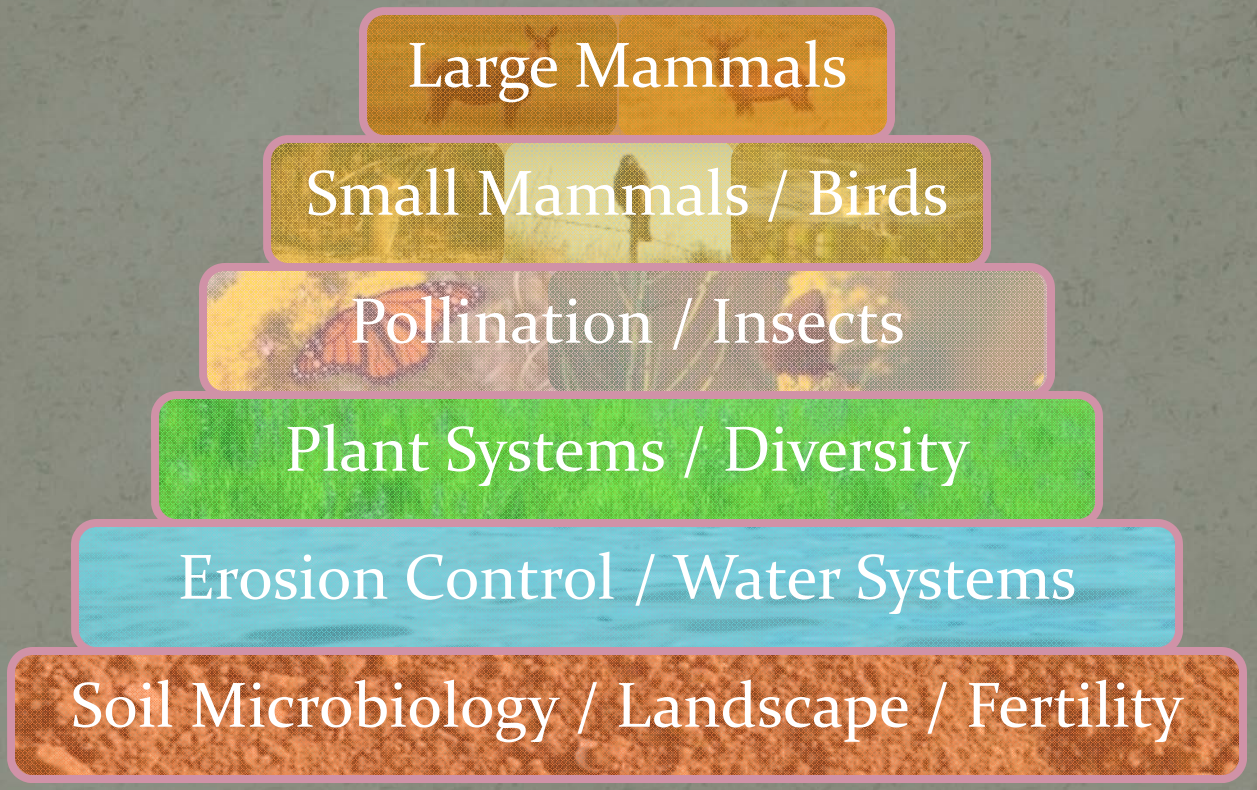

By focusing our efforts on the bottom three systems, the rest comes naturally.


Acknowledgement to those who provided support and assistance:
ACF WEST INC.
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Products | Service | Solutions
Brent Hardy, &
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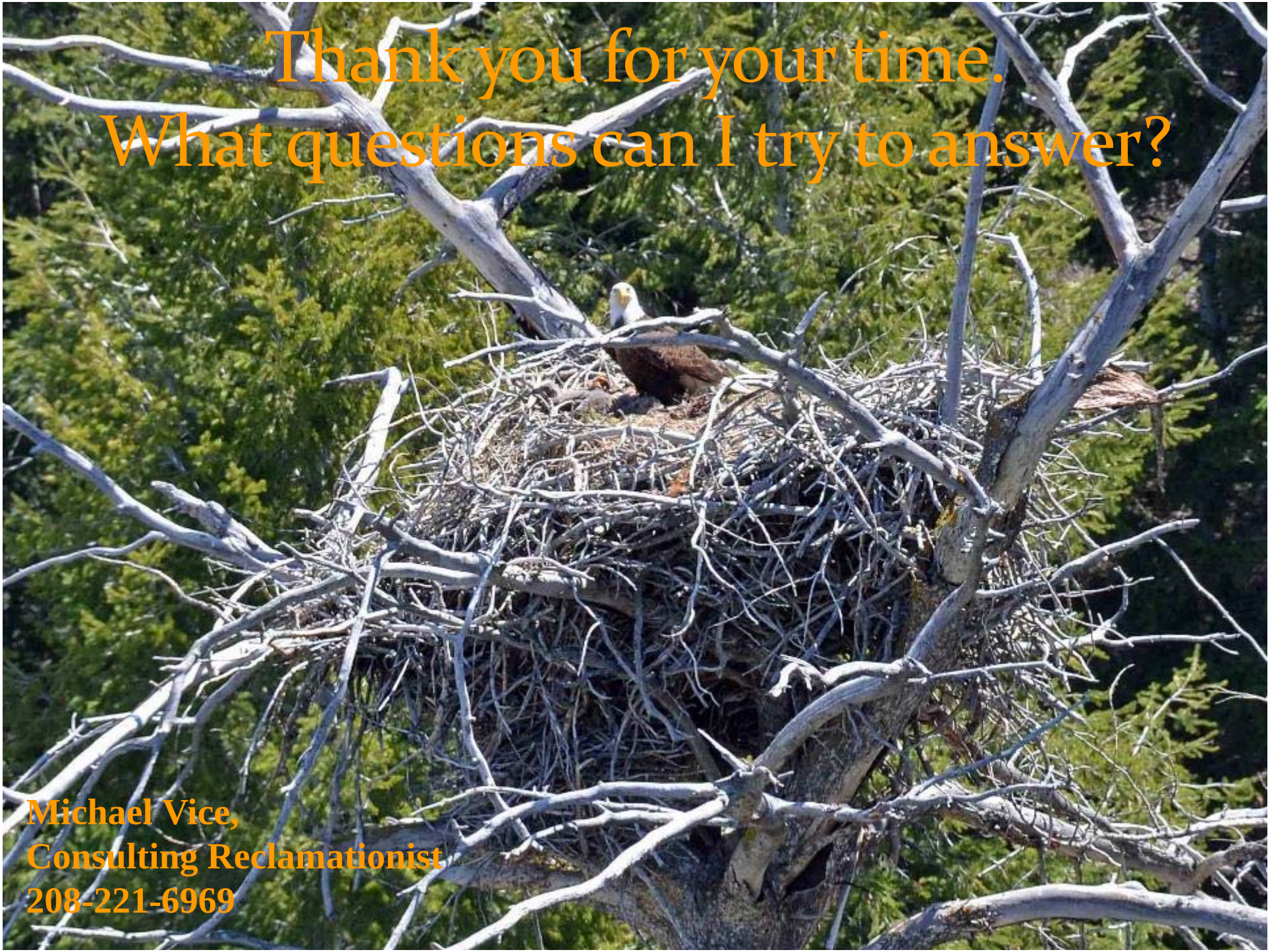
Damon Sump, &
Andy Jung


Thank you for your time.
What questions can I try to answer?
Michael Vice,
Consulting Reclamationist
208-221-6969