The Disturbance

In spring 2002, while the meadow was in a wet, muddy condition, a group of young people drove 4-wheel-drive vehicles around the meadow, destroying the existing vegetation and creating deep ruts. The participants were fined afterwards, but the damage was already done (figure 1).

Results: The Solution

Site Preparation

In order to remove the ruts from the meadow, reduce the potential for erosion, and make the meadow more presentable to the public, SNRA district personnel brought in a small tractor with a tiller and smoothed the surface after it dried out. Little vegetation grew on the site that summer.

Seed Collection

During the first week in August, people from the SNRA district and LPN visited the site and located some nearby areas where seed sources were available for revegetatingthe site. During the first week in September, we brought together a crew composed of a botanist from the SNRA, a person from LPN, and three people from the RMRS with experience in collecting native plant seeds. The crew, led by the botanist, spent 2 days collecting forb, grass, and shrub seeds in nearby meadows (figure 2).

Seeds were collected by hand-picking, or more often stripping, seeds into paper bags. The bags were labeled with time, date, species, and location. Seeds from 18 species were collected. More seeds were collected from abundant plants such as Idaho fescue (*Festuca idahoensis)* and small-winged sedge *(Carex rnicroptera).* Lesser amounts of seeds were

Figure 1—Meadow after it was roughened by 4-wheel-drive vehicles. Notice the ruts in the mud and the lack of vegetation.

Figure 2—Collecting native seeds in a nearby meadow,

collected from species where the plants were not plentiful, seeds were not quite ripe, or plants were past the peak of seed production.

Seed Treatment

The seeds were taken to LPN and processed for sowing. Initially, seeds were spread out on racks until dry. The various kinds of seeds were cleaned using three machines: clipper, dewinger, and air separator. All lots were clean enough to sow in the greenhouse.

Information on seed treatment and stratification for each species was obtained from the Native Plant Network Web site (www.nativeplantnetwork.org). The seeds were placed in small cotton bags and soaked in a 3 percent solution of peroxide (H_2O_2) for 2 hours to kill any surface pathogens. After a thorough rinse, the seeds were soaked in gibberillic acid (GA_3) for 24 hours to improve germination. The bags of seeds were then drained and place in air tight plastic bags in a cooler at 34 °F (1 °C). This stratification process lasted 3 weeks or longer depending on the species.

Tables 1 through 3 present information on how the seeds of all species were treated before sowing in the greenhouse. The shaded rows in the tables indicate which species were eventually planted on the SNRA meadow. Because there was no mold or damping-offobserved during stratification or in the greenhouse, the peroxide sanitation treatment seemed to be effective. Whether the gibberilic acid treatment had any effect is uncertain.

Sowing and Greenhouse Culture

Seeds were surface dried before sowing into 160/120 StyroblockTM containers (7.3 in^3 [120 cm^3], 9 in 122.8 cm] depth) filled with a 50:50 mixture of peat and vermiculite. The deeper than normal blocks were used to provide more rooting volume and a longer root system for outplanting. However, the plugs proved to be difficult to extract and harder to plant than standard length 160/90 Styroblock[1] plugs (5.5 in^3 [90 cm^3], 6 in [15.2 cm] depth). Several seeds (3 to 5) were sown in each cell. No thinning was done. This was fine for the grasses, but the forbs and shrubs should have been thinned to one plant per cell to develop sturdier plants. The seeds were placed on the soil surface and, after the blocks were put in the greenhouse and watered well, a very thin white fabric was put over the top to protect the seeds and maintain a high humidity in the seed zone (figure 3). The fabric was 0.5 oz (14 g) white, spunbound fabric used in commercial grass seeding. It is called "Seed and Plant Guard," available through the DeWitt Company"' (Sikeston, MO). The weave is somewhat porous to allow irrigation over the top. After germination (2 weeks), the fabric was removed. Seeding took place in early January. By mid-May, plants were mature and were extracted at that time (figure 4).

Table 1—Seed treatments and germination success for grass species.

Species	Common name	Seed treatment			Germination[a]
		H_2O_2 soak (3%)	GA_3 soak	Cold strat	
Alopecurus spp.	Meadow foxtail	2 hours	24 hours	3 weeks @34 °F	Excellent
Carex microptera	Small-winged sedge	2 hours	24 hours	4 weeks @ 34 °F	Poor
Festuca idahoensis	Idaho fescue	2 hours	24 hours	3 weeks @ 34 °F	Good
Carex aenea	Bronze sedge	2 hours	24 hours	3 weeks @ 34 °F	Poor

[a]Poor + <60 percent cells; good = 60 to 90 percent: excellent 90 percent +

Table 2—Seed treatments and germination success for forb species.

Species	Common name	Seed treatment			Germination[a]
		H_2O_2 soak (3%)	GA_3 soak	Cold strat	
Antennaria microphylla	Everlasting pussytoes	2 hours	24 hours		Excellent
Aster conspicuous	Showy aster	2 hours	24 hours	3 weeks @34 °F	Excellent
Balsamorhiza sagittata	Arrowleaf balsamroot	2 hours	24 hours	4 weeks @34 °F	Poor
Castilleja spp.	Paintbrush	2 hours	24 hours	4 weeks @34 °F	Poor
Erogonum heracleoides	Buckwheat	2 hours	24 hours	3 weeks @34 °F	Good
Geranium viscosissinum	Wild geranium	2 hours		4 weeks @34 °F	Good
Hackelia spp.	Wild forget-me-not	2 hours	24 hours	4 weeks @34 °F	Poor
Penstemon ryberg	Penstemon	2 hours	24 hours	4 weeks @34 °F	Excellent
Potentilla gracilis	Cinquefoil	2 hours	24 hours	4 weeks @34 °F	Excellent
Senecio spp.	Western groundsel	2 hours	24 hours	4 weeks @34 °F	Excellent
Zigadenus elegans	Death camas	2 hours	24 hours	4 weeks @34 °F	Excellent

[a]Poor = <60 percent cells; good = 60 to 90 percent: excellent = 90 percent +

Table 3—Seed treatments and germination success for shrub species.

Species	Common name	Seed treatment			Germination[a]
		H_2O_2 soak (3%)	GA_3 soak	Cold strat	
Lupinus argenteus	Silvery lupine	24 hours in H_2O	Tumbled for 1 minute	None	Began to germinate too quickly
Potentilla fruticosa	Shrubby cinquefoil	2 hours in H_2O_2, 24 hours in GA_3	None	4 weeks @34 °F	Excellent

Seedlings were packed into plastic bags that were arranged upright in waxed boxes. They were stored in a cooler at 35 °F 1.6 ºC) for 2 weeks. Success of germination is shown in the last column in tables 1 through 3. In general, poor germination was defined as less than 60 percent cells filled; good germination was 60 to 90 percent of cells filled; and excellent germination was 90 percent of cells filled. In total, about 4,000 plants, comprised of 15 species, were packed and outplanted.

Outplanting

Outplanting took place during the first week in June. It was a wet. snowy day on the planting site. Workers were USDA Forest Service employees who volunteered for the 1-day detail. Soil conditions were wet and the temperature was above freezing. The snowpack had melted off a few days before, but light rain and snow fell during much of the day.

Seedlings were transported in the back of a pickup covered by a tarp. The plastic bags of plants were distributed on the site by the SNRA botanist to match the right microsites to the species. Planters then came along with shovels and planting bars and put the plants in the ground.

The summer that followed was drier than normal. Most of the plants, however, were still alive in September (figure 5). Mortality was attributed to drought, shallow planting causing desiccation, and damage from pocket gophers.

Conclusion: The Consequences

The SNRA meadow restoration was only a small project. The amount of seeds, the number of plants produced, and the area revegetated were tiny in the big perspective. However, the success of this restoration project goes far beyond the borders of the SNRA meadow. For the SNRA, it has opened the possibility of restoring other sites that, for a long time, they have thought they would just have to live with. For Lucky Peak Nursery, it has been a spring board into a more

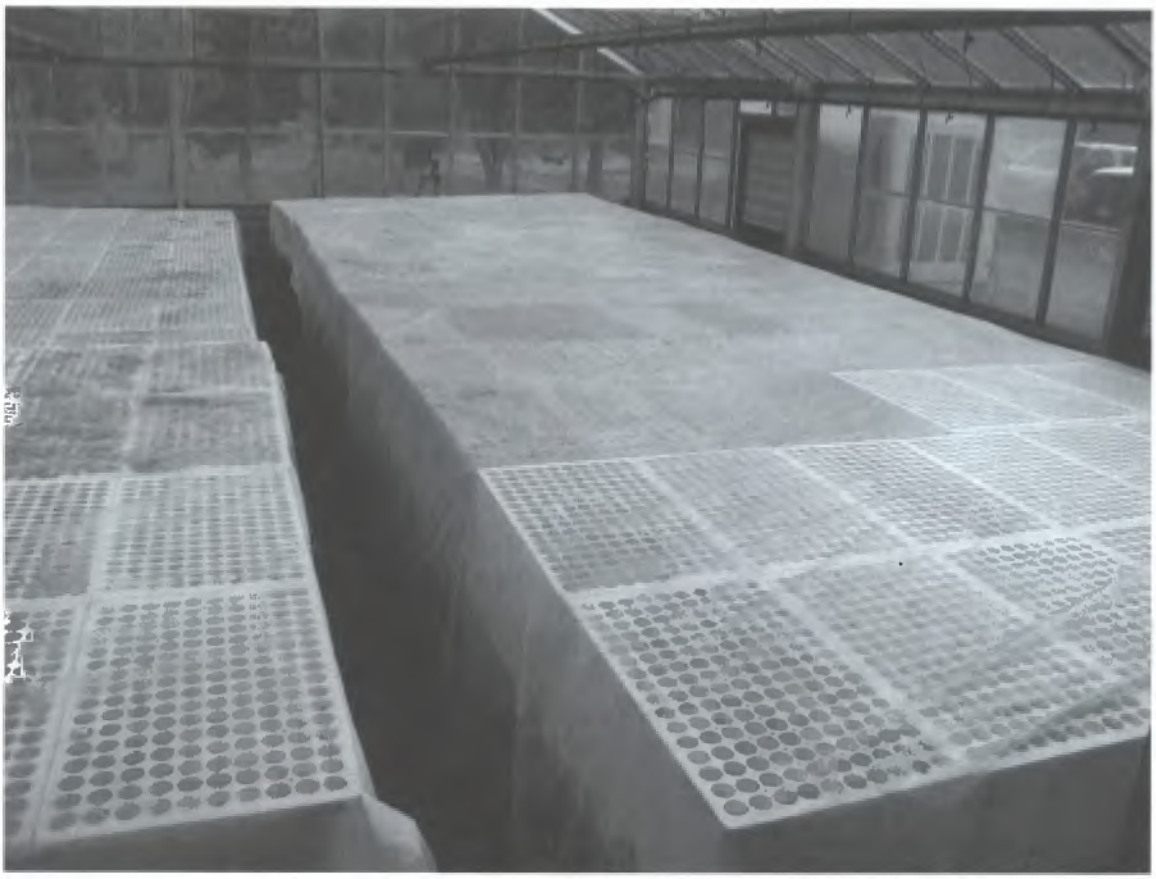

Figure 3—A light fabric called "Seed and Plant Guard" was place over the Styroblock™ containers to protect the seeds and maintain an environment to promote germination.

Figure 4—Some of the SNRA native plants in the greenhouse during April 2003. Idaho fescue and cinquefoil are in the background, meadow foxtail in the center, and pussy toes and shrubby cinquefoil in the foreground.

Figure 5—The mountain meadow in September of 2003 after one growing season following outplanting.

diversified plant business. It has led to other partnerships in the production of native plant stock and the production of native plant seeds in the nursery. Now with a new 24,000 ft2 (2,230 m^2) greenhouse for plant production and a new small plot combine for harvesting seeds, LPN capabilities just keep growing. It has given other public land managers ideas about what they can achieve in restoration of high elevation meadows and other ecosystems all the way down to the dry valley floor.

It is not within the scope of this paper to speculate on the future. However, with the need for restoration of disturbed lands in the Intermountain West currently at millions of acres, and native seed stores minimal, the task facing land managers is huge. Through cooperation, we are chipping away at this daunting task and can someday gain momentum that will bring these lands back to their original useful condition.