

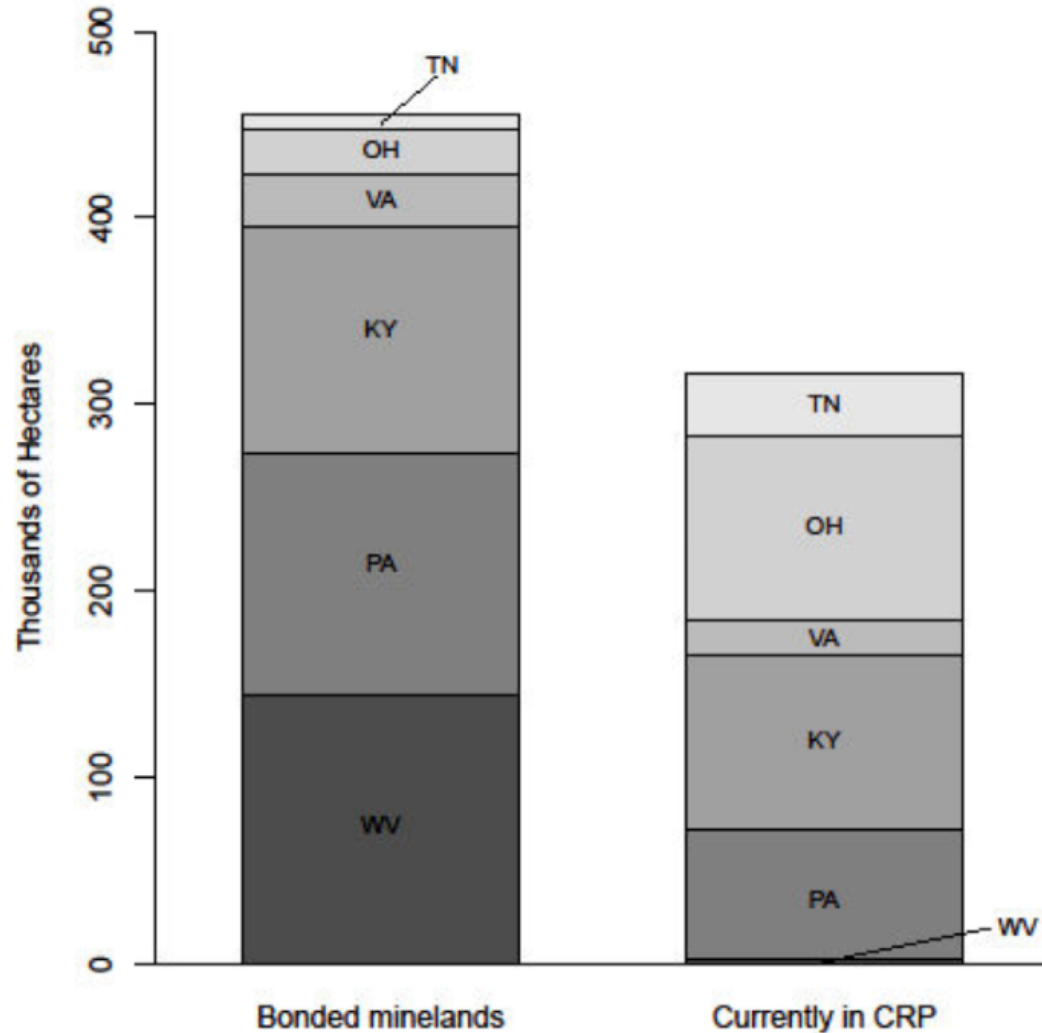
Successful Reclamation of Kentucky Minelands Using Wildlife-Friendly Mixes



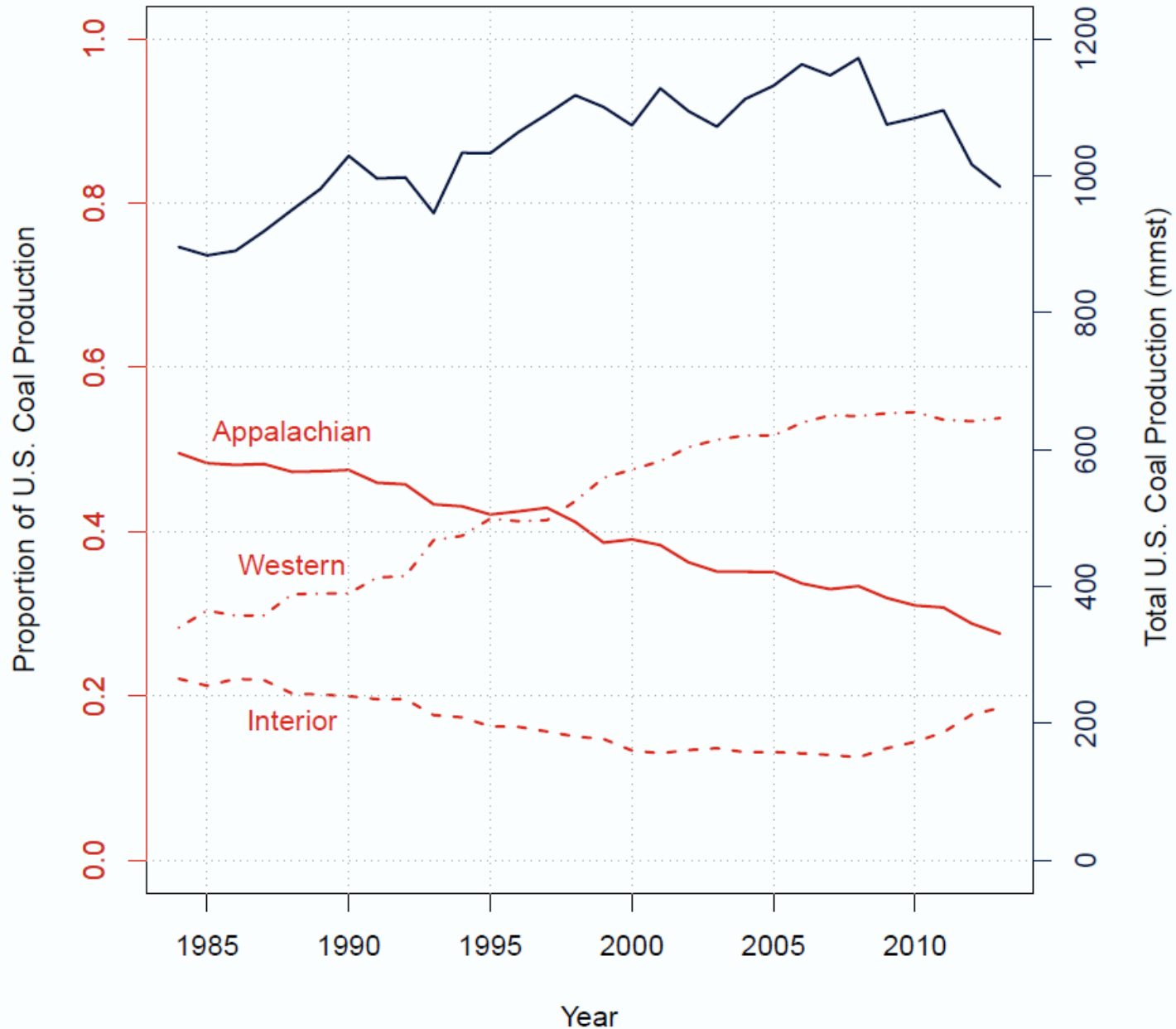
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Conservation Potential of Bonded Minelands



U.S. Coal Production 1984-2013



Background



How Do We Optimize Post-Mining Landscapes to Benefit Wildlife?

Photo: Ben Robinson





Photo: Jacob Stewart

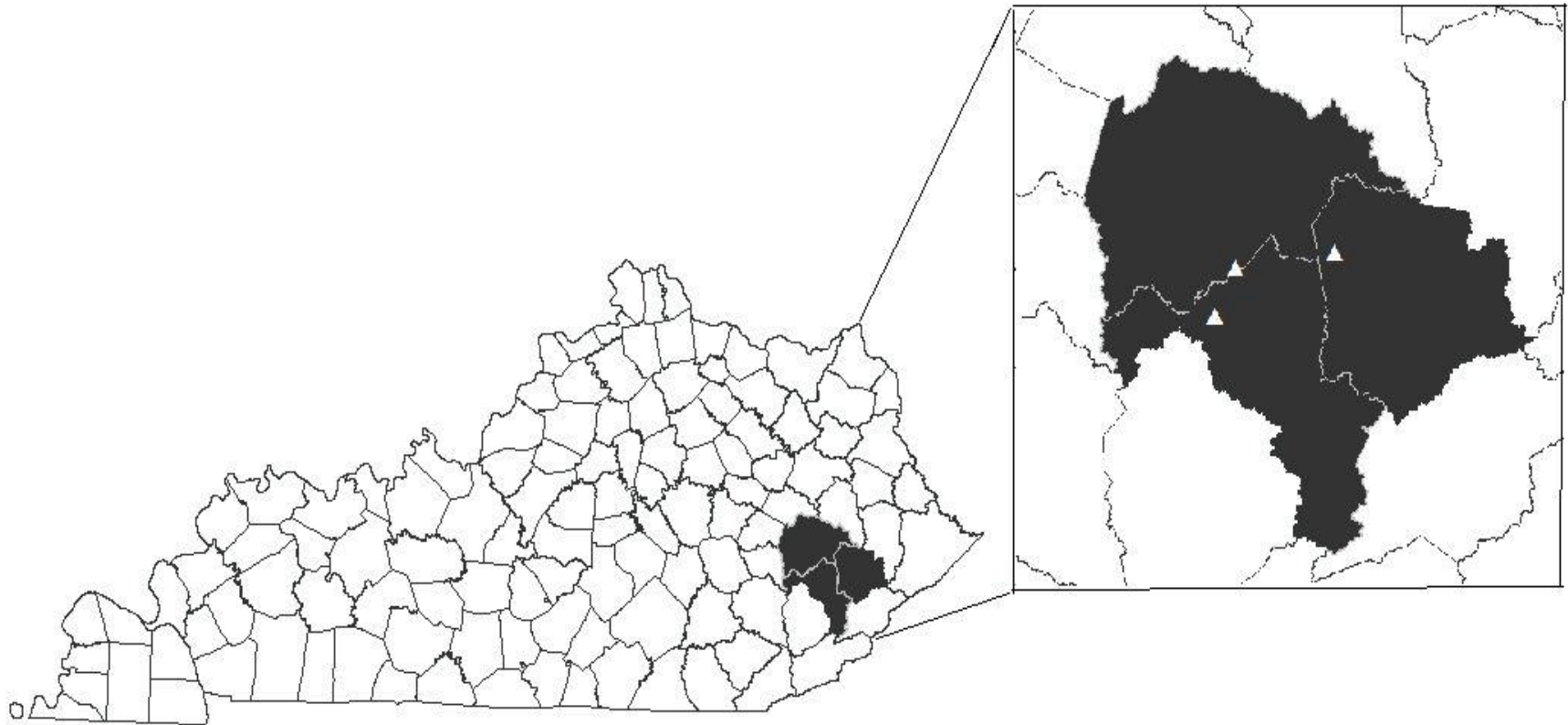
Study Objectives

Can we meet SMCRA standards (80% vegetative cover) using hydro-seeded wildlife-friendly mixes ?

Does slope position affect success of wildlife-friendly reclamation plantings?

Which wildlife-friendly plants are successful initially and after five growing seasons?

Methods: Study Area



Methods: Seed Mixes



Photo: Ben Robinson

	Pounds per Acre	2009 Cost per Acre	# Species	Composition Snapshot
Typical	155	\$209	11	Wheat, Annual Rye, Red Clover, Timothy Grass
Wildlife-Friendly	40	\$245	23	Big Bluestem, Illinois Bundleflower, Foxtail
Hybrid	65	\$276	27	Wheat, Big Bluestem, Timothy Grass, Annual Rye, Indian Grass

Methods: Vegetation Plots

- Transects stratified by slope
- 5% of each treatment block sampled
- Estimated % cover and identified plants to species within 1 m² plots

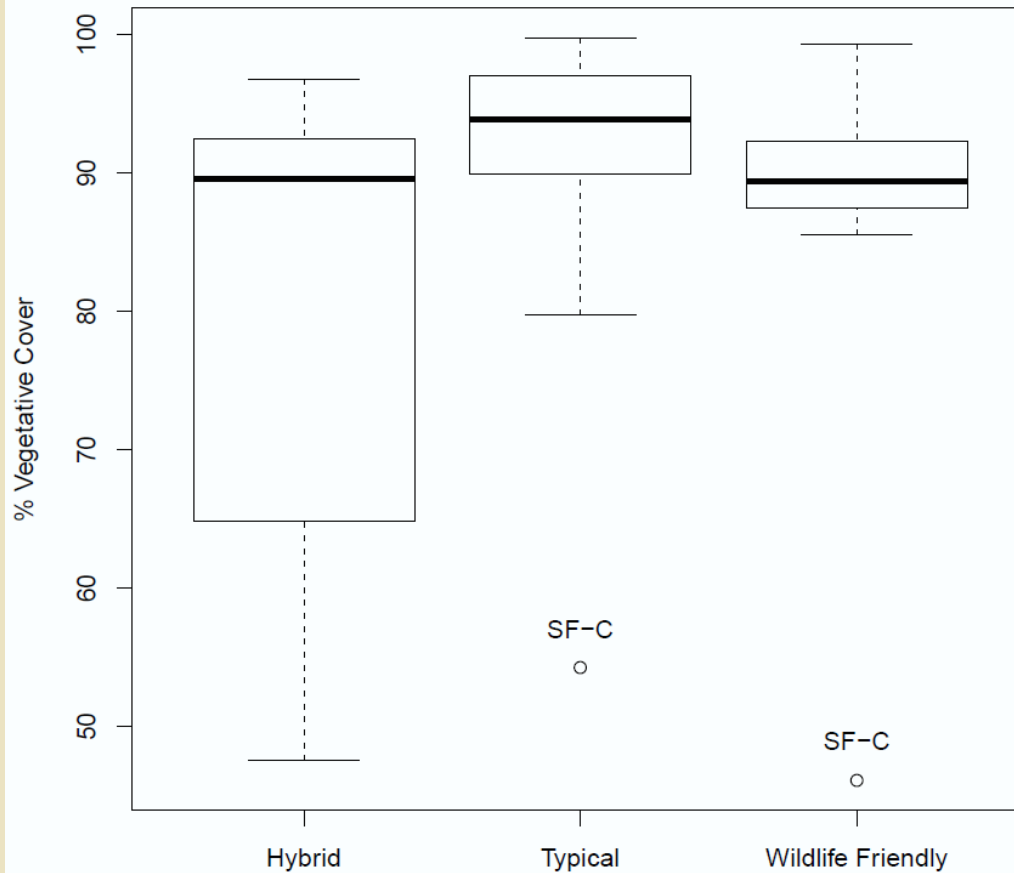


Methods: Analysis

- Compared vegetative parameters among Typical, Hybrid, and Wildlife-Friendly Plots
- Developed a Species Success Index: Year 1 and Year 5
- Conducted a Distance-based Redundancy Analysis

Results: Vegetative Cover

Percent Vegetative Cover-5 Growing Seasons



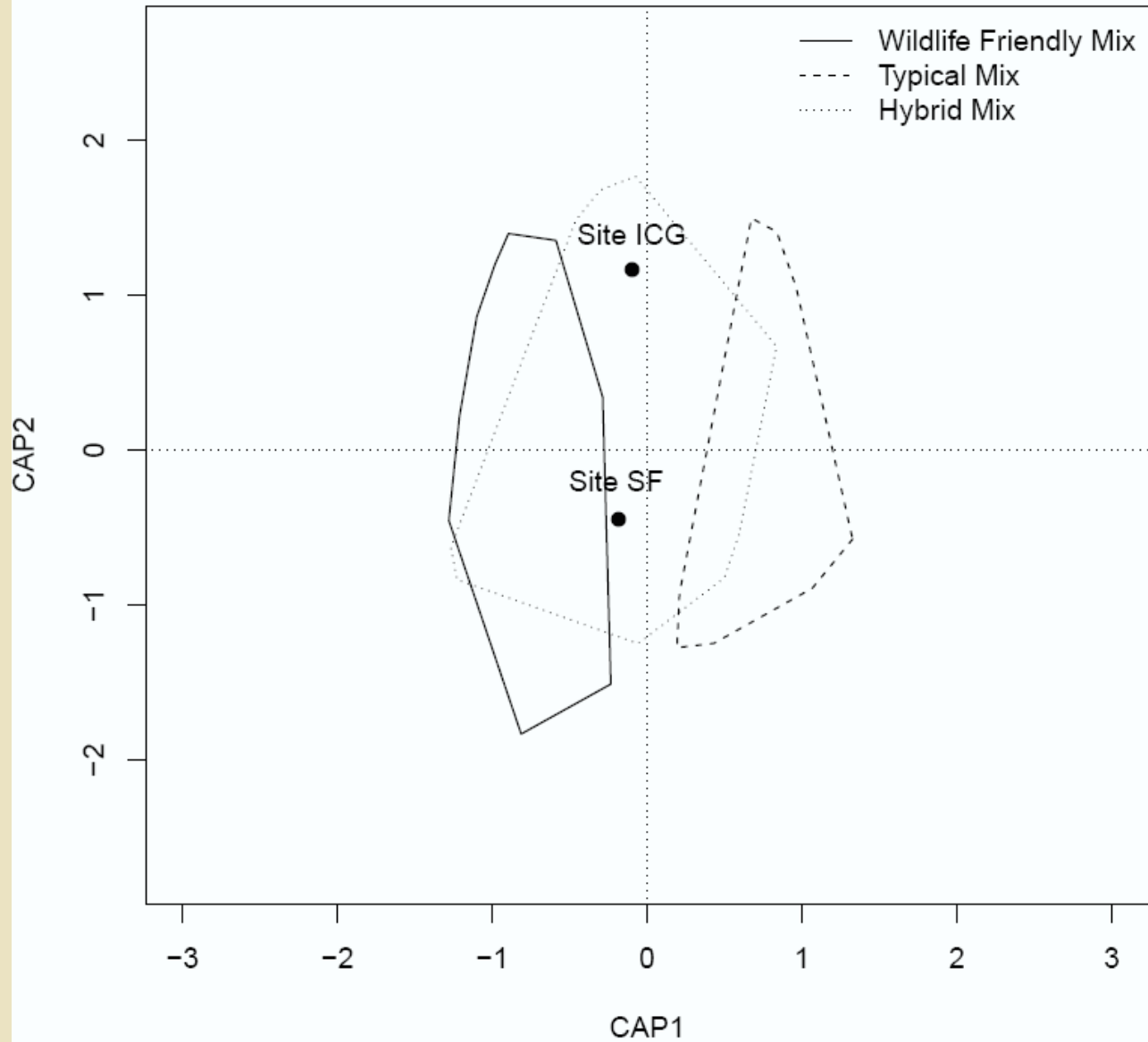
Seed Mix	Vegetative Cover (95% CI)
Typical	88.78% (79.44, 98.11)
Wildlife-Friendly	86.07% (75.94, 96.20)
Hybrid	78.93% (66.99, 90.88)

Results: Success Index > 1.0

1st Growing Season	5th Growing Season	1st and 5th Growing Season
Foxtail	Beggarticks	Korean Lespedeza
Birdsfoot Trefoil	Black-eyed Susan	Side Oats Grama
Korean Lespedeza	Gray-headed Coneflower	
Sideoats Grama	Indian Grass	
	Korean Clover	
	Little Bluestem	
	Maximillian Sunflower	
	Side Oats Grama	
	Switchgrass	



Results: Redundancy Analysis



Management Implications



Photo: John Brunjes



Photo: John Yeiser



Photo: Ben Robinson

Wildlife-friendly mixes are higher in cost: How do we facilitate implementation?



Acknowledgements

- Pittman–Robertson
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A comparison of coal mine reclamation seed mixes in Kentucky: implications for grassland establishment in Appalachia

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With approximately 450,000 hectares of mine land pending reclamation, surface coal mines present an opportunity for large-scale grassland establishment to benefit wildlife. Herein, an alternative reclamation technique is presented that encourages a transition from typical reclamation to wildlife-friendly reclamation. Efficacy of typical, wildlife-friendly and hybrid seed mixes was compared and results indicate that wildlife-friendly mixes met vegetative cover requirements for reclamation in Kentucky. Results demonstrate that alternative methods to typical reclamation have potential to establish large areas of grassland habitat in Appalachian coal regions. Partnerships among mining companies, oversight entities and resource managers are needed to facilitate a transition to wildlife-friendly reclamation.

Keywords: Appalachia; coal mining; grasslands; Kentucky; reclamation; wildlife

Questions?



Methods: Seed Mixes

Typical Mine Reclamation Mixture								
Species	lbs per ac	%	seeds per lb	seeds per ac	seeds per ft	seeds per in	\$ per lb	\$ per ac
<i>Grass</i>								
Red Top	4	2.58%	5,000,000	20,000,000	459	3.19	\$5.95	\$23.80
Timothy	20	12.90%	1,100,000	17,600,000	404	2.81	\$1.08	\$21.60
Orchard grass	20	12.90%	650,000	11,050,000	254	1.76	\$2.52	\$50.40
Perennial Ryegrass	20	12.90%	280,000	5,600,000	129	0.89	\$1.02	\$20.40
Annual Rye	22	14.19%	200,000	4,400,000	101	0.70	\$0.50	\$11.00
Wheat	29	18.71%	18,000	522,000	12	0.08	\$0.30	\$8.70
Total	115	74.19%		59,172,000	1,358	9.43		\$135.90
<i>Forbs</i>								
Birds foot Trefoil	7	4.52%	375,000	2,625,000	60	0.42	\$3.50	\$24.50
Alfalfa	3	1.94%	199,000	597,000	14	0.10	\$1.76	\$5.28
Yellow Sweet Clover	6	3.87%	260,000	1,560,000	36	0.25	\$1.16	\$6.96
Alsike Clover	9	5.81%	700,000	6,300,000	145	1.00	\$1.15	\$10.35
Red Clover	15	9.68%	275,000	4,125,000	95	0.66	\$1.75	\$26.25
Total	40	25.81%		15,207,000	349	2.42		\$73.34
	<u>155</u>	<u>100.00%</u>		<u>74,379,000</u>	<u>1,708</u>	<u>11.86</u>		<u>\$209.24</u>

Methods: Seed Mixes

Wildlife Friendly Mixture								
Species	lbs in PLS/ac	%	seeds per lb	seeds per ac	seeds per ft	seeds per in	\$ per lb	\$ per ac
<i>Native Warm Season Grass</i>								
Switchgrass (Cave in Rock)	1.4	3.53%	389,000	544,600	12.50	0.087	\$5.00	\$7.00
Indian grass (Osage)	2.67	6.74%	175,000	467,250	10.73	0.074	\$7.25	\$19.36
Big Bluestem (Kaw)	3.35	8.45%	165,000	552,750	12.69	0.088	\$9.00	\$30.15
Sideoats Grama	1	2.52%	91,000	91,000	2.09	0.015	\$10.25	\$10.25
Little Bluestem	0.8	2.02%	260,000	208,000	4.78	0.033	\$9.00	\$7.20
Total	9	23.26%		1,863,600	42.78	0.297		\$73.96
<i>Cool Season Grass</i>								
Virginia Wild Rye	1.5	3.78%	96,000	144,000	3.31	0.023	\$7.95	\$11.93
Canada Wild Rye	1.5	3.78%	115,000	172,500	3.96	0.028	\$6.75	\$10.13
Total	3	7.57%		316,500	7.27	0.050		\$22.05
<i>Annual Grass Cover</i>								
Brown-top millet	5	12.61%	142000	710,000	16.30	0.113	\$0.48	\$2.40
Annual Rye	5	12.61%	200000	1,000,000	22.96	0.159	\$0.50	\$2.50
Foxtail (Setaria spp.)	5	12.61%	220000	1,100,000	25.25	0.175	\$0.45	\$2.25
Total	15	37.84%		2,810,000	64.51	0.448		\$7.15
<i>Forbs</i>								
Partridge Pea	3	7.57%	50,000	150,000	3.44	0.024	\$9.25	\$27.75
Illinois Bundleflower	3.3	8.32%	60,000	198,000	4.55	0.032	\$12.00	\$39.60
Korean Lespedeza	2	5.05%	238000	476,000	10.93	0.076	\$0.98	\$1.96
Birds foot trefoil	2	5.05%	375,000	750,000	17.22	0.120	\$3.50	\$7.00
Beggar Ticks (Bidens spp.)	0.36	0.91%	88,000	31,680	0.73	0.005	\$13.50	\$4.86
Purple Coneflower	0.24	0.61%	115,500	27,720	0.64	0.004	\$42.00	\$10.08
Grey-headed Coneflower	0.24	0.61%	625,000	150,000	3.44	0.024	\$36.25	\$8.70
Black-eyed Susan's	0.08	0.20%	1,450,000	116,000	2.66	0.018	\$23.25	\$1.86
Maximilian Sunflower	0.24	0.61%	150,000	36,000	0.83	0.006	\$21.00	\$5.04
Lance-leaved coreopsis	0.24	0.61%	210,000	50,400	1.16	0.008	\$14.00	\$3.36
Plains coreopsis	0.24	0.61%	1,650,000	396,000	9.09	0.063	\$20.00	\$4.80
New England Aster	0.24	0.61%	1,300,000	312,000	7.16	0.050	\$100.00	\$24.00
Purple Prairie Clover	0.24	0.61%	290,000	69,600	1.60	0.011	\$12.00	\$2.88
Total	12.42	31.33%		2,763,400	63.44	0.441		\$141.89
	39.6	100.00%		7,753,500	178.00	1.236		\$245.05

Methods: Seed Mixes

Hybrid Mixture								
Species	lbs in PLS/Acre	%	seeds per lb	seeds per ac	seeds per ft	seeds per in	\$ per lb	\$ per ac
<u>Native Warm Season Grass</u>								
Switchgrass (Cave in Rock)	1.19	1.83%	389,000	462,910	10.63	0.074	\$5.00	\$5.95
Indian grass (Osage)	1.75	2.69%	175,000	306,250	7.03	0.049	\$7.25	\$12.69
Big Bluestem (Kaw)	1.91	2.94%	165,000	315,150	7.23	0.050	\$9.00	\$17.19
Sideoats Grama	0.8	1.23%	91,000	72,800	1.67	0.012	\$10.25	\$8.20
Little Bluestem	0.8	1.23%	260,000	208,000	4.78	0.033	\$9.00	\$7.20
Total	6	9.92%		1,365,110	31.34	0.218		\$51.23
<u>Cool Season Grass</u>								
Red Top	1.3	2.00%	5,000,000	6,500,000	149.22	1.036	\$5.95	\$7.74
Timothy	6.67	10.26%	1,100,000	7,337,000	168.43	1.170	\$1.08	\$7.20
Orchard grass	6.67	10.26%	650,000	4,335,500	99.53	0.691	\$2.52	\$16.81
Perennial Ryegrass	6.67	10.26%	280,000	1,867,600	42.87	0.298	\$1.02	\$6.80
Total	21.31	32.78%		20,040,100	460.06	3.195		\$38.55
<u>Annual Grass Cover</u>								
Annual Rye	7.33	11.28%	200,000	1,466,000	33.65	0.234	\$0.50	\$3.67
Wheat	9.6	14.77%	18,000	172,800	3.97	0.028	\$0.30	\$2.88
Total	16.93	26.04%		1,638,800	37.62	0.261		\$6.55
<u>Forbs</u>								
Partridge Pea	1.59	2.45%	50,000	79,500	1.83	0.013	\$9.25	\$14.71
Illinois Bundleflower	1.59	2.45%	60,000	95,400	2.19	0.015	\$12.00	\$19.08
Birds foot Trefoil	2.3	3.54%	375,000	862,500	19.80	0.138	\$3.50	\$1.12
Beggar Ticks (Bidens spp.)	0.32	0.49%	88,000	28,160	0.65	0.004	\$13.50	\$6.48
Purple Coneflower	0.48	0.74%	115,500	55,440	1.27	0.009	\$42.00	\$20.16
Grey-headed Coneflower	0.48	0.74%	625,000	300,000	6.89	0.048	\$36.25	\$5.80
Black-eyed Susan's	0.16	0.25%	1,450,000	232,000	5.33	0.037	\$23.25	\$11.16
Maximilian Sunflower	0.48	0.74%	150,000	72,000	1.65	0.011	\$21.00	\$10.08
Lance-leaved coreopsis	0.48	0.74%	210,000	100,800	2.31	0.016	\$14.00	\$6.72
Plains coreopsis	0.48	0.74%	1,650,000	792,000	18.18	0.126	\$20.00	\$9.60
New England Aster	0.48	0.74%	1,300,000	624,000	14.33	0.099	\$100.00	\$48.00
Purple Prairie Clover	0.48	0.74%	290,000	139,200	3.20	0.022	\$12.00	\$5.76
Alfalfa	1	1.54%	199,000	199,000	4.57	0.032	\$1.76	\$3.52
Yellow Sweet Clover	2	3.08%	260,000	520,000	11.94	0.083	\$1.16	\$3.48
Alsike Clover	3	4.61%	700,000	2,100,000	48.21	0.335	\$1.15	\$5.75
Red Clover	5	7.69%	275,000	1,375,000	31.57	0.219	\$1.75	\$8.75
Total	20.32	31.26%		7,575,000	173.90	1.208		\$180.17
	65.0	100.00%		30,619,010	702.92	4.881		\$276.49

Plant Success Index- 5 Growing Seasons

