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Choosing the appropriate plant material for a rangeland rehabilitation project is critical for long term success. There are many considerations to what may seem like a simple question; what are we going to seed?

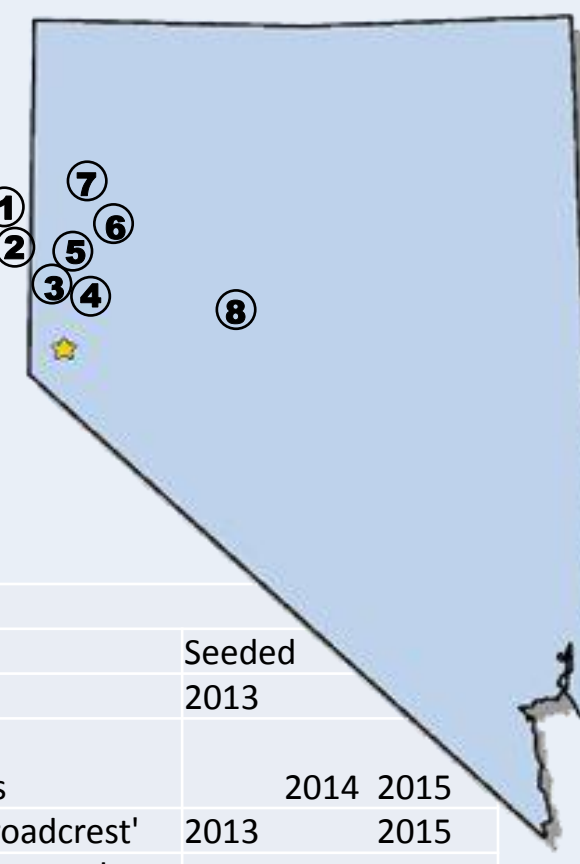
Plant material tests are a means to evaluate multiple plants for defined traits such as drought tolerance, forage production, or any measurable feature. The primary characteristic we define our tests by is establishment. Since all other features, such as forage production, rely on the assumption of establishment, we find it to be a high priority for plant material tests. We seed multiple species side by side for analysis.



Since the late 1950's the Reno, Nevada location of the Agricultural Research Service has conducted wildland seeding research in an effort to identify the optimal plant species to manage the diverse problems of this harsh environment.

Research sites

- Ave. Precipitation for all years tests
1. Noble 5.4"
 2. Doyle 6.51"
 3. Sand Hills 7.34"
 4. Bedel 6.89"
 5. Flanigan 4.76"
 6. Empire 11.17"
 7. Squaw Creek
 8. Antelope 5.42"



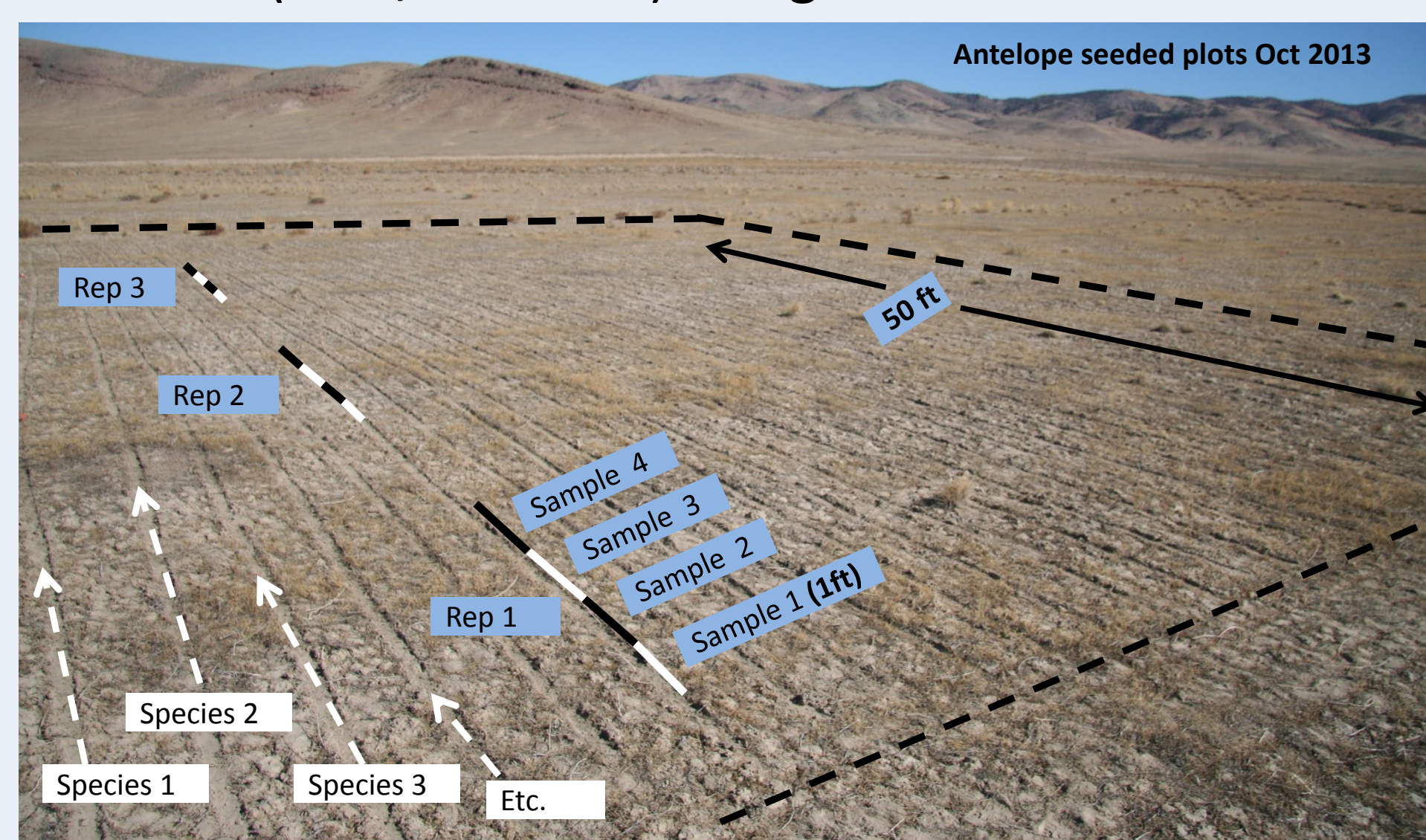
Small Plot Tests

The advantage of small plot tests is that we can test a high volume of species using less resources than standard rangeland drill techniques (Figure 1). Small plot tests can be done by a single person, require less space, less seed and thus can be conducted at multiple sites every year strengthening replication of tests.

Seeding is conducted using an Earthway garden seeder (~\$100). The seeder in the photo has seeded over 10 miles of drill row and still works great!



Annually, since 2013 we have seeded multiple (6-8) degraded xeric sites with numerous species (Table 1). At all sites each species was seeded separately in a 50ft row (15lb/acre rate) using a small hand seeder.



Each species (row) is monitored monthly throughout the growing season. Seedlings per foot (4 samples x 3 reps) are counted at fixed points. For reference, to test 50 species, 600 1ft seedling counts are conducted monthly at each site. Precipitation, soil moisture and available soil Nitrogen are also monitored at each site.

Defining the Goals

We find it necessary to define the objectives and goals before debating the merits of any plant material. Our objective is to suppress cheatgrass (*Bromus tectorum*) and decrease wildfire fuel (Figure 2). Our goal to meet that objective is to establish a high density of perennial grass (~1/ft). Without suppressing cheatgrass (i.e. resistance) seedling competition and repeated fires will halt succession.



Figure 2. 'Anatone' bluebunch seeding suppressing cheatgrass

Noble Site 2013 Plant Material Test

Colored circles are same rows
Yellow = pubescent intermediate wheatgrass [1.35/ft]
Blue = bluebunch wheatgrass [0.75/ft]
Green = crested wheatgrass 'hycrest' [0.775/ft]



March 2013: Seedlings emerged.



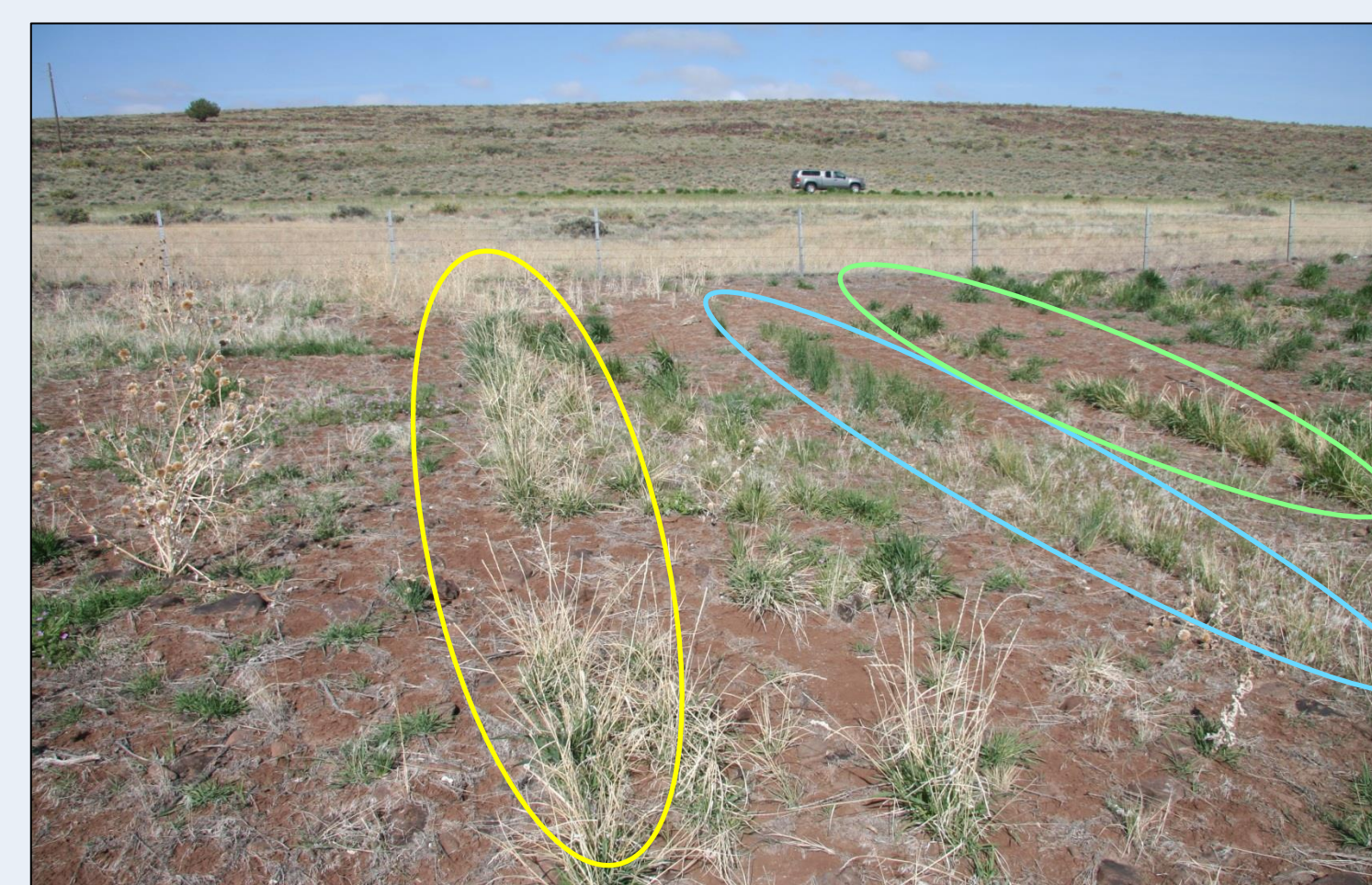
May 2013: Seedlings past the 3 leaf stage. It is critical for seedlings to reach the 3 leaf stage by June (dry) to increase survival rates.



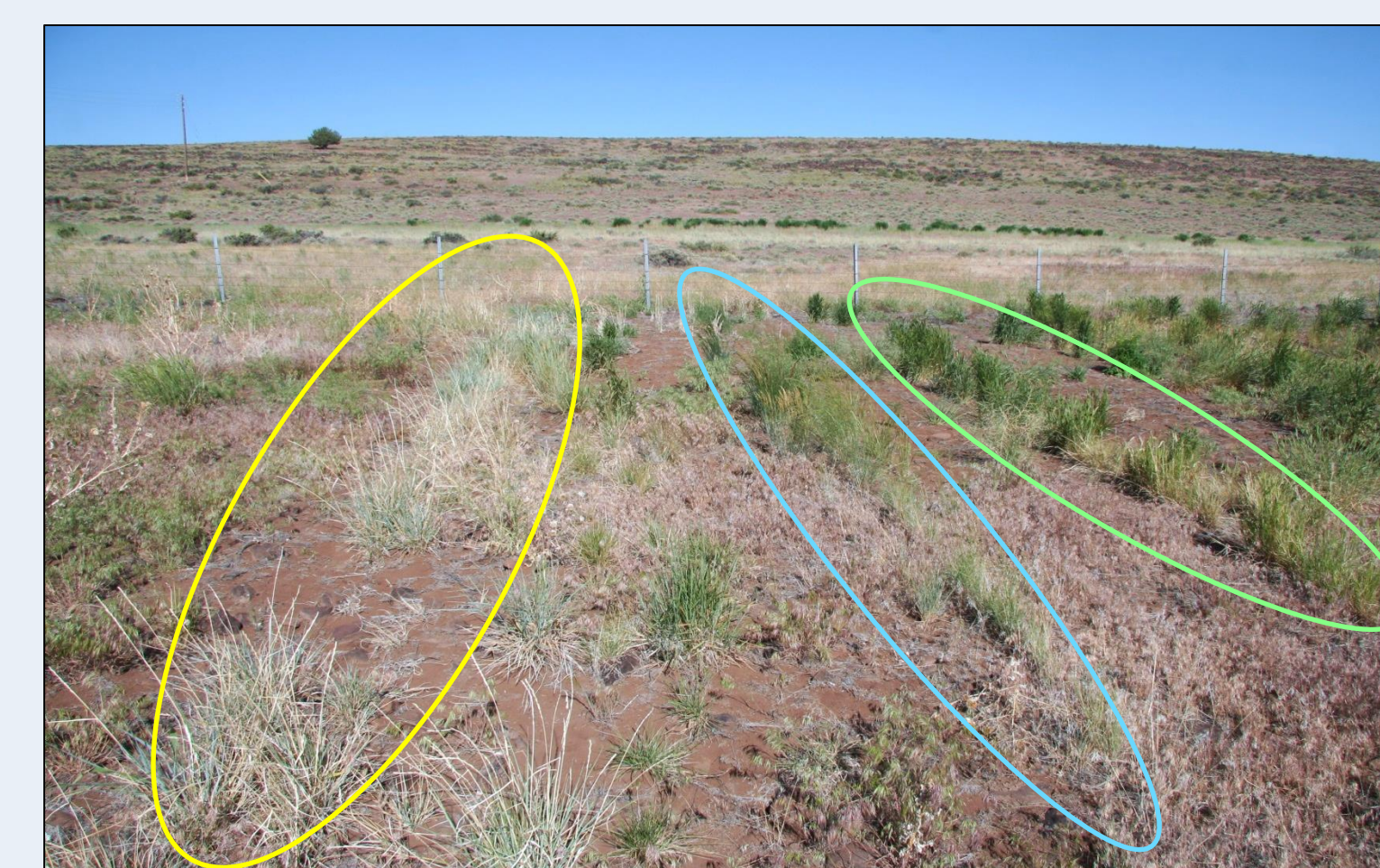
June 2013: Seedlings flowered. Often flowering does not occur until the second growing season.



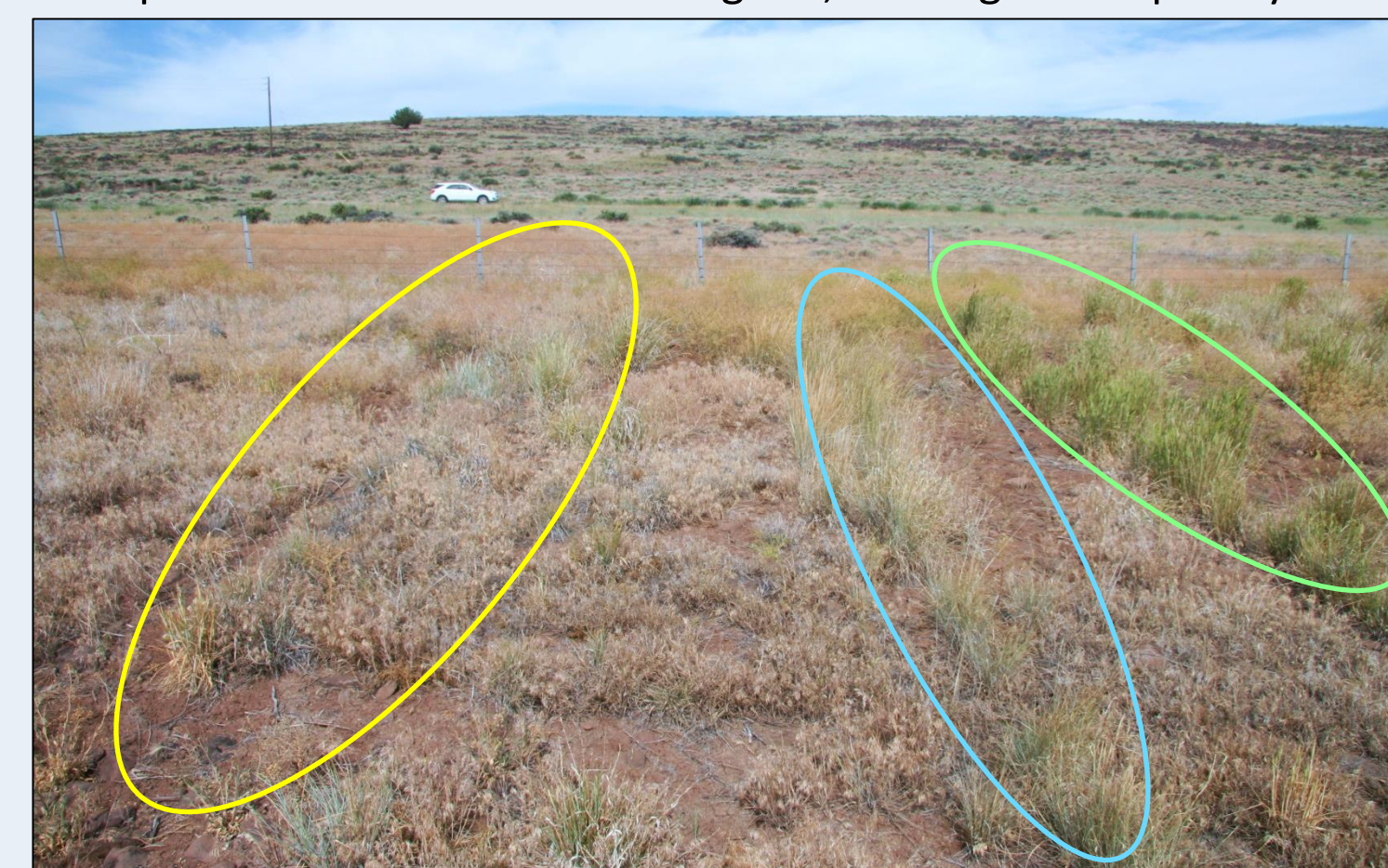
August 2013: The bluebunch wheatgrass (center) has gone dormant compared to the intermediate and crested wheatgrasses.



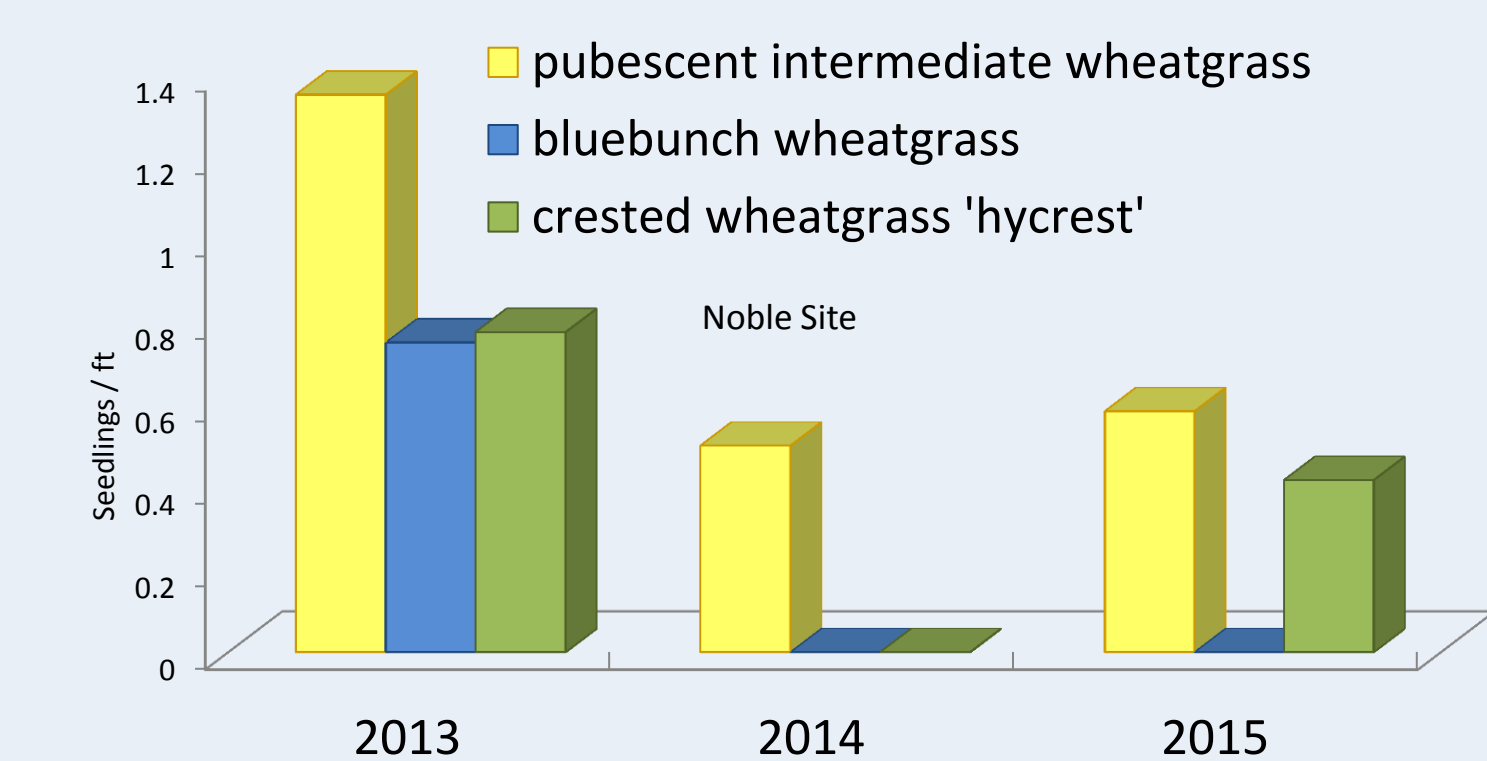
April 2014: Second year growth is much more vigorous especially for species such as crested wheatgrass, which greens up early.



May 2014: Productivity of intermediate wheatgrass which requires more water than crested wheatgrass is comparably less under dry conditions.



June 2015: The drought limitations of intermediate wheatgrass greatly reduces its growth by the 2nd growing season dry months



Comparing tests from multiple years, highlights the strong effect of annual conditions on establishment.

Results

Our results are based on 1st year seedling establishment. Our goal (~1 plant/ft) however is best measured after the 2nd or 3rd growth year. These results then do not represent our final goal as much as a ranking order of first year seedling establishment. Averaging all sites and years, less than 5 species (4.9) established 1 plant per square foot of all species tested. Promisingly 12 native species established 1 seedling per foot at least once for 17 tests (highest was squirreltail 3 of 17 tests). The most common species to establish 1 seedling per foot were Siberian wheatgrass (8 of 17 tests) and hycrest crested wheatgrass (7 of 17 tests).

Table 2. Ranking order of 1st year seedling establishment (seedling/ft) Results and precipitation are averages of all years tests. *green = native

Antelope 5.42"	Bedel 6.89"	Doyle 6.51"	Empire 11.17"
2.2 crested wheatgrass 'nordan'	1.9 crested wheatgrass 'ephrains'	1.9 crested wheatgrass 'nordan'	1.3 crested wheatgrass 'fairway'
1.8 crested wheatgrass 'standard'	1.8 crested wheatgrass 'standard'	1.8 squirreltail 'local blue'	0.9 crested wheatgrass 'ephrains'
1.6 soft chess	1.5 sherman big bluegrass	1.6 squirreltail 'local green'	0.7 crested wheatgrass 'standard'
1.2 thickspike wheatgrass	1.3 canby bluegrass	1.5 squirreltail 'local gray'	0.6 califonia bromo 'local'
1.1 pubescent intermediate wheatgrass	1.2 crested wheatgrass 'nordan'	1.5 blue wildrye	0.6 crested wheatgrass 'nordan'
1.1 squirreltail 'local gray'	1.0 siberian wheatgrass	1.4 pubescent intermediate wheatgrass	0.4 siberian wheatgrass
1.1 siberian wheatgrass	0.9 crested wheatgrass 'roadcrest'	1.3 siberian wheatgrass	0.3 crested wheatgrass 'roadcrest'
1.0 squirreltail 'local blue'	0.9 crested wheatgrass 'fairway'	1.1 crested wheatgrass 'hycrest'	0.3 crested wheatgrass 'hycrest'
1.0 intermediate wheatgrass	0.5 crested wheatgrass 'hycrest'	1.1 califonia bromo 'local'	0.3 squirreltail 'local gray'
0.9 forage kochia 'snowstorm'	0.5 squirreltail 'local green'	0.9 crested wheatgrass 'ephrains'	0.3 pubescent intermediate wheatgrass
0.8 snake river wheatgrass	0.5 squirreltail 'local blue'	0.8 canby bluegrass	0.2 snake river wheatgrass
0.8 squirreltail 'local green'	0.4 bailey's buckwheat	0.8 snake river wheatgrass	0.2 sherman big bluegrass
0.7 russian wild rye	0.3 slender wheatgrass	0.7 crested wheatgrass 'fairway'	0.2 tall wheatgrass
0.7 tall wheatgrass	0.3 sandberg's bluegrass	0.5 thickspike wheatgrass	0.2 slender wheatgrass
0.7 bluebunch wheatgrass	0.2 intermediate wheatgrass 'amur'	0.5 crested wheatgrass 'roadcrest'	0.2 squirreltail 'local blue'
0.5 rocky Mt. bee plant	0.2 intermediate wheatgrass	0.5 indian ricegrass	0.2 squirreltail 'local green'
0.5 siltai wildrye	0.1 pubescent intermediate wheatgrass	0.4 crested wheatgrass 'standard'	0.2 intermediate wheatgrass 'amur'
0.5 forage kochia 'immigrant'	0.1 squirreltail 'toe jam'	0.4 needle and thread grass	0.1 forage kochia 'immigrant'
0.5 califonia bromo	0.1 bluebunch wheatgrass	0.3 sherman big bluegrass	0.1 russian wild rye
0.4 califonia bromo 'local'	0.1 thickspike wheatgrass	0.1 tall wheatgrass	0.1 intermediate wheatgrass
0.4 yellow sweetclover	0.1 blue wildrye	0.1 bluebunch wheatgrass	0.1 bailey's buckwheat
0.3 great basin wildrye	0.1 califonia bromo 'local'	0.1 intermediate wheatgrass 'amur'	0.1 thickspike wheatgrass
0.3 crested wheatgrass 'roadcrest'	0.1 desert needlegrass	0.1 squirreltail 'vns'	0.1 squirreltail 'vns'
0.3 sherman big bluegrass	0.1 rocky Mt. bee plant	0.1 hybrid wheatgrass 'newhy'	0.1 canby bluegrass
0.2 intermediate wheatgrass 'amur'	0.1 snake river wheatgrass	0.1 califonia bromo	0.1 bluebunch wheatgrass
0.2 squirreltail 'vns'	0.1 tall wheatgrass	0.1 indian ricegrass	0.1 forage kochia 'snowstorm'
0.1 hybrid wheatgrass 'newhy'			0.1 indian ricegrass
0.1 seepweed			
0.1 crested wheatgrass 'hycrest'			
0.1 crested wheatgrass 'standard'			
0.1 bulbous bluegrass			
0.1 smooth bromo			

In conclusion, we find that small plot tests can provide great learning opportunities for species and site potential so that resource managers can improve rehabilitation efforts. In an environment as dynamic as the Great Basin, having site and yearly replication is critical to make the best plant material choices. We find small plot tests are a reliable and efficient means to achieve this.