



Transportation Corridor Vegetation Management

HIGH-ALTITUDE REVEGETATION EXPERIMENTS ON THE BEARTOOTH PLATEAU PARK AND CARBON COUNTIES, MONTANA, AND PARK AND BIGHORN COUNTIES, WYOMING

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Abstract: The Federal Highway Administration (FHWA) Central Federal Lands Highway Division is conducting a comprehensive study to identify techniques that maximize the opportunities for successful revegetation along high altitude portions of U.S. Highway 212, the Beartooth Highway. A portion of the Beartooth Highway that travels through alpine and subalpine areas is proposed for reconstruction by the FHWA. FHWA has conducted revegetation experiments in the form of test plots and seed-increase experiments since 1999 to identify the most successful revegetation techniques for revegetating alpine areas.

Over a period of four years, four revegetation experiments have been placed on the Beartooth Highway to investigate the most effective revegetation techniques for subalpine and alpine disturbances. Variables tested include topsoil placement, organic amendments, surface mulches, seeding rate, and seed source (locally collected or commercial sources).

In addition, three seed-growout experiments have been conducted at a nearby farm in Manderson, Wyoming, to assess whether seed collected on the Beartooth Plateau can be produced in large quantities and used to revegetate disturbed areas associated with construction. These seed-growout experiments tested the potential to commercially produce a variety of alpine and subalpine forb, grass, and sedge seed. The results from this study will assist highway departments, mining, oil and gas, and utility companies, and other land-management agencies in revegetating high-altitude disturbances to meet requirements of various state, local, and federal permits. The study makes conclusions about the effectiveness of several revegetation items, such as seeding rate, type of organic amendment, fertilizer reapplication, and topsoil placement and makes recommendations for further study regarding native-seed propagation.

Key words: alpine revegetation, native-plant restoration, highway revegetation, soil amendments, seeding rates, topsoil.

Introduction

The FHWA proposes to reconstruct portions of U.S. Highway 212, the Beartooth Highway, in Park County, Wyoming. The Beartooth Highway is a scenic highway that traverses subalpine and alpine areas on the Beartooth Plateau. In anticipation of the proposed reconstruction, FHWA and ERO began a series of revegetation tests in 1999, to determine the most appropriate revegetation techniques for alpine portions of the Beartooth Highway. ERO conducted an extensive literature review, which was summarized in the proceedings of the 15th annual High-Altitude Revegetation Workshop (Payson 2002). ERO consulted with several people knowledgeable in the reclamation of sensitive natural areas, including Ray Brown (formerly with the Rocky Mountain Research Station), Dale Wick and Joyce Lapp of Glacier National Park, Eleanor Williams Clark of Yellowstone National Park, Mark Majerus of the USDA Bridger Plant Materials Center, Steve Parr of the USDA Meeker Plant Materials Center, and suppliers of plant materials seed, soil amendments and surface mulches. The revegetation tests examine seed mix densities, seed sources, topsoil salvaging, organic amendments, surface mulches, the planting of nursery stock, and growout of seed collected on the Beartooth Plateau.

1999 Montana Borrow Area Revegetation-Test Plots

In September 1999, ERO placed revegetation-test plots in an existing gravel-borrow area along the Beartooth Highway. Design of the test plots was based on studies of revegetated disturbances in Rocky Mountain alpine environments. Three variables were tested: soil salvaging, seeding rates, and soil amendments. On half of the plots, fertilizer and Kiwi Power (a soil amendment) were reapplied for 2 years after the revegetation plots were originally constructed. Native seed was collected on the plateau and used for direct seeding of the revegetation-test plots and for production of plant materials (Tables 1 and 2). Additional revegetation-test areas (planting test plots) were created to determine the feasibility and cost effectiveness of planting greenhouse-grown seedling plant materials from locally collected seed. The plants included in the planting test plots are shown in Table 2. The four variables tested on the plots were:

- Composted organic matter plus fertilizer versus surface application of Kiwi Power and Fertil-Fibers NutriMulch
- High seeding rate versus very high seeding rate
- Topsoil salvaging and replacement versus no topsoil
- Reapplication of fertilizer or Kiwi Power versus no reapplication of fertilizer or Kiwi Power

Table 1. Seed Mixes for the 1999 Montana Borrow Area Plots

1999 Montana Borrow Area Seed Density					
Scientific Name	Common Name	Lower Density Plots		Higher Density Plots	
		PLS [†]	Seeds/ft ²	PLS	Seeds/ft ²
<i>Deschampsia caespitosa</i>	Tufted hairgrass	0.88	45	1.75	90
<i>Poa alpina</i>	Alpine bluegrass	1.48	45	2.95	90
<i>Phleum alpinum</i>	Alpine timothy	1.25	25	2.5	50
<i>Festuca ovina</i>	Sheep fescue	1.75	32.5	3.5	65
<i>Trisetum spicatum</i>	Spike trisetum	0.38	12.5	0.75	25
<i>Antennaria lanata</i>	Woolly pussytoes	0.40	45	0.8	90
<i>Artemisia scopulorum</i>	Rocky Mountain sage	1.02	45	2.05	90
<i>Lupinus argentea</i>	Lupine	7.50	4.5	15	9
Total		14.66	254.5	29.3	509

†PLS = Pure Live Seed

Table 2. Nursery-Grown Species Transplanted in 2000

Scientific Name	Common Name	Number Planted
Graminoids		
<i>Carex scirpoidea</i>	Downy sedge	40
<i>Carex paysonis</i>	Payson sedge	40
<i>Deschampsia caespitosa</i>	Tufted hairgrass	40
<i>Poa alpina</i>	Alpine bluegrass	40
<i>Phleum alpinum</i>	Alpine timothy	40
<i>Festuca ovina</i>	Sheep fescue	40
<i>Trisetum spicatum</i>	Spike trisetum	40
Forbs		
<i>Antennaria lanata</i>	Woolly pussytoes	40
<i>Artemisia scopulorum</i>	Rocky Mountain sage	40
<i>Geum rossii</i>	Alpine avens	40
<i>Sibbaldia procumbens</i>	Sibbaldia	40
<i>Trifolium parryi</i>	Parry's clover	40
Total		480

2000 Gardner Headwall and West Summit Slope Plots

The test plots created at the Gardner Headwall and West Summit Slope plots in 2000 address additional issues identified for the proposed project, such as new types of organic amendments, slope, and seed source. The 2000 Gardner Headwall and West Summit Slope revegetation-test plots were designed for observation and some quantitative analysis and were not designed to be statistically repeatable. This decision was made in an effort to limit disturbances to fragile alpine areas, but still permit evaluation of variables such as slope and aspect. The four variables tested in 20 revegetation-test plots (12 at the West Summit and eight at the Gardner Headwall) for their effect on revegetation success were:

- 1:2 slope versus 1:3 slope (vertical:horizontal)
- Seed collected from the Beartooth Plateau versus commercially supplied seed (Table 3)
- Surface application of BioSol Mix versus surface application of Kiwi Power and Fertil-Fibers NutriMulch
- Slope aspect

For the West Summit Slope plots, the test plots were on the south-, southeast-, north-northeast, and east-facing slopes of an old gravel-borrow area north of the parking lot. Twelve revegetation-test plots were established at the West Summit Slope plots. Four experimental 14.86 m² (160 ft²) plots and two 7.43 m² (80 ft²) control plots were placed on approximate 1:2 slopes. Four 14.86 m² (160 ft²) experimental plots and two 7.43 m² (80 ft²) control plots were placed on approximate 1:3 slopes.

At the Gardner Headwall pullout, eight revegetation-test plots were established. The test plots at the Gardner Headwall were on a north-facing slope adjacent to a pullout on the south side of the Beartooth Highway. Four test plots, two organic-amendment test plots, and two control plots, all measuring 7.43 m² (80 ft²), were established on 1:2 slopes. Four experimental test plots, two organic-amendment test plots and two control plots, all measuring 7.43 m² (80 ft²), were established on 1:3 slopes.

Table 3. Seed Mixes for the 2000 West Summit Slope Plots and Gardner Headwall Plots

2000 Gardner Headwall and West Summit Slope Plots Seed Mix Density			
Scientific Name	Common Name	PLS	Seeds/ft²
<i>Deschampsia caespitosa</i>	Tufted hairgrass	0.87	45
<i>Poa alpina</i>	Alpine bluegrass	1.48	45
<i>Phleum alpinum</i>	Alpine timothy	2.40	45
Total		4.75	135

2001 West Summit Flat Plots

In September 2001, 32 test plots 6.25 m² (67 ft²) in size were placed in a flat portion of the borrow area at the West Summit. This location was selected for its uniform topography and existing disturbances on the site. Also, topsoil and subsoil removed from the 2000 test plots was placed here, leaving an ideal growing medium for placement of additional revegetation-test plots.

The 2001 West Summit Flat plots tested three surface mulch treatments, two seeding rates, two methods of transplanting soil plugs, and one organic amendment. The treatments were:

- Two-thirds cedar/one-third fir wood chips versus bonded fiber matrix versus 70:30 straw:coconut-fiber erosion-control blanket
- Very low versus moderately low density seeding rate
- Sod transplants placed immediately versus sod transplants placed after one-month stockpile
- Organic-amendment application versus no organic amendment

Table 4. Seed Mixes for the 2001 West Summit Flat Plots

2001 West Summit Flat Plots Seed Mixes					
Scientific Name	Common Name	Moderate Density Rate		Low Density Rate	
		PLS	Seeds/ft ²	PLS	Seeds/ft ²
<i>Deschampsia</i>	Tufted hairgrass	0.35	20	0.175	10
<i>Poa alpina</i>	Alpine bluegrass	0.90	20	0.45	10
<i>Phleum alpinum</i>	Alpine timothy	0.85	20	0.425	10
<i>Trisetum spicatum</i>	Spike trisetum	0.35	20	0.175	10
Total		2.45	80	1.23	40

Seed-Growout Experiment

In anticipation of potential impacts to alpine and subalpine vegetation along the Beartooth Highway associated with the proposed reconstruction of the highway, the FHWA implemented a seed-growout experiment to evaluate the effectiveness of collecting the seed of reclamation plant species on the Beartooth Plateau and farming it as a seed crop. This process is called seed increase or seed growout. Seed was collected from both alpine and subalpine habitat on the Beartooth Plateau. The FHWA wanted to determine if seed growout is a cost-effective and reliable method of obtaining seed to revegetate disturbed alpine areas.

Two seed-growout experiments are now underway. Seed was collected for the first seed growout in 2000 (2000 Growout) and then seeded/planted in the spring of 2001. Seed was collected for the second growout in 2001 (2001 Growout) and seeded/planted in spring 2002.

2000 growout

In fall 2000, Wind River Seed collected seed from four alpine species on the Beartooth Plateau (Table 5). Two crops of weed were established in 2001, one in the spring and one in the fall. A portion of the 2000 growout crop was direct-seeded and a portion was planted from nursery stock that Bitterroot Restoration Inc. grew from seed collected by Wind River Seed. Wind River has been growing out these species since 2001.

2001 growout

An additional seed-growout experiment was undertaken in the fall of 2001. Wind River Seed and Sabine Mellman Brown collected seed from the Beartooth Plateau in the fall of 2001. The seed was planted in 2002. Again, a portion of the growout crop was direct seeded and a portion was planted from nursery stock that Bitterroot Restoration grew from seed collected by Wind River Seed. The 2001 Growout experiment is divided into two parts.

First, a small-scale supplemental seed-growout experiment (Supplemental Growout Experiment) was conducted to test forbs and sedges for use in revegetation. The purpose of this experiment was to test the effectiveness of growing out forbs and sedges to add diversity to revegetation-seed mixes and plantings.

Second, a large-scale growout experiment was conducted to see if it is possible to grow enough seed for construction in 2004 (2004 Construction Experiment). The purpose of this experiment is to determine whether it is possible to grow seed that is not commercially available, has sporadic or limited commercial availability, or is better genetically adapted to subalpine environments than available commercial stock.

Summary

ERO and the FHWA are conducting revegetation experiments on the Beartooth Plateau as part of planning for proposed reconstruction of portions of the Beartooth Highway in Park County, Wyoming. Monitoring of these revegetation-test plots is ongoing and is expected to yield valuable information about revegetation of alpine areas in the Rocky Mountains.

Biographical Sketch: Liz's areas of expertise include revegetation, wetland delineation, permitting, and mitigation. She is knowledgeable in the restoration of natural habitats, riparian, and disturbed land reclamation and has over 11 years experience conducting vegetation inventories at project sites in a variety of ecosystems. Liz has designed and supervised construction of restoration sites, wetland mitigation sites, and trout and duck ponds. She also has experience in revegetation, weed control, plant taxonomy, threatened- and endangered-plant surveys, and wildlife-habitat assessments.

Reference

Payson, L. 2002. High-Altitude Revegetation Experiments on the Beartooth Plateau, Park County, Montana and Park County, Wyoming. First Year Monitoring Results. *Proceedings: High-Altitude Revegetation Workshop No. 15*. Colorado State University. Fort Collins, Colorado.

Table 5. Seed and Plants for 2000 Growout Experiment

Scientific Name	Common Name	Spring 2001 Direct Seeding		Fall 2001 Direct Seeding		Area Planted*	
		Proposed	Actual	Proposed	Actual	Proposed	Actual
		Ac.	Ac.	Ac.	Ac.	Ac.	Ac.
<i>Deschampsia caespitosa</i>	Tufted hairgrass	0.20	0.78	0	0.51	0.20	0.73
<i>Poa alpina</i>	Alpine bluegrass	0.20	0.36	0	0.30	0.20	0.43
<i>Phleum alpinum</i>	Alpine timothy	0.20	0.36	0	0.30	0.20	0.43
<i>Festuca ovina</i>	Sheep fescue	0.20	0**	0	0	0.20	0.06
Total		0.8	1.5	0	1.11	0.8	1.65

*No. of transplants of each species: tufted hairgrass = 8,600; alpine bluegrass = 5,350; alpine timothy = 5,100.

**Insufficient seed was collected of this species to direct seed.

Table 6. Seed Amounts for the 2002 Supplemental Growout Experiment

Scientific Name	Common Name	Amount Seeded	Transplants	Transplants
		Lbs (PLS*)	Proposed	Planted
<i>Agoseris glauca</i>	False dandelion	0.25	0	783
<i>Anaphalis margaritacea</i>	Pearly everlasting	0.10	625	380
<i>Aster foliaceus</i>	Aster	0.25	625	625
<i>Carex nigricans</i>	Black alpine sedge	0.25	0	600
<i>Carex paysonis</i>	Payson sedge	0.25	625	691
<i>Carex scirpoidea</i>	Downy sedge	0.02	625	0
<i>Phacelia hastate</i>	Whiteleaf phacelia	0.20	625	11
<i>Polemonium viscosum</i>	Sky pilot	0.03	0	97
<i>Potentilla diversifolia</i>	Varileaf cinquefoil	0.20	625	985
Total		1.55	3,750	4,172

*PLS = Pure Live Seed.

Table 7. Seed Planned for the 2004 Construction Seed Increase

Scientific Name	Common Name	Amount	Transplants	Transplants	Area to	Additional	2003	2004	Total
		Lbs	Proposed	Planted			Spring 2003	Lbs (PLS)*	
<i>Danthonia</i>	Timber oatgrass	0.485	6,060	1,800	0.08	100	15	15	30
<i>Calamagrostis</i>	Bluejoint	-	800	-	-	-	-	-	-
<i>Deschampsia</i>	Tufted hairgrass	1.091	460	460	0.03	-	5	5	10
<i>Elymus glaucus</i>	Blue wildrye	0.551	7,212	7,200	0.02	455	108	108	216
<i>Elymus scribneri</i>	Scribner's	0.919	7,884	8,000	0.62	650	119	119	237
<i>Festuca idahoensis</i>	Idaho fescue	-	-	-	-	-	-	-	-
<i>Festuca ovina</i>	Sheep fescue	0.023	-	1,000	0.02	200	4	4	8
<i>Koeleria pyramidata</i>	Prairie junegrass	-	-	-	-	-	-	-	-
<i>Penstemon procerus</i>	Penstemon	4.536	530	396	0.02	-	4	4	8
<i>Phleum alpinum</i>	Alpine timothy	0.430	1,580	790	0.11	-	20	20	40
<i>Poa alpina</i>	Alpine bluegrass	0.662	-	1,750	0.26	-	74	74	148
<i>Poa nevadensis</i>	Nevada bluegrass	0.970	-	4,500	0.26	330	50	50	100
<i>Stipa nelsonii</i>	Nelson's	0.551	-	2,997	0.08	195	12	12	24
Total		10.375	25,210	29,593	1.88	1,930	416	416	832