



Commercial Wildflower Seed Mix Evaluation, 2013-2017

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ABSTRACT

Six commercially available wildflower mixes for western states comprising 62 species of flowering plants were evaluated in a side-by-side comparison from 2013 to 2017 at the Aberdeen Plant Materials Center. The different mixes were evaluated for initial establishment, weed presence, and for long-term persistence and spread using line-intercept transects. Flowering period was tracked for all species for the first and second growing seasons. Weed pressure was high during the first years of evaluation but reduced significantly over time as longer-lived perennials occupied more space and became more competitive. Several species consistently performed well in all mixes including: prairie coneflower, black-eyed Susan, Rocky Mountain penstemon, blanketflower, blue flax, annual sunflower, showy goldeneye, and yarrow.

INTRODUCTION

Commercially produced wildflower seed mixes are readily available and broadly used for attracting pollinators and adding beauty to small gardens and landscapes. These mixtures are popular with landowners because they are pre-mixed and eliminate the guess work of designing custom mixtures. They also eliminate the need to search for and purchase individual species from multiple vendors to create a seed mix.

Most commercial seed mixtures are created to cover a wide range of adaptation and may include plants adapted to extremely low precipitation areas (<9" mean annual precipitation) and plants adapted to wetter environments (>18" mean annual precipitation). This range provides some insurance that at least some of the species in the mixture are adapted to a specific site and may thrive. However, a significant number of the species in the mixture are inevitably less likely to be adapted to the planting site and thus represent an unnecessary expense.

The species in the mixtures are selected for their attractiveness to bees, butterflies and other pollinators and are purportedly composed of species well adapted to specific regions or environments. Despite these advantages, suitability of many of the species in the mixes to pollinator plantings for CRP or other NRCS programs is largely unknown. Many species are from North America outside of the Intermountain West; still others are of Eurasian or African origin. Additionally, some commercial mixes may contain plant species that can become invasive, or the mix may not contain appropriate species to provide pollinator forage throughout the year. The mix may also contain plant species that are attractive to humans but provide little value to the target pollinators. Establishment, persistence, and suitability of many of these species to pollinator plantings are poorly understood in this context. These issues need to be

examined before NRCS can recommend commercially designed seed mixes for conservation practices.

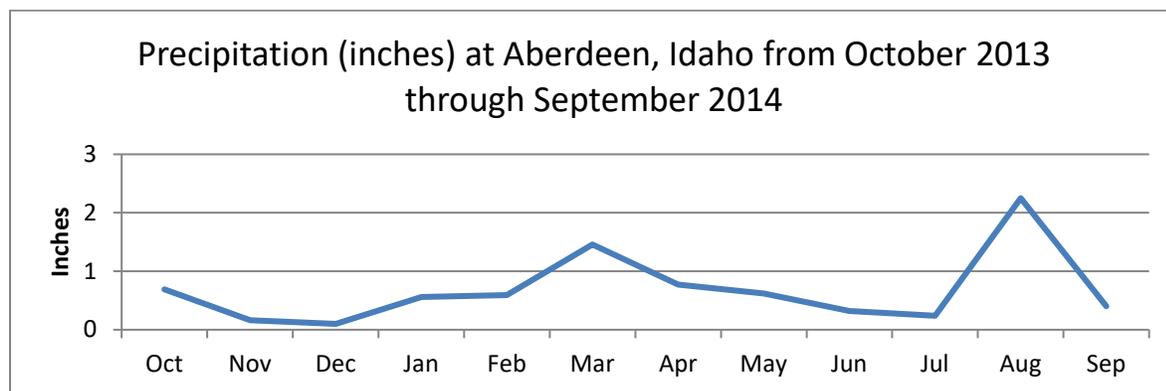
MATERIALS AND METHODS

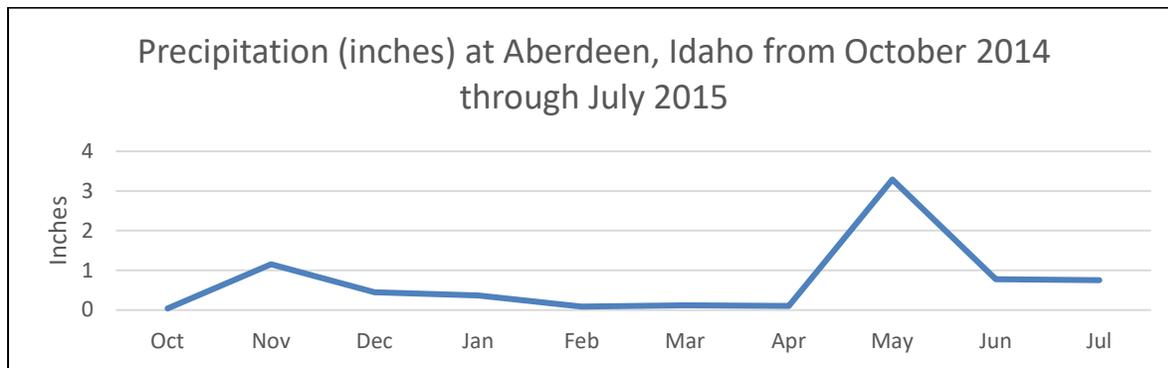
This trial was conducted on the Aberdeen Plant Materials Center Fish and Game Farm located 5 miles northeast of Aberdeen, Idaho. Soil at the site is a Declo silt loam with pH of 7.4 to 8.4. Average annual precipitation is 9.39 inches. The field had previously been planted to a crop of small grains left standing for wildlife food and cover.

We planted six commercially available wildflower seed mixes designed for use in western North America into non-replicated 90 x 20 ft plots. The mixtures selected were chosen based on their dissimilarity with other mixes in the trial to include the widest possible variety of species (see appendix). Each mix contained between 15 and 25 species. Prices of the mixtures ranged from \$23/lb to \$60/lb plus shipping. Mention of a specific mixture or company is not an endorsement by the NRCS.

In mid-May 2013 the field was mowed to knock down standing small grain cover and was treated with 64 oz glyphosate per acre to control volunteer grains and emerging annual weeds. On May 23, 2013 the trial was planted using a 3 ft Truax® broadcast seeder pulled by an ATV followed with a packer roller. Recommended seeding rates for the various mixes range from 6 to 20 lbs/acre depending on the desired density of the stand. Each plot in this trial was seeded at a target rate of 10 lbs/ac to obtain a uniform density between the plots. The trial was irrigated approximately 8 hours (2 inches) every ten days during the establishment phase in 2013. Irrigation was discontinued on August 1. On July 10, 2013 the site was sprayed with 1 pt/ac sethoxydim to control annual grasses. The plots were mowed to eliminate standing residue in early spring of 2014 and 2015.

To see how the various species performed under limited water conditions, no supplemental irrigation was applied during the 2014 or 2015 growing seasons. Precipitation totals were below average for most of the 2014 water year. Summer rains (2.25 inches in August) brought the total for the year to 8.16 inches. Fall of 2014 and spring of 2015 brought minimal amounts of precipitation; however, 3.3 inches in May and approximately 0.75 inches in June and July supported plant growth and flowering.





In 2016 and 2017 the trial received supplemental irrigation to approximate conditions found in a 14 to 20-inch precipitation zone. The plots were watered twice during each growing season for 12 hrs (4 inches) for a total of 8 inches of added water.

Plant density was evaluated on August 8, 2013 using a 1 m² frame placed in the center of the plots 5 paces and 10 paces into the plot. Plots were also visited periodically in 2013 and 2014 to observe blooming and insect visitation. The plots were evaluated for cover frequency on June 15, 2015 using an 80 ft line-intercept transect running diagonally across the length of the plot. Readings were taken every foot. Cover frequencies were generated for the categories: percent bare ground, broadleaf weeds, grass weeds, and the various target species intercepted. The trial was evaluated again in 2017 to observe long-term changes in species composition and to identify any potential management problems that may be associated with using commercial pollinator seed mixes.

By 2017 a large amount of intermixing had occurred from seed dispersal rendering the initial species composition of the individual mixes largely moot. The 2017 data are probably best viewed as an evaluation of all planted species and not as a comparison of the various mixes.

RESULTS AND DISCUSSION

Initial Density

Plant density was recorded early in the season on August 8, 2013 when plants could be easily counted (Table 1). Some species documented flowering in the later evaluations were not present at the early density evaluation. These were either located outside of the evaluated frames, or could have germinated later in the season, or were unidentifiable at early life stages. Many perennials listed here did not flower the first season, and some of the perennial species require a winter stratification period and were not expected to germinate until spring 2014.

Early plant densities were largely composed of annual species that had no stratification requirement. Seed mixtures with a large component of annuals seemed in most cases better equipped to compete against weed species.

Table 1. Initial density (plants per meter²) of target and weed species from each commercial seed mix evaluated August 8, 2013.

	AM Dry Area	AM Xeriscape	AM Native	Outside Pride	Applewood	Eden Bros.
Target species	-----plants/m ² -----					
Cornflower	1.5			2.5	1.5	3.5
Plains coreopsis	1.0			0.5	1.5	2.0
Wild cosmos	0.5					
Baby snapdragon	0.5					
CA poppy	2.5	4.5		3.0	4.0	
Corn poppy	1.0			4.5	4.0	1.0
Siberian wallflower	0.5			0.5		
Sweet alyssum	1.0				3.5	
Indian blanket	1.0	0.5	2.5		1.5	
Bird's foot trefoil	0.5					
Tidytips		2.5				
Bird's eye		1.5				
Greenthread		0.5				
Blue flax		0.5				0.5
Arroyo lupine		0.5				
Farewell to spring			2.0	0.5	0.5	
Candy tuft				3.0		
Total target	10.0	10.5	4.5	14.5	16.5	7.0
Weed species						
Volunteer millet	0.5	0.5	1.0		1.0	1.0
Green foxtail	3.5	4.0	2.0		3.5	9.0
Lambsquarters	0.5					0.5
Witchgrass	1.5	4.5	7.0	3.5	1.5	
Barnyard grass	0.5		2.5	1.0	5.0	4.0
Shepherd's purse		1.0	0.5	1.0		0.5
Prickly lettuce			0.5			
Total weed	6.5	10.0	13.5	5.5	11.0	15.0

American Meadows Dry Area

American meadows Dry Area mix contains 25, primarily introduced species. Of the 25, 14 are annual, 2 biennials and 9 perennial. Eighteen of the 25 included species are not native to the Intermountain or Rocky Mountain west. Nineteen species bloomed during the first growing season beginning in early August and continuing through the end of September. Fourteen of the 18 species that bloomed during 2013 were annuals (Table 2). This mix showed the greatest floral and color diversity during the first growing season.

Several species in the Dry Area mix showed excellent vigor and flower persistence. Most of the species present began blooming in August and continued to bloom through late September. Many of the species were highly favored by European honey bees including California poppy, corn poppy, cornflower, wild cosmos and plains coreopsis. Despite being not native to the region, these species were also observed being visited readily by native bees and butterflies.

Table 2. American Meadows Dry Area Mix flowering color and duration, 2013. Colored bars indicate flower color. Green indicates no flowers in bloom.

		8-Aug	19-Aug	4-Sep	10-Sep	20-Sep	27-Sep
California poppy	Ann.	Orange					
Corn poppy	Ann.	Purple					Green
Cornflower	Ann.	Blue					
Sweet alyssum	Ann.	Green					
Plains coreopsis	Ann.	Yellow					Green
Wild cosmos	Ann.	Pink					
Black-eyed Susan	Per.	Green	Yellow				Green
Indian blanket	Ann.	Green	Red				Green
African daisy	Ann.	Green	Orange				Green
Baby snapdragon	Ann.	Green	Green	Green	Green	Green	Green
Evening primrose	Bi.	Green	Yellow				
Catchfly	Ann.	Green	Green	Pink		Green	Green
Prairie coneflower	Per.	Green	Green	Yellow	Green	Green	Green
Siberian wallflower	Ann.	Green	Green	Orange	Green	Orange	Green
Shasta daisy	Rhiz per.	Green	Green	Green	Green	Green	Green
Sulphur cosmos	Ann.	Green	Green	Orange	Green	Green	Green
Gloriosa daisy	Per.	Green	Green	Green	Yellow		
Garland chrysanthemum	Ann.	Green	Green	Green	Green	Green	Green



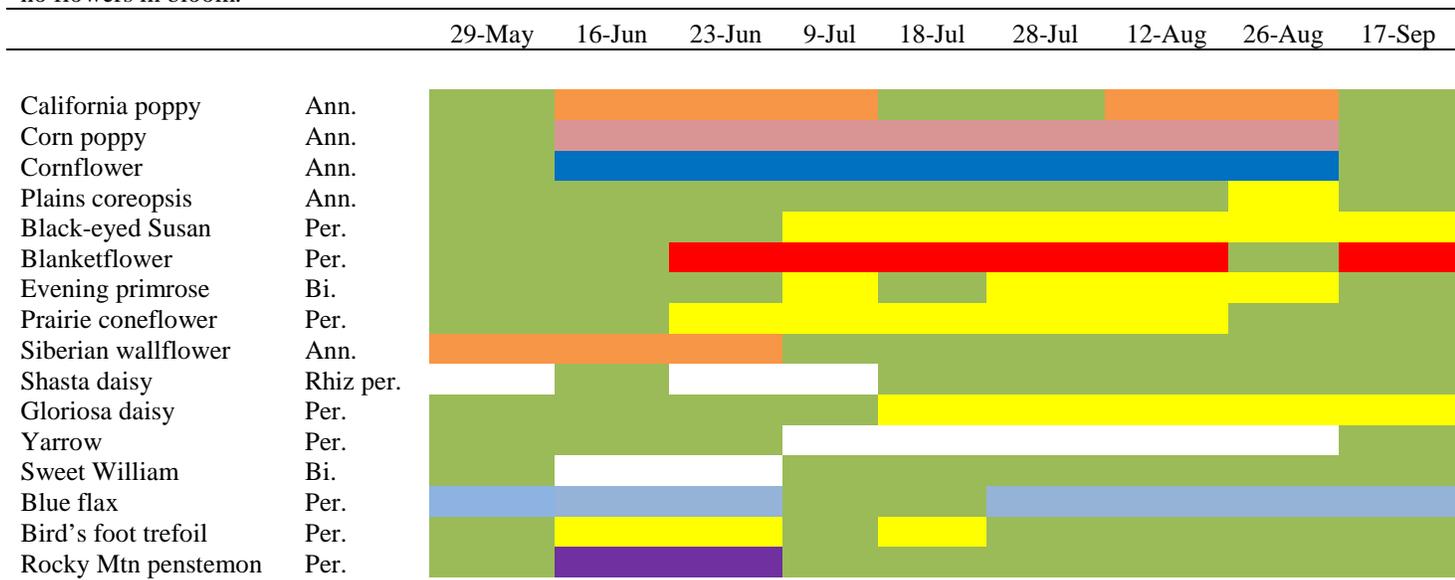
American Meadows Dry Area, July 22, 2013



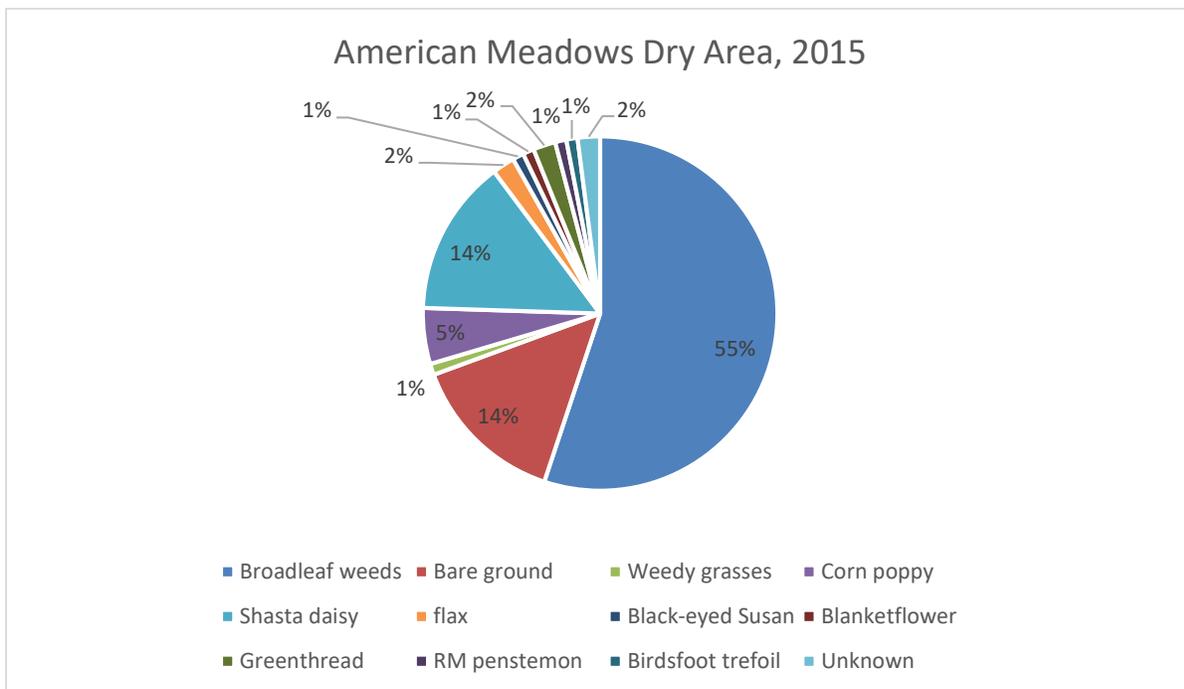
American Meadows Dry Area, August 29, 2013

Sixteen species in the American Meadows Dry Area mix flowered in 2014. In all, 5 annuals, 2 biennials and 9 perennials flowered during the second season indicating a shift from annuals to longer lived species. Black-eyed Susan, blanket flower, prairie coneflower, yarrow and blue flax all had long flowering durations. Cornflower and California poppy, both introduced annuals, also provided significantly to the floral display. This mix again provided the greatest diversity of the evaluated mixes.

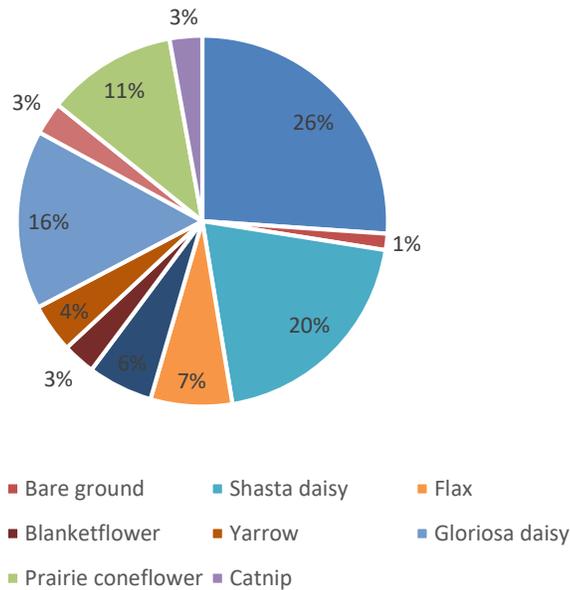
Table 3. American Meadows Dry Area Mix flowering color and duration 2014. Colored bars indicate flower color. Green indicates no flowers in bloom.



In 2015, plant cover frequency evaluations showed that over half of the American Meadows Dry Area plot was covered in broadleaf weeds, and another 15% of the cover was attributed to weedy grass species. Eight target species were recorded in the evaluation with the largest component of target species coming from Shasta daisy followed by the introduced annual, corn poppy. All other target species made up 2% or less of the total cover each.



American Meadows Dry Area, 2017



Spread from target species greatly reduced broadleaf weed cover from 55% in 2015 to 28% cover in 2017. Cover from the target species Shasta daisy, flax, black-eyed Susan, blanketflower, gloriosa daisy, evening primrose, prairie coneflower and catnip amounted to 78% in 2017 with most coming from Shasta daisy (21%), gloriosa daisy (17%) and prairie coneflower (12%). Annual grasses were absent in 2017. The introduced annual, corn poppy, was not found in the plot in 2017. The perennial target species flax, black-eyed Susan and blanketflower increased from 2015 to 2017. Three target perennials, greenthread, Rocky Mountain penstemon and bird's foot trefoil were not recorded in 2017. New species recorded in 2017 but not in 2015 included yarrow, gloriosa daisy, evening primrose, prairie coneflower and catnip. Persisting weeds included prickly lettuce, Canada thistle, western stickseed, tumble mustard.

American Meadows Western Xeriscape

American Meadows Western Xeriscape mix contains 24 species, mostly native to the PMC service area with some plants being introduced from California. It contains 12 annuals, 10 perennials and 2 biennials. Nine species in the Xeriscape mix flowered during the first growing season (Table 4). This mixture contained a large percentage of tidy tips and California poppy and provided a very yellow dominant appearance. Blanketflower was also present in good numbers. All flowering in the first season was done by annuals and the perennial blanket flower. Tidy tips and blanketflower appeared highly attractive to small native bees. California bluebell, greenthread, arroyo lupine and blazingstar were present, but not in large numbers; most were represented by one or two plants.

Table 4. American meadows Western Xeriscape Mix flowering color and duration 2013. Colored bars indicate bloom color. Green indicates no flowers in bloom.

		8-Aug	19-Aug	4-Sep	10-Sep	20-Sep	27-Sep
California poppy	Ann.	Yellow					
Tidy tips	Ann.	Yellow					
Blanketflower	Per.	Red	Green	Green	Green	Green	Red
Bird's eye	Ann.	Purple					Green
California bluebell	Ann.	Blue	Green	Green	Green	Green	Green
Greenthread	Ann.	Green	Yellow	Green	Green	Green	Green
Arroyo lupine	Ann.	Blue	Green	Green	Green	Green	Green
Prairie aster	Bi.	Blue	Green	Blue	Blue	Blue	Blue
Blazingstar	Ann.	Green	Green	Yellow	Green	Green	Green



American Meadows Western Xeriscape, July 22, 2013



American Meadows Western Xeriscape, August 29, 2013

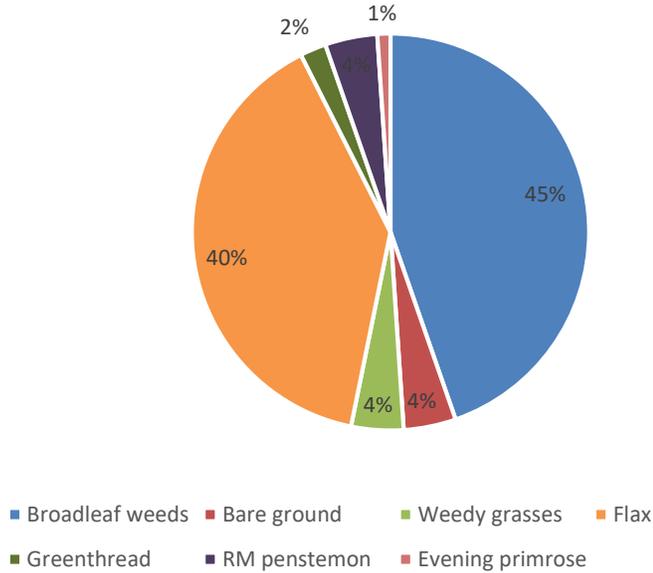
American Meadows Western Xeriscape mix had somewhat less floral diversity than the Dry Area mix in 2014. Ten species flowered in 2014 including 5 annuals, one biennial and 4 perennials. Two annual California natives, tidytips and California poppy, showed well. Green thread, which is native to the east slope of the Rocky Mountains and into the Plains States, also provided a strong floral display. Blue flax, blanket flower and Rocky Mountain penstemon are native to the region. Prairie aster added to the late season color in August and September.

Table 5. American Meadows Western Xeriscape Mix flowering color and duration 2014. Colored bars indicate bloom color. Green indicates no flowers in bloom.

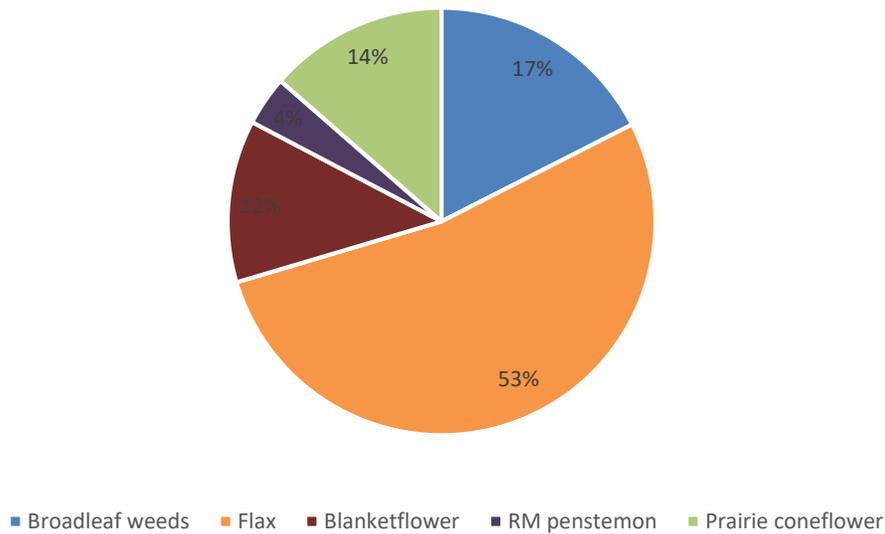
		29-May	16-Jun	23-Jun	9-Jul	18-Jul	28-Jul	12-Aug	26-Aug	17-Sep
California poppy	Ann.	Green	Orange	Orange	Orange	Orange	Green	Green	Orange	Green
Tidytips	Ann	Yellow	Green							
Blanket flower	Per.	Green	Red							
Bird's eye	Ann	Purple	Purple	Purple	Green	Green	Green	Green	Green	Green
Greenthread	Ann	Green	Yellow	Green						
Prairie aster	Bi.	Green	Green	Green	Green	Green	Green	Blue	Green	Blue
Deerhorn clarkia	Ann	Green	Pink	Green						
Blue flax	Per.	Blue								
Rocky Mtn pen	Per.	Green	Purple	Purple	Purple	Purple	Purple	Green	Green	Green
Prairie coneflower	Per.	Green	Green	Green	Yellow	Yellow	Yellow	Yellow	Yellow	Green

The American Meadows Western Xeriscape Mix plot contained a very high proportion of perennial flax in 2015 (40% cover), which was by far the greatest percentage of any of the target species. Broadleaf weeds composed the majority of the cover with 45%. Few other target species were present; prairie coneflower and Rocky Mountain penstemon were recorded at 4% and 2% respectively.

American Meadows Western Xeriscape Mix, 2015



American Meadows Western Xeriscape Mix, 2017



In 2017 cover resulting from broadleaf weeds in the American Meadows Western Xeriscape mix had decreased from 45 to 17% and weedy grasses were not detected. Most of the ground cover observed was from flax (53%) with the remaining cover coming from Rocky Mountain penstemon (4%), prairie coneflower (14%), and blanketflower (12%).

American Meadows Native West

American Meadows Native West mix is composed of 19 species, 7 annuals, 1 biennial and 11 perennials all native to North America (Table 6). However, it does contain many species that would not be considered native to the Intermountain or Rocky Mountain Region. Some come from eastern US, coastal western US or from the Southwest, all areas that are very dissimilar from conditions found in our region.

The lack of introduced annuals in the mixture significantly reduced the number of species flowering during the first growing season. Only five species blossomed in 2013, 3 annuals and 2 perennials. The All Native mix was highly red color dominant in 2013 due to the large numbers of Indian blanket. Other prominent species in the floral composition were black-eyed Susan and showy goldeneye.

Table 6. American Meadows Native West Mix flowering color and duration 2013. Colored bars indicate bloom color. Green indicates no flowers in bloom.

		8-Aug	19-Aug	4-Sep	10-Sep	20-Sep	27-Sep
Indian blanket	Ann.	Red					
Farewell to spring	Ann	Pink	Green				
Black-eyed Susan	Per.	Yellow					
Tidytips	Ann	Green					
Showy goldeneye	Per.	Yellow					



American Meadows Native West, July 22, 2013



American Meadows Native West, August 29, 2013

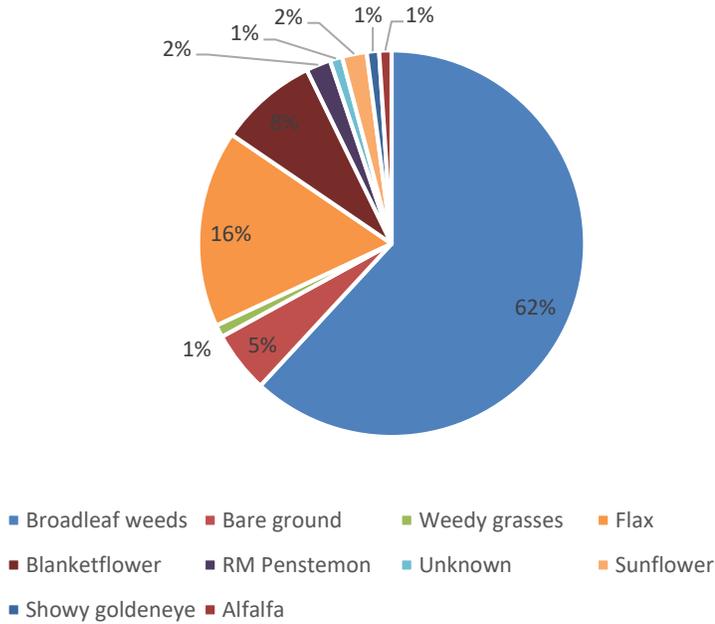
The American Meadows Native West mix improved in floral diversity in 2014 adding flowers from several perennial species (Table 7). Eleven species flowered in 2014, 4 annuals and 7 perennials. Black-eyed Susan, showy goldeneye, blanketflower, blue flax and Rocky Mountain Penstemon all did well and flowered through most of the season. Tidytips had sustained blooming for most of the mid-summer. The slow development of the perennials in the establishment year allowed weedy annual species like prickly lettuce to proliferate.

Table 7. American Meadows Native West Mix flowering color and duration 2014. Colored bars indicate bloom color. Green indicates no flowers in bloom.

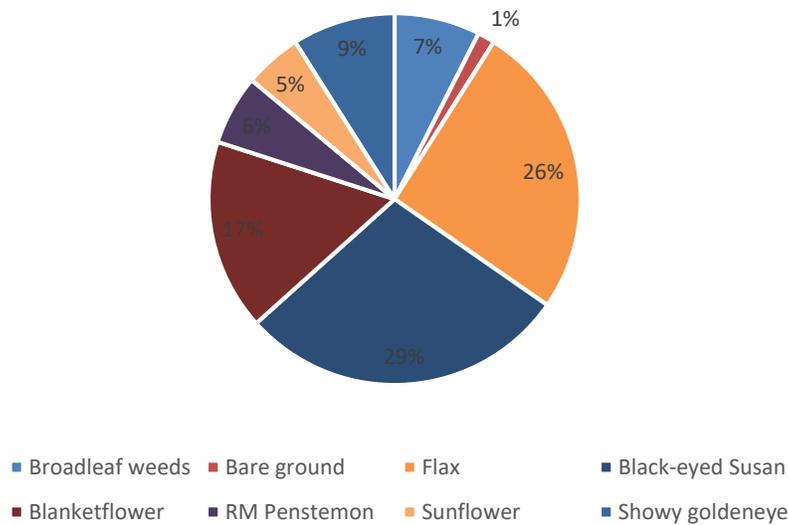
		29-May	16-Jun	23-Jun	9-Jul	18-Jul	28-Jul	12-Aug	26-Aug	17-Sep
Black-eyed Susan	Per.	Green	Green	Green	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Tidytips	Ann.	Green								
Showy goldeneye	Per.	Green								
Deerhorn clarkia	Ann.	Green								
Rocky Mtn beeflower	Ann.	Green								
Fleabane daisy	Per.	Green								
Blanketflower	Per.	Green								
Globe gilia	Ann.	Green								
Blue flax	Per.	Green								
Rocky Mtn pen	Per.	Green								
Purple prairie clover	Per.	Green								

The American Meadows Native West Mix had the largest proportion of weeds of any of the evaluated mixes with broadleaf weeds comprising 62% of the total cover in 2015. Perennial flax provided the majority of cover from the target species with 17% followed by blanket flower with 8% cover. Other species like Rocky Mountain penstemon, sunflower, and showy goldeneye were present in small percentages.

American Meadows Native West, 2015



American Meadows Native West, 2017



Broadleaf weeds decreased dramatically in the American meadows Native West plot from 62% to 7% from 2015 to 2017. This was largely due to an increase in flax (17 to 26%), blanketflower (8 to 17%), and black-eyed Susan (0 to 29%). Rocky Mountain penstemon, sunflower and showy goldeneye also saw moderate increases in cover.

Outside Pride Western Wildflower

Outside Pride Western Wildflower Mix consists of 17 native and introduced species with 9 annuals and 8 perennials (Table 8). Of these, 11 flowered in the first growing season, 8 of which were annuals. California poppy, plains coreopsis, corn poppy and cornflower were frequently visited by European honeybees. Indian blanket and showy goldeneye, both native species, were also visited by native pollinators.

Table 8. Outside Pride Western Wildflower Mix flowering color and duration 2013. Colored bars indicate bloom color. Green indicates no flowers in bloom.

		8-Aug	19-Aug	4-Sep	10-Sep	20-Sep	27-Sep	
Corn poppy	Ann.	Purple				Green		
Plains coreopsis	Ann.	Yellow				Green		
California poppy	Ann.	Yellow			Green		Yellow	
Sweet alyssum	Ann.	Green		Green				
Farewell to spring	Ann.	Pink			Green			
Cornflower	Ann.	Blue						
Indian blanket	Ann.	Red	Green				Red	
Candytuft	Ann.	Green		Purple		Green		
Siberian wallflower	Bi.	Green		Yellow	Green		Yellow	
Showy goldeneye	Per.	Green		Yellow				
Black-eyed Susan	Per.	Green		Yellow		Green		



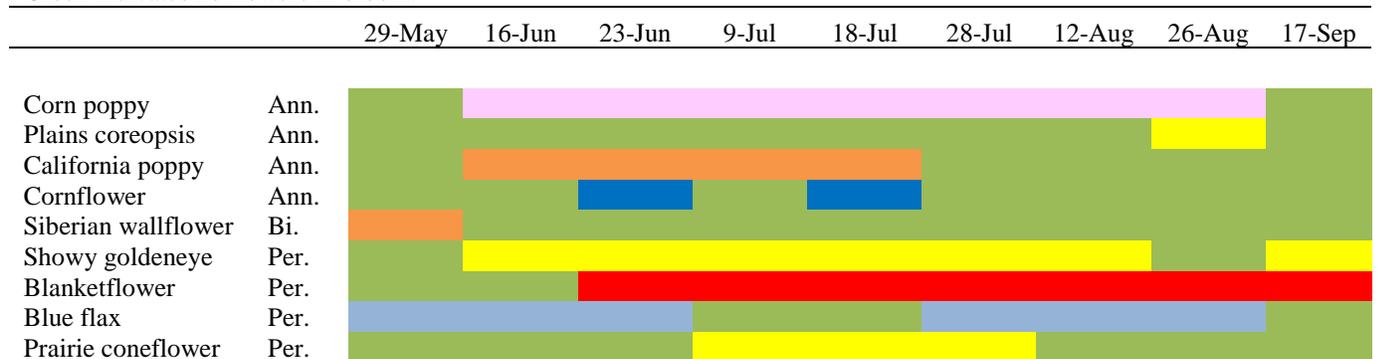
Outside Pride Western Wildflower, July 22, 2013



Outside Pride Western Wildflower, August 29, 2013

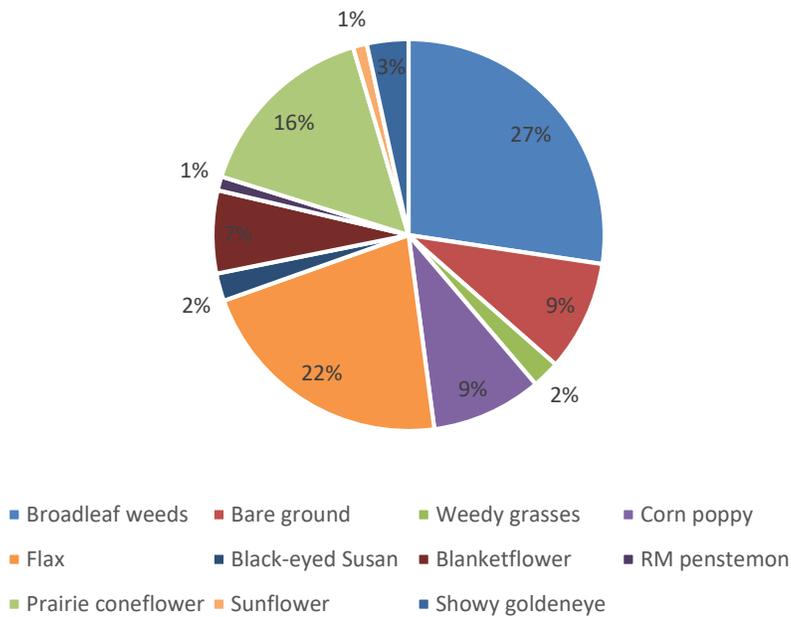
Outside Pride’s Western Wildflower mix contains a mixture of native and introduced species. Introduced annuals like corn poppy and California poppy were abundant in 2014 however. Native perennials like showy goldeneye, blanketflower and blue flax flowered through most of the season adding to the pollinator value. In total 4 annuals, 1 biennial, and 4 perennials flowered in 2014.

Table 9. Outside Pride Western Wildflower Mix flowering color and duration 2014. Colored bars indicate bloom color. Green indicates no flowers in bloom.

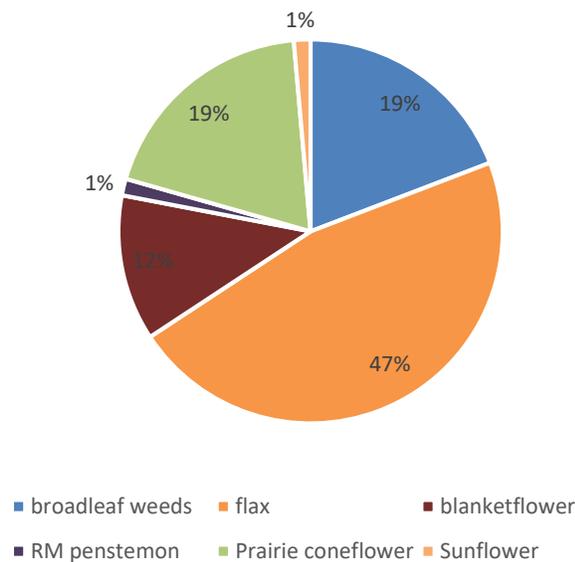


In 2015, the Outside Pride Mix had 5 target species appearing in somewhat balanced proportions. Perennial flax made up 27% of the cover, followed by corn poppy (11%), blanketflower (8%), showy goldeneye (4%), and prairie coneflower (3%). Broadleaf weeds created 33% of the total cover; while grass weeds and bare ground accounted for 3% and 11% respectively.

Outside Pride Western Wildflower, 2015



Outside Pride Western Wildflower, 2017



Total cover of broadleaf weeds decreased from 33% to 19% from 2015 and 2017. Blanketflower, flax, prairie coneflower, Rocky Mountain penstemon and sunflower were the only species encountered in 2017 comprising 12, 47, 19, 1 and 1% of total cover respectively. Species richness however also decreased from 8 species to 5 with no occurrences of corn poppy, black-eyed Susan, or showy goldeneye being encountered in the evaluated transect in 2017.

Applewood Western Mix

Applewood Seed's Western Mix consists of 20 species, 11 annuals 8 perennials and 1 biennial (Table 10). This mixture has a similar composition to the Outside Pride Western Wildflower mix and contains primarily introduced species. Eight species flowered the first season. Showy goldeneye was the only perennial to flower in 2013.

Table 10. Applewood Western Mix flowering color and duration 2013. Colored bars indicate bloom color. Green indicates no flowers in bloom.

		8-Aug	19-Aug	4-Sep	10-Sep	20-Sep	27-Sep	
Corn poppy	Ann.	Purple			Green			
Plains coreopsis	Ann.	Yellow			Green			
California poppy	Ann.	Yellow		Green		Yellow		
Sweet alyssum	Ann.	Green			Green			
Farewell to spring	Ann.	Pink	Green					
Cornflower	Ann.	Blue						
Indian blanket	Ann.	Red	Green	Red				
Showy goldeneye	Per.	Green	Yellow					



Applewood Western Mix, July 22, 2013



Applewood Western Mix, August 29, 2013

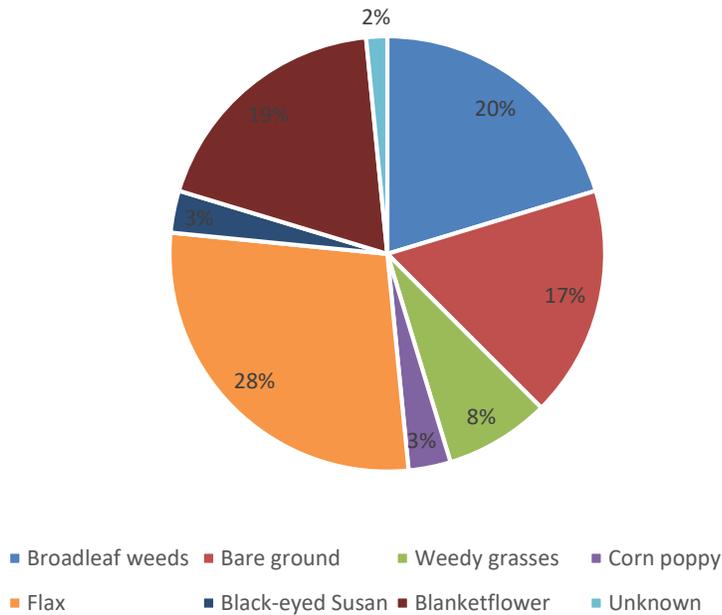
Similar to other mixes, the Applewood Western mix had an assortment of perennial natives and introduced annuals. Nine total species flowered in 2014 including 5 annuals and 4 perennials. Blanketflower, showy goldeneye, blue flax, and prairie coneflower flowered consistently in 2014. Corn poppy, California poppy, corn flower and green thread were annuals that returned for the second season from dropped seed.

Table 11. Applewood Western Mix flowering color and duration 2014. Colored bars indicate bloom color. Green indicates no flowers in bloom.

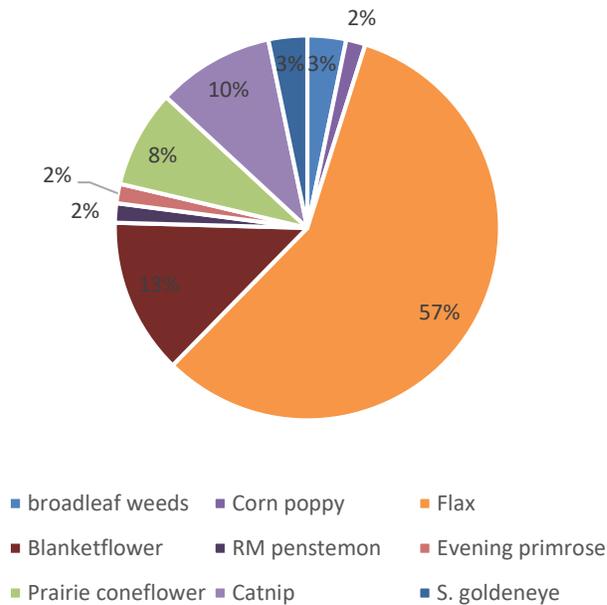
		29-May	16-Jun	23-Jun	9-Jul	18-Jul	28-Jul	12-Aug	26-Aug	17-Sep
Corn poppy	Ann.	Green	Pink	Green						
California poppy	Ann.	Green	Orange	Green	Green	Green	Green	Orange	Green	Green
Sweet alyssum	Ann.	Green	White	Green						
Cornflower	Ann.	Green	Green	Green	Blue	Blue	Green	Green	Green	Green
Showy goldeneye	Per.	Green	Yellow							
Blanketflower	Per.	Green	Green	Green	Red	Red	Red	Red	Red	Red
Blue flax	Per.	Green	Green	Green	Green	Green	Green	Blue	Blue	Green
Prairie coneflower	Per.	Green	Green	Green	Green	Yellow	Yellow	Yellow	Green	Yellow
Green thread	Ann.	Green								

In 2015 the Applewood Mix showed a considerable amount of bare ground which made up 17% of the total cover. Broadleaf weeds created less of the cover than in other mixes at 20%, but weedy grasses were present at higher rates composing 8% of the total cover. Perennial flax and blanketflower made up the majority of the target species cover with 28% and 19% cover respectively. Other target species had lower presence. Corn poppy, Shasta daisy, and prairie coneflower all had percent cover below 5%.

Applewood Western Mix, 2015



Applewood Western Mix, 2017



Broadleaf weeds decreased in cover in the Applewood Western mix from 20 to 4%. Bare ground and weedy grasses likewise decreased and were not detected in the 2017 evaluation. Flax cover increased two-fold from 28 to 57%. Other perennials such as prairie coneflower and showy goldeneye also had modest increases.

Eden Brothers Western Wildflower Mix

The Western Wildflower Mix from Eden Brothers contains 24 species, 12 annuals, 1 biennial and 11 perennials (Table 12). Flowering during the first season was similar to other mixes containing corn poppy, cornflower, plains coreopsis and wild cosmos. Surprisingly, we did not observe any flowering from California poppy during the 2013 season in the Eden Brothers mix.

Table 12. Eden Brothers Western Wildflower Mix flowering color and duration 2013. Colored bars indicate bloom color. Green indicates no flowers in bloom.

		8-Aug	19-Aug	4-Sep	10-Sep	20-Sep	27-Sep
Corn poppy	Ann.	Purple				Green	
Cornflower	Ann.	Blue					
Plains coreopsis	Ann.	Yellow					
Wild cosmos	Ann.	Pink					
Lemon mint	Ann.	Green		Grey	Green		
Prairie coneflower	Per.	Green		Yellow	Green		
Black-eyed Susan	Per.	Yellow					
Baby's breath	Ann.	Green		White		Green	
Indian blanket	Ann.	Green		Red		Green	
Sulphur cosmos	Ann.	Green		Yellow		Green	



Eden Brothers Western Wildflower Mix, July 22, 2013



Eden Brothers Western Wildflower Mix, August 29, 2013

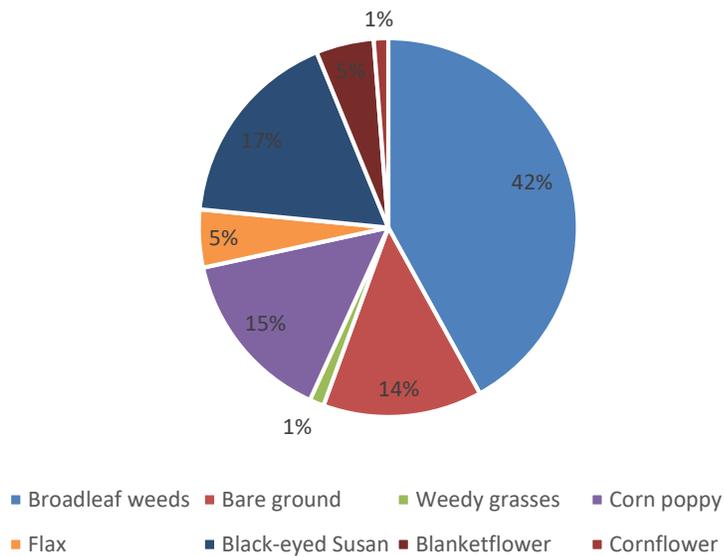
Ten species in total flowered during 2014 in the Eden Brothers Western Wildflower mix. Four annuals and 6 perennials were represented. The successful species were similar to those of other mixes including prairie coneflower, corn poppy, black eyed Susan, Rocky Mountain penstemon and flax.

Table 13. Eden Brothers Western Wildflower Mix flowering color and duration 2014. Colored bars indicate bloom color. Green indicates no flowers in bloom.

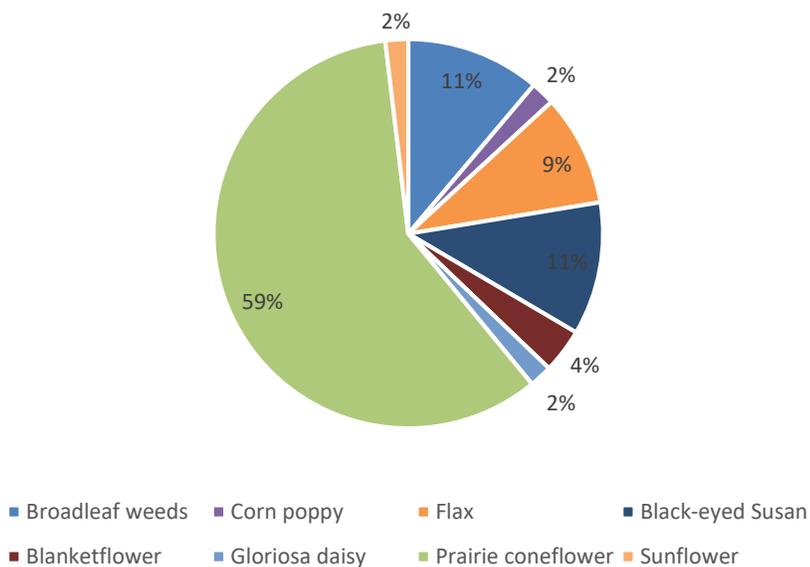
		29-May	16-Jun	23-Jun	9-Jul	18-Jul	28-Jul	12-Aug	26-Aug	17-Sep
Corn poppy	Ann.	Green	Pink	Green						
Cornflower	Ann.	Green	Blue	Green						
California poppy	Ann.	Green	Green	Orange	Green	Green	Green	Green	Green	Green
Plains coreopsis	Ann.	Green	Green	Green	Yellow	Yellow	Yellow	Yellow	Yellow	Green
Prairie coneflower	Per.	Green	Green	Green	Yellow	Yellow	Yellow	Yellow	Yellow	Green
Black-eyed Susan	Per.	Green	Green	Green	Yellow	Yellow	Yellow	Yellow	Yellow	Green
Blanket flower	Per.	Green	Green	Red	Green	Green	Red	Red	Red	Green
Blue flax	Per.	Green	Blue	Blue	Green	Green	Green	Green	Green	Green
Rocky Mtn penstemon	Per.	Green								
Gloriosa daisy	Per.	Green	Green	Green	Green	Yellow	Green	Green	Yellow	Green

Broadleaf weeds created 42% of the cover in the Eden Brothers Mix. Introduced species, cornflower and corn poppy both ranked high among the target species with 17% and 15% cover respectively. Perennial flax and blanketflower made up 5% each of the cover, followed by prairie coneflower at 1%.

Eden Brothers Western Wildflower, 2015



Eden Brothers Western Wildflower, 2017



Broadleaf weeds in the Eden Brothers Western Wildflower mix decreased by 75% in 2017 going from 42% cover to 11% cover. Prairie coneflower cover increased significantly, having not been detected in 2015 to 59% cover in 2017.

CONCLUSION

Of the total 62 species included in the trial, 30 flowered in the first growing season. The vast majority (22 of 30) were annuals, the remainder being 2 biennials and 6 perennials. Flowering was not observed until early August, approximately 11 weeks after planting. Most species had

long sustained flowers due to supplemental irrigation and late summer rains. The first frost of the season came on September 19, and all plants had ceased flowering by October 17.

The inclusion of annuals is a good way to get blooms during the first growing season. It is especially important to include annuals in post-fire rehabilitation seed mixtures to provide food for native pollinators that have relatively short foraging ranges and might not be able to reach undisturbed plant communities (Cane 2008). However, there are not many annuals available for pollinator mixes that are truly native to the Intermountain and Rocky Mountain regions.

Insect visitation varied between plots due to species composition and density. Overall, corn poppy, California poppy, cornflower, plains coreopsis, and wild cosmos were very attractive to European honeybees. Tidy tips, prairie coneflower and blanketflower were heavily visited by native bees. Hunt's bumblebee was observed frequently visiting wild cosmos. Butterflies were observed on Indian blanket and blanketflower. All of the flowering species were observed being visited at least once by pollinators. In an informal survey conducted in 2018, Idaho Fish and Game biologists observed 5 species of native bumble bees visiting flowers within the trial.

Eleven of the 62 species planted are cited in the literature as having weedy tendencies (USDA NRCS 2013). Of these, cornflower, soapwort and Rocky Mountain bee flower have been listed as being weedy in western states (Whitson et al 1996). The others are primarily western species that express weedy behavior in the Midwest and eastern US. Rocky Mountain bee flower is native to the PMC service area where it can invade and spread into ditch banks and along roadsides where moisture accumulates. Cornflower and California poppy are a concern. These species are known to escape from "wildflower" seedings and spread; however, we did not observe this from our planting. Corn poppy did spread into adjacent areas but was not difficult to control.

In addition to inappropriate target species, wildflower mixes can also contain accidental inclusions of noxious weed seed. Seed used for commerce is not to have any prohibited noxious weeds listed in the state the seed is shipped to or used. However, restricted noxious weed seeds may be included as state seed law allows. The best way to know if noxious weed seed is in a mix is with an accurate purity test and seed tag.

A small number of plants evaluated in the trial have known or suspected toxic properties. Three species, yarrow, desert marigold, and soapwort have been shown to cause disease in sheep when consumed in large volumes (Burrows and Tyrl 2001). Yarrow and desert marigold are native and are commonly present in rangelands used for sheep grazing; however, these species should be avoided or used with caution in areas where they might pose a risk to livestock.

Weedy annual species were a significant problem throughout the plots during the early years of the study. Annual grasses can be significantly reduced by using grass selective herbicides; however, we were not able to remove them entirely with a single treatment of sethoxydim in the first season. By year 4, annual grasses were essentially absent from the entire planting, and those remaining were not seen as a problem.

Broadleaf weeds are extremely difficult to control in wildflower plantings, as herbicides used to treat broadleaf weeds will also affect many of the target species in the seed mixtures. Lambs quarters and shepherd's purse were common annual weeds in the plots during 2013, but these

decreased significantly in density in 2014 as the target species had become more competitive. Prickly lettuce however increased in density in 2014 and 2015, especially in those mixes that contained few competitive annual wildflower species. Over time however, due largely to the growth and spread of long-lived perennial species, broadleaf weeds decreased significantly by the fourth and fifth growing seasons. A small number of annual weeds like sowthistle, and prickly lettuce were present in low quantities. Perennial broadleaf weeds encountered included sweet clover, musk thistle, Canada thistle and field bindweed.

In order to prevent the establishment and spread of noxious weeds and other invasive plant species, one must be careful about what seeds are planted. The best way to do this is to use a custom seed mix. If a commercial wildflower mix is used, the mix selected should be appropriate to the region; native species are recommended when possible. Mixes including known invasive or aggressive species should be avoided. Seed mixes should be tested for purity and come with an accurate seed tag. Mixtures should also be clearly labeled with scientific names included, as confusion and uncertainty can arise from the use of common names. Following these steps will help ensure that only appropriate species are planted.

During the second season of our trial, perennial species made up the majority of the floral display. Black-eyed Susan, blanketflower, prairie coneflower, yarrow, blue flax, Rocky Mountain penstemon, and showy goldeneye had numerous flowers and lasted for much of the second season. Flowering began in late May and ended with freezing temperatures in mid-September. Other perennials such as fleabane daisy, and prairie aster had blossom periods limited to late summer. Twelve annual species, California poppy, corn poppy, corn flower, plains coreopsis, Siberian wallflower, tidytips, bird's eye, Green thread, deerhorn clarkia, Rocky Mountain bee flower, globe gilia, and sweet alyssum also returned in 2014. Several species in the various mixes showed no flowering in the first or second year of the trial.

In 2014 and 2015 there was evidence of volunteering of plants into adjacent plots and should be taken into account. Tidy tips and corn poppy had spread as much as 30 feet from their original location the previous year. Movement of species that were included in two adjacent plots was impossible to distinguish but is considered likely. Wind dispersal and seed shatter from spring mowing are the likely mechanisms for transfer.

Species frequencies shifted from large amounts of annuals in the establishment year to predominantly perennials in the latter growing seasons. Weed cover in all mixes was high, reaching 20 to 30% cover after four years with the most abundant weed being prickly lettuce. Broadleaf weeds can be very difficult to control in pollinator mixes and may need to be accepted as cost of doing business. Additionally, pollinator plantings may serve as weed seed sources that could contaminate nearby cropland and fields. However, despite heavy weed pressure, the pollinator plantings appeared to be functional at supporting diverse insects.

After 4 to 5 years, the mixes had narrowed down to a few dominant species. These species established well in our planting and were able to spread and flourish under the growing conditions at Aberdeen and should be considered for use in pollinator plantings in the Intermountain West in areas receiving 14 to 20 inches annual precipitation or in sites with minimal irrigation. These species include prairie coneflower, black-eyed Susan, Rocky Mountain penstemon, blanketflower, blue flax, annual sunflower, showy goldeneye, and yarrow. The non-

native annual cornflower, corn poppy and California poppy should also be considered for inclusion in pollinator plantings for their value as first-year pollen and nectar sources.

Use in NRCS Programs

Approximately two-thirds of the original species (39 of 62) flowered in 2013 or 2014 indicating at least moderate adaptation to 14 to 18-inch precipitation sites in southeastern Idaho. Those that did not flower add to the cost of the seed mix and may be being used at the exclusion of more appropriate species. Careful selection of adapted species can reduce the cost of seed mixes as maladapted species are avoided.

The NRCS funds or cost-shares approved pollinator plantings which meet agency specifications. These specifications include seed mixture composition percentages and the rate at which the seed is planted (lb/ac or seeds/ft). To accurately calculate seeding rates, one needs to know: % of each species in the mix by weight, purity of each species, germination or viability of each species and the average number of seeds/lb for each species (Tilley and St. John 2013). This information is commonly lacking in commercial seed mixtures. Of the six mixtures evaluated, only two included percentage information.

Using rough estimates for purity and viability we calculated approximate seeds/ft for the two mixtures where percentages of each species were available based on seeding 10 lbs bulk seed per acre. Based on our calculations, Applewood Seed Western Mix was seeded at approximately 128 seeds/ft and Outside Pride Western Wildflower Mix had approximately 93 seeds/ft. NRCS specifications stipulate a target seeding rate of 75 to 100 seeds/ft for broadcast seeding of small seeded species. These numbers suggest that the recommended rate of 10 lbs/ac closely aligns with NRCS broadcast seeding rates. Species component percentages must be available to determine whether or not seeding mixtures meet NRCS standards. Mixtures not providing percentages of species components should not be used for NRCS funded seedings.

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United States Department of Agriculture

Appendix. Mix and species information

Common Name	Scientific Name	Origin	Longevity	Eden Brothers	Applewood	Outside Pride	American	American	American
				Wildflower Mix	Seed Western Mix	Western Wildflower Mix	Meadows Native West	Meadows Dry Area Mix	Meadows Western Xeriscape Mix
				\$27/lb	\$26/lb	\$23/lb	\$60/lb	\$27/lb	\$40/lb
					% of mix	% of mix			
Yarrow	<i>Achillea millefolium</i>	N. Am.	Perennial					x	
Blue columbine	<i>Aquilegia coerulea</i>	IMW ¹ and RMW ²	Perennial	x			x		
Smooth aster	<i>Aster laevis</i>	Eastern US	Perennial				x		
Prairie aster	<i>Machaeranthera tanacetifolius</i>	Western US (not PNW ³)	biennial				x		x
Desert marigold	<i>Baileya multiradiata</i>	SW	Ann., bi, per.						x
Cornflower	<i>Centaurea cyanus</i>	N. Am.	annual	x	7.3	8.13		x	
Siberian wallflower	<i>Cheiranthus allionii</i>	Eurasia	Biennial	x		12.19		x	
Garland chrysanthemum	<i>Chrysanthemum coronarium</i>	Mediterranean	Annual					x	
Shasta daisy	<i>Chrysanthemum maximum</i>	Europe	Rhiz-perr.					x	
Deerhorn clarkia	<i>Clarkia pulchella</i>	PNW	Annual		0.92		x		x
Farewell to spring	<i>Clarkia unguiculata</i>	California	Annual		1.83	1.34			
Rocky Mountain bee flower	<i>Cleome serrulata</i>	N. Am (not SE)	Annual				x		
Lanceleaf coreopsis	<i>Coreopsis lanceolata</i>	N. Am (not IMW)	Perennial	x					
Plains coreopsis	<i>Coreopsis tinctoria</i>	N. Am (not IMW)	ann, bi, per	x	0.73	1.02	x	x	
Wild cosmos	<i>Cosmos bipinnatus</i>	Central Am.	Annual	x				x	
Sulphur cosmos	<i>Cosmos sulphureus</i>	Central am.	Annual	x				x	
Purple prairie clover	<i>Dalea purpurea</i>	Midwestern US	Perennial				x		
Sweet william	<i>Dianthus barbatus</i>	Eurasia	Biennial					x	
African daisy	<i>Dimorphotheca sinuata</i>	Africa	Annual					x	
Purple coneflower	<i>Echinacea purpurea</i>	Eastern US	Perennial	x					
Fleabane daisy	<i>Erigeron speciosus</i>	Western US	Perennial				x		
Common woolly sunflower	<i>Eriophyllum lanatum</i>	Western US	Perennial						x
California poppy	<i>Eschscholzia californica</i>	California	Annual	x	11	12.19		x	x

Appendix (cont.)				Eden Brothers Western Wildflower Mix	Applewood Seed Western Mix	Outside Pride Western Wildflower Mix	American Meadows Native West	American Meadows Dry Area Mix	American Meadows Western Xeriscape Mix
Common Name	Scientific Name	Origin	Longevity		% of mix	% of mix			
Blanketflower	<i>Gaillardia aristata</i>	Western US	Perennial	x	12.83	8.13	x	x	x
Indian blanket	<i>Gaillardia pulchella</i>	Eastern US	Annual		3.67	4.06	x	x	
Globe gilia	<i>Gilia capitata</i>	Western US	Annual		1.83	1.34	x		
Bird's eye	<i>Gilia tricolor</i>	California	Annual						x
Baby's breath	<i>Gypsophila elegans</i>	Eurasia	Annual	x				x	
Showy goldeneye	<i>Helioneris multiflora</i>	Western US (not PNW)	Perennial		1.21	0.81	x		
Candy tuft	<i>Iberis umbellata</i>	Mediterranean	Annual		11	16.25			
Tidy tips	<i>Layia platyglossa</i>	CA, AZ, UT	Annual						x
Baby snapdragon	<i>Linaria maroccana</i>	Morocco	Annual					x	
Scarlet flax	<i>Linum grandiflorum</i>	Algeria	Annual	x					
Blue flax	<i>Linum perenne</i>	Europe	Perennial	x	7.33	12.19	x	x	x
Sweet alyssum	<i>Lobularia maritima</i>	Mediterranean	Annual					x	
Birdsfoot trefoil	<i>Lotus corniculatus</i>	Eurasia	Perennial					x	
Perennial lupine	<i>Lupinus perennis</i>	Eastern US	Perennial	x	14.65	16.25			
Russel lupine	<i>Lupinus polyphyllus</i>	Western US	Perennial	x					
Arroyo lupine	<i>Lupinus succulentus</i>	California	Annual						x
Blazingstar	<i>Mentzelia lindleyi</i>	California	Annual						x
Lemon mint	<i>Monarda citriodora</i>	Southern US	Annual	x					
Five spot	<i>Nemophila maculata</i>	California	Annual	x					x
Baby blue-eyes	<i>Nemophila menziesii</i>	California	Annual						x
White evening primrose	<i>Oenothera caespitosa</i>	Western US	Perennial				x		
Evening primrose	<i>Oenothera lamarckiana</i>	Europe	biennial					x	
Dwarf eve primrose	<i>Oenothera missouriensis</i>	Southern US	Perennial		1.83				
Pale eve primrose	<i>Oenothera pallida</i>	Western US	biennial		1.83				x

Appendix (cont.)				Eden Brothers Western Wildflower Mix	Applewood Seed Western Mix % of mix	Outside Pride Western Wildflower Mix % of mix	American Meadows Native West	American Meadows Dry Area Mix	American Meadows Western Xeriscape Mix
Common Name	Scientific Name	Origin	Longevity						
Corn poppy	<i>Papaver rhoeas</i>	Europe	Annual	x	7.33	2.03		x	
Palmer penstemon	<i>Penstemon palmeri</i>	SW	Perennial		1.83				x
Rocky Mountain penstemon	<i>Penstemon strictus</i>	Rocky Mtns	Perennial	x	3.67	2.03	x	x	x
California bluebell	<i>Phacelia campanularia</i>	California	Annual						x
Drummond phlox	<i>Phlox drummondii</i>	Eastern US	Annual	x					
Prairie coneflower	<i>Ratibida columnaris</i>	Midwestern US	Perennial	x	1.84	2.03	x	x	x
Gloriosa daisy	<i>Rudbeckia gloriosa</i>	Eastern US	Perennial	x				x	
Black-eyed susan	<i>Rudbeckia hirta</i>	N. am (not SW)	ann, bi, per	x			x	x	
Soapwort	<i>Saponaria officinalis</i>	Eurasia	Perennial						x
Ccatchfly	<i>Silene armeria</i>	Europe	Annual					x	
Gooseberryleaf globemallow	<i>Sphaeralcea grossulariifolia</i>	Western US	Perennial						x
Greenthread	<i>Thelesperma filifolium</i>	Midwestern US	Annual		7.33				x
Creeping thyme	<i>Thymus praecox</i>	Eurasia	Perennial						x
Strawberry clover	<i>Trifolium fragiferum</i>	Eurasia	Perennial						x
Johnny jump-up	<i>Viola tricolor</i>	Eurasia	Annual						x

¹ Intermountain West

² Rocky Mountain West

³ Pacific Northwest

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